Technology transfer: Multi-purpose cows for milk, meat and traction in smallholder farming systems

Proceedings of an Expert Consultation held at ILRI, Addis Ababa, Ethiopia 11–14 September 1995

The Australian Centre for International Agricultural Research

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ILRI Proceedings

Technology Transfer: Multi-purpose Cows for Milk, Meat and Traction in Smallholder Farming Systems

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Executive summary

The papers and summaries of discussions contained in this volume are based on presentations made at the ILRI/FAO/ACIAR Expert Consultation on Technology Transfer: Multi-purpose Cows for Milk, Meat and Traction in Smallholder Farming Systems held on 11–14 September 1995 at the ILRI campus in Addis Ababa, Ethiopia. The aim of the consultation was to explore the practicality of extending technologies that enable the use of dairy cows for multiple purposes, to help develop a regional project to transfer these technologies to relevant countries in East and Central Africa.

The consultation brought together traction experts from East and Central Africa, and Asia. There were also participants from Australia. The African participants came from countries with high potential for dairying, including Ethiopia, Kenya, Malawi, Mozambique, Tanzania and Uganda. The Asian participants came from countries that already have experience with draft cows (cattle or buffalo)—from Bangladesh, China, India, Indonesia, The Philippines and Thailand. Two participants from the Food and Agriculture Organization of the United Nations (FAO)/Rome, and several ILRI (International Livestock Research Institute) scientists also attended.

The focus of the consultation was new technologies developed by the International Livestock Centre for Africa (ILCA, now ILRI) and the Ethiopian Institute for Agricultural Research (IAR) to help introduce multi-purpose crossbred cows into smallholder production systems, focusing on traction in addition to milk and meat production. Besides the draft technology itself, the recommendations of the ILRI/IAR collaborative research programme included complementary improved management and feeding systems—high-yielding sown forage crops such as oats and vetch, and the use of concentrates. Production of feeds which do not compete for crop land such as fodder trees, back yard forage production, and forage strips was also emphasised.

Dairying with crossbred cows has been shown to substantially increase milk production and farmer incomes if appropriate agroclimatic conditions and market access are present. The motivation for using these cows for draft purposes, as well as milk and meat production, is that smaller landholdings resulting from rapidly growing human populations make it difficult to feed working oxen (used for work for only a short period each year) and the follower herd needed to produce the oxen. If cows could be used for work, the size of the herd could be reduced resulting in lower feed requirements. Thus, stocking rates would be lower and a more sustainable production system producing higher incomes would be the result.

The purpose of the workshop was therefore threefold: 1) to share the results of the collaborative technology development project carried out by ILRI and IAR that generated technologies that enable the use of crossbred cows for multiple purposes; 2) to develop a funding proposal for a regional project to implement and study the transfer of these technologies in smallholder farming systems with high dairy potential in other African countries; and 3) to promote information sharing between traction experts in Africa and Asia (and to explore the possibility of extending the project eventually to Asia).

The expert consultation was part of FAO's TSS2 project which is meant to assist in the transfer of CGIAR-generated technologies with proven viability which are ready for diffusion. The project is motivated by the desire of FAO, as a cosponsor of the Consultative Group on International Agricultural Research (CGIAR), to use its resources to promote the transfer of

technology from CGIAR centres to farmers. Recognising that there are shelf-ready technologies in the international agricultural research centres (IARCs) which for various reasons have not been transferred to the end-users, the farmers, FAO developed the TSS2 programme to carry out and study the transfer of technology from IARCs to national agricultural research centres (NARS) and then to farmers. The criteria for selection were the availability of a proven technology, its potential impact, the needs and priorities of NARS, the regional importance of the problems addressed, whether the institutional framework exists for technology transfer, and how innovative the approach is. The FAO Animal Production and Health Division, which has the mandate to facilitate the development of smallholder animal agriculture, contacted ILRI to identify a technology ready for transfer.

Of the many proposals sent to FAO, the cow traction technologies were chosen for the TSS2 project. ILRI contacted its partners in the relevant countries and was assured of their interest and commitment to the regional undertaking. Having obtained this commitment, FAO staff travelled to ILRI for detailed technical discussions on the project. A project outline was developed and sent to the potential partner countries to enable them to draft country proposals for incorporation into the regional proposal. The ILRI partners in co-operating research and extension institutions were asked to select national experts to attend the expert consultation. These experts were each asked to prepare a draft country project proposal and were invited to prepare papers on the theme of cow traction in their respective countries.

These preparations culminated in the expert consultation which provided the opportunity for national inputs into the regional project proposal, as well as an opportunity to finalise the country proposals. The consultation took the form of a workshop with participants presenting papers followed by general discussion. It became clear from the presentations and discussions that the extension of the project into other countries in East and Central Africa was indeed a priority and feasible. The workshop participants from the co-operating research and extension institutions in each country revised their individual country funding proposals with the help of the ILRI and FAO organisers. The ILRI and FAO technical divisions also finalised the regional project proposal.

A secondary purpose of the workshop was to learn from the experiences of experts from countries in Asia where female buffalo and cow traction already exists and to discuss the possibility of extending the project to Asia, if additional funding can be found. This extension of the project into Asia was seen to be feasible and desirable and it was decided that at the appropriate time such an extension should be pursued. Among the important outputs of the workshop were the south–south ties established between research and development organisations in relevant African and Asian countries. For example, the consultation benefitted greatly from participation of the Australian Centre for International Research (ACIAR) Draught Animal Power (DAP) project. This project included multidisciplinary studies of draft animal power systems in South-East Asia and feeding and management strategies for production and draft power in large ruminants.

Following the workshop, FAO was given the responsibility of submitting the regional proposal to donors through its established channels. The proposal is now being revised, and will shortly be submitted to the United Nations Development Programme (UNDP), the International Fund for Agricultural Development (IFAD), and other appropriate donors for their consideration.

The dairy–draft technology package developed for Ethiopia may need to be modified for use in other countries in East Africa. Important factors to be considered will include the conditions for adoption in the targeted farming systems (the degree to which land is constrained, the availability of feed resources, and market access and infrastructure) as well as the vision and skills of farmers. The country reports and the proposals have demonstrated how this technology, new to most countries in East Africa, could be useful in increasing the productivity of crop–livestock systems. For example, this technology could increase both milk production and animal traction use in densely-populated areas (Uganda and Malawi), increase availability of draft power in milk-producing, oxen-depleted areas (Tanzania) or help to overcome a lack of draft animals (Mozambique).

This proceedings is structured according to the sessions of the expert consultation, with the papers presented and a summary of the session discussions. Section 1 contains the welcoming addresses, the objectives and procedure of the consultation, and a short history of the TSS project. The papers in Section 2 describe the technologies and address their potential for adoption. Section 3 contains the country reports describing traction activities and potential in the African and Asian countries represented at the workshop. Section 4 contains a description of the UNDP project proposal format, including the specific requirements for objectives, outputs and activities, and the final country proposals for Ethiopia, Kenya, Malawi, Mozambique, Tanzania and Uganda. General discussions on project proposals which led to the preparation of the final proposal documents are also reported, as well as comments on the country project proposals by the Asian participants. The discussions, after a visit to the joint IAR/ILRI/MoA cow traction research project at Holetta follow, and lastly, the regional project proposal is attached.

Opening and overview

Welcome

R. von Kaufmann

Director, Donor and Board Secretariat
International Livestock Research Institute (ILRI), P.O. Box 5689, Addis Ababa, Ethiopia

On behalf of Dr Hank Fitzhugh, Director General, it is my privilege and pleasure to welcome you to ILRI—the International Livestock Research Institute.

I am sure that most of you will be aware that ILRI is a new institution. It was established by international agreement in Berne in September 1994 and only started operating in January this year. It has subsumed the assets and programmes of the former International Livestock Centre for Africa (ILCA) and International Laboratory for Research on Animal Diseases (ILRAD).

Even at the time that ILCA and ILRAD were founded, there were arguments in favour of a single institute that could take a holistic view and accommodate the linkages between animal health and productivity. Now, after 20 years of separate existence, they have finally been combined and we are able to create synergies out of the different strengths of the two former institutions. You, as experts in animal traction, will be well aware that work creates stresses on the animals, and that, to cope with this, the animals need to be given both good nutrition and good health care.

Another very important aspect of the establishment of ILRI is the adoption of a global, as opposed to a limited African, mandate. This enables ILRI to promote the exchange of knowledge and experience between scientists and production specialists from all countries that share common problems and objectives. This consultation is an excellent example of south–south collaboration. I would like to record ILRI's gratitude for the support given by FAO [Food and Agriculture Organization of the United Nations] and ACIAR [Australian Centre for International Agricultural Research] that has made this possible.

I have looked forward to this expert consultation for a long time, because it marks a very significant turning point in a research project that I remember with the greatest satisfaction from my time as co-ordinator of ILCA's Animal Traction Thrust. This research, which has been conducted by the Ethiopian Institute of Agricultural Research (IAR) and ILCA since 1989, bears all the hallmarks of the way we believe research for development should be carried out.

It was based on a very exciting hypothesis, 'that it would be possible to derive draft power, with substantial increases in smallholder productivity, through the replacement of work-oxen by dual purpose high-yielding crossbred dairy cows'. We believed that if this hypothesis proved to be true, the potential benefit for smallholders would be enormous.

However, testing that hypothesis would require very careful and detailed research, because while the concept is straightforward, it is extremely risky. Since there is limited feed available, smallholders typically cannot keep both oxen and draft cows. Thus, if the oxen are dispensed with and the work causes milk production to fall, or reduces fertility, the smallholders would not only lose their dairy income, they would also not be able to plant their crops.

The physiology of stress would have to be studied very carefully. Thus the research promised to be not just of enormous practical benefit, but also of great scientific interest. Even the process of collecting the physiological data was an exciting prospect. Research on draft animals cannot be done in digestion crates; the animals must be able to move about. A mobile set of instrumentation would have to be developed to record parameters such as heart beat rate, body temperature, oxygen consumption, power generated, speed of movement, hormone production etc. This would prove to be equipment that even researchers in human medicine might envy.

The research would have to start with an intensive on-station research phase. But to ensure that it would ultimately produce relevant technology, it should never be too far from the farmers. It was, therefore, very advantageous that this research could be carried out on IAR’s station at Holetta.

The collaboration with IAR fits well with ILRI’s belief in the advantages of collaborative research which exploits the comparative strengths of different partners to make the whole greater than the sum of the parts. This cow traction research programme demonstrates the advantages of such collaboration in a very clear way.

The instrumentation that had to be developed to record the physiological parameters certainly could not have been made at ILRI. It was necessary to involve an advanced specialist institution, in this case AFRC Engineering of the United Kingdom.

At the same time, the research had to be based on a very good understanding of the needs of the cattle and their owners. The speed with which the technology could be taken up has been enhanced immeasurably by the involvement of Ethiopian scientists, extension staff and farmers in every stage of the research.

The good progress of this research is due to the willingness of each partner institution to play its own role and depend on the others to fulfil theirs. Thus, for example, while the AFRC engineers played an absolutely crucial role, once the instruments were calibrated and validated they left the research to others.

IAR’s role has expanded as the research involved more on-farm work with the smallholders, and soon the technology should be handed over to the extension services for dissemination.

This is the way we believe research for development should be carried out.

ILRI’s involvement in this research has required conviction, because some observers have suggested that the cow traction might only be relevant to the highlands of Ethiopia. If that were true, ILRI would be in some difficulty because, as an international research centre, ILRI was established to carry out research of an ‘international public good nature’. That means it can only engage in research that is of importance to more than one country; and the more countries, the better. It is, therefore, very gratifying to see participants here from so many countries. This demonstrates international interest in the results of the research. It ensures great returns to the public money that has been invested. And ultimately, it will help spread the benefits to smallholders wherever animal traction is practised.

The participants in this expert consultation obviously share a common interest in draft animal technology. That hardly needs to be stressed. What does need to be stressed, and stressed repeatedly, is that each of us has a very strong vested interest in the success of the others. Just as the AFRC’s input has been justified by the use to which the instruments have been put, so too, we trust that ILRI’s contribution will be justified without ILRI being drawn away from its own role and mandate for international research.

If the technology is going to benefit the smallholder, as we all intend it should, then the national agricultural research systems (NARS) must take possession of it and carry out the research and extension necessary for it to be adopted in the local ecological and economic circumstances of the different countries. We look forward to seeing the proposals that the national scientists have brought with them in the expectation that the collection of experience and wisdom at this expert consultation will fashion them into projects which the FAO can propose to UNDP [United Nations Development Programme] and other donors for funding.

The FAO, as a cosponsor of the CGIAR [Consultative Group on International Agricultural Research], shares some responsibility for enabling the transfer of technology from CG centres to farmers. But more specifically, the FAO Division of Animal Production and Health has the mandate, and has accepted the responsibility, to facilitate the development of smallholder animal agriculture. And in this instance it can play a pivotal role in determining the speed with which this technology is adopted and, therefore, of its impact.

Without the commitment of the national scientists , extension workers and, most importantly the goodwill and sacrifice of the Ethiopian farmers, this research would not have been possible. I would like to end by repeating that we are aware that ILRI has been very fortunate in being able to collaborate with IAR staff. Through the General Manager, Dr Tadesse, I would like to recognise their vital contributions. I would also like to recognise the contribution of the World Food Programme and the Dairy Development Board and through Vice-Minister Sentayehu, I would like to thank the Dairy Development Board and all the staff of the Ministry of Agriculture that have supported the project. There are many other institutions that have contributed, such as the Addis Ababa University, but they are too many to name. However, they should be assured that their contributions are recorded with appreciation.

I commend the organisers for the tremendous effort they have put into this consultation and for getting you all here. I congratulate FAO for developing a programme to promote and study the transfer of technology from IARCs to NARS and so to farmers. I thank ACIAR for enabling Asian scientists to participate because they will certainly make very important contributions to the proceedings. I welcome each one of you individually and I hope that you will have a very successful consultation.

I now have special pleasure in handing over to Ato Sentayehu, Vice-Minister for Agriculture. On behalf of the Director General, Dr Hank Fitzhugh, I would like to express our appreciation for the support Ato Sentayehu has personally given ILRI and in particular for his vital support for the cow traction project. I know that I can also thank the Vice-Minister on behalf of the smallholders who have taken possession of heifers provided by the Ministry of Agriculture so that they could participate in this research.

It therefore gives me great pleasure to invite the Honourable Vice-Minister to open the proceedings. Mr Vice-Minister.

Welcome

Sentayehu Gebre Mariam

Vice-Minister, Ministry of Agriculture, Addis Ababa, Ethiopia

It is with great pleasure that I welcome you to the Expert Consultation on Technology Transfer: Multi-purpose Cows for Milk, Meat and Traction in Smallholder Farming Systems.

As you are well aware, the gravest problem many developing countries face today is the inability to produce adequate food to feed their populations. A significant proportion of their peoples are victims of malnutrition and meagre health services. In Ethiopia an estimated 65% of the population is believed to live under conditions of extreme poverty. About 64% of all Ethiopian children manifest cumulative effects of inadequate diet expressed by underweight and wasting. This is more severe in rural cash crop areas. The nutritional level of Ethiopians has been declining over the years as a result of the high rate of growth of the population at 3% [per annum] contrasted with the almost stagnant growth rate of the agricultural sector of the past years. This situation led to an increase in food imports partially financed from the scarce reserves of foreign exchange. Traditional and primitive agricultural practices have to give way to new and appropriate technology if Ethiopia and the other developing countries are to improve the welfare of their peoples, reduce their dependence on food aid and imports and be economically independent. Conducive policies are, however, decisive.

It is imperative that Third World countries optimise the use of their resources if they are to improve the lot of their peoples. But intensification of existing land, and putting additional land into production are the main options for food self-sufficiency. Food self-sufficiency has no alternative for developing agriculture-based economies. In Ethiopia as in many other developing countries livestock, especially large stock, are kept for specific purposes thereby necessitating the raising of different species. Ethiopia's estimated 6 million oxen are not used for anything more than the cultivation of 7 million hectares which is less than 15% of the arable land of the country. The 8.8 million cows in the country are kept to produce milk and as replacement stock. More than 30% of Ethiopian farmers do not own any oxen. Many more have only one ox. An additional 1 million draft animals on an equivalent amount of land would make up for the country's average annual deficit of 8 million quintals of food grain. Equines are used as pack animals for transport and sports. In all cases, however, there is clear evidence of underutilisation of livestock. This is in the face of the poor plane of nutrition of the stock, the rapidly declining source of feed as a result of encroachment of cultivation into grazing areas, and the inability of smallholders to manage large numbers of animals properly.

The multidisciplinary use of livestock for the non-mechanised, largely mixed crop–livestock system of the poor smallholders is the most probable option, at least until the commercialisation of peasant agriculture. The cow-traction initiative, to be widely adopted, should be able to improve the welfare of the smallholder. It should contribute to a higher level of nutrition and more importantly to an increased income. Tradition and age-old beliefs may create obstacles to the ideals of using cows for draft purposes. A lot of extension work has to be put into creating and raising awareness and to change some of the beliefs. More than anything, the sustainability of the technology deserves special attention. I am sure the experiences from the different countries to be delivered in this workshop will underline the need for sustainability of the intervention. I believe the workshop will establish a firm ground for the introduction of such a decisive initiative. Lastly, I wish you all an informative workshop and memorable stay, and a happy and prosperous New Year to my Ethiopian colleagues.

Opening address

B. Muller-Haye

Chief Research and Development Officer, Food and Agriculture Organization of the United Nations (FAO), Via Delle Terme Di Caracalla 00100, Rome, Italy

This year we celebrate FAO's 50th Anniversary on World Food Day (16 October). Ministers of many countries and their advisers will meet in Quebec City, Canada, where FAO [Food and Agriculture Organization of the United Nations] was founded in 1945.

As you can imagine this is a time of reflection. On one side, the Organization looks back and evaluates what has been achieved so far and, on the other, the enormous changes which are taking place in the world demand a faster moving United Nations system in order to overcome poverty and unrest. The specialised agencies of the system are *technically* prepared to help solve production problems, improve environmental conditions and enhance the role of rural women in the production process. As far as socio-economic aspects and infrastructural requirements are concerned these can only be solved through the political will of governments at the national level.

Unfortunately, the financial situation is worrying everybody. For example, FAO has to reduce its regular programme budget considerably for the next biennium (1996/97) and there are indications that the finally available funds will reach an unexpected low. These substantial reductions will affect all programmes, but most likely the organisation will respond to the crisis by closing down whole sections and activities.

The traditional financing agencies such as UNDP [United Nations Development Programme], IFAD [International Fund for Agricultural Development] and the African Development Bank also have serious problems as do many bilateral donors whose development funds have declined in real terms. FAO, by the way, is not a funding agency. It *executes* projects which are funded by others.

Why then do we sit here in this technically important consultation, bring in expertise from several Asian countries and want to elaborate an African regional project on the use of dairy cows for milk, meat and draft work if the financial future is dim? The good news is that the focus of this project is on smallholder farming systems which continue to receive support from potential donors and more so the component of technology generation, assessment and transfer.

The new Director General of FAO has declared technology development and transfer as one of his priorities and if this is linked to food security, he has wide support from member countries. This was also confirmed last week by FAO's Programme Committee.

In addition, the World Bank, regional banks and regional organisations are putting much more emphasis on the use of technologies than before. Bilateral organisations have always emphasised this.

I now take pleasure in welcoming you on behalf of FAO, co-sponsor of this consultation, and wish you much interesting discussion which will lead to a project document and proposal.

Objectives of the expert consultation

E. Zerbini

International Livestock Research Institute (ILRI), P.O. Box 5689, Addis Ababa, Ethiopia

The principal objective of the workshop was to develop a funding proposal to implement transfer of the IAR/ILRI multi-purpose crossbred cows technologies to eastern African smallholders. The workshop proposed a formal means of co-ordinating and linkage and transfer mechanisms needed to ensure the transfer of the technologies. Applying the proposed institutional arrangements and studying and evaluating the process of transferring the chosen technology would constitute the project for which funding will be sought with the assistance of the Food and Agriculture Organization of the United Nations (FAO).

The secondary purpose of the workshop was to learn from the experiences of experts from countries in Asia where buffalo and cow traction already exists and to discuss the possibility of extending the project to Asia, if additional funding could be found. For example the consultation benefitted greatly from the participation of Australian Centre for International Agricultural Research Draught Animal Power (ACIAR DAP) project leaders. This project included 'multidisciplinary studies of draft animal power systems in Southeast Asia and feeding and management strategies for production and draft power in large ruminants'. Some initial efforts at information sharing between Asian and International Livestock Research Institute (ILRI) traction experts began during the DAP project. However, these efforts were not continued, or formalised into institutionalised relations, and did not result in joint projects.

The occasion of the expert consultation was also used to set up mechanisms for information exchange and collaboration between scientists and development organisations involved in research and transfer of multi-purpose cattle and buffalo technologies in eastern Africa and Asia. This process will represent a further development of DAP collaborative programmes initiated by ACIAR and centres of the Consultative Group on International Agricultural Research (CGIAR) system.

At present in Ethiopia, the prospects for dairy development are very promising. IAR (Institute of Agricultural Research), has expressed its support of the programme to ensure the dissemination of the new IAR/ILRI technologies and to participate in the assessment of recommendations for the successful transfer of the technologies. The World Food Programme is providing financial help to IAR, the Ministry of Agriculture (MoA) and ILRI to carry out expanded on-farm trials of the crossbred cow traction technologies. The MoA acts as liaison with farmers to assess extension objectives and needs.

The impact of using crossbred cows for milk, meat and traction in eastern Africa is expected in high potential highlands regions, i.e. Ethiopia, Kenya, Madagascar, and the great lakes region — Malawi, Tanzania, Uganda.

Project history, its objectives and new developments in NARS/CGIAR relations

B. Muller-Haye

Chief Research and Development Officer, Food and Agriculture Organization of the United Nations (FAO), Via Delle Terme Di Caracalla 00100, Rome, Italy

Increases in agricultural productivity, production per unit land area and farm labour have been clearly linked to the generation and dissemination of appropriate new technologies. The successes of the Green Revolution speak for themselves.

Much of the increase in food production was due to the simple expansion of cultivated areas which now, as many FAO (Food and Agriculture Organization of the United Nations) studies show, has come to an end. With most land under production there is great demand on technologies to expand agricultural output per unit of land and obtain greater returns from the capital invested. The regional project being discussed here is a step in the right direction.

FAO has always been concerned with the identification and transfer of suitable technologies to developing countries and was instrumental in transferring the technologies which led to the Green Revolution. FAO assisted developing countries, mainly through huge projects, to apply those technologies and introduce the new high yielding varieties which were generated by the international agricultural research centres (IARCs) of the Consultative Group on International Agricultural Research (CGIAR).

To date, there are many technologies in the IARCs which for many reasons were not transferred to the end-users, the farmers.

In 1992 the Division for Global and Interregional Programmes of the United Nations Development Programme (UNDP), also a co-sponsor to the CGIAR as FAO is, and the former Research and Technology Development Division of FAO developed a project which would examine how some new, potentially important technologies developed by the IARCs could be identified and written up in concrete project proposals which would be presented to the donor community. Centres were invited to present proposals which would be pre-selected before the formulation process could start. The criteria for selection were:

- availability of a proven technology
- its potential impact
- needs and priorities of NARS (national agricultural research systems)
- regional importance of the problems addressed
- existing institutional framework
- innovative approach.

Of the many proposals, FAO and the centres selected one or two per centre. The centres then contacted their NARS partners to affirm their interest in and commitment to the regional undertaking. FAO staff then travelled to the IARCs for detailed technical discussions on the projects, and to prepare the project outlines and identify the major elements.

Table 1. *FAO/IARC Collaboration for Technology Transfer (GLO/92/T02).*

Technology:	Winter Chickpeas Promotion in West Asia and North Africa (WANA)
Developed by:	ICARDA
Expert Consult:	Aleppo, Syria, 1–5 November 1993
Project Document:	Prepared by Dr R.B. Singh. Forwarded to UNDP for funding in June 1994
Status:	Reply awaited from DDF
Others:	US$ 40,000 transferred to ICARDA and equally distributed to: Morocco, Syria, Tunisia and Turkey. RNEA allocated US$ 5,000 for the project.
Technology:	Rice/Pasture Production Systems for High Rainfall Savanna Ecosystems
Developed by:	CIAT, NARS and FAO
Expert Consult:	Cali, Colombia, 6–11 December 1993
Project Document:	Prepared by Dr R.B. Singh and Dr Kueneman, AGPC. Forwarded to UNDP for funding in July 1994 (funding support asked also from ILCA)
Status:	Reply awaited from DDF
Others:	Funds to CIAT, US$15,000, sent on 18 Augest 1994
Technology:	Eradication of Corn Downy Mildew of Maize in Africa
Developed by:	IITA, NARS and FAO
Expert Consult:	Ibadan, Nigeria, February 1994
Project Document:	Prepared by Dr R.B. Singh. Forwarded to UNDP for funding in December 1994
Status:	Reply awaited from DDF
Technology:	Insect Pest Management Technology for Rice in Amazonian Countries
Developed by:	CIAT, NARS and FAO
Expert Consult:	Cali, Colombia, 24–28 October 1994
Project Document:	The first draft has been prepared between CIAT, NARS and FAO
Status:	CIAT is finalising the project document. Dr Barbosa, AGPP, is following it up
Others:	US$ 15,000 allocated from FAO to organise the workshop
Technology	Crossbred Cows for Milk, Meat and Draft Work in Smallholder Farming Systems
Developed by:	ILRI, NARS and FAO
Expert Consult.:	Addis Ababa, Ethiopia, in September 1995
Project Document:	Circulated as draft to NARS
Status:	Preparations with AGAP and ILRI under way
Technology:	Striga and Alectra Control in Selected African Countries
Developed by:	IITA/ICRISAT, NARS and FAO
Expert Consult:	Due to take place in IITA on 3–7 April 1995
Project Document:	Under finalisation by Dr Lambrada, AGPP
Status:	Foreseen date of finalisation: end of July
Others:	Letter of Agreement signed by Dr L. Brader, Director, IITA on 15 June 1994 Money was allocated on 15 July 1994 (US$ 13,000)

Four out of the six projects elaborated will be executed in Africa (Table 1).

The next step was to invite countries to prepare papers on the theme chosen and select national experts in the co-operating countries and institutions. These preparations would culminate in an expert consultation which would give national inputs into the regional project and agree on a draft project proposal. The centres and FAO's technical divisions would finalise the project proposal and submit it thereafter through the established channels to donors.

A variety of technologies were chosen. The elaboration of the projects was demand-driven with the full collaboration of countries. FAO played a catalytic role; technical know-how was provided by the three co-operating partners, i.e. NARS, IARCs and FAO.

Improved NARS–CGIAR partnership

In this short outline I would like to inform you about a movement which gets much support from all sides and which has just taken off the ground.

I refer to an improved NARS–CGIAR partnership, particularly concerning priority-setting where NARS would like to play a more active role.

Most of us in this consultation work in the field of animal production, at the NARS and universities. But looking back to when I was working with my cows, buffaloes, pigs and horses, I find I was much satisfied with the job I was doing. Later I became interested in livestock research policies and strategies and now I am mainly concerned with global and regional policies.

Why do I reflect on this development? This is because I have learned over the years that so many things happen internationally which I am not aware of as an animal scientist. However, these things, visibly or invisibly, have a bearing on the research policy and orientation of a country, yet animal scientists still do their accustomed research without following the new trends and needs.

Developing countries want a bigger say in the research agenda of the CGIAR. For this reason several international agencies in co-operation with the IARCs, particularly ISNAR (International Service for National Agricultural Research), convened meetings and continue to facilitate consultations in order to strengthen the NARS–CGIAR partnership. The recommendations elaborated at these meetings are not only directed to the CGIAR, but often more so to governments in developing countries to give stronger support to research and technology development in their countries.

The impressive research undertaken by the CGIAR is, however, only a small part of the world-wide agricultural research going on where NARS in developing countries take the greatest share and financial contribution. This is still not enough if millions of people need to be fed today.

The following consultations and meetings took place or are planned as an ascending process for setting priorities of the CGIAR with due consideration of the participation of NARS.

1. An international consultation on the NARS vision of international agricultural research took place in December 1994 in Rome. It was convened by IFAD (International Fund for Agricultural Development) and supported by FAO.
2. A most important meeting at ministerial level was convened by the co-sponsors of the CGIAR in Lucerne in February 1995. This meeting requested the CG system to accelerate the process of systematically including the NARS of developing countries in setting and implementing the Group's research agenda.
3. Following this an action plan will be elaborated and agreed upon.
4. Regional meetings; Role of Regional Representatives to the CGIAR elected at FAO's Regional Conferences.

Discussion on Dr Muller-Haye's presentation

Zerbini: Dr Muller-Haye, could you tell us if this is part of a cycle of projects in which FAO is involved in the transfer of technologies developed by CGIAR centres and how FAO will proceed after the proposals are developed?

Muller-Haye: This was a TSS1 project to prepare project proposals. The ILRI proposal is the last project to be considered before TSS1 ends. How far it will continue with the individual projects depends on the funding but clearly our [FAO's] task finishes with the presentation of the project proposals. There are discussions with a number of people including the global and inter-regional divisions of UNDP to see if they have funds to assist in further work but we have indications that they don't.

Osuji: Dr Muller-Haye, what is the relationship between these initiatives you've described and the original initiative that is being put forward within the CG and TAC and so on?

Muller-Haye: The projects we are discussing are specifically technical projects. They are not reflected in the discussions of the regional initiatives put forward by the CG or TAC.

von Kaufmann: I think that is an important point that we should understand right at this point in the conference. What we're discussing is the development of projects for the implementation of DCTT (dairy cow traction technologies) adaptive research and extension. We're not discussing basic research programmes. They therefore don't need to be co-ordinated with the regional research programmes of the CG.

Muller-Haye: To add to this I should like to inform you that through FAO's regional conferences two regional representatives are elected every second year, or confirmed in their posts, who will represent the countries of their regions. Sometimes it is very difficult because they don't have the means to travel around and visit all the countries but wherever there is in international conference with agricultural research directors we try to bring these people there. These regional representatives are taking part in two conferences: international centers week in Washington every year and the midterm meeting of the CGIAR. These regional representatives are supposed to bring the views of the NARS into the CGIAR.

Mohammad-Saleem: I believe this consultation is taking place here in Ethiopia because recent advances have been made here in the use of cows for multiple tasks as a possible option for improving farm energy use efficiencies and for conserving natural resources. Ethiopia shares all the problems that East Africa has to grapple with. These are problems of high birth rate, rapid population growth, deforestation, land fragmentation and degradation, and productivity declines. But it is also in this country that livestock are tightly integrated into the farming systems. Oxen serve as a source of farm power working only 6–8 weeks in a whole year but they have to be kept in good condition throughout the year on the same feed base as the large herd that is maintained to replace them. Scientists from the Ethiopian Institute of Agricultural Research and also from ILRI who have been collaborating on the cow traction project have tested technologies on-station and on-farm. They are confident that cows can perform multiple tasks and the technologies they have developed can also be useful in other ecozones. This consultation provides an opportunity to share this experience and learn from others here who are doing similar work.

Development of cow traction technologies and implications for adoption in the East African highlands

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Introduction

Due to increasing population and livestock pressure on the land, farmers in developing countries may not be able to continue maintaining draft oxen specifically for work purposes. The use of dairy cows for traction could benefit total farm output and incomes through increased milk production, while making it unnecessary to feed draft oxen year-round and maintain a follower herd to supply replacement oxen (Gryseels and Goe 1984; Gryseels and Anderson 1985; Matthewman 1987; Barton 1991). Besides contributing to a better utilisation of scarce feed resources, using dairy cows for draft would allow males to be fattened and sold younger, and could also lead to greater security of replacements. More productive animals on-farm could result in a reduction of stocking rates and overgrazing, thus contributing to the establishment of a more productive and sustainable farming system.

The primary need for the working animal is to increase feed and metabolisable energy (ME) intakes to meet energy requirements for work and avoid deleterious body weight losses. This becomes more critical in working cows that require extra energy for lactation and reproduction, and where the main feed source is roughage.

A number of studies have reported no significant effect of work on feed intake in oxen (Lawrence 1985; Pearson et al 1988; Soller et al 1991) and buffalo cows (Bamualim and Ffoulkes 1988; Bakrie and Teleni 1991). Other studies indicate an increased feed intake in working buffalo cows (Ffoulkes 1986; Ffoulkes et al 1987) and dairy cows (Gemeda et al 1995). Furthermore, some authors have reported negative or no effect of work on digestion in buffalo and cattle, depending on the diet fed (Weston 1985; Bamualim et al 1987; Pearson 1990; Soller et al 1991; Pearson and Lawrence 1992), while others have shown a positive effect of work on digestibility (Ffoulkes et al 1987; Pearson and Lawrence 1992). How work could affect either rumen fermentation processes or digestion in the lower digestive tract, and other processes involved in intake regulation of roughage diets, is uncertain.

Production performance of cows is an important factor which determines whether cows are adopted for draft power. Working cows could perform at higher levels of efficiency than oxen, but only if nutrient inputs are adequate to meet their greater requirements, and milk production and reproduction are kept at levels comparable to non-working cows (Mathers et al 1985; Matthewman et al 1993). Energy deficits during the working season could result in losses in body weight and body condition, thus affecting the production and reproduction efficiency of cows (Teleni and Hogan 1989; Teleni et al 1989; Zerbini et al 1993a).

ILRI and the Ethiopian Institute of Agricultural Research (IAR) have researched different aspects of the use of dairy cows for draft work. This paper deals with work output, milk production and reproduction of crossbred dairy cows used for draft. Information generated from

ILRI and IAR research is used to elaborate the interplay of factors affecting work output, milk production, metabolism, physiological responses and the reproductive physiology and performance of dairy cows used for draft.

Work output and efficiency of draft dairy cows

Determining the optimum work-load that dairy cows can efficiently undertake is an essential component for the successful adoption of cow traction technologies into smallholder mixed farming systems.

Results of our investigation with crossbred cows in the Ethiopian highlands (Zerbini et al 1992) show that dairy cows were able to work at a rate of about 500 W. This work rate, at a speed of 0.75 m/s, implies that the sustainable horizontal draft force was roughly 670 N. This represented about 14% of mean body weight, a result consistent with those of other studies (e.g. CEEMAT/FAO 1972; Barwell and Ayre 1982). The work efficiency of cows increased from about 7% to 26% as the work-load increased to its maximum (Figure 1). Cardio-respiratory measurements indicated that during work each additional heart beat transported approximately 72 ml of oxygen which is equivalent to 1 kJ of additional mechanical work output (Zerbini et al 1992).

Over a period of three years, work output of dairy cows averaged more than 200 MJ per cow per year of net energy which was equivalent or above that required by farmers for land cultivation (Table 1).

Lactation and reproduction performance

Dry-matter intake

Dry-matter intake was greater for working than for non-working cows over the two-year period (Table 2). Roughage intake of working non-supplemented cows increased above that of non-working non-supplemented cows by 19.1% over the two years. Similarly, working supplemented cows increased hay intake above that of non-working supplemented cows by 11.1%. Over the two years, dry-matter intake of working cows increased 14.9% over that of non-working cows.

Chemical composition of diet components is presented in Table 3.

Increased dry-matter intake of working over non-working cows was also reported by Ffoulkes et al (1987). This is supported by the findings of Zerbini et al (1995) who reported that work increases the utilisation of feed energy. Even under conditions where adequate feed supplementation was not available to maintain body weight, such as for working non-supplemented cows, animals could still satisfactorily perform work by drawing on body reserves and increasing dry-matter intake. However, Zerbini et al (1995) indicated that if such a situation exists for as long as one year, cows could lose more than 15% of their calving body weight and reduce milk production by more than 50% compared with working supplemented cows.

Days in milk, milk yield, milk components and completed lactations

Total days in milk of working cows was similar to that of non-working cows (Table 4). However, days in milk of working supplemented cows were 14 to 39% greater than the other treatment groups in the first and second year, respectively. Days in milk were more in supplemented cows than in non-supplemented ones. Cumulative milk, milk fat and protein yields of working and non-working cows were not significantly different over the study period. Cumulative milk, milk fat and milk protein yields of supplemented cows over the first two years were greater than those of non-supplemented cows (tables 5 and 6). Milk yield of non-supplemented cows, whether working or not, was approximately half that of supplemented cows. In addition, in year two, milk production of non-supplemented cows was only 30% that of year one, while in supplemented cows it was still 75% of that in year one.

In another study, Matthewman (1990) reported that cows using approximately 12 MJ ME per day for walking reduced milk production between 7 and 14% depending on diet fed. In addition, Barton (1991) reported lower milk production and reproduction in draft cows in Bangladesh. However, on-farm trials in the Ethiopian highlands indicated that the effect of work on lactation of crossbred cows used for draft was minimal when feed supply was adequate and work requirements were modest (Gryssels and Anderson 1985; Agyemang et al 1991b).

In our study, over a period of one and two years, lactations completed by working supplemented cows were 31 and 25% lower than those of non-working supplemented cows, consistent with more days in milk of working supplemented cows (Table 7).

Even though over a period of two years, milk production of working cows was not significantly different from that of non-working cows, working non-supplemented cows had the lowest milk yield among all groups. This indicates that work with inadequate feeding would not be a feasible option for a production system involving the use of lactating cows for draft. However, total milk production of working supplemented cows over three years was only 10% lower than that of non-working supplemented cows. These differences could be attributed mainly to the lower number of parturitions and lactations completed among cows in the supplemented working group.

Resumption of post-partum oestrus and conception

Bamualim et al (1987) indicated that in buffalo cows, work might reduce reproductive performance. However, Winugroho and Situmorang (1989) suggested that work, *per se*, was not a major factor influencing ovarian activity if energy reserves were adequate. Feed supplementation of thin working buffaloes induced a return to normal ovarian activity. Reh and Host (1985) reported that fertility was 6 to 7% lower in working than in non-working cows. However, research conducted in India, with working and non-working Red Sindhi cows, over two lactations, showed no significant differences in milk production and length of lactation (Reh and Host 1985). Agyemang et al (1991a) reported that the reproductive and productive performance of draft and non-draft cows were similar. However, the work done was less than the amount required by a smallholder farmer.

Zerbini et al (1993a) reported that diet supplementation significantly decreased days to first oestrus and days to conception in non-working and working cows. When work treatment was superimposed on non-supplemented treatment, the rate of reproduction was very low. Differences in the first 200 days post-partum, in onset of oestrus and conception between treatment groups, seem to be related to work in the first post-partum period. However, they seem to be related to a greater extent to diet supplementation if a 365-day period was considered, suggesting a longer-term effect of the supplementation than work (Figure 2). In supplemented cows, work significantly delayed days to conception. However, by 365-days post-partum, conception rate was similar for supplemented non-working and supplemented working cows. For occurrence of first oestrus, the diet effect was considerably larger than the work effect (a probability factor of 5 versus a probability factor of 2). This was less pronounced for conception. This is contrary to results from other studies (Wells et al 1981; Spicer et al 1990) which indicated that supplementary feeding did not influence interval from calving to first ovulation, conception rate or interval from calving to conception. Body condition at calving significantly affected post-partum reproductive ability of all cows (Figure 3). This indicates that cows with greater body reserves at calving, and the ability to use these reserves during the post-partum period can partly overcome the negative effect of dietary energy restrictions on oestrus onset and conception (Zerbini et al 1993a).

The results of this study indicate a dramatic decrease in percentage of cows showing oestrus and in conception rate when work was applied to non-supplemented cows.

Post-partum anoestrous interval was extended in a larger proportion of working than in non-working cows. Work did not influence conception rate in supplemented cows, but had a substantial influence in non-supplemented cows. The significant delay of conception for supplemented working cows relative to supplemented non-working cows indicated that work output of cows might be associated with longer calving intervals. The economic trade-offs between these two factors should be examined in detail. Once pregnancy was established there was no effect of work on maintenance of pregnancy. A greater proportion of supplemented working cows cycled between 120 days and one-year post-partum indicating that work applied soon after calving delayed, but did not suppress, oestrus and conception in subsequent resting or working periods (Zerbini et al 1993a; Zerbini et al 1993b).

Ovarian function

In lactating dairy cows draft work significantly increased the length of the oestrous cycle. This was due to the occurrence of ovulations without oestrus in cows on both diets during the working period (Figure 4) (Esubalew Abate 1994). However, once cows started ovulation they continued to ovulate regularly whether they were worked or not. Greater energy intake did not reduce the incidence of ovulation without oestrus during working periods. The occurrence of ovulation without oestrus during the working period seems to decrease with time as cows adapt to draft work activity. Similarly, observations on the effect of work on ovarian activity of swamp buffalo cows indicated that although there was evidence of ovarian activity in some of the working buffalo cows, there was a tendency for ovarian activity to decrease in this group compared with the non-working animals (Bamualim et al 1987). A clear definition of the body weight/condition at the start of the work season and the rate of weight loss compatible with normal ovarian activity is desirable.

Conceptions over multiple lactations

Gemeda et al (1995) found that the number of working supplemented cows which conceived in year one was similar to that of non-working supplemented cows. However, over a period of two and three years, the number of working supplemented cows which conceived were 29 and 20% lower, respectively, than those of non-working supplemented cows. In addition, over a period of one year, the number of conceptions of non-supplemented cows was 78% lower than those of adequately fed cows (Table 8).

Body weight losses have been reported to impair ovarian activity in female buffaloes and cows (Teleni et al 1989; Agyemang et al 1991b). Furthermore, over a period of two years supplementary feeding reduced body weight loss of cows by 80% and was associated with a 59 and 63% increase in the number of conceptions and parturitions, respectively, compared with a non-supplemented diet (Table 9). In particular, supplementation of working cows reduced liveweight loss by 73% and doubled the number of conceptions and parturitions compared with WNS cows (Gemeda et al 1995). Body condition score followed a similar pattern to that of body weight change over the three-year period (Table 10). The probability of conception was not greater than 20% in cows with body condition score lower than 3 (range 1–9) and with body weight losses greater than 15% from calving body weight (average of 412 kg).

In year one the number of calves born from working supplemented cows was 80% lower than that of non-working supplemented cows, even though the number of working supplemented cows which conceived was similar to that of non-working supplemented cows. This is consistent with the delay in conception after parturition reported for working-supplemented compared with non-working supplemented cows (Zerbini et al 1993a). Relatively fewer lactations and parturitions, and more days in milk of working supplemented cows, over a period of three years, reflects the delayed conception in working supplemented compared to non-working supplemented cows. This is due to both a direct effect of work *per se* and to a deficit of energy yielding substrates, particularly during the working/lactating periods. Over a period of three years, diet was the main factor which affected reproduction of dairy cows used for draft work (Zerbini et al 1995).

Recovery after work: Long-term effects

Even after extended periods of underfeeding, acyclic and anoestrus cows resumed ovarian cyclic activity in an average of 46 days and conceived in 75 days when fed about twice their maintenance energy requirements (Zerbini et al 1995). The economic implications of long periods of low productivity or maintenance, in working and non-working cows, and the requirements for resuming reproductive activity needs to be evaluated in detail especially for farming systems with large fluctuations in feed resources availability.

Productivity index (output/input)

Over a period of two years the productivity index of supplemented cows was greater than that of non-supplemented cows (0.38 and 0.24, respectively), but it was similar between working and non-working cows (0.35 and 0.33, respectively). While the productivity index of non-working supplemented and working supplemented cows were maintained relatively constant over three years, that of non-working non-supplemented and working non-supplemented cows decreased by 21 and 34%, respectively (Table 11). This resulted mainly from reductions in milk yields and reproduction performance in non-supplemented cows.

The productivity index was used to describe the overall productivity of cows in each treatment group. Similar productivity indexes for non-working supplemented and working supplemented cows over the total three-year period indicate that work output more than compensated for the small decline in milk production and number of calvings and greater DMI of working supplemented compared to non-working supplemented cows. For on-farm situations working supplemented cows would provide the additional advantage of alleviating the need to maintain draft oxen year-round, could reduce stocking rates, and therefore could result in the allocation of more on-farm energy towards milk and meat production while maintaining draft power.

On-farm testing of cow traction in the Ethiopian highlands

The on-farm testing of cow traction technologies is designed to evaluate the effect of draft work and management on production and economic performance of crossbred dairy cows on smallholder farms. Pairs of crossbred cows (140 Friesien × Boran F_1) were purchased by selected farmers in 1993 and 1995 in the Holetta area. Stratification of participating farmers into low, middle and high income groups was based on land and livestock holdings, livestock type, labour availability, total farm assets and location. Production and economic data for 1993 and 1994 are currently being analysed and the whole-farm model based on two-year data is being constructed.

During the first year, milk production of working and non-working F_1 crossbred cows on-farm was similar (1822 vs 1999 kg), ranging from 1119 to 2432 kg for working cows and from 1209 to 2907 kg for non-working cows. Days to first oestrus and conception were similar for working and non-working cows (167 vs 194 and 258 vs 286, respectively). Average service per conception for working and non-working cows were 2.1 and 1.9, respectively. Over a period of one year cows worked an average of 26 days.

Economic implications and potential for adoption

The potential for the use of crossbred cows for milk production and traction was substantiated by simulating the production parameters and investment returns over a three-year period using the ILRI bio-economic herd model (Shapiro et al 1994). The Incremental Internal Rate of Return (IIRR) of supplemented working cows over supplemented non-working cows under on-station conditions is greater than 70%. The IIRR is very high because the incremental investment cost is very low while the benefits of work are large (Table 12).

The effect over time of introducing crossbred dairy cows into a typical farm herd of local cattle for work and milk production were also simulated and compared to using the local cows for milk production and local oxen for traction. Then, the financial implications were investigated using incremental benefit/cost analysis. The incremental benefit/cost ratio of having supplemented working cows over the traditional system of local cows and oxen is about 3.5 and the IIRR is 78%. The incremental benefit/cost ratio is high because of the very high productivity of the crossbred cows (5–6 times as much milk) relative to local cows.

The value of work more than compensated for the small reduction in milk production and longer calving interval found in working cows when supplementation took place to ensure adequate nutrition. The greater returns to investment in supplemented working crossbred cows was thus mainly a result of the higher value of the work output, in spite of the higher feed costs and lower off-take (milk and calves).

In conjunction with the technical factors then, systematic consideration needs to be given to the effects at the micro-level of socio-economic factors, including institutional and structural factors. This research would also help policy makers to choose more effective policies and programmes to develop and promote widespread diffusion of new technologies.

While in the medium term the technical feasibility and the investment/cost ratio, as well as social factors will affect the acceptance of cow traction technologies, in the long run the diffusion of crossbred cows will depend on the extension of the results of the study. The environment for dairy development, including government policies and services, especially credit, veterinary and breeding services will also be critical.

Conclusions

The results from this study indicate that draft work induced an increase in forage intake and digestibility in cows without decreasing solid phase transit time in the gut. Greater intake and digestibility could be related to increased retention time of the liquid phase and perhaps to increased gut volume. The attempt by working cows to increase intake to meet energy requirements even when fed relatively poor quality forage is important.

Over a period of three years, diet was the main factor which affected body weight and condition score, days in milk, milk production of crossbred cows, whether working or not. Supplementation did not affect work output of cows. Work performed by supplemented cows had no adverse effects on lactation and reproduction. A similar productivity index for working and non-working supplemented cows over three years indicates the potential of this technology to increase farm productivity and result in more efficient use of on-farm resources.

With appropriate feeding regimes dairy cows could be used for draft purposes without any detrimental effects on fertility, but calving intervals would be extended. Work *per se* does not influence post-partum ovarian activity when the energy reserve is adequate, but work does delay the interval from calving to conception in dairy cows. Work increased the incidence of ovulations without oestrus and short luteal phases. However, these events did not influence pregnancy in subsequent normal oestrus periods.

Economic analysis of on-station data shows that the greater returns to investment in supplemented working dairy cows compared to non-working cows or to a traditional system, was mainly a result of the higher value of the work output, in spite of the higher feed costs and relatively lower off-take of milk and calves.

There is a need to quantify the energy partition to different functions by working, lactating and breeding cows. The nutrient demand of the multi-purpose cow is complex and the success of a nutritional management strategy will depend largely on the level of feed intake and, over short periods, on the level of body reserves (Preston and Leng 1987; Egan and Dixon 1993). The mechanism by which body reserves contribute to the energy expenditure of working cows is not clear. Future research priorities should include defining minimal nutrient requirements for pregnant and/or lactating working animals to allow for an optimal reproductive performance.

To optimise the post-partum anoestrus period, draft dairy cows must regain weight during lactation and farmers must have management skills to integrate strategically physiological events such as pregnancy and lactation with draft work requirements.

On-farm comparison of working, supplemented crossbred dairy cows used for draft with the traditional system is now underway.

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Discussion on Dr Zerbini's presentation

Wandera: What was the quality of feed used during the cow traction experiments?

Zerbini: For the on-station experiments the feed used was similar to that used by smallholders in that particular area. When I talk about non-supplemented feed I talk about natural pasture hay, which has around 7 MJ of metabolisable energy per kilogram of DM, and CP of around 6–6.5%. Non-supplemented cows, therefore, fed on this forage for more than two years, did the work and produced some milk. It is remarkable that these animals survived on that particular feed. Supplementation refers to a mixture of locally produced agro-industrial by-products. This is a cake made from noug (niger seed from which they make oil) which is used as animal feed. The cake is a protein supplement which has around 25% crude protein in the dry matter depending on the type of extraction. You may find levels of fat between 2 and 8 or even 10%. The supplement was a mixture of this noug cake and wheat middlings at a ratio of 70 to 30%. These were the only feeds that were used on-station. I think Dr Alemu will expand on the on-farm work where we recommended that farmers use oats + vetch forage mixture and noug cake.

Beruk Yemane: I have a couple of questions on meat production and extension aspects. When you refer to supplementation I think it is mainly used for the work aspect, production and other things. Apart from the supplement feed and the genetically improved cow are there any inputs that are given to the animal to increase meat productivity *per se*? In other words is meat a by-product of milk and traction or is there any input or intervention to increase the meat productivity of the animal? The other question concerns the cultural and traditional aspects of this work. There are slight reservations by some of the farmers about using crossbred cows for traction. Considering these reservations, have you tried to come up with some sort of projection that says in a given period of time this number of crossbred cows would be acceptable by this number of farms to see how acceptable the technology is?

Zerbini: I will leave the second question until after the presentation by Dr Shapiro which is on the cultural aspects of this work.
The first question was on the differential feeding for milk, meat and draft. We used two different crossbred types—FB and SB F_1 crossbreds. They both received the same diet. We had a slightly greater production of milk from FB compared to SB but SB did a little more work than FB. The difference between the two breeds is that after three years of work the SB were heavier than the FB. But the specific evaluation of meat production separate from milk and work has not been done and we might do it to better evaluate the two crossbred types.

Saadullah: I could see from the slides that you have a lot of information. Have you got any information on the performance of the calves from working and non-working or supplemented and non-supplemented cows?

Zerbini: We have analysed only the birth weight. We now intend to look at growth. However, the birth weight was higher for the supplemented cows.

Social and cultural attitudes towards adoption of cow traction

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Background

This presentation deals with the prospects for technology transfer and specifically with the anthropological and cultural considerations related to this work. The anthropological work was done by Dr Alula Pankhurst, Addis Ababa University. It is quite clear that cow traction is not a technology for everyone. It is not a panacea, but it is a very important technology that can raise farm productivity and improve agricultural sustainability. We realise that adopting this technology involves a radical change in farming methods and from our experience we know that this is not something that everyone is going to adopt immmediately. Some farmers are more innovative than others. Some farmers have more resources than others and are thus better able to take risks and to adopt new techniques.

Crossbred cows have been known and used in Ethiopia for 20 years, but a great deal has changed over the last 20 years in this country. Why have farmers not spontaneously started using cows for traction? There are a number of reasons that help to explain this partially and to show that adoption is more likely now. One is that population has been increasing rapidly, making pasture land more scarce. This means that the feed resources available without intensification are far less. Cow traction is an intensification technology. It involves using more purchased inputs per unit of land. The policy environment until three years ago has been adverse and this has had a tremendous effect on the incentives for farmers to change technology.

The issue of attitudes toward using cows for draft is important in Ethiopia. The Ethiopians are called 'the people of the plough'. Ploughing and using oxen to plough have been a part of the farming system for hundreds of years. This is a system that has not changed much in the last few hundred years because farmers have found the most efficient way to use the oxen and to plough, given their conditions. It will therefore be very difficult to get the farmers to change.

Methodology

Before the on-farm trials of cow traction began only oxen were used for traction in the study area. This being the case, we had to ask whether traditional attitudes could change and whether these farmers would be willing to try using cows for traction. This necessitated a qualitative type of analysis with in depth interviews. The interviews were carried out by postgraduate anthropology students from Addis Ababa University before the project started. There were 14 households with crossbred cows, seven of which had agreed to use cows for traction. One household that had initially agreed to use cows for traction but then dropped out was also included in the survey. Thirty-six neighbouring farmers who had not agreed to use cows for traction were interviewed to determine the differences in attitude between the participating and the non-participating farmers.

Only 33% of the households surveyed had ever owned crossbred cows; 75% said they would like to have crossbred cows. Some of the households are so resource poor that they may not be able to take advantage of this technology without some support, such as credit, perhaps insurance and such things as artificial insemination (AI) and veterinary services. However, without any prior experience 19% of the farmers thought it was feasible to use cows for ploughing. Some of the farmers had seen cow traction on-station, but none had seen anybody do it on their farms. Half of the reasons given for not using cows were technical and economic. Thirty-six per cent of the reasons were related to cultural attitudes, beliefs and the values of the community.

The technical reasons against cow traction included the belief that, although cows could plough on-station, under on-farm conditions it would be more difficult. The community beliefs had to do with superstitions about cows. The reasons given included: cows cannot plough and give milk; they cannot plough when pregnant; it is morally wrong for cows to plough; it is culturally unacceptable; and cows are not strong enough because of their nature. Finally, there were various responses that had to do with the attitudes of the heads of households and the family members which accounted for 15% of the reasons why cows should not be used. These had to do with particular circumstances in terms of their household resources.

Future prospects for the technology

Short-term prospects

If the technology is to be extended to smallholders, committed model farmers or innovative farmers with conducive resource conditions are needed to test it. We must provide support to these farmers while they are learning to use this new technology. The use of cow traction requires an adjustment period during which losses due to mismanagement and accidents may occur. Support and the experience of farmers themselves would demonstrate the benefits of cow traction.

Medium-term prospects

Medium-term prospects are related more to the economics and technical feasibility of the project. Farmers would have to be able to replicate the on-station benefits on their farms and achieve the returns (or benefit–cost ratio) indicated by the on-station results. This is important because cow traction involves a significant investment. Even if the farmers get the crossbred cows through AI, they have to build the barn, feed the animals well and change all of their farming practices. There has to be a good return from this and there have to be markets for their dairy products.

Long-term prospects

The results show that the long-term prospects for cow traction depend on extension and the economic environment. There has to be a conducive policy environment and here in Ethiopia this seems to be going in the right direction.

Conclusions

We can therefore conclude that although farmers are skeptical, 19% of those surveyed are ready to try out crossbred cows for traction to establish its viability for themselves. Although cultural attitudes need to be carefully monitored, they are not expected to be insurmountable obstacles to adoption. Most of the reasons that were given for not using the animals were technical and economic. The implications for further evaluation of this technology have mainly to do with the resource endowments of the farmers. We found that most of the problems with adoption of crossbred cows are those that would be faced by the resource poor. What we have now done in the on-farm testing is to establish three categories of farmers: the resource rich, middle-income farmers and the resource poor. The next stage of technology testing involves identifying the constraints to adoption for the resource poor, e.g. credit and insurance.

Discussion following Dr Shapiro's presentation

Mohammad-Saleem: Dr Sadullah, in Bangladesh the farmers had, as Dr Shapiro has described, a negative attitude towards cow traction, but now I think there are more and more farmers taking it up. What has switched this attitude and what are the things that we can learn and incorporate into our project? Can you tell us something about that?

Saadullah: I will try to address these questions in my paper later. Thirty years back it was not socially acceptable to use cows for traction, but now the situation has changed. Probably 60% of the cows are being used as working animals.

Winugroho: In Indonesia the changes in the farming systems and the social systems are quite rapid. In 1981 there were 192 bulls in one village but by 1984 there were 69. So the number of bulls is decreasing while the number of cows is increasing, and the cows are being used for traction more and more.

Teleni: I would just like to comment on the Indonesian situation where most of the animals used for traction are cows. I think it becomes a question of the option that is available to the farmer as to how many animals he could keep on the land. In Indonesia the farm sizes range from 0.3 to 0.8 ha making the decision for the farmer very easy. I think as the demand for land increases options decrease and the choices are limited.

Shapiro: This is the process that we believe has to be continuing; we want to see how the attitudes would change over time. So, we have just done a second phase of the anthropological survey and we have included the previous households plus additional ones so that we can capture this. We hope that there is a demonstration effect from people seeing cows being used for traction on-farm and believe that this is definitely the case. This time when we increased the number of households to about 75 from the original 14 we had a much easier time finding households that were willing to use cows for traction. The first time we only had 14 households: seven using the cows for traction and seven only for milk production. It was difficult to find people who were willing to use the cows, but this time it has been much easier. So clearly, there is a change in attitude.

Ehui: In one of your slides, one of the factors which you mentioned would encourage the use of cow traction is the reduction in farm size. Of course I agree with that but I tend to also think that even more important in this particular stage would be the opportunity cost of labour itself. So, I was wondering to what extent the study is looking at that factor as one driving force for the adoption of this technology?

Shapiro: These forces are complementary; in fact we are talking about land/labour ratio. I believe they both support the introduction of cows for traction, i.e. reduction of farm size and opportunity costs of labour.

Anttila: I think I agree with some small background information about this FINNIDA smallholder dairy development project. Cow traction has not yet been part of our programme, but we have been introducing crossbred dairy cows since 1988. At that time we had 270 farmers. We left Ethiopia in 1991 and we came back in late 1993 to plan for a new programme; we continued with the old farmers. First of all we did a census: from the 270 farmers 250 were still doing the dairy farming. This was a very good result that showed some sustainability. Of the farmers who dropped out most of them simply left during the war, others had died and their widows did not continue etc. In the new phase we are planning to have 1000 farmers and we have been doing, together with ILRI, some research mainly on the nutrition side. We are using the same crossbred animals as ILRI is in this cow traction research and we try to use artificial insemination for breeding in the areas where it is available. In areas where AI is not available we have introduced bull service. We make a contract with a farmer and then the neighbours bring the cows in heat. The farmers set the price for the cost of one service. We have been doing this now for a little over a year and altogether between 253 and 300 cows have been served. We have been trying to encourage the farmers to bring local cows for cross-breeding to get F_1 crosses. There is a big market for these F_1 crosses. Everybody wants to keep these improved animals.

Question: How many farmers in your dairy programme have spontaneously adopted cow traction?

Anttila: In some areas between Debre Birhan and Wollo farmers are using cows but we haven't yet introduced the technology or collected any information on this issue.

Country reports

Extension efforts to extend oxen and cow traction in Kenya

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Introduction

The Republic of Kenya is located on the eastern part of the continent of Africa and forms an important part of East Africa. It is bordered by Uganda to the west, Tanzania to the south, the Indian Ocean to the south-east, Somalia to the east, Ethiopia to the north, and Sudan to the north-west.

Kenya has a population of 26 million people, increasing at a rate of 3.4% per year. The country covers an area of approximately 587,900 km^2 of which 573,000 km^2 is land surface while the rest is inland waters covering 11,200 km^2. About 80% of the land surface (4584 km^2) is comprised of arid and semi-arid lands (ASALs). The remaining 20% (114,600 km^2) of the total area, inland water areas included, is of high and medium potential. The ASALs carry more than 25% and 50% of the livestock and human populations, respectively. Rainfed subsistence agriculture is limited to the semi-arid lands (SALs) which receive between 500 and 800 mm of rainfall per annum.

Agriculture is the mainstay of the economy of Kenya in which the small farming sector plays an important role in food production. Generally, the small-scale farms (below 5 ha) occupy about 90% of the land under agriculture. The farmers who use draft animal technology normally produce surplus for the market.
It is expected that the importance of draft animal technology will increase because:

- land tenure regulations and inheritance patterns, combined with population growth will keep farm sizes relatively small, compared with the area normally considered economically viable for tractors
- foreign exchange constraints are likely to remain severe
- tractor-hire schemes so far have not been economically viable for smallholder farmers
- the use of tractors by smallholder farmers is unlikely to increase
- the government has a growing interest in the promotion of animal power to increase food production.

Historical perspective

In Kenya, the introduction of animal traction started over 70 years ago through European settler farmers. Little attention was given to the introduction of animal traction for small-scale farmers. Nearly all implements were imported during that time. The present importation, local manufacturing and marketing of animal-drawn implements are mainly urban oriented.

From the late 1970s, people started to realise that on small-scale farms animal power could be more appropriate than tractor mechanisation. The noticeable support for draft animal technology is gratifying, but there is still a long way to go. The technology itself is a complex system. Adoption and continued use is dependent on a wide range of complex and interrelated aspects of farming systems and community attributes including social, economic, environmental, technological, political and infrastructural elements.

Distribution of types of draft animals

Cattle, donkeys and camels are the most widely used work animals in Kenya for various operations. Table 1 gives the estimates of the numbers of these animals in the country.

Table 1. *Estimates of the number of cattle, donkeys and camels in Kenya.*

Animal population	Number
Cattle	12,000,000
Donkeys	150,000
Camels	548,000

Source: KENDAT (1993); AGROTEC in: A Study on Energy Issues on Small Scale Farms.

Operations done using draft animals

Cattle are mainly used for land preparation, planting, weeding and ridging. They are also used for transportation in households which do not possess donkeys.

Donkeys are primarily used as pack animals and for pulling carts. Farmers in Kenya hardly ever use donkeys for agricultural operations like ploughing and weeding.

Camels are used solely as pack animals.

Types of plough used

All the animal-drawn ploughs found in Kenya are of the single furrow mouldboard type. The ox-plough is widely adopted in some humid and semi-humid areas where it is used for land preparation, planting, furrow opening and weeding with the mouldboard removed.

The victory plough

This is the most common plough found in the country. It was introduced about 70 years ago from South Africa. The older ploughs have fairly strong beams and have hardly any problem of bending or breaking. However, the new locally manufactured beams are much weaker and easily deformed when operating on hard soils, especially if there are also underground obstacles like stones or roots. The shares also wear out very fast, especially on the more sandy and abrasive soils.

Advantages

- produced in large numbers by medium-scale entrepreneurs
- supply and distribution is well catered for
- widely adopted.

Disadvantages

- heavy (38 kg), leading to high draft requirements
- the high draft requirement limits the depth and width of cultivation of the implement
- difficult to operate
- beam deforms after a short period of operation
- beam is not a multi-purpose tool bar
- cannot be manufactured by small-scale enterprises.

Bukura Mark II plough

This is a multi-purpose implement introduced into the country in the early 1980s. It was developed by the Ministry of Agriculture through its Rural Technology Development Centres/Units to solve the problems associated with the victory plough.

Advantages

- beam is a multi-purpose tool frame which can accommodate various attachments (e.g. ridger, chisel, cultivator, harrow etc) depending on the farm operation to be done
- light (28 kg), leading to low draft requirements and hence less human effort required
- strong, hence it does not become deformed
- no tools needed for adjustment and hence easily adjusted
- good penetration
- much cheaper than buying individual tools as a farmer can add, at low cost, tools to extend the versatility of the tool bar
- easily manufactured by small-scale enterprises.

Disadvantages

- supply and distribution is done by the manufacturers
- mostly made on order.

Rumptstad plough

The original version came from The Netherlands and it was adapted to the Kenyan situation. The plough was introduced into the country in the late 1980s. The advantages of this type of plough are the same as for the Bukura Mark II except that the Rumptstad weighs 34 kg.

Disadvantages

- needs more draft than the Bukura Mark II plough
- supply and distribution is done by the manufacturers
- can be expensive if made using the recommended materials due to the high taxes charged for imported materials.

Types of harness

Since the first introduction of ox cultivation in Kenya early this century, the harnessing system has hardly changed. Double withers (also known as neck yokes) are common. They are found in two forms, the traditional and the improved yokes.

Traditional neck yoke

This is composed of a long wooden pole with skeis through it to separate and link the animals. The centre of the yoke has a ring or a U-bolt to which implements can be attached by a chain. The advantage of this neck yoke is that it is cheap and easy to make.

Disadvantages

- not adapted to the shape of the animals' withers
- contact area is very small, thus creating a lot of pressure on the animal's skin which in turn leads to discomfort and even injury
- reduces power output from the animals.

Improved neck yoke

This yoke consists of a smoothly finished square piece of timber. The areas of the yoke which are in contact with the animal are contoured to the shape of the animal's neck. The yoke is kept in position by two loops made of conduit pipe or round bars which are angled forward to clear the animals' throats and are adjustable by means of spring pins. The contoured areas are covered with soft pads.

Advantages

- adapted to the shape of the withers
- provides a much larger contact area, thus creating less pressure on the animals' skin, resulting in comfort and no injury
- increases power output from the animals
- can be made by rural artisans.

Disadvantages

- takes more time to make
- can be more expensive than the traditional yoke.

Management of draft animals

Yoking is the most common method used for tapping power from teams of either two or four animals. Most of these yokes are crudely made without any standard specifications. Training procedures are not based on any standard, i.e. the farmers pick animals randomly, yoke them and start using them in the fields. After a while the animals learn to work but little attention is paid to their health and well-being leading to low work output.

After harvesting, the farmers stock maize stover to use as animal feed during the dry season. The farmers tend to economise on the feed stock so that it can last for the whole dry period. No supplementary feeds are given to the animals.

Where dipping facilities are available some farmers take their cattle for dipping, in most cases once a month.

Potential for cow traction

In future, farms will be subdivided more and more. Farmers will hardly be able to keep oxen, therefore the use of cows as draft animals could be the only solution.

It is estimated that the annual demand for ox ploughs is about 12,000 and is rising due to the on-going structural change in large farms.

Small- and medium-scale farmers use hand tools and animal-drawn equipment. Small-scale holdings number roughly 1.5 million and have an average size of 12 acres (5 ha). About 59% of the farms are between 1.0 and 5.0 ha (Table 2) where draft animal power is highly needed. About 30% are less than 1.0 ha where hand tools can be used.

Table 2. *Percentage distribution of land holdings.*

Land holding (ha)	Per cent
< 0.5	13.9
0.5 – 0.9	16.9
1.0 – 1.9	27.0
2.0 – 2.9	15.1
3.0 – 3.9	8.9
4.0 – 4.9	8.0
5.0 – 7.9	7.8
8.0 >	2.4

Number of holdings: 1,500,000.

Source: Government of Kenya (Central Bureau of Statistics, Statistical Abstract, Nairobi).

The failure of traction mechanisation in small-scale farming coupled with the lack of ox technology development means that about 84% of the land is cultivated using hand tools (Table 3).

Table 3. *Sources of power used for cultivation by small-scale farmers.*

Source of power	Area (ha)	Per cent
Hand tools	1,039,000	84
Draft power	150,000	12.5
Tractors	42,000	3.5
Total	1,231,000	100

Source: Government of Kenya Central Bureau of Statistics Survey.

Oxen still comprise the greatest number of work animals in Kenya. Cows, although they dominate the cattle population in the small-scale sector (Table 4), are seldom used for draft purposes.

Table 4. *Percentage of livestock by type of management.*

Type of livestock	Smallholder	Large farm	Pastoralist
Zebu cattle	49	19	32
Grade milk cattle	82	18	–
Grade beef cattle	18	82	–
Camels	–	–	100
Donkeys	9	–	91

Source: Animal Production Branch, MALD&M, Nairobi, Kenya.

The use of cows for traction would be of benefit to total animal production from the farms because it would no longer be necessary to maintain oxen year-round and a follower herd to supply replacement oxen. Farmers are being encouraged to use cows as draft animals so the same animal can provide traction power, calves, milk, beef and manure thus reducing animal supply problems. This strategy requires improved management and adequate nutrition if the cows are to perform all their functions satisfactorily. Extension services are being strengthened to upgrade farmers’ knowledge of breeding, nutrition and disease prevention.

Constraints to adoption of oxen as draft animals

- shortage of land
- competition between crop production and land for grazing
- poor quality and quantity of feeds especially during the dry season
- traditional factors, e.g. nomadism
- lack of appropriate harnesses
- lack of appropriate implements
- lack of knowledge about animal power technology
- lack of good breeds
- lack of training facilities for rural people
- lack of high quality locally manufactured implements.

Constraints to adoption of crossbred cow traction

- lack of animal power technology
- lack of training facilities for rural people
- lack of proper harnessing
- lack of appropriate farm equipment and animal-drawn carts
- lack of locally manufactured implements of appropriate quality

- lack of available supply of crossbred cows
- fear of decreased milk production
- unreliable veterinary services
- expensive veterinary products and supplementary feeds
- poor supply and distribution of veterinary products and supplementary feeds
- poor and inadequate extension services
- diseases
- lack of training for farmers on improved cow management skills.

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Extension efforts to spread animal traction technology in Uganda

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Background to the technology

In Uganda the use of draft animal power (DAP) started as early as 1909 in the north-eastern region of the country. The technology was confined to use of oxen for ploughing only, and was used only by men. Even now the use of secondary tillage implements is insignificant. Harrowing, planting and weeding is done by hand by women. Adoption of the technology for primary tillage is high in the northern and eastern regions. In the southern and western regions of the country it was assumed that the soils were too heavy to be ploughed by animals and no efforts were made until recently to transfer the technology to farmers there. Where adoption is high, methods such as nose punching and beating the cattle to make them pull the plough were used, and still are to a declining extent. Most farmers learnt the technology on the job; it was passed on from parents to children.

Donkey traction was used in only three of the 40 districts in Uganda (Kapchorwa, Moroto and Kotido districts) until the beginning of the 1990s. Donkeys are mainly used as pack animals.

The objective of promoting DAP is to increase the productivity of both land and labour and to alleviate the drudgery of farm production.

Potential for cow traction

The potential for cow traction is quite high in Uganda. The main reasons for this are:

- Regions where DAP adoption level is high have, in the recent past, suffered from insurgency which led to loss of a large percentage of their cattle. They now have no choice but to use the cattle which are available for DAP, whether male or female.
- Female farmers would generally prefer working with cows, which are more docile. This calls for the attention of extension agents and researchers, especially if we are to move away from the concept of DAP use being a male domain.
- In the southern region of Uganda farmers have no traditional contact with cattle. As such they generally prefer working with cows, which are more docile.
- The idea of using cows for traction is attractive because cows can play multiple roles. Cow traction would allow farmers to keep only a few animals and optimise their management to achieve good outputs of draft power, milk and calves.

Extension activities to achieve objective

1. Extension service

DAP technology is incorporated in the formal extension service. Trained district animal traction officers are responsible for:

- Creating awareness among farmers about the technology. In some parts of the country farmers have not been using DAP because they lack technological information.
- Changing farmers' attitudes towards use of animals for work. In some parts of the country, notably the western part, cattle are kept only for cultural functions such as dowry and for commercial purposes. Farmers in these areas believe that using animals for DAP amounts to punishing or mistreating them. One of the ways by which extension staff try to change this attitude is to depict how overburdened women (wives) are, and ask the farmers who deserves more sympathy, the cattle or the women. Getting the participation of farmers, especially male farmers, is vital to the success of the dissemination process.
- Sensitising local leaders so that they prioritise DAP in their programmes and budgets. DAP benefits, such as increased production leading to increased tax-base, should be highlighted.
- Conducting DAP courses.
- Monitoring and evaluating adoption.

2. Train contact farmers

Potential contact farmers receive intensive training on the technology. They then spearhead technology transfer, training other farmers and demonstrating the technology and complementing extension agents.

3. Train contact blacksmiths

Rural blacksmiths are trained on the repair of DAP implements and fabrication of spare parts for them. This contributes to the sustainability of the technology.

4. Training centres

These are equipped for training contact farmers and extension agents, and are also open for use by farmers interested in DAP technology.

5. On-farm follow-up training

This is done by contact farmers supervised by animal traction officers to evaluate the quality of their technology transfer packages and to give them confidence.

6. Shows and tours

These are used to create awareness and to boost enthusiasm for the technology by demonstrating packages.

7. Mass media

This is used to sensitise farmers on the benefits of DAP technology especially in regions where adoption levels are still low.

8. Gender sensitivity

The extension staff are encouraging women to take up DAP technology. In this respect, more success has been realised with donkey traction than with cow traction.

Constraints

- Inadequate equipment
  We have too few DAP implements and spare parts and they are poorly distributed. Although SAIMMKO, a local manufacturing plant, has started making ploughs and harrows, most DAP implements in Uganda are imported by projects for specific project areas. The locally

manufactured equipment is too expensive for local farmers. Because of the liberalised market, it is hoped that local entrepreneurs will import DAP implements with proven performance.

- High prices of DAP implements
  DAP implements are made even more expensive by the fact that they are not versatile and can be used for only a narrow range of farm operations.
- Too few trainers on DAP
  There are too few well-trained extension staff and contact farmers to meet the high demand for training. Training of trainers is hampered by shortage of funds. This has resulted in the inefficient use of DAP by some farmers and slowed adoption of the technology in areas where it is new.

Draft power use in smallholder farming systems of Tanzania

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Background

Tanzania has approximately 12.5 million head of cattle. Ninety-nine per cent of this population are the Tanzania Shorthorn Zebus (TSZ). The animal, despite its low genetic potential for growth and milk production, contributes 6.7% of the nation's draft animal power (DAP) and 93% of the milk (Msechu 1988). The figures on DAP use (Table 1) indicate the technology is not traditional. It has been adopted to solve labour constraints in agriculture and transportation by both agriculturalists and nomadic pastoralists (Galema 1992; Sosovele 1994; Kwiligwa et al 1994; Roeleveld and Wella 1994). The extent of DAP use in Tanzania varies considerably (Table 1). However, use is high in the livestock-keeping areas. The technology is a male-dominated activity. The male household members have both the operational and technical knowledge, whereas the females have only the operational knowledge.

Table 1. *Draft animal power use in Tanzania.*

Zone	Oxen	Donkeys	Total	% of total
Central	90,662	53,027	143,689	13.64
Coastal	838	6,477	7,315	0.69
Lake	459,619	22,947	482,566	45.80
Northern	71,047	114,245	185,292	17.59
Southern highlands	142,941	12,407	155,348	14.74
Southern	32	37	69	0.00
Western	71,233	8,168	79,401	7.54
Total	836,372	217,308	1,053,680	
% of total	79.38	20.62	100.0	

Total cattle population = 12.5 million; Percentage of DAP = 6.69%.

Source: MALD (1984).

In fragile lands, like the Kondoa Eroded Areas (KEA) and Mvumi Division in Dodoma region indigenous livestock were evicted after the area was restocked with zero-grazed improved and local cows. In KEA draft animals, mostly indigenous oxen, are allowed to work in the fields towards the end of the dry season (October and December) and the beginning of the wet season, (December to February). However, farmers require monthly permits to use donkeys which are for farm transportation. The animals are not allowed to graze outside a 50-m radius from the household.

A participatory rural appraisal (PRA) survey conducted in KEA (Maiseli et al 1995) and Mvumi Division (Hortland 1993) identified animal traction and labour as constraints to crop and livestock production. Although farmers admitted that both problems limited farm produce, they were not aware that cows trained for draft work could solve labour problems.

Labour and productivity of zero-grazed cows in the HADO areas of central Tanzania

Zero-grazing of cows in the destocked areas of central Tanzania is carried out to maintain soil fertility and vegetation and discourage soil erosion. Improved and local cows produce on average 8.0 and 3.3 litres/day, respectively (Larsson 1993). The mean (Table 2) lactation length for the improved cow was 409 days (Shayo et al 1993) with a calving interval of between 473 (Shayo et al 1993) and 489 days (Mkonyi et al 1993). Keeping an improved cow is profitable for the smallholder if the animal is fed adequately with concentrate supplementation of 1–6 kg/day (Larsson 1993).

Table 2. *The productivity of improved cows under zero-grazing in central Tanzania.*

Productivity	Mean	SD
Calving interval (days)	473[a]	NI
	489[b]	106.17
	498[c]	97.0
Lactation length (days)	409[a]	NI
	300[c]	17
Age at 1st calving (months)	33[c]	NI
Milk yield (kg) in 300 days	1626[c]	323
Milk yield (excluding suckled) in 305 days	1675[d]	NI

SD = standard deviation; NI = not indicated.

Sources: a = Shayo et al (1993); b = Mkonyi et al (1993); c = Rushalaza and Kasonta (1993); d = Hortland (1993).

The labour input has been between 690 to 1105 and 870 to 1486 hours/animal per year for fetching water and collecting fodder, respectively (Table 3). In adopting the zero-grazing system, routine work in the household has increased. The farmer has to spend between 2100 and 3037 hours per year attending cows in confinement (Table 3).

The progress of oxenisation has been slow in solving the labour and transport constraints of the smallholder.

Table 3. *Labour input (hours/animal per year) in zero-grazing systems of central Tanzania.*

Activity	Haubi[a]	Kolo[a]	Mvumi[b]
Fodder collecting	919	1486	870
Fetching water	690	1105	690
Cleaning the shed	475	336	540
Spraying the cows	37	NI	NI
Total	2121	2827	2100

Sources: a = Maiseli et al (1995); b = Hortland (1993).

Diversification of DAP by breed and sex of the animals

The TSZ is discredited for its body size, weight, milk yield and reproductive performance (Table 4). Oxenisation using the TSZ has not been sufficient in solving labour and transport constraints especially in the Dodoma Soil Conservation Programme (Hifadhi Ardhi Dodoma, HADO) villages. The cow, due to her high social and cultural value in the society, has been reserved for breeding. Therefore introducing cow traction in an area where livestock keeping is a tradition is difficult. Donkeys (males and females) are equally used for traction.

Table 4. *The productivity of indigenous Tanzanian cows (on station).*

Productivity parameter	Range
Age at 1st calving (months)	36 – 44
Milk yield (kg) in 245 days	900 – 1050
Dry period (days)	123 – 259
Calving interval (days)	362 – 393

Source: Adapted from Msechu et al (1987).

The argument for increasing DAP by breed and sex is valid where other sources of power for farm operations are scarce and expensive. Increasing the use of work animals also means that human labour will be more accessible for other production activities in the farm. Similarly, with more land fragmentation for agricultural purposes, sustainable DAP has to include female animals as they will also provide the replacement stock.

Cross-breeding the TSZ with taurindicus breeds has provided the smallholder with superior animals in terms of meat, milk and DAP. A crossbred animal has 25–30% more body weight (Getz et al 1986), higher milk production (Table 2) than the zebu cow and a bigger body (Mpiri et al 1983). Both males and females are ideal for draft purposes. However, they are not used because males are reserved for breeding and females for milk and calf production.

The need for cow traction within the HADO project area

Zero-grazing was introduced successfully in 1989. In 1993 an economic analysis indicated an increase in the income of co-operating farmers, with an improvement in their social welfare (Ulotu 1994). The adoption of zero-grazing of cows has reorganised labour in the household with clear gender specialisation in management; women still carry out 72% of all household activities (Maiseli et al 1995). Transporting manure to the fields is the responsibility of women. The working period of oxen is limited and the farmers are not allowed to keep them in stalls. Therefore farm transportation is a big problem in the villages.

Group interviews indicated that people of Irangi Chini Village in Kondoa District used indigenous cows for ploughing their fields when the oxen were sick. However, from 1970 onwards cows were not encouraged to work in the fields because livestock extension workers wanted to promote the use of oxen. To date farmers without cattle and those with improved cows have little access to animal traction because most of the draft animals belong to agropastoralists. However, the population of improved and local cows under zero-grazing is increasing.

The feed consumption rate of 4.5 kg of air dried feeds/animal per day (Shayo et al 1993) indicates that biomass production will eventually not be sufficient for both cows and draft animals. Improved cattle in the HADO villages are not competing for feeds. However, not all farmers will accept the multiple use of cows because:

- they think it will reduce milk supply and hence cash flow from sales of surplus milk
- they believe that subjecting a milking cow to working is drudgery hence a sin
- they believe that the cow is not as strong as an ox or donkey in traction
- they have never seen a cow working.

Farmers need to be made aware that cow traction technology is a workable idea to minimise the above adoption constraints. The farmers would be convinced if they saw a demonstration using co-operating farmers in either Haubi or Kolo villages in KEA where farmers were willing to train their female animals at a younger age. The idea is logical because at a later stage in the adoption of the technology, farmers will not notice the difference in either milk or reproductive performance of their cows.

Conclusion

We have to prove to the farmers that work does not adversely affect the economic benefits expected from their cows.

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Malawi country report

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Introduction

Malawi is a small country in south-eastern Africa. It has a total land area of 12.3 million hectares, of which 2.9 million hectares are under water. The country borders Mozambique, Zambia and Tanzania. Malawi is a landlocked country with no access to the sea; however, Lake Malawi runs the entire length of the eastern side of the country. The estimated human population is about 10 million people.

Agriculture is the main occupation of the population, of which about 5% are estate farmers and 95% are smallholder farmers who cultivate about 1 ha of land (a range of 0.3–2.0 ha).

The objectives and constraints of farmers in Malawi

The objective of farmers in Malawi is to improve their incomes and food security by increasing productivity and diversification. However, the constraints to improved agricultural productivity are:

- declining soil fertility and soil erosion
- poor access to production inputs due to low levels of purchasing power
- shortage of labour
- land pressure.

Extent of animal power use and potential for use of dairy cows for draft in Malawi

The distribution of draft animals and equipment (Table 1) indicates that animals are, to some extent, used for draft.

Table 1. *Distribution of draft animals and equipment by Agricultural Development Divisions (ADDs) (1987).*

ADD	Work oxen	Ploughs	Ridgers	Cultivators
Blantyre	414	118	110	16
Karonga	10,375	3,581	443	36
Kasungu	13,613	2,977	4,253	81
Lilongwe	15,000*	1,508	1,199	156
Machinga	802	317	208	17
Mzuzu	18,494	8,694	6,037	151
Shire Valley	2,520	458	189	16
Salima	8,500*	950	829	82
Malawi	69,718	18,603	13,268	555

* Estimated figures.

Currently, only oxen and donkeys are used for draft power. Malawi Zebu cows have been used as draft animals only on stations and the technology has not yet been tested on farms. However, farmers who have seen the technology are anxious to try it.

A few farmers were asked about the use of dairy cows for draft work and their response was that it was worth trying. Therefore, there is a potential for using dairy cows for draft work in Malawi. It is a question of giving it a try.

Draft power use and use of cows for draft in smallholder farming systems in Mozambique

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Overview of cattle situation in Mozambique

In the past, livestock in Mozambique played an important role in the agricultural development of the southern and central parts of the country. However, over the years the number of cattle has decreased from one million to approximately 200,000 in 1992. Draft animals have also decreased from 100,000 to 27,000 and milk production has decreased from 10 million litres to 1 million litres/year.

The present use of cows for traction

At present in Mozambique there is increasing interest in using cows for draft and farmers have, on their own initiative, started to use cows for traction. A survey conducted in 1992 showed that more than 50% of farmers used one or two cows for traction purposes. The replacement of oxen by cows was first recorded in 1985. In areas where farmers already use local cows for draft without supplemental feeding, cows are not worked when they are pregnant. A consequence of this practice is that farmers cannot use their cows for traction during certain parts of the year and therefore have to rent either a tractor or oxen. Experienced farmers use cows for traction even during pregnancy, and occasionally cows are worked until calving.

Most farmers now using cows have been forced to because of recent heavy losses of cattle, especially males. The use of cows for traction appears to be a temporary solution to the draft requirements of smallholder farms. It appears that farmers are not convinced of the long-term advantages of using cows for traction and they are requesting oxen.

Potential of using cows for traction

This technology is particularly relevant in irrigation schemes where overgrazing is leading to erosion and damage of the irrigation infrastructure. In these irrigated systems cattle are not allowed to graze in the irrigated areas during most of the year. Mating can be controlled with little effort to minimise the number of pregnancies during the ploughing periods. In other parts of the country there is less need for the technology because of the abundance of pasture.

Discussion on the country reports

Kenya

Zerbini: Mr Masai, you have described in general what the animal traction situation is in your country and what the constraints to animal traction are, and there are areas where animal traction will or has to be introduced. When we talk about using cows I have two questions: which type of cows are you planning to introduce, local or improved cows? Is the opportunity of using cows greater where there is no animal traction currently or where animal traction is already in use?

Masai: When I talk of cow traction I am referring to the local cows to start with. When the programme of cross-breeding begins this will be available to farmers. But as we speak now we do not have crossbred animals, therefore we have to start with local cows. This will expand in areas where the adoption rate is high, but we need a change of attitude so that farmers can change from the idea of using oxen to using cows. In areas where the technology is new, they are ready to start with anything so long as it can work.

Uganda

Masai: Mrs Sseruwo, why do you need to introduce draft animals in Uganda? Why don't you continue with what you have? You could then compare the areas which had the DAP programme with those which did not.

Sseruwo: We use animal traction because the introduction of tractors in the past has failed and the only alternative that we have therefore is DAP use. We have also to change DAP use in order to increase our incomes and standards of living.

Adera: You mention that in the northern part of Uganda the adoption of cow traction is encouraging. What are the problems you encountered regarding the efficiency of the cow particularly during critical physiological stages like pregnancy and what are the measures to overcome such problems? I ask this because smallholders cannot afford the lowered efficiency particularly during the critical period of ploughing.

Sseruwo: I said that in northern and eastern Uganda, the adoption rate of improved cows for milk is high, but we are just trying to introduce cow traction. These people have been using oxen for traction, not cows; now in these areas we are encouraging the use of cows. We encourage them not to use cows during the last month of pregnancy.

Tanzania

Azage Tegegne: My question relates to the social problems of animal power adoption in Tanzania. Do you involve women in agricultural production systems in Tanzania? If you do, what is the view of men on the involvement of women?

Ulotu: Yes, women carry out many of the agricultural activities in our area. They participate in milk production and we think that cow traction can change the division of labour. Cows will also be used for transport and therefore women will have less work to do.

Zelalem Alemayehu: You have indicated that the implements used for oxen may not be applicable for cows. Have you done any research on this issue? I want to raise this question not only to you but also to other presenters. To what extent have they studied the implement aspect together with the animal husbandry aspect of cow traction?

Zerbini: Our research on-station has been done with different loads. It has been done with 7% body weight, 10% body weight, 15% body weight and 20% body weight draft force. As I indicated this morning these F_1 crossbred cows averaged 400 kg and they had the greatest efficiency when they were pulling 14% body weight. So, for any implement you can calculate how much draft force is required and estimate if the cows can pull it or not. We have all the data related to different loads and you can relate different loads to different implements.

I would like to ask Mr Ulotu a question. In the areas in Tanzania where animals have been evicted to decrease soil degradation, what happens to land cultivation? Is it still done by oxen or is it done by hand? What animals are used and what type of animals have remained on the land: cows, bullocks or others?

Ulotu: There is a big area in central Tanzania where the number of animals and grazing pressure caused land degradation. In 1973 the government decided to move all the animals from an area of around 1260 km^2 and from another area of about 950 km^2 to the lowlands 20 km away or more. Farmers were given temporary permits to bring oxen into the highlands during October and November for the ploughing season. Oxen would stay for four weeks then return to the lowlands. Later there was a lot of pressure on the local government to allow the return of at least some animals for milk production under a cut-and-carry system. Animals have been re-introduced there since 1979 under a zero-grazing system. Farmers are allowed to have only four animals per household, one bull and three cows. Since 1979 the situation has improved and at present there are around 300 households with improved animals. The demand for crosses is high and we haven’t been able to satisfy it. We have now more than 200 crosses and some of them are used for work because moving oxen from the lowlands is still difficult and also raises the risk of disease. These farmers also face transportation problems because donkeys are not allowed in the area.

Malawi

Azage Tegegne: You mentioned the use of Malawi zebu cows for traction on-station. Do you have any results on the draft performance of these cows? If you have any, how do you compare them with the oxen in terms of draft power?

Kumwenda: This work, done on-station using Malawi zebu cows, showed no significant differences between non-working and working animals in terms of milk and meat production.

Mozambique

Muller-Haye: I did not understand why farmers would reintroduce oxen. What was their rationale?

Faftine: Because when cows are pregnant they don’t use them for work.

Muller-Haye: The attitude towards using cows for work during pregnancy will change. In other countries cows are used for traction until about two months before expected parturition.

Zerbini: If I understand correctly, there was loss of animals, mainly males, during the war reducing their numbers from one million to 200,000 head. Do you expect that farmers will use cows for work until they obtain a sufficient number of males or do you think that farmers will continue to use cows for work in the future?

Faftine: Yes, I think that in most parts of the country the farmers will use cows until they have males to replace the cows. However, I think that in irrigated areas, where there are strict regulations on the number of animals allowed to graze, farmers will reduce their herds and use cows for multiple purposes.

Zerbini: Our experience over five years of on-station work with cows working 100 days per year is that cows can work up to 15 days before expected calving date and restart 15 days after parturition. In six years with 40 cows there was not a single abortion. I would like to point out to everyone who is concerned about the effect of work on pregnancy that there is no effect per se as long as cows are fed adequately.

Azage Tegegne: During the most critical period for reproductive activity (i.e. the first three months after calving), we should be able to provide alternative cow management strategies to smallholders in order to get these cows pregnant and then use them for traction purposes after pregnancy has literally settled.

Teleni: I agree with Azage. As the alternative option what I would like to ask is if you want to rearrange reproductive cycle, what sort of strategy would you adopt?

Azage Tegegne: If you are considering let us say June, July, August to be the peak season for traction power like in most parts of the highlands of Ethiopia, then you will have to breed cows in January or late December. By June, the cows will be 3 to 4 months pregnant and could be used for work for about another 3 months. This strategy will also depend on how many animals or how many cows you have on the farm for traction use. The cows would calve in late October or November and get ready for the following breeding season. This cycle where we apply a lot of pressure on these animals during mid-pregnancy could represent a solution. However, because of the extended period between calving and conception, this cycle may have to be reorganised. Probably some additional cows could be required on-farm to secure pregnant animals during the mid-gestation period for traction power. This could be worked out according to the individual countries calendars.

Zerbini: I agree with that point but we also have to consider that it might be necessary to have more than two cows on-farm. In building the crossbred herd these factors have to be taken into consideration. We are presently investigating this particular aspect on the on-farm research carried out in collaboration with IAR.

Osuji: I was surprised to hear that more than two cows may be needed to do land cultivation year round on-farm. This is because the whole argument of using cows for multiple purposes was to obtain a reduction in the number of animals on-farm to better match the feed resources available. If this technology is going to lead to more than two crossbred cows, how are farmers going to sustain them? And why is it necessary to have to insist on using the animal during mid-pregnancy?

Zerbini: Our on-station results show clearly that you can use the cows up to 15 days before expected calving but of course if the cow is expected to calve in a week's time you would prefer not to use her. It wouldn't really matter but going back to the issue of the number of animals, we are talking about farmers who have up to 10 local animals to substitute for three crossbred cows and two calves. This represents a net reduction of total TLU [tropical livestock units]. The resource poor farmers may have to deal with only two cows. So, we are not increasing the number of animals in any case.

Animal traction and the potential for use of dairy cows in the Ethiopian highlands

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Introduction

Agriculture in Ethiopia is dominated by smallholder farmers who produce 90% of the total food production of the country and cultivate 95% of the cultivated area. Eighty-six per cent of the population are engaged in agriculture (Cohen and Isaksson 1988).

The per capita gross domestic product (GDP) of Ethiopia in 1990 was estimated to be US$ 120 which placed the country among the lowest in low-income countries of Africa. This estimate was half that of Uganda and one-third that of Kenya (World Development Report 1992, cited in Fasil Gebre Kiros 1993). About 35% of the agricultural output in Ethiopia is contributed by livestock.

Ethiopia stands first in Africa in livestock holdings and has about 29.8 million cattle, 11.5 million sheep, 9.6 million goats, 1.1 million horses, 2.6 million donkeys, 0.2 million camels and 0.2 million mules (CSA 1995). Production increases to date have mainly been the result of numerical expansion of herds and flocks rather than productivity improvements. The capacity of indigenous cattle in Ethiopia in terms of both milk and meat production is very limited (Gryseels 1988, 179).

Animal traction in Ethiopia is believed to have been introduced between 1000 and 400 BC by Semetic speaking invaders from south Arabia (Goe 1987). In the Ethiopian highlands about 8% of farmers have three or more oxen, 29% have two, 34% have one and about 29% have no oxen (Gryseels 1988). Although oxen are currently the main source of power for cultivation in Ethiopia, they are used for less than 113 days in a year; however, the oxen have to be fed for the remaining 252 days.

The draft oxen/rural household ratio for Ethiopia is 0.9. This figure indicates that farm households in Ethiopia own only about one ox. The highest oxen/household ratio (1.67) is found near and around Addis Ababa. Eighty-one per cent of the total draft oxen in Ethiopia are found in the Oromia and Amhara regions (43.9% in Oromia and 37% in Amhara region). Of the total rural households in the country, 67% are found in Oromia and Amhara regions. More than 50% of crop production comes from these regions and yet households do not even own a pair of oxen on average (Table 1).

Farmers with one or no oxen are the ones who normally have problems in completing their farm operations on time. These farmers have to rent out, crop-share, exchange or loan out their land in order to finish cultivation on time. Farmers with one ox are better off than farmers with none as they can arrange a system called mekenajo, where two farmers with one animal each agree to pair their oxen and cultivate their land on alternate days. In this arrangement farmers normally do not meet the optimal planting date and obtain lower than potential yields. A delay of two weeks causes a 50% difference in crop yield (Gryseels 1988). Another alternative for farmers with one ox is to arrange a minda agreement where the farmer will take one ox from a nearby village for one crop season and in return pay 200 kg of any type of grain after the harvest.

Table 1. *Number of draft oxen over 2 years of age, number of rural households and oxen/household ratio.*

Region	Number of draft oxen[a] (in thousands)	Rural households (in thousands)	Oxen/household ratio
Tigray	520.14	598	0.87
Afar	24.71	168	0.15
Amhara Region	3,142.02	2,763	1.14
Oromia Region	3,684.13	3,375	1.1
Benshangul	34.03	94	0.36
S.E.P.A.R.	951.41	2,048	0.46
Gambela	0.21	29	0.007
Harar	5.42	12	0.42
Addis Ababa	10.17	6	1.67
Dire Dawa	9.80	14	0.71
Total	8,382.04	9,107	0.9

a. Oxen over 2 years of age.

Source: CSA (1995).

The situation is even worse for farmers with no oxen. These farmers enter *engni*, *yemoyategna* or *balegne* arrangements whereby they cultivate the land of other farmers using oxen and then take the animals to cultivate their own land for one day. Farmers who are not necessarily poor, but are too old, weak or widowed often cannot use their oxen themselves. Such people make their oxen available for others in a *megazo* agreement where they crop-share only the crop equally. Straw is left for the farmer who crop-shares in the land. All inputs are the responsibility of the farmer who crop-shares in the plot. Share of produce in this type of agreement could also be 1/3 depending on the agreement between the two parties.

At present in the traditional systems, the ard (plough) or *maresha* is used in animal traction. In hundreds of years there have not been any major changes or developments to these implements. The weight of the traditional plough ranges from 17 to 26 kg with the yoke (Goe 1987); the plough can be easily transported by a single person for a long distance. The *maresha* is usually pulled by a pair of indigenous oxen weighing an average of 300 kg each and power of between 0.5 to 0.9 kw is developed (Abiye Astatke and Matthews 1980). The average speed of a pair of oxen pulling the *maresha* was recorded at 2 km/h in light soils with an average moisture content of 22% (Gryseels and Anderson 1983, 39).

Until recently, the use of dairy cows for traction has not been given attention in Ethiopia. Plans are being developed to promote this practice; this will help improve land use efficiency (Shapiro et al 1994). It is becoming increasingly difficult for farmers to meet their basic food requirements. Declining productivity, falling income and the debt burden are some of the factors which lead to rural poverty (Fasil Gebre Kiros 1993). It was against this background that the on-station cow traction research was started by the Institute of Agricultural Research (IAR) and the International Livestock Research Institute (ILRI) at IAR, Holetta.

The IAR/ILRI dairy–draft project

The objectives of the IAR/ILRI dairy–draft project were to:

- examine the performance of F_1, Boran x Friesian crossbred cows both in terms of traction and milk
- examine the effects of crossbred dairy cows on food security
- quantify the economic returns of crossbred dairy cows used for both traction and milk versus those used for milk production only
- identify factors affecting the adoption of the crossbred cow technology on farm.

The study area

The project site at Holetta is located some 45 km west of Addis Ababa. Altitude ranges from 2200 to 2500 m a.s.l. (metres above sea level). The area receives an average of 1100 mm of rain, mainly occurring between June and September. The mean maximum and mean minimum temperatures are between 21°C and 6°C, respectively (IAR 1986, cited in Chilot Yirga 1993).

According to Murphy (1968), soil types in the Holleta area range between reddish brown to dark reddish brown clays. Some Vertisols are also found in the study area. The research site has a sloping topography. The major ethnic group in the area is the Oromo Christian (Chilot Yirga 1993).

Household demographic characteristics

Mean household size is five adult equivalent of whom 60% are male and 40% are female. Of the households in the study 33.3% of the household heads are illiterate, 33.3% are able to read and write and 33.3% have elementary education (Mengistu Buta 1996).

Livestock and dairy production

Average livestock holding per household in the project area is over 11 total livestock units (TLU).[1] In an IAR/ILRI collaborative research project at Holetta, Ethiopia, crossbred cows used for dairy and draft are being compared with crossbreds used for dairy and oxen for draft and also with the traditional practice of using local cows and oxen. Smallholder farmers in Ethiopia hand-milk their animals. Average milk production from crossbred cows in the dairy–draft and dairy only groups was found to be 1816 and 2010 litres per 365 days, respectively. Average milk production from local animals rarely exceeds 300 litres. Most of the milk produced from local cows is converted to butter as it has more butter fat than milk from crossbred cows. The milk is usually kept in clay pots for three to four days, then shaken back and forth until butter granules form. This process takes two to three hours depending on the temperature, fat content, acidity of the milk and amount of milk in the pot. This activity is mainly the duty of the household wife or children (O'Connor 1992).

1. Tropical livestock unit (TLU) is a weighing measure used to standardise different types of animals for easy comparison. An ox of 250 kg live weight is used as the basis for converting different sizes and species of animals to TLUs (Gryseels 1988).

Milk from crossbred cows is mostly sold to the Dairy Development Enterprise (DDE) at US$ 0.15/litre. The DDE is a government dairy processing and marketing parastatal that has established whole milk collection centres. The DDE also has a chilling centre where milk is kept for a few days before it is transported to the Addis Ababa milk processing centre. A small amount of surplus milk is consumed in the household, mainly by children.

Crop production

Average cultivable and pasture land in the Holetta project area is 4.4 ha of which 3.9 ha are for crops and 0.5 ha is allocated for pasture. The same land is cultivated every year with some farmers leaving land fallow for one year. Seeding plots are divided into smaller blocks of about 4 m each called *kuta*; seeds are broadcast and covered using implements drawn by a pair of oxen. The major crops grown in the area are wheat, teff, barley, field peas, horse beans and oats/vetch.

Farmers use only 186 days a year for farm operations. The remaining 179 days are either saint days or holidays and are regarded as non-working days.

On-station results

Dual-purpose crossbred cows were tested for their suitability and adaptability when used for both taction and milk production. The experiment was conducted at Holleta IAR station. Twenty Friesian × Boran and 20 Simental × Boran cross stratified into a 2 × 2 factorial experiment was undertaken for three years. Work output, body weight, milk yield, conception rate and calving interval, manure production, labour and core veterinary parameters were recorded.

The results indicated that milk production and reproduction was not significantly affected by work. Total milk yield between non-working and working cows was 2224.7 kg and 1985.3 kg, respectively (Shapiro et al 1994). The major finding on-station was that crossbred cows could be used for work if they are adequately fed. The favourable on-station results suggested that the technology be tested on-farm.

The potential on-farm investment returns

The potential competition for resources and investment decisions facing farmers on-farm when deciding whether or not to adopt dairy cows for traction were simulated using the ILCA herd model (von Kaufmann 1990). This dynamic bio-economic simulation model can be used to analyse the technical, financial or economic impacts of a new technology. Introducing interventions into a farming system like improved forages, supplementary feeds, changes in herd structure and productivity can be analysed by projecting over a multi-year period. These biological simulation results are then incorporated into a cost/benefit analysis. Based on 3 years of onstation experiments, the herd model was used to simulate the herd production parameters over 10 years. Before it was applied, the model was modified to take into account the traction performance of crossbred cows. The multi-year production effects of crossbred cows for dual purposes (milk and traction) were compared with the use of crossbred cows for milk and oxen for work (Simulation 1 in Tables 2, 2.1 and 2.2) and the traditional system of using local cows for milk production and local oxen for traction (Simulation 2 in Tables 2, 2.1 and 2.2) (Shapiro et al 1994).

Table 2. *Results of benefit/cost analysis — using crossbred cows for dairy and draft.*

Returns to the cattle production systems	Simulation 1		Simulation 2	
	Supplemented non-working cows	Supplemented working cows	Traditional practices (local animals)	Supplemented working cows
Internal rate of return (%)	20.9	200.4	18.8	32.9
Net present value	10,274	29,031	4,086	15,721
Benefit/cost ratio	1:1	1:3	1:3	1:9
Net benefit/investment ratio	1:5	2:4	1:5	2:3
Economic returns to the intervention				
Internal rate of return (%)	–	125.7	–	78.4
Net present value	–	18,757	–	11,635
Benefit/cost ratio	–	15:6	–	3:5
Net benefit/investment ratio	–	990:6	–	4:1

Simulation 1 = Supplemented non-working crossbred cows for milk production and local oxen for work versus supplemented crossbred cows for milk production and work.
Simulation 2 = Supplemented crossbred cows for milk production and work versus traditional practices of local cows for milk production and local oxen for work.

Source: Shapiro et al (1994).

Table 2.1. *Results of benefit/cost analysis.*

Results	Simulation 1		Simulation 2	
	Supplemented non-working cows	Supplemented working cows	Traditional practices	Supplemented working cows
Annual undiscounted costs per cattle head	737	792	112	233
Share of discounted costs due to:				
Cattle acquisition (%)	19	19	68	53
Herding labour (%)	1	1	7	3
Forage and feed (%)	76	76	2	32
Minerals and veterinary treatments (%)	3	4	17	9
Veterinary and livestock services (%)	1	1	5	2
Annual undiscounted revenues per cow	5,527	7,906	3,613	5,496
Annual undiscounted revenues per cattle head	957	1,222	260	709
Share of discounted revenues from:				
Cattle offtake (%)	11	8	21	16
Final herd value (%)	8	6	22	9
Milk offtake (%)	72	61	40	68
Additional revenues (%)	8	25	17	7

Simulation 1 = Supplemented non-working crossbred cows for milk production and local oxen for work versus supplemented crossbred cows for milk production and work.
Simulation 2 = Supplemented crossbred cows for milk production and work versus traditional practices of local cows for milk production and local oxen for work.

Source: Shapiro et al (1994).

Table 2.2. *Biological results — averages over 10 years with and without intervention.*

	Simulation 1		Simulation 2	
Biological results	Supplemented non-working cows	Supplemented working cows	Traditional practices (local animals)	Supplemented working cows
Changes in herd size, year 0 to10 (%)	102	70	20	–13
Average herd size, year 0 to 10	19	17	13	8
Average annual herd offtake rate (%)	27	25	7	27
Average annual herd mortality rate (%)	2	2	6	3
Average annual milk offtake per herd	12,749	12,741	1,164	4,280
Average carrying capacity utilised (%)	–	–	212	126

Simulation 1 = Supplemented non-working crossbred cows for milk production and local oxen for work versus supplemented crossbred cows for milk production and work.
Simulation 2 = Supplemented crossbred cows for milk production and work versus traditional practices of local cows for milk production and local oxen for work.

Source: Shapiro et al (1994).

Results from the working supplemented crossbred cows showed a net present value of EB 29,031 versus 10,274 EB from the non-working supplemented cows (Simulation 1) (Shapiro et al 1994). The incremental internal rate of return for supplemented working cows over supplemented non-working cows is appropriately 125%.

The effect over time of introducing crossbred dairy cows into a typical farm herd of local oxen for work and local cows for milk production were also simulated using the herd model's cost/benefit analysis function (Simulation 2). Results of using supplemented crossbred cows indicated a net present value of EB 15,721 compared to EB 4086 from the traditional practice of using local cows and oxen.

The incremental benefit/cost ratio of using supplemented working cows for milk production and traction over the traditional system of local cows and oxen is about 3.5 and the incremental internal rate of return is 78%. Even though there is substantial additional investment associated with going from the traditional system to the improved one the net incremental return on investment is 4. These results show clear potential for testing this technology under farmer conditions.

The value of work more than compensated for the small decline in milk production and longer reproductive cycle found in working cows when supplementation ensures adequate nutrition. In all the simulations done feed costs accounted for the greatest proportion of the variable costs, while the largest proportion of revenues was the value of milk produced (Table 2.1). Moreover, the value of milk produced by supplemented working and supplemented non-working cows was not significantly different. The greater returns to investment in supplemented working crossbred cows was thus mainly a result of the higher value of the work output, in spite of the higher feed costs and lower offtake.

The returns from introducing supplemented cows were also much higher than from the traditional system of using local cows (which are in effect non-supplemented). Inadequate feeding of local cows apparently is one reason that traditional practices result in a low net present value of the returns on investment. The greater costs of feeding supplemented working crossbred cows are largely offset by the greater value of milk and of manure. Inadequate nutrition results in longer calving intervals and fewer calves, as well as lower value of milk offtake.

The traditional system is a far less productive and sustainable system than the improved one in which crossbred cows can be substitutes for oxen. The introduction of the dual-purpose crossbred cows results in a smaller average herd size over time, 8.4 as opposed to 12.6 TLUs, according to the simulation results. There is a significant difference in the effects of the system on the carrying capacity of the limited available pasture land. The average carrying capacity used by the traditional herd was 212%, while it was 126% for the improved herd (Table 2.2). The improved system has a lower stocking rate, and thus a far more benevolent effect on the land resource of the farmer.

On-farm research

Before the project, only oxen were used for taction in the study area. However, an anthropological study (Pankhurst 1993) found that although farmers are skeptical about using crossbred cows for traction, they are open to testing the technology. Thus, insurmountable cultural obstacles to the introduction of crossbred cows for traction purposes on the part of Holetta farmers are not expected.

Systematic consideration in the on-farm testing is being given to the effects of socio-economic factors, as well as institutional factors, such as credit, that could prevent the adoption of this technology by resource-poor farmers. The fit of the new technologies is also being evaluated in a whole-farm context, including how their introduction would change intra-household resource allocation and distribution of the potential benefits. These analyses will help planners and policy makers to develop more effective policies and programmes to improve farm productivity and farmer incomes.

On-farm results

The on-farm research started with 14 farmers in 1993. In 1995 another 60 farmers were added to the study to make the results more meaningful. Data on the cultivation efficiency of a pair of crossbred cows versus a pair of oxen (Table 3) indicated that in both years for all farm operations crossbred cows are more time-efficient. During 1993/94 it took crossbred cows less time to complete the first, second and third planting times than it took local oxen. The results of the test for 1994/95 also indicated similar results. It took 30 h/ha and 22 h/ha for crossbred cows to complete the first and second passes, respectively, versus 39 and 29 h/ha, respectively, for local oxen.

There was also no significant difference in mean milk yield between those using the crossbred cows for dairy–draft and those using crossbred cows for milk only (Table 4).

Availability of feed both in terms of quantity and quality is very poor in traditional systems in the Ethiopian highlands. Farmers owning crossbred cows need to buy additional hay and concentrates to sustain the animals for the whole year. Concentrates and roughages are the most commonly purchased animal feeds and use up about 9% of the income from sales of dairy products.

Although share of area cultivated by crossbred cows is quite small, 10–25% of the total area cultivated, this result is still encouraging. The introduction of dual-purpose crossbred cows should be viewed also from the point of view of how the scarce feed resources can best be utilised, the alternative advantage of using male animals to be fattened and sold at a younger age and the alleviation of overgrazing due to reduced stocking rates. About 120 crossbred cows have been distributed to 60 households since 1995 and research is continuing with a larger sample.

Table 3. *Draft animal time required for cultivation (paired hours), 1993/94 and 1994/95 crop seasons.*

	1993/94		1994/95	
Particulars	Dairy–draft (h/ha)	Oxen (h/ha)	Dairy–draft (h/ha)	Oxen (h/ha
1st pass	31	37*	30	39***
2nd pass	25	33***	22	29***
3rd pass	23	31***	25	28
Seeding	28	29	27	30

* = t-test significant at 90%; *** = t-test significant at 99%.

Table 4. *Mean milk yield and average lactation days for crossbred cows.*

Group	Milk yield (kg)[1]	Lactation days
Dairy–draft group	1,816	344
Dairy only group	2,010	356

1. Milk yield adjusted to 365 days lactation.

Conclusion

The most important result of the on-station research was that properly managed and adequately fed crossbred cows could be used for both traction and milk production without any serious effect on production and reproduction. When the costs and benefits were projected over a 10-year period, the ILCA herd model gave an incremental internal rate of return of 125% for supplemented working cows over supplemented non-working cows. Furthermore, supplemented working crossbred cows gave 78% higher returns than the traditional system of using oxen for traction and local cows for milk production (Shapiro et al 1994). The higher feed cost associated with supplemented crossbred cows is offset by the greater value of milk production, traction and manure. Longer calving intervals leading to lower number of calves and lower milk offtake, however, were typical of inadequately fed crossbred cows.

According to the simulation results, introducing crossbred cows reduced herd size to 8.4 TLUs as opposed to 12.6 TLUs in the traditional system. This difference could result in a more realistic use of scarce pasture land by more adequately matching the carrying capacity of the land, thus reducing overgrazing.

The results obtained on farm complement those obtained on station. Using the t-test to compare milk yield between dual-purpose and dairy only crossbred cows showed no significant difference. Two years of studying traction-time efficiency indicated that crossbred cows are 23 h/ha faster than traditional oxen in terms of total cultivation time.

As population increases there is growing competition for land between crops and animals, making it difficult to grow more forages. Therefore, it is of prime importance for policy makers to support the reduction of low-productivity local animals and encourage farmers to keep dual-purpose cows to alleviate pressure on land.

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Research on the nutrition of cows used for draft work in Indonesia — A case study

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Introduction

This paper is largely drawn from research experience in Indonesia and Australia under the ACIAR Draught Animal Project. Presented for further discussion in this consultation are some of the considerations we thought useful and lines of investigations we pursued. No doubt, the uniqueness of each region (where draft animals are important) in its culture, resources, environmental conditions and farm systems could make some points presented here totally irrelevant or highly applicable.

Cows for draft work

Pressures of circumstances/situations usually result in developments leading to the optimisation of systems. The use of cows for draft work is an appropriate example of such developments. The increasing pressures of high human and livestock population densities and critical fluctuations in feed supply in regions where draft animal power (DAP) is used are compelling reasons for an increased efficiency in the use of our animal resource for work. Whether the initiative for increased efficiency comes from the field adviser or the research scientist seems irrelevant, for it would appear inevitable that the farmer, under intensification pressure, would logically use cows for work. Not only will the use of cows give the farmer the opportunity to harvest other products such as calves and milk, in addition to work, it could also reduce the herd size required to service the need of a rural community for DAP.

In Indonesia, where the pressure for land is high, the main class of animals used for draft work is the cow. In other Asian countries, there is evidence that as the demand for land increases so also does the tendency to use cows for draft work (see Matthewman 1987 for review). There appears to be little evidence of strong opposition by farmers to cow traction. Thus the potential for the use of cows for draft work would appear relatively limitless as long as the pressure for land is high in the given region.

Appropriate nutritional research

To increase the chances of success of nutritional research aimed at achieving a useful farm outcome, it is necessary that the resultant technology package is not only underpinned by sound nutritional science but also must be user-friendly. In the years of research on the nutrition of cattle and buffalo in Indonesia, one is constantly reminded of the importance of the terms: appropriate technology and sustainability and the fact that the farmer is central to any assessment of these terms. Appropriate technology, in the context of nutrition, is basic to the longer-term sustainability of a nutritional package and it might be characterised by:

- its high degree of user-friendliness

- the strength of the nutritional science that underpins it
- the clarity of the farm system that it targets
- the ready availability of relevant feed resources.

Because of the above, it might be suggested that while one might easily define problems in draft animal systems in a global context, one would probably find it difficult to offer general solutions.

The Indonesian study

Our research programmes were developed only after Indonesia identified the need to improve the efficiency of its draft animal systems. Our initial task was to identify and focus our research on the draft animal system most important in the country. We found this to be that which was intimately linked with cropping and therefore largely involved in land cultivation. This was followed by the selection of representative study sites and, through survey and monitoring studies, the description of the farm systems within these.

Survey/monitoring

The farms

The farms were small, ranging from 0.3 to 0.8 ha per farm. Some of the consequences of the small sizes of holdings included:

- the use of cattle or buffalo as multi-purpose animals, viz. for calf production, for work and as a ‘savings bank’
- the significant role that the cut-and-carry system had in the feeding of these animals
- the common practice of intercropping
- Where water supply was reliable, rice was the main crop, otherwise crops such as maize or cassava were predominant.

Animal performance

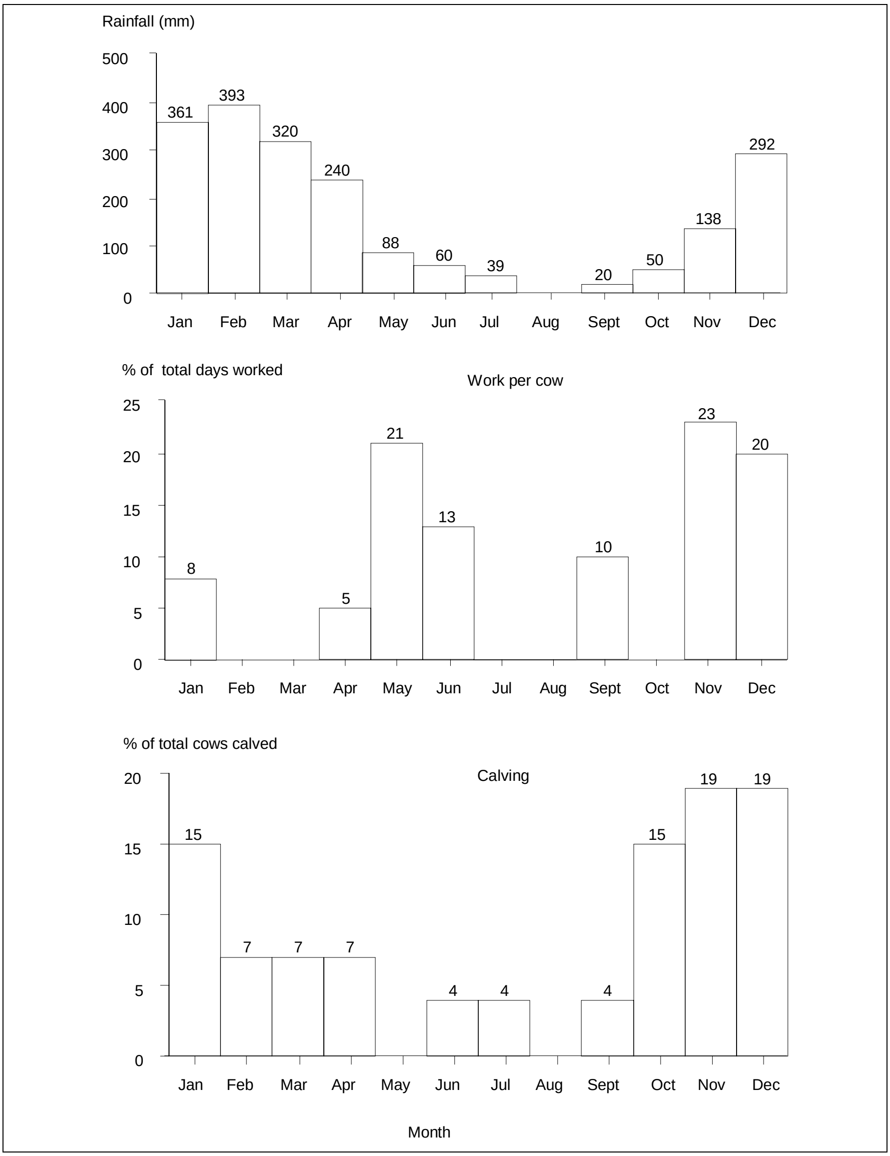
Work. In ploughing an area of land, a pair of draft cows was required to pull draft loads ranging from 40 to 60 kg, developing tractive effort equivalent to 10–14% of their combined live weights. The pair walked at 2.5–4.00 km/hr (0.7–1.0 m/sec) while ploughing, for 3–6 hrs/day. The average work season ranged from 20–30 days/year.

Using these data, we were able to establish from controlled experiments that in the high temperature range normally experienced in the tropics, an animal with a low capacity to dissipate body heat would not be able to sustain draft in excess of 11% of its live weight. Thus a pair of animals, each weighing 200–280 kg and above, should be able to cope with the work required to be undertaken on farms.

Production. The mean calving rate of cows varied from 27% to 56%. In particular, the peranakan Ongole which was the predominant breed of cattle in our study sites showed low calving rates. It was observed that the two main reasons for the low figure were the poor nutritional status of the breeder cows and the unavailability of good bulls. Problems associated with bulls included low numbers, poor accessibility, low fertility and apparently poor libido.

Even when these problems were overcome, the nutrition of the breeder cow was still a significant problem.

Cows were largely worked early in the wet season after coming through a period of five dry months (Figure 1). Some of these animals would be in late pregnancy or early lactation (Figure 1). Thus a significant number of cows would have exceptionally high nutritional demands during the work season.



Source: Adapted from Komarudin Ma'sum et al (1993).

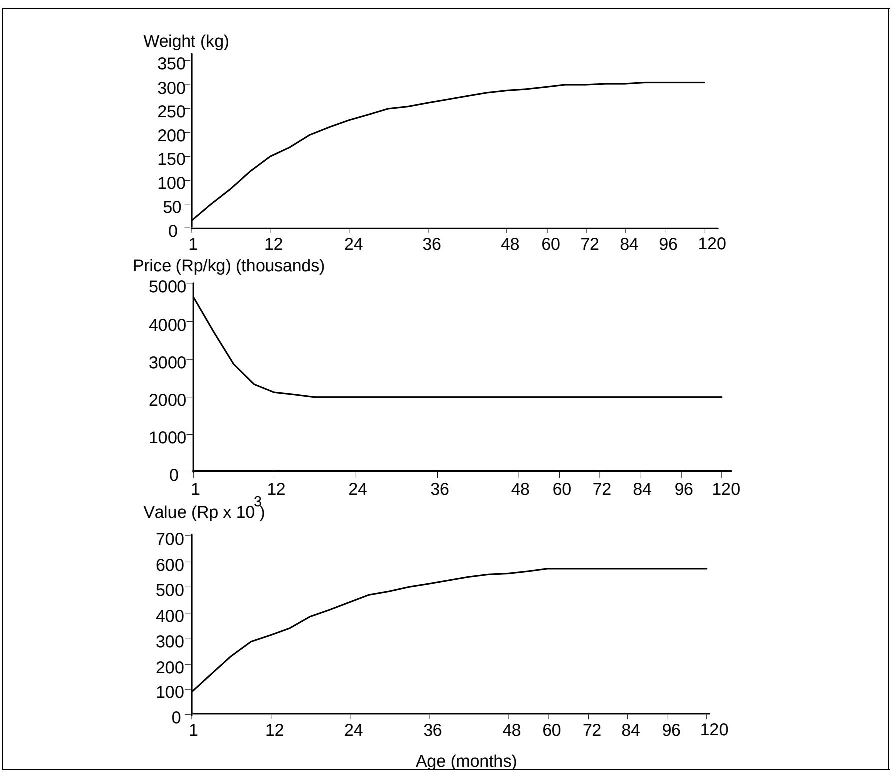
Figure 1. *The patterns of annual rainfall, work and calving of peranakan Ongole cows in study sites in East Java Province.*

Feed supply

In such small holdings, the feed given to cattle was almost exclusively made up of field and roadside grasses, crop residues such as rice straw and cane tops and shrub/tree legumes. Although animals were occasionally grazed in fields and on roadsides, they were largely hand-fed throughout the year. During the dry season, the contribution of field and roadside grasses within a village was significantly reduced, giving prominence to crop residues such as rice straw and to shrub/tree legumes and to forages harvested from outside the village area. Concentrates were not normally fed to draft cattle in this region.

Socio-economic evaluation

Given the above information on draft animal systems in the region together with other data derived from our survey/monitoring studies, the socio-economic team undertook an economic analysis of the purposes for which cows were kept by smallholder farmers. While all the purposes were very important socially and economically to the farmers, it was concluded that the incremental return on our research dollar would be greatest for improvements in efficiency of calf production. That is, significant improvement in financial returns could be realised from the achievement of a shorter calving interval by cows and a faster liveweight gain by calves to 12 months of age (Figure 2). Such returns could not be matched by any gains in draft work capacity or efficiency by the animals.



Source: Adapted from Perkins and Sabrani (1993).

Figure 2. *Age, live weight, price and value relationships; female peranakan Ongole cattle, East Java, 1990.*

It is clear from the above that priority in the allocation of quality feed should be given to cows to achieve an earlier return to oestrus, post-partum, and/or to calves to maximise their liveweight gain.

Nutritional physiology

Two sub-programmes were undertaken. One was aimed at obtaining some basic physiological information relating to the working animal. The other, more closely related to the concept which would underpin our nutritional package for the cow, was aimed at obtaining specific information directly relevant to the development of the package.

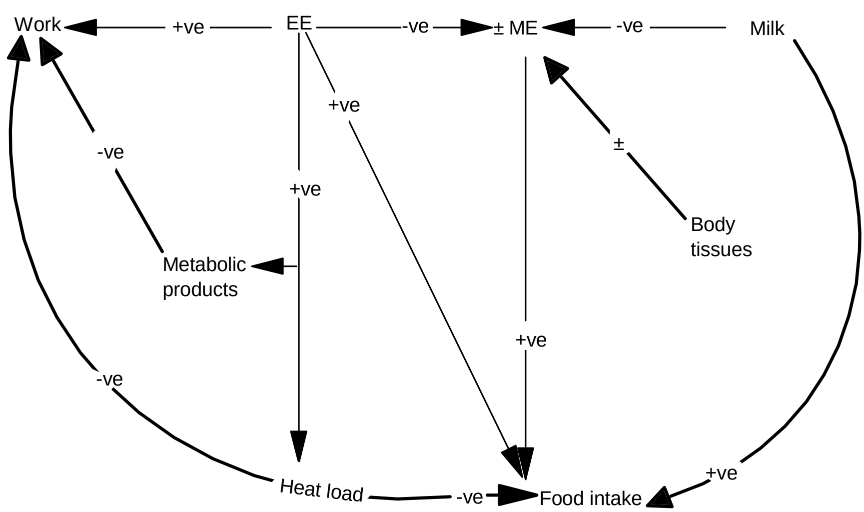
All studies undertaken in the two sub-programmes were under conditions closely similar to those which prevailed on farms surveyed/monitored in our previous programme.

Basic information

The questions asked here were:

- How much energy would be expended by the working animal?
- Would work influence the amount of food eaten and the extent to which the food is digested?
- Which nutrient(s) and how much would be required by the working muscle?

Food intake/digestibility. Our studies (e.g. Bamualim et al 1987; Bakrie 1988; Teleni et al 1991; Tarigan 1993; Mbwambo 1994) as well as those of others produced results, some of which were similar and some conflicting. Such uncertainty is quite prominent in this area of DA research and is probably a result of the varying balance, achieved in the different studies, of the different interacting factors which largely determine the amount of metabolisable energy (ME) in the working animal (see Figure 3 and Teleni 1995 for further discussion).

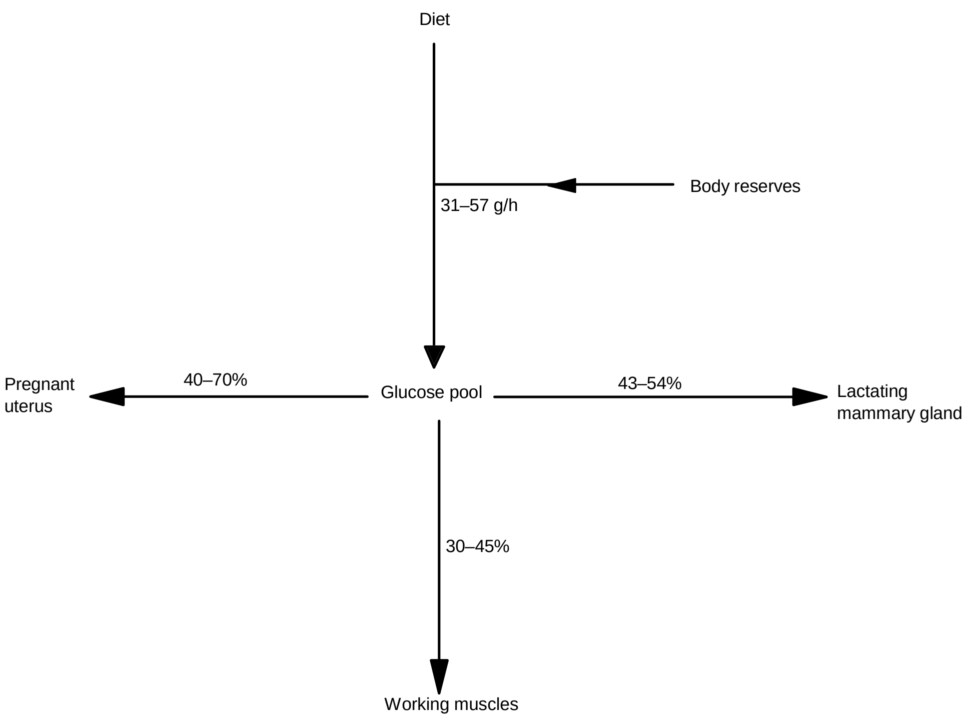


Source: Teleni (1995).

Figure 3. *The major interacting factors [work, energy expenditure (EE), milk production, body tissues, heat load, metabolic products and food intake] which influence the metabolisable energy (ME) balance in the working, lactating cow.*

Nutrients required. We have used cattle, buffaloes and sheep in studies to define the specific nutrients which are preferentially used by working muscle (e.g. see Kartiarso and Teleni 1988; Martin and Teleni 1988; Kartiarso 1993; Martin 1993). There is general consensus that glucose and free fatty acids (FFA) are the major energy-yielding substrates used by working muscle. The pattern of substrate usage appears to be glucose being prominent in the earlier stages of the work period (i.e. first two hours) with FFA becoming more dominant as work progresses.

The blood flow through the hind-limb muscles during work increases by some 300–400% of resting values. Both this increase in muscle blood flow and glucose extraction result in significantly increased rates of utilisation of glucose by the working animal (see Figure 4).



Source: E. Teleni (unpublished data).

Figure 4. *Estimated glucose entry rate (g/h) and the proportional (%) extraction of glucose by tissues of a draft cow.*

It is clear from Figure 4 that the competition for glucose by the productive tissues can be intense. The situation can be quite critical if the workload is heavy and/or glucose supply limited. Our work with lactating ewes (Dwatmadji, unpublished data) indicated no adverse effect on milk production if the animals were worked at 1.3 times maintenance energy requirement. At 1.7 times maintenance, however, there was a significant reduction in milk production. The reduction can be halted by intravenous infusion of glucose during the work period (see Figure 5).

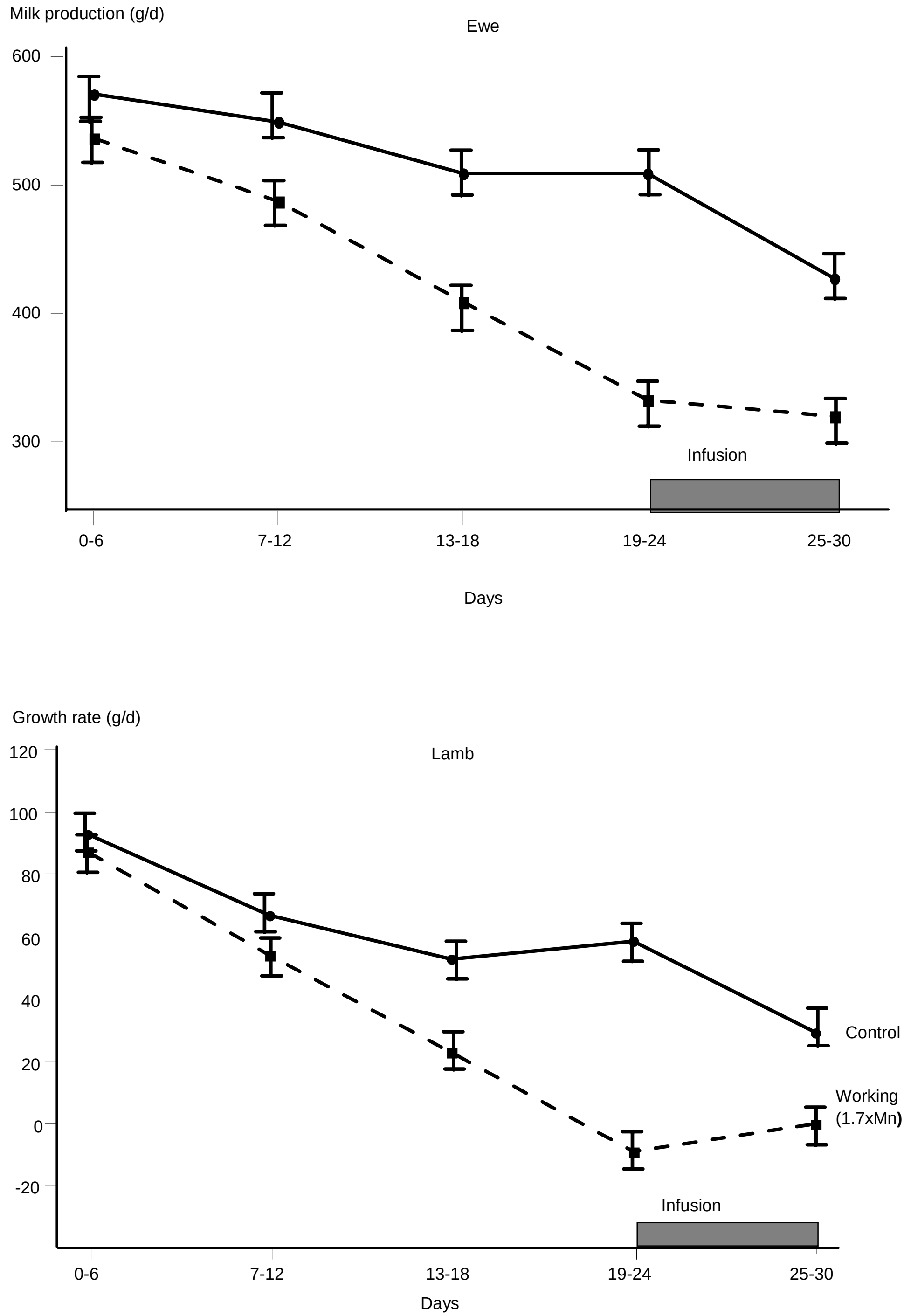


Figure 5. *Milk production of working and control ewes with their respective lamb growth rate.*

Glucose was intravenously infused into the working ewes during the working period of 4.5 hours per day for 6 days, i.e. days 25 to 30 inclusive (Dwatmadji, unpublished data). This observation is consistent with results of feeding studies in which the depression in milk production caused by work could be minimised by feeding cows with high quality diets (see Barton 1991; Matthewman et al 1993; Zerbini et al 1993). Thus for the dairy cows used for draft work, the important researchable questions might include:

- On a given basal diet, what would be the minimal level of work which would reduce milk yield?
- What would be the response curve of milk production of cows on such a diet to increasing workloads?
- To what extent could farmers economically counter with high quality diets the depressing effect of given workloads on milk production?

While it can be said that the response in milk production to a nutrient influx is relatively quick and obvious, the same cannot be said for the response of ovaries to a nutrient influx in the post-partum anoestrous cow. This is largely because the interaction between nutrients and ovaries is complex and, at present, largely ill-defined.

Nutritional package

In developing concepts to underpin our nutritional package for the draft peranakan Ongole cow, we were mindful of the fact that the smallholder farmers in the region were generally loath to spend money on proprietary or supplementary feeds for their draft cows. They preferred, instead, to spend labour on harvesting roadside and field grasses and shrub/tree leaves to feed their animals. The preference was largely due to the fact that return on investment in feeds for their beef/draft cows was not immediately obvious as in the case of dairy cows where there was usually a quick cash return for milk produced.

Taking the above into account and the fact that high quality feed was not consistently plentiful we asked ourselves the questions:

- How could we minimally feed cows without compromising their ovarian activity?
- Would it matter if the level of such minimal feeding were maintained at a flat or fluctuating pattern?
- If the cows were in a state of anoestrus, could we reactivate their ovaries by strategic surge feeding?
- What physiological setting (e.g. hormonal milieu, body composition) would facilitate a positive ovarian response by the anoestrous cow to surge feeding?
- Which mix of shrub/tree legumes could we establish (if required) on farms and on communal lands to service such a surge feeding strategy?

We have observed (Winugroho et al 1994) that if cows were maintained in good body condition, draft work had no adverse effect on parturition or on the length of the post-partum anoestrous period. We have also recorded the critical body condition, below which non-working cows will stop cycling (Teleni et al 1988; Wijono et al 1993; Winugroho and Teleni 1993). Surge influx of nutrients into anoestrous non-working cows can activate their ovaries provided the prevailing ‘physiological setting’, which at present is largely undefined, is correct (Teleni, unpublished data). Surge influx of specific nutrients into ewes has been shown to not only increase the number of ewes ovulating but also to increase their ovulation rate (see Teleni et al 1989). However, most of the results above have yet to take into account the confounding effect of work *per se*. There have been some indications (e.g. Bamualim et al 1987; Zerbini et al 1993) that work *per se* could adversely affect reproductive performance of cows. This area warrants further investigation. Our studies with sheep (P Yuwono, unpublished data) suggest that the pattern of fat and protein deposition in working animals after the work season might be different from that of non-working animals undergoing a similar pattern and amount of liveweight change. Such a difference could also be reflected in a difference in the responses of the two groups of animals to surge feeding.

We felt that a nutritional package centred on a short-term surge feeding strategy using an appropriate mix of shrub/tree legumes in the existing cut-and-carry feeding system would be highly acceptable to the farmer because

- the package can be easily obtained, developed and implemented
- it does not require any acquisition of new skills by the farmers
- it is easy to manage and sustain with minimal recurrent costs
- the shrub/tree legumes have other uses such as for firewood, fencing, soil stabilisation (therefore environmentally friendly).

Conclusion

The continuing need for DAP and increasing pressure of population on rural lands suggest future developments towards an increasing use of cows for draft work. Thus, research on DA should focus on the optimisation of the social and economic value of this class of animals to the smallholder farmers and their families. Such research should aim at developing a clearer and better understanding of the effect of work on milk and calf production and at developing feeding and management strategies underpinned by concepts which take into account the farmer's vision, preferences and skill level, the targeted farm system and the locally available feed resources.

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Discussion on Dr Teleni's presentation

Shapiro: The information we are receiving about Asia is that with the population growing rapidly, and incomes increasing very rapidly, demand for dairy products is increasing rapidly. It seems to me that this is going to completely change the situation that you have described here. In a high input system don't you think that the output/input equation of production will change?

Teleni: It will take some time. When the changes come we will be ready for them. At this stage, for example in the Indonesian situation, I believe it will take a long time before dairy cows are used for draft because most of them are used for beef which, at the moment, fetches a high price.

Shapiro: We need to be 5 and 10 years ahead in the research programme for a higher input, more intensive system.

Teleni: The high input system is already possible if farmers can afford to purchase good feed for higher milk production. But I think the challenge is more on how to get the product you need from the minimum supply of available input. I think good feeding is easy if you can afford it. If the farmer has got the money, we've got the feed and the feeding system for the animals.

Wandera: In one of the slides you showed a significant difference between milk production of the working and the non-working sheep. Working sheep had a significant reduction in milk yield. The morning presentation indicated that cows used for work in Ethiopia did not show significant differences in milk yield from non-working cows.

Teleni: Sheep were fed a basal diet; cows were supplemented. There is competition for energy substrates between tissues. To balance between the required glucose of different tissues (mammary gland and muscle for instance) we can operate in two ways: 1. decrease the work load and decrease the glucose required at the muscle level or
2. increase the amount of the glucose pool. Cows increased the glucose influx into the glucose pool from supplements while sheep were not supplemented.

Azage Tegegne: You extrapolated work done on sheep to provide recommendations for cattle. How close is the mobilisation of the energy reserves in these two species?

Teleni: Fairly similar. I think we used sheep to avoid the expense of working with cattle. So, you have to look for a model animal which is a little cheaper to maintain and to work with. We have done some initial work with sheep to see how the body reserves are mobilised during work compared to those of buffaloes and crossbred cattle. There are very similar profiles in terms of NEFA [non-esterified fatty acids] and glucose mobilisation. So, we look at the physiology of lactation using sheep as a model.

Zerbini: Were the sheep working during early lactation?

Teleni: Just after lambing we allowed three days for the lambs to be continuously suckled, and then work started.

Zerbini: You have been talking about patterns of body-store mobilisation and the resumption of ovarian activity in cows. We have recently completed a study where working cows had been under-nourished for more than two years. These cows had not cycled for two years. When they were supplemented, they cycled and conceived in less than 90 days. This was quite remarkable and resembled the ability of cattle to restore body stores and reproductive activity in times of plenty.

About your comments on body composition. It is very important and we used a fairly crude method to assess body composition changes by using the urea dilution technique. We have seen that the body fat of these cows increased by 10% from when they were placed on a higher plane of nutrition to the time they conceived; there was no further increase after conception. This area requires more studies.

Potential and extent of use of cows for draft in Indonesia

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Summary

Most draft animals (DAs) in Indonesia are cows. The main reasons for this are to provide calves and family savings besides draft power. The main draft breeds are crossbred Ongole, Bali, Madura cattle, and swamp buffaloes. The animals are mainly used for tillage. The DA system in Indonesia varies based on the farming system used, which is influenced by local agroclimate and culture. Different DA systems are compared in this paper. The systems include DA enterprise, work activities, feeding practices, breeding and housing. Feed resources and feeding and breeding strategies are outlined. There is a strong correlation between body condition scores and reproductive performance of cows. Factors affecting the potential and extent of use of cows for draft include increasing demand for power over a short period of time (determined by rainfall and planting seasons), opening new rice field areas, and the government policy to industralise the country. In some areas in Java, cattle and buffalo populations are decreasing and numbers of tractors are increasing. The government provides credit to buy hand tractors but not DAs. However, observation reveals that most of the small farmers still prefer cows for draft purposes. This may suggest that DAs and tractors are complementary.

Background

Indonesia has a population of about 9.5 million cattle (increasing at approximately 1.5% per year) and 2.3 million buffaloes. Most of the cattle are Ongole (Bos indicus) comprising 6.4 million or 65% of the total cattle population of Indonesia, followed by Bali cattle (2.2 million) with 27% of the population, and Madura cattle which are Ongole and Bali crossbreds (Ma'sum and Teleni 1991). Between 52 and 60% of the cattle are used as draft animals (DAs). Ongole cattle are white, may have a height at withers of 125–130 cm and, if well fed, a cow could weigh up to 450 kg. A mature Bali cow is smaller in size than the Ongole. Its height at withers is 110–115 cm and if well fed could reach 300 kg. Madura cows could weigh up to 270 kg with height at withers of 115–120 cm (Ma'sum and Teleni 1991). Over 80% of the cattle in Indonesia are located in the islands of Java, Sulawesi and Sumatra. Of this percentage, about 55% are located in Java island (45% of the total cattle population of Indonesia). Although Java represents only 7% of the total land area of the country, the large cattle population on the island parallels the distribution of the country's human population (61%, of whom about 60% depend on agriculture for subsistence) (Ma'sum and Teleni 1991). This indicates the importance of DAs to smallholder farmers.

Of the buffalo population, swamp buffaloes are the most abundant (about 95% of total population). They are mostly located in West Java, Sumatra, Kalimantan and Sulawesi islands. Buffaloes are commonly used as DAs in those islands.

Table 1 describes the use of draft power in Indonesia, including the common objectives, constraints and opportunities under tillage systems, transport and in other uses.

Table 1. *Use of draft power in Indonesia.*

	Tillage			
	Semi-intensive	Intensive (Govt)	Transportation	Others
DAs	Female	Female + Tractor	Male	Female
Objective	Power Calf Saving	Saving Calf Power	Power	Power Calf Saving
Constraint	Calving interval Calf mortality Bull	Feeds Bull	–	–
Opportunity	Strategic feeding Probiotics AI	AI	–	AI

Note: Others include brick making and limited trampling (mix mud and faeces) in the animal complex.

Farming systems

Local agroclimate and culture create different farming systems and hence different draft animal (DA) systems (Table 2).

Table 2. *Draft animal systems in Nusa Tenggara Timor (West Timor), East Java, West Java and South Sumatra, Indonesia.*

Draft animal system	Nusa Tenggara Timor	East Java	West Java	South Sumatra
Breed	70% Bali	75% Ongole	70% buffaloes	100% cattle
Enterprise	Owned by 2–10%	Even	1–3 head/HH	Contract (Transmigration)
Work activity	Trampling 25 days/year	Pair 10–110 days	Single/pair 40 days	Single/pair 80 days
Feeding	Grazing >>C&C	C&C >>	C&C=Grazing	C&C=Grazing
Breeding	Bulls >>	AI >>	Bull >>	Bull >>
Housing	Corrals at night Herd size 10–150	Housed 2–10	Housed/"hotel" 2–100	Housed 1–5
Health	60% SE & Parasite	Ectoparasite	Endoparasite	Parasite

C & C = cut-and-carry.

Source: Teleni et al (1993)

Patterns of rainfall, cropping, feed supply and calving in each of the areas mentioned in Table 2 have been reviewed (Teleni et al 1993). Minimal live weight and body condition score of DAs are presented in Table 3.

Table 3. *Live weight (LW) and body condition (BC) scores at which mature cows losing weight become acyclic and liveweight equivalent of one body condition score change.*

Cows	Critical LW (kg)	Critical BC score	LW equivalent to 1 BC change
Ongole	≤ 260	≤ 4	24
Bali	≤ 230	≤ 5	15
Madura	≤ 220	≤ 4.5	16
Buffalo	≤ 350	≤ 5	30

Source: Winugroho and Teleni (1993).

Indonesia has 27 provinces and recently the feed potential of 13 of them was estimated (Table 4).

Table 4. *Feed availability compared to animal requirements.*

	Area ('000 ha)			Surplus and deficit ('000 ton/year)					
				DM		CP		TDN	
Provinces	Crop	Estate	Grazing	C	F	C	F	C	F
Aceh	223.7	306.9	432	455	737	80	11	350	63
North Sumatra	1195.1	1132.8	99.7	–349	258.3	–48	103	842	910
Riau	868.9	1103.7	14	118	398	6	7	86	95
Kalimantan									
West	1460.7	899.1	0	412	1603	–53	61	–260	580
East	245.3	131.6	0	5	225	–3	3	9	51
Sulawesi									
North	215.6	468.4	41.2	–139	135	–16	–9	–63	–56
South	1220.6	492.3	498.1	649	1927	53	13	549	249
Nusa Tenggara									
West	281.2	18.7	35	1.3	633	149	14	1.06	75
East	427.4	359.2	717.3	–378	–21	–74	–47	–290	–315
Irian Jaya	2348.5	72.7	?	–312	102	–49	10	–188	36
Lampung	569.7	656.9	552.5	2.9	2.2	165	141	2.05	873
Java									
West	2190.5	329.9	?	1.5	8.0	64	269	3.5	2.6
East	2124.1	173	1.9	4.2	2.9	383	–49	–357	–419

Source: Anonymous (1995).

Environmental impacts in relation to DAP

Negative responses are still coming from people who work in forestry, irrigation and estate crops. In protected areas such as forests, DAs are blamed for killing young plants or destroying cans for collecting rubber. Ruminants are usually prohibited from entering where there are cover crops for estate crop plantations. Irrigation systems are often broken by DAs. In brief, disadvantages include:

1. Soil pollution. Buffaloes wallow. Soil cracks during dry season and practically no grass can grow. Less damage is observed when cattle are used.
2. Water pollution. Faeces and urine from buffalo and cattle are potential contaminants of drinking water via small rivers or ponds. This is more obvious in densely populated areas.
3. Air pollution. Methane gas from buffalo and cattle are wastes in relation to feed efficiency and, to some extent, contribute to global warming. Compared to tractors, DAs produce little pollution and practically no soil compaction.

The Indonesian government acknowledges the importance of DAs to smallholder farmers. Therefore, although tractors are recommended, the DA Programme developed by the government (Intek, DA intensification) proves continued government support for the use of DAs. Tractors and DAs will be complementary for years to come.

Identification of researchable issues

Interaction between power, nutrition and reproduction studies are needed. This includes:

- breed comparison —draftability (ability to do draft work)
- heat stress (internal and external)
- strategic feeding to improve reproductive performance
- improvements of implements
- alternative uses, e.g. wells, fish ponds, production of electric (dynamo) presser for sugar-cane and brick making
- socio-economic impacts.

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Discussion on Dr Winugroho's presentation

Sevilla: You mentioned long calving intervals. I would like to know whether this is due to work or delayed breeding of cows by farmers for work purposes?

Winugroho: It is mainly due to loss of body weight during the working period and therefore delay in resumption of ovarian activity after parturition.

Alemu Gebre Wold: What is the level of milk production of these cows?

Winugroho: These are beef cows producing no more than 5 kg of milk/day, only enough for the calf.

Lawrence: What type of milking cows do you have, and are they used also for work?

Winugroho: We have about 500,000 head of dairy cows mainly Friesians, cross-breeds and local cows. Local cows are adapted to the poor tropical environment and their production is about 10 kg/day. We still import more than 50% of the milk requirements, so there is room for expansion of the industry.

The use of draft animals and the potential of the draft cow system in the Philippines

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Introduction

About two billion people in developing countries depend on draft animal power (DAP) as the main source of energy for farm operations. The importance of DAP in developing countries can be gleaned from the recent FAO (1995) statistics that show a 23% increase in the number of cattle and buffalo used for draft and other purposes. With only 22% of the cultivated areas in developing countries, except China, being farmed by means of tractors, it is obvious that DAP and manual labour will remain the main energy source for food production in developing countries for many years to come.

While mechanisation may indeed result in efficiency and timeliness of farm operations and therefore increase in harvests, the social, technical and economic conditions prevailing in developing countries inhibit the rapid replacement of DAP by machines. Under this scenario, there is a need to improve the efficiency of draft animals, which has been relegated to low priority for research and development in many developing countries, if the well-being of farmers dependent on DAP is to be improved.

This paper presents the status of DAP usage and the prospect of increasing the utility of draft animals in the Philippines.

Status of DAP in the Philippines

Importance of DAP

Farming in the Philippines is characterised by large inputs of DAP and human labour at all stages of production. This is partly due to the preponderance of small-sized farms (<2 ha) being tilled by resource-poor farmers (Carangal and Sevilla 1993). The high cost of fossil fuel and mechanised farm equipment and implements, lack of technical support and services and the low purchasing power of the farmers, and the ability of the draft animals to utilise crop residues and the relative ease of their procurement and maintenance, further justifies the use of draft animals in smallholder farm systems.

The land use pattern in the Philippines indicates that DAP is used in about 70% of the land area under cultivation, with the exception of some plantation estates and the 0.8 million ha of irrigated lowland rice paddies, where hand tractors are extensively used for land preparation (Table 1).

Table 1. *Land use in the Philippines.*

Land use	Area ($\times 10^6$ ha)
Forest	7.77
Cultivated area mixed with brushland and grassland	9.66
Grassland, grass covering 70%	1.93
Plantations, coconuts, >100 ha	1.19
Cropland mixed with coconuts, <100 ha	4.26
Arable land, cereals and sugars; including plantations other than coconut, <100 ha	4.44

Sources of DAP

In these predominantly small farms, the water buffalo or carabao, *Bubalus bubalis*, is the principal power source, followed by cattle and to a lesser extent by horses. These animals are used singly by smallholder farmers in their numerous farm production and post-production operations. Carabaos are extensively used for lowland rice cultivation, while cattle are mostly found in the rainfed lowland and the upland areas and the horses in hilly and mountainous areas. Carabaos are raised primarily for draft and secondly for meat and milk while cattle are raised for meat, draft and milk; horses are raised mainly for draft.

Selection of individual animals for draft is primarily based on the size of the animal, the biggest being selected for the purpose. For carabao, both sexes (67% males and 37% females) are used for draft, while among cattle, males are usually selected. When either of the sexes of both carabao and cattle is selected for draft purposes, the consequence is a decrease in reproductive rate and/or genetic improvement. Female draft animals are deliberately not bred since pregnancy is believed to interfere with the draft ability of the animals. Draft males, usually the biggest in the locality, are normally castrated to render them docile. These selection and management practices have resulted in the decreasing live weight of draft animals, especially carabaos, in the rural areas.

Compared with our Asian neighbours, the population of cattle declined for the period 1980–89 by –2.68%, while that of the buffalo had a slight increase of 0.16%. This pattern of population growth rate has been attributed to an increase in the demand for beef, low reproductive rate, low breeder base and unfavourable policy environment. Of the estimated 2.7 million carabaos, 99% are in the hands of smallholder farmers who each raise one or two animals (Momogan et al 1990). In 1983, the inventory of cattle in commercial farms which used to be at 22% of the total population had gone down to 9.7% (Sevilla 1995b). These figures indicate that the bulk of the large ruminant population is in the hands of the smallholder farmers providing draft and a range of socio-economic functions.

Extent of use of DAP

In 1981, it was estimated that 77% of the farmers used carabao as the source of power in all their farming activities while none had a purely mechanised operation. Eighty-six per cent of the farmers used machines in only 24% or less of their farm activities (de Guzman and Perez 1981). The Bureau of Agricultural Statistics, Department of Agriculture, estimated that 60–70% of the carabao population are used for draft at varying man–animal hours of usage. Alviar et al

(1985) reported that 85% of the carabao owners purposely acquired carabaos for draft purposes. There are no estimates of the number of cattle and horses being used for draft.

A more recent survey (AMDP 1992) to assess the mechanisation needs of farms in four different regions of the country revealed that the importance of DAP was related to the cropping pattern, intensity of farming, and the prevailing economic conditions in the area (Table 2). As reference, regions III and IV are adjacent to Manila and are economically more progressive than regions VI and VIII. Region III is mainly planted to rice, while regions IV and VI are characterised by a mixed type of cropping and Region VIII is mainly planted to sugar-cane. In predominantly rice growing areas with irrigation (Region III), the use of machines for land preparation is higher than that of DAP at all levels of operation. However, in regions IV and VI, where lowland rice is not the dominant crop, DAP is used by more than 50% of the farmers. Likewise, DAP was more important than machines in upland rice cultivation and more so in less developed regions. In all land preparation activities, some farmers use a combination of DAP and machine. In such cases, the draft animal is used in the areas near levees that cannot be cultivated by hand tractors, and for haulage.

Table 2. *Draft animal power and machine usage for different crops in selected regions of the Philippines.*

	Region											
	IV			VI			VIII			III		
	DAP	M	C	DAP	M	C	DAP	M	C	DAP	M	C
Lowland rice												
Ploughing	26	65	9	45	36	19	55	36	9			
Harrowing	17	73	9	43	39	18	55	36	9			
Levelling	26	65	8	65	33	2	82	18	0			
Upland rice												
Ploughing	51	34	5				88	7	5			
Harrowing	42	40	18				94	4	2			
Levelling	49	20	21				93	5	2			
Sugar-cane												
Subsoiling	0	100	0	0	100	0				0	100	0
Ploughing	31	69	0	34	35	31				36	64	0
Harrowing	41	59	0	38	51	11				41	59	
Furrowing	39	59	0	70	23	7				44	56	0
Corn												
Ploughing				85	9	4						
Harrowing				94	5	0						
Furrowing	83			2	0							
Coconut												
Hauling							37	2	0			

DAP = draft animal power; M = mechanised; C = combined DAP and M.

With corn, farm operations from production to hauling of ears are mainly done using DAP rather than machines. In coconut plantations, the major farm operation is hauling nuts. The use of machines for this activity is low (2%), DAP accounts for 37% of the power and the balance comes from human labour. With sugar-cane, DAP is used for 31 to 70% of land preparation operations, except for subsoiling. Even in the major sugar producing area, DAP is involved in land preparation and hauling.

Socio-economics of DAP

Draft animals may not be the most efficient sources of farm power, but they are commonly regarded by farmers as the cheapest and most readily available source of draft power and financial security. More importantly, farmers, particularly those in the uplands and rainfed areas perceive that any reduction or shortage of draft animals will significantly affect their crop productivity (Alviar 1987).

A number of factors influence the extent to which DAP contributes to rural families. The type of farming system has been shown to have significant effects on the different socio-economic aspects of DAP from water buffalo (Alviar and Elauria 1991). Of the five farming systems studied, the sugar-cane- and corn-based systems required higher use of DAP (147 and 109 days/year, respectively) than the rice, coconut and hillyland systems at 54, 74 and 49 days, respectively (Table 3). However, there is an inverse relationship between the level of DAP usage and farm size on a per hectare basis. Hence, while there is an average of 1.4 buffaloes per farm, the number of animals required per hectare was 0.54 for sugar-cane- and coconut-based systems and 0.85 for rice-, corn- and hillyland-based farming systems.

Table 3. *Days of work and number of buffaloes by farming system.*

	Farming system					
	Rice	Corn	Coconut	Sugar-cane	Hilly land	All
	Number of hours used					
Location						
On-farm	11	22	5	26	16	16
Off-farm	22	33	46	42	9	31
Total	54	109	74	147	49	87
Farm size	Number of buffaloes/farm					
<1.5 ha.	1.5	1.3	1.1	1.0	1.0	
1.5–3.0 ha	1.6	1.4	1.3	1.2	1.2	
>3.0 ha	1.6	1.4	1.4	2.3	1.2	
All sizes	1.6	1.4	1.3	1.3	1.1	
Farm size	Number of buffaloes/hectare					
<1.5 ha.	1.6	1.6	0.8	1.0	1.3	
1.5–3.0 ha	0.7	0.7	0.4	0.6	0.6	
>3.0 ha	0.4	0.3	0.4	0.2	0.3	
All sizes	0.9	0.8	0.4	0.5	0.7	
No. of buffaloes required per ha	0.88	0.82	0.55	0.53	0.85	

Results of another survey (excluding farmers from five provinces who had experience raising crossbred buffaloes) showed that farmers preferred to use crossbreds (from 77 to 100% of the respondents) than the carabao for draft purposes (Momongan et al 1994). The study also indicated that training crossbreds for draft is not a major problem, although there were conflicting claims about the endurance, handling and speed of doing work between the native and the crossbred. The same group of farmers showed preference for female draft animals because of their breeding value and milk production. However, farmers in a sugar-cane-producing province claimed that the male crossbred had higher draft power output and market value.

Apart from body weight and size, farmers have a number of beliefs that they use to predict the suitability of animals for draft. These include the location of cowlicks, shape of horns, length of tail, and coat colour. In many rural areas, traditional methods of animal raising based on fallacies and superstitions have hampered the productivity of both cattle and carabaos. Technology adoption is generally unsatisfactory. While the low technology adoption rate may be due to lack of appreciation of the implications of the technologies, the economic limitations of the farmers to adopt a technology is an important consideration (Perez 1992).

Significant increases in income are attained when either a native or crossbred buffalo is used for both draft and dairy purposes. Among native carabaos, return from milk is 100% of the draft value, while among crossbreds, milk contributed as much as 600% of the draft value (Alviar 1985).

The role of women is traditionally insignificant when large ruminants are involved. However, with the use of crossbreds as dual-purpose animals for draft and dairying, the role of women and children in buffalo milk production has increased (Perez 1992).

Research on DAP

There is a paucity of information on the draft performance of the carabao and its crossbreds and more so on that of cattle. Data on draft ability and physiological responses of carabao were mainly derived from a UNDP/FAO project on improving the performance of the animal through cross-breeding with the riverine buffalo. Data on draft cattle were collected under an IDRC/IRRI/UPLB farming systems research project in a rainfed lowland ecosystem.

Philippine carabao vs crossbred

In terms of draft ability between the Philippine carabao (PC) and PC–Murrah crossbred (PM), Garillo et al (1987) found no significant differences in the depth, width and velocity of ploughing and in the draft force and horsepower generated by the animals nor in the physiological responses to ploughing by the two groups of animals (Table 4). In another study, Sarabia (1994) reported that the field capacity or the area ploughed per hour was higher among PC than PM, but this was attributed to the lack of training for work among the crossbreds. Otherwise, given the same training and management practices, the PM performed draft functions as efficiently as the PC (Table 5).

Table 4. *Work performance of Philippine carabao (PC) and Philippine Murrah F_1 (PM) steers.*

	Wetland		Dry land	
	PC	PM	PC	PM
Depth of ploughing, cm	12.25±0.5	12.23±0.5	11.92±0.6	11.14±0.7
Width of ploughing, cm	17.60±1.0	17.69±0.9	18.94±1.1	18.57±0.8
Soil moisture, %	42.96±2.0	43.7±41.9	22.92±2.1	22.55±1.9
Hardness of soil, kg/cm^2	1.66±0.4	1.66±0.3	1.91±0.4	1.92±0.1
Ploughing velocity, m/sec	0.50±0.1	0.54±0.2	0.60±0.1	0.50±0.1
Ploughing time, hours for 2500 m^2	8.89±0.8	8.29±0.7	7.14±0.8	8.72±0.7
Average draft force, kg	54.14±2.3	49.42±2.1	50.14±2.3	50.60±2.1
Drawbar horsepower, PS	0.36±0.1	0.35±0.1	0.40±0.10	0.34±0.1

Table 5. *Work performance of Philippine carabao and Philippine–Murrah F_1 bulls under rainfed lowland condition.*

	Philippine carabao	Philippine–Murrah F_1
Area ploughed in 1 h, m^2	447.09 ±119.08	439.05±113.89
Depth of ploughing, cm	14.37±1.28	14.34±1.68
Width of ploughing, cm	22.67±1.74	22.54±1.68
Soil hardness, kg/cm^2	3.14±0.71	3.04±0.73
Animal pull, kN	0.54±0.12	0.58±0.13
Draft force, kN	0.51±0.12	0.54±0.12
Ploughing speed, m/sec	0.91±0.13	0.99±0.26
Draft power, kW	0.47±0.15	0.52±0.12
Draft power, hp	0.63 ± 0.20	0.70±0.16
Average body weight, kg	411.50±30.38	496.75±37.13
Draft force, % body weight	12.30±1.88	11.56±2.09

Pulling a sledge loaded at 50% of the live weight and pack-loading at 20% of the live weight resulted in increases in the pulse rate, respiration rate and body temperature (PRT) among three genotypes, PC, PM and PC–Ravi, but the differences were not statistically significant (Tables 6 and 7). Providing wallow apparently had no effect on the differences in the final reading of PRT. However, Momongan (1993) reported that the PC pulled a sledge continuously for 43 minutes before refusing to move further, whereas the PM lasted for only 38 minutes.

Supplementation of the carabao with rice bran at 0.5% of live weight had no significant effect on the draft power generation. However, unsupplemented animals tended to respire faster and had higher pulse rates than those given rice bran (de Luna et al 1991).

Table 6. *Effect of pack-loading on average pulse, respiration and temperature of buffaloes with and without wallow.*

	Pulse (count/min)		Respiration (count/min)		Temperature (°C)	
Breed	Initial	Final	Initial	Final	Initial	Final
Without wallow						
Phil carabao	39.4	57.4	23.4	56.3	38.0	40.1
Phil carabao–Murrah	38.1	57.6	22.4	61.6	38.1	39.5
Phil carabao–Ravi	38.5	61.1	21.8	57.2	38.3	39.5
With wallow						
Phil carabao	36.6	58.6	16.6	58.4	37.8	39.5
Phil carabao–Murrah	40.2	58.1	18.9	54.8	37.9	39.2
Phil carabao–Ravi	40.4	59.9	16.9	65.2	37.7	39.5

Table 7. *Effect of pulling a sledge on the physiological responses of buffaloes without wallow.*

	Pulse (count/min)		Respiration (count/min)		Temperature (°C)	
Breed	Initial	Final	Initial	Final	Initial	Final
Without wallow						
Phil carabao	40.1	69.8	23.4	82.8	38.1	40.9
Phil carabao–Murrah	38.7	68.9	23.8	86.5	38.5	40.6
Phil carabao–Ravi	40.1	73.0	21.0	89.7	38.0	41.0
With wallow						
Phil carabao	38.1	68.4	17.5	81.3	37.9	40.3
Phil carabao–Murrah	42.5	66.1	18.8	79.1	37.7	40.1
Phil carabao–Ravi	41.2	69.3	19.0	86.0	37.9	40.6

Cattle vs buffalo

Under rainfed lowland conditions draft cattle and buffalo lost body weight in July and September coinciding with the establishment of the rice crop and then again in November and December during land preparation for the second crop (Sevilla et al 1993). Since grasses are in abundant supply in July due to the monsoon rains, the loss in live weight during this period could be mainly attributed to the heavy work demand for rice cultivation. The liveweight loss recorded in November and December could be due to the effects of both work and the low quality of feed supply. During this period, by-product roughages constitute as high as 86% of the total feed offered.

In this ecosystem, cattle, specifically bulls, were used at an average of 341 hours for rice and 42 hours for the after-rice crop. The carabao were used for 417 hours for rice and 59 hours for after-rice.

In a study conducted during the wet season, the draft capacity and physiological responses of each of four grade cattle (421–578 kg LW) and carabao (437–532 kg LW) were compared at different draft, from 50 to 300 kg for 10 min in the morning and afternoon (Sevilla et al 1993). The animals resisted pulling the 300 kg load. While the carabao developed significantly higher draft than cattle, the power generated by both animals was not significantly different (Table 8). Computed as per cent of the live weight, draft was equivalent to 15 and 16% for cattle and carabao, respectively, and ranged from 5% at 50 kg load to 30% at 250 kg. Increasing dead loads were positively correlated with pull, draft and power but inversely correlated with speed. The carabao appeared to be more docile and to behave and work more consistently than cattle. This may be partly attributed to the more uniform body conformation and genotype of the carabao than cattle.

Table 8. *Mean draft capacity and physiological responses of cattle and carabao.*

	Speed (m/sec)	Power (hp)	Draft (% of LW)	Pluse (beat/min)	Respiration (blow/min)	Temperature (°C)
Cattle	0.97	0.69	15	77.8	43.4[a]	8.8
Carabao	0.97	0.72	16	85.8	58.8[b]	38.5

ab = P < 0.02.

Respiration rate was significantly higher for carabaos than cattle when subjected to work stress. This agrees with the general observation that the carabao are physiologically more susceptible to heat stress, whether associated with solar radiation or work.

All PRT values increased with increasing draft at varying rates. Pulse rate increased by 34% from 50 to 100 kg load and by 40 and 20% from 100 to 200 and 200 to 250 kg, respectively. Respiration rate increased by 66% from 50 to 100 kg load and by 80% from 100 to 200 kg. The animals exhibited significantly faster pulse rates and respiration rates when pulling 200 and 250 kg loads compared with 50 and 100 kg loads. The 200 kg load resulted in draft force of 100 kg or 20% of the body weight and 0.91 hp. A 100 kg load generated draft of 52 kg or 10.8% of the body weight and power equivalent to 0.53 hp. The animals tend to become unco-operative and temperamental when required to pull dead loads of 200 and 250 kg, resulting in poor animal–handler co-ordination. Physiologically, the animals seem to be more comfortable with pulling loads lighter than 200 kg. Considering the average body weight of the carabao (470 kg) and draft cattle at (490 kg), the equivalent draft power generated is 52 and 54 kg, respectively. This is more than the draft force of 30 kg required to plough the rice field.

A six-month experiment was conducted to determine the effects of rice bran supplement at 0.5% of the body weight on the draft performance of cattle and carabao. Supplementation with rice bran had no significant effect on the live weight of either cattle or the carabao. There were significant animal × treatment interaction effects on differences in pulse rate, respiration rate taken after work and difference in respiration. The increase in pulse rate and respiration rate due to work was lower in carabaos given supplement when subjected to work stress than in cattle (Table 9). This may be partly attributed to the ability of the carabao to utilise low quality feeds more efficiently than cattle. There is also evidence to show that draft buffaloes in good body condition resulting from better nutrition utilise energy more efficiently than those in unfit condition.

Table 9. *Mean pulse and respiration rates and temperature of cattle and carabao taken pre- and post-work.*

	Pulse rate			Respiration rate			Temperature		
Treatment	Pre	Post	Difference[a]	Pre	Post[b]	Difference[c]	Pre	Post	Difference
Cattle									
Control	50.7	57.3	6.6	26.7	44.0	17.3	37.8	39.0	1.16
Treatment	44.7	58.0	13.3	26.7	49.3	22.6	38.2	38.6	0.5
Carabao									
Control	42.6	60.0	17.4	28.0	62.6	34.6	8.0	38.8	0.7
Treatment	45.3	55.3	10.0	22.0	31.3	9.3	38.3	38.7	0.4
	2.1	2.2	2.4	3.0	6.3	9.3	0.3	0.4	0.54

a. Animal × treatment interaction ($P < 0.02$).
b. Animal × treatment interaction ($P < 0.02$).
c. Animal × treatment interaction ($P < 0.03$).

Draft cows

Twenty heifers were used in a study to determine the feasibility of using beef cows for draft and reproduction (Sevilla 1995a). The control animals were subjected to the traditional cow–calf management practices of the farmers, which include tethering with night corralling, occasional supplementation with weeds and concentrates, mating on a year-round basis and weaning of the calves from 6 to 7 months of age. The cows in the treatment group were subjected to strategic supplementation with urea–molasses mineral blocks (UMMB) and rice bran. Breeding was planned from March to May so that calving occurred when draft was least required. To reduce nutritional stress on the cows, creep feeding was practised and the calves were weaned at 4 months of age.

Results showed that cows in the treatment group consistently had higher live weights than those in the control group. Consistent loss in live weight occurred during the months of June to July and then in October to November. These periods coincide with rice establishment and harvesting, respectively, indicating that lack of labour for feed gathering poses a serious setback on the growth performance of the animals.

Cows in the treatment group gave birth to heavier calves (29 kg) than those in the control group (22 kg). At 4 months of age, the 205-day adjusted weaning weight of calves from the treatment group was heavier at 142 kg than that of the control group at 114 kg. There was an abrupt loss in live weight of early-weaned calves a month after weaning. Nonetheless, the early-weaned calves outgrew the calves from the control group (0.42 vs 0.31 kg/d) from birth to 18 months of age. Thus, the final (18 months) live weight of the early-weaned calves was 260 kg compared to 194 kg for the control group.

Animals in the treatment group had better reproductive performance in terms of number of parturitions, calving interval and body condition than those in the control group throughout the observation period (Table 10). This was due to the better body condition, particularly during the first two reproductive cycles, found in the treatment group. Further, the occurrence of post-partum oestrus was earlier in these cows.

Table 10. *Values of some reproductive traits between cows in the control and treatment group.*

Reproductive trait	Control (n=7)	Treatment (n=10)
LW at first breeding, kg	277	289
LW at second breeding, kg	283	328
Services per conception	1.92	2.11
Gestation period, days		
Range	276–295	271–303
Mean	286	292
Calving to conception, days		
Range	133–446	33–408
Mean	267	199
Calving to conception, days		
Range	413–726	313–688
Mean	553	480

Table 11 shows the draft performance and physiological responses of 3- and 6-month pregnant cows. Draft developed by pregnant animals was the same at 23.7 and 22.6 kg at 3 and 6 months of pregnancy, respectively. Three-month pregnant cows walked faster and had higher power output than the 6-month pregnant cows. However, the physiological responses (PRT) of the animals were similar for both groups, an indication that cows of up to 6 months of pregnancy may be used for draft.

Table 11. *Draft performance and physiological responses of cows in the treatment group at three and six months of pregnancy.*

	Stage of pregnancy	
	Three months	Six months
Draft, kg	23.70±0.82	22.60±0.84
% of live weight	7.30±0.31	6.60±0.32
Speed, min/sec	1.09^{a}±0.03	1.00^{b}±0.03
Horsepower	0.34^{a}±0.01	0.30^{b}±0.01
Pulse rate, beat/min	50.10±4.4	48.00±0.45
Respiration rate, beat/min	33.70±1.3	33.80±1.3
Body temperature, °C	39.10±1.0	36.90±1.0
Live weight, kg	326.80±9.4	328.80±9.7

Treatment means with different superscripts are significantly different ($P < 0.05$).

The partial budgeting of the set of technologies tested for the draft cow system is shown in Table 12. The major portion of the added returns was derived from the higher liveweight offtake from the two successive calvings, while reduction in costs was realised from the feeds and labour saved due to shorter calving interval. The added costs were mainly from the purchase of supplemental feeds, i.e. UMMB, rice bran and creep feed.

Table 12. *Partial budgeting of the adoption of improved nutritional and management practices, P[a].*

	A Added returns	B Reduced returns
LW of 1st calf	5715	–
LW of 2nd calf	450	–
	Reduced costs	Added costs
Feeds	–	3880
Labour	480	–
Total	6165	3880
A–B	2765	

a. US$ 1.00 = P (Pesos) 25.00.

Assumptions:
Age at maturity of first calf is 2 years.
Rate of gain of weaners is 0.4 vs 0.6 kg/d for the control and treatment groups, respectively.
Feeding:
Cows were fed 2 kg rice bran/d for 8 months and consumed 5 blocks of UMMB.
Calves were given 1.5 kg creep feed/d for the first 4 months and rice bran for the next 10 months.
Costs:
Creep feed = P 7.00/kg; concentrate = P 4.00/kg; labour = one hour per day at P 8.00/hr; live weight = P 45/kg.

Potential of the draft cow system

Gradually, the draft utility of the carabao will diminish as more of the cultivable rice areas are put under irrigation and therefore mechanisation. This will lead to the concentration of draft animal power utilisation in the rainfed lowlands and the uplands, where cattle are more suitable. From the foregoing review, it is evident that beef cows have better prospects for performing dual functions of draft and reproduction than buffalo cows. Figure 1 illustrates the feasibility of scheduling the draft usage and the physiological state of the beef cow in a rainfed ecosystem. The same schedule is difficult with swamp buffalo because they have a longer gestation period (320 vs 283 days) and a more erratic reproductive performance than cattle.

Technically, improvement in nutrition and reproduction are the two major constraints to the use of draft cows. The nutritional constraints to reproduction and draft in rainfed lowlands are year-round, but vary in degree of severity due to biological (lack of feed supply during dry season), social (lack of labour during rice harvesting) and physical (lack of tethering areas during rice season) factors (Figure 1). These nutritional constraints within the system can be addressed by using proven technologies of strategic supplementation of UMMB and by-product concentrates. The more pressing problem is the timeliness of mating such that the last trimester of pregnancy and early lactation do not coincide with the period for draft. Advances in reproductive technologies, oestrus synchronisation and AI, may be used to ensure pregnancy at the desired time.

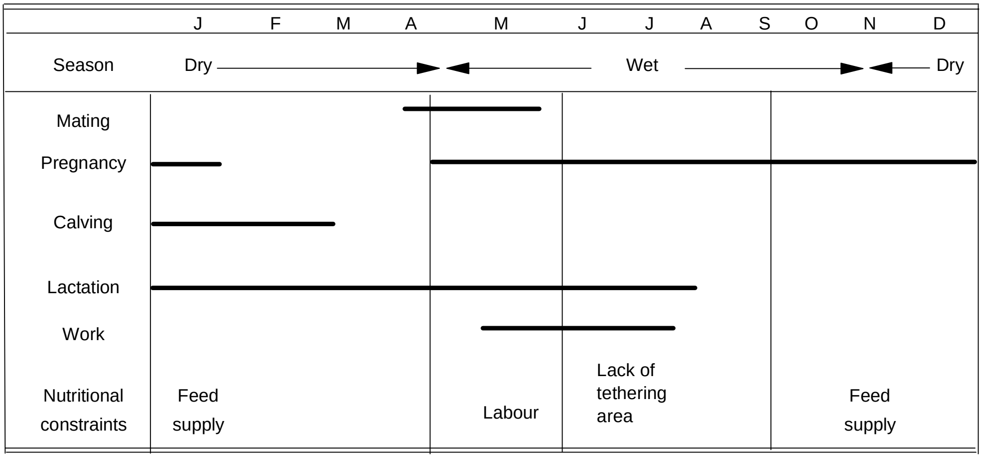

Figure 1. *Physiological state and work schedule of cows in the rainfed lowland system based on season and nutritional constraints*

However, since DAP is used by resource-poor farmers, the research approach must take into consideration the other components of the farm system. In particular, research on draft cows should be conducted for a specific farming system, with due consideration of the onset and duration of rainfall. The approach should be more towards adaptive research, that is, the application of proven nutritional and reproductive technologies *vis-à-vis* the socio-economic opportunities and constraints in the area. Since the use of beef cows is not traditional in the country, an in-depth study on the farmers' perception, attitude and beliefs about the system is as important as the technical aspects (Paris and Sevilla 1995).

Nonetheless, the draft beef cow system provides an alternative approach to the country's problem of beef supply. It also improves the well-being of the resource-poor farmers by increasing the benefits from raising cattle.

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Discussion on Dr Sevilla's presentation

Zerbini: The importance of feed for draft animals has been repeatedly mentioned. In the Philippines, what improved feed production and conservation practices do you have? You mentioned that Siratro is also part of the supplement. In what form do you supply Siratro?

Sevilla: The problems of feeds in the tropics are availability and seasonality. Generally, the most limiting nutrient is protein. We use urea and legumes to raise the protein level. The demands of draft cows are higher than those of traditional draft oxen. With regard to Siratro: we cut Siratro three to four times during the cropping period. The first three cuts are used as supplement for cattle and the last cut is incorporated into the soil.

Azage Tegegne: I am getting a bit confused about the effect of work on the cow when that is translated into calf performance. In your production system I presume calf growth performance has a significant influence on economic return of the production system. How do you evaluate the effect of work *per se* and the effect of supplementation on calf growth performance? I would open this question to the work on cow traction at Holetta as well.

Sevilla: The key is to reduce the nutritional stress on one side and the lactation requirements on the other. With supplementation we decreased the weaning time from seven to four months.

The potential and trend of using buffalo cows for farm draft power in Thailand

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Summary

In Thailand, draft animals remain an important source of farm power for crop production in most rural rainfed areas. The distribution of draft animals varies in different locations relating directly to rainfed rice growing areas where draft animal power (DAP) plays a significant role. Buffaloes and cattle are the two species commonly used for draft power, predominantly in the north-east region. Due to the increasingly specialised beef cattle business in recent years, the use of cattle for work reduced while the use of draft buffaloes remained common.

Due to a lack of research and development to improve the use of power from draft animals in Thailand, innovations in DAP technology have scarcely been developed. Therefore, the traditional yoke and harness for draft animals has remained in use by farmers. Better yokes and harnesses are known but have not been transferred to farmers. Besides, during recent years the use of draft animals has declined due to the availability of small tractors, lack of grazing areas for animals and household labour to tend animals, and the uncertainty of rainfall. With increasing use of small tractors the purpose of keeping buffaloes on-farm becomes not only for draft but also for sale, for manure and as an asset for the family. Thereby, farmers tend to keep more female buffaloes than male ones because females can produce offspring which can be sold for additional income. Inevitably, cows, including pregnant ones, are also used for work during the growing season.

An on-farm study used pregnant buffaloes for work at various stages of pregnancy, ranging from 2–3 months to 6–8 months of pregnancy. For intense work, mainly first tillage during the regular rainy season, some pregnant cows could work from 45–90 days or 225–450 hours. No incidence of health problems or abortion was observed. For first tillage performed by buffalo cows with average weight of 405–411 kg, the area that could be ploughed was approximately 405–420 m^2/h. For second tillage, cows with average weight of 404–410 kg could plough 708–807 m^2/h. The difference in draft ability between male and female buffaloes was not conclusive, since a very limited number of males was available for observation.

It is foreseeable that buffalo cows will continue to play a significant role in the supply of animal power for rural rainfed farming. Although the increase in mechanisation is evident, some kinds of work for soil preparation are best done by animals. Therefore, a more combined use of mechanical power and draft cows will be practical and economical under small farm systems in north-east Thailand.

Introduction

Agriculture is an important sector in Thailand and approximately 60–65% of the total Thai population (almost 60 million) are currently engaged in it. An estimate of farm land in 1991 was 21.3 million hectares or 41.5% of total land (OAE 1994). Most of the agriculture (about 85%) depends on rainfall; this includes most rural areas where draft animals are an important source of power for farming.

The distribution of animals used for draft power varies in different locations depending on the amount of rainfed rice growing areas where they play a prominent role. Due to advanced technology in mechanical power, power from draft animals is not highly regarded and little attention is paid to it, even though it is appropriate economically and socially especially in the remote rural areas where farmers depend on rainfall for crop production.

Availability of draft animals

The kinds of animals used for draft power in Thailand are buffaloes and cattle which predominate in crop production systems. They are abundant in rainfed rice production areas. The larger numbers of buffaloes (over 70%) and cattle (36%) are raised in the north-east where over 54% of total paddy land is located (Table 1). Only 1.6% of the total paddy land can be irrigated; the rainfed paddy land throughout the country is almost 11 million hectares. This area requires an estimated 6 million draft animals for farm production. In practice, these draft animals are traditionally integrated in small farm production systems in which farmers have an average of 3–5 ha of land to cultivate.

Often buffaloes and cattle are raised together on the same farm. They mainly contribute their power for agricultural activities and manure for fertiliser. At the same time small farmers feed animals mainly with weedy grasses or plants and crop wastes, such as rice straw, corn stover, sugar-cane tops, legume stems, vines etc. The animals, then, can convert these wastes to other valuable products besides providing draft power and manure, i.e. meat and additional income from sale of the animals.

Table 1. *Numbers of buffalo and cattle and the amount of paddy land in different regions of Thailand, 1991.*

Region	Buffalo (head)	Cattle (head)	Paddy land (ha)
North-east	3,682,852	2,031,481	6,075,655
North	765,042	1,326,572	2,431,515
Central	370,279	1,336,911	2,004,924
South	158,557	936,166	577,986
Whole country	4,976,730	5,631,130	11,090,080

Source: OAE (1993)

The use of draft animals declined between 1983 and 1992. The number of buffaloes decreased at an average rate of 2.6% per year (Table 2) due to the high rate of slaughter for consumption. However, cattle numbers increased by 2.2% during the same period because of the considerable demand for beef and the booming price of beef cattle. A village study indicated that the number of working buffaloes used for cultivation declined from year to year (Bunyavejchewin et al 1995a) due to the uncertainty of rainfall, the lack of family labour, the lack of grazing areas, and the availability of two-wheeled tractors in the villages. Nevertheless, farmers still kept some buffaloes for other purposes. Simultaneously the increase in the number of cattle on small farms of these villages was recorded. The results of this study support the change in total numbers of buffalo and cattle population in the last decade.

Table 2. *Buffalo and cattle population in Thailand during the years 1983–1992 and the rate of change per year.*

	Total number		Rate of change (%)	
Year	Buffalo	Cattle	Buffalo	Cattle
1983	6,354,349	4,832,570	–	–
1984	6,300,896	4,788,989	–0.84	–0.90
1985	6,249,926	4,828,983	–0.81	+0.83
1986	6,256,854	4,878,741	+0.11	+1.03
1987	5,998,423	4,968,845	–4.13	+1.85
1988	5,708,270	5,072,024	–4.84	+1.15
1989	5,442,614	5,284,960	–4.65	+4.20
1990	5,094,270	5,458,680	–6.40	+3.29
1991	4,976,730	5,631,130	–2.31	+3.56
1992	4,861,910	5,815,470	–2.31	+3.27

Source: OAE (1994).

Due to the above reasons, the draft animals that remain available in rainfed conditions of small farms are now multi-purpose animals, i.e. for draft, meat and manure.

DAP technology and research

Harnessing system

In Thailand, buffaloes and cattle are traditionally harnessed with a neck yoke. The yoke is normally a wooden cross-beam either straight or elliptical in shape, depending on the implement drawn. A rope tied at both ends is passed under the neck. This is the traditional harness that is still used although two disadvantages were pointed out almost 40 years ago (Garner 1957). One is that the rope under the throat pulls tight against the buffalo's windpipe, restricting normal breathing. Thus, oxygen intake is reduced and fatigue sets in within a very short period of the animal beginning to pull the load. Another is that the yoke, which is in contact with only a small area on the buffalo neck or withers, digs into the flesh when a heavy load is pulled and causes discomfort. Garner (1957) designed a collar and a breast strap made of local materials for harnessing the animal. This method increased draft ability (ploughing and harrowing) of animals by 25%. However, this technology was not accepted by farmers for unknown reasons. Some of the limitations to adoption could be the lack of effective technology transfer and the high price of raw materials used. To date, no improvement in the harnessing system of the animals has been undertaken.

Implements used with draft animals

The most common implements used with draft animals for crop cultivation are ploughs and harrows. Formerly these implements were usually made of wood available in the forest or farm lands. Due to wood scarcity in the past decade, however, a metal plough has come into the local markets of agricultural tools. For rural transportation, animal-drawn carts have been commonly used. In some locations different kinds of animal-drawn implements can be found. For example in some villages of Surin and Burirum provinces a sugar-cane crusher turned by animal power is used by small farmers to produce home-made sugar during the sugar-cane harvesting season (January to March) each year. Animal-turned water pumps can be found in some remote areas of the northern provinces where villagers are faced with drought or have difficulty bringing water to their homes from distant water sources.

No new implement has been developed to use with draft animals in recent years. However, there have been attempts to improve the traditional plough through the collaborative work of the Division of Agricultural Engineering, Ministry of Agriculture and Cooperatives (MOAC), and the International Rice Research Institute (IRRI) since 1972 (Tongpan 1982). Unfortunately, the improved ploughs have not been widely used by farmers due to constraints in technology transfer. In 1984, the water pump turned by animal power was brought back and efficiently developed for use in some northern locations through the collaborative work of Kasetsart University Research and Development Institute and the departments of Agriculture and Livestock Development (MOAC). About five years ago, an upland seeder was developed for use in the field; extensive farm testing was not possible because of insufficient numbers of trained draft animals on-station. Today, most draft animal power (DAP) scientists and engineers have deserted the DAP research work for higher technology fields where they can get higher pay or enjoy greater professional prestige.

Research on DAP

Research specifically on DAP in Thailand is scarce compared with that done in other fields. In the last two decades, long-term DAP projects were conducted by only a few institutions, i.e. improvement of animal-drawn implements by the Division of Agricultural Engineering, Department of Agriculture (MOAC); nutrition of draft animal utilising crop residues by Khon Kaen University; and buffaloes for draft power focussing on socio-economics and on-farm monitoring as well as energy requirements for working buffaloes by Kasetsart University. A compilation of published DAP research work in Thailand in the last decade which includes such disciplines directly related to DAP as engineering, socio-economics, environmental physiology, breeding and reproduction, and feeding and nutrition, reveals that only 21 research articles were available. This collection may not be complete but at least it reflects the extent to which DAP research is being neglected and how much future research work needs to be done.

Use of buffalo cows for draft

The intensity of work for draft animals in Thailand varies among locations, seasons and farming systems. Traditionally, male animals were preferred for work, while females were kept for producing calves in order to gain additional income for farmers. Due to an increasing shortage of draft animals during the recent decades both male and female buffaloes (including pregnant buffaloes) have been used for work.

A year-round household survey on the use of individual buffaloes for farm work was conducted in two villages in Surin Province. The work recorded included ploughing, harrowing and carting. The data, collected daily, show that the draft buffaloes are used on average 51–67 days per year, with a range of 8 to 115 days (Chantalakhana et al 1991). Two to three draft buffaloes can take care of farm work for 2–3 ha of farm area. Results from the same study showed that buffaloes are used most intensely during July and August which are the months of most intense ploughing and planting.

The trend in small farms has been that more female animals are raised for work than males; females are preferred because they can produce calves. Bunyavejchewin et al (1995a) monitored the number of working buffaloes in two villages of north-east Thailand; two typical farming systems were studied, namely lowland and mixed lowland–upland crop production. The data from three consecutive years (Table 3) revealed that both villages used more female than male animals for work, but the range of ratio of working male to female in the mixed lowland–upland village (1:5–1:12) was much higher than that of the lowland village (1:2.6–1:3.4). In practice, most bigger males were castrated between 2.5 and 3 years old to reduce their aggressiveness and for ease of handling during training for work. Only a few bulls in the survey villages were used for work due to their individual tameness. This gave more chance for natural buffalo mating which mostly occurred from January to March when animals were in prime conditions due to abundant feed supply in post-harvest period of October to December. Since farmers kept more cows than bulls, pregnant cows were used for work whenever necessary. Calving mostly occurred during November to January which meant that many 4–6-month pregnant cows might be worked during the June-to-August cropping season. The number of working cows calving was recorded (Table 4).

Table 3. *Numbers of working animals in two villages (lowland and mixed lowland/upland) in north-east Thailand in 1992–94.*

	Lowland			Mixed lowland–upland		
Year/No. of buffaloes	Male	Female	Total	Male	Female	Total
1992						
Total no. of buffaloes	91	158	249	93	192	285
Working buffaloes[1]	37	96	133	9	109	118
1993						
Total no. of buffaloes	92	183	275	114	172	286
Working buffaloes[1]	25	84	109	7	78	85
1994						
Total no. of buffaloes	97	170	267	97	152	249
Working buffaloes[1]	21	68	89	11	55	66

1. Worked in the last cropping season.

Source: Bunyavejchewin et al (1995a).

Table 4. *Cows calving under village conditions.*

No. of animals	Calving season 1991/92 LV	UV	Total	1992/93 LV	UV	Total	1993/94 LV	UV	Total
Total no. of buffaloes	–	–	–	249	285	534	275	286	561
Male	–	–	–	91	93	184	93	114	206
Female	–	–	–	158	192	350	182	172	355
Mature females	121	120	241	129	131	260	131	131	262
Mature bulls	–	–	–	20	13	33	49	42	91
Cows calving	31	52	83	47	46	93	32	26	58
Non-working pregnant cows	4	6	10	13	13	26	10	10	20
Working pregnant cows	27	46	73	34	33	67	22	16	38
Calving rate (%)	25.6	43.3	34.4	34.4	35.1	35.8	24.4	19.8	22.1

– = no data collected before this study; LV = lowland; UV = mixed lowland/upland.

Working pregnant buffaloes

Results from on-farm monitoring in two north-east villages (Bunyavejchewin et al 1995b) showed that 37 pregnant buffaloes were observed, 23 in 1992/93 and 14 in 1993/94 calving seasons. Twelve out of 23 were used for work in the 1992 cropping season (around May to August), while 6 out of 14 were worked in 1993. Due to different rainfall patterns between the two cropping seasons, the working intensities of the animals were different. There was an unusually short rainy season with a small amount of rainfall in 1992 in these villages. Buffalo power was therefore used less than in 1993 when rainfall distribution was normal.

The working profiles of pregnant cows calving in different months of the calving seasons are presented in Table 5. Pregnant buffaloes in this study were used for work at various stages of pregnancy, ranging from 2–3 months to 6–8 months in 1992. However, the number of working days were few, ranging from 2–5 days to 11 days during the cropping season or 3 to 17 hours per animal per season. This workload was light because of the drought during the 1992 cropping season. Many farmers who used buffaloes for tillage turned to hiring a two-wheeled tractor. During the 1993 cropping season, rainfall was near normal and buffaloes were used more intensely. Working days of six pregnant buffaloes ranged from 45–90 and the number of working hours per season was 225 to 450. The females were at 2–3 months to 5–7 months of pregnancy. No incidences of health problems or abortion were recorded, even though some of the cows were worked five hours a day during the 2–3 months of cropping season. It is reported that heavy work slightly decreased body weight of female buffaloes during midterm of pregnancy. However, there was no record concerning the effect of work on calving interval of buffalo cows.

Table 5. *Use of pregnant buffaloes for draft in two cropping seasons.*

No. pregnant cows observed	Month of calving	Average age (yr) (min–max)	Work in month of pregnancy	Period of work: Days (min–max)	Period of work: Hours (min–max)	Type of work
1992/93 calving season				1992 cropping season		
3	Nov '92	7 (4–9)	6–8	2–6	3.5–7.5	1st tillage
6	Dec '92	10 (4–19)	5–7	2–5	3–8	Mostly 1st tillage
1	Feb '93	7	2–3	11	14	1st tillage
2	Mar '93	14.5 (8–21)	2–5	4–11	5–17	1 st tillage
1993/94 calving season				1993 cropping season		
2	Nov '93	8 (4–12)	5–7	60–90	360–450	1st, 2nd tillage and harrowing
2	Dec '93	8 (7–9)	4–6	45–70	270–420	1st tillage
2	Mar '94	7.5 (6–9)	2–3	45–60	225–300	1st tillage

Work output of buffalo cows

In an attempt to compare work output from female with that from male buffaloes on-farm, measurement in terms of area ploughed was taken for females more frequently than for males (Table 6) because farmers used more females than males for work. Work done on the second tillage was one and a half to twofold more than that done in the first tillage. Since there was a wide variation in the number of observations in the two sexes and in body weights, the difference between sexes concerning draft performance could not be clearly determined. However, it appeared that work output was dependent on body weight. The first tillage worked by cows with a range of average weight of 405–411 kg covered areas of 405–420 m^2/h. For the second tillage, the area worked by cows of average weight of 404–410 kg was 708–807 m^2/h (Bunyavejchewin et al 1995b).

Table 6. *Draft ability of female buffaloes compared with males.*

Type of work	Soil type	Sex	Body weight (kg)	Number	Area ploughed (m^2/h)	CV (%)
1st tillage	Sandy loam	F	405±34	25	405±143	35.0
		M	537±70	3	503±265	52.7
	Clay loam	F	414±60	11	420±173	41.2
		M	–	–	–	–
2nd tillage	Sandy loam	F	410±47	26	807±501	62.1
		M	448±89	3	891±552	61.9
	Clay loam	F	404±57	11	708±513	72.4
		M	418±89	3	669±235	35.1

CV = coefficient of variation.

Future role of draft buffalo cows

In the foreseeable future, buffalo cows will continue to play a significant role as a source of animal power to small farm systems in some areas especially in north-east Thailand for several reasons discussed below.

During the past two decades village buffalo herds were generally 50% male and most of them were used for work and transportation. However, in recent years more female buffaloes were used for work to exploit their potential for calf production and for additional income from the sale of calves, as well as for other purposes. Village buffaloes will therefore continue to serve as multi-purpose animals with some transition from draft buffalo to a small tractor or a hand tractor where crop production depends on rainfall. The small tractor is also fashionable among rural farmers for its fast speed in working, but its cost-effectiveness is questionable (Bunyavejchewin et al 1994). Bunyaprawit (1985) reported that the break-even point for the use of small tractors was at 242.43 hours per year. Often some farmers underuse small tractors for various reasons, e.g. their pieces of land for cultivation are too small, there is not enough family labour to hire out the tractor during the off-season period, lack of knowledge in using the small tractor properly which can affect the user's health etc. In addition, some farmers turn back to draft buffaloes when the tractor breaks down (Priebprom and Sirichinda 1995). Since some kinds of work such as furrowing or ploughing near dikes are more conveniently done by buffaloes, the combined use of mechanical power and draft buffalo cows may be practical and economical under rural small farm systems in Thailand.

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Discussion on Dr Bunyavejchewin's presentation

Question: You have reported very low buffalo reproductive rates which would not even allow for replacement. How do you explain that?

Bunyavejchewin: There are two main reasons:

1. The breeding condition under which females are bred. After the harvesting season females and males are put together for breeding, but because of the small number of males breeding rate is low.
2. Feed in the village is mainly rice straw which allows for very low levels of production above maintenance.

Muller-Haye: Your data on reproductive rates are very low and do not even allow for replacement. Why?

Bunyavejchewin: Lack of quality bulls at breeding time is one reason. The second reason is poor quality feed at the village level.

Wandera: How do you explain the greater work performance of females than males shown by your data?

Bunyavejchewin: I didn't say that draft performance of females is better than that of males. I said we need more research to confirm these results.

The potential and extent of use of cows (cattle and buffalo) for draft work in Vietnam

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Background

Since 1986 Vietnam has had a policy of involving farmers in decision making related to economic activities. The hand-over of 'land-use power' to farmers and privatisation of draft working animals (DA) has encouraged an increase in production in rural areas. These are the main factors that have contributed to the rapid increase in rice production, making Vietnam the third largest exporter of rice in the world. Much of the draft power used in agriculture comes from animals, especially cattle and buffaloes.

Distribution of DAP by agro-ecological region

There were about 2 million draft buffaloes (69% of the total herd) and 1.5 million draft cattle (45% of the total herd) in 1993. The distribution of DAP by agro-ecological region (AER) is not uniform, leading to unequal agricultural production. The proportion of draft buffaloes (DB) in some AERs of northern Vietnam such as the Mountain and Midland Region (MMR), Red River Delta (RRD) and North Central Coast (NCC) is higher than that in the southern AERs. However, the proportion of draft cattle (DC) in the Central Coast Region is higher than that in the other AERs. Although rice production is highest in the two delta regions (Red River and Mekong River), only 8.5 and 6.1%, respectively, of the DB population and 8.1 and 4.6%, respectively, of the DC population are found here. This small supply of DAP is consistent with the mechanisation of rice production in these two areas.

Farmers' attitudes towards DAP

In general, farmers prefer to use DB. Therefore, the DB ratio to total herd size (69%) is higher than the DC ratio (45%). Farmers feel that DB are stronger than DC, and that DB can plough a larger area per hour than DC (450–550 m/h vs 300–400 m/h, respectively). Draft buffalo can endure hard work longer than draft cattle and can also plough in the flooded muddy rice fields while DC can only plough in the higher elevation fields with light soil. The walking speed of cattle, however, is faster than that of buffaloes.

Farmers in the southern part of Vietnam use a pair of working animals, while those in the northern part of the country use a single animal. In the Mekong Delta, the work capacity of a pair of DB is 1200–2000 m^2 per shift (3–4 hours) while that of a pair of DC is 900–1600 m^2/shift. In the Red River Delta, the capacity of a single DB is 750–1500 m^2/shift while that of a single DC is only 400–1000 m^2/shift.

Feeding and management systems for DAP

Due to grazing conditions, the number of working animals raised in a household in MMR is higher than that raised in the delta regions. The feeding system for draft animals therefore differs from one region to the next. In MMR, the animals work in the morning (0700–0900), then graze freely in the forest, or on the hillsides or communal land. No supplementation is provided even during working periods. Sometimes, the reproductive cows (cattle and buffalo) are supplied with a soup consisting of maize, cassava or rice bran for some days after calving. In the delta regions, the DAs are mainly raised in sheds. After working time (0600–0900), the DAs are grazed and taken care of by children in the afternoon when the children are back from school. The grazing land is limited to riversides and/or damsides, so the feed intake is very low. The DAs are supplied with natural grasses which are cut by children, rice straw, maize stems, or groundnut vines in the evening. During ploughing or calving the animals are given mixed feed (rice bran, waste of cassava or soybean) and are rested in stalls.

Objectives and constraints

Objectives

- Increasing the reproductive capacity of working cows (cattle and buffalo) to develop the DA population and increase the DA number per household.
- To develop a DA herd with high working and reproductive capacities in the delta region. During mechanisation, the draft buffalo will be used mainly for animal power, while the cattle herd will be used for milk and meat purposes.

Constraints

- shortage of feeds, especially green grasses, during the dry season (south) and in winter (north)
- a high percentage of anoestrus cows and long calving intervals
- calving period coinciding with ploughing
- endo- and ectoparasites.

Opportunities for increased use of cow traction

1. Growing improved grasses around farmers’ houses to meet the shortage of feed in the dry season.
2. Preserve rice straw and treatment with urea (4% ensilage for 7 days).
3. Expand the use of agro-industrial by-products (AIBP) such as molasses, sugar-cane tops, cassava waste, soybean waste, groundnut vines etc, and introduce the use of urea-molasses blocks.
4. Introduce mineral supplementation using mineral block licks.
5. Use gonadotrophin hormone (PMS and PGF2a) to stimulate ovarian activity and control reproductive performance of draft cows.

Researchable issues

- Separate the calving period from the ploughing period by using gonadotropin hormone to synchronise oestrus in cows.
- Provide adequate feed and supplements during working time.
- Improve body condition and increase body weight of local cattle and buffalo breeds by introducing a cross-breeding programme using Red Sindhi cattle and Murrah buffaloes.

Draft animals in China

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Summary

Traditionally, China has used large animals as the chief source of power for farm work and commercial transportation. A series of archaeological findings have indicated that buffalo and cattle had been domesticated and used as draft animals 7000 years ago. Animals such as buffalo, cattle, yak, horse and donkey have been extensively used as draft power in and given a major but unquantifiable contribution to all kinds of agricultural operations in the past centuries. The horse and the yak are the dominant draft animals in the pastoral areas in the northern and south-western parts of China. In the cropping areas of the central and north-eastern portions of the country, the donkey is the chief source of power and cattle are used as the complement. The buffalo is the most important source of power in the rice-producing area of South China and the small-type cattle are the primary source of power in the mountainous parts of this area. A series of research projects conducted in Guangxi, an autonomous region in South China, revealed that management and the feeding were essential for maintaining the animals' draft endurance. The studies also found that milk yield decreased by 20–30% if a dairy buffalo was used for four hours per day during lactation. In the past five years, great attention was paid to the exploitation of former draft animals for meat and milk. A nation-wide project titled 'To increase the meat production by utilising locally available feed resources in cropping areas' has been carried out in 59 counties and 24.6 million head of cattle and buffaloes were sold as meat animals.

Introduction

China has a 7000-year history of using buffalo and cattle as sources of power for farm work. Many archaeological findings indicate that buffalo and cattle had been domesticated and used as draft animals in the New Stone Age, and that the first systematic law to protect these animals came into being 2200 years ago.

Since then, the large animals which consisted of not only buffalo and cattle but also some other species such as horse, donkey and yak have been extensively used for farming and commercial transportation, and have given a major but unquantifible contribution to all kinds of social and economical activities. To protect this important means of agricultural production, their slaughter without a permit from the government has been strictly forbidden. Considerable efforts had been made by scientists to improve the work ability of these animals.

Distribution of draft animals

Five varieties of animals are used as the chief power source in farming activities and commercial transportation in China. These are horses, donkeys, yaks, cattle and buffalo. The different varieties are emphasised in different regions, and even in different districts in the same region due to the variations in farming system, geography and climate.

In the pastoral areas of north-western China where the climate is very harsh in winter and livestock production is the major component of agriculture, the horse and the yak are the dominant draft animals. They are used for riding, packing and pulling carts. The horses that are used to pull carts or as pack animals are usually overloaded. Because of this and inadequate nutrition, many horses are no longer useful by 10 years of age, and a horse of 15 years is considered quite old. The yaks are mainly maintained by the herdsmen in the plateau areas in Tibet, Qinghai, Sichuang and Gansu provinces (regions) and are used as dual-purpose animals (milk and draft).

In the north-eastern portion and the Middle Plain area where there is a vast area of plain dry land and the terrain is smooth, the donkey is probably the most important draft animal although cattle are used for farming to some extent. The large-type donkey is primarily used for draft on-farm and in commercial transportation. The intermediate and small types are both used for farm work and packing. An intermediate type donkey can cover 35–40 km with a load ranging from 80–100 kg when used as a pack animal.

In the mountainous areas of the southern portion of the country, yellow cattle are used to a great extent for farm power. They are one of the most important sources of such power on the dry land in the far south-western area of the portion. The cattle are smaller than those in northern China. The body weights average 380 kg for males and 250 kg for females. The maximum pulling power of adult males and females are 195 kg and 165 kg, respectively. When used in commercial transportation, they can cover 22.56 km with a load of 250–350 kg per day, on average. When used for tilling dry land, a male can finish 0.13 ha while females can cultivate 0.11 ha per day.

In the cropping area of South China where rice is grown, the buffalo has been used to a greater extent as the primary source of power to prepare rice fields. The animal is also used for many agricultural activities including grinding sugar-cane, milling grain, water bailing and treading mud for making bricks. Cattle are used to some extent as the complementary draft power. Buffaloes are also used to transport farm products and materials from house yard to field and market.

Role of draft animals

Historically, draft animals in cropping areas of China were reputed by both farmers and government as the essential means of agricultural production and transportation. The government restricted the killing of these animals strictly and provided owners with low price feed grain during the busy farming season. Only those animals that were no longer suitable for work were allowed to be sold as meat. Farmers regarded their animals as an important part of the family property. The animals were tied to trees in front of houses as a symbol of prosperity.

Because of the government's protection policy, the number of large animals in stock in China is great. It was estimated that the large animals numbered about 157 million head (81.19 million cattle, 22.92 million buffaloes, 12 million yaks, 9.68 million horses, 10.78 million donkeys, 5.54 million mules and 6.46 million camels) in 1994, out of which about 82 million head were used as draft animals.

Fifteen years ago, draft animals were used as the main source of power in almost all kinds of grass-root social and economic activities. The horse and donkey were more frequently used than cattle for commercial transportation and farm work in the plain areas because of their high speed and stronger traction power on the vast dry land and on the plain road. Cattle were the chief source of power for the preparation of small pieces of hilly dry land in mountainous regions, while the buffalo played a vital role in the farming system of the rice-producing areas.

Simultaneously with the decrease of arable land and extensive use of agricultural machines and modern means of transportation in the past 15 years, the importance of draft animals has gradually declined. As a consequence, farmers have a large number of surplus draft animals. According to a survey conducted in 1990, few animals were being used as the chief power to pull carts and as the other commercial transportation in the cropping areas besides a small number of horses, donkeys and yaks. These were still being used to pull farm carts to complement modern transportation in the central and north-western parts of China. An animal generally worked for 30–60 days per year, cultivating 1–2 ha of farm land. Furthermore, farming machines have been widely adopted in the comparatively well developed rural areas and in 1994 were used on an estimated 50% of the arable land in North China and 30% of the rice fields in South China.

The use of draft animals has been low in the past decade. This has led to a sharp decrease in farmers' enthusiasm to raise them. The draft animal populations have reduced by 50% in the regions where a commodity-based economy prevails and by 23% in the remote countryside during the same period.

The current practices of using draft animals in fields around villages may be classified in three ways. The small farm holder maintains an adult female with a young calf or only a bull to farm his own land. Several householders, who usually belong to one family, share two draft animals using a rotation system so that each holder can use them for farm work on certain days and is responsible for handling them during this period. In some villages some farmers specialise in raising draft animals. They buy animals from outside villages for rent in the busy farming season and sell the animals as meat in the autumn.

Opportunities for increased use of draft animals

With the development of the commodity-based economy and the popularisation of efficient, multi-purpose machinery in the sectors of agriculture and transportation in recent years, the extent of the use of the animals for draft work has rapidly declined. This tendency will undoubtedly speed up in the future although variations will remain from area to area.

A great number of surplus draft animals exist in rural areas. This provides an opportunity for the rapid development of beef production at the smallholder level and creates challenges for traditional animal production. The economic analysis indicates that 5000 kg of fresh grass and 150 labour days which cost 2000 Chinese yuan in the developed areas (552 yuan in the remote regions) are needed to maintain a draft buffalo per year while the output from it is only 1200 yuan (340 yuan in the remote regions). To reduce the economic loss on the maintenance of these surplus draft animals the government has removed the ban on slaughter and is encouraging farmers to fatten their animals before sale. The related technical support is being offered by different level scientists. This alternative is in its initial stages.

Since 1990, the strategy of combining smallholder beef production with the utilisation of locally available feed resources has been carried out in selected counties throughout the cropping areas of China. This was to set up demonstrations based on various natural resources. Fifty-nine counties have been involved in this operation and preliminary results have been obtained. In 1994, the inventory of the buffalo and cattle in China reached 104 million, an increase of 3.87% over that in 1993. Some 24.6 million head were sold in the free market as meat, an increase of 41.4% over the previous year.

Use of draft animals and related research done in Guangxi

Guangxi Autonomous Region is located in the southern-most part of China and is in the subtropical monsoon zone. Of its territory, four-fifths is occupied by mountains and hills, one-tenth by water and another one-tenth is arable land. The per capita arable land in 1994 was 0.06 ha. The large animals that were mostly used for draft work numbered 7.4 million head in 1994, out of which, 4.1 million head were buffalloes, 3 million were cattle and 0.3 million were ponies. The practices for crop production and animal husbandry are of smallholder type. A householder generally owns 0.3 ha cultivated land and 1–2 large animals. Paddy rice is the dominant crop and swine production is the major component of the holder-level animal husbandry.

Three varieties of large animals are used for draft work in the region. The horses of the region may be described as the South China pony, and are used as pack animals in the remote mountainous areas. The heights for male and female at six years old range from 102 to 113 cm and 102 to 110 cm, respectively. They can cover 40 km per day on sloping rocky roads and 60 km per day on plain dirt roads, with a load of 50–80 kg. Cattle are primarily used as power on dry land in the mountainous areas of the region. All the cattle are referred to as "yellow cattle" and are generally small in body size. The body weights of adult male and female average 350 kg and 260 kg, respectively.

The buffalo is the most important source of power on farms in the region because of its quiet temper and ability to work in the mud and water of flooded rice fields. It is used to a limited extent for milk production as a by-product of work in only a few localities. Most of the buffaloes are indigenous animals and belong to the swamp type. Their body weights vary from area to area, but generally range from 450 to 500 kg for adult males and 400 to 450 kg for adult females.

In order to better understand the draft abilities of buffalo and cattle, a series of studies were done in fields in China before the 1960s. In the meantime, several exotic breeds that included Murrah, Nili Ravi, Sahiwal and Santa Gertrudis were introduced to improve the work ability of the local breeds. From the 1980s, appreciable effort has been directed at utilising these exotic breeds for milk and meat production.

Research on draft animals

The results of the research done in the region are summarised below.

Selection of the buffaloes and cattle for draft work

A good draft animal shall possess the following characteristics:

- quiet and sensitive temper
- normal stepping
- suitable body weight (350–400 kg for cattle and 400–500 kg for buffalo when used on the limited area of land)

- suitable body conformation (beefy built body, comparatively shorter legs, and higher wither compared with the height at hip cross)
- bowl-type (square set), black hoof with the pastern at about a 45-degree angle
- 3–10 years of age.

Study on the work abilities of the native bovine and their hybrids

Buffaloes were tested in rice fields and cattle were tested on dry land. The results indicate that the crossbred is more efficient when used for draft work (Table 1).

Table 1. *The work ability of native bovines and their hybrids.*

	Native cattle	Native buffalo	Murrah grades
Draft pull (kg)	55	65	80
Work period (h)	4 (4)	6 (6)	6 (6)
Area ploughed (ha)	0.13 (0.11)	0.19 (0.13)	0.29 (0.21)
Weight loaded (kg)	350 (250)	500	800
Distance covered (km)	23 (22)	20	25

Note: The data in parentheses are on females.

Training and management of draft animals

A buffalo shall be trained for farm work at 13–14 months old and the latest age should not exceed 24–25 months. Buffaloes and cattle that have just been fed should not be used for work immediately as these animals are unable to obtain any nutrients from the newly-supplied feed because they do not ruminate during work. Therefore, it is recommended that an animal that has just been fed shall have an 80-minute rest so as to complete the first ruminating before starting work. In addition, a reasonable amount of salt (60–100 g/day) should be given to draft animals daily.

Feeding draft animals

Suitable feeding during the busy farming season is essential for maintaining an animal’s draft endurance. A referenced feeding standard and a series of ration formulas based on varied local available feed resources were worked out (Table 2).

Use of dairy buffaloes for draft work

Only animals under extensive management conditions and which are good milk producers are used for draft work. In the rural areas in Guangxi, most of the dairy animals are crossbred buffaloes (Murrah grades, Nili Ravi grades and triple breed crosses). The dairy buffaloes used for farming are quite common in a few localities. The effect of draft work on milk performance of the dairy buffalo has been studied. The results indicate that draft work significantly affects the milk yield of buffaloes. However, the extent of the influence is closely related to work period and lactational month in which the animal is used.

Table 2. *Feeding standards and diet formulas for female and male working animals.*

	Feeding standard (Quantity/100 kg live weight)		
	Dry matter	Digest. crude protein	Total nutri. matter
	–––––––––––	––––– kg –––––	–––––––––––––
Maintenance requirement	2.2–2.4	0.07	0.76–0.80
Light work (2 h)	2.2–2.4	0.106	1.00
Medium work (4 h)	2.2–2.4	0.14	1.22–1.28
Heavy work (6 h)	2.2–2.4	0.17–0.18	1.50–1.60
Per litre milk	0.15	0.0134 MNE	0.236 Mcal (NEL)
Formula 1			
	Female (400 kg LW)	Male (500 kg LW)	
Pasture hay	4.0	5.0	
Rice straw	4.8	6.0	
Concentrate			
Light work	1.2	1.5	
Medium work	2.4	3.0	
Heavy work	3.6	4.5	
Formula 2			
	Female (400 kg LW)	Male (500 kg LW)	
Chinese milk vetch	29	30	
Lime-treated rice straw	4	5	
Legume hay	2.8	3	
Carrots	2	3	
Formula 3			
	Female (400 kg LW)	Male (500 kg LW)	
Sweet potato vine	14	17.5	
Dry Chinese milk vetch	3.2	4	
Hay	4.8	6	
Rice straw	4	3	

Note: The composition of the concentrate is: 30% rice polishing, 40% wheat bran, 25% corn, 5% peanut cake, 2% salt and 0.5% lime.

When draft work begins from the fifth month of lactation and lasts four hours per day for a couple of months, the milk yield of the buffaloes decreases by 32.7% monthly (normal decrease rate ranges from 15.4 to 20.8%). When buffaloes are used for two months from the third month to the fifth month of lactation (4 hours per day), the monthly decrease rate reaches 45% (normal decrease rate is between 12.8 to 17%).

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Use of cows for draft in India

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Introduction

In India, according to a 1987 census, there were 196 million cattle, 77 million buffaloes, 99 million goats, 45 million sheep, 1.83 million horses, mules and donkeys, 1 million camels, 10.8 million pigs and 258 million poultry. Genetic diversity is large, as reflected by 26 breeds of cattle, eight buffalo breeds, 40 sheep breeds, 20 goat breeds, four camel breeds and several breeds of horses, pigs and poultry. The country has some of the world's best dairy breeds, draft cattle and carpet wool sheep and some of its most prolific goats.

Livestock make a substantial contribution to the country's agricultural economy. According to provisional estimates of the Normal Accounts Division of the Central Statistical Organization, the gross value of output from the livestock sector at current prices was about Rs 588 billion in 1992–93,[1] which is about 26% of the value of total agricultural output. This excludes the contribution of draft animal power.

Draft animal power

Animals that are commonly used for draft are cattle, buffaloes, equines, camels and yaks. The contribution of livestock as a source of power is now being realised. In spite of increasing mechanisation of Indian agriculture, working animals, particularly bullocks, continue to be the predominant source of energy for traction and rural transport. At present, about 73 million bullocks and about 8 million male buffaloes provide about 32,000 megawatts of power and help cultivate 89 million farm holdings. This accounts for nearly 70% of the total cultivated area in India. At an optimal replacement rate of 11 bullocks per tractor, this herd is equal to about 8 million tractors and saves the nation about 26 million tonnes of diesel annually, almost equal to the total production of petroleum in the country, worth Rs 222,000 million.

India possesses the most famous draft cattle breeds in the world. These are the Nagori, Khillari, Helikar, Amrit Mahal, Kangayam, Malvi, Haryana, Gir, Angol, Tharparkar and Gaualo. Most of the farmers keep the male calves of their own cows and buffaloes for draft purposes. Bullocks and male buffaloes over three years of age are the main draft animals for field operations. Although the total bovine population increased from 227 to 273 million during 1961–87, the number of draft animals declined from 80.4 to 73.0 million. Of the 73 million working draft animals, 61.64 million were indigenous cattle, 6.56 million were buffaloes, 2.34 million were buffalo cows, 0.36 million were camels and 2.1 million were crossbred cattle.

Cows as draft animals

In India, cattle husbandry has centred around milk production, manure and draft. In most circumstances milk is the primary objective. Bulls have always been considered as by-products and used for work. Less than 2% of cows are used for work, and only in a few eastern and southern states such as Assam, West Bengal, Orissa, Bihar, Andhra Pradesh and Tamil Nadu.

1. US$ 1≃ Rs 35

Research work

The earliest reports of the scientific investigations on draft animals date back to 1945–46 from the Livestock Research Station, Hissar. Vaugh (1947) reported that Haryana bullocks developed draft equivalent to 1/5 to 1/6 of their body weights. Acharya et al (1977), while conducting studies on the genetic analysis of a closed herd of Haryana cattle, tried to correlate the draft quality with body conformation. No significant differences were observed between the physiological reactions and body measurements of these animals. Mukherjee et al (1961) studied the draft capacity of 24 Haryana bullocks. Maximum loads that could be carried by these animals were tested and expressed in terms of their body weights. They indicated that 58% of the animals tested could draw a cart load up to 42% of their body weights for six hours without showing distress symptoms. Maurya (1985) reported the range of draft in bullocks as 7.5 to 24.5% of their body weights with speeds varying from 1.91 to 4.95 km/h. Rai et al (1982) stated that haulage capacity of buffaloes was greater than that of bullocks.

So far, considerable research has been conducted on draft capacity, power output, ploughing physiological parameters, oxygen consumption, haematological studies, muscle, nutritional conditions and physiological states. However, very little work has been conducted on using dairy cows and dairy buffalo cows for traction.

Buffalo cows

Investigations on Murrah buffalo cows indicated that work decreased milk yield. Fat and protein contents increased and lactose content decreased but the changes due to work were not significant. These studies suggest that dry non-pregnant and lactating non-pregnant Murrah buffaloes could be used for light to moderate work for 1–2 hours continuously without any adverse effect on body condition, milk yield and milk constituents (Singh and Upadhyay 1994).

Studies on physiological responses of buffalo heifers to treadmill exercise indicate that work increased cardio-pulmonary activity. Heart rate increased, and duration of atrial and ventricular events decreased. Rectal and skin temperatures increased, as did blood lactic acid concentration. Three hours of rest after treadmill exercise reduced lactic acid concentrations to near normal values and decreased rectal and skin temperatures to near pre-work levels. Thus a 2:1 work:rest schedule may be suitable for buffalo heifers and heifers may be used for work at moderate intensity which requires energy expenditure of about 2–3 times the resting levels (Dang and Upadhyay 1991).

Investigations on the extensive use of different breeds of buffaloes, including females, have not been carried out under different agroclimatic conditions. Load spread and fatigue relationship of different species and breeds of animals need to be investigated since such information will enable the development and adoption of technology needed to improve the efficiency of the DAP system.

Future programmes

It is proposed to undertake genetic studies on draft performance of important breeds of cattle and buffaloes so that proper selection criteria for improving draft capacity can be evolved.

Studies are underway to ascertain the status and scope of various draft animals in different regions and to develop mechanically efficient matching equipment to increase versatility of draft animals as sources of farm power. This will improve efficiency of crop production and post-harvest operations without detrimental effects on the draft animals or the operation.

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Discussion on Dr Singh's presentation

Saadullah: Do you think they are not using the cows as draft animals in West Bengal?

Singh: They are.

Saadullah: In West Bengal and Bangladesh and anywhere if you ask the farmers why they are keeping animals they will say cattle are kept first for draft purposes and secondly for milk.

Cattle as working animals in Bangladesh with special reference to working cows

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Introduction

Livestock farming is a secondary and supportive activity of cropping systems in Bangladesh. Livestock provide the major part of draft power for tillage operations, transport, threshing and crushing of sugar-cane and oil seeds. In addition, they provide meat and milk for human consumption, and hides as raw materials for industries and export. Pairs of bullocks or cows are used as draft animals for cultivation; the animals are also hired out to neighbours. Increased intensity of crop production, declining draft animal population and non-availability of feeds and fodder have caused a shortage of draft power for land preparation in the country.

Importance of animal power

Bangladesh has a long history of using cattle as draft animals and it is thought that they contribute 70% of the total power for farming operations. Their contribution to farm power is enormous, but at the peak periods of cultivation power shortage is acute. Although some efforts have been made in recent years to introduce double and single axle tractors to overcome the seasonal shortages, this has not been a success. The main reasons for this include lack of capital to buy the tractors in the first place, and then fears about the ability to maintain or repair them afterwards. The main sources of farm power (Table 1) are animals (0.208 kw/ha) and humans (0.111 kw/ha), while mechanical sources (0.006 kw/ha) are very limited (Hussain 1977). The same author also pointed out that the total power available for agriculture in Bangladesh is among the lowest of all the developing countries. It seems that animals will continue to provide the draft power for the foreseeable future.

Table 1. *Energy input from different sources for selected countries (kw/ha).*

Countries	Human	Animal	Mechanical	Total
Bangladesh	0.111	0.208	0.006	0.325
India	0.059	0.149	0.037	0.245
Pakistan	0.089	0.186	0.182	0.457
Sri Lanka	0.044	0.022	0.149	0.216
Japan	0.082	0.000	0.937	1.019

The average live weight of bullocks and cows are 152±15 kg and 128±6 kg (Saadullah 1991), respectively; hence the animals lack great pulling power as this is a function of body weight (10–12%). The average age of local cattle at first calving is 45 months with a calving interval of 20 months and a lactation period of 9 months. Larger animals do exist, but generally do not live long as they are slaughtered for religious festivals rather than being kept for work.

Farmers prefer to keep more of the smaller local animals as working animals. These animals are used to the local, low-quality feeds, eat less and have more resistance to different diseases than crossbreds or pure exotic breeds.

Type and size of working animal

Native cattle are zebus (*Bos indicus*), are small in size and have a very low milk yield. They are multi-purpose animals. A small number of *Bos taurus* crossbreeds are also found mostly in the government farms and around breeding stations. According to a livestock survey in 1983–84 (BBS 1986), there were only 0.12 million crossbred cows (Holstein, Jersey, Sindhi × Holstein, Holstein × Local, Jersey × Local, Shahiwal × Holstein etc) in the country.

Working animal population

The total number of working animals was estimated to be 11.06 million representing 53% of the total cattle population. Of these working cattle, about 90% are used for land preparation, 4% for transportation and 6% for other tasks. The number of working buffaloes is 0.36 million (80% of total population). Of these, 69% are used for cultivation of land, 26% for transport and the rest for threshing crops and crushing sugar-cane, oil seeds etc. However, variations in the reported working animal population have been noticed in different reports: 17 million (Sarkar 1986), 12.5 million (FAO 1978) and 11.1 million (BBS 1986). It is therefore necessary to determine the number of working animals available in the country for various purposes. It has been reported that 36% of cows of 3–10 years of age and 60% of the cows above 10 years of age are being used for cultivation and for transport.

Ownership of working animals

The distribution of draft animals by type and farm size is shown in Table 2. Farmers with 0.05 ha of land (39% of total households) keep 33% of the cows and 5.8% of all bullocks. A higher number of bullocks (33% of total) is owned by households with more than 2 ha of land (Saadullah and Das 1987). Gill (1982) conducted a survey in 10 villages and found that 37% of farmers had no draft animals, 10% had 1 working animal and 50% had 2 or more working animals. Hussain (1982) also reported that 62% of the households had no draft animals. The number of draft animals owned by small farmers is low, and is a cause for concern.

Table 2. *The distribution of working animals by type and landholding in a village.*

Landholding (ha)	Per cent of total			
	Household	Cow	Bullock	Young stock
0.00–0.50	39	33	6	39
0.51–1.00	18	19	23	12
1.01–1.51	15	15	23	19
1.51–2.00	5	9	15	7
Above 2	12	24	33	23

Cows as draft animals

The increasing proportion of cows being used for draft has been reported by a number of authors. Until the partition of India in 1947 only barren cows were used for draft. Use of milch cows for work in Bangladesh is a comparatively recent phenomenon (Gill 1982; Jabbar and Green 1983). Lassen and Dolberg (1984) studied the relationship between landholding, number and type of cattle kept in villages and observed that farmers with less than 2 acres of land tend to use cows as working animals. The number of cows used for work increased from 1981 to 1984 while the number of bullocks decreased during the same period (Table 3) (BAU-FSRDP). However, although the number of working cows increased, the number of calves did not.

Table 3. *Change in types of working animal kept (1981 to 1984).*

Type of working animal	1981	1984	Difference
Bullocks	192	69	–123
Cows	108	157	+ 49
Buffaloes	4	0	– 4
Calves	226	99	–129

The effect of draft work by cattle on their production is not well documented. However, using cows for work may be a necessity for the small farmer as the farm size is not large enough to support both draft bullocks and milch cows (Saadullah 1991). Many authors believed that the use of cows for draft leads to problems with fertility and lactation, although to what extent and at what level of utilisation such problems occur is not clear (Gill 1981). However, other authors have stated that well fed cows can perform work without any adverse effect on milk production and fertility (Saadullah and Barton 1986; Barton 1987).

Draft power requirements

Comprehensive and accurate information on both availability and requirements of farm power is difficult to acquire. The assumption in Bangladesh is that one pair of bullocks can normally cope with 2 ha of land. Using this criterion, draft animal power does not appear to be seriously deficient. Surveys carried out more locally in different areas of the country indicate that all farmers are able to supply their draft power needs (Gill 1982; Orr et al 1986; Barton 1987). However, this depends to a large extent on the ability of a farmer to hire or exchange animals as the need arises (Saadullah 1991). There is a current shortfall of draft animals estimated at about one million head by Ziauddin (1985) and five million head by Hussain (1982). In the second five-year plan, the government of Bangladesh estimates a shortfall of about 19% in the number of draft cattle (Gill 1982).

Bangladesh has an average total available power of 0.325 kw/ha of land compared to a total of 1.019 kw/ha in a developed country like Japan (Saadullah 1991). A study found that draft capacity of animals ranges from 0.22–0.34 kw for 3–4 hours of continuous work (Hussain and Sarker 1978). Hussain (1982) reported that the 11.4 million draft cattle available in the country can produce 1475 megawatts (mw) of power per year. Many research workers have indicated that a draft power of 0.373 kw/ha of cropped area should be available if some productivity increase is to be expected (McColly 1971). To reach this minimum power requirement (0.373 kw/ha), about 720 mw of additional power is needed (Sarkar 1982).

But a large unknown proportion of the national draft herd is quite unsuited to the purpose because of a few obvious constraints such as inadequate feed, ill health, pregnant cows, and diseased working cattle (Saadullah 1991). Barton (1987) reported that the larger farmers suffer more from power shortage for land preparation as they own less power per acre of cultivated land than the smaller farmers. In addition, farmers who do not own any working animals certainly face an animal power constraint.

Major constraints to working animal production

It is generally assumed that the physical condition of working animals in general, and cattle in particular, has been deteriorating throughout Bangladesh in recent years. The increased use of cows for work by farmers, especially smallholders, offers extra dividends for the family, such as calves and milk. The number of young animals on the small farms, however, is decreasing (Table 3). This trend has not yet been well documented but it is thought to be a result of inadequate nutrition coupled with unimproved harnesses and implements and using the cows for power during pregnancy. Various types of traditional harnesses and ploughing implements are available in the country but their effectiveness is not well known. Improving these harnesses and implements could increase power output by about 15–20%.

Research and potential improvements to draft animal power technology

The cultivated cropped land of the country is about 21.21 million acres (8.59 million ha) and the average cropping intensity is about 153% (BBS 1986). Among the various crops, rice alone covers 70% of the total cultivated land (Jackson 1982). Consequently, rice straw is the most important crop residue; it contributes 90% of the total feed energy available for cattle (Saadullah 1991). The World Bank (1982) reported that 2 kg of straw dry matter and about 88 g of concentrates are available per animal per day. This ration would barely maintain the national cattle and buffalo herds. Moreover, it is unlikely that the fodder situation will improve in the near future while the emphasis for agricultural production remains geared to the production of grain for human consumption (Saadullah 1991). Thus emphasis must be shifted to examining the ways and means of improving the perceived animal power shortage using available feed resources (Saadullah 1991).

Reports indicate that supplementation of urea-treated and untreated rice straw with *Gliricidia* increased liveweight gain and milk production (Perdok et al 1983). Azolla supplementation stimulated better performance of crossbred heifers and azolla and water hyacinth can be good sources of green roughage to supply protein (Singh 1986). Significant differences in liveweight gain of crossbred (Sahiwal x local) calves were observed when fed with 200 g (DM) water hyacinth compared to Napier grass with a straw-based diet (Hamid et al 1983). Urea–molasses block lick was found to be very effective with straw-based diets in ruminants, increasing liveweight gain and milk production (Saadullah et al 1994). Thus it appears that supplementation of straw-based diets with urea and molasses with small quantities of green roughage in ruminants has a beneficial effect on rumen fermentation. There is obviously great potential for improved livestock nutrition by simple, cheap and appropriate methods which include ammoniation of straw using urea and urea–molasses blocks, and integrated production of improved species of shrubs and tree fodder in the cropping systems besides traditional grasses.

There is, however, great potential for increasing the output of work from working animals by improving implements and harness design. The design of harness currently in use consists of a bamboo or wooden beam held in place on the animal's neck by a rope passing under the throat. This type of neck yoke can produce open sores on the neck and hump the animal if poorly fitted. This discomfort, of course, will also severely limit the power output of the animal.

Research on harnessing, feeding, health care and the design and development of improved implements should be integrated from the outset under local conditions. There is some evidence to suggest that a small animal-drawn moldboard plough reduces the time required to cultivate one acre of land when compared with the traditional country plough. From the data available it seems reasonable to assume that the use of improved harnesses and implements could help to overcome the draft power bottle-necks which occur at periods of peak demand in Bangladesh. Designs for traditional and new harnesses must be evaluated both in terms of power output and the level and type of feeding regime that each system requires to gauge their appropriateness to the Bangladeshi farmer.

If the number of working animal units on cattle-owning farms can be increased by keeping more animals, which will allow those farmers to finish their cultivation earlier, this may release some working animals for the hire market earlier. The hire market is well developed in Bangladesh as poor farmers generally own no cattle of their own because they do not have enough land from which to provide the animals with food round the year.

All available reports on animal draft power recognised the shortage of draft power in the country. The reports stressed the need to increase the power by the individual care and managament of animals, improving traditional harnesses and ploughing implements and improving nutrition using available technology, rather than increasing the number of draft animals since there is a scarcity of animal feeds and fodder (Saadullah 1991).

Many experiments suggest that urea treatment of straw has great potential for increasing production in growing and lactating cows (Davis et al 1983; Saadullah et al 1994). In an experiment designed to assess the nutrient requirements of working bullocks and lactating cows and to study the effect of work load on feed intake, milk yield and liveweight changes, Barton (1987) found that draft forces were in the range of 7–11 and 6–11% and the average working speeds were recorded at 2.3 and 2.2 km/h in bullocks and lactating cows, respectively. In that study straw treatment with urea significantly increased the dry-matter intake of working cows by 15%; the treatment also increased milk production. The live weight of working cows receiving untreated straw declined during work while that of cows receiving ammoniated straw increased (Barton 1987). Hence in the absence of potential for improving the fodder and grain production exclusively for animals, efficient utilisation of straw through ammonia treatment (from urea) may be one of the feasible solutions.

Hardly any research has been done on the possible improvement of the quality of working animals using locally available feed resources to increase draft output. The shortage of working animals may adversely affect crop production in the country. To meet the power requirements, efforts have to be made to find alternative power sources.

Effect of draft work and diet on production performance of cows

A preliminary study was recently carried out on the effect of improved feeding on the performance and draft output of cows. The objective of this experiment was to estimate milk yield, lactation period, gestation period, calving interval, birth weight of the calves and physiological parameters (body temperature and pulse rate) and working speed of working cows fed a traditional diet (as practised by farmers) and an improved diet. Efforts have also been made to record the digestibility of nutrient of the diet before and during work.

Period of experiment

Before collecting of data, an adjustment period of two weeks was allowed for cows to adapt themselves to the experimental diet and housing conditions. The cows were dewormed for internal parasites before the trial began.

Diet of the experiment cows

The conventional (traditional) feed was based on straw with supplementation using quantities of concentrate normally fed to animals by farmers in the village. The improved feed replaced the conventional concentrate with molasses and NPN (urea). All the cows received almost equal amounts of metabolisable energy (Table 4). Straw was fed *ad libitum.*

Table 4. *Diet of the cows.*

	Conventional feed		Improved feed	
Feed ingredient	Without work	With work	Without work	With work
Rice straw	*ad libitum*	*ad libitum*	*ad libitum*	*ad libitum*
Wheat bran (g/day)	300	300	–	–
Oilcake (g/day)	100	100	–	–
UMB (g/day)			450	450
ME (Mcal/day)*	6.58	6.58	6.56	6.56
Grazing (hours)	3–4	3–4	3–4	3–4

UMB = urea–molasses block lick; * calculated value.

Process of manufacturing urea–molasses block licks

The process of manufacture involves heating molasses in a metal container to about 70°C for 15 to 30 minutes to bring it to standard thickness (sticky). The container is then removed from the heating source and the other block ingredients, i.e. urea, lime, wheat bran and mineral mixture in required quantities are added to the heated molasses. The complete mixture is poured into the dice (usually $22 \times 11 \times 10$ cm^3). The dice cover is placed over the mixture in the dice and pressed firmly to give the shape of a standard brick of about 2 kg in weight. The urea–molasses block is removed from the dice and left for less than an hour to cool and harden. If these blocks are not for immediate use, they may be wrapped in polyethylene sheets to avoid contamination during storage, and for easy transport. The blocks may be stored for a year in this way without any significant spoilage and change in quality. The proportion of different feed ingredients used to manufacture the urea–molasses blocks was 55% molasses, 27% wheat bran, 9% urea, 8% CaO (lime powder) and 1% mineral mixture.

Management of experiment cows

The cow sheds were cleaned every morning from 0500 to 0530 hours. The cows were fed with concentrates two times daily—in the morning (after milking) and in the evening (at 1700 hours). The tillage was done from 0800 to 1130 hours (the animals grazed after work). The grazing time was 0830 to 1100 hours (while the animals were not working). The animals were stall fed from 1400 to 1800 hours.

Data collection

The information on the following parameters were recorded: daily feed intake of cows, milk yield, fortnightly liveweight change, first sign of heat, date of service, date of calving, lactation period, gestation period, calving interval, liveweight change and birth weight of calves. The milk yield, body temperature, pulse rate, respiration rate of the cows and digestibility of the diet were recorded before and after work.

Results

The results of the experiment are shown in the following tables. Digestibility of the ration before and during work is shown in Table 5.

Table 5. *Digestibility of the diet fed to working cows during rest and work.*

	Conventional feed		Improved feed	
Parameter	During rest	During work	During rest	During work
DMI (% LW)	3.43±0.07	3.7±0.05	3.5±0.03	4.2±0.01
Digestibility (%)				
Dry matter	55.4±0.4	58.6±1.2	59.2±0.8	61.2±1.0
Crude protein	50.4±3.1	53.3±2.3	53.9±1.9	56.3±1.6
Crude fibre	69.2±0.9	70.6±1.4	71.8±2.6	75.6±4.1
Ether extract	48.1±1.6	50.4±2.7	54.7±1.6	60.4±6.5
N_2 free extract	59.3±1.8	60.1±1.7	57.4±1.1	62.6±1.1

± indicates the standard deviation of means.

Dry-matter intake. Average daily dry-matter intake of rice straw, wheat bran, oil cake and urea–molasses block lick during the experiment is shown in Table 5. The total dry-matter intakes were 3870 g and 3982 g per day per cow in group A (conventional) and group B (supplement), respectively. The crude protein and energy intake for the two feeding regimes were significantly different (P) during work. Burton (1984) observed similar differences in the digestibility of dry matter between rest and work indicating a higher intake of nutrients to compensate for the energy and other nutrients lost while working. The digestibility of proximate constituents is shown in Table 5. The cows that received urea–molasses blocks had higher digestibility than the group supplemented with oil cake and wheat bran. This might be due to favourable rumen condition resulting from the presence of energy and nitrogen from molasses and urea.

Performance of cows. The performance of the cows fed with conventional and improved diet and with and without work is shown in Table 6. The average milk yield, lactation period and liveweight gain of cows were significantly higher with the improved than with the conventional feeding regime, although the dietary energy and protein intake were almost same from the different sources of supplement.

Table 6. *The performance of working cows.*

	Conventional feed		Improved feed	
Parameters	Without work	With work	Without work	With work
Liveweight gain (g/day)	72	11	116	88
Milk yield (g/d)	4.97 ± 0.82	4.10 ± 0.77	6.10 ± 1.01	5.55 ± 0.81
Lactation period (days)	33.00 ± 7.97	29.75 ± 6.86	36.75 ± 5.59	35.00 ± 4.40
Calving interval (days)	536.00 ± 76	561.00 ± 81	460.00 ± 83	481.00 ± 91
Gestation period (days)	282.00 ± 4.0	283.00 ± 4.0	279.00 ± 3.0	281.00 ± 4.0
Birth weight of calves (kg)	13.38 ± 1.25	13.02 ± 0.89	15.90 ± 2.64	15.2 ± 1.12

The average liveweight gain of cows under the two feeding regimes differed significantly (Table 6). The highest liveweight gain (116 g/day) was obtained with non-working cows on the improved feed, while the lowest (11 g/day) was recorded with working cows on the conventional feeding regime.

The highest milk yield/week (6.10 ± 1.01 litres) was recorded from cows under improved feeding without work followed by working cows of same feeding regime (5.55 ± 0.8 1itres) and the non-working conventional group (4.97 ± 0.82 litres). The lowest (4.10 ± 0.77 litres) was recorded from working cows under conventional feeding. A similar pattern was recorded for lactation period.

There were significant differences in average calving interval between the two feeding regimes. The lowest calving interval recorded was for non-working cows on improved feed while the highest was for working cows on conventional feed. A similar pattern was recorded for gestation period but was not statistically significant. During the study the total number of cows pregnant were four under improved and three under conventional feeding. The three cows fed conventional feeds showed the effects of work on pregnancy (Table 6).

The average birth weight of calves also differed due to feeding practice although not significantly (Table 6). The birth weight of calves was highest for working cows under improved feeding and lowest for working cows on conventional feed.

Data on milk yield and physiological parameters before (at rest), during and after work. The effect of feed on the weight change, milk yield, body temperature, pulse rate and respiration rate of cows is shown in Table 7. The data revealed that the average live weight of cows fed with conventional feeds decreased during the study while that of the cows fed improved feeds increased. The average milk yield of cows on both feeding regimes decreased during work and increased after work. The changes in live weight and milk yield were due to physiological differences in the cows under the different feeding regimes.

Table 7. *Liveweight change, milk yield, body temperature, pulse and respiration rate of cows before, during and after work.*

	Before work		During work		After work		% difference	
Parameter	C	I	C	I	C	I	C	I
Live weight (kg)	142.6	127.4	132.5	130.1	140.0	135.1	(–)4.5	(+)4.1
Milk yield (ml/d)	750.0	1000.0	470.0	820.0	580.0	950.0	(–) 30.0	(–) 12.0
Body temperature (°C)	38.6	38.5			39.5	39.3	(+) 2.3	(+) 2.0
Pulse rate/minute	47.0	45.0			55.8	51.1	(+) 17.0	(+) 13.0
Respiration rate	23.0	24.4			27.5	26.0	(+) 18.0	(+) 7.0

Note: Work from 0800 hours with one or two pairs of cows; environmental temperature was 28–30°C.
C = conventional; I = improved.

The effect of draft load on the milk yield is shown in Figure 1. The daily milk yield of cows fed improved feed containing UMB decreased slightly during work. After the working period (4–6 weeks) milk yield increased to the original level within a week of rest under the same feeding regime. The cows on the conventional diet showed a sharp decrease in daily milk yield which did not return to the original (before working period) level of production during rest.

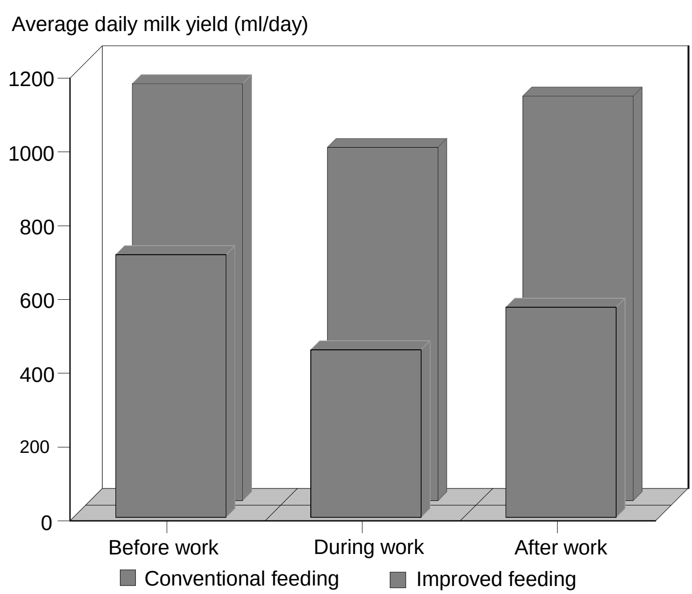

Figure 1. *Effect of workload on the milk yield of working cows.*

The body temperature of cows on both feeds increased after work. The pulse rate of cows on conventional feed showed a larger increase (17%) than that of cows on improved feed (13%) after work. This trend was similar to that of respiration rate. The average working hours/day was same for both groups of cows (Table 7).

Effect of feed on working efficiency. The working speed of the cows fed the conventional feed was slower than that of the animals on the improved feed (Figure 2). The number of steps per minute and length of steps together contributed to the respective working speed of draft cows.

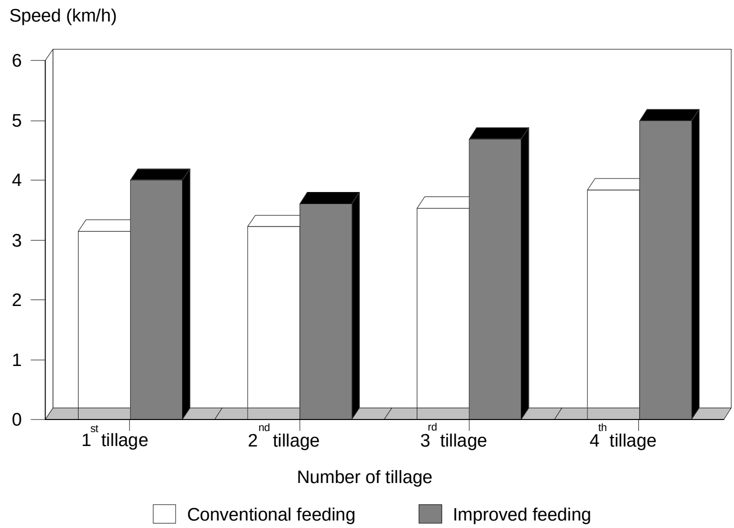

Figure 2. *Working speed of cows (km/h).*

It was observed that the depth of tillage increased with the subsequent operations. The tillage depth increased from 4.6 cm in the first tillage to 10.5 cm in the fourth tillage for draft cows fed the convestional feed. For the draft cows fed urea–molasses blocks, the tillage depth was 4.7 cm in first tillage and increased to 14.5 cm depth in the fourth tillage. Thus the urea–molasses block lick significantly increased the performance of the draft cows.

Conclusion

From the above studies, it is concluded that it is possible to improve the daily milk yield, lactation period, calving rate and birth of healthy calves with urea–molasses block licks which can provide a better rumen environment for utilisation of fibrous feed. Although the two feeding regimes had similar amounts of crude protein and energy, improved utilisation of feeds and greater milk yield, live weight and reproductive performance were observed with urea–molasses block licks. The live weight of cows in the conventional group decreased after work but increased for the cows on improved feed. This indicated the efficiency of supplementation of appropriate feed ingredients in the diet to maintain live weight during work without affecting total milk yield too much. The milk production decreased in both groups, but this decrease was significant only in the conventional feed group. This also indicated that reasonable milk production can be expected when improved diet is provided while working. Better performance in working efficiency in terms of working speed (km/h) and depth of tillage at different tillage operations was obtained with improved feeding of working cows than conventional feeding. It is concluded that the improved feeding regime of working cows has tremendous positive effects on milk yield, liveweight gain, calf growth rate, working speed, depth of tillage operations and also the reproductive performance of the cows.

Research needs

- Surveying of the existing types of working animal and systems of utilisation for animal draft power.
- Development of working animal feeding systems to increase the draft output with locally available feed resources.
- Development of better management systems, e.g. housing, health care etc.
- Strategy to use cows as draft animals without affecting the production performances, e.g. milk yield, calving interval, lactation period etc.
- Improvement of harnesses and plouging implements on the basis of physical condition of working animal (size, age, sex etc).

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Discussion on Dr Saadullah's presentation

Lawrence: What was the age of the animals used in the feeding trial?

Saadullah: Two-and-a-half years.

Muller-Haye: How did you transfer the technology to the farmers?

Saadullah: Through extension channels.

Elias Zerfu: Which group of farmers started using cows for draft work?

Saadullah: Farmers with small landholdings because their farms are not large enough to support both bullocks and milk cows. To avoid population pressure on land they preferred to use cows for traction. Fifty-five per cent of the households with small pieces of land keep 52% of the cows.

Proposals

UNDP project proposal format

The core structure of the project consists of a hierarchy of basic project elements as follows:

- Development objective
- Immediate objectives
- Outputs
- Activities
- Inputs.

A project formulated according to this structure is intended to develop a certain sequence. Namely, the inputs or raw materials are to be transformed by the activities to produce specific outputs which, when joined together, will lead to the accomplishment of the immediate objectives. The accomplishment of the immediate objectives will in turn contribute, at least in part, to the achievement of the broader development objective.

A. Context

This section should succinctly explain under the following subheadings the major characteristics of the development setting in which the project will operate.

1. Description of subsector
2. Host country strategy
3. Prior or ongoing assistance
   Mention any relevant external assistance that influences the crop–pasture system in the country.
4. Institutional framework for subsector
   Highlight public/private sector research, extension, development and policy frameworks that have direct bearing on the subsector in which the crop–pasture system is located.

B. Project justification

This section should explain the reasons for undertaking the project and why it is designed the way it is.

1. The problem to be addressed: The present situation
   Organise this portion under (a) agrotechnological, (b) biophysical, (c) institutional, (d) socio-economic.
2. Expected end-of-project situation
   State what would have been achieved in tangible terms after five years of the project; to what extent the objectives (set realistically) would have been realised; mention also whether there would be a need for external assistance beyond five years or so.
3. Target beneficiaries
   How and by whom the results of the project will be utilised.
4. Project strategy and institutional arrangement
   The particular strategy and implementation arrangements, especially institutional linkages, e.g. research–extension–farmer, and the management of linkages should be clearly spelled

out. State why the particular strategy was chosen as opposed to other possible strategies or arrangements. Provide a brief description of the methodology chosen for transfer and adoption of the crop–pasture technology.

5. Reasons for assistance from UNDP/FAO
6. Special considerations
   For example, integration of women in development, environmental and sustainability issues, equity considerations, technical co-operation among developing countries (TCDC), NGOs, involvement of the private sector, pre-investment potential etc.
7. Co-ordination arrangements
   Arrangements of co-ordinating this project with other efforts in the same subsector.
8. Counterpart support capacity
   The capacity and commitment of the host government or institution to provide the inputs and support necessary for the project's successful operation and to sustain the results at the end of the project; please quantify the inputs as far as possible.

C. Development objective

The development objective represents the achievement of a broader development goal, as normally described in country plans, at the subsectoral or sectoral level to which the project is intended to contribute. The project itself cannot, by definition, achieve the development objective, which requires a whole range of other related projects, policies, investments etc.

D. Immediate objectives

This portion is the most crucial part of the project. An immediate objective states what the project itself is expected to achieve. It should state the specific change in status or condition that the project is intended to bring about, which in turn would contribute to the development objective. It may be useful to keep in mind whether the assistance is intended to reach its target beneficiaries directly or indirectly. Keep the objectives realistic and reliable within the limits of time, money and human resources of the project. They must also be stated, to the extent possible, in terms that allow measurement or at least observation of their achievement. There should be only a limited number of immediate objectives, say up to three, for any one project. Each objective is to be stated as a separate subheading of the project document, with related outputs and activities.

E. Outputs

The outputs are the building blocks which, when assembled, lead to the achievement of one or more of the immediate objectives. They are tangible products that the project itself will produce to achieve its immediate objective(s). Outputs should be described as concretely as possible and in verifiable terms. It is likely that there will be more than one output for every objective.

F. Activities

The activities of the project must flow naturally from the outputs. They are goal oriented in that they are tasks to be performed in order to produce a specified project output. For each output there may be more than one activity. For each activity indicate, to the extent possible, its expected duration, the proposed starting point, who will carry on the project activity, where and how.

Keeping the above in mind, the immediate objectives, inputs and activities should be described in the following manner:

1. Immediate objective 1

    1.1 Output 1

    Activities

        1.1.1 activity 1

        1.1.2 activity 2

    1.2 Output 2

    Activities

        1.2.1 activity 1

        1.2.2 activity 2

2. Immediate objective 2

    2.1 Output 1

    Activities

        2.1.1 activity 1

        2.1.2 activity 2

    2.2 Output 2

    Activities

        2.2.1 activity 1

        2.2.2 activity 2

(and so on)

G. Inputs

The inputs are the raw materials of the project, be they in the form of equipment and supplies, personnel, fellowships etc, to be determined by the activities and their expected outputs. The totality of inputs required to carry out the project's activities are to be listed, then categorised into which inputs could be provided by the host government (listed first), followed by a list of inputs that need external support. The listing should include a very brief description that indicates the quantity, type and quality of the input required.

H. Risks

List each significant risk that could arise in the course of implementation to seriously delay or prevent achievement of the outputs and objectives of the project. Describe briefly how it could affect the project and what measures are envisaged to deal with risk, if and when it should arise.

Work plan

Activity	Period of implementation		
	Year 1	Year 2	Year 3

On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems of Ethiopia

A. Context

1. Description of the subsector

In eastern Africa dependence on dairy imports has grown greatly over the last 20 years. Taking Ethiopia as an example, dairy production has been lagging behind demand and the contribution of dairy to the food security of the country has eroded substantially. During the 1977–88 period the estimated annual growth rate of milk consumption in Ethiopia was 2.5% while growth in production during the same period averaged only 1.4% (Shapouri and Rosen 1991). In per capita terms, milk production has actually fallen from 27 kg/person in 1981 to 17 kg/person by 1985.

Import dependence for dairy products has grown during the same period from 4.1 to 12.8%. Imports grew at the rate of 15% annually, with commercial imports growing the fastest at 24% a year (Shapouri and Rosen 1991). This has raised the level of commercial imports as a share of dairy consumption from 0.3 to 2.3%, while the share of food aid has fallen. Besides evidence of worsening nutritional consequences for the population, these trends signify a growing financial burden during a time of rising world prices.

2. Host country strategy

With unmet demand for fresh milk existing in primary and secondary cities, there is room for the expansion of peri-urban dairying. For example, cross-breeding to improve the genetic potential of cows for milk production is the adopted dairy development strategy of the Government of Ethiopia for the highlands. This strategy is a proven means of increasing livestock productivity and therefore milk production when the cows are managed and fed properly. Crossbred cows, mainly F_1 Boran x Friesian are distributed to farmers by the Ministry of Agriculture (MoA), including recently in the Selale area in a MoA/Finnida dairy pilot project.

3. Prior or ongoing assistance

This project is a collaborative effort of the Institute of Agricultural Research (IAR), the Ministry of Agriculture (MoA), and the International Livestock Research Institute (ILRI, formerly the International Livestock Centre for Africa (ILCA)). It is a continuation of major collaborative efforts between IAR, MoA, and ILRI that have been ongoing since 1989. This collaboration has led to the development of a scheme to study the potential of crossbred dairy cows to accomplish multi-purpose tasks and secure adequate outputs of milk and meat production and draft power. For example, research results obtained so far strongly support the conclusion that the technologies to be demonstrated and tested on-farm are viable and can have a wide impact on dairy production in the Ethiopian highlands, resulting in major benefits to smallholder dairy producers as well as consumers. Funding support for this ongoing proposed project will assist in the successful transfer of these technologies to smallholder farmers.

The objective pursued by ILRI since 1984 has been to increase and sustain agricultural production and incomes in smallholder farming systems. Studies carried under the Institute's programmes have identified the need to intensify and diversify the uses of draft animals in order to increase their contribution to farm economy. Priority has been given to developing practical means of increasing the quantity and quality of feed resources, and to optimum use of feed resources produced on-farm. The programme prepared an economic analysis of draft animal use in Ethiopian farms in 1993. ILRI continues its support to the crossbred dairy cow traction scheme. In 1993 the Institute initiated on-farm testing of this technology at IAR's Holetta research station in a joint effort with 14 neighbouring farmers. The number of farmers is being increased and the testing period extended, in order to obtain representative and significant results.

B. Project justification

1. The problem to be addressed: The present situation

1.a. Agrotechnological

Smallholder farming systems account for the bulk of agricultural output of the country but their mixed-farming approach requires greater integration and intensification of crop/livestock/tree production activities to increase its overall productivity. Optimum use of land and family labour is essential to generate food for sale and home consumption plus feed for livestock. Crop residues, shrubs and fodder trees plus by-products from agro-industries, if properly used, will ensure adequate sales from livestock and animal products. Additional products will include draft power for tillage and transport, and manure for the recycling of nutrients. Adequate off-farm support is required: for timely and effective cropping operations; for rational livestock management; for adequate supplies and service in terms of harnessing and equipment; for cottage manufacture, village processing of products, and marketing schemes for farm produce and farm inputs.

1.b. Biophysical

Demographic growth rates have put increased pressure on land resulting in fragmentation of plots of land that are already small, intensification of cropping without restoration of nutrients, and cultivation of land unsuitable for sustained cropping. This leads to degradation of natural resources through mining of soil nutrients and the loss of plant cover, facilitating erosion.

1.c. Institutional

National institutions have been steadily strengthened in recent years and collaborative programmes with international institutions have allowed joint rural development activities to be established. Working procedures have been developed which allow adequate project implementation of field activities and enable smallholder farmers to directly participate and benefit from these interventions.

1.d. Socio-economic

Rural emigration is a major problem in developing countries. It progressively weakens contributions made to the national economy by agriculture, increases environmental degradation and renders rural employment uneconomical and unattractive. However, although farmland becomes available as a result of the emigration, low productivity makes farm operations economically risky, so that national agricultural output declines. Immigration to cities with inadequate urbanisation facilities and limited jobs leads to increasing urban unemployment and squalor. Demographic expansion, especially within cities, leads to food supply problems, increases in import bills for the country and higher levels of foreign debt.

Successful introduction of crossbred dairy cows in the highlands of Ethiopia requires adoption of new complementary technologies on-farm, including improved management, feed production, feeding and traction systems. Crossbred cows have to be fed better than local animals to perform better. In dairy producing areas of Ethiopia, grazing and hay have been the traditional feed resources for dairy cattle. Growing population pressure leads to increased demand for milk but also results in land shortages in peri-urban areas, making it potentially difficult to feed crossbred cows better. Much emphasis in the MoA/Finnida/ILRI project at Selale was put on improving feed production and quality due to growing population pressure.

1.e. Project goals

This project aims to promote the introduction of crossbred cows for both milk production and draft into smallholder mixed farming systems in the East African highlands by developing and transferring complementary high-productivity feed production, feeding, draft and management strategies. The use of crossbred dairy cows for traction, in place of oxen, would result in a more efficient use of available feed resources by decreasing the number of animals kept on-farm. These lower stocking rates would alleviate overgrazing and create a more productive, sustainable farming system that entails better management of the natural resource base.

The dual use of crossbred cows will increase milk production substantially, while at the same time and with the same resources satisfying the need for draft power. The number of oxen (used for work for only a short period each year, primarily for land cultivation and threshing) and the number of cattle kept as part of a follower herd to breed replacements for oxen could be reduced. More productive, smaller herds will release capital and feed resources to achieve more sustainable production systems, higher incomes and better nutrition within a five-year period.

The adoption of the technologies being developed in this project is expected to have a large impact on milk production and the incomes of highland farmers. With proper management, milk production per cow can increase four to seven times, resulting in increases in cash income. On-station and on-farm results substantiate this potential for making an impact. However, successful introduction will require complementary improved management practices, including new feed production, feeding and traction systems being adopted on-farm.

Increased milk production is also expected to have a significant effect on the nutritional status of the rural poor. Dairy products contain many important nutrients in bio-available form, especially carbohydrates, protein and calcium, as well as the micronutrient vitamin A, the B-complexes and zinc, essential for growth and proper physical and mental development. For instance, studies have shown that children deprived of vitamin B_{12}, which comes only from animal products, suffer impaired learning abilities and will not develop to their full potential.

Before the project, only oxen were used for traction in the study area. At the end of the project, the project farmers will have adopted the following technologies:

1. Replacement of at least two oxen and two local cows with two crossbred cows.
2. Construction of a barn for the crossbred cows.
3. Use of crossbred cows for traction to plough at least half of the land on average.
4. Cultivation of oats and vetch on 0.6 ha to be fed to the animals as cut-and-carry or as hay.
5. Purchase and feeding of at least 2 kg concentrate per day per cow during lactation and work periods.

The project will involve 50 resource-poor farm households currently owing only local cattle and oxen. Besides the income effect, on-farm results so far show that the use of crossbred dairy cows can increase consumption of food of all household members by about 80%. It is expected that there will be a positive impact on grazing management. In the present traditional system carrying capacity is overused by about two times. The improved system would match the carrying capacity of available grazing land.

2. Expected end-of-project situation

Results from pilot areas established by the project would indicate that the technological package has been adopted by the majority of the collaborating farmers. Overall farm output has been increased, mainly on account of better management of farm resources and some strategic inputs and services provided by off-farm services. Livestock performance results show a stable herd which contributes a substantial amount of sales, animal power and manure to farm operations and output. Economic analysis indicates a steady positive trend in total revenue, adequate remuneration of farm labour and capitalisation rate. Off-farm services are increasingly managed by organised farmers associations/groups and output of goods from rural workshops, cottage industries and village processing units has increased considerably. External technical assistance will still be required to maintain optimal levels of management but on very precise subjects that can be dealt with through short-term consultancies.

3. Target beneficiaries

Direct beneficiaries: collaborating farmers and their families plus local project staff.

Indirect beneficiaries: neighbouring farmers and their families, villagers, artisans, traders and businessmen, small-scale farm produce processors who either individually or in organised groups will participate in information/sensitisation meetings and gradually adopt technical messages derived from the technical approach encouraged by the project.

This technology package promises to benefit all the members of poor rural households, both in terms of income and nutrition, but the intrahousehold consequences including labour costs have to be studied further to ensure a positive impact on all family members. A study conducted in the early 1980s by ILRI indicated that the introduction of crossbred dairy cattle to the Ethiopian highlands, while providing a number of advantages to the household as a whole (e.g. higher milk output and incomes), increased the labour demands placed on women (Whalen 1984). Later studies (MoA/Finnida 1992), however, confirmed that while women's labour time was increased, it was the overall labour time of men that increased the most.

4. Project strategy and institutional arrangements

The implementation strategy relies on a participatory approach of the selected farmers during the on-farm validation process of the proposed technology. This means that even though the project is willing to share a larger part of the inevitable risks of agricultural operations (traditional or new), the farmer must assume his responsibilities as a partner under a properly defined commercial contract. This legal instrument will facilitate the expansion of the scheme once positive validation results are confirmed and local institutions take up follow-up management responsibilities.

The supply of crossbred dairy cows, their harnesses and equipment must be similar if not identical, and the training of both farmers and animals plus livestock management instructions must be arranged following strict common standards.

The Institute of Agricultural Research, MoA extension services and farmer's organisations will assist the project in its training programme and in the logistical support required to implement field interventions.

The project component based in Ethiopia will be entrusted to the technical direction and administrative management of operations of the regional project. Addis Ababa will become the headquarters of the project where an international team leader will co-ordinate overall operations.

5. Reasons for assistance from donor

Traditional mixed crop/livestock farming systems under growing population pressure are experiencing declining productivity and increasing degradation of the natural resource base.

Local technical service providers are aware of the need to address the technical and developmental aspects of this problem, but they do not at present have sufficient numbers of qualified staff or the material resources to deal urgently with this situation. IAR/ILRI scientists developed a cow traction technology package that could contribute to resolving these problems. The implementation of this proposal will occur at the farm level with direct participation of national research and extension programmes and selected farmers. The technical interventions would be executed collaboratively by the Food and Agriculture Organization of the United Nations (FAO) and ILRI. These development objectives will be supported financially by a donor. Regional operations of the project would be greatly facilitated by institutional support provided to participating countries by international institutions such as donors, FAO and ILRI.

6. Special considerations

The excellent chances for the sustainability of these technologies are evidenced by the continuation and further development of crossbred dairy activities in the Selale region (see section 4). The Finnida project introduced about 300 pregnant crossbred heifers to the area between 1989 and 1992 and there are now estimated to be about 1500 thriving crossbred cattle. Production of crossbred dairy cows is ensured through existing artificial insemination (AI) and bull services in the Holetta area. The IAR/Holetta research station and MoA provide training for cow traction technologies including feeding and management. Established traditional blacksmiths exist for the maintenance of harnesses and manufacture of equipment. Oilseed mills exist that provide an adequate source of feed supplements, and the local Agricultural and

Industrial Development Bank provides credit facilities. The crossbred cows provide the collateral to ensure recovery of loans, and the success of the payback programme of the Finnida project at Selale shows this approach to be sustainable.

These technologies create opportunities for the private sector to provide inputs and services such as AI and veterinary services, animal feeds, fertiliser, seed, and product marketing for both milk and processed dairy products. Marketing opportunities and profitable outlets of fresh milk for smallholders are provided by a formal collection operation run by the Dairy Development Enterprise and informally by private entrepreneurs. In addition, butter-making by women provides an opportunity to better their economic position in society.

The introduction of crossbred cows for milk production and draft will have especially positive effects on the role of women in development and the nutrition of children. Since crossbred cows require stall-feeding, they are kept close to the homestead where care is mainly provided by the women, thus increasing their role in an important income earning activity. Furthermore, the additional milk produced can lead to increased incomes for women if more butter can be made since the sale of this dairy product and the proceeds are traditionally controlled by women. Technologies designed by ILRI can cut the labour time required to make butter so that women can take advantage of increased milk production. Butter-making would thus not become a burden to the women.

Increased milk production has also been shown to lead to increased consumption within the household, mainly on the part of children (Gryseels and Whalen 1984). Dairy production can be important in achieving food security in three ways: 1) directly through increased food production that adds directly to household nutrition; 2) indirectly through increased cash income that can be used to purchase food as well as other household items; and 3) by generating employment.

The environmental effects of the dual use of crossbred cows for milk and traction also promise to be positive. Keeping fewer animals would lower stocking rates. This would help alleviate overgrazing and create a more productive farming system that makes better, more sustainable use of the natural resource base.

This intervention is an example of higher productivity livestock technologies which can have a substantial impact on the incomes of all farmers. Constraints to resource-poor households benefiting from this technology do exist, but can be overcome through programmes and other support such as credit and insurance schemes. The project will encourage technical co-operation among developing countries (TCDC).

The project will allow formal linkage mechanisms to be set up for information exchange and collaboration between scientists and development organisations involved in research and transfer of multi-purpose cattle and buffalo technologies in East Africa and Asia. The project will benefit from the participation of the Australian Centre for International Agricultural Research (ACIAR) Draught Animal Power (DAP) project. These project activities will represent a further development of DAP collaborative programmes initiated by ACIAR and African NARS (national agricultural research systems). These activities will provide an opportunity to formalise collaborative relations between Asian and African NARS.

7. Co-ordination arrangements

National dairy policy and funding of research and development programmes is co-ordinated by the Dairy Advisory Board (DAB) which is currently providing financial support to the project for the ongoing on-farm testing of the technologies. National development programmes are carried out by the Dairy Rehabilitation Development Project (DRDP) of the Ministry of Agriculture. MoA/DRDP is a collaborator in this project. Collaboration with the World Food Programme is through the DAB.

This project is designed as a regional project to expand on-farm testing of a promising IAR/ILRI technology, developed on-station, to neighbouring countries. Addis Ababa would act as the co-ordinating centre and institutional headquarters. The IAR will act as the host local institution to the regional project.

8. Counterpart support capacity

Project activities will be jointly planned and executed by the collaborating partners who will provide substantial in kind and supplementary support to the project. The Animal Science Department of IAR will provide: the project co-ordinator; scientific and support staff; livestock resources; assistance with data collection, management and analysis; and research and laboratory facilities, as well as housing and logistical support on-station and on-farm at Holetta. Region 4 MoA will provide: dairy specialists (veterinarians), forage and extension specialists; extension of feed technologies; and assistance with disease characterisation and reproduction.

Sustainable development agreement clause

If at the end of development operations these are concluded successfully, all inputs and support allocated by the Government to the executing Technical Ministry as a development budget will become an additional allocation to the Ordinary Budget assigned to the Technical Ministry by the Ministries of Planning and of Finance.

C. Development objective

The development objective of the project is to support a smallholder commercial agricultural activity which can have a significant impact on food production, food security, farmer incomes, and human nutrition. Demand driven dairy development is an example of an agricultural activity that can be a driving force to national economic development.

The project will accomplish this by transferring new crossbred cow technologies for milk production and draft that will increase the productivity and sustainability of smallholder mixed production systems in the Ethiopian highlands.

D. Immediate objectives, outputs and activities

1. Objective 1

Transfer management practices and new technologies for crossbred dairy cows to be used for milk production

1. Immediate objective 1

Adoption of dairy cow-traction technologies at farm level.

1.1 Output 1: Increased milk production and farmer incomes.

1.2 Output 2: More productive, sustainable farming system with a lower stocking rate — replacement of at least two oxen and two local cows with two crossbred cows and use of the crossbred cows for traction to plough at least half of the land on average.

1.3 Output 3: Farm management operations manual.

Crops manual:

Calendar interventions

Requirements: Inputs

Labour

Traction

Livestock manual:

Calendar interventions

Requirements: Inputs

Labour

1.4 Output 4: Results of training programme to implement interventions:
Number of farmers and field staff.

1.5 Output 5: Farm records for monitoring and evaluation.

2. Immediate objective 2

Establishment of rural-based support system for farm operations related to the use of dairy cow-traction technologies.

2.1 Output 1: Mechanism in place to support dairy crossbred cows.

Breeding system — AI or bull stations

Veterinary services

Feed input markets

Forage production extension services and inputs

2.2 Output 2: Mechanism in place to provide supervised credit:
Farmers, processors and artisans.

2.3 Output 3: Mechanism in place to train draft cows.

2.4 Output 4: Draft animal training manual for smallholder use.

2.5 Output 5: Results of training programme for animal trainers and farmers:
Number of animal trainers and farmers.

2.6 Output 6: Recording forms to monitor and evaluate logistic support.

3. Immediate objective 3

Processing of farm products and manufacture of basic farm tools and equipment related to dairy cow-traction technologies.

3.1 Output 1: Basic dairy processing manual for farmers and village milk processing units.

3.2 Output 2: Milk collection scheme in place.

3.3 Output 3: On-farm milk processing in operation:
Number of farmers processing.

3.4 Output 4: Village milk processing units in operation:
Number of dairy processors (operators).

3.4 Output 4: Village artisans' workshops in operation:
Number of cobblers and blacksmiths (operators).

3.5 Output 5: Results of training programme:
Number of cobblers and blacksmiths (operators).

3.6 Output 6: Recording forms to monitor and evaluate farm and village processing and manufacturing activities.

4. Immediate objective 4

Establishment of a monitoring and evaluation system to follow progress in the adoption of dairy cow-traction technologies.

4.1 Output 1: Monitoring and evaluation (M&E) manual.

4.2 Output 2: Establishment of an M&E central unit and its field contacts.

4.3 Output 3: Results of training programme in M&E procedures:
Number of field staff, operators and farmers.

4.4 Output 4: Bi-annual reporting system in operation:
Number of field meetings to discuss results and recommend corrective management action.

4.5 Output 5: Auto-evaluation report on effectiveness of M&E activities.

4.6 Output 6: Cross-site evaluation of technology performance.

4.7 Activities

4.7.1 Evaluate on-farm production performance of crossbred dairy cows used for both milk production and draft work

4.7.2 Assess how farmer perceptions of the acceptability of the technologies evolve with increasing experience over time

4.7.3 Assess how the technologies affect the resource use and incomes of the project farmers

4.8 Work plan

On-farm trials (1995–97)

- A pre-introduction anthropological survey in 1993 of participating and non-participating farmers was done to ascertain the initial perceptions of farmers regarding the technologies. A follow-up survey will be carried out each year to ascertain how these perceptions of the new technologies change over time.
- Data on production performance will be collected from 50 farms and will include feed intake and feed composition estimates, feed allocation priorities, milk yield, body weight, body condition, and breeding performance of all cows in the herd, milk utilisation, land cultivated and draft power use and source (1995–97).
- On-farm disease characterisation and effect on milk production.
- Economic data collection to include all input and output quantities and prices needed to do the whole-farm analysis, including the effect of introduction of crossbred cows on the investment strategies of farmers including wealth accumulation 1995–97).

- Collaborative Project Assessment Workshop (1996)
  Hold a joint IAR/ILRI/MoA/FAO workshop to include donors and development organisations. The objective of the workshop is to present and assess the project results and plan future collaborative efforts.

E. Inputs

1. Government inputs

IAR and MoA (36 months duration):

- infrastructure and logistical support (IAR/Holetta station)
- research facilities and animals
- infrastructure: State Cattle Breeding herd and AI facilities (MoA); house (IAR/Holetta station)
- scientific support: animal scientists and technical support staff
- feed and milk laboratory analysis at Holetta
- veterinarians, extension agents
- National Co-ordination Unit (IAR/Holetta station).

2. Donor inputs

The contribution to the project will be the following (36 months duration):

- personnel:

  Regional Co-ordinator (international staff): one Animal Scientist (36 months)

  Consultant staff: one ILRI Animal Scientist (9 months)

  Consultant staff: one ILRI Agricultural Economist (9 months)

  Technical Assistance: one FAO Associate Professional Officer (36 months)

  Support staff: one Regional Administrator (36 months)
- laboratory and field experiment equipment: draft measurement equipment; one ergometer, one load cell (and maintenance)
- laboratory supplies: chemicals, progesterone kits
- veterinary supplies: antibiotics, antihelmintics, minerals, vitamins
- four-wheel drive vehicle
- vehicle running costs and maintenance
- printing and publications: manuals, reports
- training
- meetings and workshops.

F. Risks

- insufficient and untimely delivery of inputs: Government and Donor
- lack of interest among smallholder farmers to share part of the risk in testing the new technology
- supply problems in dairy crossbred cows, harnesses and equipment
- insufficient farm feed stock to ensure adequate management standards
- difficulties in establishing a credit mechanism
- difficulties in establishing and managing a business-oriented milk-collection scheme
- lack of support from local pricing policies and control of imports.

ON-FARM TESTING OF MULTI-PURPOSE CROSSBRED DAIRY COWS FOR MILK, MEAT AND DRAFT WORK IN SMALLHOLDER FARMING

1.1 Project budget covering government contribution in kind (in local currency)

Ethiopian Birr (1 US$ ≃ 6.2 Eth Birr)
Country: Ethiopia
Project number
Project title: On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems

	Total staff months US$	Prior years (1986 and before) staff months US$	1995 staff months US$	1996 staff months US$	1997 staff months US$
10. PROJECT PERSONNEL					
11.01 National Project Director (Animal Scientist—IAR)		–	12 24,000	12 25,000	12 26,000
11.02 National project staff (full-time) (Dairy Specialist—MoA)		–	12 20,000	12 21,000	12 22,000
11.03 Forage Agronomist		–	12 18,000	12 9,000	12 20,000
11.04 Agricultural Economist		–	12 18,000	12 19,000	12 20,000
15. DSA			12,000	12,000	12,000
19. Component total			48 92,000	48 96,000	48 100,000
30. TRAINING					
31. Maintenance of trainees' salaries					
39. Component total					
40. EQUIPMENT					
41. Equipment	–	–	15,000	15,000	15,000
42. Supplies	–	–	75,000	85,000	90,000
43. Premises	–	–	30,000	30,000	30,000

49. Component total	–	–	120,000	130,000	135,000
50. MISCELLANEOUS			30,000	30,000	30,000
51. Animals (100)	–	–	300,000	30,000	30,000
59. Component total			300,000	30,000	30,000
99. GRAND TOTAL			512,000	256,000	265,000

1.2 Project budget covering donor contribution (US$)

	Total staff months US$	Prior years (1986 and before) staff months US$	1996 staff months US$	1997 staff months US$	1998 staff months US$
10. PROJECT PERSONNEL					
11. International experts					
11.01 Regional Co-ordinator		–	12 144,000 12 –	12 144,000	12 144,000
11.02 APO				12 –	12 –
11.03					
11.49 Subtotal experts				144,000	144,000
11.50 Consultants					
11.51 Animal Scientist				3 24,000	3 24,000
11.52 Agricultural Economist				3 31,500	3 31,500
11.97 Short-term consultants					
11.98 Subtotal consultants					
11.99 Subtotal: experts/consultants				199,500	199,500
12. OPAS experts					
12.01					
12.02					
12.99 Subtotal OPAS					
13. Administrative supports personnel					
13.01 Regional Administrator	–	–	12 13,500	12 13,500	12 13,500
13.02 Secretary	–	–	12 3,000	12 3,000	12 3,000
13.03 Driver	–	–	12 1,800	12 1,800	12 1,800
13.99 Subtotal administrative support			18,300	18,300	18,300
14. United Nations volunteers					
14.01					
14.02					
14.03					
14.99 Subtotal UNV					
15. Duty travel			28,000	28,000	28,000
16. Mission costs			8,000	8,000	8,000

17. NPPP					
17.01					
17.02					
17.99 Subtotal NPPP					
19. Personnel component total:			253,800	253,800	253,800
20. SUBCONTRACTS					
21. Subcontract X National Program Field Support			72,000	54,000	36,000
22. Subcontract Y revolving fund administration			360,000		
23. Subcontract Z					
29. Component total			432,000	54,000	36,000
30. TRAINING					
31. Fellowships					
31.01					
31.02					
31.03					
31.04					
32. Study tours/group training					
32.01 In-country	–	–	12,000	9,000	6,000
32.02 Regional	–	–	15,600	15,600	15,600
33. In-service training (vet, AI, forage etc)	–	–	6,000	6,000	6,000
39. Component total			33,600	30,600	27,000
40. EQUIPMENT					
41. Expendable equipment			18,000	12,000	
42. Non-expendable equipment			186,000	6,000	
42.01					
42.02					
42.03					
43. Premises			10,000	10,000	10,000
49. Component total			214,000	28,000	21,000
50. MISCELLANEOUS					
51. Operation and maintenance cost of equipment			40,000	50,000	60,000
52. Reporting cost			8,000	8,000	18,000
53. Sundries			3,000	3,000	3,000
59. Component total			51,000	61,000	81,000
TOTAL			730,600	173,600	159,600
GRAND TOTAL			984,400	427,400	413,400

Discussion on Ethiopia proposal

Shapiro: I am refering to the Ethiopia project. It is clear that we need a support system in place to transfer cow traction technologies. We need IAR, veterinary services, adequate extension and a feed-input market. However, it is not clear whether we need any kind of on-farm mechanisms; I am referring to immediate objective three describing the processing of farm products and manufacture of basic farm tools. It seems too ambitious to try to bring into place village milk processing units, village workshops etc.

Chirgwin: I think that, of the immediate objectives that are described here, number 2 (supply of cows) and 3 (processing) could be merged into one.

Shapiro: Let's focus on on-farm processing, but not worry about setting up small village manufacturing and processing units as part of the project.

Alemu Gebre Wold: The programme has to be sustainable and both input supply and milk and milk product markets have to be in place for the technology to be adopted and show beneficial impact.

Chirgwin: Yes, I agree. However, we may not have enough funds to tackle all the aspects of technology adoption on-farm. The essential thing is to really test this cow technology in multi-sites in East Africa through a pilot development project with the evaluation component as the main research part. Unfortunately, I don't think we can go ahead and give all the assurance that the marketing aspects are going to be considered.

Teleni: Why transfer the technology if there are no mechanisms to sustain it? I agree with Dr Alemu. I know money is limited but I think you have to develop a project which will give the people who are conducting it creditability in the long term. So, if the technology is started off but is not self sustaining because the products that have been produced have no market, it will not be supported and will fail in the long run. And I think we should not tailor a project just because there is limited money. We have to make a project which is quite complete and self sustaining.

Shapiro: I think that is true. We have to ensure, as a precondition, that we are not going to try to do this if there is not a market for dairy products.

Muller-Haye: These external inputs and mechanisms are outside the mandate of IAR or ILRI. They are government inputs which the project cannot guarantee. How can you stimulate the government (MoA) to put all these services in place (AI services, feed markets etc) in order for the project to be implemented?

Beruk Yemane: As you know, Ethiopia has got the largest livestock population in Africa. In terms of draft power I think we are talking about 5–6 million oxen in the highlands. It may be too difficult to replace all these animals and use AI, but according to the national dairy development programme different areas have already been stratified. So, there are what we call the milk-shed areas. These are the urban and peri-urban areas that include towns within a radius of 25 kilometers where it is possible to give AI services. In these situations I think there is already an agreement with ILRI and IAR to provide AI be it on-farm or on-station. But in areas that are further away from the main town, AI may not be feasible. In such cases there is always the possibility of using bulls.

Alemu Gebre Wold: I think that in Ethiopia some of the research results applicable to dairying have been left on the shelf. We have not been able to take them outside the research station. Working with smallholders and implementing a pilot project inclusive of the complete package developed on-station, gives us the opportunity to test the technology on-farm and study technology adoption. Simultaneously, we should be instrumental in trying to push either the government or the policy makers to implement the adequate measures and services to sustain the technology in the long term.

Ulotu: Dr Alemu, what is the present status of these services (veterinary services and general extension services)? Do they have to be improved or do they have to be brought in altogether?

Alemu Gebre Wold: I think, like in other African countries, this system is on paper but doesn't exist on-farm.

Chirgwin: These improved cows will produce surplus milk that needs to be marketed. The project has to make sure that arrangements, contracts and contacts with other projects are made. The project, however, will not be able to finance, for instance, the establishment of milk-collection schemes or the financing of mini-processing plants. But there could be other development projects being established with which the project could have contacts.

O'Connor: The proposal presented by Dr Alemu appears tremendously ambitious. Milk processing is, and can be, quite complicated. I have been in Ethiopia for the past seven years and I have tried to get local people to understand and to adopt or adapt technologies which we have developed, for example in butter making. My suggestion has always been that we should try to build the processing sector by getting the local producers to pool their milk and financial resources because the development of the dairy industry, even at the village level, has to come from developments in feeding technologies and better nutrition, better housing, better genetics etc.

Shapiro: If I understand, what you are saying is that, given how much we have to do in such a project, then it would be better to concentrate on on-farm processing. And because we do have technologies that are available for that and we could encourage our producers to process on-farm, this would expand their opportunities for marketing.

On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems of Kenya

A. Context

1. Description of the subsector

The dairy industry in Kenya is based on European grade cattle and dates back to the 1920s when these breeds were introduced in the highlands on the large-scale farms owned by Europeans. The African smallholder farmers were allowed to engage in commercial dairying in the early 1950s under the 'Swynnerton Plan' of 1954, by which Africans could have access to credit and other infrastructural services for dairy development.

Dairying has gradually developed into a predominantly smallholder activity, in an estimated 300,000 small-scale farms. These farms also account for 80% of the total milk produced annually. The country now boasts a dairy herd of 3 million head of cattle (grade and pedigree exotic animals), producing 1.8 billion litres of milk per year. However, this level of production has not matched the high demand for milk and milk products in the recent past due to droughts that have reduced productivity, and the high human population growth rate among other factors. The government, therefore, has recently had to import substantially to supplement the local production.

2. Host country strategy

The Kenya Government (GoK) policy to increase milk production is through intensification (in view of the diminishing land resources due to population pressure), and extension of dairying into non-traditional dairy ecological zones (semi-arid, low rainfall areas). The latter strategy would entail using crossbred cows (exotic dairy breeds x indigenous breeds), that can substantially increase milk production in the areas and at the same time be able to survive the relatively harsher conditions. The number of crossbred cows is steadily increasing, e.g. 70,000 crossbreds are found in only three districts in the low rainfall zones. These animals have either been bought-in from commercial ranches or bred through artificial insemination (AI) which, until recently, was run by the government.

3. Prior or ongoing assistance

The dairy industry in the low rainfall areas is expected to increase as more people migrate into these areas and the demand for milk and milk products rises. It is in this light that the Kenya Government in the late 1970s approached the United Nations Development Programme (UNDP) for assistance to develop suitable and economic livestock production technologies that could be integrated into the smallholder farming systems. The UNDP, with the Food and Agricultural Organization of the United Nations (FAO) as the executing agency, started work in 1979. The project's focus was on developing feed resources and feeding management, since this had been identified as the most limiting factor to improved dairying and efficient draft power production. This effort was augmented by an Australian Government sponsored project through the Australian Centre for International Agricultural Research (ACIAR) in the mid-1980s .

On-farm tests of the technologies developed were initiated for their impact on farmhold resource allocation (especially labour) and performance in terms of milk production, herd structure changes and draft power utilisation. The sample size of only six farms used (due to the financial constraints) was too limiting to draw generalised conclusions. Nevertheless, the six farmers who were supplied with the crossbred heifers and feed resource package realised a fourfold increase in milk production and were extremely enthusiastic about dairying. Through the assistance of The Netherlands Government, it is hoped that the technologies that were developed will be adequately tested on-farm.

Studies on the animal drawn implements benefitted in the early 1980s from the funding by UNDP/FAO/GoK projects. This saw the development of a multi-purpose tool bar that was lighter (28 kg) than the Victory plough (38 kg) (Figueroa and Mburu 1984), introduced in 1940, and widely used by the farmers (Connink et al 1986). The multi-purpose tool bar also had an advantage over the earlier Victory plough, in that several implements could be interchanged on the main frame. A mouldboard could be removed and a ridger, cultivator, or sweeps attached for specific operations.

At about the same time a separate UNDP/FAO/GoK project in the semi-arid areas investigated the possibility of improving draft power production on the small-scale farms using two strategies: (1) introduction of a larger animal (crossbred of Friesian x Sahiwal), and (2) improved feeding systems especially during the dry season. The study showed that when the oxen were fed at a rate of 1.5 times maintenance requirements (on alkali-treated stover and molasses, urea and minerals—MUM), there were no differences between the crossbreds and the indigenous zebu oxen in speed and depth of ploughing (Tessema and Emojong 1984).

The concept of developing cow-traction technology was not envisaged at that time probably because the farm holdings were able to cater for a pair of oxen in addition to the dairy cows. Such a situation is not likely to continue because of the progressive subdivision of land resulting in smaller parcels that can no longer sustain these animals. Thus the cow-traction technology becomes more relevant as the intensification in production takes hold. Financial resources to enable the testing and adapting of this technology for the smallholder subsistence farming system of the semi-arid Kenya shall be timely to increase milk production and sustain draft power on these farms.

4. Institutional framework for subsector

The dairy subsector in Kenya is supported by the government through a well established extension service and research system. Under the extension service of the Ministry of Agriculture, Livestock Development and Marketing (MoALD&M), advice on husbandry, feeds and feeding is delivered, disease surveillance and control is ensured and AI and clinical services are provided. Milk marketing is organised under co-operative movements (within the Ministry of Co-operative Development) that collect and process most of the milk produced. However, recent low prices in the co-operatives have encouraged farmers to hawk milk directly to consumers. This is more so in the semi-arid areas where this informal market is yet to be saturated, due to low levels of dairying.

Credit facilities are available again through the co-operative movement; however, they are more established in the high rainfall areas than in the low rainfall zones. The extension efforts are supported by research which continues to generate new technologies and management options, given the changing socio-economic environment, in order to improve and sustain the dairying enterprise. Research is also concerned with developing technology(ies) to enable opening up of semi-arid areas for dairying. These research issues are mandated to the Kenya Agricultural Research Institute (KARI).

B. Project justification

1. The problem to be addressed: The present situation

1.a. Agrotechnological

The important role the smallholder farming systems play in the overall agricultural production in Kenya cannot be overemphasised. However, as the population increases there is an urgent need to improve efficiency, if food security is to be assured on these farms. This shall entail timely operations such as early land preparations, planting and effective weeding to maximise crop production. Availability of effective draft power to ease demand for labour is an integral part of the strategy.

However, this is normally lacking in most parts of the country. Seasonality in rainfall distribution creates fluctuations in feed availability, and during the dry season draft animals are at their weakest due to scarcity of feeds. At the same time, this is when land preparation is to be done.

1.b. Biophysical

Due to increasing population and the disappearance of shifting cultivation that was formerly practised, most soils have lost their organic matter. The heavy clayey soils in the high rainfall zones have become difficult to work and require a minimum of two pairs of oxen. The lighter soils in the low rainfall zones have characteristics of capping and forming a hard pan just below the surface during the dry season. This makes them difficult to work with the weak oxen, thus delaying land preparation.

1.c. Institutional

The institutional framework within which research/extension/farmer can interact exists. This has allowed proper description of target groups, participatory problem identification and prioritisation. It is through the same institution that developed technologies can be tested for appropriateness. There is also collaboration with NGOs (World Neighbours, Church Organisations) in testing innovations.

1.d. Socio-economic

The decreasing farm size due to subdivisions is increasingly becoming a constraint to livestock keeping. armers are now being forced to make hard choices between keeping dairy animals or oxen for draft power. The situation can only get worse in future. However, milk and draft shall continue to be essential requirements.

Despite this, farmers have so far not considered using a dual-purpose animal that can produce milk and draft power. This is basically because of either socio-cultural beliefs that cows should not plough, or probably the option of using cows for draft is not known to the farmers. Further, the introduction of the dual-purpose crossbred cows requires extra care in feeding and management if both milk and draft power have to be realised. Thus a package of feeds and feeding management must be developed to accompany such technology.

1.e. Project goals

In responding to the need for intensified production, the project aims to test the use of crossbred dairy cows for both milk production and draft power in smallholder farms of the semi-arid areas. The use of crossbred cows would have the effect of reducing the number of animals on the farm through destocking the existing pairs of oxen and possibly a number of indigenous cows. This expected decrease in stocking rate would result in a reduction of overgrazing and the rate of land degradation.

Since animals of high genetic potential for milk production (Friesian x Boran) shall be used, household milk production will increase, at least by a factor of 4, and thus improve the household nutritional and financial status. Further, the improved feed resource package that will accompany cow-traction technology will ensure maintenance of the cows in good body condition throughout the year, so as to provide the required draft for timely farm operations. This will improve crop productivity. The improved feed package will also benefit the small ruminants which play an important role in the household economy of the subsistence farmers.

The increased productivity in both crops and livestock will ensure improved nutritional status of the household, create food security and provide cash for investment in the farm and for purchase of non-farm essential goods. This shall also create attractive rural employment and thus contribute to a reduction in rural–urban migration.

Currently oxen are used for land preparation, weeding and transport, while donkeys are also used for the latter in the semi-arid areas. It is expected that by the end of the project, feeding and management strategies for cows especially during the dry season will have been developed and tested on-farm, and the participating farmers will have adopted the following technologies:

1. Replacement of at least two oxen and some local cows with crossbred cows.
2. Construction of a barn for the crossbred cows.
3. Use of crossbred cows to provide draft power requirements for farming and transport
4. Clearance of natural pasture (where applicable); cultivation of 0.5 ha of a mixture of Napier or Panicum with legumes, 0.5 ha of a mixture of Rhodes grass and legumes for hay and 0.5 ha of shrub legume for dry season supplemental feeding with crop residues.

The on-farm trial will involve 20 subsistence farmers currently owning only local cattle and oxen. Among these, 10 will have non-working cows and the other 10 will have working cows.

2. Expected end-of-project situation

Farmers will have adopted a package of feeds and feeding management for the multi-purpose crossbred cows. There will be a higher proportion of farmers practising early land preparation and timely planting and weeding using draft animals. Consequently, there will be an increase in crop production and the feed resource base that will ensure improved nutritional status of the family and livestock kept.

3. Target beneficiaries

Smallholder subsistence farmers keeping indigenous breeds of cows and using oxen for draft, will directly benefit from this technology. More milk shall be consumed by the farm family because of the increased amount available on the farm from the crossbred cows. The family shall also benefit from an improved financial status from selling surplus milk. Further, the selection of the animal drawn implements shall be gender sensitive so as to properly target the type of labour on the farm. The emphasis will be to reduce drudgery for the person(s) engaged in the farming activities. For example, the lighter multi-purpose tool bar is easier for youngsters and women to handle, and use of sweeps for weeding reduces the time taken for this activity with the conventional mouldboard plough. Other beneficiaries will be artisans and traders in milk and animal drawn implements, since the demand for these shall increase.

4. Project strategy and institutional arrangements

The concept of using cows for traction is very new to Kenyan farmers and therefore both scientists (researchers and extension workers) and farmers have to be sensitised to and build confidence in the feasibility of this technology. This will be achieved by both parties working together to develop the feed and management strategies for the cows and test the adaptability of the cow-traction technology. The approach will thus be systematic, starting with the establishment of feeding levels that will not compromise the productivity of the cows using locally available feeds (mainly home-grown forages). This shall be done on-station. Once the feed rations and their effects on milk production and draft are known, then scientists can move to the farm with some level of confidence on how to manage cows that are providing milk as well as traction.

The on-farm implementation strategy shall rely on a participatory approach. This means that even though the project may take a larger part of the inevitable risks of agricultural operations (traditional or new), the farmer must assume his responsibilities as a partner under a properly defined commercial contract. This legal instrument will facilitate the expansion of the scheme once a positive validation of results is confirmed and local institutions take up follow-up management responsibilities.

The supply of crossbred dairy cows, their harnesses and equipment must be similar, if not identical, and the training of both farmers and animals plus livestock management instructions must be arranged following strict common standards.

KARI, MoALD&M extension services and farmers’ organisations will assist the project in its training programme and in the logistical support required to implement field interventions.

The project component based at ILRI (Addis Ababa, Ethiopia) will provide backstopping technical direction and administrative management of operations of the Kenya project, and

Addis Ababa would become the headquarters of the project where an international team leader would co-ordinate overall operations.

5. Reasons for assistance from donor

Traditional mixed crop–livestock farming systems under growing population pressure are experiencing declining productivity and increasing degradation of the natural resource base. The multiple use of crossbred cows increases milk production substantially, while at the same time, and with the same resources satisfying the need for draft power. The number of oxen (used for work for only a short period each year, primarily for land cultivation and transport) and the number of cattle kept as part of a follower herd for breed replacements could be reduced. More productive, smaller herds, will release capital and feed resources to achieve more sustainable production systems, higher incomes, and better nutrition within a five-year period.

Local technical service providers are aware of the need to address the technical and developmental aspects of this problem, but they do not at present have sufficient material resources to deal urgently with this situation. ILRI and the Institute of Agricultural Research (Ethiopia) have developed a cow traction technology package that could contribute to resolving these problems. The implementation of this proposal will occur at the farm level with direct participation of national research and extension programmes and selected farmers. The technical interventions will be executed collaboratively by the Food and Agriculture Organization of the United Nations (FAO) and ILRI. These development objectives will be supported financially by a donor. Regional operations of the project would be greatly facilitated by institutional support provided to participating countries by international institutions such as donors, FAO and ILRI.

6. Special considerations

The excellent chances for the sustainability of these technologies are evidenced by the continuation and further development of crossbred dairy activities in the semi-arid areas of Kenya. The government policy to upgrade the local animals through cross-breeding has resulted in about 70,000 grade and crossbred cows in the area to date. This trend is set to continue since despite the recent government reduction of subsidies in livestock production, the private sector is being encouraged to take up AI and other veterinary services. The Kenya Agricultural Research Institute (KARI)-Katumani and the MoALD&M can provide training for cow traction animal and farmer management of crossbred cows. The Agricultural Engineering Department of the University of Nairobi undertakes research and development of animal drawn implements. Established traditional blacksmiths and local artisans (commonly known as jua kali artisans) exist for the maintenance of harnesses and manufacture of equipment. Currently there are efforts to popularise a simple hand-operated oil seed press among smallholder farmers. If adopted, this would provide a source of feed supplements to the crossbred cows. The potential for credit facilities exists through co-operatives once agricultural technologies are proven to be financially viable.

These technologies create opportunities for the private sector to provide inputs and services such as AI and veterinary services, animal feeds, fertiliser, seed, and product marketing, both milk and processed dairy products. Marketing opportunities and profitable outlets of fresh milk for smallholder are provided by a formal collection operation run by the Kenya Co-operative Creameries (KCC) and informal sale to neighbours and local markets.

The introduction of crossbred cows for milk production and draft will have especially positive effects on the role of women in development and the nutrition of children. Since crossbred cows require stall-feeding, they are kept close to the homestead where care is mainly provided by the women, thus increasing their role in an important income earning activity. Further, the additional milk produced can lead to increased incomes for women if butter-making technology designed by ILRI can be made available to the Kenyan women, to take advantage of increased milk production.

Increased milk production leads to increased consumption within the household, mainly on the part of children. Dairy production can be important in achieving food security in three ways: 1) directly through increased food production that adds directly to household nutrition; 2) indirectly through increased cash income that can be used to purchase food and other household items; and 3) by generating employment.

The environmental effects of the dual use of crossbred cows for milk and traction also promise to be positive. Keeping fewer animals would lower stocking rates. This would help reduce overgrazing and create a more productive farming system that makes better, more sustainable use of the natural resource base.

This intervention is an example of higher productivity livestock technologies which can have a substantial impact on the incomes of all farmers. Constraints to resource-poor households benefiting from this technology do exist, but can be overcome through programmes and other support such as credit and insurance schemes. The project will encourage technical co-operation among developing countries (TCDC).

The project will allow formal linkage mechanisms to be set up for informal exchange and collaboration between scientists and development organisations involved in research and transfer of multi-purpose cattle and buffalo technologies in East Africa and Asia. The project will benefit from the participation of the Australian Centre for International Agricultural Research (ACIAR) Draught Animal Power (DAP) project. These project activities will represent a further development of DAP collaborative programmes initiated by ACIAR and African NARS (national agricultural research systems). These activities will provide an opportunity to formalise collaborative relations between Asian and African NARS.

7. Co-ordination arrangements

The National Dairy Cattle Research (NDCR) component of the country's National Agricultural Research Project phase II (NARP II) co-ordinates the dairy cattle research policy formulation and implementation. National dairy development programmes are carried out through the MoALD&M and a number of non-governmental organisations (NGOs) which work in close collaboration with the ministry's agricultural extension services and KARI.

This project is designed as a regional project to adapt on-station and carry out on-farm testing of the cow-traction technology developed at ILRI-Ethiopia. ILRI-Addis Ababa would act as the co-ordinating centre and institutional headquarters. KARI-Katumani will act as the host local institution to the country project.

8. Counterpart support capacity

Project activities will be jointly planned and executed by the collaborating partners who will provide substantial in-kind and supplementary support to the project. ILRI-Addis Ababa will provide: the international project co-ordinator; scientific backstopping to KARI-Katumani; livestock resources and assistance with data collection procedure, management and analysis. KARI will provide research and laboratory facilities, researchers in forage production, animal nutrition and health, and agricultural economics, and on-station and on-farm logistical support from KARI-Katumani. MoALD&M will provide extension specialists in dairy, veterinary, forage, and agricultural engineering.

Sustainable Development Agreement Clause

If at the end of development operations these are concluded successfully, all inputs and support allocated by Government to the executing Technical Ministry as a development budget will become an additional allocation to the Ordinary Budget assigned to the Technical Ministry by Ministries of Planning and of Finance.

C. Development objective

The long-term objective of the project is to improve and sustain milk production and draft power requirements of the small-scale farmers within the context of diminishing land resources, due to population pressure.

This shall be achieved through transferring the developed technologies for feeding and management of crossbred cows being used for draft as well. For instance, dry season feeds and feeding of crossbred cows in semi-arid areas based on hay, crop residues and to a lesser extent silage, supplemented with forage legumes can be developed and adopted to sustain milk and draft power production.

D. Immediate objectives, ouptputs and activities

1. Immediate objective 1

Adoption of dairy cow traction technology.

1.1 Output 1: Increase cow output: work, surplus milk and calves.

Activities

1.1.1 On-station demonstration of dairy cow-traction technology

- 1.1.1.1 Establishment of feeds
- 1.1.1.2 Acquisition of animals
- 1.1.1.3 Acquisition of implements and equipment
- 1.1.1.4 Training of animals
- 1.1.1.5 Field tests
- 1.1.1.6 Organisation of farmers' field day(s)
- 1.1.1.7 Revamp the existing feed analysis facilities at the centre

1.1.2 On-farm testing of the dairy cow-traction technology

- 1.1.2.1 Identification of volunteer farmers
- 1.1.2.2 Training of farmers on the handling and management of the multi-purpose cows
- 1.1.2.3 Construction of animal sheds on volunteer smallholder farms

1.1.2.4 Improvement of feed resource base on volunteer smallholder farms

1.1.2.5 Acquisition of in-calf heifers for volunteer farmers

1.1.2.6 Training (in collaboration with recipient farmers) of the in-calf heifers for draft power use

1.1.2.7 Identification and training of field staff on data collection

1.1.2.8 Supply of the in-calf heifers to recipient farmers

1.1.2.9 Acquisition and supply of implements and equipments to recipient farmers

1.2 Output 2: Technical supervision, monitoring and evaluation scheme in place for dairy cow-traction technology.

Activities

1.2.1 Formation of Research/Extension team for supervision, monitoring and evaluation

1.2.2 Development of monitoring and evaluation procedure(s)

1.2.3 Renovation of an office for the FAO counterpart and visiting ILRI consultant

1.2.4 Acquisition of vehicles

1.2.5 Acquisition of computers and stationery

1.2.6 Collection of field data on the performance of the dairy cow-traction technology

1.2.7 Data capture and analysis

1.2.8 Meeting of the monitoring and evaluation team to discuss and assess the project progress, and report to the Centre Research Advisory Committee (CRAC)

1.2.9 Organisation of on-farm farmers' field day(s), on participating farm(s), for farmers' evaluation and exchange of experiences on the use of dairy cows for traction

1.2.10 Reporting and publishing of the observations made on on-farm performance of the dairy cow-traction technology

2. Immediate objective 2

Establish rural based support systems for the supply of production components and market products related to dairy cow-traction technology.

2.1 Output 1: Mechanism in place for the supply of production components required for dairy cow-traction technology.

Activities

2.1.1 Make consultations with the local manufacturer of improved implements to avail them to the participating farmers

2.1.2 Liaise with the District Veterinary Officer (DVO) to ensure AI runs cover the project farmers, or establish bull camp(s) within the project farmers' group(s), where field officers pay special attention to the project farmers

2.1.3 Make arrangements with the district crops and livestock heads to ensure that the field officers pay special attention to the project farmers

2.1.4 Establishment of forage seed bulking plots

2.1.5 Sensitise the financial institutions and development agencies (e.g. NGOs, Church organisations), on the dairy cow-traction technology and possibility of establishing a credit scheme for farmers who show interest in adopting the technology

2.2 Output 2: Mechanism in place for the marketing of products of the dairy cow-traction technology.

Activities

2.2.1 Encourage project farmers to form milk collection and transportation scheme(s) to urban centres for marketing, where there is a need.

E. Inputs

1. Government inputs

- infrastructure and logistical support (National Dryland Farming Research Centre)
- research facilities: experimental farms
- scientific support: animal scientists, pasture agronomists, agricultural engineers and technical support staff
- veterinarians, extension agents.

2. Donor inputs

- laboratory and field experiment equipment: feed analysis equipment, water distillation and draft measurement equipment, nine ploughs (three Victory, three Bukura Mark III with multi-purpose toolbars), three dynamometers, four stop watches and three carts, harnesses
- laboratory supplies: chemicals
- veterinary supplies: antibiotics, anthelmintics, acaricides, minerals, vitamins
- four-wheel drive double-cab vehicle plus motor cycle
- data processing and publications: one 486 DX desk top and one laptop computer plus laser printer, diskettes, toner and paper
- training
- meetings and workshops
- animals: 40 pairs of crossbred cows and two pairs of indigenous cows.

F. Risks

- insufficient and untimely delivery of inputs by both the government and donor
- lack of goodwill by smallholder farmers to participate in technology generation and testing
- apprehension in adopting new technology (e.g. cow traction) due to traditions of using only oxen for traction
- droughts that might affect adequate feed availability to maintain milk and draft power production.

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Work plan for the KARI/ILRI impact assessment study of the dairy cow traction technology on small-scale farms of semi-arid areas of Kenya

Activity	Period of implementation		
	Year 1	Year 2	Year 3
1.1.1.1 Establishment of feeds	▬		
1.1.1.2 Acquisition of animals	▬		
1.1.1.3 Acquisition of implements and equipment	▬		
1.1.1.4 Training of animals	▬		
1.1.1.5 Field tests	▬		
1.1.1.6 Organisation of field day(s)	▬		
1.1.1.7 Revamp the existing feed analysis facilities	▬		
1.1.2.1 Identification of volunteer farmers	▬		
1.1.2.2 Training of farmers on handling and management of the multi-purpose cows		▬	
1.1.2.3 Construction of on-farm animal sheds		▬	
1.1.2.4 Improvement of on-farm feed resource base		▬	
1.1.2.5 Acquisition of in-calf heifers for farmers		▬	
1.1.2.6 Training of animals for on-farm draft use		▬	
1.1.2.7 Identification of field staff and training	▬		
1.1.2.8 Supply of animals to farmers		▬	

Work plan for the KARI/ILRI impact assessment study of the dairy cow traction technology on small-scale farms of semi-arid areas of Kenya

Activity	Period of implementation		
	Year 1	Year 2	Year 3
1.2.1 Formation of Research/Extension team for supervision, monitoring and evaluation			
1.2.2 Development of monitoring and evaluation procedure(s)			
1.2.3 Renovation of an extra office			
1.2.4 Acquisition of vehicles			
1.2.5 Acquisition of computers and stationery			
1.2.6 Collection of field data			
1.2.7 Data capture and analysis			
1.2.8 Meeting of the monitoring and evaluation team			
1.2.9 Organisation of on-farm field days			
1.2.10 Reporting and publishing			
2.1.1 Consultation with local manufacturer of implements			
2.1.2 Liaise with the district veterinary officer to establish an insemination scheme			
2.1.3 Make arrangements with district agricultural heads for adequate coverage of the project farmers by field staff			
2.1.4 Establishment of forage seed bulking plots			

Work plan for the KARI/ILRI impact assessment study of the dairy cow traction technology on small-scale farms of semi-arid areas of Kenya

Activity	Period of implementation		
	Year 1	Year 2	Year 3
2.1.5 Sensitise financial institutions and development agencies (NGOs, Church organisations)			
2.2.1 Encourage project farmers to form milk collection and transport scheme to urban centre(s), if need be			

ON-FARM TESTING OF MULTI-PURPOSE CROSSBRED DAIRY COWS FOR MILK, MEAT AND DRAFT WORK IN SMALLHOLDER FARMING

1.1 Project budget covering government contribution in kind (US$)

Country: Kenya

Project number:

Project title: On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems

	Total staff months US$	Prior years (1986 and before) staff months US$	1997 staff months US$	1998 staff months US$	1999 staff months US$
10. PROJECT PERSONNEL					
11.01 Animal Scientist (KARI)		–	12 10,000	12 10,200	12 10,400
11.02 Forage Agronomist (KARI)		–	12 10,000	12 10,200	12 10,400
11.03 Agricultural Economist (KARI)		–	12 10,000	12 10,200	12 10,400
11.04 Agricultural Engineer (MoALD&M)		–	12 10,000	12 10,200	12 10,400
15. DSA			–	–	–
19. Component total			48 40,000	48 40,800	48 41,600
30. TRAINING					
31. Maintenance of trainees' salaries					
39. Component total					
40. EQUIPMENT					
41. Equipment	–	–	–	–	–
42. Supplies	–	–	–		
43. Premises	–	–	2,000	2,000	2,000
49. Component total	–	–	2,000	2,000	2,000
50. MISCELLANEOUS					
99. GRAND TOTAL			42,000	42,800	43,600

1.2 Project budget covering donor contribution (US$)

	Total staff months US$	Prior years (1986 and before) staff months US$	1997 staff months US$	1998 staff months US$	1999 staff months US$
10. PROJECT PERSONNEL					
11. International experts					
11.01 Regional Co-ordinator					
11.02 APO					
11.03					
11.49 Subtotal experts					
11.50 Consultants					
11.51 Animal Scientist					
11.52 Agricultural Economist					
11.97 Short-term consultants					
11.98 Subtotal consultants					
11.99 Subtotal: experts/consultants					
12. OPAS experts					
12.01					
12.02					
12.99 Subtotal OPAS					
13. Administrative supports personnel	–	–			
13.01 Regional Administrator	–	–			
13.02 Secretary	–	–			
13.03 Driver	–	–	12 1,400	12 1,540	12 1,694
13.04 Data assistant					
13.99 Subtotal administrative support					
14. United Nations volunteers					
14.01					
14.02					
14.03					
14.99 Subtotal UNV					
15. Duty travel					
16· Mission costs					
17. NPPP					
17.01					
17.02			1,400	1,540	1,694
17.99 Subtotal NPPP					
19. Personnel component total:					
20. SUBCONTRACTS					
21. Sub-contract X National			–	–	–
Program Field Support			–	–	–
22. Subcontract Y revolving fund administration					
23. Subcontract Z					
29. Component total			–	–	–

30. TRAINING 31. Fellowships 31.01 31.02 31.03 31.04					
32. Study tours/group training 32.01 In-country 32.02 Regional 33. In-service training (veterinary, AI, forage etc)	 – – –	 – – –	 5,000 10,000 2,000	 4,500 8,000 –	 2,000 – –
39. Component total			17,000	12,500	2,300
40. EQUIPMENT 41. Expendable equipment 41.01 Laboratory glassware 41.02 Water distillation equipment 41.03 Load cells (for ergometers) 42. Non-expendable equipment 42.01 Vehicle 42.02 Ploughs 42.03 Harnesses 42.04 Ergometers 42.05 Stop watches 42.06 Computers (desktop and laptop) 42.08 Software 43. Premises 43.01 Renovation of existing office 43.02 Installation of electricity, telephone and e-mail lines 43.03 Construction/repair of on-farm cattle barns			 1,000 2,000 * 28,000 300 * 60 5,000 1,000 2,000 3,000 2,600 3,500	 1,000 – – – – – – – – – – – –	 1,000 – – – – – – – – – – – –
44. Animals			7,000	49,000	–
49. Component total			56,400	50,000	1,000
50. MISCELLANEOUS 51. Operation and maintenance cost of equipment 52. Data analysis and reporting cost 53. Sundries			 5,000 2,500 3,000	 5,000 1,000 3,000	 6,050 1,000 3,000
59. Component total			10,500	9,500	10,050
GRAND TOTAL			85,300	73,540	15,044

Discussion on Kenya proposal

Zerbini: Mr Wandera, I am surprised that you propose to test the technology on-station again. I thought we had described the technology very well, particularly with regard to the performance of cows over multiple years with cows that are exactly the same as those you have in Kenya. In fact, we imported cows from Kenya to Ethiopia for our on-farm trials. I also would have thought that in Kenya, with its large number of crossbred cows, you should have already developed feeding strategies for crossbred cows for milk production. The only addition is increased intake when cows are also working.
Why do you want to repeat what we have been doing for the past six years on-station again? Perhaps the most important thing you will have to adjust on-farm is to see how best to match the work activity with the reproductive cycle.

Wandera: The strategy of demonstrating this technology with on-station research is to gather data on cow performance under local conditions and to sensitise Kenyan farmers to this new technology. We need to introduce this technology carefully and gradually. It is also useful for the researchers to learn the details of this technology to be able to test it on-farm. All I would like to do is to manipulate the feeds that are available there and see how I can best utilise them for both milk production and cow traction. Feed differs from region to region and therefore your Ethiopian results could differ from what we could get in Kenya.

Tesfaye Kumsa: You have indicated that the project should be done in two agro-ecological zones. Why not only in the one with the greatest potential?

Wandera: If you look at the characteristics of those areas you will find that first, the rainfall is different and secondly, there are crossbred animals in one but mainly local animals in the other. So, in one area there are already farmers using crossbred animals and improved feeds and feeding strategies. However, farmers who do not have crossbred animals and would like to test them will be confronted with a bigger challenge and represent another situation.

Shapiro: The technology presented here is crossbred cows for traction and it seems to me that it would be useful to start in the area where crossbred cows already exist so that you are not trying to introduce too many technologies simultaneously. It is well established that farmers tend to adopt one component of the package at a time. It might be better to start with farmers who already have crossbred cows. It seems to me that the critical issue here is feed and I think that Dr Zerbini is quite correct in indicating that there is no need to repeat on-station experimentation. Perhaps you have to look at what the high milk producer is doing: Where does he get assistance? Where does his feed come from? If it is a forage-based system, then you need to help farmers in this project to establish a more intensive, higher productivity farm system. If it is supplements-based, then we have to address this input issue. How do they market their milk and milk products and how do they reinvest in supplements to feed the cows?

Wandera: I think your point about dropping one production system is well taken and I think that is why we are here—to refine these proposals. However, we probably still need to discuss further whether we should start on-station or go straight on-farm. Farmers need to be exposed to this technology gradually. They are still sceptical towards using crossbred cows for work.

Zerbini: For smallholders in Kenya, do you have a feeding package for crossbred cows for milk production?

Wandera: Yes, we do.

Alemu Gebre Wold: How acute is the animal power shortage and how intense is the pressure on the land in the area you have described? I ask this because, if you don't have these constraints, I believe this intervention may not benefit the farmers.

Wandera: The success of cereal production in those areas depends on draft power. These are also the same areas where there is the highest population growth rate. Currently, land is a constraint and a number of farmers are now giving up oxen. So, if we have to sustain both crop as well as milk prodction, this technology is very relevant in those areas.

Maiseli: Why did you include the survey of the use of indigenous medicine in your proposal? Do you have reason to doubt the support of the existing veterinary services?

Wandera: Animal health in Kenya used to be subsidised by the government. These subsidies have been removed and presently, because of the costs involved in veterinary services, a number of farmers are using local medicine to control worms and even pests. We want to know how these methods are used with improved cattle, and to work in collaboration with an NGO which is already cataloging these procedures.

Shapiro: What is the production performance of these crossbred cows under your conditions of 600 to 800 millimeters of rain?

Wandera: The farmers who have adopted the feeding regime that I showed are getting between 2000 and 2200 litres of milk per lactation. Without the use of concentrates milk yield is lower, about 1000 litres.

Shapiro: What is the ratio of concentrates to milk?

Wandera: It is one kilogram of concentrates per litre of milk. The price of concentrate is about 10 shillings and that of one litre of milk is about 20 shillings.

Shapiro: So we are talking about an input/output ratio here of 1:2 in price terms. In Ethiopia when farmers get 2000 litres of milk they also have an input/output ratio of 1:2. The use of concentrates is highly profitable and it is not clear to me why some farmers do not use them if they are available. Here in Ethiopia, we have found that they want to adopt forages but they really adopt concentrates.

Wandera: Well, that is the situation in Kenya. I am reporting it as is.

Shapiro: Concentrate is only one component of the package. A 1:2 input/output ratio only occurs when there is enough forage dry matter available. Farmers have to grow enough forage in order to meet the dry matter requirements of cows. The oats/vetch system used in the highlands here provides about 6 t a year, which is sufficient for a couple of crossbred cows.

Wandera: I think the issue here is the level of commercialisation or the conceptualisation of commercialisation. In the highlands of Kenya farming activities are highly commercialised; the farmers use concentrates. But in the semi-arid areas, farmers do not use concentrates. Their production system is mainly sell milk, buy grain and manage risk. Extra cash is used to increase stock.

Shapiro: You are talking about the general situation. I think what we want to do here is an on-farm demonstration with some innovative farmers. You take the farmers that are getting 2000 litres of milk and using concentrates. You can propose that they also use their cows for traction. In the beginning you will not find many because, as we have seen in Ethiopia, farmers are sceptical about it but after people start seeing it, you will be able to get more farmers participating. First of all you have to be convinced that it is possible to take this technology on-farm under your research supervision. You have to choose the model farmers, the innovative farmers and support them well during the first period of testing.

Teleni: Dr Shapiro, how did you get the first farmers to participate in the cow traction project here in Ethiopia? How did you convince them? Maybe Wandera could learn from that because it seems to be the issue here because he is worried about how he can convince them.

Zerbini: The farmers in the surrounding areas of Holetta knew we were working with crossbred draft cows. We invited them to field days and more than 200 participated. First we identified only 20 farmers and then the other 70, two years later. To do this you could have on-station demonstrations by training a group of cows to plough and inviting the farmers to see and try it.

On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems of Uganda

A. Context

1. Description of the subsector

Agriculture is the mainstay of the Ugandan economy; 89% of the population is rural. Agriculture accounts for 51% of the gross domestic product (GDP) and over 90% of exports, and employs 80% of the population. Food crop production forms the backbone of the agricultural sector in the country, contributing 71% to the agricultural GDP. Livestock products contribute 17% to the agricultural GDP.

Livestock are an integral part of the farming systems in Uganda, and nearly one-third of the farming households depend on livestock for the major part of their incomes. The production potential is high because quality pasture can be grown all year around. Cattle raising is the predominant livestock enterprise, but goats and sheep are also increasing in numbers.

Uganda still imports milk from Europe and other countries to try to meet the high demand in the country. Local daily production is low because of the small number of exotic dairy cattle, and low productivity of indigenous cattle. There is therefore need to increase milk supply in the country through acquisition and adoption of exotic dairy animals.

The use of animal traction in Uganda started in 1909 in the eastern part of the country. The ultimate objective was to introduce farm mechanisation beyond the use of the hand hoe, to promote cotton production. Research on animal traction was started in 1930 at Serere Research Institute. At the time, research was concentrated on training farmers to train animals and to use ox-drawn implements. Started initially to promote cotton production, animal traction technology eventually spread to facilitating food crop production and transportation.

2. Host country strategy

The current Uganda Government policy is to promote animal draft power technology throughout the country as an intermediary between the hand hoe and the tractor. Consequently, many efforts are being put in place to promote the technology.

The problem of milk supply remains unsolved, but efforts are being made to address it. The government is encouraging importation of cattle, including Friesian, Jersey, Guernsey and Ayrshire breeds; their crossbreeds now represent some 4% of the national herd. Artificial insemination (AI) was started in the 1970s mainly for dairy development. Crossbred animals are being distributed to farmers, mainly in peri-urban areas, by non-governmental organisations (NGOs) and the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).

3. Prior or ongoing assistance

This project is proposed in collaboration with the International Livestock Research Institute (ILRI). ILRI has developed a technology involving the use of crossbred cows for milk, meat and traction. This is valued in Uganda as a major breakthrough in the development and use of a multi-purpose animal. Current research at Serere is focused on a similar objective, but limits traction to oxen only.

The MAAIF is strengthening extension services in the livestock dairy sector through a livestock services project financed by the World Bank. The ministry also has an Artificial Breeding Centre for training personnel and providing AI services to farmers. Research is being undertaken by the National Agricultural Research Organisation (NARO) on livestock breeding, animal health, animal nutrition and production.

4. Institutional framework for subsector

The project will be undertaken by NARO and will be based at Serere Agricultural and Animal Research Institute (SAARI). Two sites will be selected as pilot project areas: one site will be in Teso (where SAARI is located) and the second will be in Buganda, an area where Kampala is located. Teso is a traditional animal traction region in the country where impact is expected to be realised relatively fast. What will be new in this area is the use of cows for traction since farmers are used to oxen only. There will be a major benefit to farmers in this region through increased milk production from the crossbreds. The towns, schools, hospitals etc will provide a market for the milk. At the second site, some farmers already own exotic and crossbred animals. However, animal traction technology is not well developed. The government is now encouraging the use of this technology in this area as well hence, impact is likely to be realised relatively fast.

For successful implementation of the project, SAARI will work hand-in-hand with the extension services, particularly:

- The Directorate of Agricultural Extension for dissemination of the technology to the farmers
- The Directorate of Animal Resources for animal nutrition and disease control
- The Nutrition Unit of MAAIF for advising farmers on the importance of milk in the family diet
- Artificial Breeding Centre, for use of AI services in the development of crossbred cattle.

The Livestock Services Project and SAARI have improved pasture species for livestock. There are also private commercial companies in the country that either import livestock feed supplements or make them locally. The government has established credit facilities through the commercial banks, from which farmers can borrow funds for individual agricultural developments. There are also a number of NGOs that provide credit, particularly for dairy development.

B. Project justification

1. The problem to be addressed: The present situation

1.a. Agrotechnological

The predominantly smallholder farming systems in Uganda are becoming increasingly difficult to sustain. This is a result of rapid population growth, land tenure regulations and inheritance patterns which have led to increased fragmentation of farm holdings. The farmers practise integrated crop and livestock production. This integrated approach calls for low stocking rates of high producing animals and intensification of the integrated production system. Therefore, there should be well planned optimum use of land and the available labour (mostly family labour). There is also need for a well planned environmental management programme that involves recycling crop residues and manure. Using the animal traction technology will increase agricultural production while reducing labour requirements in farm operations. Other support services required will include facilitation for the purchase of feed supplements, harnessing equipment, and access to credit.

1.b. Biophysical

Uganda's population growth rate is about 3% per year. This has contributed to the high population pressure resulting in intensified and continuous use of the land base. In addition, the high stocking rates currently in existence have led to overgrazing and its effects on the environment and the natural resource base. The land is degraded and the soil surface exposed resulting in depletion of soil nutrients and soil erosion.

1.c. Institutional

The government established the National Agricultural Research Organisation (NARO) to facilitate and co-ordinate research on crops, livestock, fisheries and forestry. The establishment of this organisation has greatly improved research in Uganda. The organisation has a research extension liaison unit and also collaborates with the Ministry of Agriculture in technology generation and transfer. There are a number of technology verification centres scattered throughout the country which are used as multi-locational sites, demonstration centres, on-farm trial sites and farmer training centres. NARO has also put a system in place that encourages and facilitates collaboration with international research institutions.

1.d. Socio-economic

A number of factors have led to increased migration, especially of the youth, to urban areas. These include increase in population, lack of capital to sustain rural farm families and limited employment opportunities (particularly for school leavers). The increasing urbanisation will lead to increased demand for food in the cities

Establishment of a successful dairy development plan will help meet these demands. Milk and other dairy products will provide incomes to the rural farm families. The related agro-industries will provide employment and there will be a general revitalisation of the national economy. Successful adoption of crossbred cows for milk, meat and traction will certainly play a big role in this area of nation building.

To be successful there is need for the smallholder farmers (who are the target clients) to clearly understand the objectives of the project and to adopt the new technology. This involves use of cows for traction, improved livestock management systems and feed supplement production and utilisation.

1.e. Project goals

The overall project objective is to introduce crossbred cows into the smallholder farming systems in Uganda to increase milk production and for use as draft animals. This new technology will be accompanied by improved livestock management practices, involving improved pasture species and supplementary feed resources. Introducing crossbred dairy cows for both milk and traction will increase the productivity of the farm family and lead to a reduction in stocking rates, therefore reducing overgrazing with its resultant environmental degradation. In collaboration with the Nutrition Unit of the MAAIF, the increase in milk production will solve the current malnutrition problem through increased use of milk and dairy products and improve the income generating capacity of the farm family.

The project will also encourage other areas of the country to adopt the use of animals for traction. This is in line with the government policy of popularising the technology throughout the country. Previously animal traction was practised only in the eastern and northern parts of the country. Adoption of the technology will alleviate the existing labour problems and help boost agricultural production.

It will be necessary to make animal drawn implements locally. This will inevitably build capacity among the rural blacksmiths and artisans and help make them viable rural enterprises.

In Uganda, the traditional source of animal draft power has been oxen. However, in the Teso region where the technology had been a tradition, a few farmers were forced to use cows as well because of cattle rustling. This project will now boost this initiative. It is also expected that at the end of the project, the following technologies will have been adopted by the farmers:

- acquisition of at least two crossbred dairy cows to replace the four oxen traditionally used to pull a single plough
- use of crossbred cows as a source of power for ploughing, planting, weeding and transportation
- establishment of improved pasture/grazing ground
- adoption of zero grazing which will involve cut-and-carry, preservation and utilisation of fodder
- adoption and use of supplementary feed resources which is important particularly during lactation and ploughing.

2. Expected end-of-project situation

This project will operate in two pilot areas in Uganda. In Teso, a traditional animal traction area with extremely few crossbred cattle, and in Buganda, a non-animal traction area with some crossbred cattle. The technology will have a different impact in each place. In Teso, the use of the technology will be intensified, while at the same time, milk production will be increased.

In Buganda, while the project will boost milk production, there will also be an opportunity for the enhanced adoption of animal traction. From each site 40 farmers will be selected who presently use oxen, and have good experience in livestock management.

Results of a study conducted by ILRI and IAR in Ethiopia show that, besides an increase in income through use of crossbred dairy cows, there has also been an increase in food supply by about 40% in value terms, indicating that there is a parallel increase of food both quantitatively and qualitatively.

It is also expected that grazing lands will be properly managed and their output improved. This will be achieved by introducing improved pasture species and by improved grazing habits arising from the reduced stocking rates. Currently, the animals are grazed communally and overgrazing is common. The improved grazing management system will be supplemented with feed and other by-products.

It is also expected that once the technology is introduced, the resulting impact will be measurable through its successful adoption. Total farm output should increase as a result of the new technology involving improved utilisation of farm resources and other external services. Once the initial farmers have adopted the technology, more farmers should show interest and be able to purchase more crossbreds for the purpose. This will increase the number of the crossbreds kept by the farmers, eventually resulting in increased agricultural production and improved national economy. In addition, related agro-industries are expected to be established and this will partially solve the problem of unemployment.

The re-cycling of natural resources and animal manure will preserve the environment and also improve soil fertility management resulting in increased and sustained crop production.

3. Target beneficiaries

Direct beneficiaries: collaborating farmers, the resource poor rural farmers and their families. NARO and MAAIF will also benefit directly through institutional development and capacity building.

Indirect beneficiaries: neighbouring farmers and their families, villagers, artisans, blacksmiths, businessmen, and agro-industrialists. Also to benefit will be farmer groups/associations that will be participating through workshops, seminars and other extension meetings.

All these individuals/groups will benefit through improved nutrition and increased incomes ultimately resulting in higher standards of living.

4. Project strategy and institutional arrangements

A farmer participatory approach will be emphasised. The farmers who will be selected will be required to commit themselves to the success of the project. The credit that will be made available to the farmer must be used only to purchase cows and other inputs for project activities. The farmers will be required to sign a ‘deed of understanding’ that will ensure that the credit shall be recovered. Once this credit is recovered, it will be available for loaning to other farmers hence creating ‘a revolving loan fund’. This fund, once established, will enable extension of technology to other farmers for widespread adoption.

The cows will be purchased from a common source to ensure uniformity. Project equipment and its utilisation will have to be uniform to enable data processing and interpretation. The methodology to be adopted in project implementation, i.e. farmer training, livestock management etc will be uniform throughout the project area.

Collaboration with relevant organisations will be emphasised. These include extension services and the nutrition unit of MAAIF, other research institutions of NARO, farmers associations, women and youth groups and NGOs.

This project will be executed by ILRI, Addis Ababa, where the project co-ordinator is expected to be based. Close collaboration with ILRI will be maintained.

5. Reasons for assistance from donors

ILRI has developed a cow traction technology that has been tested in Ethiopia and found suitable. It is therefore required that the technology be spread to other countries that need it. To facilitate this process, financial support is required. The government of Uganda has limited support for agricultural research at present, yet this is a technology that has high potential for adoption.

The process of adoption of this technology will involve on-farm trials with direct participation of researchers, extensionists and farmers. ILRI will provide technical back-stopping and monitoring and evaluation. This requires the financial support of a donor.

6. Special considerations

The government policy of liberalisation of trade, the availability of artificial insemination services, together with the versatility of Ugandan farmers, promises sustainability of this technology.

There is an opportunity to establish and expand agro-industries related to this technology. Crossbred cattle will require supplement feeds and they will be producing a lot of milk. There will therefore be an inevitable establishment of industries to process feed and dairy products. For traction purposes, artisans and blacksmiths will be engaged in making tillage equipment (ploughs, planters, weeders etc), carts etc. All these will create market opportunities and boost trade.

The introduction of crossbred dairy cows for milk production and traction will have a positive impact on women and children. Currently, women are responsible for collecting the feed used for zero-grazing cattle. There will therefore be more work for women in the farm families. Increased milk production will result in an increase in the income generating capability for the women which will create opportunities for them to buy simple tools for local processing of milk into dairy products, e.g. cheese, butter, yoghurt etc. Increased milk production will also lead to improved nutrition, especially for women and children.

The introduction of crossbred dairy cows will also have a positive impact on the environment. Since milk production will be boosted, farmers will no longer need to keep large herds of cattle. Keeping large herds and thus overstocking resulted in overgrazing with its negative impacts on the environment.

The project will facilitate interaction among scientists within the region, possibly leading to the development of a regional network. It will also expose Ugandan scientists to collaboration with those in Asia, Latin America and other countries who are working in the same field.

7. Co-ordination arrangements

NARO will co-ordinate the activities of this project in Uganda. The scientists based at SAARI will collaborate with MAAIF for extension services, use of AI centres, Animal health services and nutrition education.

There are also a number of NGOs operating in the country. Some of these are promoting animal traction technology, while others are facilitating dairy development efforts of farmers. There are also national projects that are providing credit to farmers. SAARI will collaborate with all these NGOs and projects in technology transfer and sensitisation of farmers to the advantages associated with crossbred dairy cows. These operatives will be encouraged to purchase, for their clients, crossbred cows for milk production and traction purposes.

Special consideration will be given to the role of women in utilising crossbred animals for these same purposes. There are a number of women groups in the country, and they have been found to be effective in technology transfer.

ILRI will be the main external collaborator. ILRI is required to identify the donor for the project and become the project executing agency. The Institute will also provide technical backstopping.

8. Counterpart support capacity

NARO will provide a National Project Co-ordinator, local scientists and technicians. These will be based at SAARI. NARO will also provide salaries for the scientists and technicians. The basic infrastructure such as offices, housing, laboratories and land required for on-station activities of the project exists at SAARI. There is also existing capacity in the extension service that will work jointly with NARO scientists in on-farm testing and dissemination of the technology.

Sustainable Development Agreement Clause

If at the end of the development operations these are concluded successfully, all inputs and support allocated by the Government of Uganda to the executing MAAIF and NARO as development budget for the activities of this project, these will become an additional allocation to the Ordinary Budget assigned to MAAIF and NARO by the Ministry of Finance and Economic Planning.

C. Development objective

The development objective of the project is to enhance the government policy of supporting and strengthening the smallholder farming activities to achieve commercial production to ensure food security, improved human nutrition and increased incomes through increased milk production. The resultant improvement in the dairy sector will increase its contribution to the national economy. The use of crossbred cows for traction in the smallholder farming system will contribute to ensuring increased food production while conserving the national resource base.

D. Immediate objective, outputs and activities

Transfer of new technologies and management practices for the adoption and use of multi-purpose dairy cows by the smallholder farmers.

1. Immediate objective 1

Adoption of dairy cow traction technologies (DCTT) and transfer of management practices on the use of crossbred cows for milk and traction.

1.1 Output 1: Participating farmers and testing sites identified and selected.

Activities

1.1.1 Conduct a rapid rural appraisal in the proposed project areas to:

(a) Assess farmers' attitudes towards use of crossbred dairy cows for traction.

(b) Assess the existing state of the art.

1.1.2 Sensitisation of farmers about the benefits of adopting the technology

1.1.3 Selection of sites and farmers for the project

1.2 Output 2: Increased cow output in terms of draft work, milk and calf production.

Activities

1.2.1 Analysis and evaluation of cow productivity in terms of work, milk production, reproduction and feed utilisation

1.2.2 Make contracts with contact farmers to the effect that they will train at least 10 farmers each in their localities

1.2.3 Organise farmers' competitions on:

(a) management practices

(b) utilisation for traction

(c) gains from the project

1.2.4 Train project personnel on management practices of crossbred dairy cows for multi-purpose use, and loan disbursement and recovery

1.2.5 Train identified contact farmers for DCTT on management practices for crossbred cows and utilisation of crossbred cows for traction

1.2.6 Organise on-farm trials, field days and demonstrations focusing on the use of crossbred dairy cows for multiple purposes

1.2.7 Conduct evaluation workshop with supervising and funding agencies

1.3 Output 3: Technical supervision, monitoring and evaluation scheme in place for field testing DCTT.

Activities

1.3.1 Appointment of project staff on full-time basis

1.3.2 Develop a format for recording daily milk production and traction output

1.3.3 Develop a format for monitoring and evaluating the project

1.3.4 Supervise on-farm training by contact farmers to neighbouring farmers

1.3.5 Monitor progress of contact farmers through on-farm visits

1.3.6 Training of monitoring and evaluation staff

1.3.7 Hold meetings, seminars etc for project staff for evaluation of project progress

1.3.8 Evaluation of the adoption rate

1.3.9 Reporting and publishing

2. Immediate objective 2

Establish and improve rural-based support systems for the supply of production components and market products related to DCTT.

2.1 Output 1: Mechanism in place for the supply of production components required for DCTT.
Activities

2.1.1 Improvement of grazing lands and contact farmers

2.1.2 Procure crossbred cows and breeding bulls for field testing of DCTT

2.1.3 Procure project equipment:
- vehicles
- motorcycles
- bicycles
- animal traction equipment and implements
- training materials

2.1.4 Establish revolving loan fund

2.1.5 Subcontract a veterinarian for animal health services

2.1.6 Subcontract artificial breeding centre for supply of AI services

2.1.7 Subcontract input supplies for:
- supplement feeds
- fertilisers
- pasture seed

2.1.8 Construct cow sheds, barns and stores, and fencing

2.1.9 Facilitate extension service to ensure good performance

2.2. Output 2: Mechanism in place for the marketing of products of DCTT.
Activities

2.2.1 Liaise with the nutrition unit of the MAAIF to train farmers on the importance of milk and dairy products in their diets

2.2.2 Encourage farmers to form co-operatives for effective marketing of their milk and dairy products, for a good price bargain

2.2.3 Introduce rural mini-processing units

E. Inputs

1. Government inputs

NARO and SAARI (36 months duration):

- infrastructure and logistical support
- research facilities (laboratories, offices, houses etc)
- scientific support: scientists and technicians
- dairy by-product processing units
- national project co-ordination unit

- feed resources
- veterinarian and extension services.

2. Donor inputs

(36 months duration):

- personnel:
  Regional Co-ordinator (international staff), 36 months
  Consultant staff: one ILRI Animal Scientist, 9 months
  Consultant staff: one ILRI Agricultural Economist, 9 months
  Technical assistance: one FAO Associate Professional Officer, 36 months
  Support staff: one Regional Administrator, 36 months
- initial project animals
- laboratory and field equipment
- laboratory supplies, chemicals and reagents
- veterinary supplies
- vehicles, motorcycles and bicycles
- vehicles operating and maintenance costs
- office supplies
- training
- printing and publications
- facilitation of meetings and workshops.

F. Risks

- insufficient and untimely delivery of inputs: Government and Donor
- hesitancy of smallholder farmers in adopting cow traction technology
- inadequate numbers and poor distribution of crossbred cattle and AI services
- inadequate supply of appropriate traction equipment and tools
- insufficient feed resources
- difficulties in re-orientation of farmers from large community grazed local herds to only a few intensively managed crossbred cows
- lack of support from local pricing policies and control of imports.

ON-FARM TESTING OF MULTI-PURPOSE CROSSBRED DAIRY COWS FOR MILK, MEAT AND DRAFT WORK IN SMALLHOLDER FARMING SYSTEMS

1.1. Project budget covering government contribution in kind (US$)

Country: Uganda
Project number:
Project title: On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems

	Total staff months US$	Prior Years (1986 and before) staff months US$	1997 staff months US$	1998 staff months US$	1999 staff months US$
10. PROJECT PERSONNEL					
11.01 National Project Director (Animal Scientist, NARO)		–	12 14,688	12 14,688	12 14,688
11.02 National project staff (full-time) (Dairy Specialist, NARO)			–	12 11,016	12 11,016
11.03 Forage Agronomist		–	12 11,016	12 11,016	12 11,016
11.04 Agricultural Economist		–	12 11,016	12 11,016	12 11,016
15. DSA			144 29,865	144 29,865	144 29,865
19. Component total			192 77,601	192 77,601	192 77,601
30. TRAINING					
31. Maintenance of trainees' salaries					
39. Component total					
40. EQUIPMENT					
41. Equipment	–	–	10,000	15,000	15,000
42. Supplies	–	–	50,000	65,000	75,000
43. Premises	–	–	25,000	25,000	25,000
49. Component total	–	–	85,000	105,000	115,000
50. MISCELLANEOUS					
99. GRAND TOTAL			162,601	182,601	192,601

1.2. Project budget covering donor contribution (US$)

	Total staff months US$	Prior years (1986 and before) staff months US$	1997 staff months US$	1998 staff months US$	1999 staff months US$
10. PROJECT PERSONNEL					
11. International experts					
11.01 Regional Co-ordinator		–	12 24,000	12 24,000	12 24,000
11.02 APO			12 –24,000	12 –24,000	12 –24,000
11.03			3 9,000	3 9,000	3 9,000
11.49 Subtotal experts			3 9,000		
11.50 Consultants					
11.51 Animal Scientist					
11.52 Agricultural Economist					
11.97 Short-term consultants					
11.98 Subtotal consultants					
11.99 Subtotal: Experts/consultants			66,000	66,000	66,000
12. OPAS experts					
12.01					
12.02					
12.99 Subtotal OPAS					
13. Administrative support personnel					
13.01 Regional Administrator					
13.02 Secretary			12 3,000	12 3000	12 3,000
13.03			12 1,000	12 1000	12 1,000
13.99 Subtotal administrative support	–	–	12 400	12 400	12 4,000
			4,400	4,400	4,400
14. United Nations volunteers					
14.01					
14.02					
14.03					
14.99 Subtotal UNV					
15. Duty travel			5,000	5,000	5,000
16. Mission costs			1500	1500	1500
17. NPPP					
17.01					
17.02					
17.99 Subtotal NPPP					
19. Personnel component total:			76,900	76,900	76,900

	Total staff months US$	Prior years (1986 & before) staff months US$	1997 staff months US$	1998 staff months US$	1999 staff months US$
20. SUBCONTRACTS					
21. Subcontract X National Program Field Support			15,000	6,000	4,000
22. Subcontract Y revolving fund admin.			80,000		
23. Subcontract Z				–	–
29. Component total			95,000	6,000	4,000
30. TRAINING					
31. Fellowships					
31.01					
31.02					
31.03					
31.04					
32. Study tours/group training					
32.01 In-country	–	–	5,000	5,000	5,000
32.02 Regional	–	–	9,000	9,000	9,000
33. In-service training (veterinary, AI, forage etc)	–	–	3,500	3,500	3,500
39. Component total			17,500	17,500	17,500
40. EQUIPMENT					
41. Expendable equipment			3,000	2,000	2,000
42. Non-expendable equipment			33,500	4,000	3,000
42.01					
42.02			1,000	1,000	1,000
42.03					
43. Premises					
49. Component total			37,500	7,000	6,000
50. MISCELLANEOUS					
51. Operation and maintenance cost of equipment			8,000	10,000	12,000
52. Reporting cost					
53. Sundries			1,000	1,000	3,000
			800	800	800
59. Component total			9,800	11,800	15,800
GRAND TOTAL:			236,700	119,200	119,800

Discussion on Uganda proposal

Shapiro: You propose carrying out the project from SAARI but at the same time you propose carrying it out over the whole country. Is there not a region perhaps where SAARI is located where we could start this pilot project?

Esele: SAARI is located in the eastern region where, traditionally, animal traction is used. Farmers use local cattle.

Shapiro: Are there crossbred cows in the area? You said that there are 84,000 crossbred cows in the country.

Esele: Crossbred cows are in the south and central parts of the country and they are used only for milk production.

Shapiro: Is animal traction practised where there are crossbred cows?

Esele: No, it is being introduced.

Tesfaye Kumsa: You talked about 40 technology verification centres across the country. Can you elaborate how these operate, how they are linked with the research centres and whether they are different for crops and livestock or whether they do it in collaboration? I think the way these centres operate will affect the implementation of the project.

Esele: The ministry established these centres in the 1950s in each district of the country for demonstrating both crop and livestock technology to farmers.

Zerbini: What type of support services do you already have in place for improved cows in the areas proposed for the project? And what kind of improvement do they need?

Esele: AI services are currently located in the central part of the country and serve only that region. These services have to be extended to the rest of the country.

Shapiro: This is a project that cannot be carried out all over the country. There are not enough resources. Can you tell us one region where you think this could work best? A region where there are some of these services, where, there are, perhaps, crossbred cows and the use of animal traction?

Esele: The policy of the ministry is to extend animal traction throughout the country. The crossbreds at the moment are only in the central part of the country and they are kept only for milk production.

Seruwo: would suggest that perhaps the project could be a pilot project in two regions: 1) the eastern region, where animal traction is already used and 2) the central region, where we already have crossbred cows used for milk production and AI services. Animal traction is being introduced in this area and it could use crossbred cows. I would also suggest running the project in the eastern region, where they use animal traction. It is just a question of changing the attitude from using oxen to using cows.

Shapiro: Why isn't there dairying in the eastern region? Is there a market for milk? Are the conditions favourable for crossbred cows?

Esele: The north-east is semi-arid, with pastoralist agriculture. But in the east and the south-east, conditions are adequate for crossbred cows. In addition, there is increased demand for milk because of increasing urbanisation.

Shapiro: Why do you believe that there is a need for animal traction in the central region?

Seruwo: In the past, there was extensive use of tractors in the central region, and foreign labour from neighbouring countries. However, at present tractors are not in use because of lack of maintenance and economic constraints and the foreign labour has gone. These are people used to commercial farming but currently they have a shortage of labour. At present, the only alternative to tractors is animal traction.

Shapiro: It does concern me that objective 3 is very broad and really beyond the resources that would be available to this project; establishment of milk collection centres, increasing milk processing units, artisans involved in manufacture of tools and equipment for cow traction, and increasing training of farmers and blacksmiths. We do not really need new equipment to use cows for traction.

Esele: Previously, milk collecting centres were operating throughout the country but now they are operating only in the west of the country. If we introduce crossbred cows in other parts of the country we need to re-establish these milk centres.

On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems of Tanzania

A. Context

1. Description of the subsector

In mainland Tanzania the cattle herd was slightly over 12 million head by 1988 (MALD), of which 95% was in the traditional sector. These are mainly the indigenous Tanzania Shorthorn Zebu (TSZ) cattle, the main source of milk and traction power for the smallholder. Indigenous cows produce 93% and grade cows 7% of the total milk consumed in Tanzania (Msechu 1988). In 1984 the estimated population of working animals was over one million, of which about 840,000 were oxen and 220,000 were donkeys (MALD 1984). The working animals are concentrated in those areas with higher cattle populations. Mgaya et al (1992) conducted a preliminary survey in seven regions of Tanzania involving 100 oxen-using farmers. The results of their work showed that 64% of the respondents bought all of their working animals, 26% inherited and 10% acquired them in both ways. Most animals were put to work between two and five years of age and the working period was up to 10 years. Animals worked for about five hours a day and most animals lost condition during the working period. Thirty-four per cent of the respondents supplemented their animals. The animals were neither slaughtered nor eaten by the household.

Dodoma and Singida regions in central Tanzania together have approximately 90,000 working cattle and 53,000 donkeys (MALD 1984). Oxen are the main source of traction power for different agricultural and household operations. About 1% of all the farmers in the regions use traction power and between 50 and 90% of them use the ox plough for cultivation (Anon 1993; Rushalaza and Goromela 1993). Recently ox-drawn weeders have been introduced in Singida to solve the problem of labour shortages during periods of weeding (FAO/SIDA project). Work done in the southern highlands of Tanzania, i.e. Mbeya and Rukwa regions (Kwiligwa et al 1992; Lecca et al 1992) has shown that labour was saved and there was improvement in maize production when ox cultivators were used, and the yield of rice increased when ox drawn puddlers were used. In central Tanzania, the eviction of all livestock including oxen and donkeys in villages within the area of a soil conversation programme known as Hifadhi Ardhi Dodoma (HADO) in 1979 created traction power problems. However, improved, or grade, cows are being introduced for the smallholders to solve the milk shortage. The advocated management is zero grazing. The population of smallholders owning improved cows is increasing.

2. Host country strategy

Both peri-urban and rural small-scale dairy farming are expanding rapidly to meet the high demand for fresh milk. Cross-breeding to improve the genetic potential of TSZ for milk production and promotion of animal traction to increase crop production are the strategies of the Tanzania government. Various genotypes of grade cows are produced in research parastatal farms and by non-governmental organisations (NGOs) for the smallholders to buy. The National Institute for Livestock Production Research at Mpwapwa in central Tanzania is the leading centre in the country involved in research on dairying and feeding systems for cattle. The focus is on the smallholder farming systems. In December 1994 the Central Zone Research Priority Setting Workshop identified animal traction as among the main priorities in improving farm productivity.

3. Prior or ongoing assistance

Collaborative efforts in distributing crossbred cows and animal traction implements to smallholders is being done by various institutions. For example in Dodoma region, the Swedish Agency for Research Co-operation with developing countries (SAREC), Heifer Project International (HPI) and the Livestock Production Research Institute (LPRI), Tanzania, distribute crossbred heifers to farmers. The FAO (Food and Agriculture Organization of the United Nations)/SIDA (Swedish International Development Authority) project is introducing ox weeders to Singida smallholders while the Anglican church is involved in distributing ox ploughs to farmers.

The objective of the Ministry of Agriculture (MoA) and NGOs is to increase farm productivity and incomes of smallholders. The National Agriculture and Livestock Research Programme (NALRP) has put great emphasis on production, introduction of improved cattle to smallholders and animal traction power utilisation.

4. Institutional framework for subsector

Currently, the input and output markets, essential support services and policy environment are conducive. There is an assured supply of traction inputs/implements and demand for outputs.

B. Project justification

1. The problem to be addressed: The present situation

1. a. Agrotechnological

The traditional hand hoe used by smallholders produces the bulk of agricultural output of the country. In a mixed crop/livestock farming system, the problems identified include draft power utilisation and labour shortage. Draft power technology is not traditional in most parts of the country; there is limited use of oxen and donkeys in ploughing, weeding and transportation. The draft animals in Tanzania are small in size and slow maturing and their traction capability is limited by size and feeding. These animals are few in most villages and hiring draft power is becoming increasingly expensive especially for resource poor farmers.

The zero grazing system using improved cows in smallholder farming systems has led to manure accumulation in households. Improved bulls are not used for traction because they are used for breeding.

In areas with soil conservation programmes, despite adequate crop residues, shrubs and fodder trees, plus by-products from small agro-industries, improved cows are purely for milk and calf production. The idea of extending their use for traction is not known to the smallholder farmers. Cows in confinement in the HADO (Hifadhi Ardhi Dodoma, Dodoma Soil Conservation Programme) project area are for milk production only. The eviction of oxen in HADO areas in the dry season has made hauling manure to the farm plots difficult and consequently has reduced farm productivity.

Availability of crop residues, shrubs and fodder trees will be used effectively for reproduction, milk production and traction in dairy cows. Lack of awareness on use of cows on traction could be the main reason for not using them.

1.b. Biophysical

In Tanzania, like in any other country in sub-Saharan Africa, demographic growth rates have increased pressure on natural resources. Exploitation of the natural resources for fuel wood and crop and livestock production without restoration, is a threat to the survival of both animals and plants. The current farming systems in Tanzania are not sustainable as farmers exploit more natural resources than can be replenished through afforestation programmes, recycling the nutrients and appropriate land use policies. The study area (Dodoma and Singida regions), carries approximately 15.5% of the nation's grazing cattle population. A high population of grazing livestock, together with other factors, has contributed to severe land degradation in some areas.

In 1979 the HADO project was started with the aim of reclaiming land and restoring soil fertility. This led to the forceful eviction of grazing livestock and the re-introduction of not more than four improved or local cattle per household under zero or restricted grazing. High agricultural potential areas face increasing land fragmentation and population pressure. Soil fertility is decreasing because there is less manure available to apply to the land.

1.c. Institutional

The collaborative effort of smallholder farmers, research and extension personnel has led to the identification of problems in various farming systems. Implementation of field activities to improve the farming systems is the current thrust. Rehabilitation of the extension and research system through the efforts of the Government of Tanzania (GoT) and various international agencies is in progress aiming at improving the agricultural output.

1.d. Socio-economic

High demographic expansion and rural emigration are among the problems of developing countries. These reduce agricultural land and deprive the rural areas of the required labour force. The consequences of urban inertia in developing countries are a negative thrust towards economic growth of the country.

Successful introduction of crossbred dairy cows to smallholder farmers in the rural areas requires adoption of new complementary technologies, but these technologies are either inadequate or lacking. The present feeding system of crossbred cows using the cut-and-carry system is labour intensive. For example, in the HADO areas of Dodoma, farmers spend about 2100 hours/animal per year, of which 690 hours/year are used for fetching water and 870 hours/year for collecting fodder (Hotland 1993). Despite the difficulties in managing crossbred cows under confinement, farmers with improved cows were wealthier than those with local cows and entirely dependent on crop production (Hotland 1993).

Milk production in the HADO areas has not been sufficient to meet the nutritional demand of children, pregnant women and nursing mothers. Lack of transport to carry manure has reduced farm yields. However, the positive effect seen in these areas is diversification of agricultural activities which has included keeping improved dairy cows. The system has been ecologically friendly.

1.e. Project goals

This project aims at introducing, testing and promoting crossbred cow traction to the smallholder mixed farming systems.

The multiple use of crossbred cows will reduce pressure on the land by reducing the number of animals kept on farm. The crop/livestock farming system will be sustainable if crossbred cows are used to produce milk and calves and for traction. The incomes of resource poor farmers will be increased through increased farm productivity. Increased milk production is also expected to have a significant effect on the nutritional status of resource-poor farmers.

The speed at which this takes place will depend upon the smallholders realising that keeping both specialised draft animals and improved cows is relatively uneconomical. Improved feeding systems which include supplementation with crop residues and concentrates will maintain reproduction, production and traction. Importation of work animals for ploughing, weeding, transportation of farm produce and manure in the closed areas will not be necessary, and thus the risk of importing diseases to improved cows is eliminated.

The project in the first phase will involve 40 smallholder farmers.

2. Expected end-of-project situation

The project will be located in areas where oxen are currently used by farmers as work animals and where crossbred dairy cattle are available or are known in the rural communities. Field operations will involve 40 resource poor farm households that presently only have local cattle and use work oxen. Livestock performance results will show a stable herd size which contributes substantial amounts to sales as well as animal power and manure to farm operations and farm outputs.

3. Target beneficiaries

Direct beneficiaries will be project farmers and their families and local project staff.

Indirect beneficiaries: neighbouring farmers, individual or organised groups participating in the technology transfer. Artisans, traders and businessmen, small-scale farm produce processors which either individually or in organised group will participate in information/extension meetings and gradually adopt recommendations derived from the technical approach encouraged by the project.

4. Project strategy and institutional arrangements

The dairy cow traction technology will be tested using a standardised protocol as required by the regional headquarters. This includes things like supply of crossbred cows, their harnesses and equipment, training of technical staff, farmers and animals plus livestock management instructions.

Government services dealing with livestock production research and extension activities and farmers organisations will assist the project by providing the logistical support required to implement field interventions.

There will be close contact with the regional headquarters which will give technical direction and administrative management instructions for project operations.

5. Reasons for assistance from donor

Despite the contribution of traditional work animals (mainly oxen and donkeys) in the selected areas, the demand could instead be met by including crossbred cows. The use of cows for traction is a new technology in the area. There is need to share experience from ILRI which has developed and tested the cow tradition technology in Ethiopia. The farmers and research and extension services are aware of the problems of animal traction, but those services do not currently have sufficient numbers of qualified staff or material resources. The field testing of this promising technology will occur at the farm level with direct participation of national research and extension programmes and selected farmers. The technical interventions would be executed collaboratively by FAO and ILRI. These development objectives will be supported financially by a donor.

6. Special considerations

The introduction and sustainability of cow traction technology in smallholder farming systems will have to consider the willingness of the recipients to change their perception in a positive sense. The technology will not reduce the expectations from their animal(s). Cross-breeding will be maintained while production and distribution of improved cows will continue. The technology will create opportunities for the private sector to manufacture and market appropriate farm implements for the technology. The smallholder will maintain the requirements of a working cow. Study tours, workshops and seminars for project participants will facilitate fast adoption of the technology.

7. Co-ordination arrangements

The Commission of Research and Training (CRT) in the Ministry of Agriculture (MoA) through its zonal centre—Livestock Production Research Institute (LPRI), Mpwapwa—will spearhead the work. The Farming Systems Research (FSR) unit of LPRI will assist on-farm introduction and testing of the technological packages. The project will be implemented in collaboration with FAO/ILRI.

Counterpart support capacity

Collaborative implementation of the project in the country: LPRI, Mpwapwa, will provide the project co-ordinator, scientific and support staff for on-farm activities. Since the project is farmer participatory and researcher managed, field enumerators for monitoring will be provided by the project. The research team will continue monitoring the farmer-managed adoption stage. The extension service will spread the technology to non-project villages.

C. Development objective

The development objective of the project is to support agricultural and household activities of the smallholder. Cow traction could have a significant impact on food production, appropriate management and use of land, and human and animal resources, while at the same time raising the income of farmers through sales of surplus farm produce. Human nutrition will be improved from consumption of milk.

The adoption of the crossbred cow traction technology by the smallholder will promote the sale of more crossbred heifers to smallholders. The technology is sustainable in mixed crop/livestock production systems, more so in fragile areas and good agricultural land affected by fragmentation.

D. Immediate objectives, outputs and activities

Transfer of management practices and new technologies for the multi-purpose use of crossbred dairy cows by smallholder farmers.

1. Immediate objective 1

Adoption of dairy cow traction technologies (DCTT) at smallholder farm level.

1.1 Output 1: Test sites located and participating farmers identified and selected.

Activities

1.1.1 Verification of conditions in proposed locations regarding field testing DCTT

1.1.2 Presentation to smallholder farmers and collaborating partners of the objectives and benefits of DCTT

- Preliminary Field Results from Ethiopia and video presentation
- Demonstration of DCTT
- Evaluation sheet to record interest and doubts of participants

1.1.3 Selection of farmers and verification of commitment and needs

1.2 Output 2: Monitoring and evaluation scheme in place for field testing DCTT.

Activities

1.2.1 Appointment of full time project staff to the monitoring and evaluation (M&E) scheme; permanent assignment of working facilities

1.2.2 Prepare M&E material; methodological manuals

1.2.3 Purchase of office and field M&E equipment

1.2.4 Training of M&E staff on project procedures for M&E

1.2.5 Information meeting with collaborating institutions and farmers

1.2.6 Training of collaborating staff and farmers on project procedures for M&E

1.2.7 Establish schedule of periodical M&E visits to farmers for data collection, storage and processing. Keep data bank up to date

1.2.8 Prepare monthly data reports for technical analysis required by project management

1.2.9 Special agreement to secure transport facilities:

(a) Subcontract transportation support

(b) Allocation of equipment: Type

Operating: Fuel
Oil
Service
Spare parts

1.3 Output 3: Training to achieve increased cow output (work, surplus milk and calf production) and farm productivity.

Activities

1.3.1 Training of cows for traction

1.3.2 Technical training of participating farmers in use of:

- feed resources: crop residues
- harnesses
- implements
- manure use

1.3.3 Training participating farmers in the use of cows for traction

1.3.4 Supervision of barn construction by participating farmers

1.3.5 Training of participating farmers in forage production

- fertiliser
- seeds
- plant protection
- fodder crops/trees

1.3.6 Training of participating farmers in construction of infrastructure:

- sheds
- barns
- stores

1.3.7 Training of participating farmers in management of cows:

- water harvesting, storage and daily watering
- maintenance of barns
- cleaning of animals
- feeds and feeding: fodder and supplements
- animal health and inputs
- reproduction inputs: bull service and AI

1.3.8 Training of project farmers in dairy production:

- proper milking procedures

- proper feeds and feeding
- reproduction: health, draft animal power (DAP) technology and dairy production

2. Immediate objective 2

Improvement, where necessary, of rural based support systems to ensure supply of production components and to market products derived from DCTT operations.

2.1 Output 1: Mechanism in place for supply of production components required for field testing of DCTT.

Activities

2.1.1 Provision of institutional facilities by project:

- infrastructure: implementing, collaborating
- equipment
- implements
- materials
- animals

2.1.2 Allocation of existing production components by farmers

- infrastructure: sheds, barns and stores
- land: natural grasslands
- animals
- feed resources: crop residues
- harnesses
- implements
- manure

2.1.3 Purchase of production components and improvement of infrastructure, implements, equipment by farmers

- infrastructure
- implements
- feed resources: fodder and supplements
- fertiliser
- seeds
- plant protection
- animal health inputs
- reproduction inputs: bull service and AI

2.1.4 Arrangements with suppliers of production components:

- subcontract input supplies: seeds, fertilisers, chemical products, implements and other materials
- subcontract on-farm services: reproduction and health

2.1.5 Purchase of field testing equipment and operating materials (by project)

2.1.6 Arrangements for loan applications for production components

(a) From local credit system

(b) From project revolving fund:

Seeds
Fertiliser
Animals
Implements

2.1.7 Field supervision: annual schedule

2.2 Output 2: Mechanism in place for marketing of products derived from activities testing of DCTT.

Activities

2.2.1 Meetings with farmers and potential collaborating agencies:

- assess interest for added value of milk processing

2.2.2 Training of participating farmers: dairy technology, organising farmers groups, rural mini-processing unit.

2.2.3 Farm elements to be improved or purchased:

Infrastructure
Equipment
Materials

2.2.4 Marketing arrangements for surplus milk:

On-farm storage: churns
Milk and dairy product collection
Commercial arrangements

2.2.5 Arrangements for loan applications for dairy processing and on-farm storage

2.2.6 Field supervision: annual schedule

E. Inputs

1. Government inputs

MoA (36 months duration):

- salaries to research and extension staff
- veterinary services
- scientific support
- CARMATEC Arusha, Mbeya Oxenization Project will produce and sell farm implements to project
- cross-breeding at Zonal Research and Training Centre (ZRTC), Mpwapwa, to produce crossbred cows for sale to project farmers
- transport for project officers.

2. Non-governmental organisation (NGOs) inputs

- provide crossbred heifers to project farmers, e.g. Heifer Project International (HPI).
- provide animal drawn implements.

3. Donor inputs

- consultancies and training, technical assistance
- laboratory equipment/reagents, vehicle and running costs
- meetings and workshop
- computer software
- feed and milk laboratory analysis facilities for nutritive values and progesterone (ZRTC), Mpwapwa.

F. Risks

- insufficient and untimely delivery of inputs: Government and Donors
- lack of interest among smallholder farmers to share part of the risk in testing the new technology
- supply problems in crossbred cows, harnesses and equipments
- insufficient feeds to ensure adequate management standards.

ON-FARM TESTING OF MULTI-PURPOSE CROSSBRED DAIRY COWS FOR MILK, MEAT AND DRAFT WORK IN SMALLHOLDER FARMING SYSTEMS

1.1. Project budget covering government contribution in kind (US$)

Country: Republic of Tanzania

Project Number:

Project Tittle: On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems

		1997 staff months	1997 US$	1998 staff months	1998 US$	1999 staff months	1999 US$
1.0	PROJECT PERSNNEL						
1.1	National Project Director						
1.2	National project staff (full-time)						
1.2.1	Animal Health and Management Specialist	12	720	12	740	12	760
1.2.2	Agricultural Economist	12	380	12	400	12	420
	Component Total		1100		1140		1180
2.0	TRAINING:						
2.1	Maintenance of trainees' salaries						

3.0	EQUIPMENT:	320	320	340
3.1	Equipment	300		
3.2	Supplies		300	300
3.3	Premises	Available	Available	Available
	Component Total	620	620	640
4.0	GRAND TOTAL	1720	1760	1820

1.2 Project budget covering donor contribution (US$)

		1997 staff months	US$	1998 staff months	US$	1999 staff months	US$
10.	PROJECT PERSONNEL						
11.	International experts						
11.01	Regional Co-ordinator	2	24,000	2	24,000	2	24,000
11.02	APO	12	–	12	–	12	–
11.03							
*11.49	Subtotal experts		24,000		24,000		24,000
11.50	Consultants						
11.51	Animal Scientist	0.5	4,000	0.5	4,000	0.5	4,000
11.52	Agricultural Economist	0.5	5,250	0.5	5,250	0.5	5,250
*11.53	Subtotal: experts/consultants		9,250	9,250	9,250		
12.0	OPAS experts						
12.01							
12.02							
12.03	Subtotal OPAS						
13.	Administrative supports						
13.01	Personnel	2	2,250	2	2,250	2	2,250
13.02	Regional Administrator	2	1,000	2	1,000	2	1,000
13.03	Secretary	2	667	2	667	2	667
*	Driver		3,917				3,917
	Subtotal administrative support						
14.	Duty travel (Regional)		4,666		4,666		4,666
	(In-country)		3,000		3,000		3,000
15.	Mission costs		2,666		2,666		2,666
16. *	Personnel component total		47,499		47,499		47,499
17.	SUBCONTRACTS						
18.	Subcontract X National Programme Field support						
18.1	Four-wheel drive vehicle	from sales of crossbred cows					
18.2	Motor cycle		2,000				
18.3	Bicycles		–		6,500		
18.4	Veterinary inputs (drugs, vaccines etc)		2,000				1,000
18.5	On-farm structures		1,000		–		

19.	Subcontract Revolving fund administration			
19.1	Purchase of crossbred cows	60,000	–	
19.2	Traction implements	5,220	–	
19.3	On-farm input supplies (seed, fertilisers, chemicals)	from sales of cows	–	–
19.4	Purchase of animal feeds	3,000	–	–
*	Component total	73,220	7,500	1,000
20.	TRAINING			
21.	Fellowships			
21.01	PhD	12 27,000	12 26,000	12 15,000
21.02	MSc			
*	Component total	27,000	26,000	15,000
22.	Study tours/group training			
22.01	In country	4,000	3,000	2,000
22.02	Regional	5,100	5,100	5,100
22.03	In service training (veterinary AI, forage)		2,000	2,000
*	Component total	11,100	10,100	8,100
23.	EQUIPMENT/CHEMICALS/ REAGENTS:			
23.1	Expendable equipment/ chemicals	6,000	5,000	3,000
23.2	reagents	15,000	4,083	3,500
23.3	Non-expendable equipment Computers (laptops 2, desktop 1, printers —desktop 1, portable 1)	5,500	5,500	–
*	Component total	26,500	14,583	6,500
27.	MISCELLANEOUS			
28.	Operation and maintenance cost of equipment	5,000	6,000	5,000
29.	Reporting cost	1,330	1,330	3,000
30.	Sundries	1,000	1,000	1,000
*	Component total	7,330	8,330	9,000
*	GRAND TOTAL	192,649	114,012	86,099

2. General inputs/activities to be considered

2.1 INFRASTRUCTURE	Number of interventions	Number of people	Equipment	Materials	Provider
2.1.0 Institute (LPRI)					
Offices	3 rooms/offices	3 project staff	3 sets of furniture	–	GoT
Centres	Kondoa District extension office	village (extension workers)			
Laboratory	Available Nutrition laboratory			–	

2.1.1 Farm					
Old structures	Improving farm structures of the co-operating farmers including fodder storage structures	40	Building materials		Farmers
New structures	1 cow training structure		Building materials		Donor
2.2 ON-FARM INPUTS					
Fodder seeds		40	600 kg of grasses and legumes	–	Donor contribution
Existing crop residues		40 project farmers	Depending on feed level	18,000 kg of concentrates	Farmers
Agricultural by-products	As per recommended health packages		spray pumps	Acaricides	
Health inputs		40	40 syringes		
Traction implements			40 yokes		
			40 plough	Antibiotics/ vaccines	Farmers and Donor
2.3 EQUIPMENT/ MATERIAL/ ANIMAL					
Oilseed pressing hand-driven machines		40	40		
Animals		80	–	80 in calf	Donor
2.4 TRANSPORT SUPPORT					
Four-wheel drive vehicle	1		1 Toyota double cabin		Donor
Motor cycle	1		3 Motor cycles (250 cc Honda)		
Bicycles		10			
Operating inputs (diesel, oil, petrol)	Field trips per year		Four-wheel vehicle	diesel, oil, petrol	Donor
Servicing vehicle and motor cycles	Various				
2.5 LOAN REQUIREMENTS					Donor
Spraying pumps		40			
Draft implements		40			
Animals	1	40			
2.6 RECORDING SYSTEMS					
Computers		2	2 laptop,		

Printer Software Stationery	 Various Various	1	1 desktop computers; 1 laser printers, 1 portable (Bubblejet) printer		Donor
2.7 TRAINING AND DEMONSTRATION Technical staff Farmers		3 officers 10 field enumerators 40 farmers			Donor
Study tours		Project staff		Stationery	Donor
Seminars Field days	 Twice per year starting second year	Project farmers extension and scientific staff (50 people) Project farmers neighbouring farmers extensionists researchers		Stationery Stationery Fuel (diesel)	Donor Donor and GoT
2.8 MEETINGS		Project staff	Audio-visual aids Vehicles	Stationery Fuel	Donor
2.8.1 Information pre-intervention		Project farmers extention workers			
2.8.2 Post-intervention analysis		6 project staff project farmers	Computers Vehicles	Stationery Fuel	Donor
2.9 REPORT AND PUBLICATIONS	Report quarterly publications	Project officers	Computers	Stationery	Donor

Discussion on Tanzania proposal

Zerbini: I have a few comments about the immediate objectives that you have listed. They need to be consolidated. In immediate objective 1, you propose investigating the utilisation of animal traction for various farm operations. I think this should not be an objective of this project. In immediate objective 2, you have included reduction of reproductive wastage. This is a general objective that should be in place with the existing extension system. However, when cows are used for both milk and traction the reproductive issue should be looked at in more details.

Singh: Your main objective is cow traction. Are there any opportunities for increased tractorisation in that particular area at some stage in the future that are likely to affect your strategy?

Maiseli: I think mechanisation is unlikely to happen. It is exceedingly expensive at the moment for the smallholders to use a tractor (US$ 10/ha, which is too expensive for these resource-poor farmers).

Zerbini: What is the extent of veterinary services and forage production extension services in the area where you intend to implement this project?

Maiseli: It is very good. Veterinary infrastructure is good, general extension is effective and farmers are encouraged to grow improved grass and legumes as supplements to their cows.

Shapiro: What is the marketing situation in this area for milk and dairy products?

Maiseli: I think that what the farmers are producing is consumed within the village.

Shapiro: Are you convinced that there is an adequate feeding system that will provide enough feed for these cows to work and produce milk?

Maiseli: We are sure because there are maize and groundnut crop residues and agricultural by-products from processing oilseeds.

Shapiro: I still believe you need an immediate objective for improving the existing feeding system.

Maiseli: We will have to determine under our own conditions whether the increased requirements of the milking/working cow can be met with more of the existing feed or with provision of better quality feed.

Shapiro: How much milk are cows producing now?

Maiseli: Between 8 and 10 litres per day.

Ulotu: Some of our visitors have pointed out that farmers are overfeeding these crossbred cows and therefore more exercise through work will benefit them.

Zerbini: Are there any major cultural impediments towards the adoption of this technology?

*Maiseli:*Even though there will be cultural resistance, this is an area with greater chances of successful adoption because at the moment the need for animal traction is high and there is little possibility for traditional draft technologies with oxen.

On-farm testing and transfer of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems of Malawi

A. Context

1. Description of the subsector

The livestock industry of Malawi comprises a large traditional sector and only a small, but important commercial sector. About 96% of the nation's cattle are found in the traditional sector. Of about one million cattle in Malawi only one-tenth are dairy cattle, the majority of which are Malawi Zebu. The dairy subsector is therefore not fully developed. Dairy production has been lagging behind demand, and milk consumption in Malawi is critically low: just 6.6 kg per capita per year compared with 85.2 kg in Botswana and 286 kg in Zimbabwe. In 1990, milk production was estimated at 46,000 t, about 70% of the milk and milk products consumed.

The demand for milk and milk products in Malawi still remains unsatisfied. This is exacerbated by the increase in human population, which is currently estimated at 10 million people and growing at 3.3% annually. In an effort to meet the ever-increasing demand for milk, the government is supplementing the current milk production with imported constituted powdered milk. For example, in 1990/91 Malawi Dairy Industries (MDI) imported 578,148 kg of powdered milk and 96,097 kg of butter (MDI 1991). This was a big drain on the country's economy.

2. Host country strategy

Milk and milk products have an important place in the Malawian diet as they are an important source of animal protein. The policy of the government is to be self sufficient in milk and milk products so as to alleviate problems of malnutrition. The government is now trying to justify dairy development as a component in the domestic diversification programme. This justification is based on a low and declining cattle population in the country, a sizeable unmet demand for milk and milk products, and the potential of this activity in providing a sustainable source of income to smallholder farmers.

The cattle population in Malawi is estimated at one million, the majority of which are the zebu type. Although the Malawi Zebu is well adapted to the tropical environment of the country, its genetic capacity for milk production is low.

Thus the dairy subsector in Malawi is based on a cross-breeding programme that involves crossing the Malawi Zebu cows with Friesians (using semen or bulls). The crossbred cows (Malawi Zebu × Friesian) are sold to smallholder farmers. The Ministry of Agriculture and Livestock Development (MoALD) has three departments that are involved in the operations of the dairy subsector. The Department of Agricultural Research (DAR) is concerned with research in dairy breed evaluations and nutrition (feed development and improvement and development of feeding systems); the Department of Animal Health and Industry (DAHI) is involved in multiplying livestock species (dairy cattle and other species) for sale to farmers and providing disease control and artificial insemination (AI) services; and the Department of Agricultural Extension and Training (DAET) is involved in providing extension services to farmers.

The cornerstone of the dairy strategy is to expand and improve the national dairy herd by expanding AI services in order to up-grade the local dairy cattle. The strategy is being implemented by a smallholder dairy scheme in the three milk-shed areas which supply milk to the Blantyre, Lilongwe and Mzuzu dairy plants operated by the Malawi Dairy Industries (MDI). Future plans are to promote mini-dairies in the rural areas to provide milk and milk products to places outside the milk-shed areas. The government will determine the feasibility of smallholders forming clubs, associations or co-operatives for establishing dairies capable of pasteurising milk, acquiring semen or bull service for upgrading their herds, and collecting and transporting milk. Larger smallholders and estates will be encouraged to improve existing pastures and establish improved grasses and legumes. For smallholders with limited land, zero grazing is being promoted.

3. Prior or ongoing assistance

This project will be a collaborative effort of the Department of Agricultural Research (DAR), the Department of Agricultural Extension and Training (DAET) of the Ministry of Agriculture and Livestock Development (MoALD) in Malawi and the International Livestock Research Institute (ILRI). In the past, major collaborative efforts between DAR and the International Livestock Centre for Africa (ILCA, now ILRI) have been in areas of pasture germplasm exchange, animal feed resources and cattle research through networks.

ILRI, in collaboration with the Ethiopian Institute of Agricultural Research (IAR), has developed a technology package for the use of crossbred cows for milk, meat and draft work. These technologies can make an important impact on the productivity, sustainability and incomes of smallholder farmers. Funding for this proposed project will assist in testing and transferring these technologies in smallholder farming systems in Malawi.

The objective pursued by ILRI since 1984 has been to increase and sustain agricultural production and incomes in smallholder farming systems. Studies carried out under ILRI programmes have identified the need to intensify and diversify the use of draft animals in order to increase their contribution to farm economy. High priority has been given to developing practical means of increasing the quantity and quality of feed resources, and to optimum use of feed resources produced on-farm. ILRI continues its support to the crossbred dairy cow traction scheme and is initiating on-farm testing of this technology in a joint effort with countries in eastern Africa.

4. Institutional framework for the subsector

Government, parastatal and private institutions play significant roles in strengthening the operational capacity of the dairy subsector in Malawi.

MoALD, through its three departments (DAR, DAHI and DAET), is making efforts to improve the institutional framework of the dairy subsector through the following actions.

Government sector

DAR. Livestock research will continue to improve the genetic potential of indigenous livestock (Malawi Zebu) by selecting and cross-breeding with suitable exotic species for milk production. Attention will be paid to the development of nutrition and management strategies for different dairy production systems. Research on developing methods of managing pastures, and selecting superior grass/legume forage mixtures that can improve the productivity of both livestock and soil will continue.

DAHI. MoALD will encourage collaboration between DAR and DAHI in the development of suitable disease and parasite control regimes and in strengthening the multiplication of crossbred cows for sale to farmers and improving the artificial insemination (AI) services.

DAET. DAET will improve extension delivery systems and provide specialised training in dairy production systems. Extension will also cover the integration of animal and crop husbandry in farming systems.

Parastatals and private sector

There are two institutions involved in the promotion of the dairy subsector in Malawi: the Malawi Dairy Industries (MDI) and the Livestock Feed Industry Sector.

Malawi Dairy Industries (MDI). This parastatal organisation is involved in buying milk from farmers, processing the milk in its three dairy plants (Blantyre, Lilongwe and Mzuzu) and selling the processed milk and milk products.

The Livestock Feed Industry Sector. A reliable and efficient concentrated feed industry is critical for the development of the livestock industry. An important feature of the crop diversification strategy is the production of increased quantities of maize, sorghum and cassava to provide yields above human requirements. These commodities, along with the bran from cereals, should provide a very good energy base for feed formulation. Similarly, with the development of the oil seed sector and cotton expansion, the increased availability of cottonseed meal and soyabean meal should provide the protein base for concentrated animal feeds. With increased availability of the two basic raw materials for concentrated animal feed production, the private sector will be encouraged to invest in this important sector for the promotion of livestock development.

B. Project justification

1. The problem to be addressed: The present situation

1.a. Agrotechnological

The agriculture and livestock sector is the backbone of Malawi's economy. It employs over 80% of the economically active population and accounts for more than 35% of the gross domestic product (GDP).

The sector contributes significantly to foreign exchange earnings; it generated 92% of the export earnings in 1992. With these significant contributions to the economy, successful agricultural and livestock development is of strategic importance in ensuring the sustainable development of the country.

At present cultivation is carried out by hand, animal or tractor depending on the scale and intensity of the farming operation. The majority of farmers (80%) use the hand hoe and animal drawn implements to produce food crops while estate farmers (20%) use tractors to produce cash crops. The total number of cattle is about one million and that of donkeys is approximately 1700 (Kumwenda 1991). Cattle and donkeys are the only animals commonly used for draft power (Kumwenda 1987). In Malawi, where human population is high, the best type of mechanisation would be that which would augment labour and create more jobs. This would increase productivity in rural areas and solve the most critical farm problems of land preparation and weeding which, when not properly done, are responsible for low yields. Human power by itself is not enough to make a significant impact on agricultural productivity. Cultivated land and crop yields are limited by the slow pace of hand cultivation and to date, the cattle used for animal power are oxen.

Work oxen are only used for cultivation and transportation and later as meat. Malawi Zebu cows and crossbred dairy cows have not been used for draft work in Malawi. Research on the use of Malawi Zebu cows for draft gave encouraging results. Therefore the multi-purpose use of crossbred cows for milk, meat and draft work would be a welcome technology in Malawi.

In the Lilongwe Agricultural Development Division (ADD), mixed-farming, which integrates and intensifies crop/livestock/tree production activities to increase overall productivity, is being encouraged. Farmers are growing a variety of crops such as maize, groundnuts, beans and tobacco.

Crop residues, shrubs and fodder trees plus by-products from agro-industries are being used as livestock feeds in the area. If properly used, these resources can ensure adequate sales from livestock and animal products, plus draft power for tillage and transport, and for the recycling of nutrients through manure. Adequate off-farm support is required for timely and effective cropping operations, rational livestock management, adequate supplies and service in terms of harvesting and equipment, for cottage manufacture, village processing of products and for marketing schemes for farm produce and farm inputs.

1.b. Biophysical

The high human population growth rate (3.3% per annum) in Malawi has put pressure on land, food requirements, energy and social services. The consequences of these have led to declining soil fertility and deforestation resulting in loss of plant cover that has facilitated soil erosion.

1.c. Institutional

Agricultural research is considered successful only if the knowledge it produces can be translated by the extension services into messages which farmers are willing and able to adopt. This can be achieved only with good linkages and collaborations between research, extension and the farmer.

MoALD has put in place some actions in order to improve linkages among institutions and collaborative efforts in Malawi. One such an action is to ensure adequate funding for technology generation and transfer. This will be done by establishing a strong linkage between policy makers, research workers and the extension service. MoALD is also encouraging research scientists and extension staff to conduct surveys to determine the current socio-economic circumstances of farmers. This will help set priorities and involve the farmers in the process.

This proposed project will involve collaboration between MoALD's departments (DAR, DAET and DAHI) and ILRI.

1.d. Socio-economic

The drudgeries of farming are forcing the rural young to migrate to urban areas. This is progressively weakening contributions made by agriculture to the national economy. Immigration to cities with inadequate urbanisation facilities and limited job offers increases urban unemployment. Demographic expansion, especially within cities, leads to food supply problems, increase in import bills and even higher levels of foreign debt.

The successful on-farm testing of crossbred cows for milk, meat and draft work in the Lilongwe ADD will require adoption of new complementary technologies on-farm, including improved management, feed production, feeding and traction systems.

Crossbred cows have to be fed better than local animals to perform better. In dairy producing areas of Malawi, grazing and crop residues have been the traditional feed resources for dairy cattle. The government is encouraging the development of improved management techniques for natural and exotic pastures and sustainable agroforestry and livestock farming systems.

1.e. Project goals

This project aims to promote the testing of crossbred cows for both milk and draft in smallholder mixed farming systems in the East African highlands by developing and transferring complementary high-productivity feed production, feeding, draft and management strategies. The use of crossbred dairy cows in place of oxen for traction would result in a more efficient use of available feed resources by decreasing the number of animals kept on-farm. These lower stocking rates would alleviate overgrazing and create a more productive and sustainable farming system with better management of the natural resource base.

The Lilongwe ADD is one of the major agricultural production areas in the country. It has a reasonable land size that can support the cows. Some farmers in the area already keep crossbred cows for milk production and local oxen for draft power while others keep local cattle for both meat and draft. There is infrastructure (Grain and Milling Company) in place for supplying supplementary feed and it is within the reach of farmers. Farmers currently owning Malawi Zebu cows can therefore replace these with crossbred dairy cows without fear of difficulty in management.

The dual use of crossbred cows will increase milk and meat production substantially, while at the same time and with the same resources satisfying the need for draft power. The number of oxen (used for cultivation and transporting farm produce from fields to homesteads and to markets) and the number of cattle kept to breed replacement oxen could also be reduced. More productive, smaller herds will release capital and feed resources to achieve more sustainable production systems, higher incomes and better nutrition within a three-year period. Increased milk production is also expected to improve the nutritional status of the rural poor.

All these benefits accruing from the successful testing of crossbred cows in the Lilongwe ADD in Malawi will require complementary improved management practices, including new feed production, feeding and traction systems being adopted on-farm.

Currently, only oxen and, in some cases, donkeys are used for draft purposes in the study area.

At the end of the proposed project, the project farmers will have adopted the following technologies:

1. Replacement of at least two oxen and two local cows with two crossbred cows.
2. Construction of a barn for the crossbred cows.
3. Use of crossbred cows for traction to plough at least half of the land on average.
4. Cultivation of Rhodes grass (Chloris gayana) and stylo (Stylosanthes guianesis) on 0.6 ha for feeding as cut-and-carry or as hay.
5. Purchase and feeding of at least 2 kg dairy mash (concentrate) per day per cow during lactation and work periods.

The project will involve 100 resource-poor farm households currently owning local cattle and oxen.

2. Expected end-of-project situation

Results obtained from pilot areas of the project in the Ethiopian highlands indicate that the technological package has been adopted by the majority of the collaborating farmers. Overall farm output has been increased, mainly on account of better management of farm resources and some strategic inputs and services provided by off-farm services. It is expected that the same results would be obtained with farmers in the Lilongwe ADD in Malawi.

3. Target beneficiaries

Direct beneficiaries: collaborating farmers and their families plus local project staff.

Indirect beneficiaries: neighbouring farmers and their families, villagers, artisans, traders and businessmen, small-scale farm produce processors who either individually or in organised groups will participate in information/sensitisation meetings and gradually adopt technical messages derived from the technical approach encouraged by the project.

While this technology has the potential to benefit all the members of poor rural households both in terms of income and nutrition, the intra-household consequences including labour costs have yet to be studied to ensure a positive impact on all family members.

4. Project strategy and institutional arrangements

The implementation strategy relies on the participation of the selected farmers during the on-farm validation process of the proposed technology. This means that even though the project is willing to share a large part of the inevitable risks of agricultural operations (traditional or new), the farmer must assume responsibilities as a partner under a properly defined commercial contract. This legal instrument will facilitate the expansion of the scheme once positive validation results are confirmed and local institutions follow up management responsibilities.

Before the proposed project starts, training sessions will be held for selected participating farmers. DAR, DAET and farmers' clubs will assist the project in its training programme and provide the logistical support required to implement field interventions.

The project component in Malawi will have its headquarters in Lilongwe, the capital of Malawi, where the MoALD headquarters is situated.

5. Reasons for assistance from donor

The traditional type of agriculture in Malawi is experiencing declining productivity and increasing degradation of the natural resource base. By introducing crossbred cows for both milk production and draft work, local cattle and oxen can be replaced, leading to more productive, smaller herds, which will release capital and feed resources to achieve more sustainable production systems, higher incomes, and better nutrition within a three-year period.

Those providing local technical services are aware of the need to address the technical and developmental aspects of this problem, but they do not, at present, have sufficient numbers of qualified staff or the material resources needed to deal urgently with this situation.

The cow traction technology package developed by IAR(Ethiopia)/ILRI could contribute to resolving the above mentioned problems. This proposed project will be implemented on-farm with direct participation of national research and extension programmes and selected farmers in the Lilongwe ADD. The technical interventions will be executed collaboratively by the Food and Agriculture Organization of the United Nations (FAO) and ILRI. These development objectives will need to be supported financially by a donor.

6. Special considerations

In Malawi, production of crossbred cows (Friesian x Malawi Zebu) is ensured through existing AI services provided by DAHI and an efficient extension delivery system provided by DAET using the cost-effective technologies generated by DAR. Feed manufacturing companies are in place and only recently, the Malawi Rural Finance Company (bank) was established to provide credit facilities to smallholders and large-scale farmers. Farmers requiring loans from this finance institution pay a deposit of 10% of the capital value applied for. The government is encouraging the private sector to invest in the feed industry to promote livestock development, the dairy subsector being one component of this.

Marketing opportunities and profitable outlets of fresh milk for smallholders are provided by a formal collection operation run by the Malawi Dairy Industries (MDI). Using crossbred cows for milk production and draft work will have positive effects on the role of women in development and on the nutrition of children. Since crossbred cows will require stall-feeding, they will be kept close to the homesteads where care is mainly provided by the women. This will increase the role of women in an important income-earning activity.

Dairy production can be important in achieving food security in three ways: 1) directly through increased food production that adds directly to household nutrition; 2) indirectly through increased cash income that can be used to purchase food and other household items; and 3) by generating employment.

The use of crossbred cows for milk and traction will also have environmental implications. Keeping fewer animals would lower stocking rates. This would help alleviate overgrazing and create a more productive farming system.

The introduction of this technology in Malawi will lead to a substantial impact on the incomes of all farmers. The objectives of farmers in Malawi are to improve their incomes and food security by increasing productivity and by diversification. However, the farmers have difficulties in achieving the above objectives because of:

- declining soil fertility and soil erosion
- poor access to production inputs due to low levels of purchasing power
- too narrow a range of technology for the different farming environments
- land pressure.

This proposed project will encourage technical co-operation among developing countries.

7. Co-ordination arrangements

The proposed project is designed as a regional project to expand on-farm testing of a promising IAR/ILRI technology on use of crossbred cows for milk, meat and draft work. The project will be implemented in the Lilongwe ADD in Malawi. Lilongwe will be the co-ordinating centre and institutional headquarters. DAR will be the host local institution to the regional project.

8. Counterpart support capacity

Project activities will be jointly planned and executed by the collaborating partners who will provide substantial (in-kind) and supplementary support to the project. The Livestock Commodity Team of DAR, will provide: the project co-ordinator, scientific and support staff, livestock resources, assistance with data collection, management and analysis, research and laboratory facilities, as well as housing and logistical support on-station and on-farm at Chitedze Agricultural Research Station in Lilongwe. The other local collaborating institutions will be DAHI and DAET. DAHI will provide veterinary personnel for disease control services and DAET will provide extension specialists for disseminating extension methods on feed and other related technologies. The Farm Machinery Unit of DAR will also assist in providing scientific personnel and in the data collection.

9. Sustainable development agreement clause

If at the end of development operations these are concluded successfully, all inputs and support allocated by the government to the executing Technical Ministry as a development budget will become an additional allocation to the Ordinary Budget assigned to the Technical Ministry by Ministries of Planning and of Finance.

C. Development objective

The development objective of the project is to support the overall government strategy of improving food security and human nutrition, and alleviating poverty through research into labour-saving technologies to overcome seasonal labour bottle-necks. The project will achieve this objective by on-farm testing of the IAR/ILRI crossbred cow technologies for milk and meat production and draft power that will increase the productivity and sustainability of smallholder mixed production systems in the Lilongwe ADD in Malawi.

D. Immediate objectives, outputs and activities

Transfer management practices and new technologies for the multi-purpose use of crossbred dairy cows by smallholder farmers.

1. Immediate objective 1

Adoption of dairy cow-traction technologies (DCTT) at farm level.

1.1 Output 1: Increased milk production and farmer incomes.

Activities

1.1.1 Conduct anthropological survey

1.1.2 Procure office equipment and materials (ploughs, ridgers, harness, one vehicle, two motor cycles and laboratory equipment)

1.1.3 Establish demonstration units

1.1.4 Produce training manual

1.1.5 Train staff

1.1.6 Conduct farmer field days

1.1.7 Select participatory farmers

1.1.8 Train farmers

1.1.9 Establish improved pastures

1.1.10 Establish credit fund

1.1.11 Distribute crossbred cows

1.2 Output 2: Technical supervision, monitoring and evaluation scheme in place for dairy cow traction technologies.

Activities

1.2.1 Evaluate on-farm production performance of crossbred cows for both milk and draft power

1.2.2 Assess qualitatively farmer perception of the technology

1.2.3 Assess the effect of the technology on resource use and incomes of the project farmers and nutritional status

1.2.4 Write progress reports

1.2.5 Conduct tours

1.2.6 Conduct meetings to assess progress

1.2.7 Conduct collaborative workshops

2. Immediate objective 2

Establishment of a rural-based support system for the supply of production components and market products related to dairy cow traction technologies.

2.1 Output 1: Mechanism in place for supply of production components required for dairy cow traction technologies.

Activities

2.1.1 Strengthen AI services
2.1.2 Strengthen veterinary services
2.1.3 Establish forage nurseries in training centres

2.2 Output 2: Mechanism in place for marketing the products of dairy cow traction technologies.

Activities
2.2.1 Facilitate sales of calves
2.2.2 Introduce a milk separator
2.2.3 Train farmers to make value-added products (ghee and butter)
2.2.4 Publicise project outputs through news media (radio and newspapers)

E. Inputs

1. Government inputs

Participating MoALD departments (36 months duration):

- infrastructure and logistical support (DAR/Chitedze Research Station)
- research facilities and animals (DAR/DAHI)
- infrastructure:government livestock farms and AI facilities (DAHI); house (DAR/Chitedze Research Station)
- scientific support: animal scientists and technical support staff (DAR)
- feed and milk laboratory analysis (DAR/DAHI)
- veterinarians, extension agents (DAHI/DAET)
- National Co-ordination Unit (DAR/MOALD).

2. Donor inputs

The contribution to the project will be the following (36 months duration):

- personnel:
  Regional Co-ordinator (international staff): one Animal Scientist (36 months)
  Consultant staff: one ILRI Animal Scientist (9 months)
  Consultant staff: one ILRI Agricultural Economist (9 months)
  Technical Assistance: one FAO Associate Professional Officer (36 months)
  Support staff: one Regional Administrator (36 months)
  Laboratory and field experiment equipment: draft measurement equipment—one ergometer, one load cell (and maintenance)
- laboratory supplies: chemicals, progesterone kits
- veterinary supplies: antibiotics, antihelmintics, minerals and vitamins
- four-wheel drive vehicle

- vehicle-running costs and maintenance
- printing and publications: manuals, reports
- training
- meetings and workshops.

F. Risks

- insufficient and untimely delivery of inputs; Government and Donor
- lack of interest among smallholder farmers to share part of the risk in testing the new technology
- supply problems in dairy crossbred cows, harnesses and equipment
- insufficient farm feed stock to ensure adequate management standards.

References

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ON-FARM TESTING AND TRANSFER OF MULTIPURPOSE CROSSBRED DAIRY COWS FOR MILK, MEAT AND DRAFT WORK IN SMALLHOLDER FARMING SYSTEMS

1.1 Project budget covering government contribution in kind (US$)

Country: Malawi
Project number:
Project title: On-farm testing and transfer of multipurpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems

		1997 staff months	1997 US$	1998 staff months	1998 US$	1999 staff months	1999 US$
10. PROJECT PERSONNEL							
11.01	National Co-ordinator (Animal Scientist—DAR)	12	4,000	12	5,000	12	5,500
11.02	Agriculture Extension Officer	12	3,000	12	4,000	12	4,000
11.03	Agricultural Economist	12	3,000	12	4,000	12	4,000
11.04	Farm Machinery Officer	12	3,000	12	4,000	12	4,500
11.05	Pasture Agronomist	12	3,000	12	4,500	12	4,500
11.06	Project Officer	12	2,000	12	3,000	12	3,500

11.07	Veterinary Officer	12	3,000	12	4,000	12	4,500
11.08	Dairy Officer	12	2,500	12	2,500	12	3,500
11.09	Labourers	120	1,200	120	1,500	12	1,600
Component total		216	21,100	216	32,600	216	36,600
30.	TRAINING						
31.	Maintenance of trainees' salaries		300		500		600
39.	Component total		300		500		600
	EQUIPMENT						
41.	Equipment and furniture maintenance		1,500		570		1,000
42.	Supplies		3,000		250		1,300
43.	Premises		500		900		1,500
49.	Component total		5,000		1,720		3,800
50.	HOUSING						
51.	Maintenance and repairs		5,000		6,000		8,000
52.	Office maintenance		2,500		3,500		4,500
53.	Utilities		1,500		2,500		3,500
54.	Component total		9,000		1,200		1,600
55.	MISCELLANEOUS		3,000		5,000		5,500
99.	GRAND TOTAL		38,400		51,820		62,500

1.2 Project budget covering donor contribution (US$)

		1997 staff months US$		1998 staff months US$		1999 staff months US$	
PROJECT PERSONNEL							
11.	INTERNATIONAL EXPERTS						
11.01	Regional Co-ordinator	12	28,800	12	28,800	12	28,800
11.02	APO	12	–	12	–	12	–
11.49	Subtotal experts		28,800		28,800		28,800
11.50	CONSULTANTS						
11.51	Animal Scientist	3	4,800	3	4,800	3	4,800
11.52	Agricultural Economist	3	6,300	3	6,300	3	6,300
11.97	Short-term consultants						
11.98	Subtotal consultants		11,100		11,100		11,100
11.99	Subtotal experts/consultants		39,900				39,900
12.	Administrative support personnel			–			
12.01	Regional Administrator	12	2,700	12	2,700	12	2,700
12.02	Secretary	12	1,200	12	1,200	12	1,200
12.03	Driver	12	800	12	800	12	800
12.99	Subtotal administrative support		4,700		4,700		4,700
14.	Duty travel		5,600		5,600		5,600

15.	Mission costs	3,200	3,200	3,200
16.	Personnel components total	53,400	53,400	53,400
20.	SUBCONTRACTS			
21.	Subcontract X National Program Field Support	11,500	2,500	3,500
22.	Subcontract Y revolving fund administration	50,000		
23.	Subcontract Z			
29.	Component total	61,500	2,500	3,500
30.	TRAINING			
31.	Fellowships	15,000	10,000	5,000
	Component total	15,000	10,000	5,000
32.	Study tours/group training			
32.01	In-country	4,800	3,600	2,400
32.02	Regional	6,120	6,120	6,120
32.03	In-service training	2,400	2,400	2,400
39.	Component total	13,320	12,120	10,920
40.	EQUIPMENT			
41.01	Expendable equipment	1,500	3,000	1,000
41.02	Non-expendable (office equipment: photocopier, computers, projectors, printers, video camera, VCR, TV/screen and laboratory)	30,000	3,000	1,000
49.	Component total	31,500	6,000	2,000
50.	TRANSPORT			
50.01	Four-wheel drive vehicle (double cab)	25,000	–	–
50.02	Motor cycles	2,000	–	–
59.	Component total	27,000	–	–
60.	MISCELLANEOUS			
61.	Operations and maintenance costs of vehicles and equipment	8,000	1,000	3,000
62.	Reporting costs	600	1,000	15,000
63.	Sundries	5,000	1,000	1,000
69.	Component total	13,600	3,000	5,500
	Totals	201,820	87,020	80,320
	GRAND TOTAL		369,160	

Discussion on Malawi proposal

Shapiro: This is a project that is going to be carried out on the Malawi plains, where crossbred cows are already in place, where there is AI and extension service and improved forage production.
If animal traction is already used in this area, why would you think that using dairy cows for work would be attractive to farmers in this area?

Kumwenda: As I said earlier, crossbred animals are already used by farmers for milk and meat. If we consider the shortage of draft power and the benefits that will result from the use of this technology, the package will become attractive to farmers.

Shapiro: No cultural impediment?

Kumwenda: May be for a few farmers, but in general this will be a minor problem. Perhaps Mrs Mzandawase would care to comment.

Mzandwase: It is hard to comment at this stage on the likely extent of adoption of this technology by our farmers. However, our department has done some research on the use of cows for milk and draft and has conducted some surveys in different areas in the north. After the data are summarised we will have a better idea of the attitudes of farmers in those areas.

Zerbini: What is the level of milk production of the zebu cows used in on-station trials for draft and milk production, and what is the average milk production of crossbred cows?

Kumwenda: Zebu cows: 1–2 litres/day.
Crossbred cows: 8 litres/day.

Zerbini: In the areas where you propose to implement the project, is there land reduction, livestock pressure, increasing human pressure and increasing urbanisation?

Kumwenda: Yes, pressure on the land is increasing and keeping local oxen for ploughing only may not be sustainable in the future. If we demonstrate the benefits of integrating milk, meat and traction, farmers will be attracted to adopt the technology.

Elias Zerfu: Your proposal assumes that policies regarding some of the services offered to farmers will change. How do you expect that to happen?

Kumwenda: Yes, I recognise this is a controversial and difficult issue. However, at present the policy environment is conducive to this type of innovation.

Mzandwase: I would like to add that in Malawi there are changes occurring towards a more market-oriented economy and farmers will be encouraged to form co-operatives and associations to be able to get a better price for milk and dairy products.

Maiseli: I have a comment on the sustainability of having two companies producing concentrate feeds for crossbred cows. Are you going to make any attempt to try to train farmers to make their own compounded feed in the future?

Kumwenda: Yes. With local by-product available.

On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems of Mozambique

A. Context

1. Description of the subsector

In 1970 the estimated number of draft animals in the farming sector in Mozambique was 113,000; 78,000 farmers used animals for ploughing. By 1992 the total number of draft animals in this sector was only 27,000. Shortage of draft animals due to the war and drought is thought to be the main constraint to increasing crop production in the country (LBI 1994).

According to the 1989 FAO census (MARRP 1995), cattle owners cultivated larger fields and prepared their lands better (early ploughing) than non-cattle owners. Cattle owners ploughed on average 50% more land, approximately 1–1.5 ha, than those who ploughed by hoe. In addition, many cattle owners were able to earn money by renting out their animals.

In general, livestock numbers in Mozambique have dropped from 1.4 million head in 1974 to approximately 200,000 head in 1992 (LBI 1994). In Manica Province, for example, the numbers decreased from 64,000 in 1980 to 25,000 in 1993 (MARRP 1995).

Production of milk in the commercial sector fell from 10 million litres in 1974 to 5 million litres in the following year and to one million litres in 1982, due to inappropriate management of the parastatal sector. The shortfall in local production prompted importation of milk powder and butter oil for reconstitution into whole milk. Milk processing plants have been built in larger towns, including Nampula, Chimoio, Beira and Quelimane (LBI 1994).

2. Host country strategy

The establishment of programmes to revitalise the use of animal power in Mozambique is one of the priorities for the National Agricultural Policy (PROAP 1995). The development of small-scale dairy farms also has received great attention from the government and non-governmental organisations (NGOs).

When Mozambique was a Portuguese colony the smallholder farming sector played an important role in producing milk for sale. After independence, large state-owned dairy farms were created. Since then commercialised milk production has been carried out in large enterprises using Africander and Nguni crossed with European dairy breeds (Rocha 1985).

Many studies have shown that the demand for milk and draft animals exceeds their supply and that this potential demand can absorb increased production from peri-urban areas. However, production from these areas can be limited by the shortage of transport and lack of adequate milk collection systems and markets. Intensive or semi-intensive dairy production is being encouraged only after studies to determine the suitability of a region have been carried out (LBI 1994).

Priority areas to be considered are Umbelúzi and Chokwe regions (lowlands) for milk supply to Maputo town, and the highlands of Chimoio (Manica), Angonia (Tete) and Namaancha (Maputo Province) which offer good climatic conditions for milk production. The development of milk production must be based on crossbred cows, e.g. Nguni x Friesland (LBI 1994). The F_1 cross between the Nguni and Friesland show good reproductive efficiency. Milk production of Nguni cattle varies between 573 litres and 1793 litres/lactation (Rocha 1985). The F_1 cross between Friesland and Nguni produced an average of 2495 litres/lactation while the F_1 cross between Jersey and Nguni produced 1989 litres/lactation. The F_1 Nguni x Gyr/Sahiwal is potentially appropriate for traction and milk in the existing smallholder farming systems in Mozambique.

The Ministry of Agriculture has organised several actions to support the rehabilitation of small-scale farms. An Italian project is also going to support the development of the smallholder dairy farms under an integrated programme of rural development, in the peri-urban area of Maputo. The European Commission is supporting a project for development of private dairy marketing infrastructure in the same region. A joint Mozambican and South African Government project is developing a strategic development corridor with strong commercial and industrial components. All these activities will create more opportunities for improving farming in this area.

3. Prior or ongoing assistance

This regional project is a collaborative effort of the national agricultural research institutes of the participating countries in eastern and southern Africa, the Ministries of Agriculture (MoAs), the Food and Agriculture Organization of the United Nations (FAO) and the International Livestock Research Institute (ILRI).

The main objective of the project is to field-test technologies developed on-station and begin the process of transferring them to farmers. This work will be carried out in close collaboration with smallholder demonstration farmers in several African countries. It builds on research and extension work by the Institute of Agricultural Research (IAR) and the MoA extension service of Ethiopia, in collaboration with ILRI, since 1989. This collaborative work has developed a scheme to study and transfer crossbred dairy cow technologies that make it possible to secure adequate outputs of milk, meat and draft power.

Research results obtained show that the technologies are viable and could have a wide impact on dairy production in the African highlands resulting in major benefits to smallholder dairy producers and consumers. Funding for this project will assist in the successful transfer of these technologies to smallholder farmers throughout the eastern and southern African highlands.

This project will be the first concerning the utilisation of cows for milk, meat and draft in Mozambique. Farmers themselves initiated this practice; they are being forced to use cows because of recent losses in their herds. However, in certain areas, the use of cows for traction appears to be temporary. Farmers buy multi-purpose cows as a way of helping their herds recover after the drought and the war, while at the same time providing draft power. NGOs (e.g. Helvetas have been introducing heifers for draft work in several parts of the country.

4. Institutional framework for subsector

The Ministry of Agriculture comprises several divisions within which there are: the Animal Production Institute (IPA), the Agronomic Research Institute (INIA) and the National Services for Rural Development and Extension (DNDR).

Except for research surveys, very little on-farm livestock research has been carried out to date. The present project will give extension agents and research staff training and experience in on-farm livestock research.

Considerable efforts have been made to integrate livestock research with the other research programmes carried out by INIA and DNDR. Similar efforts have been made by some NGOs through linkages with IPA. This institute has often been asked to suggest practical ways to support the development of animal production systems.

The ongoing development of private dairy marketing infrastructure will support the development of market-oriented smallholder dairy farms. The prospects for adoption of multi-purpose cows by resource-poor farmers will be greater if informal credit and extension are available.

B. Project justification

1. The problem to be addressed: The present situation

1.a. Agrotechnological

Shortage of breeding cows is one of the main constraints to livestock production development in Mozambique. Eighty per cent of the national cattle herd has been lost in the last 10 years (LBI 1994). Cereals are also in short supply. Mozambique imports 30% of its cereal needs each year. Even the production of legumes, the main source of protein for rural people, has decreased since 1970 (PROAP 1995).

The principal objectives for the farmer are to produce food for the family and income to send children to school and pay medical expenses. Cropping alone is not sustainable due to poor rainfall distribution. Farmers with cattle produce more crops than those without cattle. Dairy has a great potential to increase family income.

1.b. Biophysical

The climate of the highlands is suitable for crop and livestock production. The main highlands in Mozambique lie at 500–1500 m altitude and receive an annual rainfall of 800–1400 mm. Average temperatures range from 18 to 24°C.

The stocking rate in Mozambique is very low. Cereals (maize, rice, millet, barley and wheat) do not even meet the nutritional needs of the human population and thus cannot be used as livestock feed. However, there is a great potential for use of agro-industrial by-products (coconut, groundnut and cotton cake), molasses and citrus pulp to feed cattle (LBI 1994).

There are large area of pasture in Mozambique but several factors restrict farmers' access to them. The most prominent of these was the concentration of human and animal populations in safer areas during the war. In Manica Province, for example, nearly 90% of animals are found in the Beira corridor districts (MARRP 1995). Other important factors are land mines and frequent cattle rustling which reduce the extent and duration of grazing. In addition, the overfragmentation of plots in areas such as irrigation schemes and where human population density is high causes constant conflicts among farmers.

In Manica Province the use of cows for draft would improve the use of the available resources. It would also improve use of crop residues, which are normally burnt.

1.c. Institutional

Several institutional issues need to be addressed.

- Linkages between research and extension: the cost of monitoring studies will be moderated by using existing extension services. Some incentives should be given to technicians.
- Poor funding: this will be minimised by the timely allocation of resources to avoid discontinuity in the scheduled activities.
- Lack of qualified professionals: this will be overcome by exposing all project staff to the workshops and short courses that will be undertaken with project support.

1.d. Socio-economic

The population of Mozambique is expected to reach 22 million people by the year 2002. Meat production will have to rise by 16% and milk production by 40% per year to meet demand (LBI 1994). Such increases will be possible only if agriculture is well-integrated into the market economy. Faced with increasing population pressure, low-input agriculture can contribute to natural resource depletion and environmental degradation. In addition, low productivity makes farm operations economically risky. Out-migration to cities leads to increasing urban unemployment.

Population growth, especially within cities, leads to food supply problems, increases in food import costs and ever higher levels of foreign debt. This trend ultimately leads to unbalanced development patterns and increases the control of urban centres over livelihood opportunities of rural communities. Profitable dairy production can help reverse this trend by providing higher incomes for rural families, creating rural farm and agro-industrial employment, making productive use of natural resources that would otherwise remain idle or suffer degradation, and by revitalising the contribution of agriculture to the national economy.

Rural–urban migration is a major problem of developing countries in general and Mozambique in particular. It is aggravated by the massive demobilisation of military forces and the return of those displaced by the war since 1994.

Successful use of crossbred dairy cows by smallholder farmers requires adoption of new farm technologies, including improved management, feed production, feeding and traction systems. Crossbred cows have to be fed better than local animals to perform better. In milk producing areas, grazing and hay are the traditional feed resources for dairy cattle. The growing population, while increasing demand for milk, also reduces the availability of land in peri-urban areas, making it difficult to feed crossbred cows better. On account of this reduction of grazing land, government programmes have put much emphasis on increasing feed production and improving nutritive quality of feed resources.

1.e. Project goals

This project aims at promoting the introduction of crossbred cows for both milk production and draft into smallholder mixed farming systems by developing and transferring complementary high-productivity feed production, feeding, reproduction, draft and management strategies. Use of crossbred dairy cows for traction, in place of oxen, would be an efficient way to restock cattle after the war and drought. The present situation offers an opportunity for promotion of smaller, more productive herds, which will alleviate overgrazing and create a more productive, sustainable farming system that makes better use of the natural resource base.

The multi-purpose use of crossbred dairy cows will increase milk production substantially while at the same time and with the same resources satisfying the need for draft power. The number of oxen (used for work for only a short period each year, primarily for land cultivation) and the number of cattle kept to breed replacement oxen could be reduced.

The adoption of multi-purpose crossbred cows is expected to have a large impact on milk production and the incomes of smallholder farmers. With proper management, milk production per cow can increase five- to sevenfold, substantially increasing cash income and availability of dairy products for household consumption.

Increased milk production is also expected to significantly improve the nutritional status of the rural poor by increasing consumption of dairy products. Very few poorer families can afford meat and milk even once a month. These products contain many important nutrients, especially carbohydrates, protein and calcium, and micronutrients vitamin A, the B-complexes and zinc. These are essential for growth and proper physical and mental development. For instance, studies have shown that children deprived of vitamin B_{12}, which comes only from animal products, have lower learning abilities and will not develop to their full potential.

In most regions in Mozambique, farmers keep cows for their calves, draft and milk production. However, they usually avoid using them for more than one purpose at any one time to avoid reducing their productivity. This precaution may be less important if there is appropriate feeding management.

By the end of the project, the project farmers will have tested the following technologies:

1. Utilisation of two crossbred dairy cows for traction.
2. Cultivation of feed crops and fodder trees to be fed as cut-and-carry, fodder conservation, treatment of low digestibility crop residues to increase on-farm feed resources and improved use of feed.
3. Purchase and feeding of at least 2 kg of simple, appropriate and affordable feed supplement per cow per day during lactation and work periods.
4. Use of crossbred cows for traction to plough on average at least half of the crop land.
5. Construction of a simple barn for the crossbred cows.

2. Expected end-of-project situation

The project will be located in areas where oxen are currently used by farmers as work animals and where crossbred dairy cattle are available and have a good reputation in rural communities. Field operations will involve between 40 to 50 resource-poor farm households presently having only local cattle and using work oxen.

Results from pilot areas established by the project must indicate that the technological package has been adopted by the majority of the collaborating farmers. Overall farm output will be increased, mainly on account of better management of farm resources and the ability to use strategic cash inputs and services provided by off-farm services. Livestock performance results will show a stable herd size which contributes a substantial amount to sales, as well as animal power and manure to farm operations and farm output. Economic analysis will confirm a steady positive trend in total revenue, adequate remuneration of farm labour and capitalisation rate. Off-farm services will be increasingly managed by organised farmers associations/groups and output of goods from rural workshops, and cottage industries and village processing units will have increased considerably. External technical assistance might still be required in order to maintain optimal levels of management but it will only be restricted to very precise subjects that can be dealt with through short term consultancies.

3. Target beneficiaries

Direct beneficiaries: collaborating smallholder, resource-poor farmers and their families plus local project staff.

Indirect beneficiaries: neighbouring smallholder farmers and their families, villagers, artisans, traders and businessmen, small-scale farm produce processors who either individually or in organised groups will participate in information/extension meetings and gradually adopt recommendations derived from the technical approach encouraged by the project.

This technology package promises to improve the income and nutrition of all members of resource-poor rural households in areas where the technologies are relevant, but the intrahousehold consequences including labour costs and food availability will be closely monitored and studied further to ensure a positive impact on all family members.

4. Project strategy and institutional arrangements

The implementation strategy relies on a participatory approach of the selected farmers during the on-farm validation process of the proposed technology. This means that even though the project is willing to share part of the inevitable risks of agricultural operations (traditional or new), the farmer must assume his responsibilities as a partner under a properly defined commercial contract, especially as related to the purchase of the cows through a credit scheme. This legal instrument will also facilitate the expansion of the project once positive results are confirmed and local institutions take up follow-up management responsibilities. The proceeds from the cow purchase credit scheme will first be used for a revolving fund to meet field operating costs of the project and later be used to finance the purchase of more cows to extend the technologies to more farmers after the project ends.

The supply of crossbred dairy cows, their harnesses and equipment must be similar if not identical in all testing sites. The training of both farmers and animals plus livestock management instructions must be arranged following strict common standards.

Government services dealing with livestock production, research, and extension activities, plus farmers' organisations, will assist the project in its training programme and in the logistical support required to implement field interventions.

Project components based in each of the participating countries will be required to maintain close contact with the headquarters of the regional project and to follow the technical direction and administrative management instructions for project operations provided. The regional project will have its headquarters at ILRI, Addis Ababa, from where the international team leader will co-ordinate overall operations.

5. Reasons for assistance from donors

Local technical services are aware of the need to address the technical and developmental aspects of the problems addressed by this project, but they do not, at present, have enough qualified staff or the material resources to deal urgently with this situation. ILRI has developed a cow traction technology package that could help resolve this problem. This promising technology will be field-tested at the farm level with direct participation of national research and extension programmes and selected farmers. The technical interventions would be executed collaboratively by FAO and ILRI, with ILRI providing technical backstopping, monitoring and evaluation. These development objectives will be supported financially by a donor. Regional operations of the project would be greatly facilitated through institutional support provided to participating countries by international institutions such as donors and by FAO and ILRI.

The proposed project is relevant for the accomplishment of the priorities defined by the National Agricultural Policy. This policy advocates that investments must increase the productivity of natural resources, in order to increase the capacity for job creation and reduce the need for food aid. Beyond food production, employment is a determining factor of food security of families. In rural families, income from sales of produce and from employment determine household purchasing ability. In the last few years the opportunities for rural employment have been diminishing.

6. Special considerations

The adoption of crossbred dairy cow traction technologies creates opportunities for the private sector to provide inputs and services such as animal feeds, fertiliser, seed, harnesses, tillage equipment, carts, AI and veterinary services and product marketing. Marketing opportunities and profitable outlets of fresh milk for smallholders are provided by private milk collection operations. Farm and rural-based dairy processing operated and managed by women will provide an opportunity to improve their economic position in society.

The introduction of crossbred cows for milk production and draft will have especially positive effects on the role of women and on the nutrition of children. Since crossbred cows require stall-feeding, they are kept close to the homestead where care is mainly provided by the women, thus increasing their role in an important income earning activity. Furthermore, the additional milk produced can increase incomes for women if more dairy products can be made since the proceeds of the sale of these products are traditionally controlled by women.

Increased milk production has also been shown to lead to increased consumption within the household, mainly on the part of children. Dairy production can be important in achieving food security in three ways:

- directly, through increased food production that adds directly to household nutrition
- indirectly, through increased cash income that can be used to purchase food
- by generating employment.

The environmental effects of the dual use of crossbred cows for milk and traction also promise to be positive. Keeping fewer animals would lower stocking rates. This would help alleviate overgrazing and create a more productive farming system that makes better, more sustainable use of the natural resource base.

This intervention is an example of how higher productivity livestock technologies can substantially increase farmer incomes. Constraints to resource-poor households benefiting from this technology do exist but can be overcome through special programmes included in the project such as credit and insurance schemes.

The project will allow formal linkage mechanisms to be set up for information exchange and collaboration between scientists and extension experts; the project will also encourage technical co-operation among developing countries. This process has already begun with the participation of Asian traction experts in an Expert Consultation on Cow Traction that was organised by ILRI and FAO. This workshop, which had the main objective of finalising the country proposals and the regional proposal to seek funding to extend this technology to other African countries, also began information sharing between African and Asian traction experts. The regional project will further encourage collaborative work among development organisations involved in research and transfer of multi-purpose cattle and buffalo technologies in Africa, Asia, Latin America and the Caribbean. The project will benefit from the participation of the CGIAR centres as well as the Australian Centre for International Agricultural Research (ACIAR) Draught Animal Power (DAP) project. These project activities will also represent a further development of DAP collaborative programmes initiated by ACIAR and African NARS. These activities will provide an opportunity to formalise collaborative relations between Asian and African NARS.

7. Co-ordination arrangements

National policies that encourage better use of work animals and those that promote dairy production will be co-ordinated by specialised government units in each of the participating countries; these units also fund research and development programmes related to such activities. These units will assist project activities by ensuring that timely and appropriate government decisions will be made to allocate the financial support required for on-farm testing of multi-purpose use of crossbred dairy cows by smallholder farmers.

This present project is designed as a regional project to extend to other African countries a scheme for on-farm testing of promising ILRI technologies concerning the multi-purpose use of crossbred dairy cows. ILRI will provide facilities in Addis Ababa for the co-ordinating office, training facilities and institutional headquarters of the regional project.

8. Counterpart support capacity

Project activities will be jointly planned and executed by the collaborating partners. Livestock research institutes in each country will provide the national project co-ordinator, technical and support staff, livestock resources, assistance with data collection, management and analysis, office, research and laboratory facilities and housing and logistical support on station and on farm. Regional offices of the institutes will provide support for on-farm testing sites from their dairy specialists, animal traction specialists, forage specialists, veterinarians and extension specialists. Training and extension inputs will be provided on feed technologies, use of work animals and equipment, breeding and reproduction and dairy processing. Assistance will be provided for disease characterisation, prevention and treatment.

The national staff under both research and extension services will collaborate closely with ILRI staff.

Sustainable development agreement clause

If development operations are concluded successfully, all inputs and financial support granted as development allocation to the National Executing Unit by the Government to carry out this project will become an additional allocation to the Ordinary Budget assigned to this Unit by the Ministries of Planning and of Finance.

C. Development objective

The development objective of the project is to support a smallholder commercial agricultural activity that can significantly improve sustainable food production, food security, farmer incomes and human nutrition through substantially increased milk production while protecting the natural resource base. The project will accomplish this by promoting uptake of crossbred cow technologies for milk production and draft that will increase the productivity and sustainability of smallholder mixed production systems.

A priority of the Government of Mozambique is to improve farming technologies in order to increase food production in the country. The objective of research, therefore, is to help small-scale farmers to play their role in national economic development and reduce the need for food aid.

D. Immediate objectives, outputs and activities

Transfer of management practices and new technologies for the multi-purpose use of crossbred dairy cows by smallholder farmers

1. Immediate objective 1

Testing of dairy cow traction technologies (DCTT) at smallholder farm level.

1.1 Output 1: Test sites located and participating farmers identified and selected.

Activities

1.1.1 Verification of conditions in proposed locations regarding field testing DCTT

1.1.2 Presentation to smallholder farmers and collaborating partners of the objectives and benefits of DCTT

-Preliminary field results from Ethiopia and video presentation

-Demonstration of DCTT

-Evaluation sheet to record interest and doubts of participants

1.1.3 Selection of farmers and verification of commitment and needs

1.2 Output 2: Monitoring and evaluation (M&E) scheme in place for field testing DCTT.

Activities

1.2.1 Appointment of full-time project staff to the monitoring and evaluation (M&E) scheme; permanent assignment of working facilities

1.2.2 Prepare M&E material; methodological manual

1.2.3 Purchase of office and field M&E equipment

1.2.4 Training of M&E staff on project procedures for M&E

1.2.5 Information meeting with collaborating institutions and farmers

1.2.6 Training of collaborating staff and farmers on project procedures for M&E

1.2.7 Establish schedule of periodical M&E visits to farmers for data collection, storage and processing; keep data bank up to date

1.2.8 Prepare monthly data reports for technical analysis required by project management

1.2.9 Special agreement to secure transport facilities

- Subcontract transportation support
- Allocation of equipment: type

Operating: Fuel
Oil
Service
Spare parts

1.3 Output 3: Technical supervision for field testing DCTT.

Activities

1.3.1 Help prepare and evaluate training materials; methodological manuals

1.3.2 Technical backstopping missions

1.3.3 Meetings with country project staff; training staff on project technologies

1.3.4 Meetings with field testing participants to observe and evaluate training

1.4 Output 4: Training to increase cow output (work, surplus milk and calf production) and farm productivity.

Activities

1.4.1 Training cows for traction

1.4.2 Technical training of participating farmers in use of

- feed resources: crop residues
- harness
- implements
- manure
- daily watering

1.4.3 Training participating farmers in use of cows for traction

1.4.4 Supervising barn construction by participating farmers

1.4.5 Training participating farmers in forage production

- seeds
- plant protection
- fodder crops/trees

1.4.6 Training participating farmers in construction of infrastructure

- sheds
- barns
- store

1.4.7 Training participating farmers in management of cows

- water harvesting, storage and daily watering
- maintenance of barn
- cleaning of animals
- feed and feeding: Fodder
  Supplements
- animal health and inputs
- reproduction inputs: Bull service
  AI

1.4.8 Training project farmers in dairy production

- proper milking procedures
- proper feeds and feeding:
  Reproduction
  Health
  DAP technology
  Dairy production

2. Immediate objective 2

Improvement, where necessary, of rural-based support systems to ensure supply of production components and to market products derived from DCTT operations.

2.1 Output 1: Mechanism in place for supply of production components required for field testing of DCTT.

Activities

2.1.1 Provision of institutional facilities by project

- infrastructure: Implementing
  Collaborating
- equipment
- implements
- materials
- animals

2.1.2 Allocation of existing production components by farmers

- infrastructure: Sheds
  Barns
  Store
- land: natural grasslands and cultivated pasture
- animals
- feed resources: crop residues

- harness
- implements
- manure
- daily watering

2.1.3 Purchase of production components and improvement of infrastructure, implements, equipment by farmers

- infrastructure
- implements
- feed resources: Fodder
  Supplements
- manure
- seeds
- plant protection
- animal health inputs
- reproduction inputs: Bull service
  AI

2.1.4 Arrangements with suppliers of production components

- subcontract input supplies: Seeds
  Chemical products
  Implements
  Other materials
- subcontract on-farm services:
  Reproduction
  Health

2.1.5 Purchase field testing equipment and operating materials (by project)

2.1.6 Arrangements for loan applications for production components

- from local credit system
- from project revolving fund

2.1.7 Field supervision: Annual schedule

2.2 Output 2: Mechanism in place for marketing products derived from activities testing DCTT.

Activities

2.2.1 Meetings with farmers and potential collaborating agencies

-assess interest for added value of milk through processing

2.2.2 Training participating farmers

- dairy technology
- organising farmers groups

2.2.3 Farm elements to be improved or purchased

- infrastructure
- equipment
- materials

2.2.4 Marketing arrangements for surplus milk
- on-farm storage: churns
- milk collection
- commercial arrangements

2.2.5 Arrangements for loan applications for dairy on-farm storage
2.2.6 Field supervision: Annual schedule

E. Inputs

1. Government inputs

(36 months duration):

- infrastructure and logistical support
- research facilities and animals
- infrastructure: state cattle breeding herd and AI facilities (MoA); house
- scientific support: animal scientists and technical support staff
- feed and milk laboratory analysis
- veterinarians, extension agents
- national co-ordination unit.

2. Donor inputs

The contribution of the project will be the following (36 months duration):

- personnel:

  Regional Co-ordinator (international staff): one Animal Scientist (36 months)

  Consultant staff: one ILRI Animal Scientist (9 months)

  Consultant staff: one ILRI Agricultural Economist (9 months)

  Technical Assistance: one FAO Associate Professional Officer (36 months)

  Support staff: one Regional Administrator (36 months)
- laboratory and field experiment equipment: draft measurement equipment; one ergometer, one load cell (and maintenance)
- laboratory supplies: chemicals, progesterone kits
- veterinary supplies: antibiotics, antihelmintics, minerals, vitamins
- four-wheel drive vehicle
- vehicle running costs and maintenance
- printing and publications: manuals, reports
- training
- meetings and workshops.

F. Risks

- insufficient and untimely delivery of inputs: Government and Donor
- lack of willingness among smallholder farmers to share part of the risk in testing the new technology
- supply problems in crossbred cows, harnesses and equipment
- insufficient farm feedstock to ensure adequate management standards
- difficulties putting in place a credit mechanism
- difficulties establishing and managing a business-oriented milk collection scheme
- lack of support from local pricing policies and control of imports.

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ON-FARM TESTING OF MULTI-PURPOSE CROSSBRED DAIRY COWS FOR MILK, MEAT AND DRAFT WORK IN SMALLHOLDER FARMING SYSTEMS

1.1 Project budget covering government contribution in kind (US$)

Country: Mozambique
Project number:
Title: On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems

Infrastructure	Number of interventions	Number of people	Equipment	Materials
Institution:				
Offices		3		
		3		
Paper				
Pens				
Files				
Toner				
Chemical				
Lab/space				
Scale (600 kg)	2			
Weight feed (20 kg)	40			
Farm:				Low-cost building
New or improved old barns	40			
Feed:				
Grazing land				
Fodder	350,400 kg/year			
Crop residues				
New:	1 ton			
Seed, fertilisers				
tree seedlings				
Manure				
By-products				
Health:				
Minerals, vitamins, acaricides, anthelmintics,				
Buckets for milking	40			
Ear tags				
Cleaning materials	80			
Harness				
Equipment				
Animals				
Transport:				
Motor cycle	4	4		
Fuel	8000 litres			
Service				

Loan requirements: Materials Equipment Animals				
Recording system: Recording books Diskettes Portable computers	50 100 1			
Training materials: Manuals Food allowances Implements	100 4			
Training staff and farmers: On the job Sessions Field days	50 2/year 2/year			
Meetings: Information Pre-intervention Results analysis Post-intervention Reports and publications	1 3 1/year 1/year 1/year			

Infrastructure	1996	1997	1998
Institution: Offices Centres Laboratory/space Scale (600 kg) and weight feed (20 kg) Paper, pens, files, toner, chemicals Subtotal	1,000 4,000 1,000 6,000	 200 1,000 1,200	 200 1,000 1,200
Farm: New building and improve old Feed: Grazing land Fodder Crop residues New seed, fertilisers, tree seedlings, manure, by-products Subtotal	2,000 2,000 4,000 8,000	2,000 1,000 4,000 7,000	2,000 1,000 4,000 7,000
Health inputs (antibiotics, acaricides)	2,000	2,000	2,000

Harness Equipment Animals	4,000 60,000	1,000	1,000
Subtotal	66,000	3,000	3,000
Transport: Motorcycle Fuel Service	 6,000 3,000 1,000	 3,000 1,000	 3,000 1,000
Subtotal	10,000	4,000	4,000
Loan requirements Materials Equipment Animals			
Recording system	5,000	2,500	2,500
Training materials	1,000	1,000	1,000
Training staff and farmers	1,000	1,000	
On-the-job sessions Field days	5,000	5,000	
Subtotal	7,000	7,000	
Meetings Information Pre-intervention Results analysis Post-intervention Reports and publications	5,000	5,000	8,000
Subtotal	95,000	39,700	39,700
International experts	43,000	43,000	43,000
GRAND TOTAL	138,000	82,700	82,700

1.2 Project budget covering donor contribution (US$)

	Total staff months US$	1997 staff months US$	1998 staff months US$	1999 staff months US$	2000 staff months US$
1. New constructions a) New farm buildings	6,000	2,000	2,000	2,000	
2. Equipment					
Computer	3,000	3,000			
Vehicle (Pick-up 4wd)	23,500	23,500			
Motor cycle	4,000	4,000			
Bicycle	3,000	3,000			
2. Total equipment	30,500	30,500			

3. Agricultural inputs					
Heifers	51,000	51,000			
Seeds	3,000	3,000			
Implements	5,800	5,800			
Drugs	2,000	1,000	1,000		
3. Total agricultural inputs	149,000	149,000	1,000		
4. Training					
Study tours/group training					
In-country	3,000	1,000	1,000	1,000	
Regional	12,000	6,000	3,000	3,000	
In-service training (veterinary, AI, forage etc)	2,000	500	500	500	500
4. Total training component	17,500	7,500	4,500	4,500	500
5. Operation and maintenance cost of equipment					
Fuel and lubrication	2,784	696	696	696	696
Vehicle maintenance and repair	12,200	3,050	3,050	3,050	3,050
5. Total operation and maintenance	149,840	3,746	3,746	3,746	3,746
6. Staff remuneration					
Salary for national contract staff	24,000	6,000	6,000	6,000	6,000
Subtotal	241,484	198,746	17,246	16,246	10,246
7. Office materials	2,800	700	700	700	700
8. Travel expenses	7,200	1,800	1,800	1,800	1,800
9. Basic services	720	180	180	180	180
Subtotal	10,720	2,680	2,680	2,680	2,680
GRAND TOTAL	252,204	201,426	19,926	18,926	12,926

Work plan

Immediate objective	Output	Activities
1. Testing of DCTT on-pilot units (model) and on-farm	1. Increased cow output: work, milk, calf • Increase the number of breeding females and lactating cows in a few years • Milk production year-round for home consumption and sales • Lower mortality rates (calves) • Higher fertility rates (cows) • Profitability (increase)	1. Acquisition of dairy crossbreds (in calf) 2. Acquisition of draft implements 3. Construction of model housing and fencing 4. Acquisition of fodder seeds 5. Cultivation of forage and hay making 6. Identification and selection of willing farmers

	2. Technical supervision, monitoring and evaluation systems	Training • project officers • enumerators • cows • Willing farmers (cow heat detection, improving housing conditions)
2. Establishment of rural-based support system of production components and market products related to DCTT	1. Mechanism in place for the supply of production components required for DCTT	1. Promotion of production of implements by artisans
	2. Mechanisms in place for marketing DCTT	1. Promotion of dairy marketing associations

Methodology

Two levels of observation will be considered: the farming system (or farm) level and monitoring animal performance at the individual level. The monitoring will cover indigenous and improved breeds. Experiments will be designed for crossbred dairy cows only in Umpaputo/Namaancha.

Data collection

Step	Herd survey	Farm survey	Duration
Initialisation	Animal identification	Farm characteristics Animal management	
Monitoring	Individual measurements Cattle management • reproduction • demographic events (birth, death, sales and purchase) • productivity (milk offtake,kid growth, adult weight, draft power) • Feeding • Health	Cow management Farm budget	3 years

Discussion on Mozambique proposal

Shapiro: You propose to initiate this project in the high altitude areas of Mozambique. Are there areas where cows are already used for traction?

Faftine: Yes.

Shapiro: Then there would also be some experimentation on-farm with crossbred cows and that would be implemented once you got the feeding practices in place.

Zerbini: I think the main constraint in Mozambique is the lack of cattle. Given the relative scarcity of male animals and the high prices for beef, this is a good opportunity to demonstrate the benefits of using cows for both milk production and traction. You indicated that Mozambique is importing cattle from the surrounding countries. What type of cattle are you importing now?

Faftine: We are importing mostly the Nguni breed because we think that the Nguni is the best adapted breed and we are promoting its use. But there are some projects that import crossbreds. Before, milk was produced by large commercial farms but currently the government, through the Ministry of Agriculture, is promoting smallholder dairy production.

Shapiro: I suggest that, given the financial limits of this project, your project should focus only on the on-farm evaluation of dual-purpose crossbred cows without including the monitoring and evaluation of the use of local cows.

Faftine: Yes, I think that is agreeable.

On-farm testing of multi-purpose crossbred dairy cows for milk, meat and draft work in smallholder farming systems of eastern and southern Africa

A. Context

1. Description of the subsector

This regional project involves the following countries in eastern and southern Africa: Ethiopia, Kenya, Tanzania, Uganda, Malawi and Mozambique.

While traditional African export crops suffer from depressed world prices, dairying offers income-generating opportunities for peri-urban farmers in the countries of eastern and southern Africa (Walshe et al 1991). Policy changes on the part of the European Union, the United States of America, and other major dairy exporters have led to a decline in world market supplies, pushing up world market prices and making domestic production more competitive in most sub-Saharan African countries. Even if world market dairy prices do not continue to rise as expected (Shapouri and Rosen 1992; Shapiro et al 1992), domestic production in the countries in eastern and southern Africa will remain competitive due to recent exchange rate devaluations.

Demand for dairy products, meanwhile, is likely to be unmet in the foreseeable future. In the 25-year period up to 1987, milk production grew by 3.2% in sub-Saharan Africa, but consumption grew even faster. Despite weakening economies and foreign exchange constraints, imports were still 11% of consumption in 1989 (1.2 million tonnes). If the growth rate of milk production remains at 3.2%, at the present rate of population growth in sub-Saharan Africa, imports of 11 million tonnes of milk would be required by 2015.

Where intensified dairying is taking place in eastern and southern Africa, population pressure is also growing rapidly, reducing the land available. Where oxen for draft work and follower herds for breeding and replacement of oxen are also kept, growing land constraints often translate into overstocking and degradation of the land base, as well as severe feed shortages. Smaller herds are made possible by the replacement of draft oxen and their follower herds with crossbred cows. The resulting lower stocking rates help alleviate overgrazing and the more productive herds create a more productive farming system that entails better, more sustainable management of the natural resource base.

2. Host country strategy

With unmet demand for fresh milk evident in primary and secondary cities, there is clearly room for the expansion of peri-urban dairying. Cross-breeding to improve the genetic potential of cows for milk production is the adopted dairy development strategy of the governments of all the participating countries in eastern and southern Africa. Cross-breeding can be an effective technical option to promote a rapid increase in dairy productivity and therefore milk production when crossbred cows are managed and fed properly under favourable environmental conditions.

Crossbred cows, mainly F_1s, are being distributed to farmers on a cash and credit basis by the Ministries of Agriculture and non-governmental organisations (NGOs) in development projects, and are also becoming increasingly available in private markets.

3. Prior or ongoing assistance

This regional project is a collaborative effort of the national agricultural research institutes in the participating countries in eastern and southern Africa, the Ministries of Agriculture (MoAs), the Food and Agriculture Organization of the United Nations (FAO), and the International Livestock Research Institute (ILRI).

The main objective of this project is to field test, in close collaboration with smallholder farmers of several African countries, a technology developed through on-station work which has proven research results. This on-station project is a major collaborative effort between the Ethiopian Institute of Agricultural Research (IAR), the Ministry of Agriculture, Ethiopia (MoA), and the International Livestock Centre for Africa (ILCA, now ILRI) ongoing since 1989. The IAR/ILRI/MoA collaboration has developed a scheme to study the potential of crossbred dairy cows to accomplish multi-purpose tasks and secure adequate outputs of milk, meat and draft power. For example, research results obtained so far strongly support the conclusion that the technologies to be demonstrated and tested on-farm are viable and can have a wide impact on dairy production in the highland agro-ecological zone, resulting in major benefits to smallholder dairy producers and consumers. Funding support for this on-going proposed project will assist in the successful transfer of these technologies to smallholder farmers.

All participating countries have developed programmes which make better use of their work animal resource and they also have long standing programmes to promote dairy development. However, with the exception of ILRI's initiative in Ethiopia, cows are not used as work animals to any significant extent in African countries. Nevertheless, the technical services of several African countries have expressed their interest in field testing this technology in close collaboration with smallholder farmers.

4. Institutional framework for subsector

See Country Project Proposals.

B. Project justification

1. The problem to be addressed: The present situation

1.a. Agrotechnological

Smallholder farming systems account for the bulk of agricultural output in the project area but their mixed-farming approach requires greater integration and intensification of crop/livestock/tree production activities to increase overall productivity. Optimum use of land and family labour is essential to generate food for sale and home consumption plus feed for livestock. Crop residues, shrubs and fodder trees plus by-products from agro-industries, if properly used, will ensure adequate sales from livestock and animal products, draft power for tillage and transport and manure. Adequate off-farm support is required: for timely and effective cropping operations; for rational livestock management; for adequate supplies and services in terms of harnessing and equipment; and for effective and profitable marketing of surplus milk.

1.b. Biophysical

Demographic growth rates have put increased pressure on land resulting in fragmentation of plots of land that are already small, intensification of cropping without restoration of nutrients, and cultivation of land unsuitable for sustained cropping. This leads to degradation of natural resources through mining of soil nutrients, and the loss of plant cover, facilitating erosion.

1.c. Institutional

National institutions have been steadily strengthening in recent years and collaborative programmes with international institutions have allowed joint rural development activities to be established. Working procedures have been developed which allow adequate project implementation of field activities where smallholder farmers can directly participate and benefit from these interventions.

1.d. Socio-economic

Rural emigration is a major problem of developing countries. It progressively weakens contributions made by agriculture to the national economy, increases environmental degradation and renders rural employment uneconomical and unattractive. However, although farmland becomes available as a result of the migration, its low productivity makes farm operations economically risky, so that national agricultural output declines. Immigration to cities with inadequate urbanisation facilities and limited job opportunities leads to increasing urban unemployment and squalor. Demographic expansion, especially within cities, leads to food supply problems, increases in import bills for the country and higher levels of foreign debt. This trend finally leads to the establishment of unbalanced development patterns for the country and consolidates an unfair control of urban centres over livelihood opportunities of rural communities. Profitable dairy production can effectively contribute to reverse this negative trend by providing adequate revenues to rural families, by making productive use of natural resources that would otherwise remain idle or suffer degradation, and by revitilising agricultural contribution to the national economy.

Successful introduction of crossbred dairy cows by smallholder farmers requires adoption of new complementary technologies on-farm, including improved management, feed production, feeding, and traction systems. Crossbred cows have to be fed better than local animals to perform better. In the dairy producing areas of the participating countries, grazing and hay have been the traditional feed resources for dairy cattle. Growing population pressure leads to increased demand for milk but also results in land shortages in peri-urban areas, making it potentially difficult to feed crossbred cows better. On account of this reduction of grazing land government programmes have put much emphasis on increasing feed production and improving nutritive quality of feed resources.

1.e. Project goals

This project aims to promote the introduction of crossbred cows for both milk production and draft into smallholder mixed farming systems by developing and transferring complementary high-productivity feed production, feeding, reproduction, draft and management strategies. The use of crossbred dairy cows for traction in place of oxen would result in a more efficient use of available feed resources by decreasing the number of animals kept on-farm. These lower stocking rates would alleviate overgrazing and create a more productive, sustainable farming system that entails better management of the natural resource base.

The multi-purpose use of crossbred dairy cows will increase milk production substantially, while at the same time and with the same resources satisfying the need for draft power. The number of oxen (used for work for only a short period each year, primarily for land cultivation) and the number of cattle kept as part of a follower herd to breed replacements for oxen could be reduced. More productive, smaller herds will release capital and feed resources for individual animals with higher overall output and thus achieve more sustainable production systems, higher incomes, and better nutrition within a five-year period.

The adoption of the technologies to be tested through this project is expected to have a large impact on milk production and the incomes of smallholder farmers. With proper management, milk production per cow can increase four to seven times, resulting in increases in cash income. On-station and on-farm results substantiate this potential to attain such targets. However, successful introduction will require complementary improved management practices, including new feed production, and better feeding and traction systems being adopted on-farm.

Increased milk production is also expected to have a significant effect on the nutritional status of the rural poor by increasing consumption of dairy products. These products contain many important nutrients in bioavailable form, especially carbohydrates, protein and calcium, as well as the micronutrient vitamin A, the B-complexes and zinc, essential for growth and proper physical and mental development. For instance, studies have shown that children deprived of vitamin B_{12}, which comes only from animal products, suffer impaired learning abilities and will not develop to their full potential.

In most countries in Africa only oxen are used for traction. However, at the end of the project, the project farmers will have adopted the following technologies:

1. Replacement of two oxen and two local cows by two crossbred dairy cows.
2. Increased on-farm feed resources and improved use of them: cultivation of feed crops and fodder trees fed as cut-and-carry, fodder conservation, treatment of low digestibility crop residues.
3. Purchase and feeding of at least 2 kg of simple, appropriate and affordable feed supplement, per day per cow, during lactation and work periods.
4. Use of crossbred cows for traction to plough, on average, at least half of the cropping land.
5. Construction of a barn for the crossbred cows.

2. Expected end-of-project situation

The project will be located in areas where oxen are currently used by farmers as work animals and where crossbred dairy cattle are available and enjoy good reputation in rural communities. Field operations will involve between 20 and 50 resource-poor farm households that presently own only local cattle and use work oxen.

Besides the income effect, on-farm results so far show that the use of crossbred dairy cows will increase consumption of food for all household members by about 80%.

It is also expected that there will be a positive impact on grazing management, with good animal output being achieved while maintaining adequate stocking rates. With the present traditional system, the carrying capacity is frequently exceeded leading to overstocking. Meanwhile, the improved system would match the carrying capacity of available grazing land with animal output.

Results from pilot areas established by the project must indicate that the technological package has been adopted by the majority of the collaborating farmers. Overall farm output will be increased, mainly on account of better management of farm resources and some strategic inputs and services provided by off-farm services. Livestock performance results will show a stable herd which contributes a substantial amount of sales, animal power and manure to farm operations and output. Economic analysis will confirm a steady positive trend in total revenue, adequate remuneration of farm labour and capitalisation rate. Off-farm services will be increasingly managed by organised farmers associations/groups and output of goods from rural workshops, cottage industries and village processing units will have increased considerably. External technical assistance might still be required to maintain optimal levels of management but it will be restricted to very precise subjects that can be dealt with through short-term consultancies.

3. Target beneficiaries

Direct beneficiaries: collaborating smallholder farmers and their families plus local project staff.

Indirect beneficiaries: neighbouring smallholder farmers and their families, villagers, artisans, traders and businessmen, small-scale farm produce processors who either individually or in organised groups will participate in information/sensitisation meetings and gradually adopt technical messages derived from the technical approach encouraged by the project.

This technology package promises to benefit all the members of poor rural households, both in terms of income and nutrition, but the intrahousehold consequences including labour costs will be closely monitored and studied further to ensure a positive impact on all family members. A study conducted in the early 1980s by ILCA indicated that the introduction of crossbred dairy cattle to the Ethiopian highlands, while providing a number of advantages to the household as a whole (e.g. higher milk output and incomes), increased the labour demands placed on women (Whalen 1984). Later studies (MoA/FINNIDA 1991), however, confirmed that while women's labour time was increased, it was the overall labour time of men that increased the most.

4. Project strategy and institutional arrangements

The implementation strategy relies on a participatory approach of the selected farmers during the on-farm validation process of the proposed technology. This means that even though the project is willing to share a larger part of the inevitable risks of agricultural operations (traditional or new), the farmer must assume his responsibilities as a partner under a properly defined commercial contract. This legal instrument will facilitate the expansion of the scheme once positive validation results are confirmed and local institutions take up follow-up management responsibilities.

The supply of crossbred dairy cows, their harnesses and equipment must be similar if not identical in all testing sites, and the training of both farmers and animals plus livestock management instructions must be arranged following strict common standards.

Government services dealing with livestock production, research, and extension activities plus farmers organisations will assist the project in its training programme and in the logistical support required to implement field interventions.

Project components based in each of the participating countries will be entrusted to maintain close contact with the headquarters of the regional project and to follow their technical direction and administrative management instructions for project operations. The regional project will have its headquarters at ILRI, Addis Ababa, from where the international team leader will co-ordinate overall operations.

5. Reasons for assistance from donor

Local technical services are aware of the need to address the technical and developmental aspects of this problem, but they do not at present have sufficient numbers of qualified staff or the material resources required to deal urgently with this situation. ILRI has developed a cow traction technology package that could contribute to resolving the above mentioned problems. The field testing of this promising technology will occur at the farm level with direct participation of national research and extension programmes and selected farmers. The technical interventions would be executed by FAO and ILRI in collaboration. These development objectives will be supported financially by a donor. Regional operations of the project would be greatly facilitated through institutional support provided to participating countries by international institutions such as donors, and by FAO and ILRI.

6. Special considerations

The excellent chances for the sustainability of these technologies are evidenced by the continuation and further development of crossbred dairy activities in many regions of participating countries (see Country Project appendices).

required for a rational and profitable multi-purpose use of cows, creates opportunities for the private sector to provide inputs and services such as animal feeds, fertiliser, seed, harnesses, tillage equipment, carts, AI and veterinary services, and product marketing, for both milk and processed dairy products. Marketing opportunities and profitable outlets of fresh milk for smallholders are provided by private as well as parastatal milk collection operations. Rural based dairy processing operated and managed by women will provide an opportunity to improve their economic position in society.

The introduction of crossbred cows for milk production and draft will have especially positive effects on the role of women in development and the nutrition of children. Since crossbred cows require stall-feeding, they are kept close to the homestead where care is mainly provided by the women, thus increasing their role in an important income earning activity. Furthermore, the additional milk produced can lead to increased incomes for women if more dairy products can be made since the proceeds from the sale of these products are traditionally controlled by women. Technologies developed by ILRI can cut the labour time required to make butter and cheese so that women can process a greater volume of fresh milk. Dairy processing would thus not become a heavy and unprofitable additional activity imposed on women.

Increased milk production has also been shown to lead to increased consumption within the household, mainly on the part of children (Gryseels and Whalen 1984). Dairy production can be important in achieving food security in three ways:

- directly through increased food production that adds directly to household nutrition
- indirectly through increased cash income that can be used to purchase food, as well as other household items
- by generating employment.

The environmental effects of the dual use of crossbred cows for milk and traction also promise to be positive. Keeping fewer animals would lower stocking rates. This would help alleviate overgrazing, already present in many areas of Africa, and create a more productive farming system that makes better, more sustainable use of the natural resource base.

This intervention is an example of how higher productivity livestock technologies can have a substantial impact on the incomes of all farmers. Constraints to resource-poor households benefiting from this technology do exist, but can be overcome through special programmes such as credit and insurance schemes.

The project will allow formal linkage mechanisms to be set up for information exchange and collaboration between scientists; the project will encourage technical co-operation among developing countries (TCDC). It will also encourage collaborative work among development organisations involved in research and transfer of multi-purpose cattle and buffalo technologies in Africa, Asia, Latin America and the Caribbean. The project will benefit from the participation of the CGIAR centres as well as the Australian Centre for International Research (ACIAR) Draught Animal Power (DAP) project. These project activities will represent a further development of DAP collaborative programmes initiated by ACIAR and African NARS. These activities will provide an opportunity to formalise collaborative relations between Asian and African NARS.

7. Co-ordination arrangements

National policies that encourage better use of work animals and those that promote dairy production are co-ordinated by specialised government units in each of the participating countries; these units also fund research and development programmes related to such activities. These units will assist project activities by ensuring that timely and appropriate government decisions will be made to allocate the financial support required for on-farm testing of multi-purpose use of crossbred dairy cows by smallholder farmers.

This project is designed as a regional project to expand this promising technology to other African countries. ILRI will provide facilities to locate the co-ordinating centre and institutional headquarters of the regional project in Addis Ababa.

8. Counterpart support capacity

Project activities will be jointly planned and executed by the collaborating partners who will provide substantial (in kind) and supplementary support to the project. Livestock research institutes of each country will provide: the national project co-ordinator; technical and support staff; livestock resources; assistance with data collection, management and analysis; office, research and laboratory facilities, as well as housing and logistical support on-station and on-farm. Regional offices of the institutes will provide support for on-farm testing sites from their dairy specialists, animal traction specialists, forage specialists, veterinarians and extension specialists; training and extension inputs will be provided on feed technologies, use of work animals and equipment, breeding and reproduction, and dairy processing; and assistance will be made available for disease characterisation.

Sustainable development agreement clause

If development operations are concluded successfully, all inputs and financial support granted as development allocation to the National Executing Unit by the governments to carry out this project, these will become an additional allocation to the Ordinary Budget assigned to this Unit by the Ministries of Planning and of Finance.

C. Development objective

The development objective of the project is to support a smallholder commercial agricultural activity which can have a significant impact on sustainable food production, food security, farmer incomes, and human nutrition. Demand driven dairy development is an example of an agricultural activity that can be a driving force to national economic development.

The project will accomplish this by transferring new crossbred cow technologies for milk production and draft that will increase the productivity and sustainability of smallholder mixed production systems.

D. Immediate objectives, outputs and activities

Transfer of management practices and new technologies for the multi-purpose use of crossbred dairy cows by smallholder farmers.

1. Immediate objective 1

Adoption of dairy cow traction technologies (DCTT) at smallholder farm level.

1.1 Output 1: Testing sites located and participating farmers identified and selected.

Activities

1.1.1 Verification of conditions in proposed locations regarding field testing DCTT

1.1.2 Presentation to smallholder farmers and collaborating partners of the objectives and benefits of DCTT

-Preliminary field results from Ethiopia and video presentation.

-Demonstration of DCTT

-Evaluation sheet to record interest and doubts of participants.

1.1.3 Selection of farmers and verification of commitment and needs

1.2 Output 2: Technical supervision, monitoring and evaluation scheme in place for field testing DCTT.

Activities

1.2.1 Appointment of full time project staff to the monitoring and evaluation (M&E) scheme; permanent assignment of working facilities

1.2.2 Prepare M&E material; methodological manuals

1.2.3 Purchase of office and field M&E equipment

1.2.4 Training of M&E staff on project procedures

1.2.5 Information meeting with collaborating institutions and farmers

1.2.6 Training of collaborating staff and farmers on project procedures for M&E

1.2.7 Establish schedule of periodical M&E visits to farmers for data collection, storage and processing. Keep data bank up to date

1.2.8 Prepare monthly data reports for technical analysis required by project management

1.2.9 Special agreement to secure transport facilities:

(a)Subcontract transportation support

(b)Allocation of equipment: Type

Operating: Fuel

Oil

Service

Spare parts

1.3 Output 3: Increased cow output (work, surplus milk and calf production) and farm productivity.

Activities

1.3.1 Analysis and evaluation of cow production performance: work, reproduction, milk production and feed use

1.3.2 Analysis and evaluation of farm management practices

1.3.3 Economic analysis and conclusions of on-farm DCTT results and overall farm productivity

1.3.4 Analysis of perception and attitudes toward adoption of DCTT: farmers, collaborating units and government services

1.3.5 Meeting with field testing participants

1.3.6 Meeting with supervising and funding representatives

1.3.7 Backstopping missions: Technical

1.3.8 Evaluation missions

2. Immediate objective 2

Establishment of rural based support system to supply production components and to market products derived from DCTT operations.

2.1 Output 1: Mechanism in place for supply of production components required for field testing of DCTT.

Activities

2.1.1 Allocation of institutional facilities:

-Infrastructure: Implementing

Collaborating

-Equipment

-Implements

-Materials

-Animals

2.1.2 Allocation of existing production components by farmers

- Infrastructure: sheds
barns
store
- Land: natural grasslands
- Animals
- Feed resources: crop residues
- Harness
- Implements
- Manure
- Water and daily watering

2.1.3 Purchase production components and improvement of infrastructure, implements, equipment by farmers

- Infrastructure
- Implements
- Feed resources: fodder
supplements
- Fertiliser
- Seeds
- Plant protection
- Animal health inputs
- Reproduction inputs: bull service
AI

2.1.4 Arrangements with suppliers of production components:

- Sub-contract input supplies: seeds
fertilisers
chemical products
implements
other materials
- Subcontract on-farm services: Reproduction
Health

2.1.5 Purchase field testing equipment and operating materials

2.1.6 Arrangements for loan applications for production components

(a) From local credit system

(b) From project revolving fund: Seeds
Fertiliser
Animals
Implements

2.1.7 Training of project staff and farmers:

Feeds and feeding
Fodder crops/trees

Reproduction
Health
DAP technology
Dairy production

2.1.8 Field supervision: Annual schedule

2.2 Output 2: Mechanism in place for marketing of products derived from activities of DCTT.
Activities

2.2.1 Meetings with farmers and potential collaborating agencies: assess interest for added value of milk through processing.

2.2.2 Training of participating farmers:
Dairy technology
Organising farmers' groups
Rural mini-processing unit

2.2.3 Farm elements to be improved or purchased:
Infrastructure
Equipment
Materials

2.2.4 Marketing arrangements for surplus milk:
On-farm storage: churns
Milk and dairy product collection
Commercial arrangements.

2.2.5 Arrangements for loan applications for dairy processing and on-farm storage.

2.2.6 Field supervision: Annual schedule

E. Inputs

1. Government inputs

IAR and MoA (36 months duration):

- infrastructure and logistical support (IAR/Holetta station)
- research facilities and animals
- infrastructure: State Cattle Breeding herd and AI facilities (MoA); house (IAR/Holetta station)
- scientific support: animal scientists and technical support staff
- feed and milk laboratory analysis at Holetta
- veterinarians, extension agents
- National Co-ordination Unit (IAR/Holetta station).

2. Donor inputs

The contribution of the project will be the following (36 months duration):

- personnel:
  Regional Co-ordinator (international staff): one Animal Scientist (36 months)
  Consultant staff: one ILRI Animal Scientist (9 months)
  Consultant staff: one ILRI Agricultural Economist (9 months)
  Technical Assistance: one FAO Associate Professional Officer (36 months)
  Support staff: one Regional Administrator (36 months)
- laboratory and field experiment equipment: draft measurement equipment; 1 ergometer, one load cell (and maintenance)
- laboratory supplies: chemicals, progesterone kits
- veterinary supplies: antibiotics, antihelmintics, minerals, vitamins
- four-wheel drive vehicle
- vehicle running costs and maintenance
- printing and publications: manuals, reports
- training
- meetings and workshops.

F. Risks

- insufficient and untimely delivery of inputs: Government and Donor
- lack of interest among smallholder farmers to share part of the risk in testing the new technology
- supply problems in dairy crossbred cows, harnesses and equipment
- insufficient farm feedstock to ensure adequate management standards
- difficulties to put in place a credit mechanism
- difficulties to establish and manage a business oriented milk-collection scheme
- lack of support from local pricing policies and control of imports.

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Discussion on cow traction technologies with Asian participants

Shapiro: We would like to get your suggestions on these proposals in order to provide the East African country representatives with your inputs.

Kiran Singh: I suggest you prepare a technology description write-up in the simplest form so that the people who are going to implement this technology in other countries really understand it. I also suggest that six to nine months after the project has started in Africa, and depending upon its progress and results, it could be extended to countries outside the continent.

Wang: Comments on the project proposals in African countries.
1. I think the priority for the implementation of these projects is suitability of the identified area. The cows must already be in place because it will become very difficult to find the funds to purchase those cows and at the same time train farmers on many technologies all at once.
2. Some countries indicate in their inputs list the manufacturing of tools and equipment for cow traction. In China we use the same implements for local and improved breeds.
3. In China the government is encouraging farmers to use cows for traction. In the beginning it was very difficult because the feeding and management were not adequate. During the first five to eight years improved feed and feeding practices were introduced to meet the higher nutrient requirements of cows.
4. Training of farmers and of cows has to be given high priority. In our experience, training of heifers should start as early as 14 months of age.

Sevilla: Under the section Risks, the non-co-operation of farmers is common in all proposals. I think this is an important issue; mechanisms should be developed to ensure that co-operators adhere to the project until its completion in order to gather the information required and have the required demonstration effect.

Teleni: To add to that, I believe that a good farmer is the essential component of the project. The farmer with many options has the luxury to have an attitude, while farmers with few options may be more willing to test packages for immediate or medium-term benefits.

Bunyavejchewin: My comments are on the proposal component dealing with the cross-breeding programme. The question arises on how to handle the breeding of F_1 cows to keep the exotic blood level around 50% to maintain the production advantages as well as the indigenous resistance to disease etc. With AI, farmers may want to increase the exotic blood level.
Another point I would like to make is the importance of the socio-economic analysis of the DCTT in the long term and its sustainability. Will the cows used during the project period remain at the farm and will you be able to return to that area and check on their performance and use a few years after the end of the project?

Shapiro: Let's first discuss the breeding aspect.

Zerbini: At present, the strategy adopted in the on-farm project is to ensure the exotic level is not greater than 75% and possibly maintain it between 50 and 62.5%. Either we breed F_1 with F_1 or we cross F_1 with bulls of the same two breeds. For example, if the farmer breeds his F_1 heifer with purebred Friesian and obtains a 75% Friesian heifer, he should then breed that heifer back to a Boran sire.

Muller-Haye: Mating the 75% Friesian heifer with a pure Boran sire can be done in large operations but it will be difficult to achieve at the smallholder level.

Chirgwin: Many cross-breeding programmes that have introduced exotic blood into indigenous cattle have found it difficult to control after the first generation of F_1.

Teleni: What is the probability that the farmers will follow your breeding recommendations after the project ends?

Zerbini: Our best chance of controlling the breeding process is that IAR scientists and MoA AI centres will build into the project the long-term breeding strategy of maintaining the level of exotic blood around 62.5%. This will have to include a selection scheme for the F_1 and incentives for farmers to follow it. This is an important issue that needs to be dealt with more in general at the national level.

Singh: In the last one or two years this issue of cross-breeding has been discussed and has remained with a big question mark. Earlier, most of the countries started very ambitious programmes. Many times there were failures on account of the management of the breeding programmes, and quite often on disease aspects because crossbreds are more susceptible to diseases than native animals. I have attended a number of international forums and there this issue has been discussed time and again.
A number of developing countries have expressed their apprehensions about the continuation of their cross-breeding programmes because the maintenance of the F_1 is difficult, especially at the smallholder level. In India we had launched a very large cross-breeding programme; however, the experience has been that beyond F_1, production levels and resistance to disease are lower than that of local breeds. In addition, the indigenous germplasm was lost. Another factor to consider is that if F_1 have to be maintained, semen must be bought from developed countries and funds may not be available. In India there is the additional problem of crossbred males. They are seldom used for traction and since they are not slaughtered they are abandoned, creating additional feed and pollution problems. However, males of native breeds are managed and used by everyone. These factors might be different in other Asian, African or Latin American countries.
Perhaps a more intense selection programme among local breeds with greater potential could be adopted. Cross-breeding could be a suitable solution for commercial farms that can afford the costs and could follow the cross-breeding schemes.
I believe breeders should rethink these programmes in order to make them more sustainable and make sure that the indigenous germplasm is conserved.

Muller-Haye: The problem of the crossbred males is a specific Indian problem because in many other countries they would collect these young bulls and fatten them as they do in other Asian countries, Latin America and Africa.
The cross-breeding programmes have brought an increase in productivity which would have taken many more years to achieve through selection within indigenous breeds. What we have to do is develop better breeding schemes and make sure we conserve the biodiversity of indigenous breeds.

Chirgwin: There is a category of farmers that can do well with cross-breeding programmes, whether for higher yields of milk or meat, if they can afford their improved management. However, for small farmers in Africa, South America and maybe in Asia there are lots of indigenous breeds with high levels of productivity in their local environment. Although we can tackle the problem of milk production quickly through cross-breeding, we should not forget that there is also the alternative of selection.

Shapiro: Perhaps it is worthwhile to give you the ILRI perspective on this so that you don't go away thinking that we are recommending cross-breeding under all circumstances. I think many

times during this expert consultation we have mentioned that dairy and cow traction are not technologies for everyone. We have often talked about peri-urban dairy and have stated that the opportunity for intensified dairying is demand driven around urban areas and that is where we believe cross-breeding has its place. In addition, the conservation of genetic resources has its niche.
Are there other issues related to the proposals?

Teleni: I think that it is really important to keep in mind that this technology is not for everyone and this should be taken into account in these projects.
If the countries proposing to test this technology are really committed to succeeding it is necessary they start where most of the factors are in place.

Shapiro: This is a good point. We will have to make sure that the conditions in these different countries and the different sites proposed are appropriate.

Teleni: Your creditability is on the line. You have to go to those places where you have the greatest probability of obtaining the results you expect.

Zerbini: In the selection of countries and sites we should also attempt to assess the commitment and confidence in the technology of those proposing the project and of their governments.

Singh: I would like to point out not only the importance of having crossbred cows in place but also of having animal traction already in practice where this project is implemented.

Zerbini: This is important because in some parts of Africa the introduction of animal traction has failed. Therefore the assumption that animal traction will be adopted readily by farmers may not hold.

Chirgwin: I agree with this point. There are a lot of complex reasons for the low success rate of introducing animal traction in new areas. There must be a more integrated approach in which animals used for traction during a particular period are then used for other functions in other periods of the year and not abandoned or not used until the next season. There is a need to focus on new ways of using animals throughout the year, making the best use of all resources available on-farm.
I support the idea of testing DCTT in places where you already have acceptance of the working animal and the only change to be made would be from male to female.

Sevilla: Have the countries proposing this project conducted a rapid rural appraisal to look at the attitude of farmers towards this technology?

Shapiro: I think this goes back to the same issue of choosing the most appropriate location. We should be careful in making sure that we introduce as little change as possible into the existing farming systems except for the use of cows instead of oxen. Farmers do not readily adopt many technologies simultaneously.

Discussion on the visit to Holetta

The discussion was opened by Zerbini inviting the participants to give their feedback on the testing of DCTT at Holetta, especially with regard to feeds, feeding and management of cows.

Saadullah: What are the future plans to increase the number of crossbreds in the area? Why don't you promote the use of local cows?

Alemu Gebre Wold: The National AI Center is responsible for supplying exotic or crossbred semen through AI to farmers.
The use of local cows is not encouraged because they have low productivity and long calving intervals. The objective of using crossbred cows for milk production and draft is to increase milk production, maintain draft power on-farm and use the scarce feed resources on fewer but more productive cattle.

Ulotu: In Tanzania there is a high demand for crossbred animals. Good zebu cows are selected and bred with exotic sires. Farmers cannot keep more than four crossbred cattle. Since during the ploughing season farmers have to bring in oxen from other areas, the use of cows for multiple purposes will alleviate this situation and I expect high rates of adoption of DCTT in these areas.

Kumwenda: With a lot of demonstrations farmers will understand the benefits of DCTT, especially in areas of Malawi where crossbred cows are in place.

Wandera: Except for the heavier implements used and the lower rainfall for feed production in the Kenyan highlands, the situation is similar. This technology could be adapted to the Kenyan situation.

Maiseli: With how many farmers do you expect to expand testing of DCTT and in how many years do you expect extension to take over and some spontaneous adoption to occur?

Alemu Gebre Wold: We plan to expand it to 70 farmers divided into three resource endowment categories (rich, medium income and poor). After the project is completed we expect the MoA and IAR extension to continue with the development activities and services necessary for DCTT. The anthropological survey conducted indicated that a span of 10–15 years is necessary to examine the adoption process of DCTT.

Maiseli: Is there a need to test different implements?

Zerbini: Our on-station experimentation shows that cows are most efficient when pulling 14% live weight. Implements used should be adapted to be in that range.

Wandera: The adoption rate of DCTT should be evaluated a few years after the completion of the project.

Ulotu: The involvement of village extension personnel in DCTT testing will help adoption in the future.

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