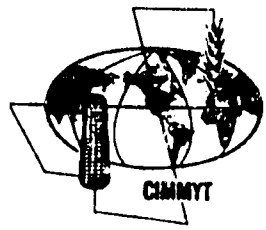
PN-ABC-794



INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER

REPORT OF A NETWORKSHOP ON DRAUGHT POWER AND ANIMAL FEEDING IN EASTERN AND SOUTHERN AFRICA

EZULWINI, SWAZILAND October 4-6, 1983

Networking Workshops: Report No.2

CIMMYT Eastern and Southern Africa Economics Programme,
P.O. Box 1473,
MBABANE, Swaziland.

June 1984

LIST OF CONTENTS

PROCEEDINGS OF THE CIMMYT NETWORKSHOP ON DRAUGHT POWER AND ANIMAL FEEDING - SWAZILAND 4 - 6 OCTOBER 1983

Introduction and Summary

Report Layout

This report presents the proceedings of the CIMMYT networkshop on Draught Power and Animal Feeding held in Swaziland from 4 - 6 October, 1983. The report is arranged in three sections. A summary inventory of the cross-country experiences discussed is given at the end of this introduction.

In Section One a summary is given of each country's presentation of the local farming system based on wall charts prepared by participants. An abbreviated version of the discussions on the systems as depicted on the wall charts and presented the previous day in submitted papers follows in each case.

The relevant submitted paper(s) referred to are not included in this report. Copies of any of the listed papers can be provided on request from: Allan Low, Regional Economist, CIMMYT, PO Box 1473, Mbabane, Swaziland.

Section Two deals with the experimental programmes on animal nutrition, tillage, forage production and crop residue feeding that were described by participants. For each presentation an abstract of the submitted paper is provided, together with any additional information not given in the papers. This is followed again by an abbreviated version of the discussions on each experimental programme.

Again, the papers referred to are not included in this report, but can be obtained on request.

Section Three summarises discussion on the need for networking and how to do it and indicates how the participants assessed this networkshop in terms of general approach and the specific format followed.

A first draft of this report was distributed to all participants in November 1983. We are grateful for the numerous comments/ammendments received, most of which have been incorporated in this final version

The Origins of the Networkshop

In 1982 USAID and CIMMYT agreed to co-operate in a project to promote on-farm research with a farming systems perspective in Eastern and Southern Africa. USAID's interest stemmed from its commitments to agricultural research and extension projects in ten countries through the region from Sudan to Swaziland. CIMMYT's interest stemmed from its world-wide experience in on-farm research with a farming systems perspective and the desire to expand the coverage of its on-farm research support programme in the Eastern and Southern African region.

One of the major activities of the combined CIMMYT/USAID project is networking. This activity is defined as the facilitation of discussion and exchange among both national researchers and USAID team members in various programmes so that the accumulating experience can be shared. The first networking activity took the form of a seminar for senior agricultural research administrators which was held in Nairobi in April 1983. At this seminar the research administrators endorsed the need for networking and recommended that this include focusing on specific technology issues, and the inventoring of cross-country problems and solutions (CIMMYT, 1983).

The Need for Networking and the Role of Technical Workshops

There is no need to emphasise the value of exchanging ideas, information and experience in any sphere of life. In a new field of activity, such as on-farm research, the need for special networking efforts arises because:

(a) practitioners tend to be few and scattered;

(b) formal links, e.g., through specialised journals, do not exist;

(c) the development of sound methodologies will not speedily occur in the absence of cumulative trial and error experience.

On top of this we have the situation in Eastern and Southern Africa where on-farm research is being promoted very largely through international donor-aided projects in support of national research and extension programmes. Each of these projects is individually funded, contracted, implemented and assessed. Ever within USAID there is no provision for exchange of ideas and experience among the various contractors. Regrettably, co-operation and exchange of experiences between donors is even less likely.

In these circumstances there is every chance that the lessons and experience gained in one project in one country will not be taken account of in the planning or implementation of the next project in a neighbouring country. Given the young stage of on-farm research methodology and the way it is being rapidly promoted through a large number of individual projects (over 30 USAID projects in Africa have an on-farm research component), networking is expected to pay substantial dividends.

The dividends from technical workshops such as this are expected to come from generating exchange and widening the data and experience base from which technical researchers can draw in their local specific situations. We do not expect networkshops such as this to come up with common solutions to a common problem. Rather, we expect that knowledge of how the same problem manifests itself under different circumstances and a knowledge of a range of potential solutions that have been tested under different conditions will allow researchers to:

(a) better understand the specific nature of the problem in their own localities;

(b) be in a better position to choose technologies for on-farm experimentation that have a good chance of being successful in their particular localities; and

(c) identify gaps in current component research efforts.

Networking Modes

Given the need for networking, the next question is what is the best way to go about it. The widespread distribution of a regular publication is one obvious way of keeping OFR/FSP researchers in touch with what is going on outside their own localities or countries. CIMMYT puts out a farming systems newsletter from Nairobi. Experience suggests that this type of networking tends to be somewhat passive in that most readers are happy to receive information and ideas but only a few make significant contributions. More active ways of seeking out ideas, experiences and results and bringing them to the notice of others can usefully complement the newsletter approach.

Mike Collinson recently circulated some proposals on how a more active networking initiative might function. He suggested that the first stage should be to identify specific areas of concern that were common across country locations. The next stage would involve the inventoring of two aspects of the area of concern:

(a) First, we would describe the characteristics of local specific systems where the problem area was important. The aim would be to see how the problem manifested itself under different agro-climatic, economic and social conditions and to inventory the ways in which farmers were managing the problem under different circumstances.

(b) The second inventoring task would concentrate on listing past and ongoing component, station-based, research and generate a directory of current researchers working on the problem area.

The aim of the two inventoring tasks being to give on-farm researchers ready access to a body of information which they can bring to bear on particular problems when they are diagnosed as important in a local farming system.

This workshop was programmed to follow the same format, i.e., description of systems where access to draught power has been diagnosed as important and reporting on experimental work that addresses this problem through animal feeding or reduction in draught requirements.

The advantage of workshops such as this one is that they maximise potential for active participation among researchers. But not all researchers involved in a particular problem can possibly be represented at one time so coverage of systems and experimental

work cannot be as comprehensive as with the direct inventoring approach. We think that both the inventoring and workshop modes have their place and it is envisaged that both types will be initiated under the CIMMYT/USAID networking activity.

A report of the first inventory exercise on the draught power and animal feeding problem in Botswana, Lesotho and Swaziland is being sent to conference participants and is available to others on request from the CIMMYT Swaziland office.

Draught Power and Animal Feeding

The subject of this first technical networkshop is draught power and animal feeding because timely access to draught for initial cultivations has been observed to be a major problem in many local farming systems from Sudan to Lesotho. Difficulty in gaining access to adequate draught power appears to be limiting the development of many farming systems. Because oxen are weak at the start of the season, or because they are not readily available at all, plantings are delayed, seedbeds are inadequately prepared and weeding becomes a problem. This problem of draught power presents us with a major research opportunity where we could make a big impact on the productivity of many farming systems in the region by improving the availability and/or effectiveness of draught power.

Workshop Summary - Inventory of Cross-Country Experiences

The following summary of workshop proceedings is presented in the form of an inventory of interventions identified as being appropriate in local systems and of research work described and discussed.

Table 1 presents a summary of the interventions thought to be appropriate in the local farming systems described by participants. The types of intervention mentioned have been divided into two broad categories:

(a) interventions aimed at improving the capacity of animals to generate more draught power;

(b) interventions aimed at reducing the demand for draught.

It would appear that the latter type of intervention was thought to be more appropriate in Southern (Zambia, Zimbabwe, Botswana, Lesotho and Swaziland) than Eastern Africa (Kenya, Sudan). This may be related to better agronomic opportunities for increasing animal feed production in Kenya especially through crop residues and forage production. But it is probably also related to the fact that in areas where the animal/grazing clash is more severe (e.g. Kenya as opposed to Zambia), labour intensive methods of producing and feeding crop residues or forages become more appropriate.

TABLE 1

SUMMARY OF IDENTIFIED INTERVENTIONS

	Country in which the intervention was mentioned as being appropriate in a local system
1. IMPROVE ANIMALS	
(a) Feeding	
- Forage Crops	KhKm/Su/Bot
- Fodder Shrubs	KmKh
- Forage Legume inter-cropping	Zimb/KmKh/Bot
- Pasture improvement	Zimb/Km/Su/Bot
- Crop residues/by-products	Bot/Les/KmKh/Su
- Fencing	Bot
- Controlled grazing/stocking	Bot/Sw/Zimb/Km
- Mineral Supplements	Bot/Su
- Other Supplements	Zimb/Les/Kh/Su
- Selective feeding	Zimb/Les
- Education on nutrition requirements	Les/Km
(b) Animal	
- Water conservation	Km
- Improved conformation (breeding)	Zimb
- Cow management in draught	
- Stock management education/extension (destocking)	Bot/Zimb/Su
2. REDUCE DEMAND FOR (INCREASED EFFICIENCY) ANIMAL DRAUGHT	
- Reduced/minimum tillage	Zimb
* - Change tillage/planting sequence	Sw/Zimb/Les/Za
- Tractor use	Sw/Bots/Zimb
- Improved implements	Za/Sw/Zimb/Bot
- Herbicides	Sw
- Maize breeding/improvement	Za/Km
- Cultivation planting techniques	Bot/Sw
- Education on handling animals and implements in draught	Zimb

* e.g. Winter ploughing/staggered planting with different varieties

KEY

Bot	=	Botswana	Kh	=	Kenya (high (potential)
Km	=	Kenya (medium potential)	Les	=	Lesotho
Su	=	Sudan	Sw	=	Swaziland
Za	=	Zambia	Zimb	=	Zimbabwe

Apart from those generalisations no clear-cut divisions of appropriate interventions by region or country emerged. Some parallel work on forage legumes is being conducted across countries. Data on the treatment and feeding of crop residues came largely from Kenya, while reports of work on tillage methods and planting sequences came from the southern countries.

In terms of the two broad categories of intervention, the experimental programme work discussed in Section Two break down as follows:

IMPROVING ANIMALS

Lesotho

- pen vs range feeding value of protein mineral lick

Botswana

- Babala and Dolichos Lablab production
- direct and undersowing of grasses and legumes
- range re-seeding and strip discing

Western Kenya

- silage production
- intercropping legumes
- Napier grass for zero grazing
- stall feeding
- stripping and topping of maize plants
- intercropping sorghum and early ratooning
- pigeon pea interplanted
- leucaena production

Eastern Kenya

- improved productivity of natural pastures
- physical and chemical treatment of crop residues
- grown pasture and fodder crops
- Zebu vs crossbred oxen in draught

Ethiopia (ILCA)

- forage legume screening and germplasm bank
- improving digestbility of crop residues
- feed quality requirements for traction

REDUCING DEMAND

Botswana

- plough planter vs broadcast and plough
- tractor draught implements

Zambia

- winter ploughing
- seed placement vs dribbling
- planting implements
- minimum tillage and herbicides

Zimbabwe

- minimum tillage (ripper type and herbicides or direct planting into winter ploughed fields)

ILCA

- single ox plough
- use of cows in draught

---oOo---

References

CIMMYT (1983) "Report of a Seminar for Senior Agricultural Research Administrators from Eastern and Southern Africa", Networking Workshops Report #1, Nairobi, Kenya, April 18-20 1983.

LIST OF PAPERS PRESENTED AT CIMMYT NETWORKSHOP ON DRAUGHT POWER AND ANIMAL FEEDING 4 - 6 OCTOBER 1983

PAPER No.	TITLE OF PAPER	AUTHOR
1	Opening Speech	G. Dlamini
2	Networking and the Draught Power/ Animal Feeding Problem	A. Low
3	Draught Power in Botswana I The Draught Power Problem in Perspective	T. Farrington and C. R. Riches
4	Draught Animal Feeding and Management on Swazi Nation Land	V. Watson, Z.Mamba, S. Mamba
5	Aspects of the Draught Power Constraint on Maize Production in Recommendation Domain No. 5, Kabwe Rural District, Zambia	C. Chabala
6	The Crop - Livestock Interrelationship and Farmer Adaptation to Problems of Reduced Cattle Numbers and Lack of Dry Season Feed in Communal Areas of Zimbabwe	E. M. Shumba
7	The Draught Power Problem in Zimbabwe: An Extension's View of the Causes, Effects and Solution	G.D. Mudimu
8	A Description of a Local Farming System (in Kenya) focusing on Draught Power and Animal Feed Problems	H.K. Muiruri
9	Sources and Utilization of Power and Equipment for Malawi's Agricultural Sector	D.D. Singa
10	Animal Feeding and Management in India	K.V. Ramanaiah
11	A Realistic Look at Livestock Research and Development in Lesotho	E.W. Klosterman
12	Value of a Winter Lick Fed to Cattle under Lesotho Farmer Conditions	M. Molapo, L. Motjope E.W. Klosterman

13	Draught Power in Botswana II The Design and Testing of Solutions	T. Farrington and C. R. Riches
14	Ground Preparation and Planting - A Key Constraint for Ox Cultivators in Zambia	T.G. Maynard
15	On-Farm Minimum Tillage Experiment: A Possible Solution to Draught Power Problems gripping Zimbabwe's Communal Areas	E. M. Shumba
16	Forage Legumes in the Ethiopian Highlands	S. Jutzi
17	The Grazing Animal and Land Pressures in Small Farm Systems	D.R. Chandler
18	Feed Production Research for Smallholder Agriculturalists in Western Kenya	S. Russo, R. Hart, K. Otieno, J. Owino J. Onim
19	Animal Feeding in Small Farm Systems	S. Tessema
20	ILCA's Approach to Livestock Nutrition in the Farming Systems Context	A. K. Mosi and M. Butterworth

BACKGROUND PAPERS

Improving the Nutrition of Grazing Animals using Legumes, Fertilizer and Mineral Supplements	R.J. Jones
Research on a No-till, Tropical Legume-ley Farming Strategy	R.J. Jones, R.L. McCown

Copies of the above papers are available on request from:

Allan Low,
Regional Economist,
PO Box 1473,
MBABANE,
Swaziland.

SECTION ONE

Systems Descriptions

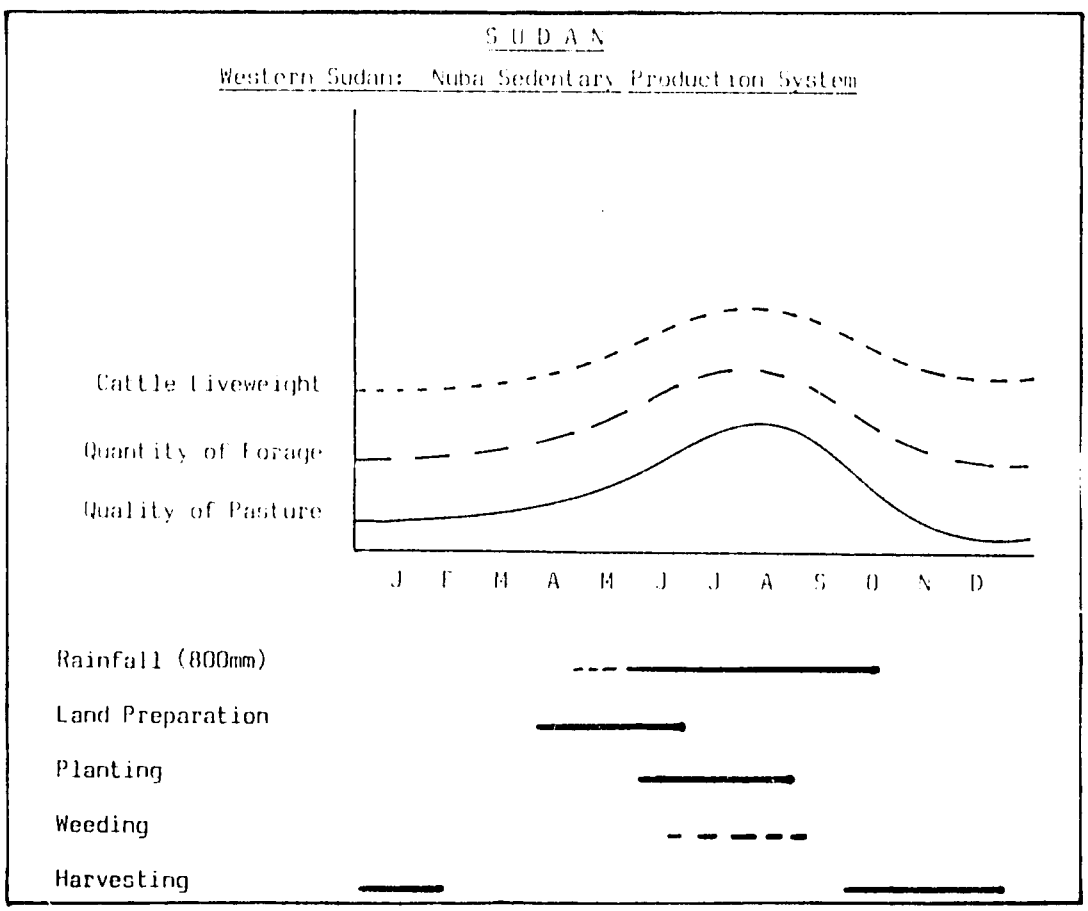
SUDAN

(Western Sudan Agricultural Research Project)

Dr. Henson substituted for the invited Sudanese participants who were unable to attend and gave the following presentation in lieu of their submitted papers. Dr. Henson's presentation addressed research being carried out by the Western Sudan Agricultural Research Project (WSARP). The Nuba sedentary system specifically was addressed.

The Farming System

The area under consideration is approximately 250 miles south west of Khartoum in the Nuba Mountain area of the Kardofan region. Animal traction as a mechanism for crop production is only in its infancy. The Nuba practise a sedentary system of agriculture, but maintain livestock as well. The area is fairly densely populated, but the amount of land available is not a limiting factor. The Nuba cropping system includes livestock with animals for traction now being introduced by a French group co-operating with the project.



In the cropping system in the Nuba mountains, each household maintains three different farming areas. First, a house garden is located around the dwelling, usually on the foot slopes of the hills. Vegetables are grown here, e.g. early maturing maize, sweet sorghum, tomatoes and others. This is for family consumption and provides an early food input at the end of the dry season. Some of the produce may be sold in the market. The second area of crop production takes place on the near farm, which is generally on sandy or sandy-clay soils close to the mountains. Crops grown are for family sustenance and marketing: sorghum, groundnuts, okra and sesame are produced. The third area is the far farm usually on cracking clay soils. Sorghum, sesame, cotton and groundnuts may be grown primarily for market, but used for subsistence as well.

The sequence of planting commences with the house garden in early May followed by the near farm in May/June, and the far farm in June/July.

Rainfall is about 800mm, falling late May to September. Land preparation takes place April/May. Weeding: June to August. Harvesting: September to December. Tillage of the far farms is difficult due to the heavy soils. There are difficulties of transportation from far farms so crops stay in the fields for a long time.

Families usually consist of a man, his wife or wives and children, making up an independent production and consumption unit.

In terms of livestock nutrition and production, cattle, goats, sheep and pigs are maintained with cattle most numerous. The cattle, sheep and goats depend primarily on natural range forage for the bulk of their nutrition. Crop residues are also grazed in the field, but play a more limited role than natural vegetation in terms of importance. Livestock numbers are limited since the Nuba are primarily sedentary crop producers.

During the dry season from November to May livestock lose weight and produce decreasing quantities of milk due to the poor quality and limited availability of forage. After the rains begin, natural forage regenerates, but is dominated by annual species, which mature early and subsequently decline rapidly in nutritional value. After the onset of the rains, the livestock regain their lost weight, only to repeat the weight loss cycle again as the dry season begins. This is shown in the included systems calendar.

The use of animal traction has only recently been introduced by a French group co-operating with the WSARP. The Nuba are interested in the use of bullock power, but it is too early to evaluate.

Based upon field observations, the primary constraint to livestock product and hence on the potential use of animal traction is nutrition. Nutritional inadequacy results in slow growth, poor reproductive performance, increased susceptibility

to disease and others. Females reach sexual maturity at 4 years of age and reproduce only about every 2 years. These factors plus the advsere impact of nutrition on milk production greatly decrease livestock production.

In an attempt to alleviate the nutritional constraints, the WSARP is investigating the use of forage legumes and grasses on fallow land. Lab-lab and clitoria are examples. The harvesting of native grass for hay is also being attempted as is the use of supplementation such as sesame cake. It is too early to evaluate the results at this time.

Discussion

Asked whether the annual species in the pasture types would respond favourably to cutting and still maintain nutritional value, Dr. Henson replied that annuals which have been evaluated are of reasonably good quality if they can be cut at the right time.

Asked for information on farm sizes, Dr. Henson said that the house garden is very small - just the area round the house. Near farms are usually less than 1 ha., and far farms approximately 2 - 4 ha. The distance from the house garden to the far farm can be about 2 - 4 kms.

In some instances people are involved in mechanised co-operative schemes and can hire tractors and therefore farm a larger area.

The house garden requires early maturing varieties of vegetables to get food as quickly as possible. From a horticultural standpoint, utilisation of species which have a long producing time would be better. Early maturing varieties of sorghum could give more flexibility but have not been as acceptable as the traditional longer maturing varieties.

Asked about cutting grass on communal areas, Dr. Henson indicated that people would be able to harvest large areas. Availability of grass is not a problem, but labour is.

Pastoralists utilize the same areas as the Nuba for pasture, but the pastoralists go north with the rains; therefore the sedentary people have access to the land while pastoral people are north.

Burning is probably the most important factor in changing the forage species from primary perennial to annuals. It is done for a number of reasons. Pastoral people feel that if they burn they get more nutritious new growth. However, there is limited re-growth before the next season. This may have evolved from earlier times when the land was dominated by perennials. Farming people burn to keep out pastoral people. Also grass fires are started accidentally by charcoal burners, honey hunters and from domestic cooking fires.

It was suggested that there was a different appearance in perennials due to burning rather than grazing and that with a

combination of grazing and burning you still get perennnials coming up.

In the Sudan situation in Southern Kordofan it was said that grazing pressure (forage resources in terms of mass of forage) is under-utilized. Examination of present circumstances suggest that the major impact on shift of species from perennial to annual is because of burning.

The major range degradation is in the northern areas and is less evident as one moves south. Very little work has been done to identify the causes. When the rains come in the south the mud gets very deep because of the clay soils and insects and endemic diseases become greater. Pastoralists move their livestock north to the sandier areas and where most markets are located - the result is increased grazing pressure in the more ecologically fragile north and underutilization of the southern areas where the forage is optimal in terms of nutritional quality. As indicated, when the rains come it is very difficult to maintain cattle on heavy clay soils. The Nuba people move their small numbers of livestock and put them on the mountains. They recognise livestock as an important economic resource. They invest in cattle and migrate those cattle with the nomads. Well-to-do people have joined their cattle up with the nomads so that they migrate. Young men take jobs with the nomads caring for the cattle.

Asked whether they use manure in the home gardens, Dr. Henson said that they bring livestock in and maintain them whenever the house garden is not actively growing. Cattle feed on residues and make manure.

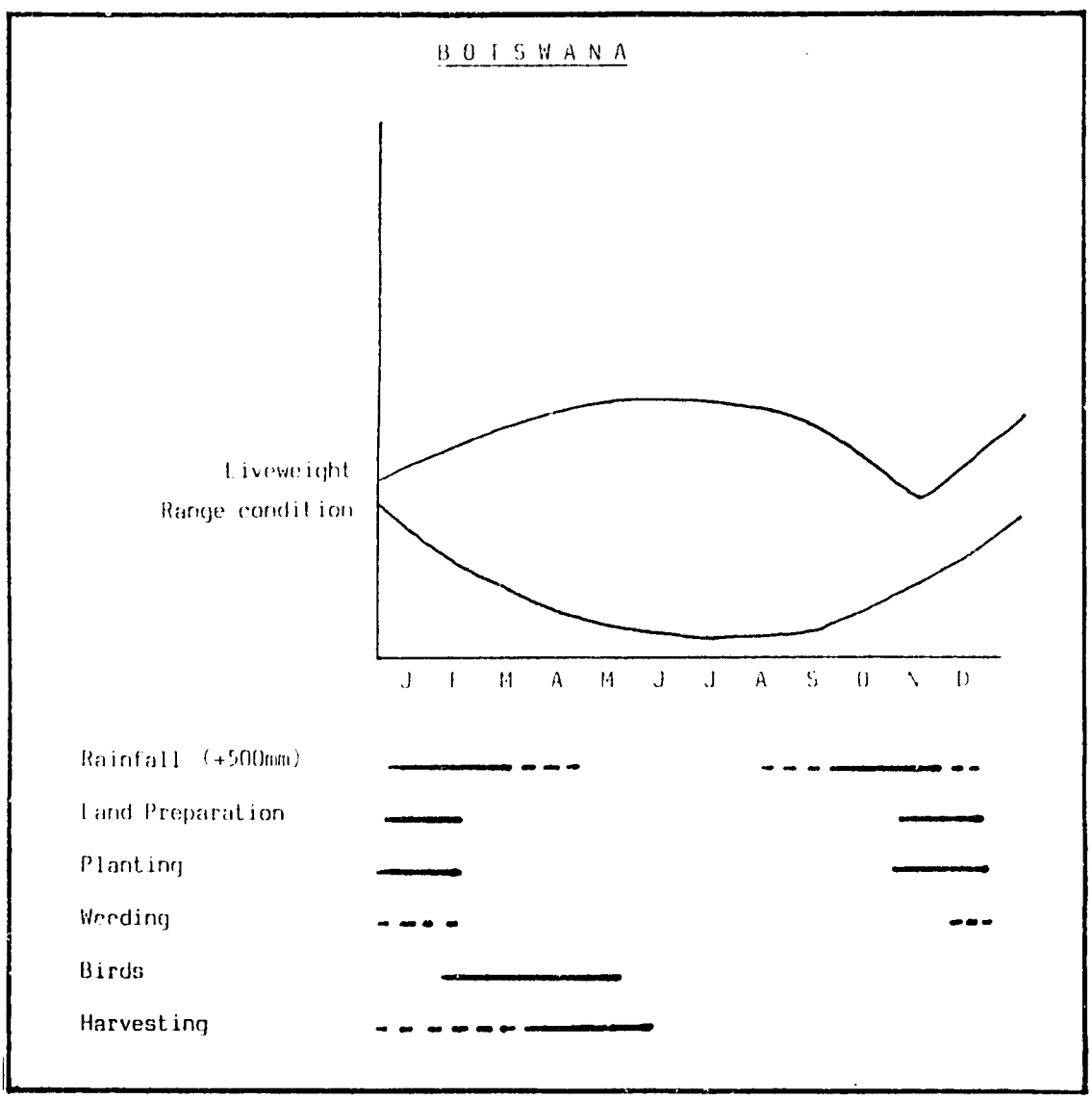
BOTSWANA

Refer to paper # 3 by Farrington and Riches

The Agroclimatic Environment (East and Southeast Botswana)

Rainfall is variable and averages 500mm per annum. Rains start in October/November. A mid-season drought sometimes occurs around the middle of December. Rainfall picks up again after Christmas and eases off in February. In mid-July frost is common.

Crops grown include sorghum, maize, millet and cowpeas. Minor crops include jugobeans, mungbeans, melons, squashes, pumpkins, groundnuts and occasionally sunflower.



The range exhibits a very rapid growth of fresh grass at the onset of the rains. Liveweight gains are greatest in the first two months of the rains and tail off towards the end of February as grasses flower. Where overgrazing is not severe some liveweight gains occur in July/August. Cows calve in August and September.

The Nature of the Draught Power and Animal Feeding Problem

Cattle make up 80% of the draught, donkeys 10% and tractors the balance. No more than 45% of farmers have access to their own source of draught power. The majority of farm-households will have problems in getting a draught span together as they will have to borrow or hire animals. Access to draught power is only one of the factors causing farmers to plant late. Other reasons are that earlier planted crops mature earlier and are more prone to attack by birds and that cattle range freely on arable land during the winter until the onset of the first rains.

Planting does not start until after the first rains and only a few days following rains are suitable for planting. Because of this time constraint, uncertain rainfall and shortage of labour due to off-farm employment, seed is usually broadcast and then ploughed in either by draught animals or tractors.

Compounding these problems is the large increase in cattle numbers (over 4% per annum over the last decade) and overgrazing. As a result cattle are undernourished by the end of the dry season and ploughing is delayed while they gain strength once the rains start. Where grazing is poor animals move further afield in search of food and a farmer can spend three days locating his animals when the rains start.

Farmer Strategies

In the high risk situation of Botswana farmers tend to adopt a low input approach. Low plant populations are planted, little fertiliser or insecticides are used and few farmers do any weeding. The exception to these low investments in cropping is the hire of tractors. The costs at 40 Pula per ha are barely covered by the average value of production (45 Pula/ha). However, tractor hire enables farmers to follow one of their main strategies for combating labour scarcity and rainfall uncertainty which is to plough and stagger plant as large an area of land as possible. Land is generally not limiting and very few farmers have resources to plough more than what they currently have access to.

Discussion

The discussions centred around four major themes:

a) Migrancy
b) The number of animals required for making up a plough team
c) Cattle numbers, control, and fencing
d) Tractorisation

Migrancy

Since some Batswana have as many as three rural homes, there was a query on how they spread their resoruces between the three: village, lands and cattle posts. The village and the lands are generally not too far apart. Women and children from 10 years do most of the work on the lands. Most households indicated that given sufficent water and cattle feed, they would stay on the lands the year round. The cattle post is generally far from the village and lands and is where the cattle are herded. Boys and the old men of the family are generally employed at the cattle post.

Many young men and women work in off-farm wage employment. The question as to where this work existed was answered as being on the mines in Botswana or South Africa or in the Civil Service. These wage earners generally send back money to hire tractor or oxen as a substitute to coming back to do this work themselves.

Size of Plough Teams

In answer to the question why farmers on small land holdings require 6-8 animals to plough, it was stated that anyone who is ploughing will use 6-8 animals whether the area to be ploughed is 1ha or 8ha. Animal condition dictates the need for teams of 6-8. For row planting and cultivating a two animal team is used.

It was asked if oxen become stronger later in the season and whether this enabled teams to be reduced. The answer was that farmers do not reduce numbers of animals in their teams, but that the area covered per day may be greater.

Cattle Control

The importance of fencing to control cattle movement was noted but participants queried the expense of fencing and its economic viability. There was said to be a government subsidy on fencing. Subsidised fencing was being well taken up in order to keep animals off the land at the beginning of the season rather than to keep fodder in at the end of the season.

Emphasis was now being placed on identifying communities who see the need for grazing control and could be educated into conservation. This is becoming increasingly difficult with increasing populations of cattle and humans. Whether traditional controls through headmen saying when enough stock were on a specific area could work was questioned in view of the increased populations of today.

It was asked whether there is a possibility of increasing rural ground water availability to cope with increasing cattle numbers. Ground water resources are being studied and new dams are being built. But although ground water supplies seem adequate, it is not known whether they are fossil or rechargable. However, the supply of more water must also be considered in conjunction with

work on grazing. Under the Tribal Grazing Land Policy there is now a freeze on boreholes being drilled by individuals, only syndicates can now drill. No individual has the right to deny watering facilities to his neighbour, but these rights can be sold.

Tractorisation

A question was raised as to whether the tractorisation strategy being employed by farmers was a problem in terms of production. It was agreed that the use of tractors increased the speed of ploughing, but it was said that tractors often did not do a good job and tended to shallow plough. Also, there was the problem that all of a farmer's land could be ploughed quickly at one time, but that farmers often preferred to stagger their planting to minimise the risk of total crop failure.

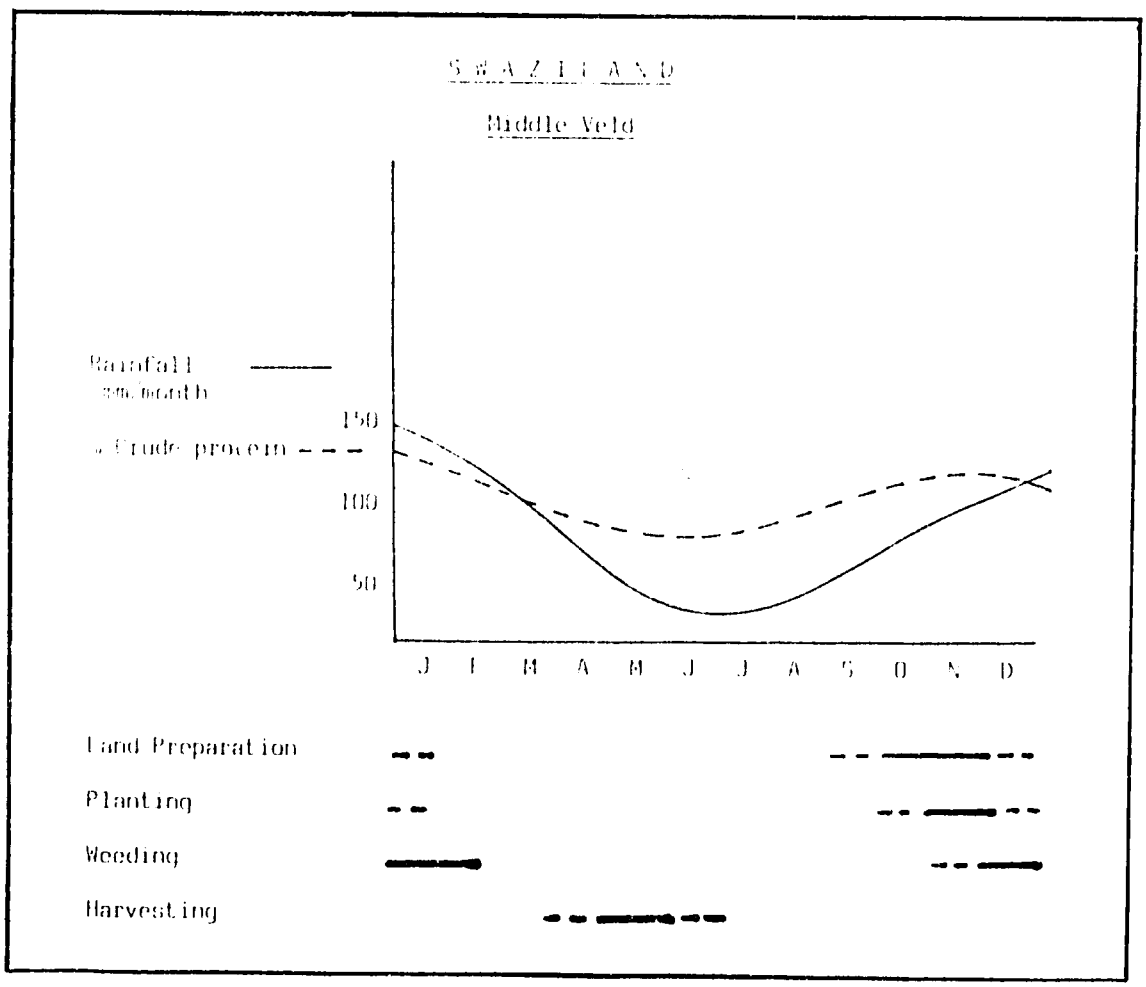
SWAZILAND (Middleveld)

Refer to paper # 4 by V. Watson, Z. Mamba and S. Mamba

The Agroclimatic Environment

Rains start in October and increase on through to December. In January and Februuary 150 mm per month is received. The rains begin to taper off in March and April.

A few farmers do winter ploughing from July to September. Most of the ploughing is done in October/November, tapering off in December and January. Planting starts towards the end of October through to November with some late planting in December. Beans are planted in December/January. Weeding takes place from the beginning of December to February. Maize is grown on 80% of the land and is often intercropped with pumpkin and beans. Other crops grown are jugo beans, groundnuts, grain sorghums, cow peas and millet.



The Nature of the Problem

Most homesteads derive income from three highly related activities: off-farm wage employment, cropping and livestock. Very few homesteads earn a living totally from the land. About 82% of the Swazi Nation land farmers have off-farm income and all engage in subsistence cropping as well. Often wages from off-farm employment provide for recurrent cash needs: school fees, supplementary food, farm inputs and other consumer demands.

Cattle start picking up in September and are in peak condition in November/December. During land preparation time cattle are not in good condition to do the job required, mainly because there is a shortage of feed in relation to the number of cattle. Farmers regard cattle as a form of security and the tendency is to keep them in preference to selling. The result is that planting is done late and soil preparation is hurried and poor.

Farmers make only broad distinctions between livestock in terms of management along lines of species. Cattle are grazed by day and returned to kraaal at night and the accumulation of manure is used to fertilise the soil. In winter cattle are free to roam crop land as well as the veld.

Possible Interventions

In a recent survey conducted in the Highveld region 60% of farmers indicated that if oxen had improved feeding and were in better condition, they could begin ploughing earlier or do winter ploughing. On the stooling of maize the most frequent response was that it was not done because farmers were not aware of the benefits. One quarter of farmers indicated that they did store maize stover for animals but not especially for oxen. Better storage and selective feeding are research opportunities.

Supplementary feeds could be produced in connection with the "green belts" developed in the RDAs in areas between the crop lands and the veld.

The demand for tractors is high and outstrips demand. The Tinkabi is a low cost machine which has been purchased by 400 small farmers, but its lightness and 16 horsepower engine does not permit adequate penetration of compacted soils.

Government has implemented a fencing programme in which veld areas are separated from crop land and paddocks divide veld areas. Paddock demonstrations have been very effective because farmers can see the results. To enter a grazing scheme farmers usually pay E2 per beast per year and 80 cents per month.

Discussion

The discussion covered cattle feeding, stocking rates and farmers' strategies and problems.

a) Cattle feeding

Asked whether there was a digestibility cut-off with supplementary feeding so that no weight gains took place thereafter, it was said that if supplementation was started between February and March they gained weight for 4 months and then continued to do so when the grass greened up. This was not said to be a common practice, it only occured in the grazing demonstrations where 5 hectares are to be established for fodder production.

On the question of whether small farmers going in for forage production did this on small plots and whether neighbours objected to this, it was stated that if a farmer indicates that he wanted to raise a dairy cow he has to put some of his crop land into forage and fence this area.

b) Stocking Rates

A question was asked on the stocking rate in Swaziland and the carrying capacity of the range. Swaziland was divided into 4 regions where the carrying capacities differed. Grazing time on the high veld is 5 months, on the middleveld 8 months and on the lowveld 12 months. No supplementation is necessary in the lowveld. The national herd has been stable for the last few years, but the data indicates that the calving percentage has dropped from 39% to 30% in the last decade or so.

c) Cropping Problems and Farmer Strategies

Because of delayed land preparation planting is late and yields are reduced. If the rains are delayed and the people cannot get back from working in town they end up doing ploughing and planting as one operation which puts a burden on them and the oxen. This is why in some areas 95% of the land is planted with the safim planter. Part of the reason for farmers doing staggered planting is that they have to borrow oxen or implements, but they also stagger plant because of hail risk, lack of inputs and to spread the weeding burden. The situation of the homestead, the labour they have, the equipment they own, the cash that is available for inputs (including tractor hire) and the other activities that they are involved in all affect their timing and method of ploughing, planting, weeding etc.

Nutritional considerations also affect farmer practices. Maize planting is staggered to produce a long period of green mealies. Pumpkin has a double function: leaves are eaten as spinach and the fruit itself is eaten.

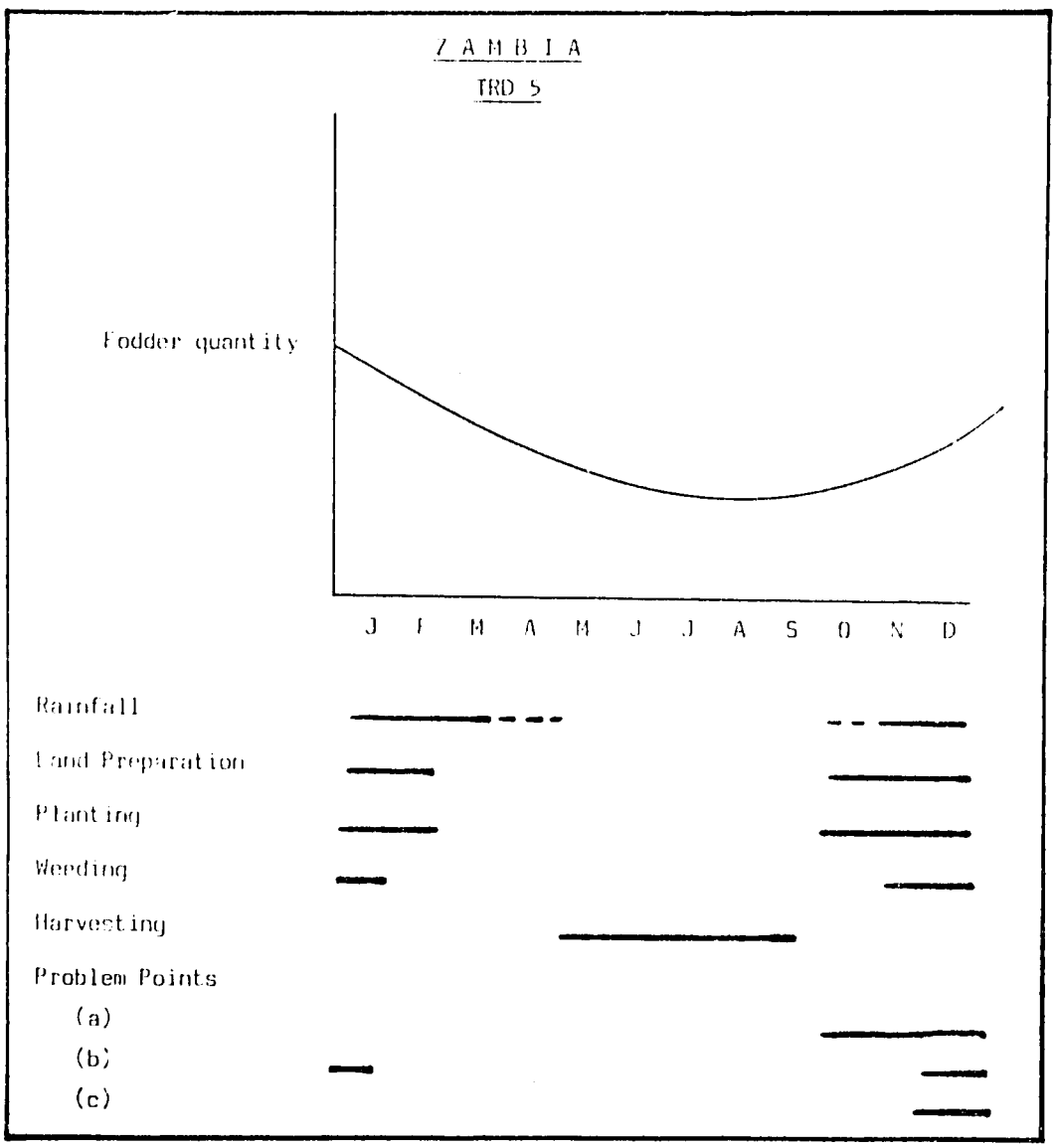
Noting that 400 farmers had spent E5000 on a technology, it was asked if they had an abundance of off-farm income. It was stated that most of the men have jobs off the farm and that Swaziland was a country where people do spend a lot of money on farming. 80% of farmers hire tractors and some of them own tractors. For the same reason herbicides represented a potential intervention: people were not afraid of spending money on farming.

ZAMBIA (Central Province)

Refer to paper # 5 by C. Chabala.

The Agroclimatic Situation

The climate is typified by a long dry season from March to October and a short rainy season between November and March. Both sandy and clay soils occur. Dambos are common where the soils in shallow basins drain slowly and the grass remains green.



Maize is the staple. Local maize is planted first for early food supply then hybrids are planted for consumption and sale. Cotton, sunflower and vegetables are also grown. During the dry season dambos are used for planting vegetables. Cultivations are all by oxen or tractor, only 2% hoe. 54% of farmers own oxen and 73% own ploughs. Seedbed preparation is done using oxen and tractors.

Livestock production is poor. Most farmers do not have any deliberate livestock management policy.

The Draught Power Problem

The draught power problem is reflected in two ways. Cattle are poorly managed and therefore very weak. Secondly farmers do not train their oxen.

In this area we are talking about a very extensive system where farmers are fully occupied with arable farming and are cultivating up to 10 hectares by ox cultivation. There is no land limitation. The decision is whether to plant more or whether to go back and weed the first planting. Priority is generally given to the establishment of crops.

A major problem is late crop establishment. The draught constraint comes in when there is enough moisture available in the soil for planting and at the beginning of the rains there are a lot of days when an acceptable moisture threshold is not there.

Possible Interventions

a) Maize breeding for types that can be established in a low moisture threshold

b) Improving soil moisture by winter ploughing or using planters that place seed more optimally

c) Increase rates of planting so that larger areas can be planted with reduced or zero tillage

Discussion

Asked why animal food supply does not appear as an intervention or priority, Mr. Maynard answered that the people who did the survey were not livestock specialists. Also there are dambos within the area which provide winter feed and it has not been identified as a key problem. Cattle do not appear to be in bad condition and there is a potential clash with vegetable gardens competing with cattle feed production.

Dr. Henson pointed out that a survey was done in an area of the Sudan which included economists agronomists and in which the information in relation to livestock was not satisfactory. The survey was done again with a team including livesock specialists and different perspectives emerged. It is therefore important to have a correct mix of specialists.

Burning dambos was said not to be a problem. Neither was livestock numbers a problem at the moment. However with recent immigration into the area which had resulted in a doubling of the population in 5 years it is likely to become more of a problem. Tsetse was being controlled at the moment, but with increasing herd sizes and if control measures were not kept up, tsetse could come into the area again.

Asked what interventions were seen in terms of training animals, it was said that this required closer contact between extension and veterinary staff who do not go into the area. The facility exists but it is not being exploited.

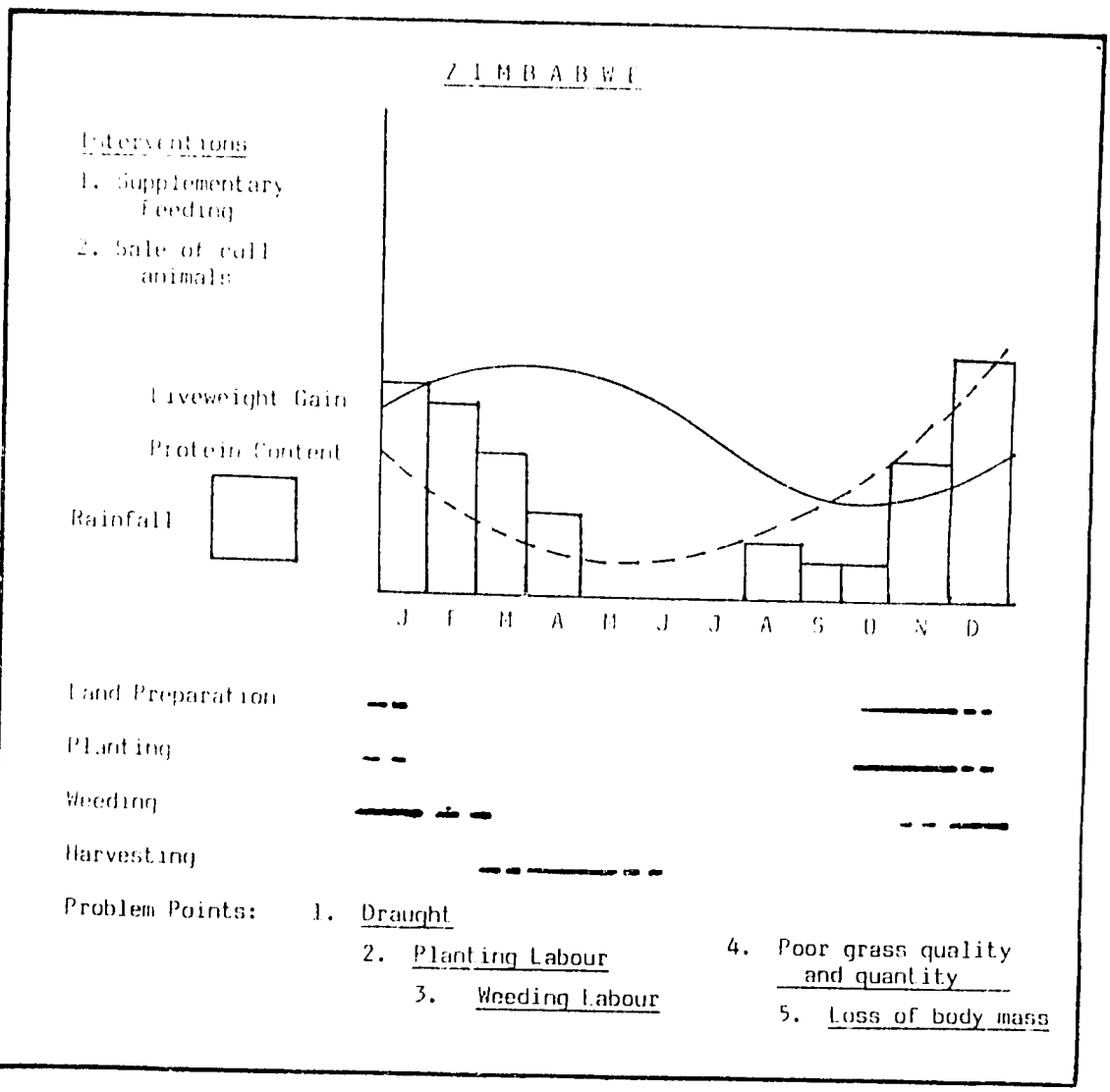
ZIMBABWE

Refer to papers #6 and #7 by E. Shumba and G. Mudimu

The Agroclimatic Environment

As in many parts of Africa, rainfall in Zimbabwe is seasonal. The rainfall season is November to March. This is followed by a dry winter period, April/May to August and then a hot dry season, September-October.

Vigorous grass growth starts with the onset of rain. Peak growth is in January. In May the grass begins to dry. Quality of grass improves as from the onset of rains and it peaks at the time of flowering of the grass. From then on the quality drops.



Cattle ownership is associated with differences in the cropping system. In a recent survey in Mangwende it was found that those households with cattle have larger arable holdings, better land preparation, timely weed control, apply manure and achieve higher crop yields than those without cattle. Cattle owners cultivated larger areas of maize, groundnuts and vegetables and sold these for cash, giving them a larger income than non-owners. While only 10% of non-owners grew sunflower, 45% of owners did so.

Cattle ownership and crop production performance also tended to be closely related to other factors associated with cattle ownership in the area. These included more members working permanently on the farm, more farmers involved in farmer organisations, fewer household heads involved in off-farm employment, less female heads of households, more non-farm cash income to supplement crop inputs purchased on credit and less risk aversion.

Farmers' Responses to The Problem of Falling Cattle Numbers

In 1975, 72% of sample farmers owned cattle in Mangwende compared with 46% in 1982. Average herd size (cows and oxen only) fell from 6.86 to 3.29 and the total pool of animals dropped by 52% over the same period.

Cattle owners have reacted to falling numbers by including cows in their draught teams and supplementing veld grazing with crop residues in winter. Use of cows in plough teams has contributed to lengthening the calving interval (one calf every three years) and slow calf growth rates (weaned after two years) and hence low build up of herds.

To counteract the winter feed problem farmers continue to supplement veld grazing with crop residues until September to October. However these residues do not have much feed value.

Mangwende farmers, particularly the cattle owners, have tackled the problem of a weak draught power pool at the beginning of the growing season by winter ploughing fields after crop harvesting when soil is still moist. A few farmers (11%) indicated that they planted directly into winter ploughed land with or before the first rains to solve the problem of insufficient and weak draught power at the start of the growing season. However 65% of sample farmers indicated that the problem of early weeds discouraged the practice.

To counter the combined problems of draught power and low fertility sample farmers have intensified their crop production by concentrating available inputs on smaller areas. These farmers have indicated a willingness to hire tractors at higher rates than they now pay for oxen hire (Z$24/ha).

Discussion

Discussion focused on forage legumes, control of livestock numbers and the use of cows for draught.

a) Forage Legumes

Asked why it had been decided to intercrop maize with forage legumes, it was said that this had only been done in the lower rainfall areas where the situation is most serious. In high rainfall areas it is not going to make any improvement. We are trying to improve quality of feed in winter by intercropping crop residues with legumes since farmers are already using crop residues. To prevent other animals from eating the crop it is necssary to cut and take it to the homstead and store it. In higher rainfall areas the quantity of the residues would be sufficient. Planting forages in fallow land is limited by land availability. Legumes had been sown into the veld but the problem there was lack of control of animal numbers on the improved range.

To questions on when and what legumes were planted the answers given indicated that cowpea and three kinds of beans were being used. Legumes were late planted into the early planted maize crop. The effect on maize yields was being monitored.

Asked whether the amount of arable land that could be fenced to produce forage would be enough to supply the whole herd or just for the oxen over the winter, it was said that both possibilities existed.

It was suggested that one of the principal requisites for planting forages is a favourable land tenure system. A team was said to be looking at ways in which local people can have title to their land. Government policy was that if you are a wage earner you are not entitled to land. In resettlement areas if you have an urban source of income you are not entitled to resettled land.

b) Cattle Control

It was said that one of the major problems in Zimbabwe with regard to fodder was that there were too many cattle and that people should be educated to sell excess animals (e.g. old oxen and cows). But farmers want to keep large numbers of animals and there is a resistance to sell even in times of drought. Asked how one could meet this resistance and educate farmers to sell excess stock, Mr. Mudimu indicated that they were thinking in terms of fencing off the grazing areas. Government is encouraging the formation of grazing committees and hoping that these committees will come up with a solution. The trouble was that farmers were not concerned with quality, they were only interested in numbers.

Also there is very little incentive to manage the range because it is communal. Overgrazing is occuring mainly because the management aspect is missing. Extension programmes have tended to neglect the livestock aspect.

It was asked how far people in Zimbabwe had got in thinking in terms of ideal herd structures (number of breeding cows related to the rest of the herd), and what a reasonable unit

herd would be acceptable. This had not happened in the communal areas, but in the resettlement areas beef models had been developed for each agro-ecological zone. Projections had been made up to 30 years. Five livestock units per homestead was being used as a standard in high rainfall areas and up to 25 in low rainfall areas.

c) Use of Cows for Draught

Since the calving interval was 3 years could not cows be used for draught in the interim, it was asked. The recommendation was said to be that a farmer does not use a cow for draught when it is in calf. This decreases its productivity as her system is being disturbed.

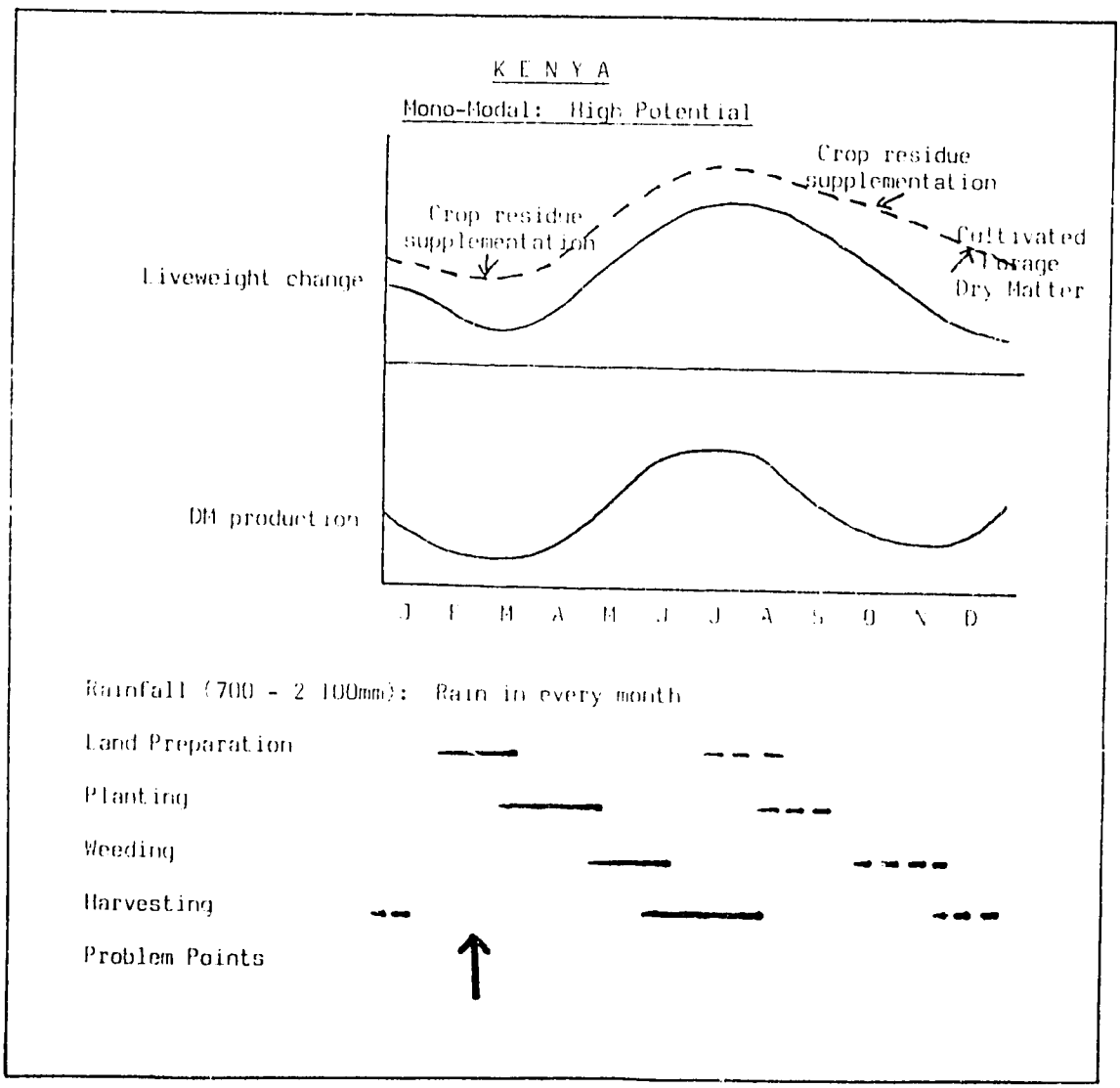
Asked if there was any interest from animal production people in terms of using cows for draught and how this might affect the reproductive system, the answer was given that the animal production people are not interested in this. All they look for from females is a calf. If there is a shortage of draught animals they suggest building up the herd.

KENYA (High Potential)

Refer to paper #8 by H Muiruri

The Agroclimatic Environment

The average annual rainfall is 990 mm and occurs in three peaks. The soils are mainly sandy loams and slightly acidic. The average altitude is 2,000 meters above sea level with a monthly mean temperature of 18 degrees celsius.



Most farms are 1-2 hectares and owners have registered title. The main crops are maize, inter-cropped with beans and peas and potatoes and vegetables. Land preparation is done during the dry period of January to March by tractors mostly. Generally no harrowing is done. Planting occurs with the onset of rains, which come at the end of March to mid-June. Most farmers plant maize and grow only one crop per year but during the short rains in October/November, they may grow a second crop of beans and potatoes. Weeding is done by family labour in May and June. This is a job for women and children and as children are back at school at this time there is generally a labour shortage for this operation.

Livestock are kept for dairy production not for draught. Dairy cattle are grazed on vacant plots, on public land and along roadsides. There is very little potential for animal traction as farmers will not use their expensive animals for draught. They will continue to rely on tractor hire for land preparation.

Problems

The main problem with cattle is poor nutrition during the dry period. Farmers have not set aside any of their land area for cattle. The vacant plot areas will reduce as more settlement takes place and roadside grazing is to be banned. Farmers will then have to set aside areas for fodder crops and will have to practise supplementary feeding.

At the moment maize stovers are used as supplementary feeds in the dry periods. These are of low nutritional value though. Drought resistant fodder crops will have to be grown to provide feed in the dry months.

Discussion

1. High Potential Areas

Asked to elaborate on the use of crop by-products, Mr. Muiruri said that the main by-product fed was maize stover. Some farmers are using maize cobs and had rejected grain. Asked why bean hay was not used as a feed, it was said that beans and peas are harvested around July/August and at this time there is a lot of forage in residues and empty plots. There is no conservation of these residues.

Asked whether anyone had tried making silage, it was said that this had been tried but there had been problems. There was no motorisation and the problem of the container to make it in had not been overcome. Oil drums could be used but are costly and difficult to obtain. Sugar bags are cheaper but do not hold very much. Another problem was being able to chop the material finely enough.

It was explained that after harvest the whole area becomes communal and this is why farmers do not grow short maturing crops because they would leave the land empty earlier.

Asked about the annual income of the average farmer in view of the high prices paid for weeding labour, Mr. Muiruri said that sources of income are both on-farm and off-farm. In most cases the value of the crop harvested would be $300 per hectare. There would also be sales of milk.

On the question of the potential use of donkeys for draught, it was said that donkeys were very important for transport of produce and of water. Most families will keep 1 or 2 donkeys, but they are not used for cultivation.

It was said to be important that interventions to improve cattle feed in the high potential areas did not reduce yields on arable lands. Three possibilities were mentioned:

a) Intercrop with pigeon pea which can be cut off and will keep on growing and maize will grow around them.

b) Try to plant forages along fenced roads. All animals are bomaed at night so the fodder could be fed in the bomas, but this depends on labour availbalility.

c) Utilise the by-products of large plantations nearby of sugar, rice and pyrethrum. Pyrethrum is available cheaply and is a high quality feed.

2. Medium Potential Areas

Discussion also covered problems in the medium potential areas which were rather different to those in the high potential areas.

In the medium potential areas feed is distributed more evenly through the year on account of the sharper bimodality in rainfall. Here cattle are kept for draught and there is no arable land constraint since no more than 65% of farm areas are put under cultivation. The major problem here is overstocking. In some cases there is no alternative to destocking. Farmers do not like to sell their animals because they are a form of investment and security against crop failures.

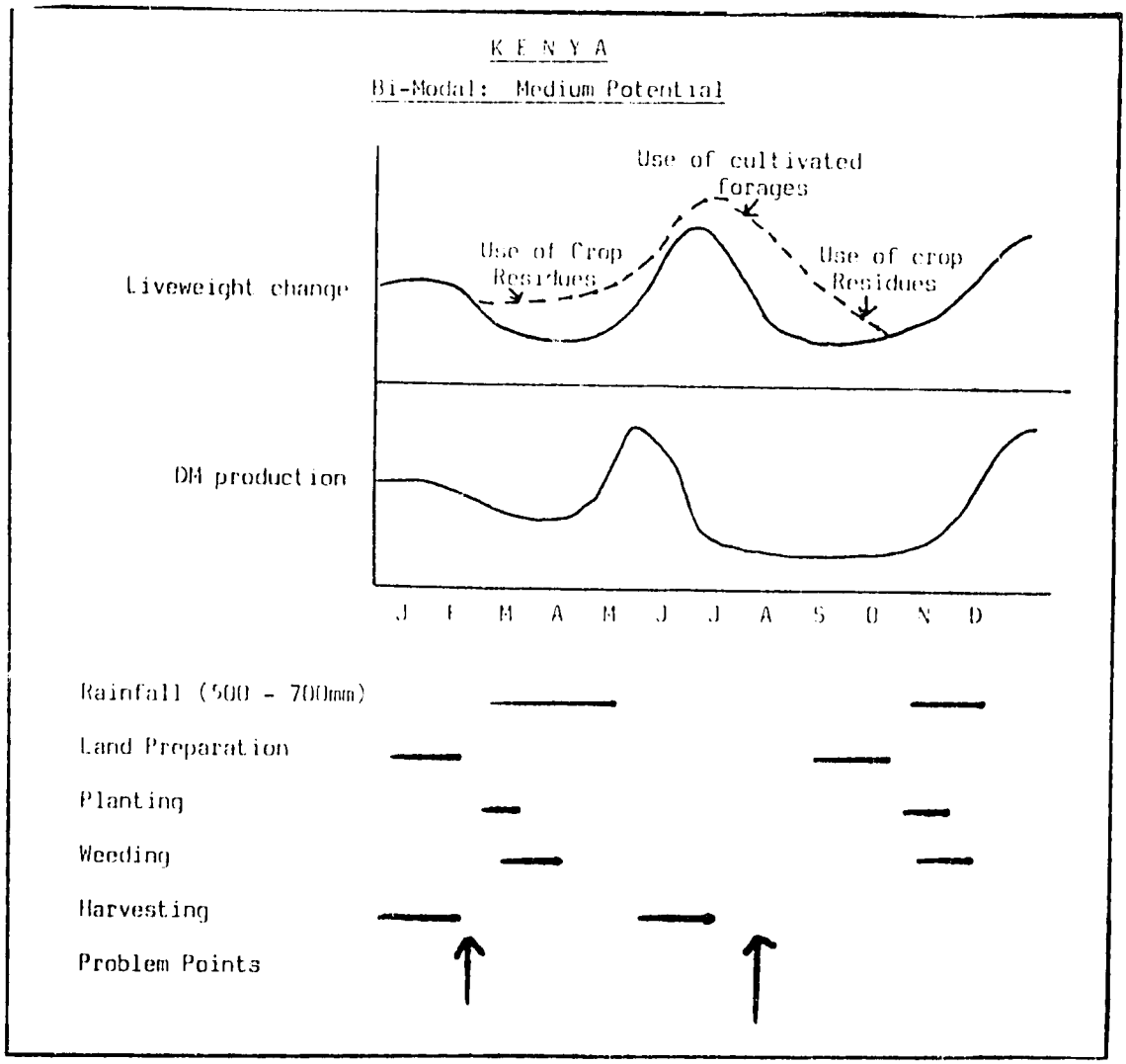
Natural pastures are an important feed source. Bush clearing, burning and re-seeding could increase the feed available from this source. However if destocking is not possible there is a limit to what can be done to improve natural pastures and more emphasis should be put on using crop residues more effectively by better collection methods and better storage. At the moment most farmers graze their fodder crops in situ and lose 40% of their nutrient value.

Land is available for growing fodder crops in these areas. Legumes and drought resistant fodder crops need to be evaluated.

The point was put that in the majority of situations in this part of Africa people have a tradition of extensive animal management systems in which low labour inputs are needed. At what point, it

was asked, do we anticipate that people will accept the concept of investing more labour time into animals and when does it become economic to do so.

Dr. Tessema answered that if we really want to integrate livestock into the production system we must look at the feed resources available from the various elements of the system. Fodder production and conservation is labour intensive but it can also provide a high output. Cattle can utilise high quality feed and give sufficient return to utilise the land more efficiently than simply letting it into natural pasture. Some of the very small farms will not be able to do this. But we have projected that, for farms of 7-10 hectares, this will be possible. If you work out the flow of labour use, there are only a few times when there is competition between labour in terms of fodder. At these times you can hire labour from the surrounding area. There is a market for milk and production can be intensified to the extent that the farmer becomes a commercial producer.

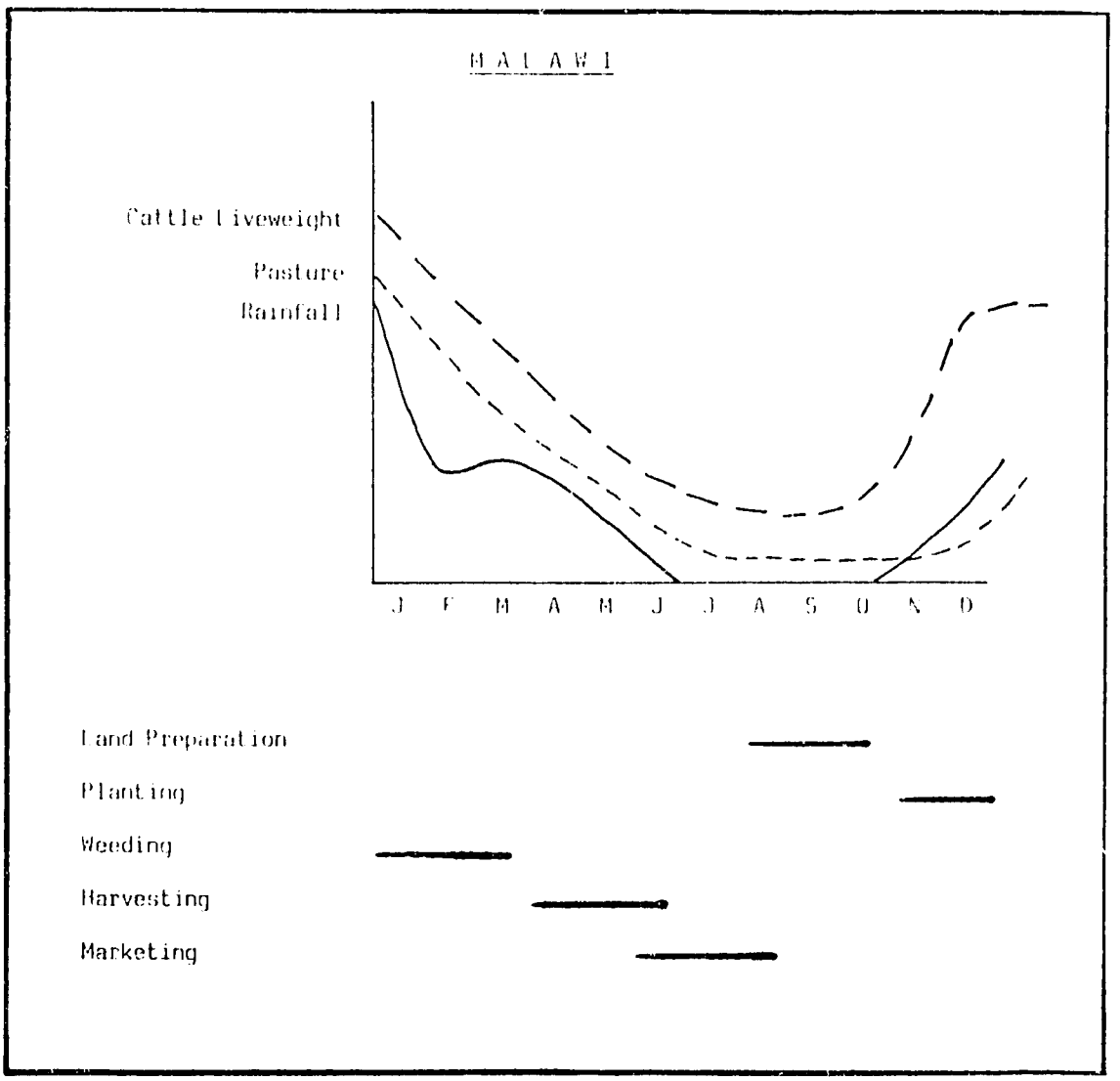


MALAWI

Refer to paper #9 by D. Sinna

The Agroclimatic Environment

In Malawi the inter-tropical convergence zone, the rain-bearing equitorial low pressure zone, and the North-east Monsoon are experienced during summer. Trade winds blowing into and from the Indian Ocean, often bringing with them considerable moisture, are experienced during winter months. The seasons commonly fall under "wet" (November to March) and "dry" (April to October). Mean annual rainfall ranges from 1000 to 3000 mm, depending on altitude.



The principal food crop, maize, is grown all over the country and covers 78% of the cultivated area. Of the cash crops, smallholders grow dark fire-cured, sun air-cured and oriental tobacco and confectionary groundnuts (Chalimbana). Cotton is grown in the lower areas of the country.

Almost all smallholder cultivation is done by hand, using a tanged hoe set in a wooden handle. In addition to hoes, smallholders use axes, pangas, slashers, ox-drawn implements (ploughs and ridgers), water cans and sprayers. There has been a tremendous increase in the use of machinery since 1969. The same applies to work oxen, ox carts, ploughs and sprayers.

Problems and Research Work

One of the major constraints faced by the small farmer in Malawi is labour shortage at peak periods. The country has a unimodal rainfall and timeliness of operation is very important. Late or inadequate land preparation with accompanying late planting and weeding difficulties have usually resulted in low yields.

Research on reducing labour demand has included:

a) Animal power: Improvements are being made in breeding, nutrition, management, harnessing and the use of oxen for the majority of smallholder farmers.

b) Animal drawn equipment: Over the past year a multipurpose animal drawn toolframe, which is capable of accepting a wide range of attachments has been developed, tested, recommended and is being manufactured locally. Attachments currently available are plough, ridger and groundnut lifter. Work on planter, cultivating tines, weeding sweeps and clod-crusher is underway.

   Oxcarts have been developed and are used more for transporting farm produce to the market, fertiliser from the market to farm, manure from farm to field, firewood from field to barns and for other forms of transport.

c) Weeding trials investigating alternative cultivation systems and subsequent weeding methods using ox-drawn equipment on maize and groundnuts are being conducted.

d) Hand tools are being developed for maize shelling, groundnut shelling and rice threshing and wheat harvesting.

Discussion

Discussion focused on types of animal draught.

There was said to be no experience of cows being used for draught in Malawi. Horses were not used for cultivation not so much because of their size but because of the shape of the horse. The angle between the horse and the ground is more obtuse and more force is therefore needed to plough. Implements have to be different. The advantages to the introduction of buffaloes would

be that they are more powerful than oxen, can work longer, have a high resistance to disease and can live on material that oxen would not eat.

Since an animal is said to be able to pull 10%-14% of its weight, the heavier the animal the better. Because of its shape the horse has certain advantages and it was asked whether anyone had tried using Zebra which have the same shape as a horse. It was said that Zebra are difficult to work with, maybe Zebra crossed with horses would be possible, but not straight Zebra.

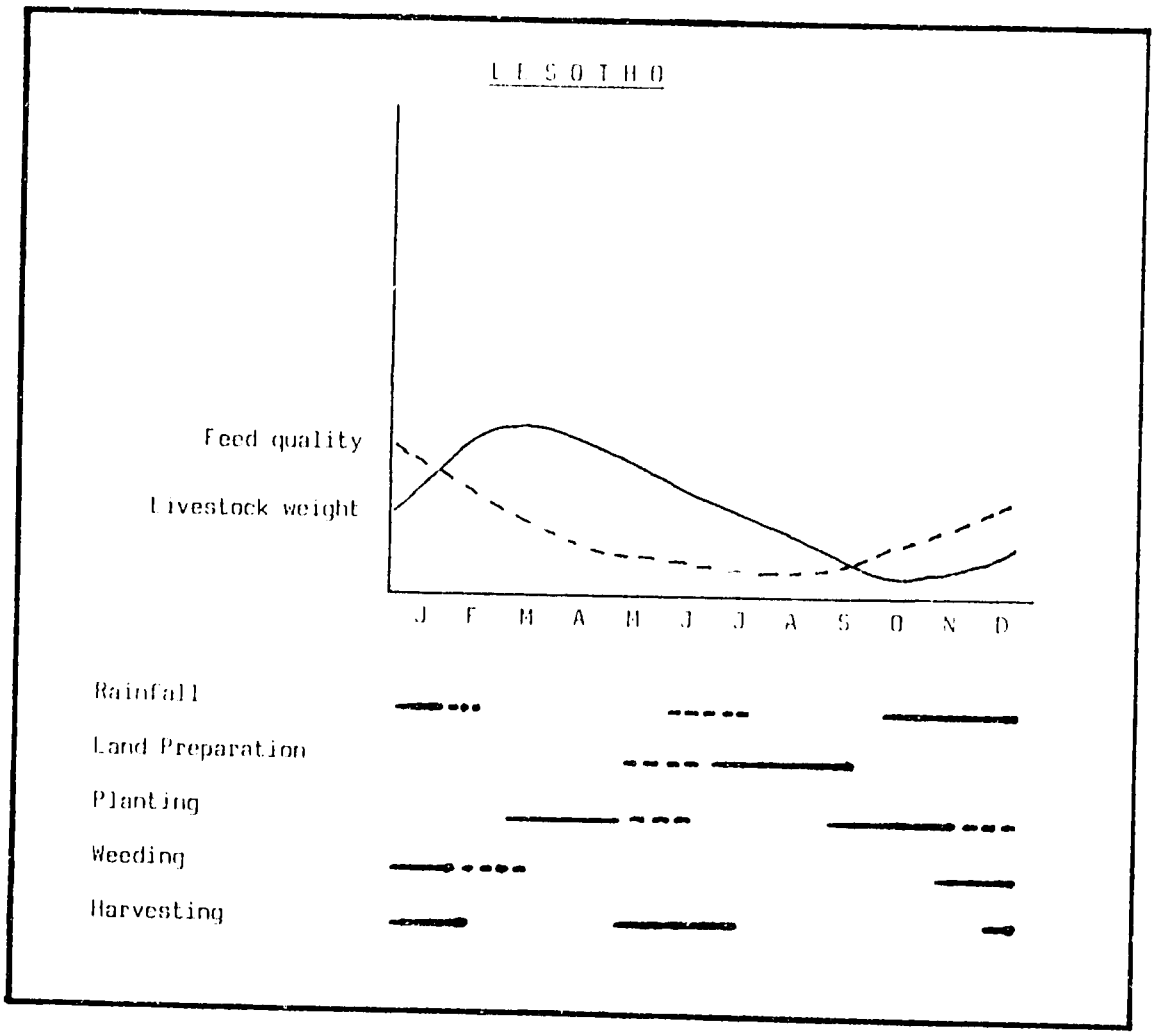
The advantage of Malawi Zebu over Zebu cross Fresians is that they are more disease resistant. Trials are ongoing to investigate the best way to feed the Zebu to get more work out of it. Comparisons of different legumes and varieties of grasses are being made. Reference is made to the paper, pages 15-17.

LESOTHO

Mr. M. Matli gave the following presentation in lieu of a submitted paper.

Farming systems started in 1979 and focused on creating productive agricultural enterprises, looking at mechanisms which are acceptable to farmers and to their management skills, appropriate to their available resources and the communal land tenure system. There are agronomists and specialists in range livestock, farm managment, marketing, extension and sociology, operating in three prototype areas:

1. Mountains - Molumong
2. Foothills
3. Lowlands - Siloe



In 1980 farming systems conducted a survey and identified three domains:

1. Rich farmers
2. Middle farmers
3. Poor farmers (see Table 1)

TABLE 1

Characteristics of Poor, Middle and Rich Households[1]

HOUSEHOLD TYPE BY CHARACTERISTIC	Siloe[2]			Nyakasoba			Molumong		
	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Percent of Total Households	45.0	35.0	18.3	60.7	32.1	7.1	17.2	51.7	31.0
Average Number of Fields per Household	2.0	2.4	3.3	1.9	2.3	2.5	2.0	2.1	3.7
Average Number of Hectares per Household	2.7	3.2	4.7	1.1	2.0	1.6	1.8	2.1	3.8
Average Number of Adult Labourers per Household	1.6	2.5	2.7	1.4	2.0	2.5	1.2	1.9	3.2
Average Number of Absentee Adult Male Labourers per Household	0.6	0.9	0.4	0.6	0.7	0.7	0.6	0.7	0.4
Average Number of Cattle managed by Household	0.6	3.8	2.0	1.7	4.9	8.5	1.2	11.1	27.1
Percent of Household managing at least 4 Cattle	3.7	47.6	81.8	11.8	66.7	100.0	20.0	73.3	100.0

[1]The households were typed on the basis of ownership of ox-drawn ploughs, planters and cultivators as follows:

"Poor" households own none of the above equipment
"Middle" households own a plough only
and "Rich" households own a plough and a planter and/or cultivator

[2]One household in Siloe owned a cultivator, but not a plough or a planter and was excluded from this analysis

The number of adult labourers per household (as defined in Section II) also increases from the "poor" to the "middle" to the "rich" households. "Rich" households average at least one adult labourer per household more than the "poor" households. However, the number of hectares per adult labourer per household are not all that different between the "poor" and the "rich" households.

The Problem

The survey was based on the ownership of ox-drawn implements as well as of cattle. In Lesotho all livestock (cattle, sheep, goats - for mohair) is dependent for a very long time on the veld. Lesotho is also a horse-riding nation and donkeys and asses are also kept. There are excess animals and much over-grazing which, together with soil erosion, has led to less

food for livestock. This lack of food together with cold winters results in very weak cattle in spring at the start of ploughing.

Research Approach

The farming systems section was developed to combat this lack of food.

(a) Range Improvement: The range section conducts trials and looks at enclosures. Fodder and food have to be used for more than a year. They are also conducting trials on the range that is infested with weed. Four treatments have been tried: hand pulling, spraying with herbicides, arresting and burning. Results indicate that burning has been the most effective treatment but as far as increase in feed is concerned it has been the lowest. They have also been doing work on perennial forages, looking at digitaria, trifolia species. Because of drought, germination was not good but what they got indicated that if things had gone well production would have been good.

(b) Livestock Feeding: (Refer papers # 11 and 12) Here we have included the growing of fodders and the use of concentrates. Concentrates have not had much emphasis because concentrates would mean spending money and not many farmers can afford that. Selective feeding is practised. Farmers are encouraged to feed draught animals in April or May so that they can sustain weight in satisfactory conditions until the grass starts coming up after the onset of the rains.

(c) Tillage: The agronomy section is looking at minimum tillage, hoping that it will help conserve moisture and reduce the need for draught power. They are also doing winter ploughing and trying to encourage farmers to reduce the number of animals that trample their fields during winter.

(d) Fodder Production and Crop Residues: Winter fodders being tested are: triticale, barley, vetch, turnips and kale. We are aiming for maximum utilisation of all crop residues. Farmers do harvest crop residues but what usually happens is that due to labour shortage some farmers do not take all of it home. We should try and encourage farmers to harvest all crop residues and educate them to realise how much feed animals require.

(e) Marketing section is investigating markets for excessive livestock. It is also attempting to find out whether livestock farmers can buy feed for their animals.

(f) Extension and sociology sections are trying to mobilise farmers into accepting the Ministry's recommendations of winter ploughing, rotational grazing and livestock reductions.

(g) Livestock Control: The Ministry of Agriculture is to impose charges on livestock imported into the country. R10 per

head for cattle and R5 for sheep and goats. Even so, people still want to import cattle.

Discussion

Asked how minimum tillage was done, how it conserved moisture and how animals could be prevented from trampling fields, it was said that instead of a plough a cultivator only was used. This conserved moisture because the soil was not being turned, but only the surface scratched. To reduce the number of animals that trample the land, you cut and stook stover and then winter plough instead of allowing the animals to trample the land.

It was pointed out that there was a high differentiation between the three geographical areas in terms of herd size. As the altitude increases, one finds more livestock. Generally in the low lands there are less cattle, more in the foothills and even more in the mountains.

Asked if one wanted to start feeding in April/May what farmers would have available as feed, Mr. Matli replied that crop residues are often kept from the previous year. Japanese radish, barley and oats can be grown as winter fodder. People rely heavily on the veld. In answer to the question whether farmers in the mountains were growing barley and oats, it was stated that this was in the low lands and the foothills. Nothing was grown in the mountains in winter. Trials have been conducted in the mountains, but the crops are not frost resistant. Nothing survives in the mountains in winter. In the low lands, both winter and summer crops are planted. In the mountains only summer crops are grown.

On ground preparation and planting it was explained that ground preparation may be started in May because winter ploughing is practised. Actual land preparation, if winter ploughing is not done, starts late July, August and September but planting is not done until after September because of the danger of frost.

Asked how the population reacted to winter ploughing, Mr. Matli said that it was a question of educating the farmers. It was pointed out that in Botswana the ground was too hard until after the onset of the rains.

It was suggested that it would be better to sell younger animals which would have a better value than to encourage the sale of old stock to reduce numbers.

It was thought that it was very difficult to tell farmers to sell their animals. They prefer to sell their animals when they are old and believe in having a lot of animals for prestige. We should try to improve the condition of the animals which the farmer wants to sell. Farmers should be encouraged to stall feed animals for two or three months. An animal will gain about 100 lbs as a result of stall feeding whereas without stall feeding it would be an inferior animal.

Another participant agreed that farmers resist selling any

animal. We are trying to make them see that old animals are no longer productive. At least you can get some money for an old animal and relieve pressure on grazing. We must change the situation where people are not livestock-oriented and they must also breed for the market so that they also sell young animals.

It was also noted that the cow will always be kept, regardless of age, because of the possibility of another calf. They disregard the fact that she is infertile once she has lost teeth.

INDIA

Refer to paper #10 by K. Ramanaiah.

Abstract

Dr. Ramanaiah described some of the elaborate strategies that had been adopted by Indian farmers to improve animal nutrition and increase efficiency and speed of crop cultivation using animal draught.

In India 90% of farm power comes from animal traction. Preparatory cultivations, weeding, harvesting, threshing, lifting water from wells and transport are all operations performed with animal draught. In addition to being used for draught, buffaloes and cattle produce large quantities of milk. Cattle are not kept for beef production by the small farmer.

Forage Production

Various means of fodder production being used by the Indian farmer were described:

1. Crop residues

   In general crop residues play a very important role and Indian farmers give as much importance to the crop residues as they give to the grain.

   a) The use of groundnut haulms is common and the method of storing and feeding is elaborate. The haulms are stored mixed with roughage in such a way that the animals get the required proportions of pulse and roughage when they feed.

   b) Cereal straws are cut into small pieces to increase efficiency of utilisation and generally a variety of mixed roughages are fed. Quality of roughages are improved by adding mineral salts, urea molasses etc.

2. Forage Crop Production

   This is achieved either through sole cropping or by intercropping with food crops. Elaborate rotations and intercropping mixes were described.

3. Forage Trees

   Leaves of trees and shrubs are an important source of fodder especially during drought periods. Camels, goats and sheep derive the major portion of their feed from the leaves and pods which are either browsed or cut and fed.

4. Pasture Grass

Improvements to natural grasslands include soil and water conservation measures, reseeding and legume introduction.

Improved Efficiency of Animal Traction

Increased efficency of animal traction is brought about by (a) better training of the animals and (b) by improving the agricultural implements.

Farmers' implements are locally made and there has been continuous improvement and innovation over time. Local village blacksmiths do all the manufacture and maintainance and it is rare for farmers to depend on factory made implements. Examples of planters (using bamboo tubes), ploughs, cultivators, ridgers were shown.

SECTION TWO

Experimental Programmes

ANIMAL NUTRITION EXPERIMENTS IN LESOTHO

Paper # 12 entitled "Value of a Winter Lick Fed to Cattle Under Lesotho Farmer Conditions" was presented by Ms. Motjope.

Abstract

Description of Experiments

This paper described a series of experiments that were conducted to encourage and enable farmers to improve their livestock feeding methods, especially those animals used for draught power.

The objectives of the experiments were:

a) To compare the performance of oxen fed in pens during the winter period to those fed and managed in the usual manner by village farmers.

b) To determine the value of a supplemental protein and mineral lick when fed with each of the above two systems.

c) To enable farmers to improve their total oxen feeding and management methods.

Two of each farmer's cattle were to be fed at the research pens and two at home in his usual manner. Rumevite Cattle Block was the supplemental lick selected for use in the experiments. It was fed to half the cattle at the research pens and half of those at the home farm.

Results

Due to an inadequate supply of fodder, farmers were erratic in taking their animals to the research pens every night. Thus only the Rumevite comparison under home conditions was considered valid. The results obtained indicate no consistent differences among replicates in response to either method of feeding with or without access to Rumevite.

Supplementary Information Presented

Data on further feeding experiments using hominy chop as an energy supplement were presented and the results are summarised in the following Table.

Expected Versus Observed Performance of Hominy Chop

Treatment

1.5 kg Hominy Chop fed daily = 2.325 Mcal NEg
= 0.55 kg daily weight gain

Results

	Average Gain (kg)		
	Fed	Control	Difference
11/7 to 28/4 (44 days)			
- Observed	+2.5	-6.9	9.4
- Expected		(44 x 0.55)	24.2
24/8 to 21/9 (28 days)			
- Observed	-3.7	-2.3	1.4
- Expected		(28 x 0.55)	15.4

The large discrepancies between the expected and observed weight gains were said to show that farmers had not been feeding the hominy supplement as instructed. Also it was stated that the animals that had been fed the hominy supplement were worked harder and this may be another reason why observed differences in weight gain were so much lower than expected.

Discussion

The discussion focused on:

a) Other experimental work on animal nutrition in Lesotho
b) Protein content of the supplementary feed
c) Clarifications on the hominy chop treatment

a) Other Nutritional Work

The rumevite supplementation experiments showed clearly that since there is a shortage of energy in Lesotho, there is no point in feeding protein to cattle. Thus hominy chop is now being purchased. Experiments are now being conducted on feeding hominy chop

a) to sheep at critical times such as breeding and lambing
b) to cows in milk production
c) to selected young oxen

Other nutrition interventions being examined include beef cattle improvement through performance testing and controlled grazing for sheep and goats.

b) Protein Content of Supplementary Feed

The supplementary feeding experiment seemed to be using high levels of protein. Figures of 27.5% protein and 7% urea were

quoted. It was explained that the supplement was only a lick and animals only ate about 25 gm of the lick per day.

c) Hominy Chop Treatment

While there was a problem with farmers taking fodder to feed cattle in pens, the hominy chop was supplied free to farmers where they needed it so it was more readily given to the cattle. It was said to be not so much the time involved in cutting and carting fodder that resulted in small amounts being fed, but that farmers would bring only one bag and expect it to last a week.

It was explained that hominy chop was maize bran, similar to wheat bran. It was the hull part of the maize and included the germ. About 25% of the harvested maize was said to end up as hominy chop. It contained about 7-8% protein and was 65% digestible. It currently costs 17c/kg and comes in 50-100kg bags.

TILLAGE EXPERIMENTS IN BOTSWANA

Paper # 13 entitled **"Draught Power in Botswana: the design and testing of solutions"** was presented by Mr. C. R. Riches

Abstract

Types of Trials and Some Results

Three types of trials have been conducted:

a) Increasing Efficiency of Animal Draught

The possibility of reducing the draught team from six to four cattle for primary tillage was investigated by the introduction of two multi-purpose wheeled toolcarriers - the Versatool and the Makgonatsotlhe. Moulboard ploughing was replaced by chisel tines or Texas Sweeps. However the size and condition of the cattle did not enable the draught team size to be reduced. In addition the need for more than one pass with tines and weed problems led participating farmers to revert to the plough.

The Sebele single row planter used with a Mahon cultivator required one extra planting operation, but needed less labour and draught than broadcasting on a whole farm basis because of the smaller areas needed to be planted for subsistence.

For those not wishing to or being able to make more than one pass the plough planter was developed and tested. With this equipment seed is dropped into the furrow slice to be covered by the subsequent bout of ploughing. Trials indicate that fewer animal hours at equivalent team sizes are required to establish sufficient area for subsistence by plough planting than by traditional plough and broadcast methods.

b) Substitution of Animal Draught by Tractor Power

The plough planter was modified to fit a tractor plough. More on-farm testing is needed to establish reliability.

Partial substitution by tractor power may be achieved with the use of a single row ox planter and cultivator. Sorghum stands planted by single row planters have given mean production levels of 700 kg/ha in on-farm trials over 4 years. The farmer would need to plant 3.8 hectares at this yeild level to ensure family subsistence and cover all cost. Since 700 kg/ha may be difficult to maintain on a whole farm basis the system may only become applicable on larger areas.

c) Improving Draught Animal Nutrition

From the limited data available from trials to date, it would appear that even 1/2 hectare of late sown Babala and 1/2 hectare early planted Dolichos could each produce 600 kg dry matter, sufficient for supplementary feeding to six 350 kg animals for 50 days on a 50:50 cereal/legume ration. This is

applicable to farmers with relatively high resource levels. For other farmers emphasis would be placed on use of crop residues rather than grain fodders.

Discussion

Questions on the working of the planter and plough planter were answered by saying that the planter was a single row machine and the land did not have to be harrowed before using it. The planter was designed for sorghum, millet and cow peas. It works less well with large seeded crops such as maize but a drop planter for maize is now being developed. The two furrow plough planter has been mounted with a fertiliser applicator, with the single furrow version addition of a fertiliser applicator makes it difficult to balance. On the question of the availability of rural blacksmiths for maintaining the ploughing and planting machinery, it was said that there was a shortage of these skills but that people were being trained.

Questions on fodder related to the possible difficulty of getting the roots out of the ground with sorghum fodder and whether animals were fed in a closed place in winter. No problem was reported with disposing of the sorghum fodder. It was either cut and carried or grazed off. One of the advantages of supplementary feeding was said to be that it made the animals more manageable because they willingly came to the place where they were being fed. Feeding took place in the open.

TILLAGE EXPERIMENTS IN ZAMBIA

Paper # 14 entitled "Ground Preparation and Planting: a key constraint for ox cultivators in Zambia" was presented by Mr. T. Maynard.

Abstract

The Constraint

Maize is both the staple food and the main cash crop for the area and there are acute difficulties in getting sufficient areas planted near the beginning of the rainy season, before the rapid drop in yield potential which occurs at a rate of 2% per day through December. Maize planting often continues well into January.

Technologies to Reduce the Constraint

a) Breeding varieties with shorter maturation periods

b) Improving the ability of the soil to provide sufficient water by improved soil management (e.g. winter ploughing), or by changes in the planting technique (e.g. use of a planter).

c) Increasing the rate of planting

Results

Winter ploughing has been widely promoted over a number of years, but is rarely practised by farmers in the area. Even in systems where more land is left fallow and which could be winter ploughed, it is the exception rather than the rule, even though most farmers have tried it on previous occasions and are aware of any benefits.

Several planting methods were tested against current farmer practice during the last growing season. The very poor performance of all planters was further compounded by the very dry planting conditions. A trial in the 1981/82 season showed an average of 243 manhours if the recommended practice of hand planting with a rope following ox cultivation was used, compared with 118 manhours using farmer practice.

Further reduction in tillage is likely to involve the use of herbicides. On-farm trials over four seasons tested herbicides in conjunction with reduced tillage methods. The package was shown to work technically where the pre-emergent herbicide was synchronised with rainfall and prior to weed emergence. Non-adoption by target farmers was perhaps due to this timing conflicting with the farmers' desire to plant only after a certain probability of sustained soil moisture had been reached, which usually occurs after significant number of weeds are beyond the susceptible stage, and conventional ground preparation is necessary. Thus the key constraint is no longer addressed.

Conclusions

Under good conditions, the farmer's method of third furrow planting achieves an adequate stand and is rapid, simple and cheap. The advantage of alternative methods will depend on the number of extra days he can plant (or the increased area per day), and how much sooner this allows him to plant his required area. This is difficult to determine, even when a lot of data is collected.

There were no questions on this presentation

TILLAGE EXPERIMENTS IN ZIMBABWE

Paper # 15 entitled **"On-Farm Minimum Tillage Experiments: a possible solution to draught power problems gripping Zimbabwe's communal areas"** was presented by Mr. E. Shumba.

Abstract

Ongoing Trials

This paper discusses on-farm trials aimed at improving the performance of the available draught power pool through minimum tillage techniques. In Mangwende the use of a ripper tine in conjunction with chemical weed control is being investigated, while in Chibi South planting directly into winter ploughed fields in conjunction with varied hand weeding treatments is being tried.

Results in Mangwende

Minimum tillage work using the ripper tine was initiated in Mangwende in the 1982/83 season. The tine treatment outyielded the conventional late plough treatment across sites irrespective of whether the field had been winter ploughed or not. To combat the problem of early weed infestation associated with minimum tillage, a herbicide treatment was included in this trial. Although the use of the herbicide gave an overall 11.7% yield advantage over hand weeding, it resulted in lower yields at 2 out of 5 sites.

Supplementary Information

In addition to the information presented in his paper, Mr. Shumba elaborated on some of the pros and cons of minimum tillage using herbicides.

Type of Herbicide

Preplanting posed a problem of incorporation which needed to be in wet soil or followed by rain. Pre-emergence gave the problem of spray direction if the plants had already emerged. Post-emergence seemed best but there was the question of whether Gardomol or Atrozine was best. It depended on the moisture, method of application and tillage method.

Weed Spectrum and Persistence

A good knowledge of the weed spectrum in the area was needed. Persistence may pose a problem in relation to a maize-groundnuts-millet rotation. For example Atrozine on heavy soils can kill groundnuts after 18 months. Faster leaching of such chemicals is one advantage of sandy soils on communal areas in Zimbabwe. Use of herbicides rules out intercropping of forages for animal nutrition improvements.

Appropriateness of Herbicide re Economic Circumstances

The following comparison between Chibi South and Mangwende was made.

	Chibi South		Mangwende	
	with cattle	without cattle	with cattle	without cattle
Yield (t/ha)	1.4	0.8	3.2	2.1
Income ($)	241	105	752	449
% of Income off farm	50	60	20	30

It was said that herbicides would not be so appropriate for Chibi South as Mangwende because:

a) Yields were lower in Chibi South so other factors were more important

b) Incomes were lower in Chibi South, so the ability to purchase herbicides was less

c) The proportion of income earned off the farm was greater in Chibi South so there was less incentive for farmers here to purchase herbicides.

Labour Saving Advantages

While there may be no yield advantage from using herbicides, it may allow labour to be released for other activities, especially gardening which provides the second greatest cash income throughout the year.

	Mangwende ($)	
	with cattle	without cattle
Maize Sales	347	168
Vegetable sales	130	84
Groundnut sales	40	26
Sunflower sales	11	3

Other Problems with Minimum Tillage

a) Manure Incorporation

	Chibi South		Mangwende	
	with cattle	without cattle	with cattle	without cattle
% applying manure	74	12	52	12

As the table above indicates, many farmers with cattle incorporate manure. However, this has only a 40-50% yield advantage in the first year and minimum tillage should be followed by conventional tillage every third year.

b) Pests and diseases

These may be more of a problem as a result of overwintering in crop residues. Possible solutions are (i) removal and storage, (ii) grazing in situ and (iii) burn ungrazed stalks.

c) Soil Erosion

This may be aggravated if residues are removed. Minimum tillage should therefore be practiced in conjunction with soil conservation measures, e.g. mulching, inter-row cultivations and contour ridging.

Discussion

Discussion focused on the tine tillage method. It was suggested that if the tine could be bolted onto the plough this would save having to supply separate implements for farmers. For the experiments only 5 tines were taken into the area but demand is growing and more are being provided.

Asked why the use of the tine seemed to be popular in Zimbabwe but had been rejected in Botswana it was said that different implements were used in the two cases. Also soil differences could be important. It was stated that there are advantages of deep ploughing and it was confirmed that the ripper tine did tend to go too deep at first. Adjustments were made to keep this from happening. It was again stressed that conventional ploughing should be done every three years.

It was confirmed that the tine was used to rip the planting row only. Asked how weed control was effected without ploughing, it was restated that this was why herbicides were being investigated to be used in conjunction with the tine.

FORAGE LEGUMES IN THE ETHIOPIAN HIGHLANDS

The paper entitled **"Forage Legumes in the ILCA Highlands Programme"** was presented by Dr. S. Jutzi.

Abstract

The Setting and Problems

Due to the high population pressure in the highlands, forage production from permanent pasture is confined to shallow, stony and steep upland soils and to the seasonally waterlogged and/or flooded valley bottoms. Forage production from the intermediate arable land is currently restricted to the provision of crop residues (barley, wheat, teff, oat, pulses) and in some areas to a rather scarce spontaneous fallow land vegetation. Crop residues account for approximately 15% of the total annual feed supply.

Conserved forage is mainly fed to draught oxen and lactating cows. The permanent pasture areas are heavily and permanently overgrazed by cattle.

Constraints

The constraints to increasing animal productivity through improving the feed supply are:

- total feed supply (relative to livestock numbers)
- seasonal feed supply
- low feed quality
- feeding management (no splitting of herd)
- malnutrition, lack of nutrition knowledge
- lack of information on feed sources

Guidelines for Forage Research

Based on the present situation of the smallholder and on the production constraints detected a number of guidelines for forage research activities were discussed. These included the following:

1) On-station research is the appropriate way to identify the basic technical problems. On-farm research is the best way to commit researchers and extensionalists to the generation of appropriate and accessible technologies.

2) Forage legumes are to play a key role not only in forage production but also in food crop systems

3) Exotic pasture germplasm is to be tested against best native germplasm

4) Any attempt to extend pasture growth into the dry season will alleviate feed shortage in this critical time.

5) N-fertiliser is not a justified input in pasture production of the traditional smallholder.

6) No pasture development without powerful back-up by herbage seed production.

7) Pasture legumes are the basis for high quality forage supply and for soil fertility improvement strategies. Pasture grasses are the basis for the realisation of the quantitative needs in animal feed (utilizable biomass).

Discussion

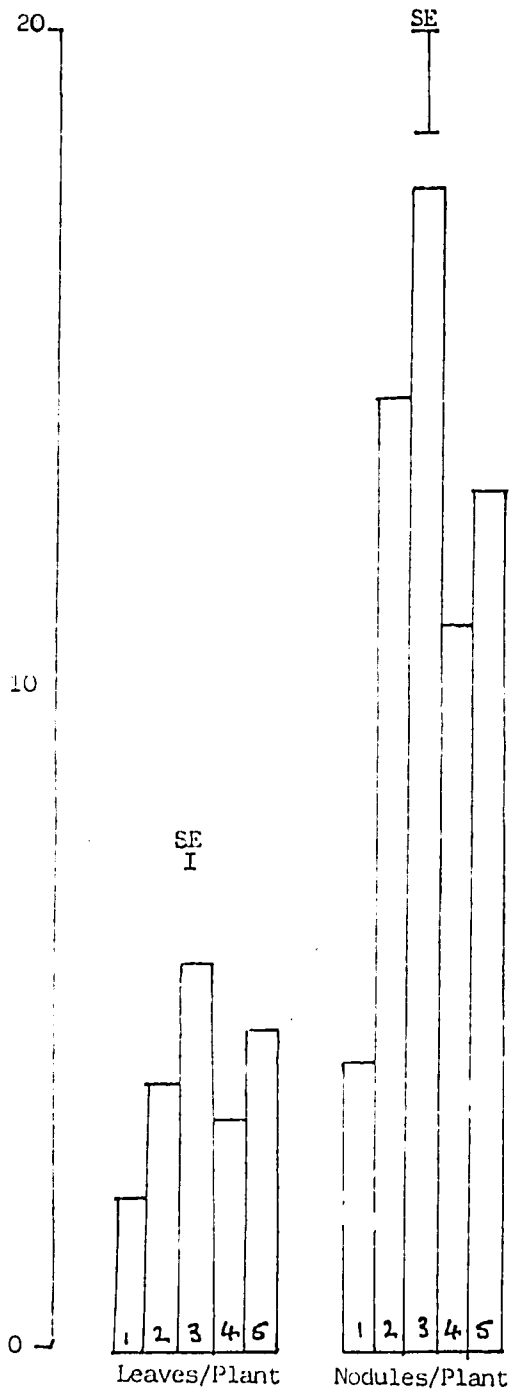
Asked what recommendations of ILCA have been adopted by Ethiopian farmers, Dr. Jutzi replied that only oat rich mixtures for dairy cows had been adopted on any scale.

Screening for legumes was done on the basis of efficiency of nodulation of native species. Application of phosphorus benefited both leaves and nodules. Nodule weight decreased slightly by the application of nitrogen. (Refer Figures 1 and 2).

The problem of supply of hybrid seed was raised. At the moment all legume seed needed in Botswana has to be imported. Asked whether it may be possible for certain countries to be bulk providers of certain species, Dr. Jutzi answered that support services and training could be organised on a regional basis but that commercial seed production needed to be done by companies or farmers within specific countries.

The intersowing of legumes and the planting of hazard resistant species in communal pastures was not a major problem in terms of community involvemnet because the Ethiopian farmers were organised into co-operatives and one dealt with the co-operatives not individual farmers.

EFFECTS OF (STARTER-) N AND P ON DEVELOPMENT AND NODULATION OF TRIFOLIUM TEMBENSE ON A BLACK CLAY SOIL (VERTISOL)



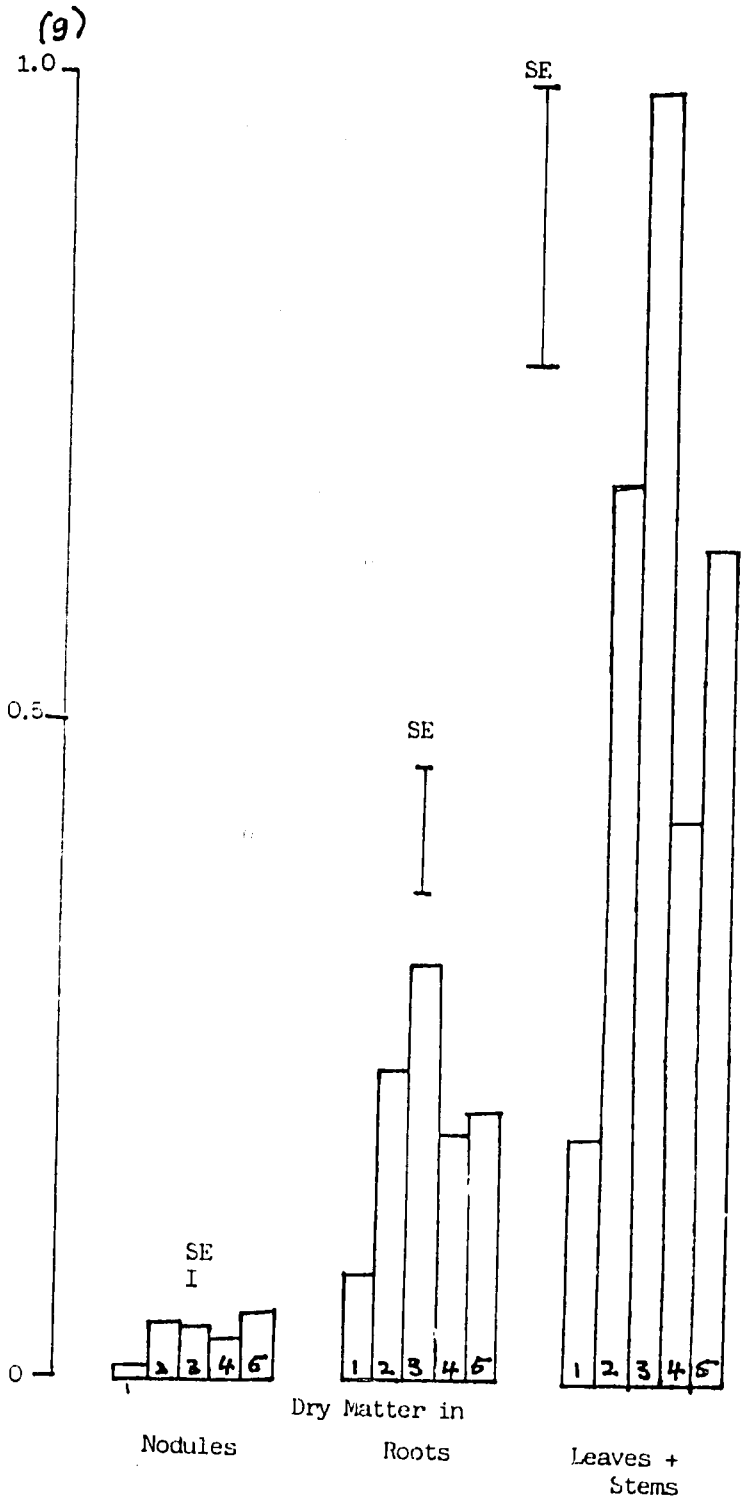
a) Leaves per plant and nodules per plant.

TREATMENTS

1. Control
2. 9 kg/ha N + 23 kg/ha P205
3. 27 kg/ha N + 69 kg/ha P205
4. 23 kg/ha P205
5. 69 kg/ha P205

(sample size: 60 plts / treatment)

FIGURE 1



b) Dry matter in nodules, roots and leaves/stems.

TREATMENTS:

1. Control
2. 9 kg/ha N+23 kg/ha P205
3. 27 kg/ha N+69 kg/ha P205
4. 23 kg/ha P205
5. 69 kg/ha P205.

FIGURE 2

FORAGE LEGUMES IN BOTSWANA

Paper # 17 entitled **"The Grazing Animal and Land Pressures in Small Farm Systems: must ruminant nutrition create inevitably a confrontation between arable land and grazing requirements?"** was presented by Mr. D. Chandler.

Abstract

The Problem

In Botswana yields from crops are very low (average 210 kg/ha) and risks are high. Yet 84,000 farm-households cultivate 300,000 hectares. Mixed farming is carried out by 68% of these households, 18% have livestock only and 14% raise crops only. There is said to be a biomass limitation to support acceptable levels of production from livestock, but the extent to which this is due to poor nutrition, bad management or overstocking is debatable.

Research Orientation

Herd structures need to be improved in order to provide better draught. The only way to do this is to improve the productive performance of the breeding female and subsequently improve the growth rates of the young animal, whilst at the same time reducing mortality to a minumum. Comparisons of productivity on the Animal Production Research Unit ranches and communal areas gives some indication of the improvements that can be made.

	Productivity Levels	
	A.P.R.U	Communal
Calving %	75	46-27
Mortality %	6-8	12-20
Weaning wt (kg)	175	125-80
8 month wt (kg)	275	200-140
Productivity per cow		
- at weaning (kg)	120	50
- at 18 months (kg)	188	85

The only criterion that will make sense under the current circumstances is the intensification of fodder production from a unit area that will be of the magnitude to provide not only very significant increases in total bulk of dry matter available to the grazing animal, but also of such a quality that digestibility and available protein levels can be expected to affect productive potential.

Improving Biomass Supply

Various methods of improving biomass supply were discussed. These included range regeneration, planted grasses, improved crop

production and forage legume production (intercropped, direct planted, mixed sowing, undersowing, annuals or perennials). Details were given of experiments on a number of these approaches conducted at the Integrated Farming Pilot Project between 1979 and 1982. These included

a) direct and undersowing of a variety of grasses and legumes in the 1979/80 and 1980/81 seasons

b) range reseeding in 1980/81

c) Dolichos Lablab trials, direct and undersowing of fodders and range strip discing in 1981/82

Discussion

It was said to be very difficult to get the Batswana farmer to think of the problem in terms of draught power. The basic problems were carrying capacity, range resource capacity, stocking rate, grazing index and herbage availability.

At IFPP, researchers have never yet attempted to grow fodder without basal phosphate dressing.

On the question of perennials it was said that Siratro provided yields of 4000 to 5000 kg/ha of dry matter per year with never less than 9% protein. It was best planted with E. Teff. There was said to be no point in trying to establish a grass without a legume.

FORAGE AND CROP RESIDUE EXPERIMENTS IN WESTERN KENYA

Paper # 18 entitled **"Feed Production Research for Smallholder Agriculturalists in Western Kenya"** was presented by Dr. S. Russo.

Abstract

The Problem

Due to high population pressures availability of communal pasture land is decreasing and the major constraint to livestock productivity is inadequate nutrition and large ruminants are going out of the system. There also exists a severe shortage of family labour time, since most of the males migrate to off-farm employment and the women left to take charge of the farm have many non-farm responsibilities to see to.

Appropriate Feed Resource Production Options

Given the nature of the problem the feed resource production options examined centered around the integration of dual purpose goat production into the current system. Goats are more suitable than cows in the circumstances due to their greater versatility and are able to provide meat and milk products. Research was aimed at providing sufficient quality and quantity of feed at appropriate times during the production cycle so that goats could produce milk and meat.

Interventions Tested

Non-successful interventions included:

a) Silage making
b) Intercropping forage legumes into maize and beans
c) Napier grass as a fence-row cut-and-carry crop
d) Stall feeding

Silage making was too time intensive, legume intercrops were not successful because not enough biomass was produced from the low growing plants to justify harvesting for animal feed. Napier grass was not cut-and-carried frequently enough and was labour intensive. Stall feeding was unacceptable because of the high refusal rate on the part of the goats and the labour intensity.

More successful interventions included:

a) Stripping and topping maize plants
b) Intercropping sorghum and early ratooning
c) Pigeon pea interplanted and planted in fence rows

Stripping and topping reduced yields by 25 and 15 percent respectively. Stripping from 6 weeks after planting to tasseling

and from the milk stage on may not reduce yields. Pigeon pea interplanted in the 1982 dry season did well if seed beds were well prepared and kept weeded.

Discussion

Discussion focused on the topics of pigeon pea, leaf stripping and Leucaena.

Pigeon Pea

Asked how pigeon pea could be used a fodder crop, it was said that it could be used as supplement mix for livestock.

On the question whether pigeon pea would be suitable for Botswana and whether varieties were available for trial, it was stated that in Kenya there was great hope for pigeon pea. It normally takes 7-8 months to mature but work is being done on a single season crop that can be cut off after the short rains, but the plants remain in the field, re-grow (ratoon) and can be harvested a second or even third time. Pigeon pea will still be standing green at the height of the dry season. The ability of pigeon pea to withstand dry conditions was confirmed by experience from IFPP in Botswana.

It was suggested that pigeon pea could be used successfully in Botswana but that in frost zones it would not be so productive. Early establishment before the frosts, was suggested as a way of overcoming this problem.

On the availability of seed we heard that it is available in Kenya and could be bought from farmers in Zimbabwe.

As an intercrop in Western Kenya pigeon pea was planted with maize during the short rains and left when the maize was harvested. In the long rains maize was planted in between.

Stalk borer was said to be a problem with pigeon pea, but the variety used in Western Kenya (Kioko) was resistant.

Leaf Stripping

The answer given to the question of how many leaves were stripped per plant was 5 leaves per plant over 100 metre row.

Leucaena

Leucaena was said to have the problem of tainting milk. Goats were said to have been particularly suseptible to this problem in the Phillipines. Some animals have material in their rumens that will break down the toxic substance. This is related to environment and genetics. In Malawi fairly high levels were said to have been fed without toxic effects. Management and feeding regimes were said to determine the toxicity. Leucaena would be used as an appetiser allowing increased utilisation of crop residues. It takes about 60 days for the rumen to adjust to the diet.

The biggest problem in Botswana was said to be in establishing the crop. It proved difficult to establish on the range. Digitaria is more easily established. Siratra requires two discings. Next season earlier establishment will be tried.

FORAGE AND CROP RESIDUE EXPERIMENTS IN EASTERN KENYA

Paper # 19 entitled **"Animal Feeding in Small Farm Systems"** was presented by Dr. Tessema.

Abstract and Supplementary Information

The Cropping System

Farm sizes range from 2.0 to 24.0 hectares. Even where farm sizes are less than 5 hectares, no more than 56% of the land is used for crop production. A considerable proportion of the farms are managed by women (26-47%). The men are away in town and cities for extended periods earning wages.

The main crops grown are maize, sorghum, millet, pigeon peas, cow peas, and beans. Although manure is produced in bomas, only a limited number of farmers use it on their fields: mainly because of the difficulty in carrying and spreading it on fields.

Natural pastures are the primary source of feed for livestock. Most farmers use maize stover (grazed in situ or cut and carried) and pigeon pea threshings as supplementary feeds. The cultivation of fodder is practised only to a very limited degree: only 8% of farmers reported growing fodder.

Objectives of On-farm Trials

The aim of the on-farm trials in the livestock sub-system was to bring together and test improved technologies in a range of feeding methods that will strengthen the role of livestock in small farm systems and increase production and profitablity. Description of trial work conducted out of the National Dryland Farming Research Station at Katumani included the following.

a) Improved Productivity of Natural Pastures

TABLE I

DRY MATTER YIELD OF NATURAL PASTURE HERBAGE
AT DIFFERENT SEASONS OF THE YEAR
(Katuman - 1981/82)

1st Cut		1st Regrowth		2nd Regrowth		3rd Regrowth		TOTAL
Date	Kg/ha	Date	Kg/ha	Date	Kg/ha	Date	Kg/ha	Kg/ha
9.12.81	670	7.3.82	149	3.6.82	1410	31.8.82	203	2432
31.12.81	750	29.3.82	208	25.6.82	814	21.9.82	178	2050
13.2.82	672	12.582	1030	8.8.82	326	3.11.81	155	2183
Average Yield	663		497		789		189	2147
Kg/ha								
2,5%	85		64		102		24	

TABLE II

THE INFLUENCE OF STOCKING RATES ON THE WEIGHT GAINS
OF STEERS, SHEEP AND GOATS GRAZING NATURAL PASTURES (KATUMANI)
FOR A PERIOD OF 323 DAYS (13.8.81 - 2.7.82)

ANIMAL TYPES	STEERS		SHEEP		GOATS	
Stocking Rate*	.35	.54	.35	.54	.35	.54
No. of Animals	10	14	20	28	20	28
Initial Weight (kg)	246	260	31	32	30	29
Final Weight (kg)	308	312	42	42	38	42
Average Daily Gain (gms)	189	161	30	31	25	36

* Livestock Units per hectare: 1LU = 250kg

TABLE III

LIVEWEIGHT GAINS PER HECTARE

Stocking Rates	Average Daily gains/animal (Kg)		Animal Days per hectare		Liveweight gain per hectare (kg)
.35 LU/ha					
(a) Steers	.189	x	(.35 x 323)	=	21.37
(b) Sheep	.030	x	(.35 x 323)	=	3.39
(c) Goats	.025	x	(.35 x 323)	=	2.83
TOTAL					28.09
.54 LU/ha					
(a) Steers	.161	x	(.54 x 323)	=	28.08
(b) Sheep	.031	x	(.54 x 323)	=	5.40
(c) Goats	.036	x	(.54 x 323)	=	6.28
TOTAL					38.76

TABLE IV

THE INFLUENCE OF GRAZING MANAGEMENT (CONTINUOUS VERSUS ROTATIONAL GRAZING) ON THE WEIGHT CHANGES OF SHEEP AND GOATS WHEN GRAZING NATURAL PASTURES AT KATUMANI (2.8.82 - 4.7.83)

ANIMAL TYPES	SHEEP		GOATS	
GRAZING MANAGEMENT*	Continuous	Rotational	Continuous	Rotational
Number of Animals	18	18	18	18
Initial Weight (kg)	17.2	17.2	15.7	15.7
Final Weight (kg)	32,7	32,2	30,6	30,0
Average Daily Gain (gms)	46,2	44,7	44,1	42,8

* The stocking rate for both continuous and rotational grazing was similar and was adjusted to .54 LU/ha

The results presented in the tables above were obtained on a natural grazing land that has been bush cleared. Our results show that, grazing a properly managed (bush cleared only) natural pasture, livestock could maintain their weight and make modest gains at a stocking rate of between 2 and 3 hectares per livestock unit. However farmers were very unresponsive to advice given on bush clearing. Many were unwilling to carry out the work because they say it is a hard and difficult task even though it does not conflict with other (farming) operations as it can be done in the dry season when there is little other (farm) activity.

b) Improved Utilisation of Crop Residues by Physical Treatment, Chemical Treatment and Supplementation

TABLE V

EFFECT OF NaOH (5%) TREATMENT UPON CHEMICAL COMPOSITION AND IN-VITRO DRY MATTER DIGESTIBILITY OF MAIZE STOVER

COMPOSITION	UNTREATED STOVER	TREATED STOVER
NDF%	85,8	71,2
ADF%	51,0	49,4
ADL%	5,6	5,6
CP%	3,19	3,86
INDMD%	35,9	44,5

TABLE VI

EFFECT OF NaOH (5%) TREATMENT ON INTAKE OF MAIZE STOVER BY SHEEP AND GOATS (July/October 1981)

ANIMALS	Average DM intakes (gms/animal/day)			
	Chopped Maize Stover as the only source of feed		Chopped Maize Stover plus natural pasture grazing	
	Untreated	Treated	Untreated	Treated
Sheep and Goats (48)	650a	674a	470a	715b

a,b means with different subscripts were different at P0.05 level

TABLE VII

THE EFFECT OF NaOH (5%) TREATMENT AND CONCENTRATE SUPPLEMENTATION OF MAIZE AND SORGHUM STOVER WHEN FED TO GRAZING SHEEP AND GOATS DURING THE DRY SEASON (July/October 1982)

	TREATMENTS				
	Grazing Alone	Untreated Stover	Treated Stover	Untreated Stover + MUM*	Treated Stover + MUM
No. of Animals	16	16	16	16	16
No. of Days on Trial	90	90	90	90	90
Initial Av. Wt. (kg)	24.0	24.0	23.9	23.4	24.2
Final Av. Wt. (kg)	18	25.7	25.5	25.3	26.2
Av. Daily Gain (gms)	-22a	19ab	18ab	21ab	22ab
Av. DM intake/day (gms)	-	271	420	516	730
Daily Feed Cost (K.Sh.)	-	-	.51	.36	.92
Feed Cost/kg gain (K.Sh.)	-	-	28.33	17.14	41.82

*MUM = Molasses, urea and mineral mixture fed at 200gm/animal/day
NaOH = K.Sh.13 per kg
MUM = K.Sh. 1.80 per kg
a,b means with different subscripts were different at P0.05 level

TABLE VIII

PERFORMANCE OF GRAZING SHEEP AND GOATS FED VARIOUS SUPPLEMENTS WITH MAIZE STOVER DURING THE DRY SEASON

	TREATMENTS					
	Grazing Alone	Treated Stover	Treated + MUM	Treated + Leucaena*	Untreated + Leucaena	Maize Silage
Number of Animals	8	8	8	8	8	8
No. of days	112	112	112	112	112	112
Initial Av. Weight (kg)	35.9	35.0	35.2	35.6	34.6	33.9
Final Av. Weight (kg)	32.1	39.4	40.4	40.4	38.8	40.8
Av. Daily Gain (gms)	-34a	39b	46b	43b	38b	62ab
Av. DM intake/day (gms)	-	210	290	250	350	580

* Leucaena leucocephala was fed as green chop and mixed with chopped stover at 20% of dry matter intake

a,b means having different subscripts were different at P0.05 level

TABLE IX

PERFORMANCE OF SHEEP AND GOATS SUPPLEMENTED WITH DIFFERENT LEVELS OF LEUCAENA

	TREATMENTS			
	30% Leucaena		50% Leucaena	
	Sheep	Goats	Sheep	Goats
Number of Animals	6	6	6	6
Number of Days	48	48	48	48
Initial Av. Weight (kg)	15.7	17.0	15.6	16.7
Final Av. Weight (kg)	16.0	14.3	17.0	14.6
Av. Daily Gain/Loss (gms)	11.07	-95*	46.8	-76.4
Av. DM intake/day (gms)	453	474	456	416
Leucaena	126	132	212	196
Bana	327	242	235	218

* One goat in this group had severe diarrhoea for 8 days

Farmers have particularly shown interest in the use of leucaena to supplement stovers and many of them have already accepted and planted seedlings in their farms.

One major factor upon which the technology of improved utilisation of crop residues would hinge is that of the use of some kind of a chopping implement that will reduce particle size of the crop residues. A locally fabricated machine costs K.Sh. 1700.00, which is a very big investment for a small farmer.

c) Growing Pasture and Fodder Crops

Two of the major problems with getting the farmer to cultivate pasture and fodder crops are land and labour scarcity. Because land is scarce a farmer usually finds it difficult to set part of his cultivated land, his labour and oxen time for growing fodder and/or pasture crops until he is assured that he can get two or three-fold increase over the crop production that he gets from the same plot of land. Furthermore the growing of forage and pasture grasses and their utilization for animal feeding is a labour intensive technology that creates peaked labour demands at food crop planting and harvesting time, or creates peaked labour demands by increasing regularity of operations.

d) Keeping Dairy Cows to Utilise Cultivated Fodder Crops

Trials conducted at the station showed that, when fed at **ad libitum** level, Bana grass can support up to 6.83 kg of milk per day without recourse to concentrates. An increased milk production of 31% was achieved with 1.49 kg dairy meal per day which, at current prices, was not economical.

e) Efficiency of Draught Breeds

Our results show that, given the present cultivation implements, there would be no advantage in using a cross-bred oxen over indigenous (Zebu) oxen. Properly and adequately supplemented indigenous oxen do perform just as well as the bigger and hungrier cross-bred oxen.

Rate of Adoption of Innovations

The rate of adoption of the above innovations was disappointingly very poor. It seemed that farmers valued their leisure more then the gains they could get from clearing bush to encourage good forage growth. While most farmers are grazing their crop residues in situ and realise that they are wasting about 40% of production in so doing, they still go ahead and practise it. It seemed that, in terms of labour use, farmers choose the least burdonsome way of doing a job, even if they are aware that an increased input will give a higher return. The growing of fodder crops created greater demand for labour and oxen time, which the farmer cannot cope with if he has to carry out operations of ploughing, planting and weeding for food crop production. Only a handful of farmers were able to be persuaded to include fodder crops in their cropping system.

It is assumed that failure to develop integrated recommendations for the whole farm system may perhaps have been the cause of low adoption rates of the recommended practices. It has therefore

now been decided to carry out the pre-extension trials on a fewer number of farms based on the whole farm approach. A well balanced mixed farming farm plan is to be made specific to each farm. It is intended that the station shall provide the basic inputs necessary for implementing the recommended innovations.

Discussion

Zebu vs Crossbred Oxen

Asked to elaborate on the preference for Zebu oxen, Dr. Tessema said that with feed resources based on crop residues and minimum supplementation of 700g of MUM, the Zebu were able to perform all duties that were required for reasonable planting. That is, they were able to go onto the land and plough at a reasonable depth (12-13 cm) and within a time period that was acceptable (2.5 ha in 8 days), and that there was no difference between the Zebu and the cross-bred in these respects. However if you were to start using implements that went deeper and required faster work, then you would need to feed better and might even need to go to a larger animal.

Dr Mosi noted that in Ethiopia their experiments had indicated that under normal feeding conditions the bigger animal barely performed at the same rate as the local animal, but when feeding became better you could harness bigger implements to the bigger animals. Mr. Singa noted that in Malawi implements had to be modified a little to fit larger animals.

Asked whether any cattle were not supplemented with MUM in the experiments comparing Zebu and cross-breds, Dr. Tessema answered that all the oxen received the same supplementation and the object of the experiment was to see whether they could all do a reasonably good job of land preparation.

Measuring Draught Efficiency

The question was raised as to how one could measure cost effectiveness of supplementing feed of draught animals under communal conditions. It was stated that if you are late in planting you lose 6% production per day. It was suggested that the first thing to do was to ensure that the animal maintained its weight. Under communal conditions it was thought that it was impossible to record statistical results. Farm management research was said to be missing; one needs to assess how efficiently the animals are being used.

CROP RESIDUE EXPERIMENTS IN KENYA

Dry Season Feed Resource Budgetary Problems - The Kenyan Experience and Efforts

Dr. Kayongo-Male gave the following presentation in lieu of a submitted paper.

The Problem

Kenya is about 225 sq. miles in area, but only 15% of this area lies within the high potential area. The human population is approximately 17 million and the population growth is 4% per annum. Kenya is therefore facing a very acute shortage of good arable land. Within the high potential areas, the population density is 500 people per hectare and because of this we estimate plot holdings to run between 1 and 2 ha. per family of 8 - 12 people. Because of pressure on land agricultural production increase is estimated to be below 1% annually.

Kenya has about 10 million livestock units, mainly cattle, sheep and goats. A big proportion of these animals live in high potential areas and because of unfavourable land-to-man ratio there is great competition between crop and livestock production. It was shown that 75% of the land is given to crops and 25% is given to livestock production. What has happened in Kenya as a result of those unfavourable ratios is that a number of systems have evolved such as zero grazing where forage is cut and taken to the animal. This brings problems of variable quality and quantity of feed given to the animal. A common figure quoted in Kenya is that animals pick up about 80% of feed requirements and this figure is much lower during the dry season.

Research Approach

We have taken three approaches to try and solve the feed shortage problem. We have looked at conventional interventions, i.e., pasture improvement programme; crop by-products; and, of late, we have moved into unconventional areas like maize stripping.

1. "Traditional" systems

   For any animal production system to be successful a balanced increase of feed resources and animals is very important. The conventional systems of pasture improvement in terms of grasses mixed with legumes; and in terms of fertiliser application have been tried with the idea of increasing pasture productivity. Fodder crops have been tried to be fed as silage or green chop. We think this kind of system is untenable to the small-scale farmer. With very small plots, grazing will become a luxury. The technology involved in making silage is not easily grasped by the small-scale farmer. As inflation goes up we are going to find ourselves producing grass at a very high cost. The cost of buying seed, fertiliser and the cost of power are all becoming prohibitively high. Grass is no longer the cheapest feed.

2. Crop Residue Feeding

The quality of agro-industrial by-products is very poor and they are not very useful in terms of animal production as shown in Table 1.

TABLE 1

Animal Productivity on Untreated Crop Residues

Crop Residue	Quantity (tonnes)	Quality %CP	%ADF	Animal Performance DMI (g)	ADG (g)
Maize stovers	5.0 million	4.3	31.0	1 000	(+79 to +35.0)
Maize cobs	4.0 million	2.0	29.0	500	(+62 to -11.0)
Sugarcane tops	0.4 million	5.0	38.0	800	(-10 to - 1.0)
Wheat straw	0.2 million	4.3	44.0	-	-
Rice straw	0.05 million	4.0	46.0	-	-
Barley straw	0.05 million	6.0	48.0	-	-

CP = crude protein ADF = acid detergent fibre
DM = dry matter intake ADG = average daily gain

We are trying to improve the feeding value of crop by-products and the methods used are shown in Table 2. Broadly, they are:

1. Physical treatment
2. Chemical treatment
3. Feed residues with something else (supplementation)

TABLE 2

Common Methods of Improving Utilization of Crop Residues in Kenya

Physical	Chemical	Supplementation
Grind	Alkalis	Concentrate - mixed ration
	NaOH	- starch
	$Ca(OH)_2$	- protein
	KOH	
Chop	Bicarbonates	
	Na_2CO_3	
	$NaH\ CO_3$	Minerals
	Magadi soda	
	Urine	Fodder - Napier
	Ammonia	- potato vines
		- haulms
	Halogens	
	Chlorine	Molasses-Urea-Minerals (MUM)
	Fluorine	
	Water	

In all three methods, the idea is to try and increase digestibility of the residue. This increases intake and nutrient availability. The farmer can physically grind or chop the residue but this is not feasible because of the cost factor. As far as chemical treatments in Kenya are concerned, we feel that the only thing which has a chance is Magadi soda. This is not expensive and is easily available because it is produced locally. There are dangers involved in the use of chemicals by small-scale farmers and the improvement to animal production does not warrant the risk. Supplementation or feeding the crop residue plus small amounts of common fodders such as napier and leucaena or commercial and home-made concentrate seems to hold more promise, at least from the data obtained so far (Table 3).

TABLE 3

Animal Performance on "Treated" Crop Residues

Materials	Treated with	Species	% Improvement
Maize stover	NH_3	Sheep	65
Maize cobs	NH_3	Sheep	44
Maize cobs	NaOH	Cattle	34
Maize cobs	Magadi soda	Cattle	24
Maize cobs	Ground (10mm)	Cattle	12
Dry maize leaves	Fed with 200g conc.	Sheep	500*

* The animals rose from a loss of 11.0g daily to a gain of 46.0g per day

3. New Integrated Systems of Crop and Animal Production (NISCAP)

This is the new idea that is being proposed after some research by the scientists at the Department of Animal Production, University of Nairobi. Since the common crop residues cannot improve animal performance without the added costs of treatment, the idea to be explored was - can the farmer feed crop residues before they deteriorate in quality to warrant treatment? In maize we looked at 4 broad areas in which this could be achieved, namely:

(i) Harvest early and dry the maize grain artificially
(ii) Top the maize plant
(iii) Strip the maize plant
(iv) Plant excessive numbers and thin

We decided on systematic stripping by picking one leaf per plant once a week. We found, among other things, that by defoliating 1 ha. of maize, we could sustain three sheep per year (Table 4).

TABLE 4

Established Quantity, Quality and Utilization by Sheep of Defoliated Maize Leaves (H512; H511)

Parameter	Range Values
Dry matter yield	1.0-1.2 tons/ha./season
Crude protein content	10.5 - 14.6%
Fibre (ADF) content	37.7 - 48.2%
Fibre (ADL) content	5.1 - 9.8%
Digestibility	51.0 - 62.6%
Dry matter intake	770 - 950 g/sheep/day
Average daily gain	95 - 136 g/sheep
Feed conversion ratio	6.5 - 12.2
Carrying capacity	3 sheep/ha./year

With 1 million ha. of maize grown in Kenya per year, this would increase feed resources. One of the advantages of this method is that the labour involved in collecting materials (stripping the leaves) is minimal - about 2 kg of dry matter can be collected in 1 minute. Secondly, data in Table 5 clearly shows that fresh maize leaves are superior to dry maize leaves and other common dry season feeds such as Napier grass and Rhodes hay.

TABLE 5

Comparative Performance of Sheep and Cattle fed on Maize Leaves and other Common Dry Season Feeds

Species	SHEEP			CATTLE	
Roughage	Fresh Leaves	Dry Leaves	Napier	Fresh Leaves	Rhodes Hay
Initial weight (kg)	20.2	25.0	21.0	66.3	77.0
Final weight (kg)	29.8	24.5	24.9	87.2	85.8
DMI, g/day	890	730	690	2 660	1 793
ADG, g	136	- 11	48	336	147
FCE	6.5	-	14.0	7.9	12.2

DMI - Dry Matter Intake ADG - Average Daily Gain
FCE - Feed Conversion Efficiency

The major problems involved in maize defoliation as a technique to increase feed resources are:

(a) Defoliation causes a grain loss. However, as the maize matures you get a small boost in maize production when one leaf is removed weekly (Table 6).

TABLE 6

Grain Trade-Off with Age of Maize and Intensity of Defoliation

LEAVES OFF/WEEK	AGE OF PLANT 75	POST-EMERGENCY (Days) 100	115
1	- 10.0	- 5.0	+ 3.0
2	- 34.0	- 26.0	- 18.0
3	- 42.0	- 38.0	- 23.0

(b) Maize lodging - increased lodging was related to defoliation (Table 7) but the cause of increased lodging is not very clear yet.

TABLE 7

Effect of Defoliation on Maize Lodging

Lodging %	Defoliated		Undefoliated	
Total	23.8		14.4	
Stem	16.4		7.9	
Root	7.4		6.5	
	Lodged	Standing	Lodged	Standing
Stem height, cm	324	315	315	328
Root weight, g	25	48	19	42
Lignin in stem, %	9.9	10.2	12.0	12.3

Four theories have been advanced so far:

(i) Stems grow taller with defoliation
(ii) Insufficient root development
(iii) Insufficient lignification of the stems
(iv) The act of defoliation itself

Theories (i) to (iii) have been investigated (Table 7) with inconclusive results.

(c) Preservation - the concern is dry season feeding. The fresh highly nutritious maize leaves are available only during the wet or growing season. During this period, there is also plenty of grazing. Table 8 shows the three methods that have been tried in a pilot study, namely, sun drying; air/shed drying; and blanching coupled with sun drying. The appearance, texture and smell of the preserved material indicated that fresh maize leaves can be preserved for animal feeding. The adaptation of any of these methods will largely depend on specific local conditions.

TABLE 8

Possible Methods of Maize Foliage Preservation

Method	APPEARANCE Start	APPEARANCE End	TEXTURE (feel)	SMELL (odour)	TIME TO DRY (days)
Sun dry	green	grey-green	soft	Sweet/hay	4 - 5
Air/shade dry	green	deep green	very soft	Sweet/hay	6 - 7
Blanching + Sun (Heat Treatment)	yellow	brownish-green	soft	Molasses	3 - 4

Discussion

Discussion centred on leaf stripping and touched on pasture improvement and chemical treatment of residues.

Leaf stripping

On the question of storage of leaves it was said that this was a pilot project so storage was not significant. However, it could be a problem on a bigger scale. Leaves were fed fresh and chopped. It was observed that in maize there is considerable variation in leaf numbers and size. On the question of testing the effect of stripping on different varieties it was stated that only three varities were tested - H511 and H512 and 600 series. The 500 series has about 14- 15 leaves per plant and the 600 series about 20 per plant. When plants were defoliated three leaves were left on top plus the two leaves that subtend the cobs, thus leaving a total of 5 leaves per plant.

Dr. Collinson observed that farmers in that area are actually planting the 600 series to get fodder but as the 600 series has just been introduced into that area it had not been used in the experiments that much.

Asked whether the findings that starting defoliation before 115 days seriously penalised grain yield was disappointing, Dr. Male said that grain yield was reduced but with gradual stripping this was minimized and furthermore material was not accumulated so storage problems were minimised.

The possibilities of carrying out grass weeds as a fodder while stripping and/or thinning were discussed.

Use of Magadi Soda

Asked whether people may prefer to use Magadi soda for purposes other than chemical treatment of crop residues, Dr. Male replied that at the moment Kenya has large deposits of soda and it is hoped that more will be extracted and there will be no conflict between home use and the export market. In Kenya sodium hydroxide costs $4 per kg and Magadi soda 10 cents per kg.

LIVESTOCK NUTRITION RESEARCH BY ILCA

Paper #20 entitled **"ILCA's Approach to Livestock Nutrition in the Farming Systems Context"** was presented by Dr. A. Mosi.

Abstract

ILCA's Nutritional Programme

In each of the zones of Africa the most severe husbandry problem has been the provision of good quality feed year round for meat, milk and for traction. The current nutritional programmes focus on the farming system practised in each zone and how best the system can be manipulated to provide more feed for increased animal nutrition. This approach emphasises the following topics:

(a) the use of cereal and legume crop residues for ruminant nutrition

(b) the introduction of good quality forages into the arable system and agropastoralist settlements

(c) a rational use of existing rangelands

(d) animal traction

(e) water provision during the dry season

Some Preliminary Findings

(a) Cereal Crop Residues: Cereal crop residues are of poor nutritive value but it has been found that the addition of a good quality legume forage can improve digestibility and intake to a point where reasonable levels of productivity are possible. Mixed farmers in densely populated areas could use cereal crop residues and farm-produced legumes to feed the livestock component.

The African Research Network on Agricultural By-Products (ARNAB) has been formed to stimulate research in this area throughout Africa. ARNAB headquartered at ILCA, publishes a quarterly newsletter.

(b) Introduction of Good Quality Forages: A germplasm collection has been established and a computerized indexing system based on 120 descriptors has been devised which allows the rapid identification of those accessions believed to be best suited to the climatic edaphic and livestock production conditions of various African countries.

Strategic feeding of forage legumes with crop residues would enable agropastoralists to feed in-calf and lactating cows after natural pastures have been exhausted. This target group has the greatest protein deficit and is where improved nutrtion will generate the greatest benefits: increased milk offtake for human consumption, higher calving rates and faster calf growth.

The benefits of rationing scarce feed resources to selected animals was demonstrated at the ILCA study areas in Kurmin, Biri and Zonkwa in northern Nigeria. Agropastoralists were encouraged to feed cotton seed cake to in-calf and lactating cows only, instead of feeding it sporadically and unsystematically to the whole herd, which was the general practice.

The undersowing of stylosanthes into a stand of sorghum in the vicinity of Kaduna is technically attractive, but the desired date of undersowing coincides with a period of high labour demand for weeding. This technique may thus prove not too attractive for agropastoralists.

The ILCA team has demonstrated that under controlled conditions DM yield of 6.8 tons/ha. containing 56% stylosanthes and a CP range of 14% - 6% (rainy season - dry season) is possible. Under pastoralist conditions, DM yield is about 5 tons/ha. with up to 68% stylosanthes and a CP range of 13% - 7%.

(c) Animal Traction: The performance of work by local oxen may involve a small increase in protein requirement but considerable increments in energy demand. Appetite is probably increased and marginal quality roughages may be utilised. There are important nutritional implications for feed utilisation strategies with draught oxen and research is being carried out to determine the exact maintenance requirements of Zebu and cross-bred animals as well as the breed responses to feeding high and low energy levels on work output and general body condition.

Discussion

(a) Animal Feeding: While there is a problem in producing enough food to feed animals well the animal scientists are producing animals with more body mass. It was asked whether this aspect was being considered. No real answer was given. Dr. Mosi said that the efficiency of feed conversion with good quality feeds is better with fast-growing ruminants. This is not true when poor quality feeds are offered to genetically synthesized heavy breeds.

Asked how frequently animals need water, Dr. Mosi replied that it depended on the moisture content of the feed the animal was getting. With fresh forage you get a lot of moisture. If it is dried food you need more water.

Ruminants need water at least every 3 days. To improve performance access to water is needed.

On the question of the use of cassava and cotton seed cake as feed for animals it was suggested that some varieties of cassava contain some cyanide but the effects on ruminants depended on quantities ingested. Usually scrapings from daily food preparation are used as supplementary feed in West Africa.

Asked to expand on what he thought were the nutritive requirements for draught animals in terms of energy and protein digestibility, Dr. Mosi said that current trials are ongoing. Except in the early work of Brody, nowhere are actual nutritive requirements of draught animals established. We are measuring this on an input/output basis. We can measure how much energy the animal is receiving. The equilibrium stage of energy input and energy output comes when the animal is neither gaining nor losing weight but still offering traction. When you get to this point you can then assess amounts of energy needed.

It was observed from some of the graphs (refer systems descriptions) that cattle condition improves quite rapidly at onset of rains under natural conditions. Mr. Maynard asked whether much work has been done on just a period of two or three weeks feeding and how this compares with maintaining liveweight over the whole of the dry season in order to improve draught power at the beginning of the season. Weight attained prior to work is rapidly lost if that condition is not maintained through balanced rationing. Body reserves (especially fat) are mobilized to provide work. These reserves must be replenished simultaneously with depletion. Dr. Tessema said that in Kenya they fed for one month prior to the start of ploughing with maize stover plus MUM at a minimum amount. The cattle were worked for a total of 8 days to finish 2.5 ha. Transport and weeding work was still to be done. To keep them in condition feeding continued over the dry season. Within 110 days with this kind of supplement as well as natural pasture, both Zebu and cross-bred animals gained weight with the work. It is necessary to keep animals in good condition over a minimum period of about 6 weeks.

(b) Plough teams: Asked whether ILCA was looking at the question of female animals ploughing and the effect on their reproductive cycle of the stress period of ploughing, Dr. Mosi replied that they were even looking at a single ox to plough. Indications are that where land availability does not exceed 2.5 ha. per family, one ox could prepare the land satisfactorily. Dry female animals can do the work. What is not known is how far into the pregnancy situation one can use them. If they are dry animals will it lengthen the dry interval? Trained dry cows can do as good a job as oxen. It is not known how work will affect the incidence and maintenance of pregnancy. These issues will have to be resolved.

(c) Rangeland Improvement: Mr. Riches noted that even though ILCA, as a matter of policy, said that we should not be involved in re-seeding the rangeland we have heard that work is going on by a number of people already involved in experimental programmes of reinforcing the rangeland with legumes. Dr.Mosi replied that ILCA is not against re-seeding the rangeland. The cost factor and inputs such as seeds do not exist in most African countries. If you are going to conscientiously re-seed you must protect the seedlings, so what do you do with the cattle? Dr. Henson observed that experience in the US, where re-seeding of the range has been tried for many years, has shown that, from an economic standpoint, any substantive effort to re-seed ranges has to be limited to specific localities. One finds in African and US experience that if one could manage the range and control livestock the range would regenerate with natural growth.

SECTION THREE

Networking and Workshop Assessment

NETWORKING AND WORKSHOP ASSESSMENT

Networking

The objectives and context of the draught power and animal feeding networkshop was outlined in paper #2 by A. Low.

The need for networking in on-for research was especially evident because:

a) Practitioners tended to be few and scattered

b) Formal links through established journals do not exist

c) Development of sound new methodologies must rely heavily on cumulative trial and error experience.

The forms of networking suggested were:

a) Newsletters: experience with the farming systems newsletter put out by CIMMYT from Nairobi suggests that this type of networking tends to be somewhat passive in that many readers are happy to receive information and ideas but only a few of them make significant contributions.

b) Studies to inventory aspects of special concern in terms of systems where the aspect is of importance as well as past and ongoing related research work. The advantage with this approach is that it can actively seek out experiences and provide a comprehensive picture of ongoing work.

c) Networkshops with the same objectives as in (b) but being less comprehensive though more interactive.

Discussion

The discussion revolved around three aspects:

- context and form of networking in general
- percieved output of this networkshop
- assessment of this networkshop in terms of:
  a) approach
  b) format

Context of Networks

It was agreed that there was a need for some co-ordination of effort and for keeping people working in more remote areas informed of what was going on elsewhere. However it was felt that there may be a duplication of effort by different International Research Centres. For example ILCA was operating a By-Products and Residues network (ARNAB) and was going to start a draught power network. IDRC had made some provision for a Minimum Tillage network. SADCC was inventoring past research and

talking about developing an Agricultural Research network. It was felt that there was a need for some organisation to take an overview of the situation and that the appropriate institution may be IDRC.

It was agreed that newsletters on their own were not totally satisfactory because the response was often poor. ILCA said that they had tried to circumvent this by arranging annual visits to members of the network and hold discussions of general interest in situ. As the membership gets bigger ILCA intends to hold annual get-togethers.

CIMMYT made it clear that its interests were very specific, to try to bring together systems and component oriented researchers focusing on the same problem. It did not propose to perpetuate these groupings. Each workshop would have a different focus. CIMMYT would however be happy to facilitate any networking which emerged from these groupings, through travel and meetings. CIMMYT would also endeavour to keep participants informed of other activities in the region relevant to this focus.

Output from this Workshop

Participants were asked to comment on work they had heard about outside their countries or areas that might be appropriate in their own local specific situations.

a) The Botswana plough planter and the work in Zimbabwe on direct planting into winter ploughed land with herbicides and tines were said to have potential value in Swaziland as time-saving devices.

b) The Kenya work on crop residues was thought to be relevant to Western Sudan

c) The minimum tillage and herbicide work in Zimbabwe and elsewhere was thought to have some relevance in Botswana, but posed problems in Kenya where mixed cropping of cereals and legumes was being introduced into the system.

d) ILCA's work on improved efficiency of harnessing animals to implements was seen as being valuable in Botswana.

e) Selective feeding of animals in Kenya and Lesotho was of interest in Malawi, where performance tested bulls given to farmers had died because they had not been fed adequately.

f) Stall feeding work in Kenya and Lesotho could tie in well with areas where work was being done on collecting and feeding crop residues.

g) One beneficial output of the workshop was said to be that participants had written down what would not have been put on paper except in an annual report. Even though some papers came late information had been recorded which may not have been otherwise.

Workshop Assessment

a) General Approach

It was felt that the divergence between systems was too great and that areas of concern needed to be more closely defined. There was acceptance that it had proved difficult for presenters to get down to detail. People tended to preface their presentations with general statements of the problem of which everyone was already aware.

Disappointment was expressed that the presentations were so abbreviated that much useful information was lost.

It was thought that the idea of using the systems calendars (wall charts) was good and that time could have been saved if these had been prepared in advance so that those areas with similar systems could have got together.

It would have been advantageous for participants to have received the papers in advance. This would have enabled groups with similar systems or research work to get together for presentations and discussions.

b) Workshop Format

The format of the workshop was designed to expose the component worker to the different system situations and the implied differences which appropriate solutions would have to handle. Participants were given guidelines for presentations (appendix 3) and instructions for discussions (appnedix 4) after arrival.

The prescribed formats were felt to be good but several suggestions for improvement were made:

a) Guidelines for presentation must be given out well before the meeting. Many presenters could not react adequately to guidelines given to them on arrival.

b) The two group sessions (one on discussion of systems and one on discussion of interventions in relation to those systems) should be reorganised.

   (i) Groups should have systems, problems and therefore intervention possibilities in common.

   (ii) Group discussions should wait until both systems and interventions have been covered in plenary session.

c) Less time should be spent in general descriptions of farming systems by systems researchers (this is what the guidelines were intended to ensure). More time should be spent on actual experimental results by component reseachers and this should include information on the costs of the interventions.

APPENDIX

Appendix 1

LIST OF PARTICIPANTS AND ADDRESSES

Mr F Buckham
Malkerns Research Station
PO Box 4
Malkerns
SWAZILAND

Mr C Chabala
Adaptive Research Planning Team
(Central Province)
PO Box 80908
Kabwe Regional Research Station
Kabwe
ZAMBIA

Mr D Chandler
Integrated Farming Pilot Project
PO Box 69
Lobatse
BOTSWANA

Dr M Collinson
CIMMYT
PO Box 25171
Nairobi
KENYA

Ms T Faria
Faculty of Agronomy
PO Box 257
Maputo
MOZAMBIQUE

Mr T Farrington
EFSAIP
Agricultural Research Station
P/Bag 0033
Gaborone
BOTSWANA

Dr J Henson
Office of International
Development Programme
Washington State University
Pullman
Washington 99164
U S A

Dr S Jutzi
Ethiopian Highlands Programme
ILCA
PO Box 5689
Addis Ababa,
ETHIOPIA

Dr J Kategile
IDRC
PO Box 62084
Nairobi
KENYA

Dr E Klosterman
Agricultural Research Division
PO Box 829
Maseru
LESOTHO

Dr B A Koch
c/o D Norman - ATIP
PO Box 90
Gaborone
BOTSWANA

Dr H Kayongo-Male
Faculty of Veterinary Medicine
PO Box 29053
Kabete
KENYA

Dr A D Malithano
PO Box 257
Maputo
MOZAMBIQUE

Ms Z Mamba
Malkerns Research Station
PO Box 4
Malkerns
SWAZILAND

Appendix 1

Mr S Mamba
Ministry of Agriculture
PO Box 162
Mbabane
SWAZILAND

Mr M 'Matli
Agricultural Research Division
PO Box 829
Maseru
LESOTHO

Mr T Maynard
Adaptive Research Planning Team
(Lusaka Province)
Mount Makulu Research Station
P/Bag 7
Chilanga
ZAMBIA

Ms L Mokjope
Agricultural Research Division
PO Box 829
Maseru
LESOTHO

Dr A K Mosi
ILCA
PO Box 5689
Addis Ababa
ETHIOPIA

Mr G Mudimu
AGRITEX
PO Box 8117
Causeway
Harare
ZIMBABWE

Mr H Muiruri
Animal Science Department
Egerton College
PO Njoro
KENYA

Dr K V Ramanaiah
Department of Agronomy
PO Box 257
Maputo
MOZAMBIQUE

Mr C Riches
EFSAIP
Agricultural Research Station
P/Bag 0033
Gaborone
BOTSWANA

Dr S Russo
c/o American Embassy
PO Box 596
Banjul
THE GAMBIA

Mr E Shumba
Agronomy Institute
Research & Specialist Services
PO Box 8100 Causeway
Harare
ZIMBABWE

Dr J Siebert
c/o D Norman - ATIP
PO Box 90
Gaborone
BOTSWANA

Mr D Singa
Chitedze Research Station
PO Box 158
Lilongwe
MALAWI

Dr S Tessema
FAO Drylands Farming Research
and Development Project
PO Box 340
Machakos
KENYA

Dr V Watson
Malkerns Research Station
PO Box 4
Malkerns
SWAZILAND

Mr A Zimba
Chitedze Research Station
PO Box 158
Lilongwe
MALAWI

Appendix 2

OPENING SPEECH

NETWORKING ON DRAUGHT POWER AND ANIMAL FEEDING

- by Mr Gilbert Dlamini

Introduction

We are pleased to be hosting CIMMYT's first technical networking workshop here in Swaziland not only because we enjoy welcoming visitors from so many different countries, but for three other special reasons as well:

First, being a small country, we particularly recognise the importance of networking which allows the exchange of ideas, findings and results between countries. This does not only apply to the field of agricultural research, although it is perhaps of most value here given the heavy demand of research on resources and the limited capacity of small countries to meet all their research needs by themselves.

Second, the topic of this technical workshop is of particular relevance to Swazi Nation Land farming. The integration of livestock and cropping is a well-recognised feature of our agriculture, but it is one that has not been afforded the attention it deserves by either researchers or development planners.

Third, the farming systems approach to research is of particular interest to us at this time. We, like many other countries in the region, are undergoing a fundamental re-thinking on our approach to agricultural research in an attempt to make our experimental programmes more relevant to the needs of the majority of small farmers on Swazi Nation Land.

Let me elaborate a little on why each of these three areas is of interest to us in Swaziland.

The Farming Systems Research Approach

We in Swaziland have come to recognise the limitations of the conventional approach to agricultural research. This approach, which focuses on specific crops and seeks to maximise production of that crop per area of land in isolation from other crops of farm-household activities, has not provided us with appropriate recommendations for the majority of our small farmers.

We have come to recognise that a major weakness of our Rural Development Areas programme has been the lack of appropriate recommendations for crop and livestock production. Through the Rural Development Areas programme we have developed rural infrastructure, provided input supply and marketing services and increased our extension coverage but the majority of farmers still do not follow the available production recommendations and crop and livestock yield levels remain well below the potential

Appendix 2

that could be achieved if the recommended practices were followed.

What is wrong? It is now generally recognised that the problem does not lie with the farmers, but with the recommendations themselves. We need to ask how practical are the recommendations for the average small farmer on Swazi Nation Land. Early planting, the preparation of a fine seedbed, clean weeding, heavy liming, high fertiliser application rates are all sensible recommendations for achieving high yields of hybrid maize per hectare. But how practical are they for the average Swazi Nation Land farmer? Can a man who has to borrow the oxen he needs for ploughing always plant early? And given delayed ploughing, can he afford the time needed to perform a good harrowing of his seedbed before planting? Does he have the labour resources to keep all his fields clean weeded? Does he have the financial resources and logistical support to apply high rates of lime and fertiliser? For most farmers the answers to one or more of these questions will be "no". Yet these are the types of recommendations that have come out of the conventional research approach in Swaziland and they therefore form the basis of our extension advice. We are attempting to change the orientation of our agricultural research work so that we can provide our extension officers with more appropriate recommendations for more of their farmers.

To come up with appropriate recommendations for small farmers, it is clearly necessary to investigate and diagnose the constraints under which the majority of small farmers operate. And since many of these constraints will be caused by social rather than technical factors, it becomes important for social and technical scientists to work together in diagnosing constraints and developing appropriate technical, social or economic instruments to help farmers overcome these constraints. Technical solutions to production problems devised by researchers will only be of any value if farmers can put them into practice given the socio-economic circumstances in which they operate. Instead of determining optimal fertiliser rates for early planted, clean weeded, hybrid maize, which is only applicable to a few farmers, it would be a better use of scarce research resources to generate fertiliser recommendations for those, more numerous, farmers who cannot plant early or clean weed. Social scientists can assist technical scientists in establishing the most appropriate areas for research that are relevant to most instead of only a few farmers, and prevent the waste of time and resources on generating technically feasible recommendations that are socially or economically inappropriate for the majority of farmers.

In the restructuring of our agricultural research capacity in Swaziland, we are attempting to develop a research programme that is more relevant to the majority of small Swazi Nation Land farmers than it has been in the past. We recognise the need for social and technical scientists to interact in this process and I am pleased to note that there are a number of social scientists amongst the delegates to this technical workshop.

Appendix 2

Systems Interactions

When it comes to the topic of this meeting, i.e., draught power, the need to be thinking in systems terms becomes obvious. In the system of farming we have in Swaziland, livestock husbandry cannot be divorced from crop husbandry. Cropping depends on cattle for draught power, for manure and for the transport of inputs and harvest, while crop residues provide essential winter season sustenance for livestock. By the same token, here in Swaziland, we cannot think of farming activities being separate from and unconnected with other farm household activities. Just as few Swazi farmers are either croppers or herders few are either housewives or farmers, few are either producers of crops or producers of handicrafts, few are either farm workers or wage earners, few either grow crops or brew beer. Most farm households combine a few or more of these activities and more time spent on one of them implies giving up time spent on another.

Sometimes it is possible to satisfactorily combine more of one activity with another. Thus, for example, many male wage workers send money home for their wives to hire tractors for ploughing. By providing Government tractor hire pools in the Rural Development Areas, we have enabled households to better combine wage earning with family farming. Farming systems research should be looking for similar ways to increase farm production, not at the expense of other activities, but in conjunction with them. Technologies that are complementary with other activities will be adopted much more readily than ones that are competitive. If you ask a Swazi rural housewife to spend so much time tending her crops that she does not have time to fetch the family's daily water requirements, she would be foolish to listen to you.

At least we should be considering how the competitiveness between increasing farm production and reducing the output of other activities can be minimised. This is the challenge for farming systems research in Swaziland. In our Rural Development Areas programme we have gone some way to reducing such conflicts through, for example, our programme of rural piped water supplies. Unfortunately, the production technologies that have become available to us from conventional research have tended to be competitive rather than complementary with other activities. This is why they have often not been appropriate for the majority of Swazi rural families.

Here in Swaziland the draught power problem provides a good example of the complexity of the inter-relationships that need to be considered when examining ways of increasing crop production on Swazi Nation Land. One of the factors causing low crop yields is that draught cattle are weak at the beginning of the season so that ploughing and planting is delayed and seedbeds are not adequately prepared. At the same time more families need draught power at the beginning of each season.

Appendix 2

But we are often told that there are already too many cattle in Swaziland. Not only do more people need draught teams each year, but at the same time more households are requiring their land to be cultivated more quickly than before, since men in wage employment who return to their farms to plough the lands have limited holiday periods in which they can operate. Given the increased demand for draught in an overstock situation and the need for speedier operations, we have looked at alternative methods of draught power in Swaziland. I have already mentioned the Government tractor pools. We have also developed the small Tinkhabi tractor here in Swaziland and are doing work on improving implements such as the Safim planter. I am pleased to see from the agenda that you will have an opportunity of seeing something of these areas of research and development while you are here.

Alternative possibilities for better meeting the draught power needs are also being examined. For example, we have an inter-cropping research programme here which is looking at the economics of inter-cropping forage legumes with maize. With all these options, though, we need to think carefully about their wider implications on the rural way of life. Can ever-increasing numbers of cattle be supported to meet the future increase in demand for draught power? What does more time and effort spent on feeding and managing cattle mean in terms of other household activities?

I would urge delegates to not only think in terms of a farming system, but also to apply the systems approach to the broader rural and household production systems, of which farming is an integral and not an isolated part.

Networking

There are obviously a whole range of ways in which the draught power problem can be tackled. I have mentioned some of these already:

(a) improved winter feeding with forage legumes, conservation of crop residues or supplementary feeding;

(b) improved draught implements to speed operations or reduce draught requirements; and

(c) alternative power sources such as the Tinkhabi or conventional tractors.

Other options include:

(d) zero or minimum tillage;
(e) chemical weed control; and
(f) selective oxen feeding and management.

Some of these options will be more feasible in one area than another, but in order to judge whether these options are likely

to be applicable in any particular situation, much research needs to be done. Information is needed on how each of these options affect production, what level of inputs are required and in what form, how much time the operations take, how reliable they are under different climatic conditions, how they affect the performance of cattle either in terms of draught or in terms of growth and reproduction.

Even for large countries with well-developed agricultural research establishments, it would take a long time to research into and generate results about all aspects of the many alternative options for reducing the draught power problem. With a knowledge of the research approaches and experiences in other countries where draught power presents an important development problem, much time and duplication of effort can be saved.

Smaller countries, such as ours, need to rely heavily on relevant research in other countries. We can undertake adaptive research to see how results from elsewhere fit into our particular circumstances, but we do not have the resources to conduct a wide range of component research. For us, mechanisms to keep us appraised of possible solutions to problems, approaches to experimentation and results obtained elsewhere are absolutely essential.

We are therefore extremely pleased to be hosting this first technical networking workshop, which we hope will be only the first of many. From the number of countries represented, it is clear that the draught power problem is a very widespread one and that there is much relevant research work going on in relation to it in many different disciplines. Our researchers will undoubtedly benefit from learning about the range of experiences represented in this workshop and I hope that your getting together here will be the start of a continuing and growing co-operation and exchange of ideas and results on this most important aspect of agricultural development in Eastern and Southern Africa.

---oOo---

Appendix 3

GUIDELINES ON PRESENTATIONS AND DISCUSSIONS

Time Limit for Presentations

Given the good response we have had to our requests for papers, we are going to have to be very firm about the time we allow for presentation and discussion of each paper. If we are to get through them all and allow some time for questions on each, we must set a limit of 20 minutes for each presentation.

Background Information

Most of your papers provide quite comprehensive background information aimed at placing diagnostic findings or experimental work in its proper context. While this is essential to a full understanding of your work, you will not have time to present the background information in much detail. The papers are being made available to all participants and I would urge you to rely on the papers for background information. We would like the presentations to assume that the background material has been read and to focus more directly on the nature and causes of the draught power or animal feeding problem or on the results of experiments aimed at the solution of particular specified problems.

Format for the Presentation of Problems in Local Farming Systems

(a) Problem specification: describe the nature and the cause of the problem

(b) Describe current farmer strategies for managing the problem. Identify possible solutions and indicate how the resource and management facets of the local system influence the applicability of these solutions.

(c) Suggest best bet research opportunities in the light of the problem and the system constraints.

Format for the Presentation of Experimental Results

(a) Describe useful or promising results or technologies

(b) Specify management and resource implications of the technology, as well as climatic and environmental requirements

(c) Discuss problems with implementation, reliability of results and flexibility of the management and environmental requirements.

Appendix 3

Instructions to Chairpersons

Chairpersons should be strict with time allocation. Extra time taken on presentations will be deducted from the time allowed for clarification.

Chairpersons should try to guide clarifications into the above headings. If they feel it necessary or useful they should take 2 minutes of the clarification time to summarise the presentation and discussion under these heads.

Appendix 4

INSTRUCTIONS FOR GROUP DISCUSSION

1. **Objective**

Representatives from each country will summarize the problems, the consequences of the problems for the system, and the potential interventions for the system using a common format (systems calendar) in order to highlight similarities and differences in case study situation.

2. Information required and format

(a) Individuals from each individual country will work together.

(b) Fill in the system calendar provided for the individual case study (estimates).

(i) Indicate the months during which rains fall.

(ii) Estimate the quality and fluctuations of pasture forage by months. (In some cases cattle may not be maintained on pasture. In those cases describe fluctuations in feed used.)

(iii) Show trends in cattle liveweight by calendar months.

(iv) Indicate timing of crop production activities by months - land preparation/tillage, planting, weeding and harvesting. Also list major crops grown.

(v) On a separate sheet, list major problems arising from poor cattle nutrition, throughout the farming system and indicate where the problems occur on the system calendar (in red).

(vi) List on a separate sheet apparently appropriate interventions to alleviate the problems and/or their consequences and indicate leverage points for such alleviations on the systems calendar (in green).

(c) Be prepared to discuss the systems calendar, the problems and their consequences and the appropriateness of the interventions.

(d) In summary, a systems calendar, a list of problems, and a list of interventions will be prepared for each country's case study by participants from that country.

3. **Procedure**

After each country has presented its case study, a general group discussion will address differences, similarities and the rationale for proposed interventions.