The contribution of small ruminants in alleviating poverty: communicating messages from research

Proceedings of the third DFID Livestock Production Programme link project (R7798) workshop for small ruminant keepers

Izaak Walton Inn,
Embu, Kenya,
4-7 February 2003

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Editors' note

This document summarises the events, action points and conclusions of a United Kingdom Department for International Developments (DFID) Livestock Production Programme (LPP) funded workshop on 'the contribution of small ruminants in alleviating poverty: communicating messages from research', held at Izaak Walton Lodge, Embu, Kenya, and organised by FARM-Africa, between 4th and 7th February 2003. The papers have been organised by country, in alphabetical order, rather than the order in which they appeared. The terms 'service provider' and 'target institution' have been used interchangeably throughout the proceedings.

In editing the contributions made by the speakers and participants some omissions and misrepresentations of the facts may have been inadvertently made. For these the editors apologise.

We would like to thank everyone who contributed to the workshop and to the putting together of these proceedings.

Tim Smith, Sarah Godfrey, Peter Buttery and Emyr Owen

Acronyms

AATF	Africa Agricultural Technology Fund
ADC	Agricultural Development Corporation
ADF	Acid detergent fibre
ADG	Average daily gain
ADIN	Acid detergent insoluble N
AFK	Age at first kidding
AHA	Animal Health Assistant
AHP	Animal Health Programme
AI	Artificial insemination
AKIS	Agricultural Knowledge and Information Systems
ANT	anthelmintic
ANOVA	Analysis of variance
ASAL	Arid and semi arid areas
Asl	Above sea level
ATIRI	Agricultural Technology and. Information Response Initiative
Au	Absorbance units
BWT	Birthweight
CAHNET	Community Animal Health Network
CBAHW	Community Based Animal Health Worker
CCPP	contagious caprine pleuropneumonia
CEAPRED	Centre for Environmental and Agricultural Policy Research, Extension and Development (Nepal)
CGIAR	Consultative Group on International Agricultural Research
CP	Crude protein
CPP	Crop Protection Programme
CPS	Commercial protein supplement
CSO	Central Statistics Office
CT	Condensed tannin
DEPROSC/N	Development Project Service Center/Nepal
DFID	Department for International Development (UK)
DGAK	Dairy Goat Association of Kenya
DM	Dry matter
DMY	Daily milk yield
ED	Effective degradability
EGODEN	Eastern Africa Goat Development Network
EPG	Eggs per gram

FAO	Food and Agriculture Organization of the United Nations
FEC	Faecal egg count
FORWARD	Forum for Rural Welfare and Agricultural Reform for Development (Nepal)
GDP	Gross domestic product
GI	Gastrointestinal
GoK	Government of Kenya
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
H	Hour
HPI	Heifer Project International
ICIMOD	Bee keeping project
ICT	Information communication technology
iDMD	*in vitro* dry matter degradability
ILRI	International Livestock Research Institute
INGO	International non-Government Organization
iOMD	organic matter degradability
KARI	Kenya Agricultural Research Institute
KBC	Kenya Broadcasting Company
KEGODEN	Kenya Goat Development Network
Kg	Kilogrammes
KTN	Kenya Television Network
KVAPS	Kenya Veterinary Privatization Scheme
Li-Bird	Local Initiatives for Biodiversity, Research and Development (Nepal)
LL	Lactation length
LM4	lower midland 4
LPP	Livestock Production Programme
LY	Lactation yield
MDGAH	Meru District Goat and Animal Health Project
MGBA	Meru Goat Breeders Association
MOALD	Ministry of Agriculture and Livestock Development, Kenya
MSE	micro and small entrepreneur
MZE	Maize
NALEP	National Agriculture and Livestock Extension Project
NARS	National Agricultural Research Service
NARMSAP	Natural Resources Management Sector Assistance Programme
NDF	Neutral detergent fibre
NDIN	Neutral detergent insoluble N
NGO	Non-Governmental Organization

NR	Nepalese rupees
NRF	Nitrogen Rich Forages
NRG	Natural Resource Group
OFT	On-farm trials
OM	Organic matter
OVI	Onderstepoort Veterinary Institute
PBS	Phosphate buffered silicon
PEG	Polyethylene glycol
pi	Post infection
PJ	Prosopis juliaflora
PPR	pestes des petits ruminantes
QT	Quebracho tannin
RPLK	Resource-poor livestock keepers
RPT	Reading Pressure Technique
RRN	Rural Reconstruction Nepal
SAS	Statistical Analysis System
SC	Scheduled castes
SCT	Soluble condensed tannins
SDP	Smallholder Dairy Project
SEA	Small East African
SH	sorghum + horsegram
SIDA	Swedish International Development Cooperation Agency
STIR	Short Term Intake Rate
T	Toggenburg
T & V system	Training and visit system
TCP	Technical Cooperation Project
TON	Tonic
UM1	upper midland one
UMG	Urea molasses granules
VIT	Vitamins
VT	Veterinary technician
WT	Wattle tree
WWT	Weaning weight

Executive Summary

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The United Kingdom Department for International Development (DFID) has via its Livestock Production Programme funded a series of workshops where the results of its demand-led research programmes on the use of small ruminants to alleviate poverty are presented. These proceedings are of a workshop held in Embu, Kenya in 2003 which described the results of studies aimed at alleviating poverty via the use of small ruminants, especially goats, in India, Kenya, Nepal, South Africa, Tanzania and Zimbabwe. The results obtained are discussed with the aim of exchanging experiences such that the total contribution of the programmes exceeds that of its individual components. Research is of little use if its results are not disseminated and a major feature of the workshop was to consider and develop strategies for the dissemination and promotion of the results to ensure that poor, under-resourced farmers benefit from the work. The volume contains a discussion by established experts in the field of generic methods of disseminating and promoting the results of research to farmers, extension workers, to NGOs and other service providers. These are then illustrated by the presentation of extension messages and future dissemination strategies from the individual DFID funded projects, which were at varying stages of being able to provide results ready for implementation in the field.

The publication provides a useful reference source for those who were present at the workshop and also for those who did not attend it. It also contains a list of the contact details of the participants so as to facilitate further the creation of a lasting network.

International workshop on small ruminants research and dissemination, Embu, Kenya

J.I. Richards

Livestock Production Programme, Natural Resources International Ltd, Park House, Bradbourne Lane, Aylesford, Kent, ME20 6SN, United Kingdom

Introduction

In introducing the theme of this third meeting of the Livestock Production Programme (LPP) small ruminant cluster group, I will assume that you are all familiar with the major issues which are facing poor farmers in the developing world who are dependent to a larger or lesser extent on smallstock for survival, subsistence or semi-commercial reasons. These issues include: reduced access to and declining fertility of land; the globalization phenomenon which has provided greater opportunities for marketing livestock produce for some more commercially oriented farmers and higher input prices for others; the existence of a 'livestock revolution' which predicts a greater and more sophisticated demand for livestock commodities: and the eclipse of state advisory services.

The other issue which you will be aware of is that the major donors and international research centres have now embraced the Millennium Development Goals; resolving the constraints of poor farmers is at the heart of many of these poverty reducing Goals.

The challenges which R&D professionals in livestock and agriculture face thus include the generation and provision of new pro-poor knowledge which addresses the foregoing. The Department for International Development's (DFID) LPP has addressed these issues over the last eight years through commissioning demand-led research employing teams of northern and southern partners and I am pleased to report the programme has generated a number of appropriate technologies, guides and policies which, given due exposure and time, will lead to improved productivity of livestock systems and ultimately result in improved livelihoods of people.

The focus of this meeting is to confirm the validity of the research knowledge and to develop the messages to ensure that farmers and target institutions are given this 'exposure'. To enable you to do this we have designed this meeting such that most of the projects will make two presentations: one on the scientific outputs; and the other on associated dissemination products directed at target institutions such as civil society groups, farmer cooperative groups, extension agents and the commercial sector. To facilitate this process, and provide a level of guidance and training, I am pleased to welcome experts in the field of dissemination and promotion of knowledge in East Africa from the Mediae Trust and the University of Reading. I am also pleased to see that some representatives from the non-governmental organizations (NGO) and commercial sector have accepted our invitation to attend this meeting as they are key to any strategy for moving knowledge from researcher to farmers and vice versa.

To conclude, the objectives of the workshop are:

- Sharing scientific information with fellow researchers and encouragement of critical rigour to ensure sound validation of outputs;

- Sharing knowledge, appropriately written and packaged, with target institutions;
- Sharing knowledge on the most effective ways of disseminating knowledge to ensure optimal uptake by service providers;
- Developing partnerships at all levels.

A final word of thanks to the local organizers of the meeting, FARM-Africa. In particular, I would like to thank Camillus Ahuya and his team for their hard work, organizational skills and good humour in transforming an idea into reality.

Karibu sana; a warm welcome to you all.

Introduction

M. Ong'ayo
FARM-Africa, PO Box 49502, 00100, Nairobi, Kenya

On behalf of FARM-Africa I would like to welcome to you to this important workshop on small ruminants. FARM-Africa in Kenya has the goal of addressing poverty alleviation food security.

The Meru project has proved that small ruminants, capable of thriving on a small area of land, can make a big improvement to peoples' lives. Goats are a miraculous way of improving people's livelihoods. I would like to thank the Department for International Development for supporting the work in Meru.

FARM-Africa believes research plays a big role in assisting the livelihoods of poor people. I would like to thank the Ministry of Agriculture and Livestock. The Ministry has supplied field level support to the project. The Meru project shows that the government and non-governmental organizations can work closely together. We hope the new government provides an environment in which we can work even more closely. I would like to thank Camillus Ahuya and his team for all their hard work. I hope this workshop is a fruitful experience.

Opening address

R. Kiome
Director of the Kenya Agricultural Research Institute (KARI), Kaptagat Road, PO Box 57811, Nairobi, Kenya

Mr. Chairman

Distinguished guests

Ladies and gentlemen

It gives me great pleasure to be with you here today and to officially open this important international workshop. I wish to join the organizers of the workshop in welcoming you all to Embu, which is one of the towns located in the rich agricultural zones on the eastern slopes of Mount Kenya. In particular I would like to welcome participants from outside Kenya to our beautiful country and invite them to spend some time after the workshop seeing and enjoying our beautiful countryside and its rich natural and cultural heritage, as well as our friendly and warm people.

Mr Chairman, I am informed that the theme of this workshop is "generation and transfer of technology for small ruminant production and development to improve livelihoods of the resource-poor rural communities in the East and Southern African Region". The theme could not have been more relevant to this region where poverty alleviation and food insecurity are among the major socio-economic problems that we face today and which we must address as matters of priority because they have a great and negative impact on the quality of life of our people. For example, it is estimated that on average, over 50 per cent of the Kenyan population currently live below the poverty level, i.e. on less than US$1 per day, such people do not have access to the basic needs of life, good shelter, clothing, health services, food and education, and, therefore, cannot contribute effectively to national development initiatives.

Ladies and gentlemen, as you may be aware, the Eastern Africa Region (Kenya, Uganda, Tanzania, Sudan, Ethiopia, and Somalia) holds the largest ruminant livestock population in sub-Saharan Africa. The region is also recognised as a major global centre of livestock resources, both in terms of numbers and diversity. For example, Ethiopia, Sudan, Tanzania and Kenya, respectively, are the four leading countries in terms of cattle numbers. Together Kenya, Tanzania and Uganda, which make up the East African region, carry approximately 36 million cattle, 14 million sheep, 32 million goats and 106 million chickens. Unfortunately, Mr. Chairman, this abundant resource has not been exploited optimally to generate wealth and improve the welfare of the people, especially the poorer rural communities which are in the majority.

Against this background, ladies and gentlemen, the purpose of this workshop is to create a forum for researchers, extension and development workers and other stakeholders, in small ruminant research and development in the region. To share experiences, information and news concerning on-going research and development activities is, indeed, appropriate. I expect that after this workshop, the various link projects will re-focus their strategies to enable them to achieve their goals efficiently. I have seen from the workshop programme that presentation and discussions will cover key areas of sheep and goat production and development, including community based genetic improvement, feeding and management,

health and disease control, technology generation and transfer and service provision from a background of diverse production systems. These are all important themes in livestock research and development, especially in this region where a lot more work is needed to achieve both our short and long-term development priorities of poverty alleviation and food security.

Ladies and gentlemen, allow me to digress a little and emphasise here the importance of building partnerships and linkages in rural development. In this regard, I wish to recall the popular saying which is also the title of the famous book on development projects in Africa by Rene Dumont, "A false start in Africa" (Dumont, 1966). Basically the author has pointed out the serious flaws in the development projects that were packaged by the developed world for Africa. Prominent among those weaknesses was the non-inclusion of the major stakeholders in project planning and management to ensure post-project sustainability. Because of this weakness, in many projects communities did not understand the goals and benefits of such projects to them, nor did they have a basis to claim project ownership.

Ladies and gentlemen, this weakness has been largely overcome and today most projects attempt to include target groups and other stakeholders in the development process and also to seriously address the question of sustainability. For example, in the Kenyan FARM-Africa goat project being implemented in Meru a broad-based partnership has been built, including farmers, the Kenya Agricultural Research Institute (KARI), the University of Nairobi, the International Centre for Research in Agro-forestry, community based organizations and the Meru Goat Breeders Association. However, as we build partnerships and linkages locally, we must also endeavour to promote the same at the regional and even at the global levels. I am convinced that this workshop, as well as other link activities, has built regional and global partnerships and linkages, as demonstrated by this workshop and the earlier one held in Morogoro, Tanzania about two years ago. I would like to encourage you to strengthen these useful contacts that you have established.

Mr Chairman, I know that a detailed presentation will be given in this workshop on the FARM-Africa's dairy goat development project in Meru, Kenya, but allow me to make a few remarks here on the same project because I am very familiar with its activities since my organization, KARI, is a major collaborator and, on a personal level, I consider myself a key stakeholder because the project covers my home district. The overall mission of FARM-Africa is to reduce poverty by enabling marginal African farmers and herders to make sustainable improvements to their well-being through more effective management of their renewable natural resources. With this mission in mind, the Kenyan project was initiated in 1996 with two main thrusts:

1) Community based goat improvement, and,

2) A decentralized animal health delivery system.

I am pleased to state here that the project has made good progress despite the many constraints and challenges with which it has been faced. For example, there are now: 83 farmers' groups keeping bucks, compared with 8 in 1996; over 20,000 crossbred goats, up from less than 100 in 1996; and about 400 pure-bred dairy genotypes, mainly Toggenburgs, compared to almost none at the start of the project. The beneficiaries have formed an organization, the Meru Goat Breeders Association (MGBA), to take over after the project phase is completed. I am informed that you will have a chance to meet and discuss with some members of the association in the course of your field visit tomorrow.

Ladies and gentlemen, it is my hope that you will conclude this workshop with specific and clear outputs for future application and follow-up activities. I also hope that the outputs will reflect the purpose of the workshop and suggest solutions to problems of research and technology transfer in small ruminant production and development, as well as ways to enhance regional collaboration. I believe your goals will be easily realised given your expertise and experience of diverse working environments and production systems.

In concluding my remarks, Mr. Chairman let me take this opportunity to wish you success in your four-day deliberations. It is now my pleasure to declare this workshop officially open.

Thank you

References

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Brief on sheep and goats in Kenya

F K Kamau

Assistant Director, Head of the Sheep and Goat Branch, Ministry of Agriculture and Livestock Development, Nairobi, Kenya

Introduction

The livestock industry, which is an integral part of the agricultural sector, plays a major role in the economic development of Kenya. It is estimated that the industry contributes about 10 per cent of gross domestic product (GDP) and accounts for over 30 per cent of the farm-gate value of agricultural sector commodities. The industry also employs about 50 per cent of the total agricultural labour force.

The goat and sheep industry, which is a major component of the livestock sub-sector, plays an important role in the economic and social life of many Kenyans. Nationally goats and sheep contribute about 30 per cent of the total red meat (estimated at 80,000 metric tonnes annually) consumed in the country. In addition they produce other products such as wool, skins and, in the case of goats, milk.

Traditionally, many communities have kept goats and sheep with their cattle. In addition to providing livestock products, goats and sheep are often used to settle debts (dowry, loans, traditional fines etc.) as well as representing savings, wealth and security against risk and uncertainty.

Due to their small body size, higher prolificacy and shorter generation intervals compared to large stock, goats and sheep are easier to de-stock and restock as required. Often they are sold when there is a need for cash that does not warrant selling large stock.

In pastoralist areas, where frequent droughts are experienced, goats and sheep are attractive since they can easily be de-stocked during drought and re-stocked afterwards, hence reducing the losses due to starvation.

In the past, the sheep and goat industry has received relatively little attention in terms of research and development when compared to large stock. This has resulted in the huge potential of goats and sheep to the industry not having been fully exploited.

Population of sheep and goats

The population of goats and sheep in Kenya in 2001 was estimated to be about 19 million, broken down as follows:

Table 1 Table showing breakdown of type of sheep and goats in Kenya 2001

Type	Number	Per cent
Milk/dairy goats	90,826	0.48
Meat goats	10,780,522	5.40
Hair sheep	6,845,140	57.57
Wool sheep	1,010,771	36.55
Total	18,727,259	100.00

The current Government Priority Development Policy Strategy is geared towards poverty reduction. In line with this, the Ministry of Agriculture and Livestock Development has made poverty reduction oriented projects a priority with the following guidelines:

- Produce results within a short time
- Benefit many people
- Promote food security
- Contribute to employment
- Contribute to improved incomes

In the livestock sub-sector smallstock projects have been identified as having priority in addressing poverty reduction since most of them meet the above criteria.

The strategy for smallholder farmers in the high potential areas will be dairy goat development and dual purpose sheep production. For the medium and low potential areas the focus will be on improvement of goat and mutton meat production using Galla goats and Dorper sheep, respectively, as the improver breeds. Improvement of marketing and other production support services will be addressed accordingly.

Sheep and goat improvement initiatives

Past initiatives

Major past initiatives on goat and sheep improvement included those undertaken through the following programmes and projects:

- Agricultural Development Corporation (ADC), Livestock Improvement Farms (1970s and 1980s)
- FAO/UNDP/GoK Sheep and Goat Development Project (1972-1983)
- EMI (Embu, Meru and Isiolo districts) Small Stock Improvement Project (1982-87)
- GoK/GTZ Integrated small Livestock Project (1992-1999)

On-going sheep and goat improvement efforts

Meru and Tharaka Nithi Dairy Goat Project

This project started in late 1996. It is being implemented by FARM-Africa in conjunction with the Ministry of Agriculture and Livestock Development. The Project operates in two districts (Meru Central and Tharaka-Nithi) in Eastern Province.

The project is assisting small scale goat farmers to acquire improved dairy goats through upgrading the local goats with Toggenburg dairy goat bucks. In addition the project is encouraging small scale dairy goat breeders to produce pure bred Toggenburgs in order to ensure sustainability through continuous availability of suitable breeding stock, particularly bucks.

The project is using the farmers' group approach in implementing the activities. The goat farmers partaking in this project have been assisted in setting up the Meru Goat Breeders Association (MGBA) which is expected to take over the dairy goat project when FARM-Africa withdraws from the project in December 2003.

Sheep and Goat Breeding/Multiplication Stations

Currently there are nine goat and sheep stations under the Ministry of Agriculture and Livestock Development. These Stations are responsible for breeding policy and multiplication of various breeds of goats and sheep, subsequently supplying them to local farmers as breed improver stock to upgrade their herds and flocks.

The Stations also offer extension services to farmers through shows and field days. However, during the last few years, virtually all the stations have been operating at about 30 per cent of their capacities due to under- funding and deterioration of the infrastructure.

Goat Breeds

Meat Goats breeds

The main meat goat breeds include: Galla; East African; Boer and crosses of these three with local goats. The meat goats are mainly reared in the low potential areas.

Dairy Goats Breeds

The dairy goat breeds in the country include: Toggenburg; Alpine; Saanen; Anglo-Nubian and crosses and upgrades of these four breeds with local breeds.

The number of pure-bred dairy goats in Kenya is very small. The majority of the dairy goats are crossbreds and upgrades.

The Toggenburg is the most popular dairy breed. It has performed well in terms of adaptability and milk yield. The Alpine has recently been introduced in some parts of Central Kenya, to help upgrade the local goats to dairy goats. The performance of the upgraded goats is being monitored.

Although the Saanen is potentially a high milk yielder, its adaptability has been a problem. The Anglo-Nubian has also shown poor adaptability to local conditions.

Sheep Breeds

Hair Sheep breeds

The major hair sheep breeds include: Dorper; Nyanza Fat-tail; Persian Black Head; Red Masai and crosses of these four with local stock. The hair sheep are mainly reared in the arid and semi arid areas (ASAL).

Wool and dual purpose breeds

The major wool and dual purpose sheep breeds include: Merino; Corriedale; Hampshire Down; Romney Marsh and crosses of these breeds with local stock. The wool sheep are reared mainly in the high rainfall areas.

Promotion and dissemination

C.J. Garforth

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Introduction

Research in support of poverty reduction is based on the implicit assumption that livelihoods are constrained by production and/or efficiency, which are in turn constrained by (lack of) knowledge. Thus the aim of research is to remove knowledge constraints which should in turn increase production and/or efficiency, thereby enhancing livelihoods, as illustrated in Figure 1.

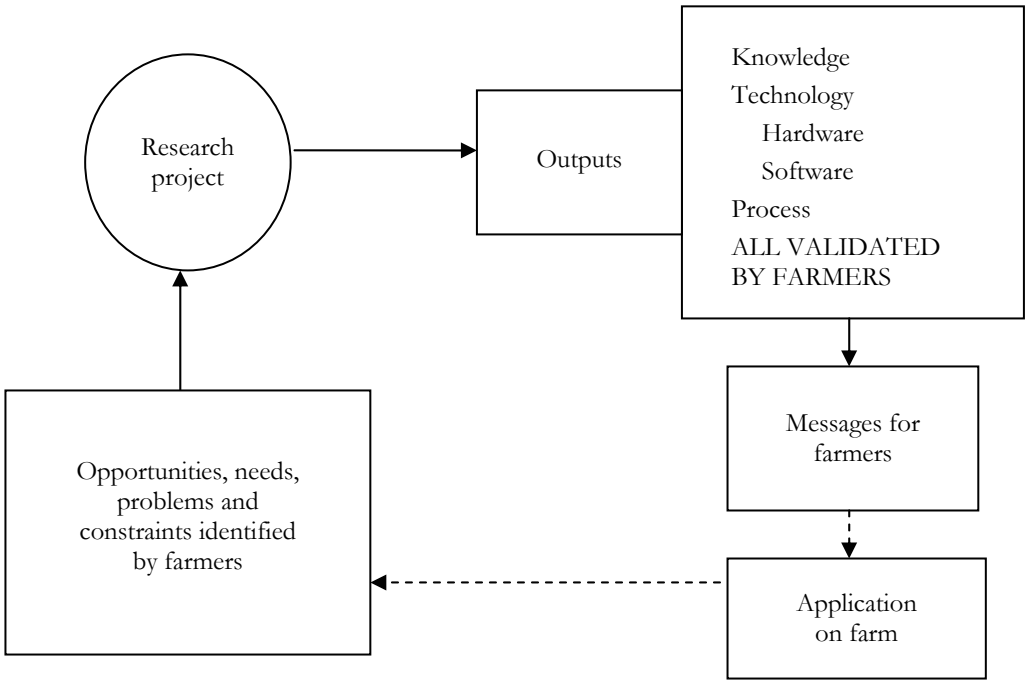

Fig 1 Model of the research process

Farmers obtain knowledge from different sources, including:

- Researchers
- Credit sources
- Markets
- NGOs
- Extension staff
- Veterinary services
- Dealers
- Shows
- School pupils
- Newspapers
- Radio programmes
- Other farmers
- Farmer organizations

Therefore the challenge for researchers is to get information based on their research findings into the channels the farmers use to access information and advice.

However, even if information (or "the message") get into the appropriate channels, there may be a blockage between the message and its application as illustrated below in table 1:

Table 1 Possible blockages between messages and their application

Possible constraint	**Which may affect the extent to people can:**
Knowledge	interpret the message
Information	make decisions
Capital	invest in new inputs
Risk (and farmers' *perception* of risk)	feel confident in changing practices or investing in new inputs
Attitudes and those of peers	feel that changing practices is a good idea
Credibility of message and its source	feel that the message can be trusted
Markets	be confident that they will be able to sell any increased in output
Inputs	acquire the inputs they need to put the new knowledge into practice
Regulations	and their implementation
Livelihood strategy	may need diversifying in order to implement message
Competing demands on resources	may mean message cannot be implemented due to lack of resources

Implications for project teams

1. find out who the farmers trust as sources of information
2. place the messages for farmers with *service providers* and other *promotion partners* identified above
3. communicate with *other audiences* to address other constraints
4. use channels and processes which allow *dialogue*
4. develop *strategy* for promotion and dissemination

Promotion and dissemination strategy

Ideally, project teams should plan their dissemination strategy at the inception of their project. The following table can act as a useful template.

Table 2 Template for planning dissemination strategy

Audience	Objective	Message	Channels and media
Farmers	example: awareness knowledge decisions attitudes informed choice specific action		
Researchers			
NGOs			
Policy makers etc			

Steps in preparing a message

Each project team should complete the following tasks:

For each project:

1. Develop an outline of a *promotion and dissemination strategy* – including opportunities for working with service providers and other partners

2. Prepare *draft print material*

Processes to follow during this workshop that can be applied later

- learn from service providers' / promotion partners' perspective
- share ideas on project messages
- learn from the case study: promotion and dissemination in Meru goat project (paper by Kaberia, see later in these proceedings)
- learn from the overview of print and other media options
- work as a group to develop strategy and draft print material
- present and discuss ideas with a wider audience

Easing seasonal feed scarcity for goats in semi-arid India through a process of participatory research

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Abstract

The project was aimed at identifying technologies and interventions to alleviate seasonal feed scarcity for goats in the semi-arid regions of India. The project area covered villages across five districts in four states of the country. The first step toward this was through understanding the production systems and the needs before deciding on the focus at each location.

Several on-farm experiments were conducted to address a variety of feed-related constraints (augmentation or better utilization) using locally available materials. In all the trials the treatments had beneficial effects on the goats although these were not always statistically significant.

The project tested and developed two technologies that seem to have good prospects for wider adoption in the country. The first, involves collection and feeding of pods of *Prosopis juliflora* during the period of feed scarcity. In Rajasthan, this resulted in higher kidding rates in goats. The other uses trichomes of pods of *Mucuna pruriens*, a leguminous creeper, as an anthelmintic. In Karnataka this improved the growth rates of kids of treated does, with a possibility for a reduction in the mortality of kids born in rainy season.

Introduction

In the semi-arid regions of the country, a mixed farming system involving crops and livestock is very common, with more than 70 per cent of rural families owning livestock. The trends in livestock numbers during the last few decades indicate:

- Increasing populations of most categories of livestock
- Relatively low growth rates in the cattle population compared to buffaloes
- A rapid rise in goat population.

The main reasons for these changes in large ruminant numbers are:

- Decreasing requirements for draught animals, due to land fragmentation
- Declining quantity and quality of accessible common lands, leading to insufficient forage available to support large ruminants
- An increasing preference from the urban population for buffalo milk.

The increase in the goat population is a response to the increased demand for meat and development of infrastructure for better access to rural areas (Rathore, 1993). It is also partly due to the reduction in the amount of forage suitable for large ruminants from the degraded common lands while goats, more dependent on browse, are not as severely affected.

The semi-arid areas (with 450-800 mm of annual rainfall) are characterized by low and uncertain precipitation. The availability of adequate quantities of forages during the long dry period has been recognized as the major constraint for livestock production, which is further aggravated during droughts, which occur every few years. Reduction in nutrient supply adversely affects the body condition of the animals and this also has a long-term effect on the performance of the younger animals. Augmentation of feed supply during this critical period will enable better livestock production and, therefore, increased income to the rural families. A number of such studies have been reported for large ruminants while relatively little information is available from studies involving small ruminants. This project was, therefore, initiated with the purpose of improving the seasonal availability and utilization of locally available feeds and to promote appropriate feed management systems. The specific objectives were:

- To understand prevailing goat production systems, especially feeding systems
- To develop recommendations for improving local feed resources and feed management systems
- To develop participatory methodologies for the analysis of feed resources, constraints and for testing of interventions
- Disseminate project findings, recommendations and methodologies.

Materials and Methods

Project Location

The project was initiated in three states, one of which was subsequently dropped. Two more states were added in the middle of the project. All the areas were from the semi-arid regions of the country.

Participatory methods

Seasonal calendars and mapping

Besides the baseline survey of the areas, other participatory approaches were also practiced to obtain specific information. These included seasonal calendars and mapping of resources to understand the production and feeding systems prevailing in the project villages. The identification of constraints and research issues was done through a ranking exercise with the community, which was cross-checked with the survey data.

One of the difficulties faced was goat keepers' recall of changes in their herds during the previous year or two, in response to questions from the research team, which was often unreliable. To overcome this, a more participatory, pictorial herd history method was developed which starts by showing the current herd (using symbols) and working backwards for each animal. It can be used to trace births, deaths, acquisitions, sales, quantitative information related to reproductive performances, marketing patterns etc. For

these and the on-farm trials (OFTs) various protocols with participatory monitoring were followed. These and other methodological details have since been published (Conroy, 2001, 2002).

One technology with high potential for addressing feed scarcity is development of silvi-pasture on common lands, which is being promoted by many non-governmental organizations (NGOs) in Rajasthan, including BAIF. The project investigated 15 individual projects to assess their contribution to alleviating feed scarcity. This paper will not be dealing with the findings of this work, which has been published as a project Technical Bulletin (Conroy and Lobo, 2002).

Although the project was targeted to test technologies directly related to feed resources some other interventions, indirectly affecting nutrient utilization of available feedstuffs, were also included in the study, e.g. water scarcity and parasitic load.

Two of the technologies investigated showed great promise and are highlighted in this paper. One involved collection and feeding of tree pods (*Prosopis juliflora*) to improve the kidding rates of goats belonging to poor farmers. The other involved the use of trichomes of a leguminous creeper (*Mucuna pruriens*) as anthelmintic to reduce kid mortality and improve the weight gain of newborn kids.

Supplementation studies

These were conducted in two states, namely Rajasthan and Karnataka. The Rajasthan goat keepers reported unsatisfactory reproductive performance of does due to feed scarcity in the dry season, which is the main breeding season. This resulted in a large number of does remaining open at the end of the breeding season. It was, therefore, hypothesized that supplementation during this critical period would reduce the problem. Supplementation studies were undertaken for four years. The supplement consisted of a mix of *P. juliflora* pods and barley (1:1 ratio) for the first two years while in the last two years *P. juliflora* pods were fed alone. In all cases the supplement was fed at 250g/day/doe for a period of 10 weeks.

In the Karnataka studies the goat keepers reported high kid mortality in kids born at the onset of the monsoon. Research identified two possible explanations for this. The first is that this period coincides with low feed availability to the does, as they are reluctant to graze outside on rainy days, which may thereby reduce the milk quantity available to the new born kids. It was, therefore, thought that supplementation during this period might enable better kid survival through increased milk production of the does. These trials were conducted for two years. In the first year a supplement of sorghum+horsegram (3:1 ratio of 200g/day/doe)) was offered, while in the second year only *P. juliflora* pods were offered (250g/d/doe). In all cases pods were collected during their production season and stored for use during the scarcity period.

Deworming studies

The second possible explanation identified for high kid mortality during the rainy season was that the worm burden of does may be high at this time of the year. Deworming pregnant does 2-3 weeks before kidding has been recommended to avoid preparturient increases in egg numbers (Mobini, 2000; Smith and Sherman, 1994; Wilkinson and Stark, 1987). Deworming has also been reported to be involved in transfer of immunological substances from the does to kids (Deshapande *et al,* 1991). The increased gastrointestinal parasites combined with the lack of proper nutrients could be responsible for abortions

and the birth of weak kids, resulting in high kid mortality. It was, therefore, considered worthwhile to investigate deworming of pregnant does to see if it resulted in better utilization of available nutrients, thereby improving kid birthweight and survival. The deworming study was conducted for two years in Karnataka. In the first year, the treatment used was a commercially available anthelmintic (Fenbendazole) at 7.5 mg/kg body weight. In the second year, the efficacy of Fenbendazole was compared with the trichomes of *Mucuna pruriens* pods as a deworming agent. These trichomes are used by a local community for deworming buffalo calves and the dose for the preparation for does was decided on the basis of that given to the calves (20 mg/kg body weight). The required quantities of the scraped trichomes of the pods were mixed with sugar solution and the animals were drenched with the mixture. The deworming treatment was given twice:, the first time about 15-30 days before the probable date of kidding; and the second on the day of kidding.

The approach adopted for testing both supplements and deworming agents started by using technologies familiar to the goat keepers before attempting to use the locally available products.

The goat keepers taking part in the trials belonged to the poorer sections of the community (scheduled castes or tribes). They were divided between control and treatment groups so as to have roughly equal number of does in each. In the Rajasthan trials there were different goat keepers in each group, to avoid the risk of goats in the control group eating the supplement provided for the goats in the treatment group. In the Karnataka trials, on the other hand, the same goat keeper had goats in each of the groups. During the course of the trial some animals were lost (sold or died).

In all the studies a local person was trained to monitor the trial animals. Every participating household was visited every 15 days during the experimental period and the kidding season. Observations were recorded on breeding (oestrus, number of services, conception), number of kids born and their mortality, health and general body condition of the animals, and the birthweight of kids.

In the second deworming trial faecal samples of 6 or 7 animals in each of the three groups were collected before the treatment and seven days after the first treatment for analysis of the parasitic load. The faecal pellets were collected directly from the anus of the does and stored in 10 per cent formalin prior to analysis by the Stoll Egg Counting Technjque (1986)). Samples were only collected from herds in which all three treatment groups were represented.. The does were weighed every fortnight before and after kidding while the kids were weighed every week from birth till 2 months of age. The descriptive statistics were calculated using Excel^{R} (Microsoft), while statistical tests were done using SPSS^{R} . Kid mortality was subjected to the chi square test. Incomplete observations were not considered for analysis and kids dying from accidents were excluded from the analysis. The faecal egg count and birthweight data were tested using the student's 't' test while the regression coefficients of body weights on age were also compared by the 't' test.

Results and Discussion

Production systems

The prevailing goat production systems in different regions are presented in Table 1. The areas represent a variety of agro-ecological situations. All the production systems were

based on grazing with little or no stall feeding. The main production systems identified were related to three groups of goat-keepers;

1. Smallholder agro-pastoralists
2. Landless agricultural wage labourers
3. Marginal or landless livestock specialists.

The details of these groups of goat keepers are presented in Table 2. Most feeding systems are heavily dependent on grazing, with some supplementation in two locations (Gujarat and Rajasthan) for some time in the year. In many cases the feed sources are the same; however, the contributions of each of these change according to season and social group. The landless wage labourers often raise other people's goats for which they receive a fee or 50 per cent of the kids produced (share rearing). Their herd size is small, and is often determined by the farmers for whom they work, who may allow labourers to take one or two does into their fields. For agro-pastoralists who do not specialize in goat production the small herd size is often due to lack of family labour for herding (children and women managed flocks). The relatively large herd size in some groups of livestock specialists may require the owner or manager to migrate in periods of scarcity (every year or during drought years).

Constraints

Disease seemed to be the single most important constraint identified across all of the project villages. However, there are also major regional differences. Water scarcity was expressed as the major issue in Gujarat and some villages in Rajasthan, while feed scarcity was a constraint in villages in Rajasthan, Maharashtra and Karnataka. In Madhya Pradesh the major constraints identified were theft and predators, while feed scarcity was not a constraint due to proximity of these villages to forest areas. Since these constraints were outside the scope of the project mandate this Madhya Pradesh was not considered for further studies.

Table 1 Production and Agro-Ecological Characteristics of the Survey Districts

District (State)	Production Systems studied	Main Product	Mean annual rainfall (mm)	Other Agro-Ecological Characteristics
Bhavnagar (Gujarat)	a) Extensive, Commercial b)Semi-extensive, subsistence	Milk	550	Little forest. Some areas experiencing groundwater depletion and seawater ingress
Bhilwara (Rajasthan)	Semi-extensive, semi-commercial	Meat	700	Plains area. Little forest
Udaipur(Rajasthan)	Extensive, Semi-commercial	Meat	624	Hilly area, some forest
Vidisha (Madhya Pradesh)	Semi-extensive, semi commercial	Meat	1000-1200	Plains area. Forest is relatively abundant
Pune (Maharashtra)	Semi-extensive	Meat	500	Plains, no forest
Dharwad A (Karnataka)	Semi-extensive	Meat	800	Hilly, forest
Dharwad B (Karnataka)	Semi-extensive	Meat	600	Plains, no forest

Table 2 Production systems in different locations

	Smallholder agropastoralists		Landless wage labourers	Marginal/Landless livestock specialists	
	Small ruminants specialists	Non-specialists		Only goats	Mixed herds
Regions	Rajasthan	Rajasthan	Gujarat, Maharashtra, Karnataka	Gujarat, Maharashtra, Karnataka	Gujarat, Maharashtra, Karnataka
Livestock species	Sheep Goat	Goat	Goat	Goat	Cattle Goat
Flock size	30-100	1-10	1-4	20-30 (share rearing)	30-50*
Managed by	Adult male	Children/women	Women	Adult males	Adult males
Feed resources	Private waste lands, crop residues, commons	Commons	Tethering in field where working, cut-carry weeds etc. to stall feed.	Commons, crop lands of other farmers	Commons, crop lands of other farmers

* This is the number of goats in the herd. Total herd size is often a few hundreds.

Identification of constraints by the participants is often based on recent experiences rather than the long term view. Water scarcity thus became top priority for areas suffering from drought during the survey year (see comment above). Similarly occurrence of a recent disease epidemic may get high importance. In this kind of exercise often the participants' responses are likely to be influenced by their expectations from the project, for example the need for a breeding buck or provision of shelter.

It is also to be noted that marketing or availability of family labour was not mentioned as an important constraint despite previous research studies, which show that availability of family labour is one factor that is "uniformly important in determining the herd size" (Sagar and Ahuja, 1993).

The prioritization of constraints was also done separately by women, and in some cases their responses were different from men, for example in Gujarat the scheduled castes (SC) men identified disease as the major constraint while the SC women (responsible for watering the animals) ranked water scarcity as the main constraint. Even a constraint like water scarcity had different implications for men and women. For men of the Rabari caste scarcity of drinking water meant herding animals over longer distances to the water source, while for SC women it meant fetching water over long distances for the animals.

Supplementation Trials

Effects on reproductive performance

The results presented in Table 3 indicate higher conception rates for the supplemented animals as compared to controls. The incidence of twinning was affected by treatment, while the kidding rates were increased by supplementation in both years.

Table 3 Reproductive performance of animals fed supplement* in a four year study

	Treatment group				Control group			
	Y1(98)	**Y2(99)**	**Y3(00)**	**Y4(01)**	**Y1(98)**	**Y2(99)**	**Y3(00)**	**Y4(01)**
Number of does at start	25	56	48	87	25	63	50	82
Number of does completing trial	24	50	37	72	23	55	35	57
Number of does pregnant	24	39	34	72	18	34	28	50
Incidence of twinning %	17	28	29	26	6	19	17	11
Kidding rate %	117	100	117	139	78	69	70	97

*In the first two years the treatment was *Prosopis juliflora* pods and barley, and in the second two years it was only pods.

The difference in conceptions was significant ($P<0.05$) for year one only.
The difference in kidding rates was significant ($P<0.05$) in all the years.

Reducing kid mortality

In Karnataka two trials were conducted in 2000 and 2001. In the first year supplemented (sorghum+horsegram) does were compared with unsupplemented controls while in the second year unsupplemented controls were compared with *P.juliflora* pods as well as the original supplement. The results presented in Table 4 for the first year show significantly lower mortality (chi square=10.124) in the treatment group than the control group. The mean birthweight was higher in the treatment group while more abortions were recorded in the control group.

Table 4 Performance of does supplemented with sorghum + horsegram (SH) or *Prosopis juliflora* (PJ) pods in Karnataka

	2000		**2001**		
Parameter	**Supplemented group(SH)**	**Control group**	**Supplemented group(SH)**	**PJ pods**	**Control group**
Number of does	19	15	22	21	22
Number of kids born	33	24	36	27	31
Number of kids dead (0-30 days)	4	11	1	0	0
Kid mortality %	12	45	2.7	0	0
Mean birthweight in kids (kg)	2.32	2.08	1.89	2.13	1.85
% abortions	9	28			

In the second year the mortality was low in all the groups, which may have been due to the low rainfall (50 per cent of normal) in that year. The mean birthweights were similar in all the groups while the body weight gain of kids in the four weeks after birth was non-significantly higher ($P<0.05$) in the two supplemented groups (3.2 kg) as compared to the control (2.9 kg) suggesting better milk production in does receiving the supplements. The *P. Juliflora* pods have been reported to increase milk production. (Antilla *et al*, 1993).

Other supplementation trials

In addition to the trials reported above, a number of trials involving other supplements were tested for improving the productivity of goats. The supplements included urea molasses granules (UMG), complete feed and pods of *Acacia nilotica*. The results of feeding trials with UMG were indicative of the beneficial effects of supplementation, however, the results were not statistically significant and also in one of the trials the UMG available was of poor quality affecting its intake, which may have vitiated the results. In other trials involving the same supplement the results were confounded by other factors (different grazing areas, pregnancy) and hence were not analyzed.

In case of feeding the acacia pods the results indicated no differences between the groups for the conception rates but the kidding rates were higher in the treatment group.

Alleviating water scarcity

At the suggestion of the goat-keepers, and with their assistance, a water trough and storage tank were constructed next to a well near to the main dry-season grazing area. This intervention was conducted in the same village in Gujarat in which a UMG trial had been conducted in the previous year. Production performance of 12 does monitored during the study indicated an increased milk production over the previous year's production data. The decline in milk production in the latter part of the dry season (after provision of water trough) was slower than that experienced in the previous year. (Conroy *et al.*, 2000). These results must however be viewed with caution, as the two sets of data are not necessarily for the same animals.

Anthelmintic trials

The results of the first year's trial (Table 5) indicated that kid mortality in the dewormed group (8 per cent) was lower than in the controls (18 per cent), while the mean birthweights were similar in both groups. The kid mortality over a 60 day period was higher in kids of the control group does (24 per cent) than the treatment group kids (8 per cent). The body weight gains until four weeks of age were markedly higher in the treated group. The low response to the anthelmintic may be because the trial was not conducted in the monsoon season and hence the helminth infestation may have been lower than in the second trial.

The results of the second year experiments are presented in Tables 6 and 7. It was observed that the parasite infestation was prevalent in all the cases with a predominance of *strongyloides* and *haemonchus* species. This is consistent with other observations. (Dhar *et al,* 1982; Smith and Sherman, 1994; Mobini, 2000). The *M. pruriens* triomes treatment was as effective as the commercial product for deworming the does.

There was no difference in kid mortality during the first thirty days, which was low, perhaps due to low rainfall in that year (50 per cent lower than normal). The reasons for higher mortality of control group kids during days 31-120 are not clear. Deworming of does in late pregnancy or early lactation has been reported to increase the milk production, which may have positively affected the kid survival (Peacock, 1996; Wilkinson and Stark, 1987) in treated groups. The other possibility includes lower chances, or lower levels, of infection of these kids (Smith and Sherman, 1994). The birthweights of the kids were not affected by treatment, which was to be expected as the treatments were applied in late pregnancy and on the day of the kidding. The growth rates of kids from birth to one month of age, monitored weekly, showed significant differences due to treatment. The difference in growth rate due to type of anthelmintic used was not significant. The higher growth rates in treated animals could be due to a number of factors including lower infestation of the kids from dewormed does (Smith and Sherman, 1994) and increased milk production and greater availability of milk to the kids.

Table 5 Results of the deworming trial, 2000

Parameter	Treatment (commercial anthelmintic)	Control
No. of does	27	23
No. of kids born	38	33
No. of kids dead in 0-30 days age	3	6
Kid mortality %	8	18
No. of kids dead 31-60 days	0	2
Kid mortality % (0-60 days)	7.9	24.2
Birthweight (kg)	2.08	2.02
Weight gain from birth to 4 weeks age (kg)	2.52	2.34

Table 6 Faecal parasitical egg count in does before and after treatment

Group	No. of Does	Mean no. of eggs (per gramme of faeces)		Difference
		Day 0	Day 7*	
Control	6	717	983	+267
Mucana pruriens pods	7	971	271	-700
Fenbendazole	7	757	114	-643

* Differences between control and treatments statistically significant (P <0.005).

Table 7 Results of deworming trial, 2001

Parameter	Treatment		Control
	Mucana Pruriens triomes	Fenbendazole	
No. of does	24	24	23
No. of kids born	31	30	35
No. of kids dead in 1-30 days	3	2	3
Kid mortality % (1-30 days)	9.6	6.6	8.5
Kid mortality %(1-120 days)	16.1	20.0	40.0
Kid birthweight (kg)	2.28	2.23	2.12
Weight gain up to 4 weeks (kg)*	2.60	2.58	2.00

*Difference between control and treatments significant (P <0.05)

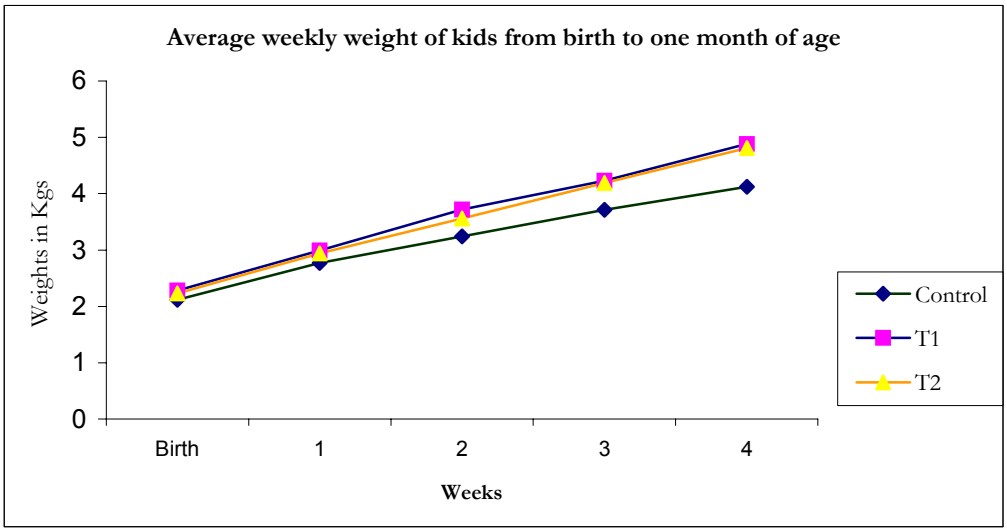

Figure 1 Average weekly weight of kids from birth to one month of age

Impact of the technologies on herd size

In the supplementation trials reported earlier a consistent, although non-significant ($P<0.05$), effect on increased twinning rate was observed. In the deworming trials the treatments, applied in late pregnancy, had no effect on twinning rates. It is often observed that mortality rates are higher in multiple births compared to singles. Tables 8 and 9 confirm that mortality rates were higher for twins than for singles in the deworming trial and supplementation trial, respectively. Interestingly the difference is much larger in the former trial than in the latter in which (Table 9) the female kid mortality was lower among twins than among singles.

Since all the treatments increased the herd size in the short term it was interesting to know the changes in the herd size occurring as a result of adoption of the technologies. In some trials the kids born were scrutinized through surveys. The surveys sought information from the participant and non-participant goat keepers from the project villages in Karnataka. These results are summarized in Tables 10 and 11.

Table 8 Status of kids born to the experimental animals in the deworming trial

Parameter	Total numbers		Singles		Twins		Triplets	
	M	F	M	F	M	F	M	F
Kids born	37	34	18	16	14	14	5	4
Deaths	11(30)	6(18%)	3(17%)	1(6%)	4(29%)	4(29%)	4(80%)	1(25%)
Sale	18(49%)	5(15%)	3(17%)	3(19%)	8(58%)	2(14%)	1(20%)	0
Slaughtered	2(5%)	0	2(11%)	0	0	0	0	0
Transferred	1(3%)	1(3%)	0	0	1(7%)	0	0	1(25%)
Retained	5(13%)	22(65%)	4(22%)	12(75%)	1(7%)	8(57%)	0	2(50%)

Table 9 Status of kids born to experimental animals in the supplementation trial

Parameter	Total numbers		Singles		Twins		Triplets	
	M	F	M	F	M	F	M	F
Kids born	28	29	7	13	18	16	3	0
Deaths	10(35%)	7(24%)	1(15%)	4(31%)	9(50%)	3(19%)	0	
Sale	17	17	5	6	9	11	3	
Slaughtered	0	0	0	0	0	0	0	
Transferred	0	0	0	0	0	0	0	
Retained	1	5	1	3	0	2	0	

Table 10 Status of all goat keepers and adult goats in the project villages in Karnataka

	Villages in the deworming Trial			Villages in the supplementation trial		
	Nigadi	Benkankatti	Devarhubali	Naiknoor	Boganoor	Shelawadi
Goat keepers, no. before	15	11	20	41	27	76
Goat keepers, no. after	18	11	16	41	25	75
Goat no. before	89	85	42	124	287	582
Goat no. after	136	85	54	239	289	329
Percent change in adult goats	+53	0	+29	+93	+0.007	-56
Overall % change in adult goats	+27			-14		

Table 11 Number of adult goats belonging to project partners

	Villages in deworming Trial	Villages in supplementation trial
Goat keepers, no. before	17	17
Goat keepers, no. after	15	14
Adult goats before	121	153
Adult goats after	133	83
Percent change in adult goats	+10	-54

The total number of goat keepers, (trial participants and non-participants) in the villages before and after the studies, remained about the same. The number of adult goats showed an overall increase of 27 per cent in the first group of villages (deworming studies) while in the other three villages the overall population decreased by 14 per cent. However, as Table 10 shows there was a lot of variation between villages, particularly in the supplementation trial villages, where there was a marked decrease in one village and a marked increase in another. This suggests that adoption of the project technologies is only one of several factors affecting goat ownership levels, and that the factor(s) may be location-specific.

The total number of adult goats kept by the families involved in the experiments increased slightly among those involved in the deworming trial (Table 11); by contrast it decreased markedly amongst those involved in the supplementation trial. This confirms the earlier observation that there may be other factor(s) influencing the number of goats owned.

The status of male and female kids born to the experimental animals in the two groups of villages is presented in Table 8 and 9. It was found that male kids born were usually sold before reaching 9 months of age, with less than 15 per cent being retained and so they did not increase the herd size in the medium or long term.

Some female goats, on the other hand, were retained in the herd. The female retention rate was much higher among the participants in the deworming trial (65 per cent) than in the supplementation trial (17 per cent), as shown in Tables 8 and 10 respectively. Furthermore, there has been a dramatic reduction in the number of adult goats owned by participants in the supplementation trial (Table 11) suggesting their comparatively low retention rate was insufficient to even maintain the herd size.

Conclusions

The project identified constraints to goat production, and designed and implemented interventions to address these in a participatory manner. The project developed two technologies to improve the goat production with poor farmers in semi-arid regions. The technologies were aimed at a better supply of nutrients, either through supplementation (with *P. juliflora* pods) or by minimizing the nutrient losses from available nutrients (by deworming with a commercial or local product). These technologies have been found to be effective in improving kidding rates and, or, growth of new born kids, which will generate additional income for the poor farmers. The technologies have a good chance for wide spread adoption by resource poor farmers as:

- These are based on locally available products
- There is no purchase involved and the cost depends on the opportunity cost, if any, attributed to the labour involved
- The trees and shrubs are found in a large area of the country, including along roadsides, making the products available to the landless
- The collection time occurs, when goat keepers are not very busy.

The follow-up studies on the impacts on goat population in the area indicated that introduction of technologies to improve production may be one of the many factors determining the herd size of small goat keepers.

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Improving goat production in semi-arid regions through better nutrition management

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Introduction

In large semi-arid regions of India mixed farming systems, involving crops and livestock, are practiced by farmers. These areas are characterized by long hot dry seasons, when most vegetation dries out and the availability of forages for livestock is reduced drastically. This results in lower livestock production and often loss of body weight due to decreased supply of nutrients in quantitative and qualitative terms. Droughts are a common feature in such regions and affect the livestock population, especially large ruminants. Small ruminants, like goats and sheep, are often kept by poorer farmers in such regions as a source of income, particularly to meet contingencies as well as for food. Alleviation of feed scarcities during the dry season would improve the livestock production and reduce the mortality, thus generating more income for farmers. The possible interventions can be listed as:

1. Increasing tree fodders
2. Increasing fodder production
3. Improved management of feed resources
4. Improved utilization of feeds
5. Providing external inputs
6. Access to new or better markets.

While a large number of agencies have been involved in implementation of some of these long and short term interventions the emphasis has been on the large ruminants. The project 'Easing Seasonal fodder Scarcity for Small Ruminants' (R6953) was, therefore, undertaken for participatory situation analysis and development of interventions to reduce the problems in goat husbandry arising from seasonal feed scarcity.

Project activities

The project activities were initiated in three states but one area was deleted due to the absence of feed related constraints to goat production. Two new states were added during the implementation of the project. All the areas were from the semi-arid regions of the country (annual rain fall 400-800 mm).

Participatory approaches were used for obtaining the baseline information, resource mapping and calendars, identification of constraints and their ranking etc. Various

protocols for participatory monitoring of the trials were followed (Conroy, 2001, 2002). As indicated above various alternatives have been investigated by different workers to address the feed related problems of large ruminants but for the project the two main themes studied were interventions related to increased tree fodder and those involving improved management of feed resources.

While the silvi-pasture development has been undertaken by many agencies in Rajasthan a review of literature revealed very little information on the effect of these initiatives on livestock numbers and feeding systems. The project, therefore, compiled information from 15 silvi-pasture development projects implemented in the state in the 1980s or early 1990s. The findings of the study and the key issues involved have been published (Conroy and Lobo, 2002).

During the participatory identification of constraints faced by the goat-keepers and their ranking, it was found that while disease was perceived to be the single largest problem there were some regional differences. The two major constraints for which the project sought the cooperation of the participants were lack of feed in the dry season and internal parasites. To address these issues, participants opted to try the following interventions:

1. In Rajasthan poor goat keepers reported that a large number of does were not pregnant at the end of the breeding season due to lack of feed in the dry season. The farmers suggested supplementation with *Prosopis juliflora pods* during this period. The trials for the first two years were thus conducted with a mix of *P. juliflora* pods and barley (1:1 ratio), while in the subsequent two years only *Prosopis* pods were used. The supplement was fed at 250 g/day/doe for a period of 10 weeks.

2. In Karnataka the pregnant does were not sent out for grazing in the rainy season and were not getting enough nutrients to support the growth of healthy kids. This coupled with the high incidence of intestinal parasites affected the nutrient availability to the does resulting in the birth of weak kids with poor post-natal growth, due to low milk availability from the dams. The traditional feed supplement used in the region (mainly for large ruminants) was a mix of sorghum and horsegram (3:1 ratio), which was tried in the first year trials while in the second year the traditional supplement was compared with the *P. juliflora* pods.

3. In Karnataka, the control of intestinal parasites in pregnant does was also attempted. For this in the first year of the study a commercially available preparation was used (Fenbendazole at 7.5 mg/kg. body weight) while in the second year the commercial preparation (Fenbendazole) was compared with herbal preparation (trichomes of pods of *Mucuna pruriens* at 20 mg/kg body weight), traditionally used by a local community for deworming buffalo calves. The does were treated twice, the first time 2-3 weeks before the probable date of kidding and the second time on the day of kidding. The preparation of trichome infusion is described in Box 1.

Box 1

Preparation of the trichome Mixture for deworming of goats

The material required consists of Mucuna pruriens pods, sugar/jaggery (20 g) and two glasses of water. The trichomes of the pods are scraped off with a sharp knife. The knife is used from top to bottom to avoid the spread of the trichomes. Care is required to be taken to avoid contact of the trichomes with the skin as this leads to severe irritation. Half of the sugar/jaggery is dissolved in one glass of water and the animal is drenched with it. The remaining sugar is mixed in water with the required quantity of trichomes. For a mature doe (25-30kg body weight) trichomes from two mature pods are enough. Again the animal was drenched with this mixture taking care to avoid the entry of the solution in to the respiratory tract.

In the supplementation studies in Rajasthan the goats in the control and treatment groups were owned by different farmers while in Karnataka each goat owner had goats in every treatment.

Identification of does and kids was done in consultation with the owners (identification marks) and colour coding of animals in different groups. A local person was trained to undertake monitoring of trial animals every 15 days during the supplementation period and every week during the kidding season. A number of parameters including breeding status, health and body condition, number of kids born, and their birthweights were recorded. In the Karnataka studies the body weights of kids were recorded weekly. Mortality of kids was recorded from birth to 30, 60 or 120 days, depending on trial and year.

Results

Supplementation studies

The results of the Rajasthan studies are presented in Figure 1 (kidding rate) and Figure 2 (twinning rate). Although there were differences between years, the supplementation treatment showed higher conception rates, twinning and kidding rates in all the years. The differences between supplements, indicating a nutritive value of pods similar to the barley and pods mixture.[1]. Farmers were concerned that feeding *P. juliflora* pods may encourage encroachment of this species (see Box 2).

[1] * The supplement was a mixture of *Prosopis juliflora* pods and barley (1:1) in first two years and only the pods in the next two years**.**

The difference in conceptions was significant ($P<0.05$) for year 1 only.

The difference in kidding rates was significant in all the years.

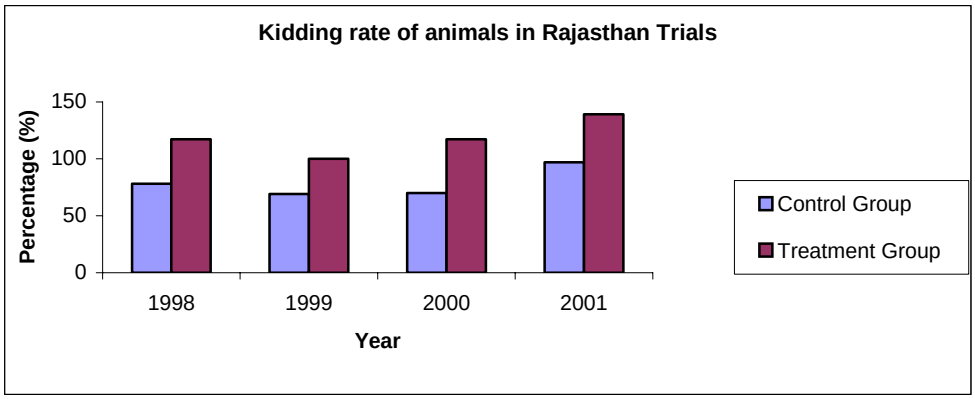

Figure 1

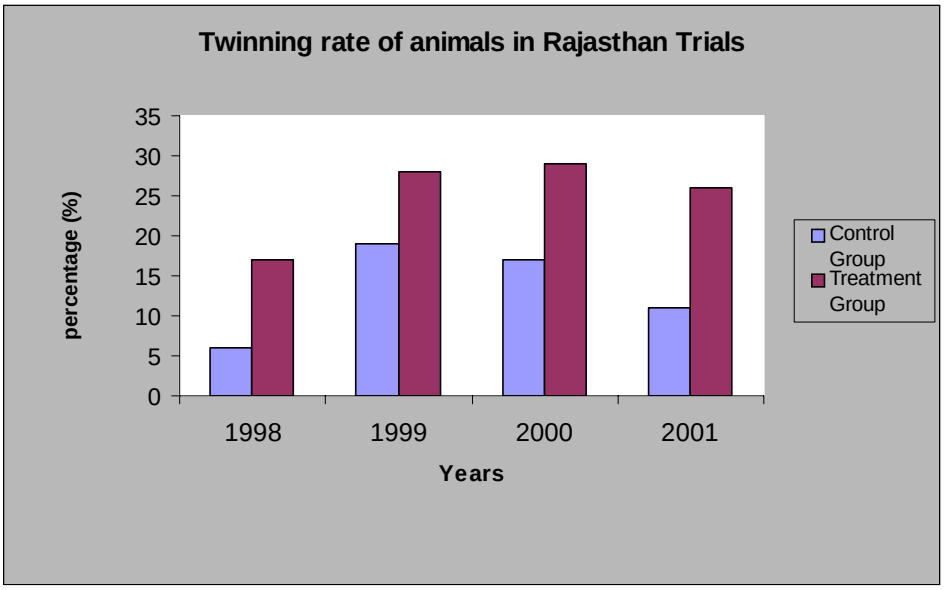

Figure 2

In the Karnataka trials (Table 1) the results were affected by climate. In the normal rain fall year (2000) the mortality of kids was reduced as a result of supplementation of the does, while in a drier year (2001, rainfall 50 per cent below normal) the mortality in general was low and was not affected due to treatment. The results in terms of birthweights and growth rates were consistent in both the years, with the birthweights being 100-300g more in supplemented does and the gain in weight in kids during the first four weeks was also higher in the supplemented group. The pods were as effective a supplement as the sorghum and horsegram mixture in improving birthweights and growth rates.

Table 1 Performance of supplemented (sorghum and horsegram (SH) or *Prosopis juliflora* (PJ) pods) does in Karnataka

	2000		2001		
Parameter	**Supplemented group(SH)**	**Control group**	**Supplemented group(SH)**	**PJ pods**	**Control group**
Number of does	19	15	22	21	22
Number of kids born	33	24	36	27	31
Number of kids dead (0-30 days)	04	11	1	0	0
Kid mortality (%)	12	45	2.7	0	0
Mean birthweight of kids (kg)	2.32	2.08	1.89	2.13	1.85

Costs and benefits

The following table (Table 2) indicates the income and expenditure associated with the Rajasthan trials based on a herd of 10 does.

Table 2 Costs and benefits of the supplementation[#] in the Rajasthan trials

Parameter	**Treatment group**		**Control Group**	
	Years 1 and 2	**Years 3 and 4**	**Years 1 and 2**	**Years 3 and 4**
No. of does	10	10	10	10
Average kidding rate	109	128	74	84
Extra kids due to treatment/year (no)	3	4	-	-
Extra income due to additional kids (at Rs.300/kid)	900	1200	-	-
Extra cost of supplementation (Rs./year)*	656	525	-	-
Additional income (Rs./year)	244	675	-	-

In year 1 and 2 the supplement was a mixture of barley and pods while in year 3 and 4 only pods were used for supplementation.

*The barley and rosopis *Prosopis juliflora* pods mix was costed at Rs. 3.75/kg while the pods alone were costed at Rs. 3/kg.

Box 2

One of the concerns expressed by the participants in the supplementation trial, in which Prosopis juliflora pods were fed, was unintentional spread of the species in the farms. It was also thought necessary to understand if the pods needed grinding before feeding, as the seeds may escape digestion due to their hard coat. This study required a careful investigation of input and output of seeds. The study was done in controlled conditions with stall feeding at the Central Research Station of BAIF, at Urulikanchan, near Pune. The study revealed that over 85 per cent of the seeds were digested completely in the digestive tract. The germination rate of seeds escaping digestion was very high (100 per cent).

The Karnataka trials show similar trends in costs and benefits. The first year results show an additional 4 kids per 10 does due to supplementation, with an extra income of Rs. 1200/year. In addition the better body weight at marketable age is likely to amount to Rs.50 per kid, or Rs. 600 for all the 12 kids. The total additional income will thus be Rs. 1800 as against an extra cost of supplementation (Rs. 975 for 10 does assuming a cost of Rs. 6.5/kg for the supplement used). This indicates a net income of Rs. 825/year. In the second year, although the gains were not evident due to low mortality, the net income can be expected to be larger (Rs.1238/year) assuming similar gains as in year one and a pod price of Rs. 3/kg.

These studies clearly indicate the potential of *Prosopis juliflora* pods as a dry season supplementary feed for goats. The daily quantities used (250g/day/doe) would mean collection and storage of approximately 150 kg of pods for supplementation of 10 does over two months. This will not be a very difficult task. The problem of kid mortality was not fully addressed by the present work and will need further investigations for firm conclusions.

Deworming studies

The results are presented in Table 3 and Figures 3 and 4. In the first study the mortality of kids (up to 60 days) was lower in the dewormed animals (8 per cent) as compared to the controls (24 per cent). It was further observed that growth rates of kids born to dewormed does was higher than the untreated does. The second study revealed a high incidence of parasite infestation in the goats with eight types of termotodes and nematodes being present in variable proportions. The parasite egg count decreased significantly on the seventh day after the treatments with both anthelmintics. There was no difference in the egg count between the two anthelmintics.

Although the dewormed does tended to have kids with higher birthweights the difference was not significant. The treatment influenced the growth rate of kids until 4 weeks of age and was significantly ($P < 0.05$) higher than in the kids born to untreated does. There were no differences in growth rates of kids due to the type of anthelmintic used.

The mortality rate of kids from birth to one month of age was not affected by the treatments in the second year. The overall mortality was lower in the second year compared to the first year. This was perhaps due to the low rainfall in the second year (50 per cent less than year 1) which meant that the does were not kept indoors for as long as is the practice during this season. The data also revealed a higher mortality of kids in the control group, compared to the treated group, until months 4 of age.

Table 3 Faecal parasitical egg count in does before and after treatment

Group	No. of Does	Mean no. of eggs (per g)		Difference
		Day 0	Day 7*	
Control	6	717	983	+267
M. pruriens pods	7	971	271	-700
Fenbendazole	7	757	114	-643

* Differences between control and treatments statistically significant ($P<0.05$).

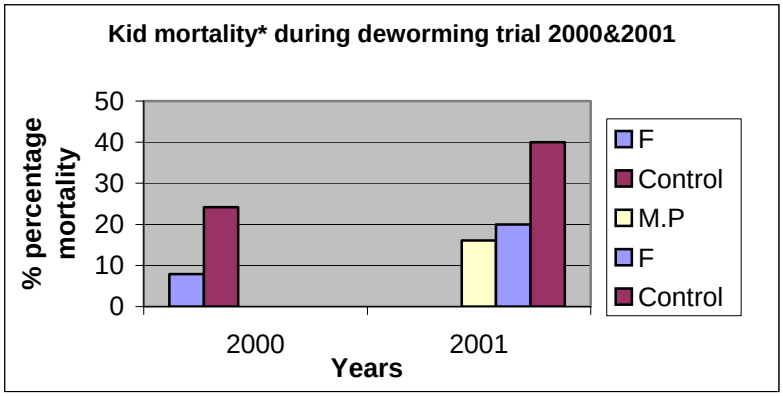

Figure 3

*Mortality up to 60 days (trials 2000) and 120 days (trials 2001)

F = Fenbendazole

MP = Muruna prurients

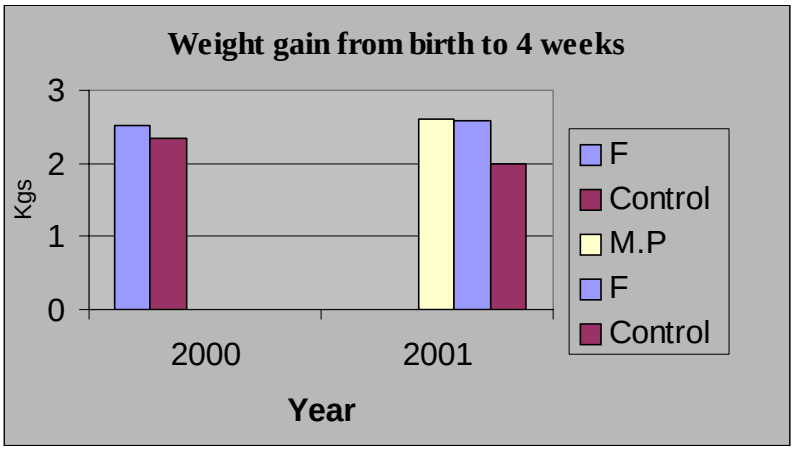

Figure 4

F = Fenbendazole

MP = Muruna prurients

Costs and Benefits

The trial showed the effectiveness of the deworming technology in improving the productivity of goats. In the first study the kid mortality in dewormed does until 4 weeks

of age was 40 per cent of the control, while in the second year the mortality of kids until 4 months of age was reduced by 50 per cent due to deworming. It can thus be estimated that the treatment would produce about 2 kids more per 10 does per year with an additional income of Rs. 600/year. The higher growth rates of kids would also mean a higher body weight at marketable age worth Rs. 50 per kid or Rs. 500 for 10 does. The total additional income would thus be Rs. 1100/annum with the cost of treatment of Rs. 100/10 does/annum for the commercially available anthelmintic (Fenbendazole). The cost of treatment with *Mucuna pruriens* pods will be even less than the one for the commercial preparation. The benefits accruing from the treatment thus seem to outweigh the costs even with a commercial anthelmintic. The use of pods will ensure not only a better benefit:cost ratio but also the local availability of the pods will be an additional advantage.

Dissemination

As the project progressed the findings were shared in different fora with others. The project also published various printed material, reports, manuals, and technical bulletins (see list). In addition two 'end of project workshops' were held, one in Rajasthan (September 2000) and the second in Karnataka (March 2002). In the Rajasthan workshop the findings of this project and a related one (R6995)[2] were presented to livestock extension and research workers in North-west India. The workshop also discussed the findings of the silvi-pasture research work done in the project. The workshop was also attended by scientists from Tanzania and Zimbabwe who are involved in similar research programmes. The workshop proceedings have been published (BAIF and NRI 2000).

In addition to the workshop papers and other technical publications the project has also produced posters in Hindi and Kannada for use of the extension workers and goat keepers. These posters show the methods of using the pods of *P. juliflora* and *M. pruriens* for better production from goats.

Conclusions

The present studies have conclusively proven that knowledge of nutritional and medicinal properties of locally available plants can be effectively used to develop technologies for improving livestock productivity. The low cost and easy availability of such materials is more likely to make it cost effective alternative to the conventional treatments.

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[2] Application of laboratory feed evaluation to identify methods of easing feed scarcity in NW India

HEALTHY GOATS GIVE MORE KIDS AND MORE MONEY

Feed Vilayati Babul Pods during the dry season

Collect and store between December to February

In the dry season give one tin per doe per day

Dissemination channels from project R6953 'Easing seasonal feed scarcity for small ruminants in semi-arid crop/livestock systems through a process of participatory research'

Audience	**Objective (Message)**	**Channel**
Farmer	Increase coverage	Poster
Farmer	Increase knowledge	Radio (TV)
Ext. Officer	Enable Extension agent to understand the technology for application in farm group	Transfer of technology
Farmer	Sharing experience	Farmer to Farmer / Visit / Field day
Farmer	Reference Material	Leaflet

India: Questions and answers

How do you process the pods to ensure they are digested?

The pods and barley are not processed; eighty five per cent of the *Prosopis juliflora* seeds are completely digested.

Do you encourage farmers to keep records?

The Meru Goat Project shows that records have financial importance; goats that are recorded have higher sale values because farmers realize the importance of keeping records; they are able to adapt to keeping them.

Is twinning to be encouraged or are single kids more likely to survive?

Weaning rate is more important than twinning rate, as in a situation with scarce resources a high twinning rate can have a negative impact. The project is still working on the data for weaning rates.

Growth, survival and milk production of Toggenburg goats and their crosses with East African and Galla goat breeds on the Eastern slopes of Mount Kenya

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Abstract

Data on growth and milk production from farm records of a community based goat improvement project in Meru Central and South districts in the Eastern Highlands of Kenya were analysed to determine growth parameters and milk production potential of Toggenburg goats and their crosses with local goats. Least Squares means and their standard errors for birthweight (kg), were 3.6 ± 0.16, 3.2 ± 0.19, 3.5 ± 0.18 and 2.6 ± 0.55 for ¾Toggenburg, Toggenburg x East African (F1), Toggenburg and East African respectively. Weaning weights (kg) were 15.3 ± 0.12, 12.7 ± 0.14, 12.5 ± 0.09 and 12.10 ± 0.67 for ¾Toggenburg, Toggenburg x East African (F1), Toggenburg and East African respectively. Average daily gains (g) were 127, 105, 104 and 78 for ¾Toggenburg, Toggenburg x East African (F1), Toggenburg and East African respectively. Daily milk yields (litres) were 2.6 ± 0.18, 2.4 ± 0.14, 1.8 ± 0.07 for ¾Toggenburg, Toggenburg x East African (F1) and Toggenburg respectively. Ages at first kidding (days) were 616 ± 35, 615 ± 27 and 761 ± 16 for ¾Toggenburg, Toggenburg x East African (F1) and Toggenburg respectively. Lactation lengths (days) were 295 ± 29, 316 ± 23 and 205 ± 12 for ¾Toggenburg, Toggenburg x East African (F1) and Toggenburg respectively. Lactation yields (litres) were 531±37.1, 486±29.6 and 378±16 ¾Toggenburg, Toggenburg x East African (F1) and Toggenburg respectively. The ¾Toggenburg was superior to other genotypes in all these traits.

Introduction

The Eastern slopes of Mount Kenya are characterized by a high population density that reduces as you move down the slopes. The rainfall pattern also changes as there is a higher annual rainfall, of over 2000mm, in the upper areas, dropping to below 600mm lower down the slopes. Agro-ecological zones range from upper midland one (UM1 = temperate and humid with a mean temperature of 18-21^{o} and annual average precipitation of at least 80 per cent of the potential evaporation), to lower midland 4 (LM4 = marginal, warm and transitional zone with a mean temperature of 21-24^{o} and annual average precipitation of 40-50 per cent of the potential evaporation). In all the zones, there is a mixed crop/livestock production system with tea, coffee, maize, livestock (mainly dairy), and beans, and in the lower zones tobacco, cotton and livestock (mainly indigenous cattle, sheep and goats). The high population, characteristic of the area, particularly in the upper midlands and the marginal areas, has led to a decline in farm sizes. It has become increasingly difficult for farmers with small farms to keep large livestock, such as dairy cattle. A major problem is the unavailability of feed resources for maintenance and production. The dairy goat has, therefore, been identified as an alternative milch animal in

this system. The exotic Toggenburg dairy goat breed has been introduced, in a community-based goat genetic improvement programme, to upgrade and improve the productivity of the local indigenous goats. The goat genotypes available in the study area range, therefore, from indigenous to a few pure-bred exotic dairy animals. A choice of genotype can be made within this range, after consideration of the following issues:

- The prevailing production system
- Husbandry skills of the farmer
- The available resources
- Disease challenges
- Access to markets.

The prevailing environment on the Eastern slopes favours crossbred animals, although, in the higher zones pure-bred dairy goats, like the Toggenburgs, can produce well.

This paper presents a comparative analysis of performance of different goat genotypes in smallholder production systems.

Materials and methods

Production data from various goat genotypes was collected from records kept by farmers (January 1997 and December 2002) participating in a community-based dairy goat genetic improvement and health care project, being under taken by FARM-Africa in collaboration with the Government of Kenya, in Meru Central and South districts of Central Kenya.

The goat genotypes included the exotic dairy Toggenburg (T), the indigenous meat breeds (East African (EA), Galla (G)), and the F1 crosses from mating Toggenburgs with the EA and G breeds. The detailed mating plan and the project's approach are given elsewhere (Ahuya *et al.*, 1987, Ahuya 1997). The farmers are grouped into voluntary farmer groups, with each group sharing one or two bucks at any given time, to which all their does are mated. The buck is managed by a member of the group, who is referred to as a buck-keeper and his home is the buck station. One member of each group takes care of a breeding unit, which is composed of one buck and four does, all pure Toggenburg dairy goats, with their offspring. This is referred to as a breeder unit or breeding station. Both buck keeper and breeder keep records of the goat activities taking place at their homes. At the buck station records are kept on number of does brought for mating, their owners, and breed of the doe, sire, amount of money paid and the date the dam is taken for mating. Kid births are also recorded. At the breeding units records kept include date of birth of kids, amount of milk, sire, dam, treatments and diseases treated.

The farmers decide whether the animals should be managed individually or collectively. In 60 per cent of the groups, the animals are managed individually by the breeder or the buck-keeper, while the rest manage their goats collectively. Under a collective arrangement, a rota is made for every member to bring the feed to the animal on a given day. Also one member of the group has been trained as a community animal health worker and he or she takes care of the community's animal health and is paid by individual members for services

rendered. The population of the goats and the number of participating families between 1996 and 2002 are presented in Table 1.

For this study, birthweights were taken using a spring balance, within six to nine hours after birth. Body weights were taken while monitoring for other activities across the study area. Because it was not practically possible to synchronize activities, farmers weaned their goats at different ages. Weaning weight was, therefore, standardised at 120 days according to the following formula:-

$$120\text{-day weight} = \frac{(WT1 - BWT)}{WAGE} 120 + BWT$$

Where, WAGE= weaning age (days);

BWT= birthweight (kg) and WT1= weight (kg) at WAGE

Statistical analysis

Least squares analysis of variance was performed using GLM procedures of Statistical Analysis System (SAS), version 6.12 (SAS 2001) to investigate the effects of breed, season, year of birth, agro-ecological zone, parity, sex and type of birth on birth and weaning weights, daily milk yields, age at first kidding, lactation length and yields.

The following model was fitted for growth traits: birthweight (kg) (BWT), weaning weight in kg (WWT) and average daily gain in grammes (ADG).

For growth traits the model used was:

Y = u + year of birth + season of birth + zone + genotype

+ sex + type of birth + parity + residual

Milk, traits considered in this analysis included daily milk yield in litres (DMY), lactation length in days (LL), age at first kidding in days (AFK), and lactation yield in litres (LY).

The following model was fitted for milk traits:

Y=u + breed + year + season + type of birth (no. of kids) + parity + residual

Results and discussion

Least squares means and their standard errors for birthweight, weaning weight, average daily gain, daily milk yield, age at first kidding, lactation length and lactation yield for various goat genotypes are presented in Tables 2 and 3 respectively. The three quarters Toggenburg was superior to the F1 in average daily gain, birthweight and weaning weight respectively, while the pure Toggenburg was superior to the F1 in birthweight but had the same weaning weight as the F1 (Table 2). In an earlier study, but with a smaller data set (Ahuya *et al.*, 2002), Toggenburg kids were superior to all the other genotypes in all the growth traits, while the East African kids' performance level was the poorest for all traits,

with F1 kids, as expected, being mid-way between their parental means for birth and 60-day weights, but with higher average daily gains than their mid-parental means.. The Toggenburg kids were twice as heavy at 60-days and gained two and half times as much weight as their East African contemporaries up until weaning. The backcrosses, with the exception of the ¾ Toggenburg/ ¼ Galla, were not significantly (P>0.10) different from the F1 in all the traits measured. These findings were consistent with, and slightly better than earlier results on crossbred goats involving the same breeds and breed levels (Ahuya *et al.,* 1987; Ruvuna *et a*l., 1988, Ruvuna *et al*., 1992; Okeyo *et al*., 1999). Both in this and the earlier studies it was observed that crossing the Toggenburg with the Galla resulted in heavier and faster growing animals than when the former was crossed to the East African.. In this study, three quarter Toggenburg crosses between the East African and the Galla were pooled together, due to the small numbers of the Galla crosses. Gallas in the study have been bought from neighbouring districts because they are not indigenous to the study area. However, the East African goats are more tolerant of, and resilient to, the local diseases and gastro-intestinal parasites (Okeyo *et al.,* 1985; Baker *et al*., 1998); hence the need to have a combination of all the three breeds (EA, G and T).

Three quarter Toggenburgs were superior to F1s and pure Toggenburgs for daily milk yields, lactation length and total yields respectively, as shown in Table 3. They produced 0.2l litres extra milk; higher than the F_1s, which gave 0.5 litres more milk than the pure Toggenburgs. In these three genotypes the low performance by the Toggenburg, an established dairy breed, can be attributed to the fact that it was not in its traditional production system and, therefore, it could not cope with the low quality forages and, high ambient temperatures, typical of the area. Management skills, for animals of the production potential of the Toggenburg, are still being acquired by the small scale resource-poor farmers of the area.

Breed, season of birth, year of birth and type of birth had a significant effect (Table 4) on daily milk yield with does with single kids producing 0.3 litres of milk more than the does with twins. Because the milk yield recorded represented the amount of milk extracted, does nursing twins had less milk extracted than those nursing singles, to ensure adequate residual amounts were left for the twin kids to suckle. It is a common practice among farmers to fully extract milk from only one teat and sparingly extract the milk from the other teat for twin-born kids, whereas for single-bearing does, more milk is extracted from both teats. In season 2 (wet season, April-June) daily milk yields were 0.32 litres lower than in season 1 (dry season, January - March), which was associated with a more abundant and nutritious forage supply. The highest daily milk yield, of 2.6 litres, was recorded in 2002.

In looking at the sources of variation in performance, only three genotypes of three-quarter, F1s and pure Toggenburgs were considered. The numbers of milking Gallas were very low and, therefore, were left out of this analysis (Table 5). The improved yields could partly be attributed to improved management by the farmers as they became used to keeping dairy goats. Farmers who have consistently recorded higher yields have also been those that have conserved fodder and, or, planted legumes used for supplementation.

The population of the goats and the number of families that are adopting the dairy goat technology is increasing as can be seen in Table 1. Rubino and Heinlein (1998), working with Alpine crosses in a tropical environment reported a daily yield (litres) of 1.77, 1.76, 1.65 and a lactation length of 420 368 and 268 days respectively. In this study the yields (litres) were 2.6 $\pm$.18, 2.4 $\pm$.14, 1.8 $\pm$.070, respectively; and lactation lengths were 295 $\pm$ 29.4, 316 $\pm$ 23.06 and 205 $\pm$ 12.18 days for three-quarter Toggenburgs, F1s and pure Toggenburgs, respectively. When pooled, the overall lactation length was 202 days. Three-

quarter Toggenburgs have performed better in this study than F1s and pure Toggenburgs. To ensure the kids have a good start, by having enough milk in the early stages of life, farmers often wait for up to two weeks before milking the does.

Table 1 Increases in the numbers of Buck stations, breeder units, groups and families, together with the estimated crossbred goat population in the study area from 1996 to 2002

Category	Year*							Total
	1996	1997	1998	1999	2000	2001	2002	
Buck stations	10	20	10	11	8	8	14	83
Breeders Units	5	10	5	8	12	6	2	48
Groups	10	20	10	11	8	8	14	83
Buck services		809	1994	3376	3936	3892	3253	17260
Families	250	500	250	275	200	200	350	2050
Estimated Crossbred population		990	1894	3241	3817	3736	3187	16865

Source: FARM-Africa Dairy Goat and Animal Healthcare Project, Six monthly reports, July-December 2002

* Year totals refer to gains in that year, the total column is accumulative

Table 2 Least squares means and standard errors for birthweight (BWT), weaning weight (WWT) and average daily gain (ADG) for three-quarter Toggenburg, F_1, and pure Toggenburg and East African goats

Genotype	Trait		
	BWT (kg)	**WWT (kg)**	**ADG (g)**
¾ Toggenburg/ ¼ East African (653)	3.6± 0.16	15.3 ± 0.12	127
Toggenburg x East African (F_1) (944)	3.2± 0.19	12.7± 0.14	105
Toggenburg (509)	3.5± 0.18	12.5 ± 0.09	104
East African (628)	2.6± 0.55	12.1 ± 0.67	78

Numbers in bracket represents the numbers of animals involved in the analysis.

Table 3 Least squares means and standard errors for daily milk yield (litres), age at first kidding days), days after kidding before milking starts, lactation length (days) and lactation yield (litres).

Genotype	Trait				
	Daily milk yield	Age at first kidding	Days before milking	Lactation, length	Lactation yield
¾ Tog (38)	2.6 ± 0.18	616± 35	16.6 ± 2.2	295± 29	531 ± 37.1
F1 (74)	2.4 ± 0.14	615± 27	14.7 ± 1.7	316.8 ± 23	486± 29.6
Tog (147)	1.8 ± 0.07	761± 16	14.9± 87	205.6± 12	378 ± 16.1

Numbers in bracket represents the numbers of animals involved in the analysis

Table 4 Number of improved goats born and their survival rates (%) to weaning by genotype and year from December 1996 to January 2003 in the farms being monitored in the project area

Year	Genotype/Trait					
	Pure Toggenburg		**F_1 (Toggenburg x Local)**		**¾ Toggenburg/¼Local**	
	No. Born	% Weaned	No. Born	% Weaned	No. Born	% Weaned
1996	37	98				
1997	106	91	230	95	17	95
1998	83	94	428	95	121	90
1999	92	90	876	90	198	96
2000	102	92	988	97	246	97
2001	93	88	864	98	334	92
2002	104	90	970	94		
Total	617	92	4356	95	916	94

Table 5 Sources of variation for birthweight (BWT), average daily gain (ADG), daily milk yield (DMY), weaning weight (WWT), lactation length (LL), age at first kidding (AFK) and lactation yield (LY)

Source of variation	df	BWT	ADG	WWT	DMY	LL	AFK	LY
Breed	2	S	S	S	S	S	S	S
Type of birth	1	S	S	S	S	NS	NS	S
Year of birth	6	S	S	S	S	S	S	S
Season of birth	3	S	S	S	S	S	NS	S
Division	4	S	S	S	S			
Zone	3	S	S	NS	S			
Parity	3	S	S	NS	NS			NS
Sex	1	NS	S	S	S			

S = Significant

NS= Not Significant

Conclusions

The population of the desired crossbreds has steadily increased from 230 to about 20,000 goats in six years, so the genotype(s) being developed are showing evidence of adaptation, given the observed high survival rates among the crossbreeds (Table 4). The growth rate and milk yield are reasonably high, given the levels of inputs. The demand for the improved goat genotypes is also very high and increasing, suggesting the crossbred is popular with farmers. Local farmers' willingness to participate in the livestock management, especially the breeding programme, has resulted in partnerships being built which will ensure sustainability. The families who keep the improved goats have improved their own nutritional levels, through having more animal protein available, and increased income levels. Improved dairy goats have an important role in enhancing the livelihood of the resource-poor farmers in developing countries.

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Extension messages from project R7634

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Messages

- Upgrading adapted, but "less" productive local goat breeds with exotic dairy breeds such as the Toggenburg, can enable farmers to quickly and flexibly match the available genetic resources to the existing production environment in a socio-economically beneficial way (production of milk and meat)

- Participatory farmer-group approaches can help resource poor farmers to mobilize resources and inputs from among themselves and various service providers for sustainable breed improvement and development, including easy access to otherwise expensive but high quality genetic material and an affordable animal health delivery system

- Farmers should keep simple livestock records to help them in making management decisions. Demand driven and farmer adapted records provides an effective means of realizing or facilitating effective genetic evaluation and improvement

- The processes involved in community-based goat improvement require close, genuine and highly interactive linkages between the various players, including farmers, policy makers and other service providers, all of whom are important. This will result in partnerships that are likely to enhance the sustainability of a farmer-led goat improvement programme

- The crossbred Toggenburg (exotic, 3/4) * local goats (1/4) is the most promising genetic composition for dairy goats that can be recommended for the resource poor smallholder farmers on the Eastern slopes of Mount Kenya.

Dissemination strategy used by the smallholder dairy project and the integrated pest management project in Kenya

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Setting the research agenda

In recognising the importance of involving stakeholders in setting the research agenda the Smallholder dairy (R&D) project (SDP) set up a steering committee with representatives from farmer groups, government departments, national universities and regulatory bodies in the dairy industry. Proposed activities are cleared through the steering committee and results from the agreed activities are presented. The Maize Integrated Pest Management Project (R7955) holds stakeholder meetings every year to review results coming from the research work and to decide on issues to be researched in the next year. The stakeholder meetings bring together farmers, input suppliers, maize breeders, extension agents (public and private) and researchers. This process helps the stakeholders to buy-in to the project activities and encourages them to own the results of the research activities and, therefore, disseminate them in their institutions.

Research approach

The SDP has employed the following research approach with the aim of enhancing the quality of research but also making sure that its activities are relevant to the situation in the dairy sector in Kenya.

Dairy sector appraisal

In an effort to understand the dairy sector in the country characterization and longitudinal studies were carried out.

Developing a "basket" of options

After identifying the constraints through the surveys, a basket of solutions ("best bets") was developed.

Validation

The technologies ("best bets") were then validated in a participatory way. Farmers and other stakeholders were involved in the validation of the technologies.

Dissemination

After validation the dissemination of the technologies started.

The integration of herbaceous legumes into the Napier grass fodder system is used as an example to show how the strategy was used.

Constraint identification and technology development

A survey looking at the sources of livestock feeds was conducted in central Kenya. This survey identified lack of year-round feed supply as a major constraint to dairy production in the area. During the dry season availability as well as the quality was identified as a problem. Maize stover supplies a large proportion of the feed during this period. The main problem with maize stover is the low nitrogen content and poor digestibility and, therefore, it cannot sustain milk production. Possible solutions were identified as follows:

(i) Purchase N rich supplements

(ii) Integration of nitrogen rich forages (NRF), e.g. herbaceous and shrub legumes.

Nitrogen rich supplements like oilseed cakes are not readily available and are also expensive and, therefore, this option was not considered viable. The second option of planting NRF was considered the best option. Through a literature review herbaceous "best bets' were identified. The "best bets" included *Desmodium intortum, Macrotyloma axillare,* and *Neonitonia wightii.* As legumes had previously been introduced without much success a survey was conducted where farmers, who had experience with the legumes and key informants (extension officers and farmers) were interviewed. The following constraints to the adoption of NRF were identified:

- Availability of seed
- Poor persistency of legumes when intercropped with Napier grass
- Some of the benefits emphasized in the legume technology like nitrogen fixation could not be demonstrated on-farm. However, after growing the legumes for sometime farmers have noted benefits of using the technology.
- Research proposals were developed aiming to address the constraints. The experiments were established both on-station and on-farm. The strategy included visits by groups of farmers to both the on-station and on-farm sites. These visits helped the farmers and researchers to exchange ideas and evaluate the legumes

Availability of seed

Technologies developed to overcome the identified constraints included the use of vines instead of seed and the establishment of small nurseries on the farms. The nurseries were approximately 1 x 6 m and from this area a farmer can produce about 1,000 vines in a season.

Poor persistency of legumes when intercropped with Napier grass

To address the issue of lack of persistency of the legume in the Napier grass intercrops, experiments looking at the affect of different spacing on the persistency and productivity were initiated. The aim of these experiments was to reduce interspecies competition by utilizing spatial arrangement of the plants. The results were then discussed with farmers during field visits.

Other niches

The availability of planting material from the nurseries established on farm allowed the farmers to experiment with the legume. The project recommendation was that *D. intortum* should be intercropped with Napier grass. Farmers started experimenting by putting the

legume under coffee, fruit trees like avocadoes and on soil conservation structures, i.e. terraces. The legume was doing very well under avocadoes, a niche that was not being utilized before.

Dissemination strategy

Working with farmers to determine issues and assess benefits

The strategy of involving farmers in technology development was adopted with the objective of getting input from them early during the technology development cycle and, therefore, being able to adjust the technology accordingly. Feedback from the farmers was used to bring out factors that might limit the adoption of the technology. These issues were then discussed during the farmer forums and included in the leaflet that was later developed.

Partnerships

The project developed partnerships with extension providers and involved a number of them in the technology development phase so that they were aware and up-to-date with the findings.

Field days

Field days were held on the farms where the technology was validated and farmers not involved directly with the validation were invited. During these field days the host farmers became the "experts" on the technology and discussed it with the invited farmers.

Leaflet

A farmer leaflet (see below) was developed by a team of researchers and extension experts, with the help of a dissemination expert from "Mediae Trust". The leaflet was later pre-tested during a field day to make sure that the farmers understood the message. Based on the feedback from the pre-testing the leaflet was revised.

Scaling up of the technology

Using GIS tools the areas where *D. intortum* would grow were determined based on bio-physical limits. Having identified the areas in which the legume would grow, it has to be remembered that adoption will also be influenced by the production system and by access to markets for the milk produced. Therefore, access to market was superimposed to determine areas where the technology was more likely to be adopted. By combining the bio-physical requirements and socio-economic variables the areas where the technology was to be scaled up were identified. These areas were then targeted for dissemination. It was estimated that approximately 350,000 farm households could benefit from the technology.

In the scaling up exercise the project linked with several partners who had an interest in forage development. These included the dairy goat association of Kenya (DGAK), Ministry of Agriculture and Livestock Development and the Focal Area Development Committees of the Swedish International Development Cooperation Agency (SIDA) funded National Agriculture and Livestock Extension Project (NALEP).

Adoption study

The project has a student currently looking at adoption of technology. The movement of planting material and the type of information on the technology passed on from farmer-to-

farmer will be determined. This is part of a wider study looking at agricultural knowledge and information systems (AKIS) being carried out by the project. The AKIS study will help identify the sources of information available to dairy farmers and then use them to disseminate this and other technologies. The adoption study will identify factors that might limit or enhance adoption of the technology, which then will be used to improve on the leaflet and also refine the dissemination strategy further.

Lessons learnt

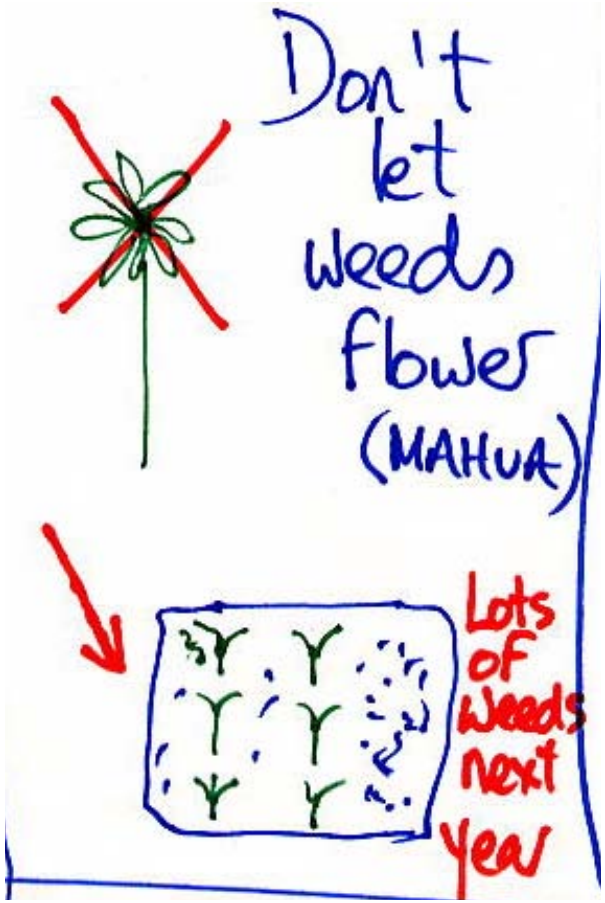
(a) In order to improve technology adoption, the technology must address a constraint identified by the end users, in this case the farmers.

(b) Involving the farmers in constraint identification is insufficient, if they are not involved in identifying and testing the possible solutions to the constraints. They should be involved at an early stage in the technology development cycle.

(c) Other partners should be involved in technology development so that they can buy into the technology thus developed.

The leaflet reproduced on pages 54-55 summarises outputs from project R7955 'Strategies for feeding smallholder dairy cattle in intensive maize forage production systems and implications for integrated pest management'.

For more forage from thinnings and stover and for more grain, control weeds soon after you see them.



For fewer weeds next time, don’t let weeds flower!

6 Control weeds, pests and diseases to produce more forage and grain from maize.

Keep extra forage for the dry season.

More forage means more milk. More milk means more money.

This leaflet is primarily for maize-dairy farmers in the Kiambu District of the Central Highlands of Kenya.

By B. Lukuyu, DM. Mwangi, J. Njuguna KARI-NARC-Muguga, J. Maina KARI-NARL, John Muthamia, KARI-NARC-Embu and AJ Murdoch Reading University.

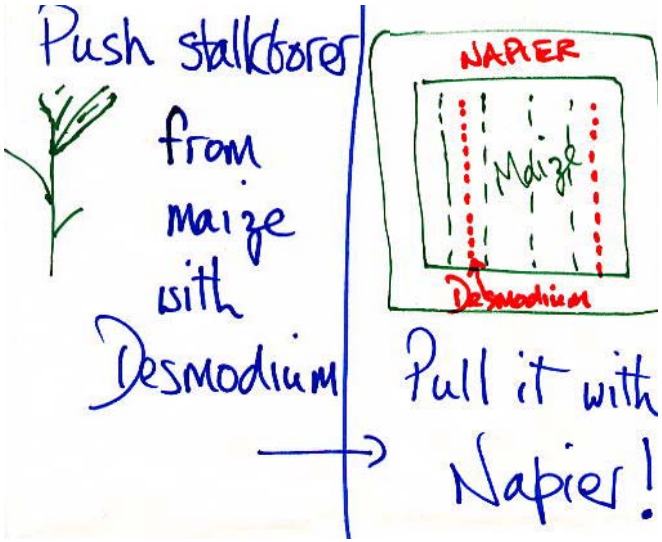
Contact: Dr J. Njuguna, KARI-NARC-MUGUGA, PO Box 30148, Nairobi, Kenya.

This publication is an output from a research project funded by the United Kingdom Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID.
Project R7955, IPM of maize forage dairying: *Renewable Natural Resources Knowledge Strategy Livestock Production (LPP) and Crop Protection (CPP) Programmes. LPP and CPP are managed by Natural Resources International, Ltd., Aylesford, UK.*

4

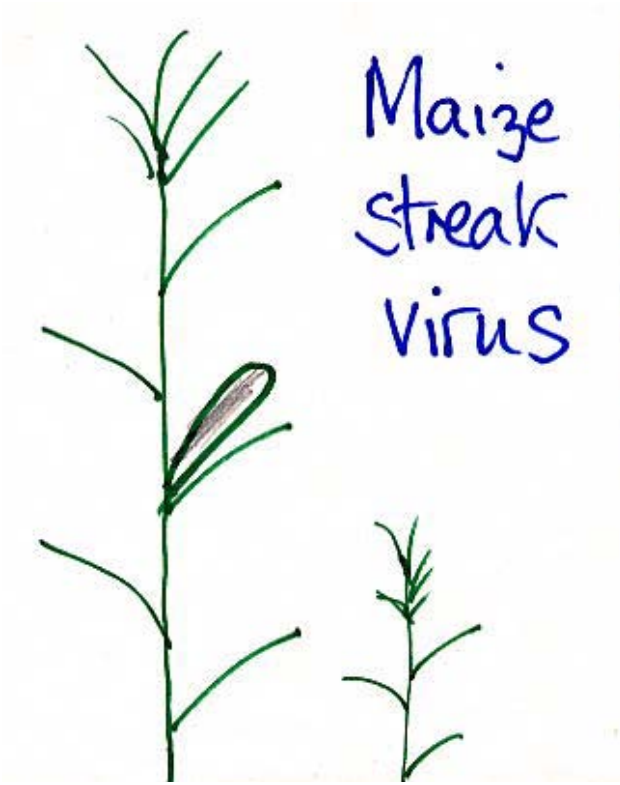
Does stalkborer sometimes spoil your maize?

Try “Push:Pull”.



Plant Napier grass round your maize and Desmodium between some maize rows.

5



Do you sometimes have small plants due to maize maize streak virus disease?

Choose a maize type which tolerates the disease.

Promotion and dissemination in the Meru and Tharaka-Nithi Dairy Goat and Animal Healthcare Project: a case study

B. Kaberia
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Background

Because of the diminishing size of land holdings, as a result of inheritance fragmentation, it is becoming evident that many farms can no longer easily support cattle because of their high feed requirement. Many families' livelihoods depend on the milk from cattle. The milk is consumed in the family and sold to those without their own supply of milk, often the very poor. Increased malnutrition is a possibility if cattle cannot be supported. In many cases goats are a viable option, in that, with good management it is possible to obtain 5 litres of milk per day from a Toggenburg goat with less feed input than would be required for the same output from a cow. This is usually enough milk for family use. Goats are browsers hence they can feed on most of the trees found on the farm without creating pressure on the land. Farmers can plan their farms such that the fence comprises fodder trees and hedges for goat feeding.

FARM-Africa introduced a dairy goat and animal health care project (MDGAH) in the Meru districts, in Kenya, in 1996. The Project is based in the medium potential zones of Meru Central and Meru South Districts, in the Eastern Province of Kenya. The districts are variable: altitude range is 500 - 5,000m; the rainfall ranges from 500 - 2,500mm and is erratic and bimodal in the lower zones. Soils are fertile, as they are made up of deposits from soil erosion in higher areas. A major constraint to reliable crop production is lack of moisture so livestock production (cattle, sheep and goats) is the main activity.

The purpose of the MDGAH Project is to increase the productivity of local goats, through better management and genetic improvement systems, and of both goats and local cattle through better access to sustainable healthcare systems**.** The project has two components: the Goat Breeding Component and the Animal Healthcare Component.

Goat Breeding Component

The target beneficiaries of the project are poor farmers in the poorer divisions of the districts, the majority of whom are women. The project has been implemented through self-help groups, most of which were formed specifically to carry out project activities. The community was assisted to identify the poorest families by selecting indicators of wealth and using them to rank households accordingly. Project beneficiaries, are for example, those without regular income, those with an income of less than KSh 1000 (U$ 13) per month, and those who cannot afford to send their children to school (over 75 per cent of farmers in the project). In each group, basic training was provided to farmers in goat husbandry, animal healthcare, and leadership and group dynamics. A member of each group was trained as a Community Based Animal Health Worker (CBAHW) to equip them with relevant skills to serve the group and the wider community, and generate a private income.

The aim of the breeding component is to produce a crossbred goat which can produce enough milk for the family and has the ability of the local goat to resist diseases. This is being done by cross-breeding local goats with the Toggenburg.

Buck stations were established within each group that FARM-Africa was introducing to cross-breeding. Pure Toggenburg breeding stations were also established to replace the bucks in the event of death or disability and to avoid in-breeding. Farmers form into groups of twenty-five people. Each group appoints a breeder and a buck keeper from among its members (not selected on wealth indictors), who are trained and then provided with goats to accommodate on behalf of the group. The breeder receives four female Toggenburg goats, as a loan from the group and to be paid for in kind. The buck keeper receives one male Toggenburg goat. Members of the group, as well as the community surrounding the group, if they so wish, take their local goats to the buck keeper for cross-breeding. The remuneration and benefits for the buck keeper and the breeder are determined by the group, to whom they are responsible. They can be dismissed by the group membership if they do not conform to group rules.

The group also provided the necessary inputs for construction of the goat sheds and any other input required to rear the goats. Some capital is generated through charging for use of the buck and goes towards maintenance of the goats.

Animal Health Component

With the introduction of the exotic breed into a new environment, disease surveillance as well as prompt access to health care could not be over-emphasized. Constant monitoring was paramount to achieve the project breeding goals. In view of this, FARM-Africa developed a decentralized animal health delivery system with the aim of:

- Increasing community access to veterinary services and drugs in rural areas
- Establishing sustainable links between private and public services
- Providing supervision of Animal Health Assistants (AHAs) and CBAHWs by private veterinarians
- Establishing a sustainable veterinary drug supply
- Improving disease surveillance and reporting of outbreaks to the Ministry of Agriculture and Livestock Development (MOALD).

The strategy to achieve this involved establishing a mix of AHAs at location levels and vets at divisional levels. The AHAs were advanced credit to establish rural drug shops, which sell drugs, and offer clinical services to farmers. They also supervise and supply the CBAHWs with drugs.

Farmers go directly to the nearest supplier to obtain veterinary services (suppliers include the CBAHWs). The project hopes to increase accessibility to animal health care services and drug supply to smallholder farmers in the lower potential areas. This also reduces the cost of services tremendously by eliminating or reducing costs of transport. The project has linked up with the Kenya Veterinary Privatization Scheme (KVAPs), which is developing private services in high potential areas.

Each veterinary officer is in charge of two or three divisions and operates from a practice office within an 'agro-vet' shop. The office has a telephone and is located in a main town. The AHAs are located in the rural markets and operate a rural drug shop, which supplies

drugs and agrochemicals to farmers as well as the CBAHWs. The distribution of the CBAHWs depends on the distribution of the dairy goat groups FARM-Africa is working with. Each dairy goat group has one CBAHW.

The veterinarians were given bank loans through Barclays bank on the basis of a written business proposal. Farm-Africa guaranteed about a third of the loan, KVAPs another third and the recipient had to provide collateral for the remaining third, that could be a third party guarantee or a mortgage on equipment to be purchased, for example a motor bike.

Promotion and dissemination strategy

The Meru dairy goat and animal healthcare project is an excellent example of the application of FARM-Africa's vision of a prosperous rural Africa.

The aims of offering practical, specialist, help and an innovative approach to agriculture are well applied in the project. It has introduced affordable veterinary and breed improvement services, thus enabling farmers and their families to greatly enhance the health and nutritional status of their households. This has been achieved by a vast improvement in goat husbandry and a consequent substantial increase in the household consumption of goat's milk.

Community benefits include the establishment of the veterinary service, acquisition of organization skills, and the recognition of women. Most important of all, over 40,000 poor farmers have benefited economically from the work of veterinary staff and breeders.

FARM-Africa has created a project which is both appropriate and effective and the need to replicate and disseminate this technology to a wider audience than the project area has arisen. From the beginning, FARM-Africa aimed to build capacity in Government of Kenya (GoK) extension staff and farmers. Members of groups were trained as CBAHW or breeders and sent to train fellow group members.

Farmer-to-farmer extension was used to disseminate messages, and between 1997 and 1999 sixty two farmer groups had been trained by CBAHWs on aspects of goat husbandry and disease control. Other methods built in to the project for dissemination included:

a Interpersonal communication

b Local shows held by the Meru Goat Breeders' Association (MGBA)

c Formation of networks as a means of sharing information

- Eastern Africa Goat Development Network (EGODEN)
- Kenya Goat Development Network (KEGODEN)
- Community Animal Health Network (CAHNET)

d Documentation of lessons leant in the project

e Participation in workshops through decentralized animal health workshops, forums, etc.

f Study tours for interested parties.

As the demand for the dairy goats increased, there was a need to focus our dissemination strategy to a wider audience. FARM-Africa approached the Mediae Trust to seek a partnership in designing an appropriate dissemination strategy. FARM-Africa in partnership with Mediae developed a proposal and submitted this to the Department for International Development (DFID) for funding. A stakeholder workshop was called with the following objectives:

a Identify the audience and its characteristics.

- Farmers
- NGOs
- Policy makers
- Extension

b Identify information needs and channels for different audiences

c Identify how to reach these audiences.

- The implications of goat numbers on different channels of communication available; radio, TV, printed material, the press, extension messages, etc.
- The advantages and disadvantages of each channel compared to the others.

Channels of promotion and dissemination developed

Objectives of FARM-Africa's promotion and disseminations strategy

These can be summarized as follows:

- Inform different stakeholders and the general public what FARM-Africa is doing in Meru
- Share experiences and the lessons learnt in the course of project implementation with farmers, other development agencies, policy makers and researchers etc
- Increase adoption and uptake of the project outputs to a wider audience:
  - Entails providing information to beneficiaries and development agents interested in building on our experiences with an objective of scaling up and spreading the benefits to a wider community than the project area.
- Inform and influence policy makers through advocacy, using our experience as development agents and the lessons learnt from stakeholders, by the following steps:
  - Examples
  - Poverty reduction strategy paper
  - Kenya rural development strategy paper
  - Review of Kenya veterinary laws
  - Advocating acceptance and recognition of CBAHWs by the veterinary board

- Based on the stakeholder workshop, mentioned above, FARM-Africa developed the following materials in collaboration with the Mediae Trust.

Interpersonal communication

Individuals can visit or call at any time to our project or head office and be sure to get face-to-face information about the project without any bureaucracy involved. This is a key channel that the project has employed. The other channels mentioned below are in support of this interpersonal communication

Goat poster

During the workshop farmers, said they wanted a simple poster that they could hang in the house to remind them of key extension messages. The target audience here was the farmers. The extension agencies would use the material in training and to pass extension messages to interested farmers

Booklet

Many farmers, in and outside the project area, were acquiring goats from the MGBA. The workshop participants felt that there was need for a small booklet based on our experience that could be given to farmers to help them understand goat management. The messages in the booklet have been simplified so that the extension agencies would easily be able to translate the information.

Video

There were many enquiries, regarding the project, from different groups, farmers, policy makers, NGOs, extension staff and donors. An explanatory video of the project made, this is sent out by FARM-Africa to people requesting information on its activities. If the video triggers the recipient to wanting further information, they are invited to visit the project.

Press

In the year 2001, we had a standard article of about half a page. The objective of the article was to let the public know what FARM-Africa was doing. This elicited interpersonal communication from different individuals.

Banner

Banners, similar to those used to publicise this Workshop, are employed to inform people about FARM-Africa activities, both locally, around Meru, and throughout Kenya. These banners improve knowledge, and project the image of the organization.

Radio and television programmes

This is the most effective channel of communication. In the years 1999 and 2000, there were news items on KBC and KTN, regarding the project. This also elicited a lot of communication between the project personal and the other stakeholders; FARM-Africa and Mediae are now developing '*Kimeru',* radio programme extension messages to be broadcast locally around Meru. The messages will be concentrating mainly on community based goat breeding and animal health issues.

Training package for other development agencies.

FARM-Africa has developed a package for capacity building of other institutions willing to undertake development of the dairy goat industry, and who would like to build on our experiences. The package targets:

- Farmers
- The Extension staff and Ministry officials
- Implementers of new projects

The above material (video, poster, booklet etc) is used in this training. Opportunities to interact at a personal level with different key players in the Meru project are given. This package is seen as a template that could be used by FARM-Africa to assist organisations in elsewhere (within and beyond Kenya) to start similar projects with a minimum of delay.

Impact

There is need to undertake a study to assess which of the above channels has greater impact. Currently the following impact has been observed in the project area

- Doubling of goat project groups, from the initial 40 formed by FARM-Africa to the current number of 80 groups
- A total of 150 farmers have been trained in Mbeere for Plan International, using the training package
- Extension staff of Plan International and Christian Partners Development Agency have been trained
- Breeding material from the project has been acquired and spread to over 37 districts in the country by various development agencies
- Visits to the project area have revealed that many farmers in Meru have adopted the goat housing technology.

Conclusion

The basic pattern of FARM-Africa projects has been to begin with a pilot phase that tests and develops a technology package with farmers and, or, improves an aspect of the development process. This may involve research. When the experience and confidence is gained, the technology, or approach, is scaled up through dissemination. FARM-Africa seeks to build on this experience and meet an increasing demand from partners and other organizations for access to this experience and expertise through the establishment of the Natural Resource Group (NRG) with the objectives of:

- Developing links between grassroots and higher institutions and policy makers
- Document and disseminate information through publications, the internet, exchange visits etc.
- Build the capacity of other local organizations to spread the benefits.

Acknowledgement

The Ministry of Agriculture and Livestock Development, the Department for International Development and the Mediae Trust are thanked for their participation in this development process.

Farmer owned goat breeding and multiplication centres: a case study of the Mogor Goat Multiplication Project

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Introduction

Heifer Project International/Kenya (HPI/K) is an NGO whose mission is to work in partnership with others to end hunger and poverty and to care for the earth through the sharing of livestock and knowledge.

In Siongiroi Division, HPI/K works with community groups to end hunger, poverty and environmental degradation through responsible management of animals and natural resources. The organization extends a living loan of livestock to farmers, who are organized into self-help groups. To date, HPI/K has given a living loan of 53 dairy goats to 2 women's' groups and one multiplication farmer in the division, and at the multiplication farm has facilitated the training of a farm manager in goat production, artificial insemination and milk processing techniques under tropical conditions. The manager has been working with the multiplier farmer to make cheese under tropical conditions.

Background Information

The inhabitants of Siongiroi are livestock keepers whose other main occupation is maize production. Among the livestock they keep are cattle, sheep and goats.

Being a settlement scheme, Siongiroi had been opened up earlier and developed for dairy cattle farming by the European settlers. Their main occupation is milk production from dairy crossbred cows, but they also keep smaller stock including sheep, goats and chicken.

The demand for goat milk in Bomet is high and there are adequate feed resources for goats. Incidences of disease are low. The farm holdings are very small, at around 2-2.5 ha per household. While the men mainly occupy themselves with cattle from which they earn income from milk sales, the women are left at home looking after the local goats that cannot provide them with sufficient milk to sell, thus compromising their economic well being. However, the resource poor smallholder women goat owners would achieve economic empowerment if they could be given an opportunity to rear dairy goats which could be expected to produce enough milk to be sold or processed for raising family income. This of course assumes that the women would be able to make decisions about the money earned and that it is not passed immediately to their male relatives.

The demand for dairy goats in Kenya, by smallholder farmers who are mainly women goat owners, is high and supply of good breeding stock is not available. The location where the project was initially started is inhabited by people who are consumers of goat's milk as a substitute to cow's milk. The location has a high population density and small land holdings per family. It nevertheless has a good climate for livestock rearing, good soils, adequate rainfall and a market for surplus stock.

Objectives:

The goal of the project was to develop a sustainable source of high quality dairy breeding stock in Kenya to meet the following objectives:

- To encourage smallholder farmers to engage in intensive livestock farming systems
- To start breeding goats and pass on female offspring to at least 100 smallholder farmers, especially women
- To introduce business development in the location revolving around processing of goats' milk

Achievements

A farmer responsible for multiplication of the goats was provided with 32 does and 3 bucks to begin the project. To date the following objectives have been realized:

1. Creation of a model farmer owned goat breeding/multiplication farm

The goat breeding farm has distinguished itself in the neighbouring districts, and the country at large, as a model goat breeding and multiplication farmer managed unit that fellow farmers, extension workers and research institutes such as the International Livestock Research Institute (ILRI), currently rely on for gathering and disseminating knowledge on modern dairy-goat farming technologies.

The farm provides demonstrative on-farm teaching on routine management of dairy goats. There is a complete fodder programme, based on such feeds as napier grass, lucerne, desmodium, sweet potato vines and natural grasses, to provide for a "cut and carry" zero-grazing system for the goats all the year round.

2. Animal health management and disease control

All the goats are kept under a zero-grazing system, ensuring more effective disease control, especially of tick-borne disease and contagious ones like contagious caprine pleuropneumonia (CCPP), Foot and Mouth Disease (FMD) etc.

It also ensures better utilization of feed for good milk production since the energy cost of foraging is saved. More importantly zero-grazing avoids environmental degradation as a result of the destructive eating habits of goats and trampling of the soil

3. Effective breeding plan

In the multiplication farm, the breeding objective is for increased milk production in terms of quality and quantity, through improving the genetic potential of the females available. The buck pen is, therefore, separated by at least 50m from the doe pen on the windward side to avoid tainting of milk with buck odour. It also ensures effective line-breeding as the doe is taken to the desired buck when on heat.

The bucks are of four breeds, Saneen, Alpine, Togenburg and Anglo-Nubian. Artificial insemination (AI) is also used alongside natural service to ensure the continuous upgrading of the genetic pool. Bucks produced through AI are also sold to other goat farmers to upgrade their local breeds to increase milk production. The 50 per cent index offspring are also well adapted to the local environment.

4. Sharing of the offspring - loan in kind

Through the spread effect of offspring 43 beneficiaries have been helped. These are two farmer groups with a total of 45 members and 25 families.

Another seven Bucks have been passed back to HPI as part of the living loan repayment.

5. Training/technological transfer

The project has trained one micro- and small entrepreneur (MSE), who is also self-employed as the farm manager of the goat multiplication unit and in charge of goat cheese processing and AI. He has also been the lead trainer to the many farmers and other people who visit the farm to learn about dairy goat husbandry.

6. Milk for home consumption and sale

The multiplication farm produces 30-50 litres of milk daily depending on the season and stage of lactation of the milking does. Some of the milk is used for family consumption.

7. Buck sales for family income and project sustainability

To date the farm has sold a total of eight breeding bucks to other farmers who want to up-grade their local goats, earning Kshs 40,000 (US $526.00)

The dairy goat development programme

The other districts where Heifer Project International/Kenya operates its dairy goat development programme include Kwale and Nyando districts. These are areas characterized by high child malnutrition, high poverty levels and high population densities. In areas like Nyando, the goat project is found on the Western side of Nyakach escarpment overlooking Lake Victoria. This area receives little and unreliable rainfall, the soils are rugged, heavily eroded and almost barren, resulting in food crops that benefit from applications of goat manure.

Current Challenges

Source of good quality breeding stock

The demand for dairy goats by smallholder farmers in the whole country is very high yet there is no local source of good breeding stock. This challenge is now being addressed through the multiplication farm and many more farmers want to become goat breeders after training at this farm.

Goat milk marketing

In order to economically dispose off the excess milk at the multiplication farm, together with that from the benefiting farmer groups, the issues of collection and processing to produce a value added product needs to be looked into.

Table 1 shows the summary of HPI/K assistance to date.

Table 1 Summary of HPI/K assistance to date

District	Total No. of groups funded	Total membership	Total No. of families assisted	Total No. of 'pass on' families
Nyando	2	49	26	16
Bomet	3	46	16	20
Kwale	3	77	38	11
Total	**8**	**172**	**80**	**47**

The potential for improving dairy goat farmers' livelihoods from agroforestry fodder technologies in Embu Kenya

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Abstract

Calliandra (*Calliandra calothyrsus*) and mulberry tree (*Morus alba*) are two fodder tree species that have adapted well in eastern parts of Kenya and are increasingly being planted by farmers. However, their nutritive potential and benefits has not been fully demonstrated to farmers. Two experiments were, therefore, conducted to evaluate diets based on the two fodder species on dairy goat performance. In Experiment 1, Napier grass, the standard basal feed offered to goats was replaced with diets containing Calliandra, at rates of 20, 40 and 80 per cent and their effects on milk yield observed. A 4 x 4 Latin-square design was used involving 8 lactating does selected from eight farms. Experiment 2, done at the research station, was jointly planned together with farmers. The objective was to test for the effects of partially substituting maize germ, a commercial supplement with another diet containing fresh mulberry leaves and fishmeal on live-weight performance over a 91-day period. The two diets were allotted to two groups of 4 recently weaned female goats in a completely randomized design. Results for Experiment 1 showed that diets containing Calliandra generally resulted in higher milk yields than the standard feed with the diet containing 80 per cent Calliandra and 20 per cent maize stover recording significantly higher milk yield over the standard diet (1.14l/day vs. 0.89l/day; $P<0.05$). In Experiment 2 there were no significant ($P>0.05$) differences in average daily gains between goats on maize germ supplement alone (46.9g/day) and those on supplements containing mulberry leaves and fishmeal (46.7g/day). A post-project study showed that there was a sustained use of the improved feed practices involving use of fodder trees by 37 of the participating farmers. Farmers had also realized several benefits associated with improved feeding which included enhanced family income and milk. Scaling up of the feeding practices has been catalyzed through farmer-to-farmer sharing of information and materials.

Introduction

Farmers in the coffee-dairy cattle land-use system of Embu District are at the forefront of a significant development in dairy goat production. It was noted from a characterization survey conducted in 1998, that dairy goat keeping in the dairy cattle-coffee land-use system of eastern Kenya was on the increase (Kiruiro *et al.*, 1998). The main driving force prompting farmers to venture into dairy goat keeping is the realization that goats offer higher returns compared to other enterprises, such as coffee whose returns in the last decade have sharply declined. Besides the income, goats provide manure for supporting crop production, and milk to meet the nutritional requirements of the household. However, the increase in goat production has not been matched with any significant expansion in the forage resource base. Inadequate feed both in terms of quality and quantity is, therefore, one of the most serious constraints to dairy goat production. Two on-farm dairy cattle feeding trials carried out elsewhere in Embu by Paterson *et al.* (1999) clearly demonstrated the nutritional superiority of Calliandra (*Calliandra calothyrsus*). However, studies involving dairy goats are limited. This article reports on two farmer participatory research studies to investigate the contribution of fodder trees, namely

Calliandra and mulberry (*Morus alba*) in dairy goat nutrition. This paper aims at demonstrating the opportunities for expanded dairy goat production based on fodder trees and the economic implications from an integrated fodder-dairy goat production system.

Study area

The on-farm forage evaluation study was carried out in Manyatta Division in Embu. The area is characterized by high population density (average of 440 persons per km^2) and a mixed crop-livestock production system. Thus, dairy cattle and goats, both reared under stall-feeding (zero-grazing) conditions are integral components of the farming system. Farming is highly intensive due to the generally small land holdings (average 1.5 ha). Napier grass, the main fodder occupies only 20 per cent of the cropped land (Franzel *et al.*, 1999). Indeed, farmers cite feed shortage, particularly in the dry seasons, as the major production constraint to livestock production, including dairy goats.

Materials and Methods

This paper reports on two experiments (Experiments 1 and 2) carried out between 1998 and 2000 with a broad objective of developing and evaluating various feed resources for dairy goat improvement on smallholder farms of the central Kenya highlands. Experiment 1 was carried out on-farm between October and December 1998, whereas Experiment 2 was done at the KARI-Embu Research Centre between December 2000 and January 2001. Both coincided with the dry seasons, a time when farmers experience severe shortage of feed and rely more on crop residues. The experimental procedures pertaining to the two studies were as follows:

Experiments 1: On-farm assessment of the effects of substituting Napier grass with diets containing varying levels of Calliandra and maize stover on milk yield.

Participatory meetings with farmers

As a first step, 28 farmers rearing dairy goats from the study participated in a workshop whose objective was to discuss the rationale behind the study, the objectives and design of the experiment, and the roles of both the researcher and farmer in the implementation of the study. During the meeting, 8 farmers were selected through consensus to participate in the experiment on the basis of having a doe in its second month of lactation and the main feeds being Napier grass and maize stover. There was also an understanding that animals on trial would be separated from others in the herd including the suckling kids. Non-participating farmers were encouraged to visit those participating in the experiment. An end of experiment workshop was also held to evaluate the results and more importantly, to assess their significance from a farmers' perspective.

Experimental design

The experimental design involved two 4 x 4 Latin squares in which two goats each from individual farms received each of the four designated diets above at any one period. This particular design was simple for farmers to relate to and practical in terms of data collection and general management of the animals. Each of the test diets was offered for a period of 10 days before changing over to the next diet, allowing for 5 days diet adaptation and 5 days data collection

Diets and feeding

The rationale was to develop diets for which the farmers' standard basal feed offered to goats would be substituted with mixtures of diets containing foliage from Calliandra and dry maize stover and their effects on milk yield assessed. The experimental diets were therefore as follows:

Diet A = 100 per cent standard feed (Napier grass at approximately 8 weeks re-growth) + 250 g/head/day maize germ

Diet B = 40 per cent of standard feed substituted with mixture of Calliandra (20 per cent) and maize stover (20 per cent) + 250g/head/day maize germ

Diet C = 60 per cent of standard feed substituted with mixture of Calliandra (40 per cent) and maize stover (20 per cent) + 250g/head/day maize germ

Diet D = Entire standard feed substituted with mixture of Calliandra (80 per cent) and maize stover (20 per cent) + 250g/head/day maize germ

Farmers harvested the Napier grass from their farms whereas maize stover was brought from the local research centre (KARI Embu Research Centre) in weighed quantities to last the entire feeding period. The maize stover, derived from maize (Hybrid variety 512), was chopped by hand to particle sizes of about 2-3 cm in length. Similarly, maize germ, in 250-gm packets was taken to the farms from the research centre in sufficient quantities to last the entire trial period. The total amount of the basal diet mixture offered was determined on the basis of the potential amounts of fresh forage goats would take, as determined earlier. However, these amounts were such that they would ensure that intake would be on *ad-libitum* basis. The actual amounts of the above diets offered and the estimated crude protein (CP) content are shown in Table 1.

Table 1 The physical amounts (kg/day) of individual basal diets and estimated crude protein (CP) content (g/kg DM) of the mixed diets.

	Basal Diet Composition (see text for details)				
Diet	**Caliandra**	**Maize stover**	**Standard feed**	**Total**	**CP (g/kg DM)#**
A	0 (0)+	0 (0)	5 (100)	(5.250)	88
B	1 (20)	1 (20)	3 (60)	(5.250)	103
C	2 (40)	1 (20)	2 (40)	(5.250)	127
D	4 (80)	1 (20)	0 (0)	(5.250)	173

+ Figures in brackets indicate the per cent composition of the basal diets: Diet A= 100 per cent standard feed (Napier grass at approximately 8 weeks regrowth); Diet B=40 per cent of standard feed substituted with mixture of Caliandra (20 per cent) and maize stover (20 per cent); Diet C= 60 per cent of standard feed substituted with mixture of Caliandra (40 per cent) and maize stover (20 per cent); Diet D= 100 per cent of standard feed substituted with mixture of Caliandra (80 per cent) and maize stover (20 per cent)

$ Values represent total daily amounts offered per goat with inclusion of 250g/day maize germ

Estimated from chemical composition of individual ingredients

Each of the basal diets was thoroughly mixed before offering to goats. However, the daily amount of maize germ (250g/hd) was offered in the morning, before feeding of the basal diets.

Simple measures such as plastic containers, which farmers could easily relate to, were used in order to reduce the need for farmers to weigh the basal diets. The daily milk yields were measured using calibrated measuring jugs. The management of the experiment was largely by farmers but researchers made routine visits to monitor progress.

Feed sampling

Samples of the feeds were not collected. for chemical analyses due to logistical problems. The crude protein (CP) contents of the feed ingredients were assumed from the literature values recorded for past trials.

Statistical analysis

Data on milk yield was subjected to the Analysis of Variance (ANOVA) using the procedure of the Statistical Analysis Systems Institute (SAS, 1990). Results are presented as least-square means with standard errors of difference between means.

Experiment 2: The effects of substituting maize germ with diets containing mulberry leaves on the performance of weaned goats.

Participatory meetings with farmers

Twenty-three farmers including 10 who participated in Experiment 1, were invited for a one-day workshop at the research centre where this particular experiment would be carried out. The discussion focused on the same workshop objectives as for Experiment 1. The basis for undertaking the experiment, as explained to farmers was to assess mulberry leaves as a forage–based supplement for its potential to replace commercial maize germ. The choice for research centre was due to the ready availability of mulberry leaves since the number of trees on the farms at the time was rather low. The condition of the area within the research centre is typically similar to the agro-climatic conditions found on the farms. A workshop similar to that held at the conclusion of Experiment 1 was held to evaluate the results.

Experimental design

Eight recently weaned female goats were selected from the centre herd based on the live-weight. These were divided into two groups of four animals each such that the mean live-weight for the two groups was 12.3 kg at the start of the experiment. The goats were housed in individual feeding pens containing slatted floors. Each pen was provided with a feed trough and a water bucket. All animals were drenched with a proprietary drug (Wormcid®) one week before the start of the experiment. The two experimental diets (see below) were assigned randomly to the two groups of animals to assure a completely randomized design. The diets in each group were offered on a continuous basis during the entire experimental period of 91 days during which live-weights were taken on a weekly basis. The daily growth rates were estimated by linear regression of weight as a function of age (weeks) between the beginning and the end of the experiment.

Diets and feeding

Napier grass formed the main basal diet. However, the daily amount of the standard supplement (maize germ) normally offered to goats by farmers was established to be about

200 gm. This supplement was offered as Diet E. The amount of maize germ and fishmeal that would be the alternative supplement (Diet F) was then calculated based on the market cost of maize germ, such that both supplements cost KES 2.50 or US$ 0.4. Fishmeal, offered at a daily rate of 37g/head in the mixture, contributed 15 per cent of the mixture. The amount of mulberry leaves that would form the additional supplement in Diet F was arbitrarily fixed at 300g/head/day but the cost of harvesting was considered minimal. The amounts of feed offered and feed refusals were determined daily. However, the amount of each supplement was adjusted on weekly basis according to the mean metabolic body weights for each treatment group, but was fixed at the 7th week to avoid substitution effects of supplements over basal diet of Napier grass.

The physical composition of diets E and F was as follows:

Diet E: Napier grass *ad libitum* + 31 g maize germ/kgW$^{0.75}$ daily

Diet F: Napier grass *ad libitum* + 7.5 g maize germ/kgW$^{0.75}$ + 4.5 g fishmeal/kgW$^{0.75}$ + 45 g fresh mulberry leaves/kgW$^{0.75}$ daily.

Sampling

Samples of feed offered and refusals were regularly collected to determine the dry-matter (DM) content after drying in the oven at 60°C for 48 hours. The DM values were used to calculate the voluntary DM intakes.

Chemical analyses

Bulked samples were sub-sampled and ground through a 1-mm sieve and then kept under refrigeration for subsequent chemical analyses to determine crude protein, neutral detergent fibre (NDF) and acid detergent fibre (ADF) according to AOAC (1993) methods.

Statistical analysis

A similar method to that adopted for Experiment 1 was used in the statistical analysis of data on feed intake and live-weight change.

Results

Milk yield and live-weight performance

There were no problems encountered in the implementation of both experiments and all animals remained in good health and readily took their diets. The performance of animals in terms of daily milk yield (Experiment 1), and feed intake and growth rates (Experiment 2) are shown in Tables 2 and 3, respectively.

Table 2 Total and Daily Milk Yield (l/head) by the Lactating Does (Experiment 1)

	Diets (see text for details)				
Component	**A**	**B**	**C**	**D**	**s.e.d**
Total Milk Yield (l)#	36.0	39.1	44.5	45.0	
Daily Milk Yield (l/head)	0.89[a]	1.04[a, b]	1.00[a,b]	1.14[b]	0.783

Based on total recorded from 8 farms

[a,b] Values with similar superscripts are not significantly different (P>0.05)

Table 3 The mean daily voluntary feed intake (g DM/head or as stated) and average daily gains (ADG, g/head) by weaned goats fed different supplements (Experiment 2).

Variable	**Diets (see text for details)**		
Feed intake (DM)	**E**	**F**	**s.e.d.**
Napier grass (g/day)	560	609	
Supplements (g/day)	183	190	
Total DM intake (g/day)	743	799	
Total DM intake (g/kgW$^{0.75}$)	102.4	103.5	
Average daily gains (ADG, g/day):			
No. of animals	4	4	
Initial Lwt.	11.6	12.9	
Final Lwt	15.8	17.2	
ADG#	46.9[a] (43.6)	46.7[a](43.9)	0.56

Values estimated from regression analysis; values in bracket obtained by calculating the difference between the final and initial mean live-weights

[a] Values with similar superscripts are not significantly different (P>0.05)

The results for Experiment 1 (Table 2) demonstrate a general trend towards increased milk yield as the standard feed in the diet was reduced. However, only Diet D with the highest level of Calliandra registered significantly (P<0.05) higher milk yield relative to the standard feed (Diet A). In Experiment 2, there were no significant (P>0.05) differences found between the two diets tested in terms of feed intake and ADG by goats (Table 3).

General discussion

Animal performance

The low quantity and poor quality of feeds especially during the dry seasons is widely acknowledged to affect feed intake, digestibility, milk production and live-weight performance by animals. Supplementation of low quality feeds increases the digestibility, feed intake or animal performance (Minson and Milford, 1967). There is normally a shortage of Napier grass the main basal diet offered to goats on smallholder farms in the dry seasons yet there is abundance of crop residues, predominantly maize stover.

The average CP contents of the Napier grass and maize stover in Experiments 1 and 2 were 46 and 89g per kg DM. These values fall below that considered necessary for efficient microbial activity in the rumen (Milford and Minson, 1967). Goat performance would be affected unless supplemented with quality feeds. In the case of the lactating does, milk yield could be compromised resulting in suckling kids not getting sufficient milk for rapid growth and maintenance of health. Similarly, post-weaning growth of young goats could also be impaired resulting in delayed maturity. The ability of smallholder farmers in Embu to utilize commercial supplements is limited due to high costs of feeds and unavailability. Occasionally farmers supplement goats with maize germ but amounts offered are generally low.

Results of Experiment 1 have demonstrated the importance of augmenting the quality of the basal diets by incorporating quality supplements. The milk yield from goats fed the Napier grass diet (Diet A) was the lowest, which could be attributed to the low protein content. By substituting part of the Napier grass with incremental levels of Calliandra, this generally corresponded with higher milk yield. Calliandra constituted about 19, 38 and 76 per cent of the total diet in Diets B, C and D, respectively. The results suggest that incorporating Calliandra, (240 g CP per kg DM) into the basal diet, possibly increased the overall CP of the diets and other valuable nutrients such as minerals and vitamins. This could have enhanced the efficiency at which diets were digested by micro-organisms in the rumen and thus total nutrients available for milk synthesis. Paterson *et al.* (1999) alluded to the same argument after observing increased milk yield from cattle supplemented with fresh Calliandra. Perhaps even more significant is the fact that maximum use could be made of maize stover that is widely available in the dry seasons, by incorporating Calliandra, or other high protein forage sources.

The potential for use of mulberry leaves as a cost-effective forage-based supplement was the basis for undertaking Experiment 2. The results indicated that up to 75 per cent of the maize germ supplement was substituted with diets largely made up of mulberry leaves without affecting performance (Table 3). This has practical significance in that farmers could, therefore, reduce the cost of feeding by relying more on locally grown forages of superior quality. The CP content of mulberry leaves in Experiment 2 was 180g/kg DM. Kariuki *et al.* (1999), in a study carried out locally, showed that sheep supplemented with mulberry leaves had comparable live-weight gains to those supplemented with commercial dairy meal, which was attributed to the nutritional superiority of mulberry leaves. Indeed, studies done in Tanzania revealed that mulberry leaves are highly digestible (Shayo, 1997). The leaves could, therefore, be a major source of readily available nutrients for effecting efficient use of other feed ingredients. While the use of fodder trees as strategic supplements should be encouraged, Leng *et al.* (1991) have suggested the need to include supplements predominantly composed of by-pass nutrients either for feeding alone, or in a combined form with other sources of nutrients. These workers have highly recommended the use of fishmeal due to its ability to release amino-acids post-ruminally for productive purposes. Incorporation of fishmeal in Diet F in Experiment 2 was decisive and was intended to further augment the nutrient availability to the animal from the amino-acids that would be released. However, despite a high CP content of the fishmeal used in the experiment (350g/kg DM), the amount offered to goats in the supplement (about 40g/day) was possibly low to promote significant amounts of by-pass nutrients. The amount of nitrogen released from mulberry leaves could also have been low and not commensurate with the energy released from maize germ (offered at a daily rate of 250g/day). Interactions between energy and protein can affect microbial growth in the rumen and hence dietary degradation of nutrients (Chikunya *et al.*, 1996). However, the

fact that appreciable rates of growth were maintained for both forms of supplements in Experiment 2, at a time when animals would possibly be losing weight during the dry season, demonstrates the importance of supplementation.

One practical implication of the results from the two studies is that farmers will be able to reduce the adverse effects of the dry seasons on animal performance by efficiently utilizing low-quality crop residues. Additionally, the farmers could cut down on the cost of feeding by relying more on low-cost forages grown on the farms rather than the costly commercial supplements. Fodder trees confer the greatest advantage since the cost of management is generally low and niches for growing them without interfering with cropping are readily available on smallholder farms.

Fodder adoption and socio-economic impacts of fodder technologies

The results of the two experiments reported here do not only have biological importance but could have significant economic implications at farm level. Most farmers have specialized on dairy goat production for income generation from live sales of animals. Faster growth rates, as a measure of high productivity and, therefore, high turn-over sales of dairy goats is directly associated with improved feeding practices. The practical implication to this is that farmers are able to derive higher returns under the intensive forage production and utilization system. A case study of the Manyatta Dairy Goat Keeping Self-help Group showing the economic impact of fodder trees from selected households after the fodder trees were introduced in 1999, to both the farmer and community levels is illustrated in Table 4.

Table 4. The relative number of dairy goats, manure and milk produced, and gross returns (KES[#].) derived from the sale of breeding animals and manure between 1996 and 2002*

	1996	By May 2002
Number of goats[1]		
Total	16	68
Mean per household	1.5[a]	5.7[b]
SE (P=0.05)	0.1001	0.1813
Animal sales[1]:		
Total sold		116
Gross returns		745,000.00 (USD 10,000)
Mean income per household		67,772.30 (USD 9,000)
Manure production[2]		
Total produced (loaded ox-carts)	11	102
Total sold		12
Gross returns (KES.)		20,600 (USD 270)
Mean returns per household (KES)		2,942.85 (USD 45)
Milk production [3]		
Mean daily yield per doe (L)	0.8[a]	2.5[b]

* Case study of a community-based group, the Manyatta Dairy Goat Keeping Self-help Group (Adapted from Kiruiro *et al*., 2002)

KES Kenya shillings

1, 2, 3 Data derived from 11, 7 and 10 households with intensive forage production, respectively.

a,b Means with different superscripts are significantly different ($P<.05$)

The data in Table 4 indicate that the returns per household with improved forage production strategies could be significant, even after accounting for production costs, which in the case of goats are minimal. This has important ramifications since farmers at the moment have narrow income generating options with the decline in the earnings from the coffee and dairy cattle sub-sectors. There is, therefore, tremendous opportunity of goats uplifting the livelihoods of smallholder farmers with the adoption of improved feeding and management practices. While this data in Table 4 represents an economic dimension, it might be argued that any assessment of the impact of the dairy goat sub-enterprise, needs to consider other wider considerations such as the effects on crop production and human nutrition, besides other social benefits. Nevertheless, the improved cash returns from sales of livestock and products has given impetus to adoption of fodder trees particularly Calliandra and mulberry trees. Cases of farmer willing to expand their fodder base using various species of fodder trees rose after the on-farm experiment with nearly all of the 38 participating farmers requesting planting materials.

Community-based fodder tree nurseries were initiated after the trials with the help of the researchers in order to scale-up adoption further. An *ex-post* assessment of the status of adoption by farmers within the study area in 2002 showed dramatic increases in the number of farmers adopting the superior forages as well as enhanced skills in utilization (Kiruiro *et al*., 2002). The accelerated farmer-to-farmer sharing of information has stimulated rearing of dairy goats by other farmers in other areas. In fact, 20 other community-based farmer groups interested in dairy goat keeping with an average of 15 members had evolved between the year 2000 and 2003. This is mainly due to the increased sharing of technical knowledge, skills and forage materials between research participating farmers belonging to the Manyatta Dairy Goat Keeping Self-help Group and others. There is also widespread use of forage conservation practices to stabilize feed availability, mainly through hay making from Calliandra, *Leucaena trichandra,* sesbania, mulberry, maize leaves and sweet potato (*Ipomea batata*) leaves. In addition, the dried leaf hay from fodder trees is increasingly used to formulate home-made protein-rich supplements containing either maize germ and wheat bran with or without addition of fishmeal.

Conclusions

There is growing interest in dairy goat keeping in the central highlands of Kenya including parts of the coffee and dairy cattle land-use system of Embu. However, high productivity could be limited by inadequate feeding resulting from low amounts and poor quality of feed. The potential of using locally grown tropical fodder trees to increase dairy goat productivity was demonstrated in two feeding experiments. On-farm assessment of the potential impact of the forage based feeding practices indicated tremendous opportunity for improving the income base of smallholder farmers and sustained livelihoods. Integrating fodder trees into low-input production systems could be a means for improving farmers' livelihoods, sustainability and productivity of the smallholder farms.

Recommendations

a) There is need to develop a more integrated feed resource base that takes recognition of various feeds sources including local shrubs found on the farms and the seasonal variations in feed quality.

b) Given the opportunity for an improved socio-economic status of farmers, detailed *ex-post* benefit-cost analysis through research or improved monitoring and assessment, is required as a measure of livelihood changes in relationship to poverty reduction, overall farm productivity, natural resource management and sustainability.

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Kenya: Questions and answers

How do farmers view the project?

Farmers have been involved in all stages, from the inception onwards, of the project development. The MGBA is their organization. Targeting poor farmers has worked well, particularly in transferring ownership.

What is the grazing system?

The small scale farmers confine their goats and they are zero-grazed.

Is there a problem with detection of heat?

FARM-Africa provided the farmers with a course on heat detection. In most cases, the farmers can detect heat. At some buck stations the farmers are charged according to the length of time the doe stays there, so there is a cash incentive to detect heat accurately.

Is the Project aimed at all farmers in the project area?

The project has been focused on poor farmers in the community. However, richer farmers can afford to pay more for the goats because there is a demand for the milk. Richer farmers are also able to purchase better feeds, thus their goats produce more milk.

How does the breeding policy work?

FARM-Africa is working with the farmers to ensure that bucks are moved according to a plan to avoid inbreeding. A problem arises when a poor farmer may think that the goats of the richer farmers are superior and their bucks best for mating. This is not to be encouraged as it would confuse the breeding programme. Maybe the project should target the whole community with the breeding programme instead of only poor farmers. This would be likely to have more impact and be more sustainable.

A meeting on cattle and small ruminant breeding policy in East Africa was sponsored by RELMA. Uganda has an animal breeding policy and legal frameworks are in place. Tanzania has a formal committee working to on the problem. In Kenya, the MGBA has been involved in raising awareness of the issues involved.

Is there a danger that the haphazard crossing of local goats 'with exotic breeds will lead to some kind of undesirable results as is already the case in cattle in Kenya today?

Yes, there is potentially some danger. However, the Meru Goat Project breeding component contains a breeding programme, rather than a mapping plan as was the case in the dairy cattle upgrading scheme. Emphasizing the need to know when to stop (i.e. what level of exotic blood is desirable) is indeed the way forward. Farmers must be made aware of the consequences of mismanaging the breeding programme

Has the potential for use of AI been considered in this project?

The project has two programmes, a breeding programme and animal health programme. We have collaborated with Kabete on semen collection at the request of farmers.

When it becomes necessary to use AI for the goats it should not be a problem because our private vets and animal health assistants are currently carrying out artificial inseminations in cows. Some training to work with goats will be necessary.

What is the possibility of using AI for goat breeding to increase the numbers of up-graded goats, because it is not practicable to continually import live bucks from overseas to give to the resource poor farmers?

Agreed, but currently the success rate of AI in goats, especially the use of frozen semen, is so low that it is not economically viable. However, strategic use of AI to preserve semen of high quality bucks, or those that are injured, is advisable and is already happening. Several doses of semen of top bucks are stored at the National Artificial Insemination Station. This batch is owned by the Meru Goat Breeders Association.

Collection of semen may allow for screening of pathogens such as Brucella which may be transmitted venereally.

Why is milk production in the Toggenburg less than in the cross-breds?

It was noted that level of production is low for the Toggenburg. This is because generally the forage quality is reasonably good, thanks to the 'package' of advice given to farmers by the project and, therefore supplementation is not felt to be required. However, the pure Toggenburg needs more nutrients to reach its full potential. The value of a ten month-old doe is similar to that of a three year old steer. The Meru Goat Breeders Association project should be seen as a success story.

Due to the high demand for improved goats isn't it time we scaled up?

The technology promoted and the processes used have worked well. Yes, we feel strongly that these experiences need to be replicated in other areas. The demand for breeding materials and capacity building is enormous, both in Kenya and neighbouring countries. We have now developed expertise in the Meru project that could help replicate the project. FARM-Africa is already talking to the Kenya Government and potential donors to support replication in other areas.

Although the science and results behind the success story of the Meru project is not new, the process and social aspects, including organizational structure that has helped the project to achieve the results it has need to be documented.

Comment

BAIF has experience in using AI in goats including the use of frozen semen. The experience (conception rates) so far is that the costs involved will be high and would therefore be applicable only in certain locations. BAIF have similar experiences of operating a cross-breeding programme on similar lines to that at Meru. This process has been documented. The technicians trained have now become self-employed, which in itself can be seen as a success story from the project.

Animal health inputs to Meru project were said to have had an impact on making the project a success. However, this needs to be documented.

Comment

A key to the success of the MGBA project is the organizational/institutional skills and 'values of the game'. The question was raised as to whether the project will generate guidelines on the 'processes for other smallholder farmers to follow. It was stated, and it is true, that in addition to focusing on developing and transferring technical options to farmers, there is need to pay attention to the social process: facilitating group development, through strengthening the capacity of local associations (the Meru Goat Breeders Association and the community animal health workers association) to continue

managing the breeding programme and providing affordable health service to farmers. It is this focus on capacity building and promoting farmer participation that has contributed to the feeling of ownership and motivation.

Strategies to increase the contribution goats make to the livelihoods of resource poor livestock keepers in Nepal

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Abstract

An experiment was conducted with 80 farmers in four villages in the Dhanusha district of the plains of Nepal. Within each village, farms were randomly allocated to one of five treatment groups. The farms' goats were then subjected to either: dosing with anthelmintic (ANT) in July and September; supplementary feeding of 100g maize grain/day for adult goats (MZE) for 60 days from August; a combination of these two treatments (A+M); supplementation with a mixture of vitamins and minerals (VIT); or treated with a digestive tonic (TON). The TON treatment was considered the control treatment. Goat health, live weight and condition were monitored every two weeks for four months (from July to November). Entries and exits from the goat flock were recorded, and the reasons for these changes noted. Household income and sources of income were also monitored every two weeks throughout the study. Goats that were treated with A+M had a lower disease incidence than the other goats in the study and their live weight gain was also greater. This was associated with a tendency for the asset value of A+M goat flocks to increase more than the other flocks, and it was also the treatment that was most highly valued by the farmers in the study.

Introduction

Goats are an important component in the livelihoods of resource poor livestock keepers (RPLK) in Nepal, which is one of the poorest countries in the world. In Nepal, goats have the advantage that there are no cultural restrictions to goat keeping, and they are a source of income for women (who take primary responsibility for their care) as well as being a valuable 'safety net' that can be sold to raise cash in times of need. However, a number of constraints limit the contribution goats can make to improved well-being and the aim of this project is to work with RPLK to develop strategies to overcome some of these key constraints.

One such constraint that was identified during a longitudinal survey at the beginning of this project was the high incidence of disease and death that occurred in the goat flock during the wet season, with many goats being sold because they were sick. These losses accounted for up to 33 per cent of the goat flock in the 2001 wet season. A review of research on goat disease in Nepal suggested that helminthosis was likely to be a primary

cause of this disease. The objective of this experiment was, therefore, to investigate the effect of different strategies to reduce the level of helminth infection on the health and performance of goats, and on the livelihoods of the RPLK who managed them.

Materials and methods

Communities

Four villages were selected in the Dhanusha district of Nepal. This is a district in the south of the country, on the Gangetic plain. Its elevation is below 600 m above sea level (asl), and it has a tropical climate, with summer temperatures rising to 40^0C, and winter temperatures ranging from 7-23^0C[1]. The villages that were selected were Jamunibas, Baluwa Biman, Birendra Bazaar and Kemalipur. Jamunibas and Baluwa Biman were relatively close to a road (less than 10 minutes by jeep), while Kemalipur and Birendra Bazaar were relatively distant. Within each village, 20 households were selected that represented both poor (average monthly income <NRs 2000, US$27) and less poor households (average monthly income >NRs 2000, US$27). In each village, households were randomly allocated to one of five treatment groups

Treatments

One of five treatments was applied to all adult goats in a household's flock. Each household was treated as a block. The first treatment (ANT) was the administration of anthelmintic (fenbendazole and oxoclozanide) in July and September. The second treatment (NUT) was the inclusion of ground maize in the diet of goats for two months from August to October. The amounts of maize fed were 100 g/d for goats over eight months old, and 50g/d for goats aged between four and eight months. The third treatment (A+N) involved administering anthelmintic (in the same way as for ANT) and supplementing the diet with ground maize (in the same way as for NUT). The fourth treatment (VIT) involved the supplementation of the diet with a vitamin and mineral supplement while the fifth treatment (TON) involved the application of a digestive tonic. The fifth treatment was taken to be the control, with farmers employing their normal husbandry practices in the management of their goats. The tonic was considered to be a placebo, and included in the experiment to maintain the commitment of farmers in the control group. Goats and households were monitored at fortnightly intervals for four months from July to November.

All goats were vaccinated against *pestes des petits ruminantes* (PPR), either by His Majesty's Government of Nepal's Department of Livestock Services, or (if this had not been done) by the project. The inputs of maize, anthelmintic, vitamin and mineral mixture and digestive tonic were provided by the project. It was recognised that these inputs represented a high cost to the farmers, but the objective was to determine whether these inputs had a significant impact on the livelihoods of RPLK, with a view to developing a more strategic use of inputs in future experiments if this experiment was successful.

Household economics

Local facilitators were appointed in each village, and at fortnightly intervals for four months they visited each participating household. At the initial visit, the physical, human,

[1] http://www.nepalpage.tripod.com/general/geography.htm.

natural and social resources of the household were recorded. At subsequent visits, householders were questioned on their sources and size of income since the last visit.

Monitoring goat performance

At the initial visit by the facilitators to each household, the size and composition of the goat flock was described. Each goat was allocated an individual record card, which described the goat (age, sex, breed, parity if a doe, initial live weight and condition score). During the facilitators' fortnightly visit to each household, these records were updated to note if a doe had kidded, and if the goat had left the flock. The reasons for exits from the flock were noted, and if the goat was sold, the price obtained was also recorded. If a goat entered the flock, a record card was made up for it, which also noted how the goat had entered (through birth, purchase, gift, etc.). At monthly intervals, the goats were weighed and their condition score noted.

Recording the incidence of disease in goats

A veterinary technician (VT) was recruited by the project to monitor the incidence of disease in the goats. When a goat was sick, the VT was called to make a provisional diagnosis and recommend treatment. Both the farmer and the VT took a detailed case history of the goat. These case histories were then compared, and a diagnosis of the goat's disease made by the Animal Health Research Division of the Nepal Agricultural Research Council.

Analysis of results

The effects of community, treatment and community x treatment interaction on a range of parameters were determined using analysis of variance. Parameters that were investigated were total household income, income from goats, incidence of disease and death in the goat herd (per goat at the beginning of the study), live weight change in the goats (excluding does that kidded during the study) and changes in the asset value of goats during the study. Analysis of variance could not be used to investigate the effect of treatment and community on the sale price of goats because of insufficient data, but descriptive statistics to illustrate the effect of time of sale and treatment on sale price were produced.

At the end of the experiment, each community was visited and asked to report their findings from this experiment. All meetings were facilitated by the same person and attended by representatives of the participating research organizations. Farmers were asked what differences they had observed between households, and within households when compared with previous years. They were also asked which treatment they considered to have been the most beneficial. The results of this analysis were compared with the objective measurements that had been made by linear regression.

Results

Description of the households

The households were quite consistent across the four villages. Household size ranged from 0-9 males and 1-6 females, but the mean size of household consisted of three males and three females. All the householders owned their own house, the majority of which (77 per cent) had a tiled roof, while the remainder (23 per cent) had a thatched roof. Landholdings were small, the mean size of landholding being 0.25 ha. This ranged from 0-1.3 ha for 15 per cent of householders of Jamunibas and Kemalipur and 50 per cent of householders in Baluwa Bhiman and Birendra Bazaar owning no land at all. These landless householders

appeared to have no access to land either, as they did not grow any crops at all. Land that was held by householders in this project was not irrigated.

All householders kept some livestock. No sheep were kept, and half the households kept no chickens. Of the remaining households, the mean number of chickens kept was seven, with a range from 1-19. One household in Baluwa Bhiman kept one pig, but pigs were not kept by any of the other householders. The numbers of large ruminant animals that were kept by the householders are summarised in Table 1. More households in Kemalipur kept at least one buffalo, more than in any of the other villages, while Birendra Bazaar had more households that kept cattle compared with the other villages. There was one very large herd of cattle (24) in Birendra Bazaar, but otherwise the herd size generally ranged from 1-5 for both cattle and buffalo.

The numbers of goats kept by the householders is summarised in Table 2. Keeping goats was a criterion for household selection, and this may have introduced a bias to the results. Flocks ranged in size from 3-10 goats, although Baluwa Bhiman and Birendra Bazaar tended to have slightly smaller flocks compared with Kemalipur and Jamunibas.

Table 1 Number of large ruminant animals kept by householders participating in the study

Village	Cattle			Buffalo		
	% households with no cattle	Head of cattle kept in households with cattle		% households with no buffalo	Head of buffalo kept in households with buffalo	
		Mean	Range		Mean	Range
Kemalipur	70	6.7	2-10	35	2.4	1-5
Jamunibas	75	3.0	1-5	80	1.5	1-2
Baluwa Bhiman	75	2.0	1-3	65	2.4	2-4
Birendra Bazaar	55	5.2	1-24	65	1.7	1-4

Table 2 Number of goats kept by householders participating in the study

Village	Mean	Range
Kemalipur	5.5	3-10
Jamunibas	5.1	3-10
Baluwa Bhiman	4.8	3-8
Birendra Bazaar	4.3	3-9

Household economics

There was no significant difference between villages in terms of the monthly income of households (Table 3), although householders in Birendra Bazaar tended to have higher incomes than other villages. This is associated with the larger numbers of cattle kept in this village compared with the others. There were no significant differences (between villages

or between treatments) in the mean monthly income made from the sale of goats. This does not reveal the full picture, however, as many households chose not to sell goats throughout the whole of the study period.

Table 3 Total monthly household income, and mean monthly income made from the sale of goats during the study

Monthly income (NRs)	Village				SEM	Sig.[1]
	Kemalipur	Jamunibas	Baluwa Bhiman	Birendra Bazaar		
Total	1806	2272	1908	3060	1363.3	ns
From goat sales	326	316	372	393	239.0	ns

[1]ns: not significant (P <0.05)

Description of the goat flocks

There was no significant difference between villages in either the numbers of goats that a household had or in the structure of the flock. The flock structure is summarised in Table 4. Of the five goats that most households owned, two were less than nine months old, and these young goats were evenly divided between males and females. The rest of the flock was almost entirely made up of adult does; on average each household owned 2.4 adult does and only 0.6 adult bucks. This shortage of bucks was noted by the villagers as a constraint, with many does failing to conceive (and being sold for infertility) because of a shortage of bucks. Most goats were of a 'local' breed, although there were some cross-bred with an 'exotic' breed, but there were no pure-bred 'exotics'.

Table 4 Mean number of goats (percentage of flock) kept by householders in the study

	Village				SEM	Sig.[1]
	Kemalipur	**Jamunibas**	**Baluwa Bhiman**	**Birendra Bazaar**		
Male goats:						
Kids	0.1(1.6)	0.4(7.7)	0.6(11.8)	0.2(4.3)	0.13	ns
Young	0.8(13.1)	0.6(11.5)	0.9(17.6)	1.3(28.3)	0.19	ns
Adult	1.6(26.2)	0.3(5.8)	0.5(9.8)	0.0(0.0)	0.16	ns
Female goats:						
Kids	0.1(1.6)	0.4(7.7)	0.4(7.8)	0.4(8.7)	0.14	ns
Young	0.7(11.5)	0.8(15.4)	0.6(11.8)	0.6(13.0)	0.19	ns
Adult	2.8(45.9)	2.7(51.9)	2.1(41.2)	2.1(45.7)	0.28	ns

[1]ns: not significant (P < 0.05)

There was a significant difference between treatments in the number of young and adult male goats owned by each household. This was an artefact of the allocation of treatments, as this difference was observed at the beginning of the experiment. The number of young adult goats kept by households was 1.6, 0.6, 0.6, 0.6 and 1.0 (sem 0.21, P<0.01) for

treatments ANT, NUT, A+N, VIT and TON respectively. The corresponding numbers for adult male goats were 0.8, 0.8, 0.4, 0.4, 0.6 (sem 0.18, $P<0.001$).

A total of 66 of the does kidded during the experiment, compared with 242 which did not. The number of does per treatment that kidded was 13, 13, 9, 15 and 16 for treatments ANT, NUT, A+N, VIT and TON respectively.

Effect of treatment on goats' health and live weight change

There were no significant interactions between community and treatments on the live-weight change or incidence of disease in goats. The effect of treatment on these parameters is summarised in Table 5. Supplementing the goats' diet with maize significantly ($P<0.05$) reduced the incidence of disease. Treating the goats with anthelmintic significantly ($P<0.001$) increased their live weight gain during the experiment, especially if this was accompanied with supplementary feeding of maize. There was no significant difference between treatments in the number of deaths, with a mortality rate (during the experiment) of 12.5 per cent. There was also no evidence of differences between treatments of enforced sales of goats due to sickness, with only three goats in the entire experiment being sold at a time when they were sick.

There was a total of 38 cases of disease reported during the experiment. The commonest causes of disease were respiratory (29 per cent) and skin (26 per cent) disorders. Suspected infection with internal parasites accounted for 11 per cent of reported cases. One case of internal parasite infection was observed in each of the treatment groups, except those that had been treated with anthelmintic (when no cases were observed), and the VIT group that had two suspected cases of infection.

Table 5 Effect of treatment on the live weight change and disease incidence in goats

	Treatment[1]					SEM	Significance[2]
	ANT	NUT	A+N	VIT	TON		
Live weight change (kg)	5.11	3.21	5.95	4.11	3.06	0.365	***
Disease incidence (%)	13.9	3.9	2.5	24.9	12.0	1.25	*

[1]ANT, treatment with anthelmintic; NUT, supplementation with ground maize; A+N, combination of ANT and NUT; VIT, supplementation with a vitamin/mineral mixture; TON, treatment with a digestive tonic (control treatment).

[2] * = $P<0.05$, *** = $P<0.001$

Factors affecting the sale price of goats

The sale price of goats is determined by season with higher prices being achieved at the festival time of Dashain and also at the beginning of the Nepali New Year in April. Dashain occurred at the end of this experiment, and the mean sale price rose from NRs 989/goat (in August) to NRs 1721/goat (in October/November, when Dashain occurs). Goat live weight also affects the sale price, and of the 76 goats that were sold in this experiment, the average sale price was NRs 99/kg. There were insufficient goat sales to be able to determine whether treatment had any significant effect on the sale price achieved.

Asset value of the goat flocks

The asset values of the goat flocks were predicted by estimating what the sale price of the goats that remained in the flock would have been had they been sold. This was achieved by relating the sale price of the goats that were sold to their sex, age, live weight and month of sale using best subsets regression. The best fit that was obtained used sex, age and live weight as predictors, and the relationship that was observed was (R^2=0.45, P<0.001, s=574.9):

Sale price (NRs) = 1177 - 496 Sex (1=male, 2=female) + 9.07 Age (months) + 53.6 live weight (kg).

The mean asset values of the goat flocks at the beginning of the experiment are presented in Table 6. Flocks that were treated with A+N tended to have a lower asset value at the beginning of the experiment, and this affected the relative value of these flocks throughout the experiment. The asset value of the flocks, together with the cumulative income from goat sales throughout the experiment, is also summarised in Table 6.

Table 6 Effect of treatment on the asset value (NRs) and sale income of goat flocks

Asset value and income from all goat sales (NRs)	Treatment[1]					SEM	Sig.[2]
	ANT	NUT	A+N	VIT	TON		
Experiment start	8178	7282	5840	6840	6894	766.1	ns
After 1 month	8481	7573	6241	7009	6947	800.1	ns
After 2 months	9094	8313	6473	7538	7158	978.8	ns
After 3 months	9468	8547	6607	7669	7381	1041.1	ns
After 4 months	9804	8575	6703	7972	7282	1071.0	ns

[1]ANT, treatment with anthelmintic; NUT, supplementation with ground maize; A+N, combination of ANT and NUT; VIT, supplementation with a vitamin/mineral mixture: TON, treatment with a digestive tonic (control treatment).

[2] ns: not significant (P < 0.05)

The changes in the combined asset value and sales income of goat flocks during the experiment are illustrated in Figure 1. In the later months of the experiment, there were no significant differences between treatments, but in the first month the differences were almost significant (P=0.10), with treatment A+N resulting in a greater increase in the asset value compared with the control treatment (TON). All treatments tended to result in a greater increase in asset value compared with the control treatment (TON) throughout the whole experiment.

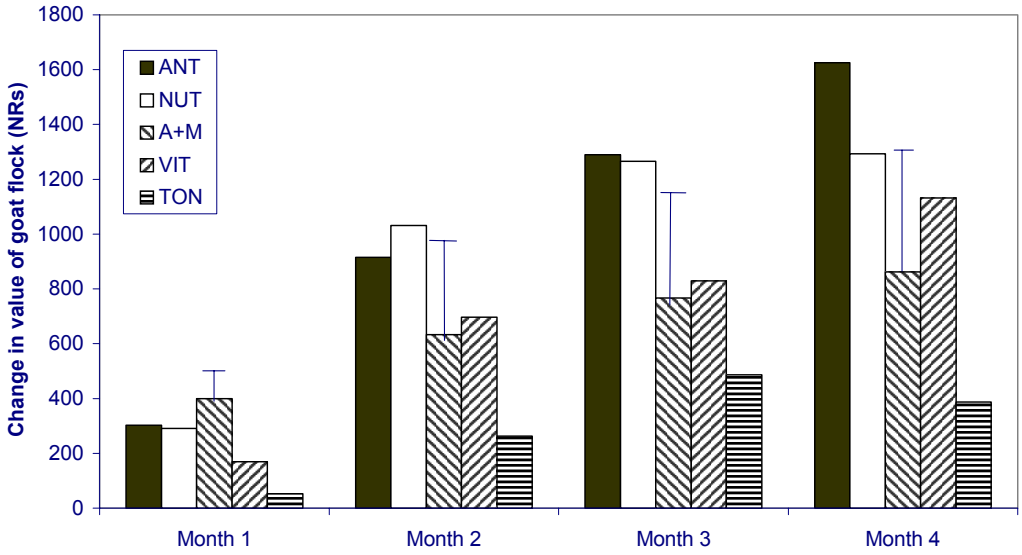

Figure 1. *Changes in the combined asset value of the flock and income from all sales since the start of the experiment*

Farmers' evaluation of experiment

Not all farmers were clear about what the treatment groups had been or indeed what treatment their own goats had received. They obviously knew if their goats had received maize or were on a combined treatment but they were not all able to tell whether they had received the ANT or the VIT treatments. However, when sitting in their groups, they were vocal in discussing the effects they had noticed in their own goats compared with a normal season.

The observations of the farmers about the different treatments are summarized in Table 7. There were no obvious differences between villages in their evaluation of the different treatments. When asked to rank the different treatments, farmers ranked them (in ascending order of usefulness) TON, VIT, NUT, ANT, A+N.

Table 7 Summary of the farmers' evaluation of the different treatments

Observation	Treatment[1]				
	ANT	**NUT**	**A+N**	**VIT**	**TON**
Appetite	Increased. Some goats had eaten soil, but this stopped after treatment				Increased
Weight gain	Goats became fat and sold at a good price	Improved body condition and live weight gain	Very effective at increasing live weight gain. Improved condition of goats and goats sold for a good price.	Goats gained weight, improved condition, and had glossy coats	Improved body condition and live weight gain.
Disease incidence	Health was improved, and no worms were seen in the droppings after treatment	Goats were healthy			
Comparison with neighbours				Goats treated with VIT looked better	
General comments		It would be good to feed maize in the future			

[1]ANT, treatment with anthelmintic; NUT, supplementation with ground maize; A+N, combination of ANT and NUT; VIT, supplementation with a vitamin and mineral mixture; TON, treatment with a digestive tonic (control treatment)

Relationship between farmers' observations and objective measurements

Based on the farmers' ranking of treatments, the treatments were ascribed the following scores: ANT 4, NUT 3, A+N 5, VIT 2, TON 1. These scores were correlated with the mean change in asset value and sale income in the first month, the mean live weight change during the experiment, and the mean disease incidence (percentage) during the experiment. The correlation coefficients between the treatments' score and these assessments were 0.975, 0.865 and –0.527 for the change in asset value, live weight change and disease incidence respectively. When the change in asset value and live weight change were regressed with treatment score, the relationship that was observed was:

$$\text{Score} = -0.772(\pm 0.4769) + 0.00883(\pm 0.00144)A + 0.379(\pm 0.1560)B$$

where A is the change in asset value and income from goat sales in the first month of the experiment (in NRs) and B is the live weight change (in kg) during the experiment. The regression statistics were R^2=0.987, P=0.013, s=0.252.

Discussion

The administration of anthelmintic and the supplementary feeding of maize brought about observable benefits in the health and condition of the goats. Disease incidence was reduced and live weight gain was increased during the experiment by the application of these treatments. However, compared with the previous year, the disease incidence was generally lower anyway. This might have been because all goats were vaccinated against PPR, and were, therefore, less vulnerable to opportunistic infections. Although helminth infection is an important cause of disease in goats in the wet season, the results of this experiment would suggest that skin and respiratory problems are, if anything, more prevalent, although they may not cause the debilitation that acute helminth infection can bring about.

Disease incidence in goats was only poorly related to live weight change (r=-0.175) and the change in the asset value of the flock (r=-0.563). These relationships may be stronger in years when general disease incidence is higher. Live weight change was strongly related to the change in asset values (r=0.758). The poor relationship between disease incidence and other objective parameters may explain why it was not strongly related to the farmers' ranking of the treatments. The evidence from this experiment suggests that farmers will value interventions that result in increased goat live weight gain (and an increase in the asset value of the flock).

During the farmers' evaluation, it became clear that an important factor constraining goat production in Nepal is a failure to get does back in kid. This may be because of a shortage of bucks (which results in available bucks being overworked), or because of infertility in the doe, or a combination of the two. The ANT, NUT and A+N treatments were valued because the 'goats became fat'. This helped to increase the price that goats would achieve when they were sold. However, these interventions may also help to reduce the losses of does from the flock (as a doe that fails to conceive twice is sold). Improving the health and nutrition of the doe around the time of kidding may help to increase her chances of conceiving again.

Future work

This experiment used a relatively high level of input to help demonstrate the beneficial effects such inputs might have. A more strategic targeting of these resources is required if they are to be widely adopted by resource poor goat keepers in Nepal. The strategic timing of anthelmintic administration has been investigated in Nepal, but needs to be demonstrated to farmers. The strategic use of increased supplementary feeding before a planned sale of a male goat, or before and after kidding in a doe, may help bring about an affordable increase in the contribution that goats can make to the livelihoods of resource poor livestock keepers.

Conclusion

Goats that are strategically dosed with anthelmintic and fed a supplement of maize (100 g/d for adult goats) had a lower incidence of disease and gained more live weight than goats subjected to other management strategies. This resulted in a greater tendency for the

asset value of the flock to increase, and this was the management strategy that was most highly valued by farmers participating in the experiment.

Verification and confirmation of appropriate extension techniques for resource poor livestock keepers in Nepal

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Introduction

The development of appropriate strategies and techniques to overcome the constraints that limit livestock production, and the contribution that livestock can make to the livelihoods of resource poor livestock keepers, are of little value if they are not communicated to the people who could make use of them. A number of extension methodologies have been developed to facilitate dialogue with farmers, and to communicate research messages to them. However, not all methods are equally effective to disseminate information and technologies at the farmers' level. The objective of this survey was, therefore, to determine which extension methodologies were considered most effective by extension agencies, and by farmers groups.

Materials and methods

A survey was conducted using a structured questionnaire. Key persons and extension agents working in different institutions and with farmers' groups were interviewed. The criteria for selection of institutions was to ensure representation of government bodies, research institutes, international non-government organizations (INGOs) and farmers' groups. The validity and reliability of the set questionnaire was pre-tested both in English and Nepali with extension professionals and relevant stakeholders and partner collaborators, government officers and NGOs. Their comments helped in revision of the questionnaire before it was used in practice. The list of institutions that were involved in this survey is presented in Table 1. A second questionnaire was administered to farmers' groups. These were groups that had been associated with projects managed by the institutions involved in the survey. The farmers' questionnaire was also piloted before being used with farmers in this study. The questionnaires that were used with the institutions and with the farmers' groups are presented below.

Table 1 Institutions involved in the survey on appropriate extension methodologies

Institution	Location
Agriculture Research Centre (i) Key Person (ii) Group (iii) Extension agent (Junior Technician and Assistant Junior Technician)	Pakhribas, Dhankuta
Nepal Agroforestry Foundation Forest Project (i).Key person (ii). Group	Badahari, Dhanusa
Agriculture Development Bank (i). Group	Dhanusa area
Local Initiatives for Biodiversity, Research and Development (Li-Bird) (i) Key person	Nadipur, Pokhra
Plan Nepal (i) Key person	Hetaunda
Centre for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED) (i) Key person	Kathmandu
Heifer Project International (i) Key person	Satdobato, Lalitpur
Forum for Rural Welfare and Agricultural Reform for Development (FORWARD) (i) Key person	Tandi, Chitwan
Development Project Service Center/Nepal (DEPROSC/N) (i) Key person	Kathmandu
New ERA (i) Key person	Kalopul, Kathmandu
Rural Reconstruction Nepal (RRN) (i) Key person	Chitwan
Natural Resource Management Sector Assistance Programme (NARMSAP) (i) Key person	Babar Mahal, Kathmandu
Department of Forest (i) Key person	Babar Mahal, Kathmandu.
CARE Nepal (i) Key person	Patan, Lalitpur
Bee-keeping Project (ICIMOD) (i) Key person	Kathmandu
Didi Bahini(Elder, younger sister)	Anamnagar, Kathmandu

Institution	Location
(i) Key person	
Women Development Training Center	Jawalakhel, Lalitpur.
(i) Key person	
National Goats Research Centre	Bandipur, Tanahun
(i) Group	
(ii) Extension agent (JT & JTA)	
District Agriculture Office	Kavrepalanchowk
(i) Group	
(ii) Extension Agent	
District Forest Office	Kavrepalanchowk
(i) Forest User Groups.	
Department of Agriculture	Hariharbhawan, Lalitpur
(i) Key person	
Department of Livestock Services	Hariharbhawan, Lalitpur
(i) Key person	
Outreach Section, Nepal Agricultural Research Council	Khumaltar, Lalitpur
(i) Key person	
District Livestock Services Office	Bardibas, Mahottari
(i) Extension agent	
(ii) Group	

Questionnaire used with institutions

A. General Information

1. Name of the organization:

2. Mailing address:

P.O. Box:

Tel:

E-mail (if any)

3. Name of the staff involved in completing the questionnaire.

4. Designation:

B. Extension related information

5. What is the major area in which your organization is involved?

a. Agriculture b. Livestock

c. Horticulture d. Socioeconomic

e. Poverty alleviation f. Others, specify

6. What are the extension methodologies that your Organization/ Department has adopted?

a. Individual contact	b. Committee / group approach
c. Mass awareness	d. Group meeting
e. Group training	f. Group exposure visits
g. Agriculture / livestock fair / exhibition	h. Radio
i. Television	j. Poster/pamphlet
k. Supervision & follow up	l. Farmers' cooperative approach
m. Training of key farmer to act as demonstrator and trainer	n. Others, specify

7. How do you rate the effectiveness of the extension methodologies you have used?

Name of the adopted extension methodologies	**Name of technologies for which the method was applied.**	**Degree of effectiveness**			**Why do you rate it so?**
		Very effective	**Effective**	**In effective**	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

8. What extension methodologies would you recommend to apply in practice to livestock keepers and why?

	Recommended extension methodologies	**Why**
1		
2		
3		
4		
5		

C. Group related information

9. Does your organization work with groups?

No Yes

10. If yes, what type of groups has your organization worked with?

Membership of group	**Region / district**	**Degree of mobilization**		
		Highly mobilized	**Mobilized**	**Less mobilized**
a. Ethnic/ caste group				
b. Women's farmers' group				
c. Men's farmers' group				
d. Mixed farmers' group				
e. Dairy (cattle/buffalo) farmers' group				
f. Poultry farmers' group				
g. Goat farmers' groups				
h. Pig farmers' group				
i. Vegetable farmers' group				
j. Marginal farmers' groups				
k. Landless farmers' group				
l. Others, specify				

11. Does your organization provide a subsidy to the groups?

No Yes

12. If yes, what type of subsidy was provided to the groups?

a. Help with interest payments on loans b. Vaccination

c. Feeding materials d. Medicine/drugs

f. Technical advice g. Technical support

e. House improvement f. Others, specify

Questionnaire used with farmers' groups

1. Farmer's name:

2. Name of the group:

3. Year the group formed:

4. Number of members in the group: Male: Female: Total:

5. Address: VDC/ Municipality Ward: Settlement:

Tel no: P.O.Box:

6. What are the major livestock related activities during the last 5-10 years in your community/village?

Name of livestock related activities	**Major Achievements**

7. Which organizations were involved in these activities?

8. Which types of extension methodologies were used by these organizations?

a. Committee (group) approach

b. Individual contact

c. Village based farmer training

d. Livestock fairs/ exhibitions

e. Extension media

f. Farmers meeting

g. Farmers competition

h. Extension education

i. Training and visit system (T & V system)

j. Input Supply

k. Technical advice

l. Supervision and follow up

m. Linkages and feed back mechanism

n. Cooperative farmers' development approach

o. Training of key farmers to act as demonstrators and trainers

p. Passing on gift

q. Others, please specify

9. Which extension methods have you found to be the most effective for farmers' groups?

10. Which sources of information do you trust, and why?

Source of information	**Why**
Extension agent	
Farmers' leader	
Farmers' training	
Fairs and exhibitions	
Farmers' meetings	
Local teacher	
Market information	
Others (specify)	

11. Where do you obtain the information that you are seeking?

a. Hat bazaar (Local market)

b. Teashops

c. Schools

d. Farmers visit

e. Extension agent (Junior Technicians and Assistant Junior Technicians, JTs & JTAs)

f. Others, specify

12. In your perception, which do you think is the most effective dissemination pathway for farmers' groups, and why?

Results

The extension approaches that have been adopted by the surveyed institutions are summarized in Table 2, together with an assessment (made by the institutions) of the relative effectiveness of these approaches. The commonest approach, which was considered the most effective among the contacted organizations, was the group approach. Sixteen (77 per cent) organizations are working with a group approach and say that it is the most effective. Three organizations (14 per cent) described it as just effective. For awareness raising, posters and pamphlets were considered most effective by six (29 per cent) organizations and effective by a further seven (33 per cent). However, some believed that posters were more effective than pamphlets for Nepalese resource-poor livestock keepers. Only two organizations (10 per cent) considered the farmers' cooperative approach the most effective, although a further 12 (57 per cent) considered it effective.

Based on their experiences, the organizations made recommendations on which extension approaches would be most appropriate to adopt for a livestock project. These recommendations are summarized in Table 3. As might be expected from the observations summarized in Table 2, the farmers' group approach was the most highly recommended method of engaging with farmers and communicating extension messages

Table 2 Extension approaches adopted by institutions, and their relative effectiveness

Approaches Adopted	Number (%) of institutions finding the approach:		
	Very Effective	Effective	Ineffective
Committee/Group Approach	16 (76)	3 (14)	0 (0)
Supervision and Follow-up	10 (48)	3 (14)	1 (4.8)
Group Meeting	11 (52)	6 (29)	0 (0)
Group Training	11 (52)	6 (29)	0 (0)
Individual Contact	8 (38)	5 (24)	0 (0)
Group Exposure Visits	8 (38)	7 (33)	0 (0)
Poster/Pamphlet	6 (29)	7 (33)	0 (0)
Farmers' Cooperative Approach	2 (10)	12 (57)	1 (5)
Mass Awareness	2 (10)	10 (48)	1 (5)
Fair/Exhibition	1 (5)	6 (29)	0 (0)
Radio	1 (5)	6 (29)	1 (5)
Television	0 (0)	4 (19)	1 (5)

Table 3 Extension approaches recommended by extension organizations

Extension Approach	Number of organizations recommending approach	Percentage of organizations recommending approach
Group approach	16	76.19
Group meeting	11	52.38
Individual contact	9	42.86
Poster and pamphlets	6	28.57
Supervision and follow-up	6	28.57
Group training	5	23.81
Farmers' cooperative approach	4	19.05
Mass awareness	4	19.05
Groups exposure visits	4	19.05
Fair/ exhibitions	4	19.05

The approaches that farmers' groups found the most effective are summarized in Table 4. Farmers were in agreements with the institutions that the group approach was the most effective extension methodology to use. However, farmers rated fairs and competitions much higher than did the institutions, but did not appear to value the use of extension media (radio, pamphlets and posters) to anything like the same extent. They were also less convinced of the value of individual contacts compared with the institutions.

Table 4 Extension approaches recommended by farmers' groups

Extension approach	Number (%) farmers' groups recommending approach	Rank
Group approach	6 (75)	I
Farmers' competition	4 (50)	II
Training and visits	3 (37.5)	III
Passing on gifts	3 (37.5)	III
Village-based farmers training	3 (37.5)	III
Supervision and follow-up	2 (25)	IV
Technical advice	2 (25)	IV
Individual contact	1 (12.5)	V
Farmers' visits	1 (12.5)	V
Farmers' meeting	1 (12.5)	V
Extension media	1 (12.5)	V

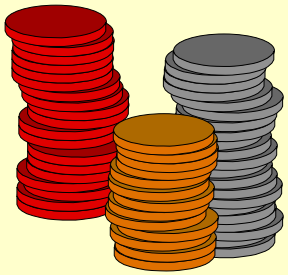
Conclusions

The results of this survey suggest that effective extension requires the adoption of a group approach. The use of this approach is recommended by both farmers and institutions. The use of extension media may assist in the dissemination of information, but many farmers are excluded from this approach, and did not find it helpful. The use of a group approach is very expensive in terms of resources, and will also exclude farmers who are not involved in the group. Means of engaging with farmers who are not usually involved in groups need to be established if they are not to be permanently excluded from dialogue and the dissemination of information. It should also be noted that an extension approach that is found to be effective in one location will not necessarily be equally effective in another location. Some extension methods may also be more appropriate for relatively resource-rich farmers rather than the more resource-poor farmers.

An example of an extension message presented as a leaflet follows.

MAKING YOUR GOATS WORK FOR YOU

Managing your goats so they make more money for you



Are you getting enough from your goats?

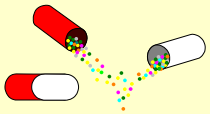
•Can't get your does back in kid?
•Having to sell goats because they are ill?
•Think you ought to get more money for them when you sell?

What are the problems?

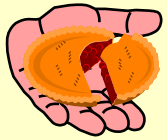
•Most goats are infected with worms in the wet season
•Worms make your goats ill, and stop them growing
•Does which are ill and underfed cannot get back in kid again.
•Goats which have not grown well do not get a good price when they are sold
•Stopping the worm infection and making sure your goats eat enough will make them healthier, and you will get more money from them.

So what can you do?

•Worm your goats in April and September
•Feed goats a handful of maize a day for a month before you sell them
•Feed does a handful of maize a day:
Two weeks before she kids
For another six weeks after kidding



Worm in April and September



Feed a handful of maize a day to:

•Your does for two months at kidding

•Your goats for one month before you sell them

And then goats will produce more money for you.

Nepal: Questions and answers

Comment

This project is very interesting because of its economic and livelihoods component; it is looking at the growth rate of goats but also at the economics involved and people's wellbeing. Other projects should also think about doing this.

What was the name of the anthelmintic used in the trial?

The anthelmintics used by the project were fenbendazole and oxoclzanide. The disease was helminthosis.

When you used the anthelmintic combined with the maize, was the same amount of anthelmintic offered as when it was offered alone, because it would be expected that the anthelmintic/maize mix would do better than maize alone? Was the mix economic?

The net benefit was obtained after the maize price had been deducted

The issue of maize feeding was discussed.

Livestock keepers working with the project fed maize to their goats once a week. The project was advised that it would be better to feed smaller amounts of maize to the goats on a daily basis.

Improving the livelihood of resource-poor goat farmers in Southern Africa through strategic drug and nutritional interventions against gastro-intestinal nematode infections: 2002 to 2003 update

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Abstract

The Department for International Development (DFID) Animal Health Programme (AHP) is funding a project in South Africa that began in April 2002 and will run for three years. It is testing the hypothesis that, under the farm management and agro-ecological conditions found in the resource-poor areas of South Africa, the holistic approach of strategic anthelmintic treatment of gastro-intestinal nematode infections of goats and, or, additional supplementation of their diet with urea-molasses blocks will lead to sustainable and cost-effective improvements in health and the value of livestock products. The study will include on-station and on-farm trials, socio-economic investigations and the dissemination of current information on worm control during the course of the project, as well as the results of current research towards the end of the project.

Background

Parasitic gastro-enteritis is indisputably a cause of serious production losses to small ruminants in sub-Saharan Africa (Connor *et al.*, 1990; Over *et al.*, 1992), and indeed world-wide (Fabiyi, 1987). Within the resource-poor semi-arid summer rainfall areas of South Africa, information on the production constraints caused by parasitic gastroenteritis is relatively sparse, as the main emphasis was previously directed to the South African commercial sector. However, *Haemonchus* has been shown to be one of the most important helminth species in the small ruminants farmed in these resource-poor areas (Vatta *et al.*, 2002).

The application of a strategic drug treatment for the control of parasitic gastroenteritis has been shown to improve production in small ruminants in sub-Saharan Africa (Connor *et al.*, 1990; Over *et al.*, 1992), as have improvements in the nutritional status of goats (Chartier *et al.*, 2000).

Anthelmintic resistance is known to be widespread in the commercial sheep-farming sector of South Africa (Van Wyk *et al.*, 1999). There is, therefore, a drive to slow down the rate of development of anthelminthic resistance and in addition to reduce the amount of chemicals in the production chain (Waller, 1993). Thus more recently, attention has been directed towards a holistic approach to parasite management involving sustainable integration of options which reduce the reliance on frequent chemotherapy (Coop and Kyriazakis, 1999). This includes examining the interaction between helminthosis, nutrition

and strategic drug intervention (Mahato *et al.*, 2000). Although the individual effects of strategic anthelmintic treatment and nutritional supplementation on goat productivity in South Africa are to be established in the present project, the effect of the interaction between nutritional supplementation, drug treatment, gastrointestinal nematode infections and goat productivity will also be examined. This information is currently almost totally lacking and needs to be quantified.

Research hypotheses

The project will test the hypothesis that under the farm management and agro-ecological conditions found in the resource-poor areas of Southern Africa (sub-Saharan Africa), the holistic approach of strategic anthelmintic treatment of gastrointestinal nematode infections of goats and, or, additional supplementation of their diet with urea-molasses blocks will lead to sustainable and cost-effective improvements in health and the value of livestock products.

This general hypothesis gives rise to four specific hypotheses which will be addressed through on-station and on-farm experiments, and which will attempt to answer the following:

- Hypothesis 1: that a strategic treatment administered before the peak in faecal egg counts will lead to a lower peak (lower worm burden) and hence better production.
- Hypothesis 2: that supplementation with urea-molasses blocks will help maintain or increase body weight. Such supplementation increases microbial fermentation which leads to increased microbial protein post-ruminally. This increased protein is thus available for the processes of regeneration and repair in the damaged alimentary tract and for mounting an effective immune response. This in turn leads to less protein being diverted from body tissue and hence maintenance of body weight.
- Hypothesis 3: that the interaction between nutritional supplementation with urea-molasses blocks and strategic anthelmintic treatments for gastrointestinal parasitism will lead to measurable improvements in goat productivity. This will provide particularly novel information.
- Hypothesis 4: that the benefit to production of the combined improved feeding and drug treatment strategy will not be unduly affected by extrinsic management practices in a selected agro-ecological zone.

Experimental programme

Experiment 1 (On-station)

The purpose of this trial is to quantify, under the conditions at Onderstepoort Veterinary Institute (OVI), the effect of urea-molasses supplementation in ameliorating the negative effects of gastrointestinal nematode infection of goats, with or without the inclusion of strategic anthelmintic interventions. This will test hypotheses 1, 2 and 3 and will allow the most cost-effective management programme to be determined. This management programme will be selected for the on-farm trials.

Experiment 2 (On-farm)

This experiment will determine the effect of varying management practices on the production benefits of a combined feed supplementation and strategic anthelmintic treatment. This will investigate hypothesis 4.

Socio-economic analysis

In the first year of the project a socio-economic analysis will be carried out. Full use will be made of data gathered in earlier studies by various authors, as well as rapid rural appraisal methodologies, informal farm interviews and semi-structured questionnaires where appropriate. Data such as current income from livestock, livestock numbers, numbers of small-scale farmers, numbers of women involved in farming and current marketing practices will be collected. The data will be used to estimate the costs to South African resource-poor farmers of the supplementation methods, the cost of anthelmintic treatments and the availability of anthelmintics, and the value of the stock. This information can then be used as a baseline to determine whether or not the various management changes suggested are indeed cost-effective and acceptable. The project has engaged the services of an independent company (Strategy and Tactics, South Africa) to carry out the socio-economic work. This company is experienced in questionnaire design and techniques, including assessing the risks associated with both questioner and responder bias. The additional advantage of their involvement is that the socio-economic information gathered will not be biased by direct involvement of the project team, as they and the socio-economists will interact with the resource-poor farmers independently.

Goat-keeper extension packages

A goat-keeper interest group, that will include farmers participating in the on-farm trials, will be provided with information on 12 topics, including roundworms, coccidiosis, abortions, abscesses, footrot, heartwater, mastitis, orf, pneumonia, pulpy kidney, rectal prolapses and tetanus. Information will also be provided on basic procedures such as drenching and injections. The topics were determined through a participatory process and through observations made at veterinary clinics held by the State Veterinarian of Ixopo, KwaZulu-Natal, in the South Western Region of KwaZulu-Natal (B A Letty, unpublished work). The information is being compiled into an A3-size flipchart-type manual which will be laminated for easy reference while working with goats and made available to participating farmers in Zulu, the local language. The manual will be tested in the field during the second year of the project. Training in the FAMACHA© system will form part of contact sessions with the farmers. The FAMACHA© system is a method used to determine whether a sheep or goat requires treatment for haemonchosis by clinically evaluating an animal for anaemia (Malan *et al.*, 2001; Vatta *et al.*, 2001). This is done by comparing the colour of the conjunctival mucous membrane with a colour chart. The chart depicts five degrees of red, from white (anaemic) to red (non-anaemic or healthy). Animals are scored in one of the five categories and those animals in the anaemic categories are treated with an effective anthelmintic.

Following the outcome of the on-station and on-farm trials, and taking into consideration any other disease or management deficiencies noted on-farm, a modified animal health package will be produced and distributed to participating farmers, Provincial Departments of Agriculture, the Society for the Prevention of Cruelty to Animals, local NGOs, Nufarmer and African Entrepreneur (a local newspaper aimed at the developing farmer), the Community Outreach Programme of the Faculty of Veterinary Science, and through the activities of the Animal Health for Developing Farmers Programme at OVI.

It is anticipated that such an approach will lead to the rapid dissemination of the project findings to the target beneficiaries (goat farmers in resource-poor areas of South Africa). The findings would equally be applicable to other areas of sub-Saharan Africa and the information will be disseminated to appropriate bodies.

Progress to date

On-station trial

Before the project could start it was necessary to locate a source of goats from a heartwater-free area, because the OVI experimental station is free of the blood parasite causing heartwater (*Ehrlichia ruminantium*), but is not free of the vector (which is the bont tick, *Amblyomma hebraeum*). Some modifications had to be made to the buildings and grazing areas at the OVI experimental station, to improve the fencing and night accommodation for the goats before they were moved to the farm. Milkweed (*Asclepias fruticosa*) was growing in the camp and had to be treated with a herbicide.

Interestingly, anthelmintic resistant worms were discovered in some of the purchased goats. Eighty-eight goats were bought for the on-station trial, one was slaughtered (because it was found to be lame with degenerative changes in the left stifle joint and the prognosis for recovery was very poor) and the remaining 87 were intensively dewormed, while being kept in concrete pens at OVI. We were unable to clear the infection from three of these goats. Suspected resistance was found to oxfendazole, levamisole and ivermectin. Samples of the resistant worms have been collected and frozen in liquid nitrogen for possible future studies. The animals in which the infection was cleared were re-infected with a known anthelmintic-susceptible strain of *Haemonchus contortus*. These goats were then moved to the experimental farm.

The factors mentioned above combined to delay the planned start of the on-station trial by three months, from June 2002 to September 2002. Following a four-week pre-experimental period, which began on 27 August 2002, the goats were ranked for live weight on 25 September 2002 and randomly assigned to four groups. They are green (basal diet), blue (basal diet with "dry"-season supplementation), orange (basal diet with "wet"-season supplementation), and red (basal diet with "wet"- and "dry"- season supplementation). The four groups are housed separately at night and are fed their supplements, commercially produced urea-molasses blocks (Voermol Protein Blocks, Voermol Feeds, KwaZulu-Natal), in their night pens.

The nutritional interventions are taking place from the beginning of December 2002 to the end of February 2003 for those groups receiving the "wet"-season treatment and from the beginning of June 2003 to the end of August 2003 for those groups receiving the "dry"-season treatment. Animals are being monitored on a weekly basis for faecal egg count (FEC), haematocrit (packed cell volume), total serum proteins, serum albumin and urea. The goats are weighed and scored for body condition. They are also FAMACHA© scored and treated with ivermectin orally if the animals score 3, 4 or 5 (Vatta *et al*., 2001) on an individual basis. The strategic anthelmintic intervention was administered on 28 January 2003, although the FECs were still low (Figure. 1). This is probably related to low rainfall during the previous months (Figure. 2), the size of the camp (150 ha.), and the presence of large amounts of browse in the camp. It is still too early to make any detailed deductions from the data.

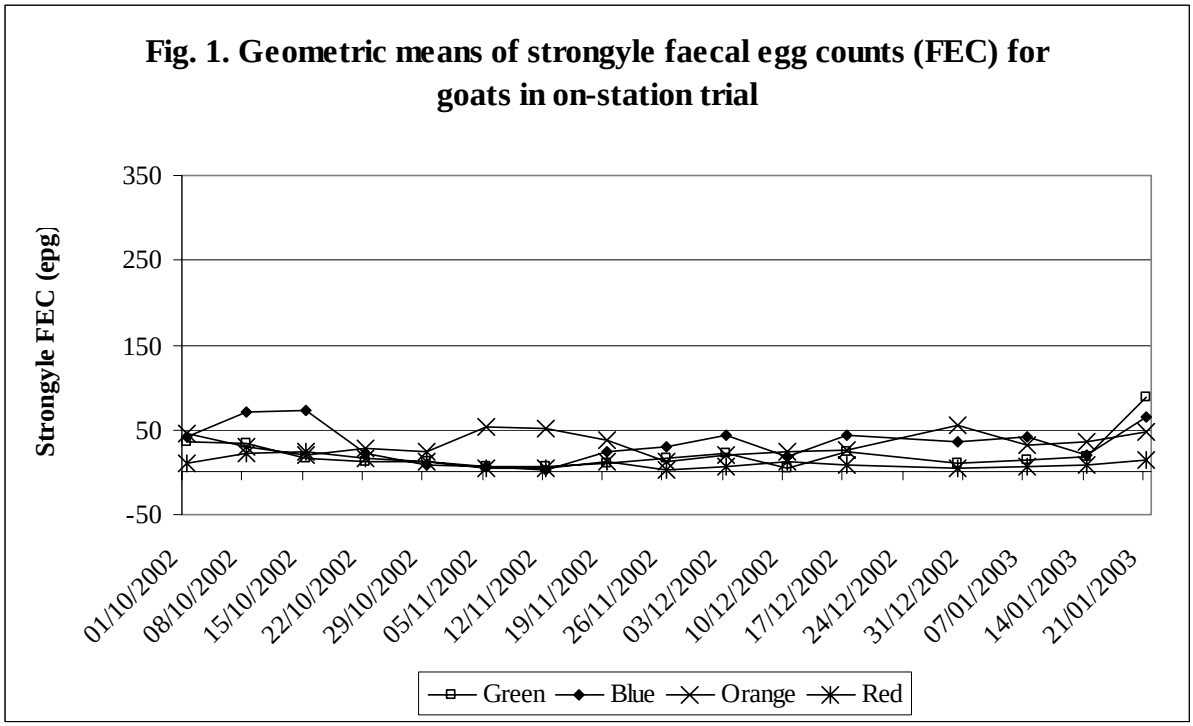
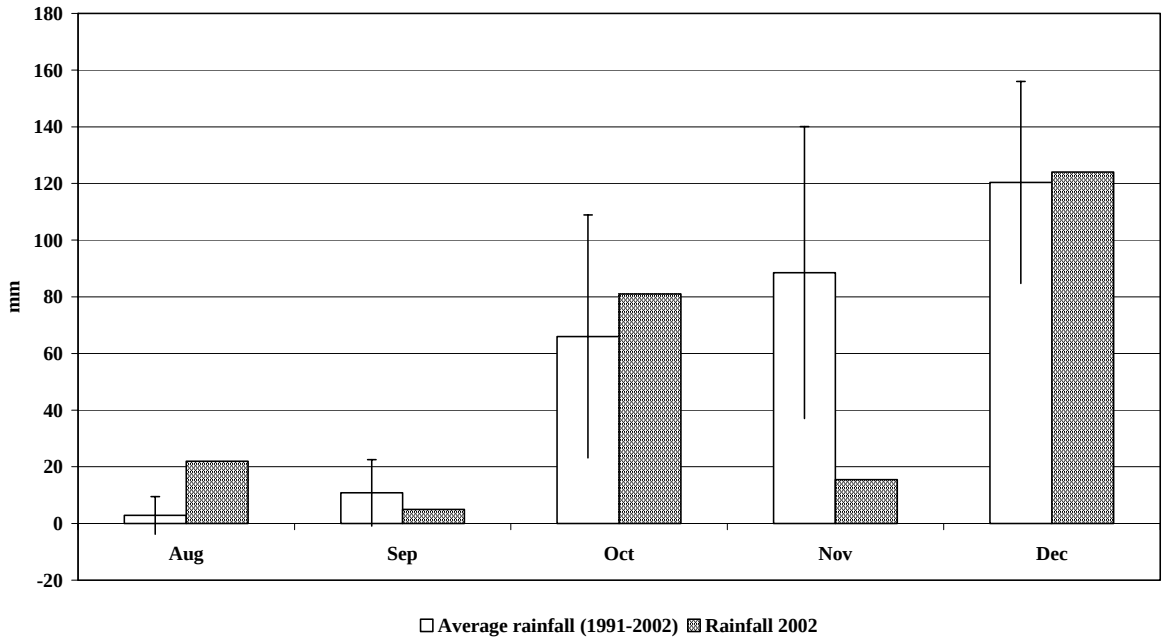


Fig. 2. Rainfall for Onderstepoort Veterinary Institute Experimental Farm ("Kaalplaas")



Field studies

The Sub-Wards of Nkwazela, Hlafuna and Njobokazi in the Maphephetha Ward in the Hlanganani District of KwaZulu-Natal, situated on the road between the towns of Bulwer and Donnybrook, have been identified as a study site for the fieldwork planned for 2003/2004 and a very successful initial meeting has been held. The aim is to continue with the provision of information to the villagers during the first 9 months of 2003 and to obtain the co-operation of a small number of farmers (probably four) to take part in the on-farm trial. Specific farmers will be identified in the second year of the study shortly

before the start of the on-farm trial. The project team is being assisted by the extension services in KwaZulu-Natal Province.

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Roundworms in goats – getting the message across

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Abstract

Effective extension to resource-poor farmers is a two-way process: farmers inform researchers of areas in which they require information and assistance, and extension workers provide information to farmers that is currently available, while researchers provide a pool of new knowledge that farmers via extension workers can draw upon at a later stage. Extension messages need to be clear, simple and easily understood. This is demonstrated in the article by means of the example of the control of roundworms in goats. A three-prong approach to the management of roundworms is proposed. This consists of the use of worm remedies, improvements in nutrition and the use of the FAMACHA© system, a method of selectively treating anaemic animals with a worm remedy.

Background

A number of projects that have been funded at Onderstepoort over the past several years have had an extension component. These included:

- Food and Agriculture Organization (FAO) Technical Co-operation Project (TCP/SAF/8821)
- Survey of Internal Parasites of North-West Province, South Africa
- Animal Health for Developing Farmers' Programme at Onderstepoort Veterinary Institute.

Our aim has been to provide information on diseases that affect the animals of resource-poor farmers in South Africa. This is to fulfil a large demand for information that has come from resource-poor farmers (Getchell *et al.*, 2002; Krecek, 1999; Letsoalo *et al.*, 2000; Masika *et al.*, 1997a; Masika *et al.*, 1997b; Minnaar and Krecek, 2001; Wells and Krecek, 2001). We wish to emphasize, however, that our main function is research, not extension, but that we have become involved in extension because resource-poor farmers have requested information to help them improve their knowledge, farming skills and productivity.

Objectives

This paper has two objectives:

1) To convey a simple message on roundworms in goats that can be offered to resource-poor farmers, if appropriate.

2) To explain briefly about our methods of extending the message to the farmers.

Effective extension

In effective extension, there is a two-way flow of information:

- From the livestock owner on what he or she knows about management and treatment of diseases

- From the researcher, veterinarian, and extension officer by providing information on topics of relevance to the farmer

Some questions that need to be asked are:

1. What information and assistance do resource-poor farmers require?

2. What information and assistance can the researchers currently provide?

3. What research still needs to be done?

This should lead to:

1. The provision of available information.

2. New research.

The example of roundworms in goats

Resource-poor farmers complain that their goats "don't multiply" and that worms (locally known as "izikelemu" or "dibokwana") are a major cause of death. It would appear that the milk tapeworm is more commonly implicated, although roundworms are also mentioned. Symptoms, such as bottle jaw, occur that are indicative of worm infection.

Our approach includes the use of a slide set, large pictures of parasites, simple display units of preserved parasites, posters, a video, a CD, a booklet, and a "goatkeepers' extension package" on animal diseases (the latter is still in development.)

The focus of this discussion is on a poster which we have developed (Figure 1). The current poster has been considerably simplified from a previous draft and it will be translated into a local language, Zulu, and tested with the farmers for a period of a year before a final copy is made and printed.

The aim of the poster is to answer the questions:

1. What is the problem?

2. What causes the problem?

3. What signs do you see?

4. What is the treatment and prevention?

To answer the question of what the problem is: roundworms are parasites of grazing animals such as cattle, goats and sheep. Roundworms are more dangerous than tapeworms, even though tapeworms appear to be more commonly seen by farmers.

To explain the cause of the problem: goats get roundworms when they ingest the immature worms on the grass. These immature worms grow into adult worms in the animal. The worms feed on the proteins and, or, blood of their host. Young animals are most badly affected.

The signs of roundworm infection may be any one or more of the following:

- Bottle jaw
- Paleness of the mucous membranes (anaemia)
- Diarrhoea
- Animals in poor body condition
- Worms seen in dead animals with signs of paleness of the carcase, fluid-filled intestines or bleeding.

To treat and prevent roundworm infection, we propose a three-fold approach that includes the use of worm remedies, improved nutrition and the use of the FAMACHA© system, where appropriate.

Worm remedies

Worm remedies are still the cornerstone of worm control, but there are problems with worm remedy resistance. The search for alternatives to worm remedies is an active area of research.

Improved nutrition

Animals in good condition, that are well-fed, are less affected by worms than animals that are fed poorly. Our message here is, "Give your animals supplementary feed, which should include a protein supplement, during times of food scarcity". This advice is because a protein supplement has been shown to improve the animals' ability to withstand the effects of, and build up immunity against, worm infection (Coop and Kyriazakis, 1999).

The FAMACHA© system

A novel technique for the assessment and subsequent treatment of *Haemonchus* spp. (wireworm, barber's pole worm) has been developed in South Africa in response to the emergence of severe worm remedy (anthelmintic) resistance (Malan *et al.*, 2001). The technique is referred to as the FAMACHA© system (named after its originator, Dr Francois "FAffa" MAlan CHArt). It is a method of selective treatment which may lead to a large reduction in the use of anthelmintics. It is currently being tested in other countries of Africa, North and South America, and Asia.

The system is based on the fact that *Haemonchus*, a parasite of the abomasum (milk stomach) of sheep, goats and cattle is a voracious bloodsucker, which causes anaemia in severely affected animals. This may be seen by examining the mucous membranes of the eyes. Capitalizing on this fact, a colour chart depicting five shades of red corresponding to degrees of well-being, from healthy ("red") to severely anaemic ("white") was developed for use in sheep. The chart is compared with the colour of the mucous membranes of the eye, allowing the sheep to be classified into one of the five colour categories. A decision is then made on treatment. The method was subsequently tested in goats (Vatta *et al.*, 2001; 2002).

Goats (and sheep) are examined in sunlight and the colour of the mucous membrane of the lower eyelid is noted. The eye should be opened for a short time only. The colour of the mucous membrane is then compared with the chart and the goat is scored from 1 to 5. Goats are treated with an effective anthelmintic if they fall into categories 3 to 5. If in doubt, the goat is scored at a paler category. Treated goats are marked or their treatments recorded.

There are a number of precautions that should be borne in mind when the FAMACHA© system is used. Firstly, only properly trained persons should use the FAMACHA© method. The card is an aid in the control of *Haemonchus* spp. only. Standard worm control measures need to be maintained, for example animals must be on a good plane of nutrition. The system should only be used by farmers where back-up assistance is available from a veterinarian or scientist.

Use of the FAMACHA© system leads to a reduction in the use of worm remedies for treatment when compared with conventional drenching practices. This will have economic gains for the farmer. The method should also slow down the development of anthelmintic resistance. This is important because new worm remedies are not yet on the market. The FAMACHA© system may be used to identify animals that repeatedly require treatment, to enable them to be culled from the flock. This leads to better livestock management.

Conclusion

We have proposed a three-prong approach to roundworm control in goats, namely the use of worm remedies, the supplementation of animals with protein and the selective treatment of animals using the FAMACHA© system. This three-prong approach is based on current scientific knowledge, which we have attempted to simplify to be understood and adopted by the resource-poor farmer. When new methods of worm control become available, through further research or from practices used by farmers which prove to reduce helminth levels, these will be added to the recommendations to farmers.

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ROUNDWORMS

WHAT ARE ROUNDWORMS?

- Roundworms are parasites of grazing animals such as cattle, goats and sheep.

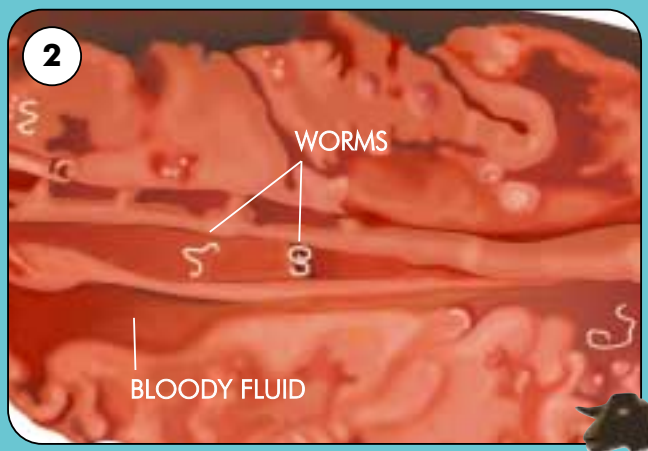
WHAT CAUSES ANIMALS TO GET ROUNDWORMS?

- Goats, sheep and cattle get roundworms when they ingest the immature worms, on the grass. These immature worms grow into adult worms in the animal. Young animals are most badly affected.

WHAT SIGNS DO YOU SEE?

PHOTO COURTESY OF THOMAS TERRILL

- You may see bottle jaw which is a soft, cold swelling under the chin of the animal.
- The inside of the eyelids could be pale.
- Diarrhoea may occur. Diarrhoea may also have other causes (such as coccidian parasites or toxic plants).
- During winter or the dry season, particularly, animals may be in poor condition.

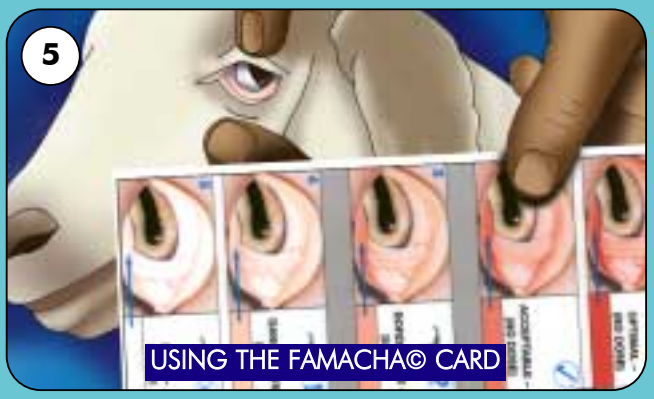


- If you open the carcass of an animal, there may be bleeding or worms on the stomach or intestinal lining.

TREATMENT AND PREVENTION

- If you see these signs treat with a worm remedy.

- Keep your animals in good condition. Give them hay and a lick - they will be less likely to become ill from worms.



The FAMACHA© system can be used to determine which animals require treatment - instead of treating the whole flock.

MILK TAPEWORM

- Another type of worm, the milk tapeworm, commonly occurs in sheep and goats and appears as white segments on the droppings of the animal. The milk tapeworm should not be mistaken for the more dangerous roundworms.

For further information contact your animal health technician, veterinarian or other appropriate persons

South Africa: Questions and answers

Why use urea/molasses blocks?

Urea/molasses blocks are used because they have been used before, are cheap and are easily available because of the sugar industry.

Is there a guaranteed response to feeding the blocks?

If soluble energy is missing from the diet, as would be the likely situation with crop residue-based feeds, molasses will help guarantee a response to urea, thus improving the energy and microbial protein derived from the diet.

Is tethering of goats common?

Tethering is established in South Africa, it is a system of grazing that requires comparatively little labour and protects growing crops from damage

You mentioned a training manual. Is it available?

The manual is still being developed. It will be produced in the local language. It has not been tested on farmers yet, but has been based on comments they have made regarding identification of problems. The commercial sector has shown some interest in the manual.

The potential of controlling gastrointestinal parasitic infections in tropical small ruminants using plants high in tannins or extracts from them

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Abstract

A series of previous studies with quebracho tannin (QT) had shown that the tannin was effective at reducing the worm burden of temperate sheep infected with *Haemonchus* and *Trichostrongylus*. The potential of using tanniniferous browse plants available in the tropics as a means to reduce or control nematode infections of small ruminants was, therefore, investigated. Leaves of different browse trees and shrubs were assayed for condensed tannin (CT) concentration using a colorimetric method. Five species with the highest levels were sampled monthly and analysed in order to map their seasonal variation in CT. The level of CT in the leaves ranged between 58 – 283g kg^{-1} DM. Purified quebracho tannin was used as the standard. Seasonal changes in CT levels were affected by the stage of leaf maturity with peak levels occurring after the end of main rain season in June. Anthelmintic activity of crude extracts from leaves of two of the plants shown to have a high tannin content (*Acacia polyacantha* and *Tamarindus indica*) and that of commercial tannin preparation from wattle tree (WT) was then tested *in vitro* against freshly isolated goat nematodes. Time of death of the parasites was recorded. Survival of the nematodes was significantly *(P*<0.001) reduced by both leaf extracts and by the WT.

Acacia sp. leaves were then feed to goats to investigate their effect on faecal egg output and worm burdens of animals with a mixed nematode infection. Twenty-four bucks were infected with a single dose of nematode larvae and faecal egg counts (FEC) were monitored regularly. On day 38 post-infection (p.i.), half of the goats were offered a supplement of dried acacia leaves at 130g per animal for 20 days while the remaining half (control) received a grass supplement with comparable nutritional value but without condensed tannins. All goats were humanely slaughtered at the end of the trial for worm burden estimation. Mean FEC of the acacia-fed group was 27 per cent lower with a slight reduction (13 per cent) in the population of the large intestine worm, *Oesophagostomum columbianum*, compared to the control group. In a second trial, 36 bucks were infected as before and then randomized on the basis of their FEC into three equal groups 30 days after infection. For three consecutive days one group received 1.2g WT/kg body weight, one 2.4g WT/kg and the third group received a placebo drench. All goats were humanely slaughtered on day 42 p.i. Neither FEC nor worm burdens were significantly reduced by the drench administration. This is in contrast to studies with quebracho tannin and temperate sheep conducted earlier.

Studies are also required using sheep reared in the tropics to determine whether the apparent species differences are real rather than due to adaptation of the animals to tannins prior to the experimental study.

It is not possible yet to come to a definitive conclusion on the value of tannins in controlling parasitic infections in tropical small ruminants.

Introduction

Gastrointestinal (GI) parasites are responsible for significant production losses in livestock worldwide (Gill and LeJambre, 1996) particularly under tropical and subtropical climates (Waller, 1997). Marginal levels of nutrition and a climate that favours survival of the parasites in most of the year explains why GI infections are more devastating in these regions (Waller, 1997). Control of GI nematode infections has traditionally been done using anthelmintics (chemotherapy) with best results being obtained when this approach is integrated with proper grazing management and resistant animals. However, in the last 2 - 3 decades there has been over-dependency and even misuse of the chemotherapeutic approach with consequent evolution of anthelmintic resistance (Ngomuo *et al.*, 1990; Prichard, 1994). This is especially true among major nematode species of small ruminants. Apart from anthelmintic resistance, poor availability and affordability of anthelmintics to resource-poor farmers in developing countries have compounded the problem (Hammond *et al.*, 1997). Moreover, there is a growing concern over drug residues in the food chain and the environment. Search for novel anthelmintics that are both more sustainable and environmental friendly is undoubtedly a sensible approach to the control of parasitic infections. One such alternative could be harnessing of the available ethnoveterinary knowledge (Hammond *et al.*, 1997), i.e., the use of medicinal plants with anthelmintic activity. Plant anthelmintics have been known and used in many parts of the world for a long time but little research has been done to validate their use, especially in veterinary medicine. Forages rich in condensed tannins (CT) have been found to improve general performance of parasitised sheep through reduced worm burdens (Niezen *et al.*, 1993; 1998). Furthermore, our recent studies have shown that dietary inclusion of CT in quebracho extract dramatically reduced egg output and worm burdens of sheep infected with *T. colubriformis* (Butter *et al.*, 2000). This has been confirmed by other workers (eg. Athanasiadou *et al.*, 2000). As reported to the Morogoro workshop (Max *et al.,* 2002), an oral drench of QT is effective at reducing both faecal egg counts and worm burdens in sheep infected with *H. contortus*. Some effect was also noted on *T. colubriformis* infection. *In vitro* studies had also shown that the wattle tannin extract available in Tanzania also had antihelmintic properties.

The main objective of the current phase of project (R7424) was to determine whether locally available tanniniferous browse materials or readily available extracts from them could be used to control or reduce the impact of nematode infections in small ruminants under the conditions found in the tropics.

Materials and Methods

Location

The studies were conducted in Morogoro region, which experiences an equatorial type of climate with a bimodal rainfall pattern; a main wet season, usually from March – May and minor wet season from November to January. Browse trees and shrubs constitute the largest proportion of small ruminant feed especially during the long dry season because they are drought tolerant and readily available.

Tannin sources

Wattle (mimosa) extract (WT), a commercial preparation of tannin from the barks of the tropical tree, *Acacia mearnsii* was supplied by The Wattle Tannin Company, Tanzania. Wattle tannin is used in the leather industry. Drench solutions were prepared by dissolving 1 part of WT in 2 parts of lukewarm water (w/v). Solutions of varying concentrations were

used in *in vitro* studies to determine the potency of WT against cultured parasites. Freshly prepared crude aqueous extracts from dried leaves of tropical browse trees, *Acacia polyacantha* and *Tamarindus indica*, were also used as another source of CT for the *in vitro* assays.

Test parasites

Three important caprine nematodes, *Haemonchus contortus*, *Trichostrongylus vitrinus* and *Oesophagostomum columbianum* were isolated and maintained as a mixed infection through passage in goats held at the Sokoine University of Agriculture. Faeces from the passage goats were cultured to obtain infective stage larvae (L3). The L3 were suspended in distilled water and kept at 4 – 8 °C in plastic tubes until used (maximum of 2 weeks).

Animals, housing and feed

Small East African (SEA) entire bucks aged between 12 and 14 months were purchased from small-scale goat keepers in Morogoro, Tanzania and housed in individual, raised-floor, wooden pens. The goats were offered a daily allowance of urea- and molasses-treated rice straw and supplemented with 150g maize bran-based concentrate. Once in the experimental house, the animals received a single oral dose of broad-spectrum anthelmintic to clear any gastrointestinal nematode infestations and sprayed with acaricide to rid them of ectoparasites. Due to the endemic nature of coccidiosis in the area of experimentation, a coccidiostat was given regularly as prophylaxis. Body weights were monitored weekly to the end of the trial.

Determination of the concentration and seasonal variation of condensed tannin content of selected browse plants

Browse plants including trees and shrubs from Morogoro were used in the study. Pilot sampling was conducted in January, April and June 2000 to represent the end of the dry season and the onset of the rain season and cool season respectively. These samples were analyzed to shortlist the selected browse plants to five species with the highest tannin content. Briefly, about 1 kg of twigs, 10 - 15 cm from the branch tip were harvested from different branches of a mature tree or a shrub. The leaves and leaflets were separated from the twigs and dried in an oven at 55 °C to a constant weight. The dried leaves were ground to pass through a 1-mm screen and then stored in clean airtight glass jars at room temperature pending laboratory analysis. Concentration of CT in the plant samples was assessed using the acid-butanol method (HCl-butanol-iron) as described by Terrill *et al.*, (1992). Since quebracho tannin was used as a standard, the final concentrations are expressed as quebracho tannin equivalents. It should be noted that due to the complexity of tannin molecules accurate determination of CT is difficult and the acid-butanol method was chosen because its relative simplicity makes it possible to rapidly handle a large number of samples.

***In vitro* anthelmintic activity of browse plant extracts and WT on goat nematodes**

(a) Worm recovery

A goat parasitised with both abomasal and large intestinal nematodes (*H. contortus* and *Oe. columbianum* respectively) was humanely slaughtered each time the survival assay was undertaken. On slaughter, the entire gastrointestinal tract was removed and ligatures were applied to separate the abomasum and the large intestine. Contents of each compartment were processed separately to recover the live worms. The recovered worms were placed on a Petri dish containing lukewarm phosphate buffered saline (PBS). The entire procedure

was carried out quickly to ensure that worms were not excessively exhausted prior to incubation.

(b) Preparation of culture media and survival assay

Dried leaves of *A. polyacantha* and *T. indica* were ground to pass through 1-mm mesh. Five grammes of the leaf powder were placed in a 50-ml plastic tube; PBS was added to give a 10 per cent w/v extract solution and left to soak for 90 minutes with regular shaking. The mixture was passed through a coffee strainer to make clear culture media for each plant species. Equal amounts of acacia and tamarind leaf powders were thoroughly mixed and then soaked as before to make a 10 per cent solution of mixed culture medium. Preparation of culture media containing wattle extract was carried out using lukewarm PBS to give 0, 2, 4, 8 and 12 per cent w/v concentrations. To about 20 ml of the culture medium in a Petri dish, known number of male and female worms (approximately 10 - 15 each) were placed, covered and incubated at 38 - 39°C for a period of 10 hours. Survival rates were recorded over different time intervals. Motility and viability of the parasites was assessed by gently prodding the worms using a pointed probe or forceps. The response was recorded as either live or dead. Worms were considered dead when a minimum reaction to touch was observed.

Determination of the effect of tanniniferous browse on FEC and worm burdens of goats with mixed nematode infection

(a) Collection and preparation of supplemental leaves

A. polyacantha leaves were collected in June 2002, approximately a month after the end of main wet season. Leafy twigs, 10 to 15 cm from the tip were removed from main branches and sun-dried within 24 hours. The dry twigs were stamped using sticks and then passed through wire gauze to separate the leaflets from stalks and petioles. The dry leaflets were kept in a cool dry place until needed. To balance for the nutritive value discrepancy between browse-fed and the control group *Panicum trichocladum* (donkey grass) leaves were used. *Panicum* sp. was selected because it contains no condensed tannins and has a crude protein value comparable to that of *A. polyacantha*, it is palatable and was readily available during the trial. The dry *Panicum* sp. leaves were ground to pass through 2-mm screen and kept as before. Samples from the two species were taken for estimation of CT and crude protein content.

(b) Experimental design

After two weeks of acclimatization to the experimental environment, 24 bucks live-weight 15.8 ± 2.4 kg were infected using a single oral dose of the mixed nematode infective stage larvae at a rate of 2000 larvae per 20 kg body weight. Faecal egg outputs were monitored regularly and on day 38 post infection the goats were randomly allocated into two equal groups (n = 12). Animals in one group, the browse-supplemented, received their daily concentrate allowance of 150g/animal/day in which 100g of dry *A. polyacantha* leaves were added. Animals in the control group were supplemented with 100 g/animal/day of dry ground grass leaves (*P. trichocladum*). The browse and control supplements were increased to 130g per day on day 44 post-infection as the goats became more used to eating the leaves. Any refusals were collected and weighed early in the morning before the daily allowance was offered. On day 59, all animals were humanely sacrificed and the abomasa, small and large intestines removed for worm burden assessment as described by Dawson *et al.* (1999).

Investigating the effect of WT drench on FEC and worm burden of goats with experimental mixed nematode infection

The effect of WT drench on FEC and worm burdens of tropical goats was investigates in a very similar experimental design. Thirty-six goats weighing 13.5 ± 2.2 kg were infected as before. Faecal egg counts were monitored regularly from day 16 post-infection to the end of the trial. On day 29 post-infection, the goats were blocked according to faecal egg numbers and randomized into three groups (n = 12). Two groups (LWT and HWT) received low and high doses of WT (1.2 and 2.4 g kg^{-1} body weight), respectively, whereas the third group (control) received a placebo drench (tap water). The goats were drenched for three consecutive days from day 30 to day 32 and allowed to rest for 9 days before they were slaughtered for worm burden estimation on day 42.

Statistical analysis

The effect of tannin concentration on the survival time of the worms was analysed by survival analysis for censored data using a statistical package, Genstat 6, Lawes Agricultural Trust, UK. A linear model was used to predict estimated mean survival times with their upper and lower confidence limits. Faecal egg output data were subjected to ANOVA as repeated measurements with treatment structures and individual animals as blocks. The impact of treatment on faecal egg output was measured using faecal egg counts taken a day after the first dose of treatment to the day of slaughter inclusive. Worm burden data were subjected to one-way ANOVA with individual animals as block structures. Differences were assumed significant at $P<0.05$.

Results and Discussion

Concentration and seasonal variation of foliar CT in selected browse plants

Figure 1 shows concentration and seasonal variation of CT in five browse species, which were selected for their high levels. *Acacia polyacantha* had the highest overall mean CT concentration (282.5g/kg^{-1} DM) whereas the lowest value (58.2 g/kg^{-1} DM) was measured in neem tree (*Azadirachta indica*) samples. The average levels of extractable CT reported here were very comparable to those usually found in tropical herbaceous legumes (Sotohy *et al*., 1997; Getachew *et al*., 2000). Variation in CT levels in the plants followed a regular pattern with the lowest concentrations being recorded in samples collected in November to February; the values increased gradually to a peak in the month of July before declining gradually toward November. Stage of leaf maturity was pointed out as an important factor determining the seasonal changes in CT concentration. The two leguminous tree species, *Acacia polyacantha* and *Tamarindus indica* (Tamarind) are widespread, not only in Morogoro region but country-wide and throughout tropical Africa with several varieties (Mbuya *et al*., 1994). The trees are well adapted to a range of soil types and they are leafy especially towards the end of the main wet season. The remaining three species relatively less abundant but yet widely distributed in the country especially in rural communities where they are used for medicinal (*Azadirachta indica*) and horticultural (*Psidium guajava* (guava) and *Persea americana* (avocado)) purposes (Mbuya *et al*., 1994).

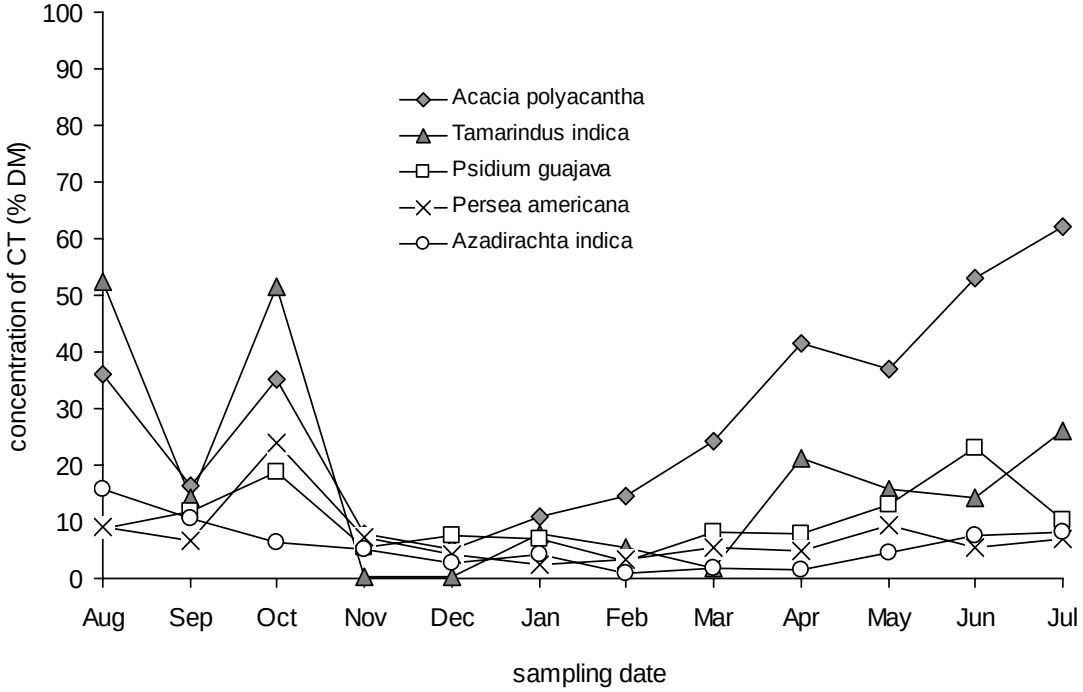

Figure 1 Seasonal change in foliar concentration of condensed tannins in selected browse trees. The values represent a mean of quadruplicate analysis of a pooled sample for the particular month.

It is accepted that the assay used may not have given an absolute value for the tannin content of the various leaves but rather an indication of the seasonal variation.

In vitro activity of crude leaf extracts and WT against goat nematodes

Reports about the use of parasitic stages of target nematodes to study anthelmintic activity of plant extracts *in vitro* are rare due to difficulties in obtaining and maintaining the parasites outside their hosts (Witty, 1999). The current findings indicate that *H. contortus* and *Oe. columbianum* adults can be recovered live and maintained in a simple culture medium for up to 16 hours. The survival of the parasites in culture media containing the crude leaf extracts and WT was significantly ($P<0.001$) reduced (Figures 2 and 3). The results suggest a direct anthelmintic activity of WT and crude extracts from acacia and tamarind. Similar results have been reported using QT against rat nematodes (Butter *et al.*, 2001) and purified tannins from four forages against ovine nematodes (Molan *et al.*, 2000). The possible increase in survival time when the parasites were incubated in culture media containing WT concentrations above 2 per cent might have been due to the astringency of extract which deterred the worms from ingesting the surrounding medium. Although the mechanisms involved in the toxicity of CT to nematodes are not known, recent studies studying the effect of ellagitannin preparations against the tree-living nematode, *Caenorhabditis elegans*, have shown fatal disruption of internal organs including the gonads, uterine wall and the intestines (Mori *et al.*, 2000).

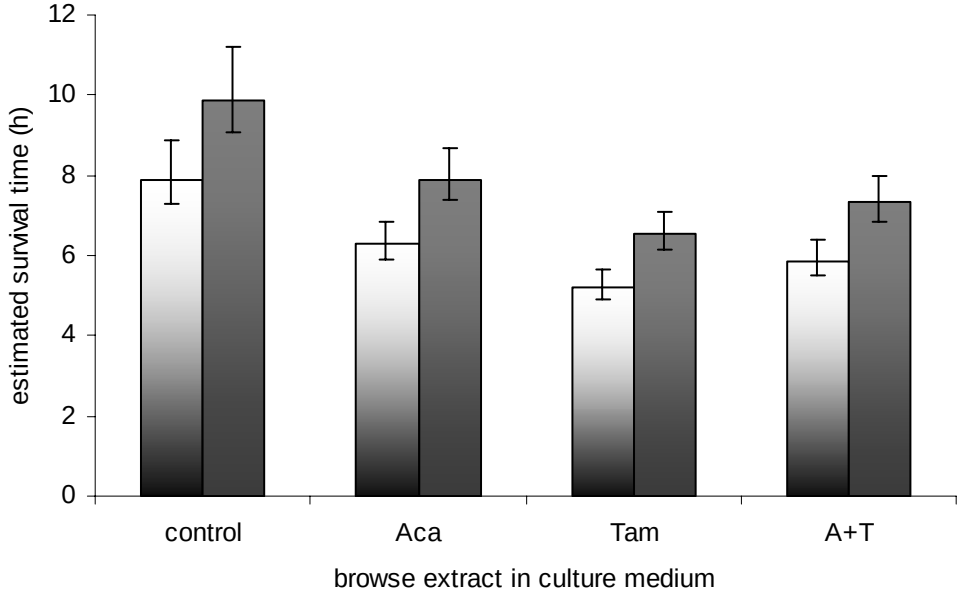

Figure 2 Survival of *H. contortus* in culture media containing 10 per cent (w/v) aqueous crude extracts from various browse plant leaves. (□) Males; (■) females; (Aca) acacia; (Tam) tamarind; (A+T) mixture of acacia and tamarind. Values are mean of triplicate assays.

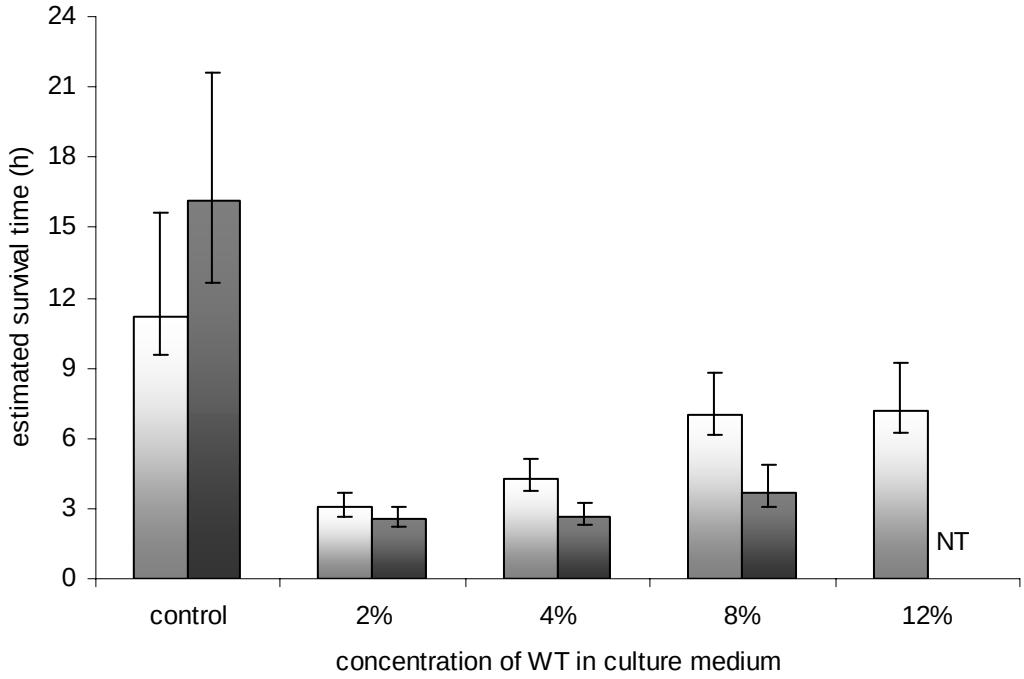

Figure 3 Survival of *H. contortus* (□) and *Oe. columbianum* (■) adults in culture media containing varying concentrations of wattle extract; (NT = not tested). The values are mean of quadruplicate assays; the error bars indicate 95 per cent upper and lower confidence limits.

Effect of a tanniniferous browse supplement on mixed nematode infection in tropical goats

With time, the goats accepted the browse supplement; a few refusals (involving concentrate-browse mixture) were observed in the browse-supplemented group during the

first week of treatment introduction. Egg counts were first observed in faeces of most goats on day 21 after infection. Although supplementation of goats with dried *A. polyacantha* leaves for 20 days did not significantly ($P>0.05$) reduce FEC, the supplemented group had an average of 27 per cent fewer eggs than the control group from day 46 to the day of slaughter (Figure 4). Comparison of egg counts between the two groups on the day of slaughter alone showed a reduction of 33 per cent in the browse supplemented group. Similarly, no significant reductions in total worm burdens of the treated group but a slight reduction (13 per cent) in worm burden of the large intestine dweller, *Oesophagostomum* sp. (means: control vs. supplemented, 273 and 238 worms respectively; pooled SED: 32) was observed (Figure 5). Significant drops in both FEC and worm burdens following consumption of tannin-rich browse have been observed in a similar study (Kabasa *et al.*, 2000) but unlike the current trial, the goats were allowed free access to various browse plants for up to 6 months. In the current study, the control group tended to void wetter faeces than the browse-fed group (treatment x time interaction, $P=0.041$).

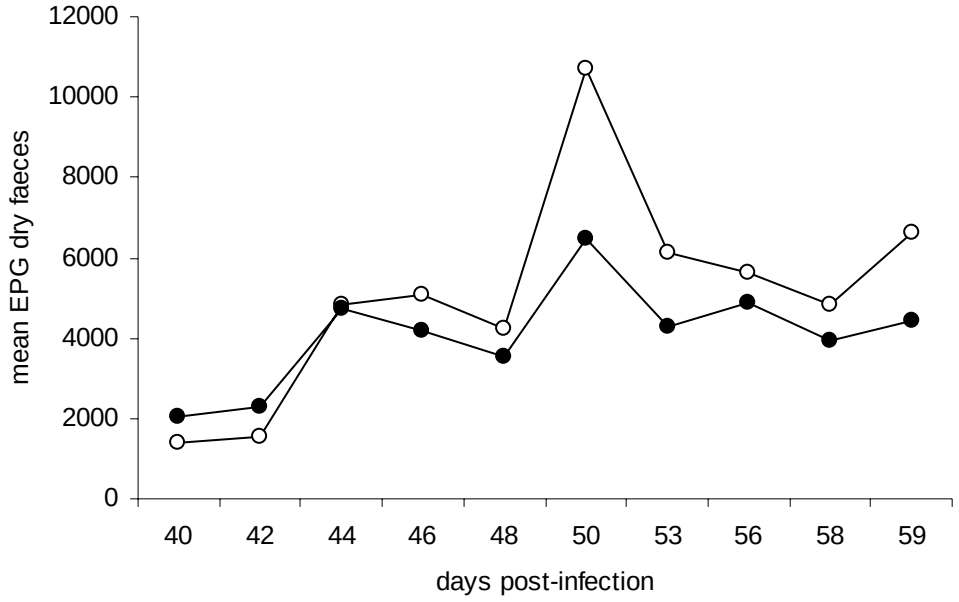

Figure 4: Effect of *Acacia polyacantha* leaf supplement on faecal egg outputs (eggs per gram (EPG) dry faeces) of goats with mixed nematode infection. Each goat in the supplemented group (●) received acacia leaves at 130g/day from day 44 to the end of trial. The control group (○) was offered a similar amount of grass supplement. (SED = 1355, df = 22).

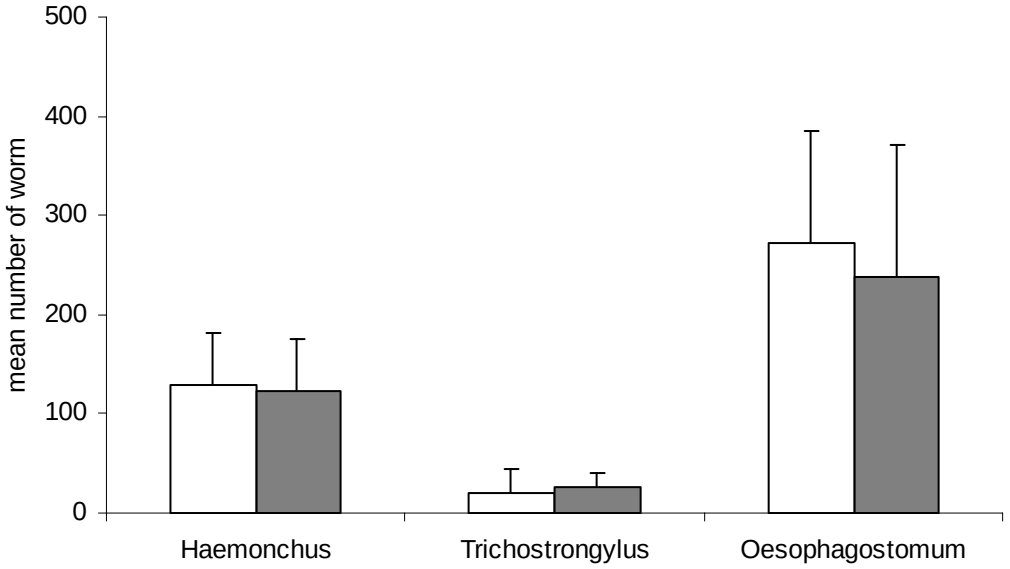

Figure 5 Effect of *Acacia polyacantha* leaf supplement on total worm burdens of goats with mixed nematode infection. Supplemented (■), non-supplemented control (□).

Effect of WT drench on FEC and worm burdens in tropical goats

Following its encouraging *in vitro* activity against goat nematodes and the results of studies with QT drenches of sheep, WT was administered as a drench to investigate its impact on faecal egg output and worm burdens of tropical goats with mixed nematode infection. Surprisingly, neither FEC nor worm burdens were reduced ($P>0.05$) after three consecutive days of drenching with WT. Unlike drenching temperate sheep with QT, WT induced only slight physiological changes to the goat's GI tract probably due to their adaptation to high tannin feeds. It was, therefore, possible that the *in vivo* anthelmintic activity of commercial preparations is a result of physiological changes in the gut (mucus hyper-secretion and increased faecal water content). These changes could promote dislodgment and expulsion of worms. The present study appears to be the first to report the effects of a commercially available WT extract on parasitised tropical goats. However, the heterogeneous nature of tannins as a group implies that results of one study using a particular type or source of tannin could not be used to generalise their potential as future anthelmintics. The fact that drenching nematode-infected goats with wattle extract, which contains a large proportion of CT, produced poorer results than supplementing them with tanniniferous browse is interesting. McNabb *et al.*, (1998) has stated that the chemical structure of CT may be more important than their concentration. It should, however, be noted that the WT was very effective *in vitro*. In addition it should be accepted that the potency of the extracts (from browse leaves and those produced primarily for the leather industry) may not be directly due to their tannin content *per se* but due to other bioactive components in these preparations.

Conclusion

The work undertaken so far has demonstrated significant *in vitro* anthelmintic activity of commercial tannin preparations (quebracho and wattle extracts) and crude extracts of tanniniferous plants (*A. polyacantha* and *T. indica*) against mice and goat intestinal nematodes. Furthermore, administration of QT as drench to the temperate sheep with

mono-specific and mixed nematode infections was found to drastically reduce FEC and worm burdens of *H. contortus* but had less effect on *T. colubriformis*. However, administration of WT drench to tropical goats with a mixed infection did not significantly reduce FEC or worm burdens of any of the nematodes including *H. contortus*. It is suggested that, since the drench was also associated with gut physiological changes in the temperate sheep, but not as marked in the tropical goats, then the *in vivo* anthelmintic activity of the commercial tannin extracts was a result at least in part of gut changes. The reduction in both FEC and worm burden of *Oe. columbianum* following acacia supplementation in goats was an indication that an interaction between specific type of CT, other attributes of the plant and the complex host gut environment might be involved.

While several but not all of our studies have indicated the use of dietary tannins to reduce intestinal parasites in small ruminants, at present it is not yet possible to develop a protocol to exploit these observations in the field. Parasitic nematodes remain as a major problem in small ruminants kept by resource poor farmers in the tropics.

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Dissemination strategy for control of gastro-intestinal parasitic infections in small ruminants using plants rich in tannins

Audience	Objectives	Message	Channel
Farmers	Help farmers to be more aware of the loss of productivity and income that can result from even moderate parasitic infections. Suggest sustainable ways of reducing worm burdens in their goats and sheep. Suggest simple methods of determining when level of infection indicates the use of commercial anthelmintics e.g. the examination of eye colour.	Locally available plants that are rich in condensed tannins can be fed to small ruminants to control worms in a cheap way. There is still a need for the use of drugs in cases of severe infection	Leaflets, posters, radios, TV, farm visits and demonstrations
Extension workers	As for farmers plus more technical information such as the limitations of the approach, the need for alternative control methods, the importance of protecting the effective plant species from overexploitation, etc	The limitations of the method e.g., the fact that response to tannins can vary widely as a result of changing levels and types of tannins in plants. There is still a need for the use of drugs in cases of severe infection.	As above together with training
NGOs	As for the farmers and extension workers with emphasis on the impact of improved animal productivity on livelihoods. The need to integrate other practices such as improved feeding, proper use of existing drugs to reduce infections i.e., a holistic approach	That the nematode infections poses a real problem which requires concerted efforts from animal scientists, extension workers, policy makers and funding agencies.	Bulletin, technical notes, meetings etc.

It is essential that further 'on-farm trials' are conducted to determine if feeding of browse plants with high tannin content are beneficial in reducing intestinal parasitic burden under practical conditions. These trials should be conducted practicing the principles of participatory research.

Tanzania: Questions and answers

Would the different feeds available in temperate and tropical environments have affected the results?

It is possible that the nature of feed in the tropics affected the results. Many tropical browse plants, which make a significant component of small ruminant feed, contain substantial amounts of condensed tannins. Thus tropical subjects can be referred to as 'tannin-adapted' whereas their temperate counterparts are 'tannin-naive'. This was clearly evident in our findings because administration of tannin preparation as drench to temperate sheep was associated with significant gut physiological changes that were less marked in the tropical goats following similar treatment. These changes were believed to have helped to facilitate expulsion of the parasites from the gastrointestinal tract. Absence of these changes in the tannin-adapted tropical goats reduced the effects of tannins. It has to be remembered that tannins also appear to have direct effects upon the parasites.

Are there differences in response between sheep and goats?

It should be noted that when the tannin extracts were tested *in vitro* they were equally toxic to nematodes of both tropical and temperate origin. It is however known that there are differences in the response of sheep and goats to antihelmintics. One of our future plans is to try to find out whether the same principle will apply to a natural product such as tannins or not. For example to compare the effects of a tannin drench on nematode infected tropical sheep compared to tropical goats.

Why was the lower concentration of tannin more effective than the higher levels?

The presentation showed that worm survival in culture media containing the lower concentration of 2 per cent (quebracho or wattle tannin) were more effective than the stronger concentrations of 4, 8 and 12 per cent. Tannins are usually described as having unpalatable (or astringent) taste, it is therefore possible that when incubated in a medium containing 2 per cent tannin the worms were more likely to eat/ingest the medium, rather than the stronger tasting concentrations of 4, 8 and 12 per cent. A similar behaviour has been observed when nematodes were incubated in increasing concentrations of anthelmintics, levamisole and pyrantel. This increase in the rate of survival when the concentration of drug is increased has been noted by others and is often referred to as 'recovery phenomenon'. Perhaps we should look more carefully at the effects of lower doses *in vivo*.

Why, when you reduce the egg count, can the animal have more worms?

For the faecal egg count test, it is generally assumed that faecal egg counts (FEC) correlates well with worm burdens and it is therefore accepted that FEC is an indicator of worm population in the gut. However, this does not hold true always because of a phenomenon called hypobiosis (or 'arrested development'). Hypobiosis is a survival strategy whereby nematodes in the host's gut sense unfavourable external environment and burrow into gut mucosa (stopping further development) until the conditions are favourable. In this case there will be more worms in the host's gut than the FEC will indicate. It is also important to know the type of parasite in question since some worm species (e.g. *Haemonchus*) are known to be prolific egg layers while others (e.g., *Trichostrongylus*) are less so.

Alleviating seasonal nutrient fluctuations in semi-arid areas of Zimbabwe: potential for tree fruits as protein supplements for goats

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Abstract

This paper presents the studies undertaken to evaluate the potential of locally available tree fruits as supplements for goats in the dry season in semi-arid areas of Zimbabwe. Initially the evaluation process was carried out in laboratories. This process entailed chemical characterization with emphasis on protein and phenolic content, these being the two main constituents that affect the value of fruits as protein supplements. Chemical composition and *in vitro* fermentation of fruits and separated fruit fractions from *Acacia nilotica*, *A. erubescens*, *A. erioloba*, *Piliostigma thoningii* and *Dichrostachys cinerea* tree species were determined. The presence of phenolics reduced fermentation *in vitro* and interfered with the determination of *in vitro* organic matter degradability, due to their solubility in the fermentation medium. The nutritional effects of tannins were investigated using an *in vitro* tannin bioassay where fruit substrates were incubated with and without tannin-binding polyethylene glycol (PEG). Treatment with PEG increased the fermentation of tree fruits suggesting that tannins limit their fermentation.

Wood ash solution, a locally available alkali, inactivated tannins in *D. cinerea* and *A. nilotica* fruits, resulting in improved fermentation *in vitro*. The effect of alkali and PEG treatments on nitrogen balance of goats was evaluated using *D. cinerea* fruits as protein supplements. Goats were offered a basal diet of standing grass hay. Fruit supplements were compared to a commercial protein supplement (CPS). Treatment with PEG caused excessive protein degradation in the rumen resulting in nitrogen loss through the urine. Goats offered untreated fruits had the same nitrogen retention as those offered CPS. *Dichrostachys cinerea* fruits used in this study did not require tannin inactivation treatment. A feeding trial in which does were offered fruit supplements showed that supplemented does had higher conception rates, weaning weights and fewer kid mortalities.

Introduction

Zimbabwe's smallholder agricultural sector, based in the communal lands, holds about 97 per cent of the estimated 4.7 million goats (CSO, 1997) in the country. Most of these animals are in the dry and less productive agro-ecological zones (Kusina and Kusina, 1999). With the exception of drought tolerant sorghum and pearl millet, crop production in these semi-arid areas is risky due to the low and unpredictable annual rainfall of less than 600mm. The result of recurrent droughts and poor rainfall is that high quality animal feed is always in short supply resulting in the drought tolerant goat and donkey playing a prominent role in the livelihood of the smallholder farmers in semi-arid areas. Despite the potentially high rate of reproduction, the productivity of the goat in Zimbabwe is low (Kusina and Kusina, 1999). This is attributed to dry season malnutrition, high rates of kid mortality and incidence of disease, as well as poor marketing structures (Kindness *et al.*,

1999). Kids that are born during the rainy season (from December to April), when feed quantity and quality is high, show good health and survivability. This suggests a link between nutritional status of the doe and reduced kid mortality, which in turn affects goat productivity. The number of does kidding in October and November is low (Kindness *et al.*, 1999) suggesting poor conception rates due to feed shortages in June and July (dry season).

The *Acacia* thornveld is the main feed resource for goats in the semi-arid areas of Zimbabwe. Goats browse on green leaves for most of the rainy season while in the dry season fallen fruits from the same trees are consumed. In most cases goats and other animals, are given free access to the fruits, hence the fruit supply does not last through the dry season, and under-utilization often occurs, especially in the early dry season when the goats have a wider choice of feed. Fruits from these trees could be used as a protein source for animals feeding on low quality roughage later in the long dry season. Many *acacias* produce potentially nutritious fruits with up to 20 per cent crude protein. While supplementation with fruits has the potential to improve goat productivity little is known about the nutritive value of the fruits. Anti-nutritional factors are known to be a significant component of most browse tree species (Aganga and Mosase, 2001). Caution should be exercised especially on the quantities that are fed to an animal, the frequency of feeding and the form in which the fruits are fed. Feeding large quantities of fruits frequently may result in animals developing haemorrhagic lesions in the gastro-intestinal tract, resulting in the death of the animal (Terblance *et al.*, 1967).

The objectives of the study were to improve the productivity of smallholder owned goats through dry season feeding interventions based on locally available tree fruits. Several studies were undertaken to assess the potential of tree fruits to reduce the fluctuations in nutrient supply experienced during the dry season in semi-arid areas of Zimbabwe.

Material and methods

Chemical characterization

Mature and ripe fruit samples were harvested by hand in June 1999 from *Acacia. nilotica, A. erubescens, A. erioloba, Piliostigma thoningii, Dichrostachys cinerea* and *A. sieberiana* trees growing in the thornveld in Mbembeswana communal areas, about 100 km south west of Matopos Research Station, Bulawayo, Zimbabwe. Annual rainfall in this area averages 400mm. The fruits were bulked by species and stored in brown paper bags until required for use.

Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined by refluxing 1 g samples in neutral and acid detergent solutions, respectively, according to the method of Goering and Van Soest (1970). Acid detergent insoluble nitrogen (ADIN) was determined by nitrogen analysis on ADF, dried at 40°C for 48 hours, using the Dumas total combustion method with a Carlo Erba Elemental Analyser 2100.

Samples used for the analyses of N and phenolics were further ground to pass through a 1mm sieve. Total N was determined on 50mg sample using the Dumas method as for ADIN.

Phenolics were estimated after extraction of 40mg sample three times with 10ml 70 per cent aqueous acetone for a total of 15 minutes. Soluble condensed tannins (SCT) were estimated using the butanol-HCl reagent (95:5 v/v) (Porter *et al.*, 1986). Aqueous acetone extract (0.5ml) was pipetted into a glass screw cap test-tube and 5ml butanol-HCl reagent

added. The test-tube was closed and then placed on a heating block at 100°C for 1 hour. Absorbance was measured after the test tubes had cooled to room temperature. The measurements were reported as absorbance units (au) at 550 nm. Determination of trivalent ytterbium precipitable phenolics was done on a 70 per cent aqueous acetone extract, which was obtained as described above for SCT and insoluble condensed tannins (ICT). Ytterbium precipitable phenolics were gravimetrically determined using the procedure described by Reed *et al*., (1985) Results were expressed in g kg^{-1} DM.

Effect of tannins on *in vitro* fermentation

Microbial fermentation was assessed using the Reading Pressure Technique (RPT) (Mauricio *et al*., 1999). About 1g of sample, ground to pass through a 2mm sieve, was weighed into 125ml serum bottles. Using an automatic dispenser (Jencons, Hemel Hemstead, England), 90ml reduced buffer was added to each serum bottle. The buffer was divided in two and polyethylene glycol (PEG) dissolved in one set to give an application rate of 1g PEG per 1g DM of substrate, based on work done by Makkar *et al*. (1995) and Salawu *et al*. (1997). Serum bottles without samples (blanks) were also included for each of the six withdrawal periods (6, 12, 18, 24, 48 and 96 h post-incubation) to allow correction for gas produced from rumen liquor. After addition of the buffer, the flasks were sealed and stored at room temperature (20°C) before being transferred into the incubators, set at 39°C, 8 h before inoculation with rumen fluid.

Rumen fluid was obtained from a cow fed *ad libitum* on a diet comprised of grass and maize silage and concentrate (wheat, barley and soya bean meal). Rumen fluid was collected at 07.00 h, prior to feeding. Inoculation was complete within 60 minutes of fluid being prepared. Rate of gas production, *in vitro* dry matter degradability (iDMD), *in vitro* organic matter degradability (iOMD) and partition factors were determined.

Detannification: *in sacco* evaluation

Alkaline treatment was carried out by soaking fruits overnight in distilled water, in which NaOH pellets had been dissolved to give a 6 per cent (w/w with the fruit sample) NaOH treatment level. Sufficient water was added to wet the entire sample, producing a thick paste ensuring that no leaching of the sample occurred. Polyethylene glycol-4 600 (Aldrich Chemical Co. Inc, USA) was dissolved in distilled water and the solution mixed with *D. cinerea* fruits. A PEG application rate of 200mg g^{-1} of sample was used. The mixture was left to react overnight. The treated samples were then spread onto polythene sheets and sun-dried for 24 h.

Three adult male Matebele goats fitted with ruminal cannulae and weighing about 25kg live weight were used in this study. These animals had been used in a previous experiment, where diets containing mixtures of fruits were compared. The goats were housed individually in crates under a roofed shed with a concrete floor. They were fed on 200g mixed fruits per animal per day and grass hay *ad libitum*. Water was available at all times. The animals had been on this diet for 85 days. Dry matter loss from the rumen and nitrogen degradability were determined using nylon bags (Lockertex, Cheshire, England), measuring 6cm * 12cm with a pore size of 40 μm. About 5 g of each sample were weighed in duplicate, for every treatment and each incubation time, into nylon bags, which were incubated in the rumen of the fistulated goats (internal diameter of the rumen cannulae was 40mm). The incubation was carried out in a 3*3 Latin square design trial. Each period was of 3 days duration and a 24h changeover period was allowed, to ensure that there was no residual effect of the previous treatment on the following treatment. All bags were inserted into the rumen at the same time (07.00 h) on the first day, before the morning

feeding, and were incubated for 4, 6, 12, 24, 36, 48 and 72 h. The bags were withdrawn at different times (sequential withdrawal). Upon removal from the rumen the bags were cleaned with tap water and immersed in ice water to stop microbial fermentation activity (Shannak *et al.*, 2000). The bags were frozen until all the incubated bags were withdrawn at the end of the period. Together with the 0h bags, incubated bags were washed with cold water three times in cycles of ten minutes, in a twin-tub semi-automatic washing machine (Rotary tub, Goldfish, South Africa). Washed nylon bags were then dried in a forced-draught oven at 60°C for 48 hours and cooled in a desiccator, followed by weighing.

Loss in dry matter (DM) for each incubation period was calculated as follows:

$$\text{DM Disappearance} = \frac{\{\,(OSBW - BW) * DM1\,\} - \{\,(RSBW - BW) * DM2\,\}}{(OSBW - BW) * DM1}$$

where:

OSBW	=	Original sample weight + nylon bag (g)
BW	=	Nylon bag weight (g)
RSBW	=	Residual sample weight + nylon bag (g)
DM1	=	Dry matter of feed sample
DM2	=	Dry matter of residue sample

Loss in N was calculated on the basis of N incubated as follows:

$$\text{N Disappearance} = \frac{(\%N1 * OSW * DM1) - (\%N2 * RSW * DM2)}{\%N1 * OSW * DM1}$$

where:	%N1	=	Percent nitrogen in original feed sample
	OSW	=	Original sample weight (g)
	DM1	=	Dry matter of feed sample
	%N2	=	Percent nitrogen in residue sample
	RSW	=	Residual sample weight (g)
	DM2	=	Dry matter of residue sample

Degradation data were fitted to the Ørskov and McDonald (1979) non-linear model using NEWAY Excel Version 5.0 package (Chen, 1997). The Ørskov and McDonald model reads:

$$p = a + b(1 - e^{-ct})$$

where	p	=	disappearance of DM and N
	a	=	washing loss or soluble fraction
	b	=	degradable part of the insoluble fraction

c = degradation rate of fraction b

This gave estimates for the soluble and insoluble fractions as well as the rate of degradation. Effective degradability (ED) of N was calculated, after assuming a 5 per cent h^{-1} solid outflow rate, according to the following equation:

$$ED = a + \frac{b * c}{k + c}$$

where ***a***, ***b*** and *c* are the constants from the Ørskov and McDonald (1979) equation above and ***k*** is the outflow rate of the solid phase in the rumen.

The effect of treatments on chemical composition (DM, OM, NDF, ADF, N and NDIN) was obtained by subjecting the data to a one-way analysis of variance. The effect of treatments on the *in sacco* degradability was analysed using the general linear models procedures of SAS (SAS/STAT, 1996) for a Latin square.

Detannification: *in vivo* evaluation

Thirty castrated Matebele goats, aged 18 – 22 months and weighing on average 27.4kg, (s.d. = 2.5) were assigned to five diets, using a randomized complete block design after the animals had been blocked according to initial live-weight. Each of the five diets was randomly allocated to the five animals in the six weight-blocks. The goats were then penned individually in metabolism crates measuring 120cm long, 54cm wide, and 90cm high and raised 90cm above the floor. The crates were fitted with feeders and drinking bowls. All the goats were dewormed at the beginning of the adaptation period, by oral administration of 8ml of Systemex liquid, active ingredient, oxfendazole 2.265 per cent m/v (Cooper Zimbabwe, Pvt Ltd), using a 10ml syringe.

The five experimental diets consisted of mixed grass hay in combination with the following supplements:

Diet A - 200 g $day^{-1}$of alkali treated *D. cinerea* fruits

Diet B - 200 g $day^{-1}$of polyethylene glycol treated *D. cinerea* fruits

Diet C - 200 g day^{-1}untreated *D. cinerea* fruits

Diet D - 200 g day^{-1} CPS (National Foods Pvt Ltd, Bulawayo, Zimbabwe) (positive control)

Diet E – 800 g grass hay fed alone (negative control)

All animals received a daily ration of 600 g of mixed grass hay' except for those on Diet E. Fruits were treated with NaOH and PEG in bulk and sun-dried to ensure less variable supplements were offered to goats throughout the trial. The treatment involved soaking fruits overnight at the rate of 0.6kg in a litre of distilled water in which 36g of NaOH pellets had been dissolved to give a 6 per cent NaOH treatment level. Polyethylene glycol treatment was carried out by dissolving 120g polyethylene glycol-4 600 (Aldrich Chemical Co. Inc, USA) in a litre of distilled water and mixing the solution with 0.6kg of *D. cinerea* fruits to give a PEG application rate of 200mg g^{-1} feed. The mixture was left to react overnight and sun-dried to improve intake.

Feed supplements were offered at 0800 h everyday and the animals were allowed 2h to consume them. After 2h, supplement refusals were weighed and removed from the feeding troughs. All the animals were then offered half of the grass hay ration, 300g for animals receiving supplements and 400g for the animals on the negative control. The other half was offered at 1600 h. Refusals were weighed and collected before fresh feed was offered. Clean, fresh, drinking water was offered at 0800, 1400 and 1600 h everyday. Grass hay refusals were weighed in the morning before the feeding of supplements.

Goats were allowed to adapt to the different diets and metabolism crates for 21 days. During this period feed intake was closely monitored to ensure that the goats were eating approximately the same amount everyday.

The collection period lasted seven days. During this period a complete collection of faeces and urine from each experimental animal was made. Sub-samples of faeces were taken for dry matter determination everyday. The DM was determined by drying the faecal samples in an oven at 100°C for 12 h. About 10 per cent of the total faecal collection from each animal was bulked over the entire collection period and stored in a freezer at –4°C to await chemical analyses.

Urine was collected in plastic containers over 25ml of 10 per cent (v/v) sulphuric acid. The volume of the urine was then measured using a measuring cylinder and a 10 per cent aliquot was removed everyday, bulked over the collection period and stored at –4°C pending nitrogen analysis. Refusals from supplements and the basal diet were weighed separately each morning and dried at 60°C for 48 h to determine dry matter refused. Sub-samples of the feed offered were also taken and similarly dried to determine the amount of dry matter offered per day. The difference between dry matter offered and dry matter refused was used as the measure of dry matter intake. Feed, faeces and refusals were both analysed for OM, N, NDF, ADF, neutral detergent insoluble nitrogen (NDIN) and ADIN to estimate the intake and digestibility of these constituents.

The proportion of average daily feed intake not excreted in faeces was used as a measure of apparent dry matter digestibility:

1. DM apparently digested = DM intake (g day^{-1}) – Faecal DM (g day^{-1})

2. Apparent DM digestibility = DM apparently digested / DM $intake^{-1}$ (g g^{-1}DM)

3. Digestibilities of organic matter, NDF, ADF, N, NDIN and ADIN were calculated as in 1 and 2 on a DM basis.

Nitrogen retention was calculated as the difference between total nitrogen intake and the losses through faeces and urine:

N retention (g day^{-1}) = Total N intake – (Faecal N + N in urine)

Intake and digestibility data for OM, N, NDF and NDIN as well as retention of N were statistically analysed using the general linear models procedures of SAS (SAS/STAT, 1996).

Results and Discussion

Table 1 shows the chemical composition of tree fruits from different tree species. Terblance *et al.*, (1967) reported incidences of poisoning leading to deaths when goats consumed excess *A. nilotica* fruits in South Africa. Symptoms observed include abortions, dyspnoea, tachycardia, methyglobinaemia, ruminal atony and hyperglycaemia. Although the toxic principle was not identified at the time, the report indicates that caution should be exercised when feeding *A. nilotica* fruits to goats on a daily basis. Soluble condensed tannin content is much lower in *A. nilotica* fruit while *D. cinerea* and *P. thoningii* fruits have higher levels.

Table 1 Nitrogen (N), acid detergent insoluble nitrogen (ADIN), neutral detergent fibre (NDF), ytterbium precipitable phenolics (YbPh) (g/kg DM) and soluble condensed tannins (SCT) (au) content of tree fruits

Species	N	ADIN	NDF	YbPh[1]	SCT[2]
Dichrostachys cinerea	19.9	5.7	441	485	3.4
Acacia erioloba	21.3	3.9	415	206	0.7
A. erubescens	27.1	6.7	543	175	0.5
A. nilotica	14.7	7.8	236	758	1.2
Piliostigma thoningii	13.5	4.2	493	299	4.1

[1]YbPh – ytterbium precipitable phenolics

[2]SCT – soluble condensed tannins

As shown in Table 2, PEG inclusion increased cumulative gas production in all tree fruits except *A. erubescens*. The highest response was obtained with *D. cinerea* fruits indicating that the tannins in the fruits from this species may reduce the availability of nitrogen to the rumen microbes. Although a 100 per cent increase in cumulative gas production was obtained with *A. nilotica* fruits, it is important to note that the majority of phenolics in this species are not condensed tannins (Table 1). The effect of PEG inclusion on OM degradability was underestimated due to the presence of PEG-tannin complexes in the residue (undegradable material) after filtration. In addition, the procedure of determining *in vitro* degradability means that phenolics that are solubilised in the fermentation medium are erroneously quantified as degradable material since these are lost during filtration.

Table 2 Responses to Polyethylene glycol (PEG) inclusion (+/-) of cumulative gas production (ml/g OM) and organic matter (OM) degradability (g/g OM) at 48 h post-inoculation

	Cumulative gas production		Organic matter degradability	
Species	**-**	**+**	**-**	**+**
Dichrostachys cinerea	48	156	0.37	0.48
Acacia erioloba	130	164	0.54	0.60
A. erubescens	102	115	0.49	0.50
A.. nilotica	78.8	150	0.62	0.76
Piliostigma thoningii	143	193	0.56	0.50

Having established that tannins may reduce the utilisation of some tree fruits (Table 2), an experiment was carried out to evaluate the effect of detannifying *D. cinerea* fruits on nitrogen availability both *in sacco* and *in vivo*. Table 3 shows DM and N disappearance in the rumen of goats. Treatment with PEG caused excessive N loss in the rumen while alkali treated and untreated fruits caused moderate losses of N in the rumen. It is, therefore, likely that PEG treatment of *D.cinerea* fruits will cause a reduction in N retention in animals compared to alkali treatment.

Table 3 *In sacco* disappearance of dry matter and nitrogen from treated and untreated *Dichrostachys cinerea* fruits incubated in the rumen of Matebele goats

	***Dichrostachys cinerea* fruits**			
Parameter‡	**Untreated**	**NaOH treated**	**PEG treated**	**s.e. mean**
a	26.4[a1]	29.3[b]	42.8[c]	0.71
b	48.3[a]	36.4 [b]	32.8[b]	2.22
c (% h^{-1})	3.26[a]	3.92[a]	5.78[b]	0.549
PD[2] (a + b)	74.7	65.7	75.6	-
ED[3]	44.5[a]	43.5[a]	59.7[b]	1.19
a	47.5[a]	52.8[b]	61.8[c]	1.72
b	43.1[a]	29.0[b]	27.9[b]	1.74
c (% h^{-1})	3.59[a]	6.76[b]	11.63[c]	1.463
PD (a + b)	90.6	81.8	89.7	-
ED	64.7[a]	68.8[b]	81.0[c]	0.49

[1]In a row, means with the different superscripts differ significantly ($P < 0.05$)

‡Units: For Dry matter a, b, PD and ED are measured as per cent of DM, for Nitrogen a, b, PD and ED are measured as per cent of N incubated.

[2]PD = Potential degradability

[3]ED = Effective degradability estimated as: $ED = a + \frac{b * c}{k + c}$, k (outflow rate of solids) assumed to be 5 per cent h^{-1}

Table 4 shows the results when detannification treatments were compared in a metabolism trial. Goats offered untreated fruits had significantly ($P < 0.0001$) higher N retention values when compared to those offered treated fruits. There were significant ($P < 0.05$) differences among treated fruits, with alkali treated fruits causing higher N retention values than PEG treated fruits (2.70 vs. 0.96 g N day^{-1} respectively). All supplements increased the goats' intake of grass hay by at least 50 per cent over the unsupplemented animals. This confirms that provision of N to rumen microbes improves the utilization of fibrous poor quality feedstuffs. An increase in grass hay intake was observed when calves were supplemented with *Acacia tortilis* fruits (Coppock, 1993). Tanner *et al.*, (1990) reported similar findings when sheep fed on maize stover were supplemented with *A. tortilis* fruits.

Table 4 Metabolism trial: *in vivo* evaluation of detannification treatment of *D. cinerea* fruits

	Treatments				
	Untreated	**NaOH[2]**	**PEG[3]**	**Goat Meal**	**Unsupplemented**
OM intake (g)	610^{bc1}	598^{b}	640^{c}	622^{bc}	297^{a}
Urine N (g)	0.67^{a}	0.46^{a}	1.68^{b}	0.48^{a}	2.09^{c}
OM dig	0.54^{b}	0.50^{a}	0.56^{b}	0.58^{b}	0.58^{b}
NDF dig	0.46^{b}	0.51^{b}	0.55^{c}	0.51^{b}	0.59^{d}
N balance (g)	3.7^{c}	2.7^{b}	0.96^{a}	4.1^{c}	-3.4^{d}

[1]In a row, means with the different superscripts differ significantly ($P < 0.05$)

[2]NaOH = sodium hydroxide treated *D. cinerea* fruits

[3]PEG = polyethylene glycol treated *D. cinerea* fruits

The unsupplemented animals in this experiment represent the plane of nutrition for smallholder owned goats during the dry season. Negative N balance and low feed intake suggest that the animals gradually lose weight during the dry season and thus are prone to malnutrition and disease. By offering *D. cinerea* fruits as a protein supplement, farmers may be able to maintain their goats through the dry season. In absolute terms, the production improvements, as a result of the N retention, observed in this study are modest but it is important to emphasise that maintenance of animals through the dry season is the most appropriate production objective in the communal farming system. It appears that tannins in *D. cinerea* fruits used in this experiment are beneficial to the animal and hence did not require inactivation. This raises questions about the suitability of *in vitro* tannin bioassays as predictors of *in vivo* tannin effect. There is need to include, as part of *in vitro* tannin bioassays, measures of the effect of tannins on protein degradability. This might be investigated by fermenting tanniniferous forages with and without PEG in a nitrogen deficient medium. This ensures that the nitrogen deficient rumen environment when goats

are consuming low quality fibrous diets in the dry season is adequately simulated. The improvement in fermentation with PEG treatment can then be attributed to the increased availability of nitrogen in the fermentation medium.

Conclusions

This study revealed that tree fruits harvested from Mbembeswana communal lands contain enough protein to improve the utilization of poor quality feeds during the long dry seasons experienced in this area. However, the presence of phenolics reduced protein degradability *in sacco*. Up to 70 and 50 per cent of the dry matter of *A. nilotica* and *D. cinerea* fruits, respectively, were made up of phenolics, which negatively affected *in vitro* fermentation of the fruits. Evaluation of feedstuffs rich in phenolics has concentrated on the colorimetric and gravimetric assays, which unfortunately say little about the potential biological activity of the phenolics.

Alkaline treatments had limited efficiency (up to 30 per cent) on fruit tannins compared to PEG. This could be because tannins in ripe and mature fruits exist in bound form and their reactive sites are not accessible to the alkali. Polyethylene glycol was more efficient because its mechanism of action is mediated through its high affinity for tannins allowing it to bind tannins, which are already bound to other constituents.

Results from the nitrogen balance trial showed that alkaline treatment, unlike PEG, did not cause excessive protein degradation in the rumen.

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Supplementation of on-farm goats using feed resources available in south-west Zimbabwe

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Introduction

Goats in the communal areas of Zimbabwe are primarily dependent on natural range for their forage requirement. During the dry season, when the quantity and nutritional quality of grazing in natural pastures is low, browse species form a major portion of food for goats,. In these areas goat productivity is severely affected by high kid mortality and low growth rates. Most of the goats in the drier regions kid in the dry season. In the smallholder sector farmers can lose more than 50 per cent of goat kids born in a year.

In the present study communal goat flocks were evaluated in terms of animal performance when supplemented with browse pods.

Area

The study was conducted in eight sites located in Matobo, Matabeleland South Province, at 21° S and 28°3′ E longitude, in the south-west of Zimbabwe. The district is in natural region IV, on a scale of 1 (high potential) to V (arid).

The vegetation is mainly *Colophospermum mopane* and *Acacia* species and other thorny bush species; and some perennial grasses provide ground cover. Rainfall is between 450mm-650mm and the altitude is above 900m. Drought cycles are common in this area. Soils are shallow, coarse clay and sand over reddish brown sandy clay from granite.

Animals

A total of 254 female goats were monitored during the dry season, August to October 2001. Only pregnant and lactating goats were monitored.

Farmers

A total of 66 farmers, resident at the eight sites, hosted the on-farm trials. Farmers fed the goats their own choice of pod supplement, mainly determined by availability. A few farmers did not supplement their goat and their flocks were regarded as control groups.

Measurements

Monthly weights were collected for both adults and their progeny.

Results

The results are presented in Figure 1 as an example of an extension message for farmers.

Does being monitored had twins. Kid mortalities were very low. Kid birth weights appeared high, probably because weighing was dependant on Matopos Research Station, who visited each site on a monthly visit. There was a weight difference between supplemented and unsupplemented does. In two of the areas does lost weight.

Farmers who fed their animals with pods (whole or ground with a pestle and mortar) expressed satisfaction in the condition of their animals. Further work is needed to quantify milk yield in both supplemented and unsupplemented does. Most households value the contribution of milk produced in excess of the requirements of the kids. Dry season supplementation has the potential to increase this.

Figure 1 Extension message

Dry season supplementation is necessary

Supplementation of goats in the dry season supports high growth rates

Browse trees produce fruits and leaves which are rich in protein

Fruits can be collected and stored for later use

Benefits

Increased kid survival

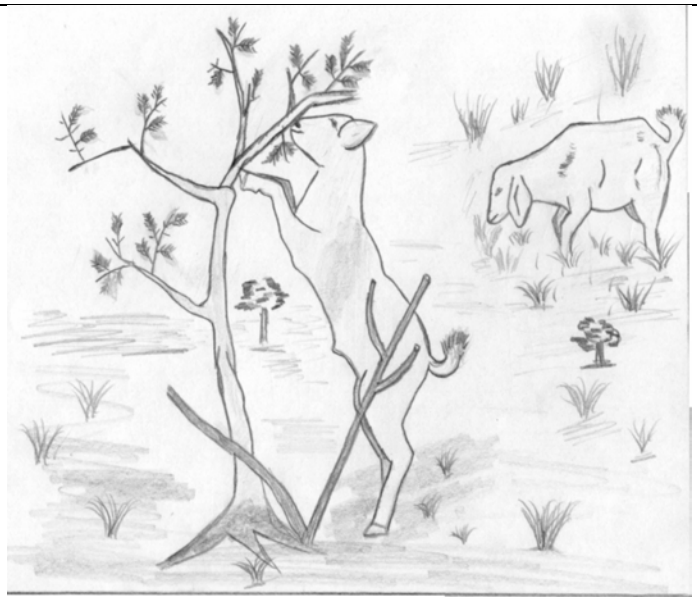
Increased milk production

Increased meat production

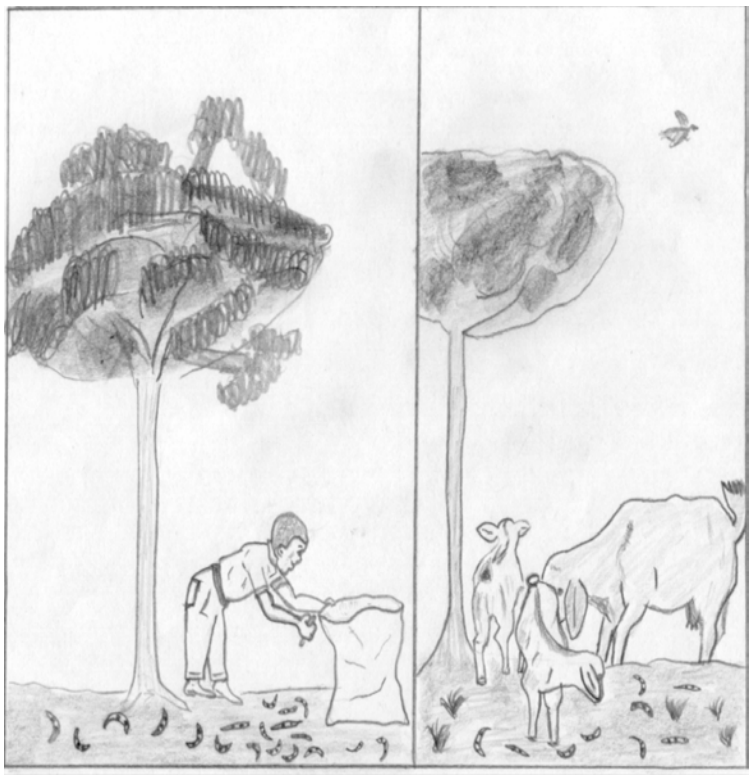
Cheap feed resource for farmers in the rural areas

Easy to process

More value to natural resources

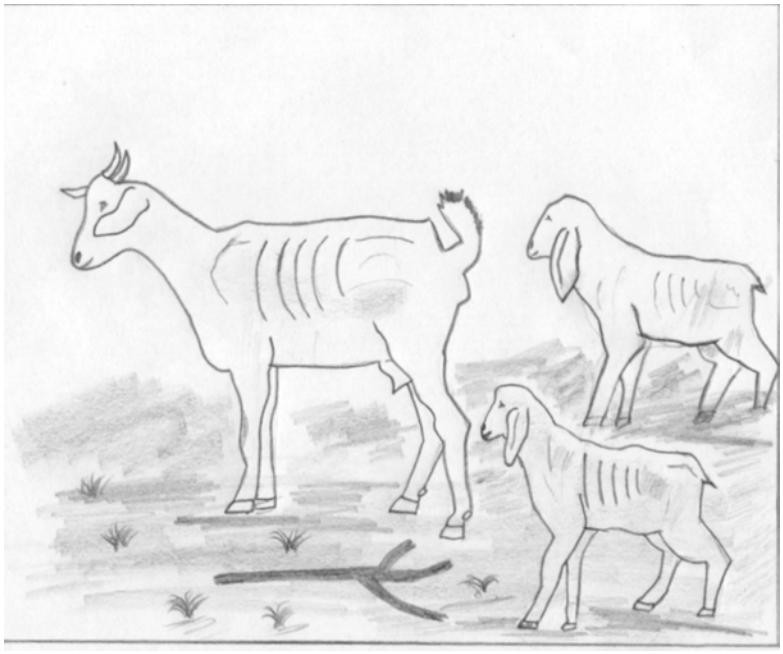


During the wet season goats feed on browse leaves and grass

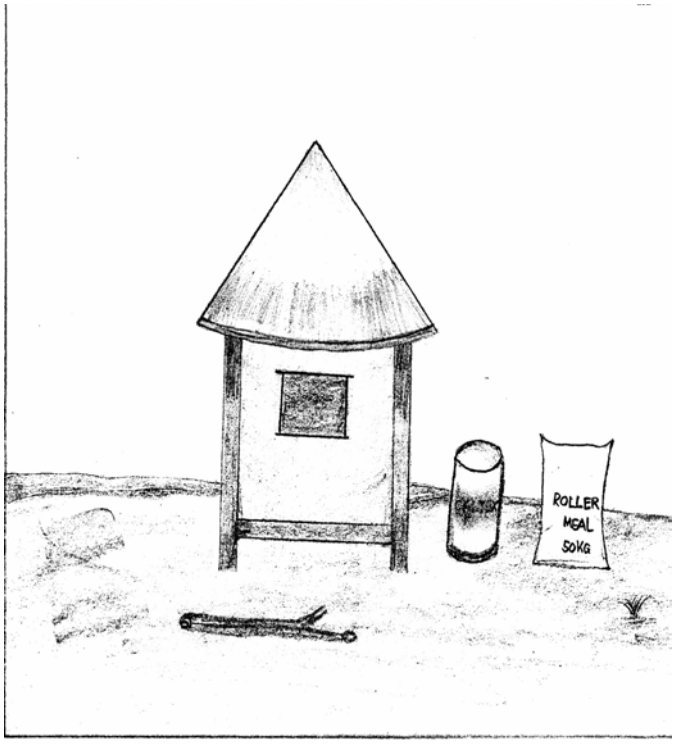


1. A farmer picking browse pods during the dry season

2. Goats feeding on fallen browse pods

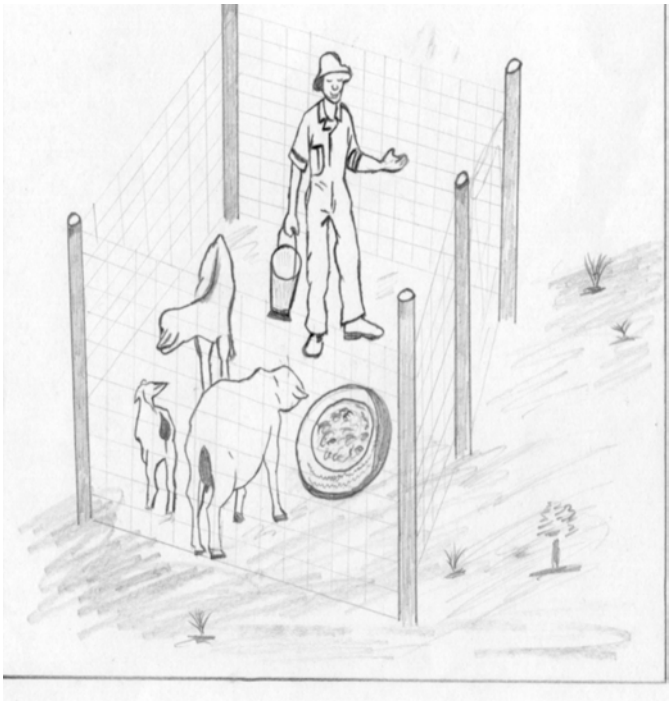


Goats kidding in the dry season when there is no feed: doe and kids in poor condition

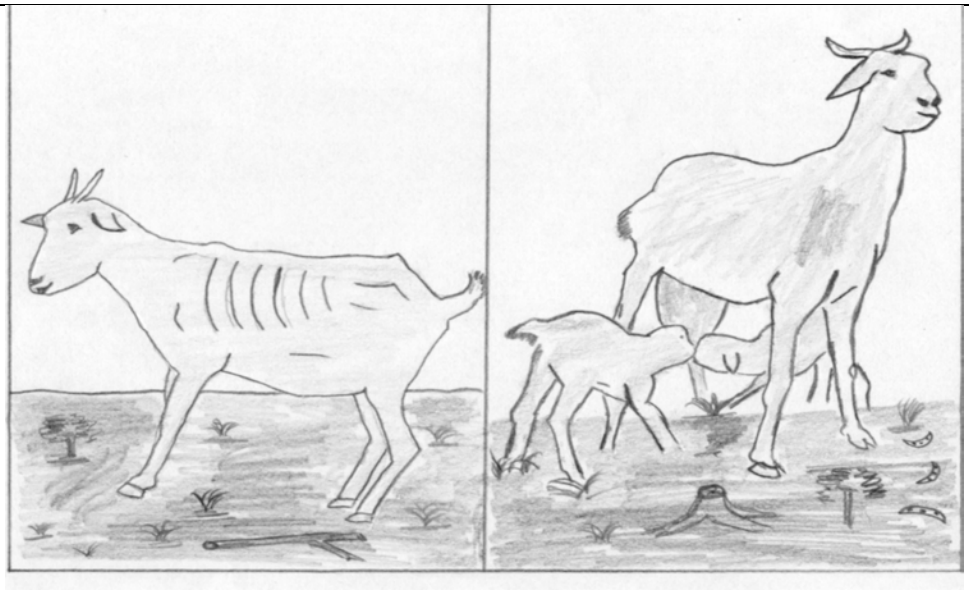


Pods collected can be stored in a granary/drum/plastic bag

Farmer processing pods: pounding (pestle and mortar)



A farmer feeding goats in a pen/kraal Ration: one handful of pods per adult goat



Goat not fed (lost all her kids)

Goat fed with pods (her kids survived)

Browse trees

isinga

uguwe

umtshatshatsha

iwohlo

umkhaya

ugagu

ihabahaba

Zimbabwe: Questions and answers

Is supplementation provided at the best time, e.g. at the time of breeding?

Bucks are available throughout the year but the trial may generate change, especially when farmers want to sell finished kids around Christmas. The issue of whether it would be better to advise farmers to change their management strategy so that kidding takes place during the rainy season or when there is enough forage to reduce high mortalities was raised earlier. However, generally there is no controlled breeding in the rural areas. Bucks run with females throughout the year. With time, controlled breeding will be discussed with farmers and thereby strategies will be set. This could reduce kid mortality and farmers could supplement young animals for sale.

Were pods fed at the same stage of maturity in each year?

It is difficult to control the stage of maturity across years as pods are collected at 'pod fall', There are large differences between trees of the same species within relatively small plots. Pods, of each species, are bulked for each trial to reduce variation in the supplements fed.

Was treatment with NaOH making the carbohydrate fraction more digestible as well as inactivating the tannins?

This is an important question, how to apportion the possible effects of treatment. The issue of whether the effects of treatment with alkali (wood ash) was due to improved digestibility of the pods or solely through reducing the tannin content was considered. Alkali treated material was incubated with PEG and the increase in digestibility was compared to that of the untreated material also incubated with PEG. The effect of PEG on treated material was expected to be less than its effect on untreated material.

Have you ranked the acceptability of the different pod species?

We have intake and refusal data from feeding and metabolism trials.

Two comments were made from the floor:

1) It can be useful to have a cafeteria system in ranking the browse supplement to assist in selecting pod species for study in long-term feeding trials to supplement information from the laboratory. We have data available in our laboratory (Professor S.A. Abdulrazak)

2) This is an example where the STIR (Short Term Intake Rate) technique could be used (Professor E. Owen).

General Discussions

The discussions following the presentations often resulted in the discussion of general issues, as well as the more project-specific ones that have been included at the end of each country chapter.

Worm burdens: three approaches to the problem

Three approaches to the problem of worm burdens were presented at the workshop:

a) Increasing energy
b) Increasing protein
c) Use of tannins

The first two approaches are limited by the environment the farmers are working in.

Are the approaches of increasing energy or protein causing different responses in the animal? For example, does increased energy supply increase immunity?

- No, an increase in protein would have more effect on an increase in immunity.
- Maize and barley contain energy and protein, both necessary for the formation of microbial protein. An increase in energy to the diet results in an increase in digestibility.

When you feed a ruminant it is difficult to separate protein and energy supply. When you get a gut infestation that causes leakage of bodily fluids, therefore, the increase in protein and energy can just be replacing lost nutrients. The gut is one of the most important organs for protein metabolism.

How can you suggest increasing protein and energy supply when these aren't always available to farmers? Will farmers accept this approach?

Maybe alternative sources of proteins could be used, i.e. ones that don't compete with human diets. One example would be *Mucuna pruriens* used by farmers in Karnataka, India (Project R6953).

It is difficult to tell people to give feed supplements to their smallstock as they are very expensive. But, if you can demonstrate their benefits it might be easier to convince people to invest in them.

Farmers need to know the best time to provide supplements to their smallstock. The critical time is often at the start of the rainy season.

Is enough known about the use of tanniniferous plants as anthelmintics? For example, how long do the animals need to be supplemented with them?

First, we need to demonstrate that tanniniferous plants work in practice. Wattle tannin was used here because of its availability from the local leather industry. There is a massive database of plants with biological control available from the USA at a very low cost to non-profit making organizations.

The plants used by Project R6953, in India, are found to have an effect as anthelmintics. It was agreed that LPP would supply funding to enable the University of Nottingham to

analyse the plants used in Dr Joshi's project. It was suggested that the programme should be working with entomologists to look at the nature of the tanniniferous plants used.

Urea molasses blocks

The use of urea molasses blocks was heavily promoted a few years ago by FAO, but what has happened? Are they being used by farmers?

These have been used in India, molasses granules are also used. In Tanzania the blocks weren't used because people preferred to use the molasses for making spirits.

When interventions are suggested to farmers, they should be given a full explanation of the reasons for this. Often farmers are told to do something but not given all the information, the treatment does not work and the farmers lose trust in the information-provider. In some instances, this may have happened with the block technology.

One of the advantages of urea molasses blocks was that all animals had an opportunity to lick the block; with a supplement added to communally available feed weaker animals were less likely to receive a fair share.

Where farmers feed their animals with conserved residues they get better results from their animals. Some farmers are using poultry litter as a feed supplement for smallstock. However this increases the risk of disease transmission and can also be expensive.

Contribution of research to development by 2005

Donor expectations are felt by researchers to be unrealistic. Providing livelihood improvements by 2015 may well be achievable but the process of moving demand-led interventions from the researcher to the farmer requires a minimum of 10 years. The process requires many steps: dissemination / promotion / uptake by service providers / adaptation by farmers / adoption by farmers / impact on livelihoods / up-scaling.

It was felt that inter-agency activities at research and development level (CGIAR, NARS and international NGOs) should share more of the effort and resources, so that more effective delivery of research findings could be ensured. Farmers must be involved in this process. Interdisciplinary problems or approaches should be given top priority.

Basket of options

An approach that the link project should consider is to consolidate their outputs into a basket of options. The concept is that farmers (and service providers) are more likely to adopt knowledge if they were presented with a choice of interventions to choose from. This is a hypothesis which needs to be tested. However, it must be an improvement on the golden bullet approach often promoted by researchers where a single intervention or 'fix' is expected to resolve all a farmers' problems.

In South Africa, there are a number of studies showing that farmers need basic information on simple concepts. An example is the importance of nematodes as pathogens in goats, indicators of when they are present in the animal, the signs of disease and how to treat animals to remove the worm burden. This information can be put in a 'basket' of options that farmers can use/adopt/gain from.

Maybe there is a need to re-visit the analysis of project outputs so that they are all analysed from a process perspective with a particular emphasis on examining how the research process has helped to embed target/goal farmers within a problem-solving partnership.

A Participatory Rural Appraisal from project R7351 in Zimbabwe has indicated that pods are traded but which pods and how much has not been known. The project has tried to answer this. There is information for a 'basket'.

From a Zimbabwean perspective, farmers visit the stations (Matopos Research Station and others) from time to time. The Station staff advise them on management issues for successful goat production. For example, general management, disease control (tick borne), proper shelter for goats, appropriate feed resources (pods and commercial feed) for pen finishing, supplementation during the dry season. This information is appropriate for inclusion in a basket.

There is a need to look at the farmers' needs from a holistic approach and certainly the sociological aspects have to be considered. Farmers need to be involved more in the research process

The issue of involving farmers in technology development has been addressed by KARI since 1993, where farmers have been participating in diagnosis, prioritization of constraints and interventions, research and to some extent dissemination. What was lacking was the up-scaling of these technologies from the few participants to the wider community and moving to other areas with a similar environment. This is now being addressed by the Agricultural Technology and. Information Response Initiative (ATIRI) where farmer groups are demanding the technology, are helped to get it and are given a 'backstop', through access to the researchers. What is lacking is an integrated, or holistic, approach to the farmers' needs. The farmer is a soil manager, livestock manager, economist, marketer and the vet operating for his survival within a constraining sociological environment.

We need to go beyond the basket to 'how to be successful'. The 'how to' may mean 'what partners to work with to transfer the basket,' so you pre-empt other obstacles that might arise after the basket begins to be used. For example, a partner to deal with marketing of the increased output may be needed. These are some of the strategies that the Africa Agricultural Technology Fund (AATF) is encouraging other scientists and players to follow, for example forming partnerships with the private sector to promote uptake of research outputs. We need to break down the isolation of groups.

Recap of the meeting

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Scientific presentations

On Tuesday we heard teams of scientists who over the last few years have been grappling with the variability of farming systems outside the laboratory and research station. I felt that the research teams presented a lot of learning they had gone through about how to do rigorous research in variable environments, e.g. those with seasonal or annual variation etc. I also heard a lot of frustration in conversations over having to squeeze scientific research into timeframes set by donors. I also heard caution, both in the presentations and later, at the end of the day, in the general discussions, about being asked to articulate specific messages on a number of grounds:

- Ethical concerns – are we sure we won't be running the risk of harm to animals? Do we know enough?
- Broader concerns about the research, i.e. is more research needed to refine the information to be promoted?

Perhaps because the emphasis on Tuesday was on science, I heard very little about the potential impact on livelihoods. There was some talk of economic analysis but as we are aware, the assumptions lying behind the economic analysis may not be matched by people's realities in the field. A simple example is using the value of an increased production of milk as an economic benefit when people aren't selling milk. Does that match with the way the goat keeper would estimate value to the household?

Very little data was reported regarding on-farm data to report **who** we are working with in relation to resource-poor poverty. Is this because we don't know who we are working with?

At the end of Tuesday the feeling I was left with was that we need the same kind of rigour applied to science to be applied to reaching conclusions about the livelihoods and poverty effects of our findings. That perhaps is one of the challenges the programme faces over the coming years.

Field visit

The workshop visited members of the Meru Goat Breeders Association and learnt how different groups were benefiting from involvement in the scheme; both by obtaining access to goats and also to learning how to work in partnership with one another. Like many other people I was impressed with the set-up of the Meru goat project. Some questions have been raised about the question of economics at the household level. From the questions raised, there is no doubt the members of the groups feel their efforts are more than worth it for the benefits derived. Maybe it is more in terms of the social capital they gain and the human capital, e.g. knowledge gained, not just in relation to breeding and goat management but in relation to the wider farming system. The people involved think it is worthwhile. How do they articulate the costs and benefits?

Equally impressive was the whole institutional set up of the Meru Goat Breeders' Association (MGBA), a very bottom-up institution from local groups up to the breeders association itself. It is a strong civil society organisation that has already achieved power in local affairs and has given people a voice.

Also impressive was the very effective collaboration between the service providers, vets, research, non-government organisations (NGOs, e.g. FARM-Africa and others), and government extension officers all working together. It was suggested that leadership and the personalities of individual people who initiated the programme have been an important factor in that. I think it also reflects the project set-up that provides incentives for all those organisations to play a part. One of the incentives is the creation of an environment that allows the organisations to do their jobs correctly. We should learn from this.

Extension messages and dissemination workshop

I think we were all disappointed we didn't have more service providers here despite all the work of the workshop organisers. That is disappointing on three fronts:

1. We know we need service providers and we know we want to work with them. We are a small number of researchers, we have very limited time and budgets for dissemination and promotion and we need to use these resources strategically. We need these intermediate groups to deliver our messages.

2. We wanted to engage in dialogue with them. There are questions we want to ask. For example, how much information do service providers want before they will accept our messages? We want to know how we can serve their needs more effectively.

3. Maybe, although this may be reading too much into a single event, it gives us a hint towards service providers' attitudes towards research. Maybe they didn't think the Workshop would be particularly relevant to them. This implies we have to convince the service providers that they can benefit from dialogue with us.

The term service provider is controversial and some people have expressed unease with it. For some it implies organisations that are contracted by a public body to carry out a service, e.g. street-sweeping. If we are stuck with the label we must articulate what we mean. Dan Kisauzi made the point that there is a danger in using the label because it lumps together some very disparate organisations. It is a convenient label but we need to be clear what we mean by it.

Message presentations

It was interesting that after all the caution expressed earlier the teams were prepared to come up with very specific messages that they felt could be promoted to farmers and others. Some were based on existing knowledge, with the provision that research would refine the results. Other people said this is what we think we would be willing to promote, but more work is required. Some of the caution expressed earlier had disappeared. There were both technical messages and process messages.

Working groups in the afternoon

In a very short space of time all the groups came up with useful dissemination and promotion frameworks within which strategic decisions could be made about communicating to different audiences. There was very little time to do this. One possible further step would have been to prioritise the constraints to uptake identified by different audiences; e.g. if credit is a major limiting factor, how does this affect uptake?

We have to prioritise because we can't do everything. We should focus on those things that will have impact.

Within the matrixes drawn up, it was very clear that many of the strategies identified need to be interactive based on face-to-face communication. A lot of the activities are not one-off but are ongoing and iterative, based on dialogue and discussion, trying to win people over to a point of view. So when we look at specific media applications, such as videos and posters, it must be remembered that the main role of the media is to support ongoing discussion, by providing essential inputs into that process. When we talk about deriving messages from research we are not suggesting that a message is synonymous with a single leaflet, which may simply be part of the process in understanding an idea.

Draft leaflets

I would like to re-emphasise that this was an **exercise**. The leaflet is a useful vehicle for realising the challenges for translating simple messages for farmers. One of the ways in which the groups tried to make the link was by highlighting the financial benefits of a particular practice.

Reflections on the leaflets

D. Campbell
Mediae Trust, Nairobi, Kenya

Introduction

I was really impressed with the leaflets. I was impressed that the groups arrived at simple messages quickly as it can be hard for scientists to use the 5-word concept[1]. Two of the messages can be used to emphasise some general points:

Nepal

The project from Nepal used very simple messages and had a clear image, the handful of maize. More work is required on this message to decide who it should be aimed at (children or adults).

In a leaflet produced by the Mediae Trust looking at malaria prevention, the **actions were listed** along the top, and the **why** underneath. The Nepal leaflet needs to provide back-up in the leaflet.

South Africa

The group had listed everyone as an audience but needs to be aware of their limited budget. One thing you could do is mix and match; for example the principle audience may be farmers, but the leaflet could also be of use to front-line extension officers as they have a similar level of understanding. I would always target one audience then look to see if it is acceptable to others, rather than trying to make something that will appeal to all.

Next steps for production of promotion materials

Look at your budget. Look again at the strategy of your dissemination and decide who the main audience will be. If you decide on a leaflet, I would suggest the next step would be to speak to the people involved in developing your print material, including the designer and printer. Using your notes, get them to lay out your designs on the computer. Work out what you want, and get 10-20 printouts in colour for pre-testing. Speak to farmers, give them the leaflets and ask them study them for later discussions. Then, taking account of the farmers' comments, print a larger run (e.g. 1,000 copies) for wider field testing. Feedback on the first trial of the malaria leaflet resulted in the picture of the bed being changed because people said that no-one slept on a bed like the one depicted. The greater the quantity of leaflets printed, the lower the cost per leaflet. You need to over estimate the number of leaflets you need. In Meru we printed enough for the farmers known to us, plus an additional 50 per cent. My point is that you are not far away from getting your leaflets underway. You need to get the cost from the printer so you can see if it will fit into your strategy cost-wise. You will need to balance your books. Radio may be another option so you should look into the costs of that.

In general, I was very impressed with the leaflets. I think the next step is pre-testing.

[1] Mediae Trust advise that words of more than 5 letters should not be used in promotional materials

Where do we think we are going with dissemination? Where do you think you should be putting your project efforts? What are the priorities?

On a project basis the LPP would like to think projects consider this to be a milestone for the coming year. The LPP would like to see a prioritised list of dissemination products coming out of each project's work. A lot of people believe research is not delivering and it is partly a marketing issue. You need to make donors aware that there is a product there. Make sure you send your promotion messages to the donors as well as the other stakeholders.

- Participants said they had found the dissemination workshop very useful and interesting. Those at the end of their projects thought it would have been very useful to have had such a workshop at the start of their projects.
- It was suggested that dissemination guidelines should be produced for future projects.

Monitoring uptake and impact of promotion message – how do you go about this?

Before message transmission

In many countries, including India, Kenya, South Africa, Uganda and Zimbabwe, information is available. A good source of information is often the commercial providers of inputs, who need to know which socio-economic group they are communicating with at all times, and to have reliable measures of impact. Where applicable, there is basic data which can help projects decide which radio station to use, although they probably already have a feeling about this. Statistics can be obtained from a commercial organisation such as advertising agencies. Your printer or designer may also have access to relevant data.

After message transmission

Some monitoring of uptake and impact of promotion messages can be done by finding out how many people watched or listened to a transmission. It is expensive to do statistically viable monitoring regarding change of knowledge: Mediae Trust has done this in Kenya but as it is very difficult and expensive they are going to stop. Knowledge and attitude is slightly easier to measure. For project teams, the best bet is to go back to your target audience and see if they heard the radio programme; this could be done by working with small focus groups where you hand out leaflets and test people's understanding of the message before and after receipt of the leaflet or listening to the radio programme etc.

The option of commissioning an independent group to find out attitude change is expensive; a recent nationwide analysis cost the Mediae Trust £22,000. It would be cheaper to use existing statistics plus 4 or 5 focus groups.

Service providers / promotion partners[2]

A lot of service providers / promotion partners had been invited to the workshop but unfortunately most were unable to attend. Although participants at the workshop were pleased to see representatives from Heifer Project International, Meru Goat Breeders' Association, BAIF, FARM-Africa, Nkoola Institutional Development Associates and Mediae Trust, concern was felt about the service providers who did not attend. The research teams realised that although their role included carrying out the research and testing the efficacy of a dissemination product with a local target audience, promotion of the research findings could be passed to a much wider audience by the service providers

The following were suggested as reasons why service providers may not have attended the workshop:

- They are too busy to attend
- They feel the research findings are not relevant to their work
- They feel the research teams are not including them sufficiently, and are concerned the research teams are trying to carry out their role
- Their organisations may not have enough people to attend the different workshops whilst ensuring that day-to-day work is carried out
- Lack of remuneration for attendance
- Lack of desire to interact with scientists
- This is the first meeting on this topic at Embu. If it was repeated annually attendance would increase with time.
- Organisers have targeted the wrong people, including those who aren't aware of the project so have no interest in attending the meeting.

Possible solutions

- Maybe research teams should work more closely with the service providers, particularly in designing the final dissemination products (i.e. those aimed at the livestock keepers)
- Be more sensitive to service providers. For example, do not send a team of researchers, equipped with food and per diem payments etc., to an area where the extension worker is not provided with anything
- We also need to make it clear what people could get out of the meeting
- The interest to attend will depend on peoples' motivation. The title of 'international workshop' is good to target people at the national level, because they can then delegate to their local office.

[2] During the meeting use of the term 'service providers' was discussed. Several of those perceived to be 'service providers' disliked the term as they felt it was misleading, e.g. it represented people hired for one specific service, or referred to organisations contracted by the government. The term 'promotion partners' was preferred by some people. To make easier reading these proceedings will use either term interchangeably. It should be recognised that service providers / promotion partners are not homogeneous; they will have different agendas and different roles to play in promoting research messages.

More emphasis needed on dissemination?

Most research projects underestimate the proportion of their budget which should be used for dissemination. There are some exceptions, notably the pharmaceutical companies who spend a much larger proportion of their budget on marketing. The research departments of the pharmaceutical companies are also often a lot more targeted than other research teams. However, with limited funds, a huge push on dissemination is usually well beyond the mandate of a single project.

So, where should this effort come from?

The research managers need to work together with the appropriate service providers to refine the research messages and to pass them on to the livestock keepers. It is unlikely that the service providers are going to be excited by a single fix so there needs to be a steady stream of fixes. The service providers also differ in their interests and, therefore, will concentrate on different aspects of the research findings.

If research managers are to take a more targeted approach, maybe project findings that are ready to be scaled up should be identified. We need to analyse more carefully who we should be working with. You do have to pick your service provider as somebody who has initiative and enthusiasm because that is very important for the sustainability of the work.

Heterogeneous nature of service providers

If we want to work with and through service providers and promotion partners we need to understand what motivates them. For an NGO working with small farmers, they may be interested in working with the projects represented here today because they see that the tools we have may add to their existing basket of knowledge, so that may not require financial inputs. The same could apply with extension. The private sector is a very varied mix, including companies with general interests and those with a particular service to offer, e.g. a design company. Input suppliers in the business of selling might be interested in taking up a particular technology because it may lead to increased sales. A drug company may want to combine a veterinarian and nutritional message. Others may want to improve their image with the general public. In identifying the most appropriate service providers, we need to understand what makes them tick and, therefore, which messages are appropriate to their operation.

Perhaps research teams need a negotiator to try to promote the basket of research outputs to the service provider. You need to go to the national level because local level people may not have sufficient authority. Promotion of particular research findings then becomes part of national policy.

What messages should be sent to those who didn't attend the workshop?

The workshop discussed this issue and agreed that succinct summaries of the extension messages of the projects should be sent to service providers who were unable to attend the workshop, as well as service providers in those other countries represented at the workshop. The service providers would be given relevant contact details so that they could order copies of the proceedings of the Workshop if they required them.

The future of the link project

Summary

The following actions were agreed during the workshop:

- Each of the 6 projects would produce a leaflet for distributing to the service providers. Mediae Trust agreed to provide the structure guidelines: headings, approximate layout and word count.
- Mediae Trust kindly offered their service free of charge in providing guidelines on producing these summaries, and designing them. The guidelines will be sent to the LPP to distribute to the project teams
- Projects to send text and photos to David Campbell, Mediae Trust, by the end of March 2003.
- We need to try to get the service providers on board so needs to be aimed at them. We need to have an introductory page.
- The LPP will pay for the printing of the summaries

It should not be a problem that all the messages in the book are not appropriate to everyone. The booklet could include suggestions as to its use, for example certain companies might want to use this tool in a certain way. So the booklet would be a marketing ploy to facilitators in the different countries. This could be an opportunity to produce the term promotion partners

Feedback on the workshop

- Got to know what other people are doing and the links between the projects eg Zimbabwe and Tanzania working with the same plants in different ways and these findings could be combined. The projects have worked together and will do so more.

- Very happy to have been involved in the link from the start of my project as it has made me much more aware of dissemination issues

- We have a lot of intellectual benefit from the link meetings but we have limited resources. Is this the best way of spending link money or are there alternative ways in which the money could be spent to promote linkages?

- The field visits are very useful.

- These workshops are quite useful in learning what people are doing. The time is a constraint ie would be better to have a longer workshop.

- The original link project had 3 meetings scheduled and this was the 3rd one. The difference in presentation from the 1st meeting to this one is remarkable so that is an achievement. Yesterday was a real success, we all learnt a lot. Maybe the next thing is to cement the link. Maybe we should facilitate people working in different areas for eg a couple of weeks to get more exposure. Then we could have a final workshop in eg 2004.

- If we had another workshop it would need a theme. The success of this workshop was its theme.

- What about looking at other smallstock groups eg poultry keepers?

- Maybe to continue cementing relationships there would be sense in exchange visits. There would need to be clear objectives.

- The International Goat Conference takes place in October 2004 in South Africa so maybe the link workshop could tie onto that. We could have the proceedings of this workshop available at that conference.

Where do we go next? How can we continue collaboration?

There are very clear links between the projects in South Africa, Zimbabwe and Tanzania. Representatives of the project in Tanzania thought they would benefit from the veterinary knowledge of the project in South Africa.

If exchange visits were to take place, their main objective would be lesson learning eg if a technology has worked in one area but not in another you could learn from the area where it worked ie you could learn whether mistakes were in your planning etc.

It was agreed that Peter Buttery would continue with the leadership of the Link Project, and would devise a mechanism whereby each project participating in the link project would be able to prioritise the technical exchange visits they would like to make. Peter Buttery would manage the budget and would authorise visits. Clear objectives should be set for the visits, and the visitors should impart knowledge to the hosts as well as learning from them.

Maybe the final workshop could be around the theme of testing the dissemination and providing LPP with some data on the impact of the dissemination and lessons learnt. It would be good to have methodology on measuring impact.

Mediae Trust could act as a central point of information by email to provide support to projects.

Action points:

- Peter Buttery to put together a format for people to use to apply to
- Project teams to discuss and send proposal to Peter Buttery.
- New funding period starts 1st April so LPP would need to know budgets before then.

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The meeting consisted of presentations of findings from DFID LPP projects based in India, Kenya, Nepal, Tanzania and Zimbabwe and a DFID Animal Health Programme project based in South Africa.

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