Small stock in development

Proceedings of a workshop on enhancing the contribution of small livestock to the livelihoods of resource-poor communities

Masaka, Uganda, 15–19 November 2004

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Proceedings of a workshop on enhancing the contribution of small livestock to the livelihoods of resource-poor communities

Organised by Serere Agricultural and Animal Production Research Institute (SAARI), part of the National Agricultural Research Organisation (NARO), of Uganda and held at Masaka, Uganda, 15–19 November 2004

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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 'enhancing the contribution of small livestock to the livelihoods of resource-poor communities', held at Hotel Brovad, Masaka, Uganda, and organised by the National Agricultural Research Organisation (NARO) of Uganda, between 15 and 19 November 2004. The workshop was opened by a speech from the Minister of State for Animal Industry, Mrs Mugyenyi, whose speech was delivered by the LCV Chairperson, Masaka district, who thanked NARO for organising the workshop and the LPP for funding it.

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: the presenters; the rapporteurs and the support staff; and to the putting together of these proceedings.

Tim Smith, Sarah Godfrey, Edward Ssewannyana, Peter Buttery and Emyr Owen

Acronyms

ADF	acid detergent fibre
ADRI	Animal Diseases Research Institute
AES	Awutu-Afutu-Senya (an administrative district in Ghana)
AI	artificial insemination
AKIS	agricultural knowledge and information systems
ANOVA	analysis of variance
AR	action research
ASAL	arid and semi-arid lands
BC	backward castes
BCRDV	Baby Chick Ranikhet Disease Vaccine
BHP	Black Head Persian (ram)
BUN	blood urea nitrogen
CAHW	Community Animal Health Worker
CBO	community based organisation
CCU	Carrying capacity unit
CIAT	Centro de Investigación Agrícola Tropical
CP	crude protein
CRD	completely randomised design
CREATE	Centre for Recreation, Education and Appropriate Training for Everyone (Uganda)
CT	condensed tannins
DAREP	Dryland Applied Research and Extension Project
DFID	Department for International Development
DLS	Directorate of Livestock Services (Bangladesh)
DLSO	District Livestock Service Office (Nepal)
DM	dry matter
DOC	day old chicks
DP	Duck Plague
EE	ether extract
ENRECA	Programme for Enhancement of Research Capacity in Developing Countries
FADO	Faith Action Development Organisation (Uganda)
FARA	Forum for Agricultural Research in Africa
FBO	farmer-based organisation
FEC	faecal egg counts

FER	feed efficiency
FOAG	Farmer Overseas Action Group
FSRE	Farming Systems Research and Extension
GIS	geographical information system
IFTS	Indigenous forage trees and shrubs
KDGP	Kayungo Dairy Goat Project
KMA	Kumasi Metropolitan Area (Ghana)
LPEC	Livestock Productivity Efficiency Calculator
LSD	least significant difference
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries (Uganda)
MAR	maximum adoption rate
MBC	most backward caste
MC	maize bran and cottonseed cake
ME	metabolisable energy
MFI	micro-finance institutions
MGBA	Meru Goat Breeders Association
MJ	mega joules
NAADS	National Agricultural Advisory Services (Uganda)
NAARI	Namulonge Agricultural and Animal Production Research Institute
NAF	Nepal Agroforestry Foundation
NARC	Nepal Agricultural Research Council
NARO	National Agricultural Research Organisation (Uganda)
NARS	National Agricultural Research Service
NGO	Non-governmental organisation
NR	nitrogen retention
OVI	Onderstepoort Veterinary Institute
PDIFF	probability of difference
PEG	polyethylene glycol
PLA	Participatory Learning and Action
PMA	Plan for Modernisation of Agriculture (Uganda)
PPR	peste des petits ruminants
PRA	participatory rural appraisal
PRP	proline rich proteins
PTD	participatory technology development
RD	recommendation domain
RELMA	Regional Land Management Unit (in ICRAF)

RI	revenue inspector
RPH	resource-poor household
RPT	Reading Pressure Technique
RRA	rapid rural appraisal
SAARI	Serere Agricultural and Animal Production Research Institute (Uganda)
SC	scheduled caste
SEA	Small East African (goats)
SFR	sunflower residue
SHG	self-help group
TARP II	Tanzania Agricultural Research Project
TFS	Teso Farming System (Uganda)
UPE	universal primary education
VA	village accountant
VFA	volatile fatty acids
VGD	Vulnerable Group Development
VSF	Veterinarios sin Fronteras
WEI	wean to oestrus interval
WT	wattle tannin

Executive Summary

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Via its Livestock Production Programme (LPP), the United Kingdom Department for International Development (DFID) has funded a series of workshops where the results of its demand-led research programmes on the use of livestock to alleviate poverty are presented. This volume is the proceedings of the 2004 meeting held in Masaka, Uganda. Previous workshops were held in Morogoro, Tanzania in 2002 and Embu, Kenya in 2003. The earlier workshops concentrated on small ruminants (sheep and goats). The scope of the Masaka workshop was extended to include other small stock ranging in size from bees to pigs. The majority of the research findings presented have been supported by the Livestock Production Programme and describe work originating in Bangladesh, Bolivia, India, Kenya, Nepal, South Africa, Tanzania, Uganda and Zimbabwe. A significant feature of the workshop was a consideration of methods of enhancing the appropriate dissemination of research findings. To promote these aims and to facilitate further the impact of the research on resource-poor farmers a series of individual workshop sessions were held; summaries of these are also included in these proceedings. It was clear that by combining the experiences of the individual research groups their potential impact was greater than the sum of the individual components.

A notable feature of the Masaka workshop was the active participation of representatives from local NGOs, NARS, extension officers, other service providers and above all farmers. During the workshop the entire conference visited local small stock enterprises to gather information on the impact of small stock in the Masaka region of Uganda. The success of the meeting was enhanced by the dedicated work and hospitality of the local organising committee under the chairmanship of Dr. Edward Ssewannyana.

It is hoped that these proceedings act as an aide memoir to the participants and a reference book for those who were unable to attend the meeting. A comprehensive list of the contact details of the participants is included. It is hope that these details will facilitate continued contact between the delegates and encourage others to become members of the network.

Introduction

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Background to the LPP

At the time of the workshop, the UK Government's Department for International Development's (DFID) Livestock Production Programme (LPP) is in its tenth year. When the programme began, the majority of the research was carried out on cattle, with the emphasis on increasing productivity.

In 1997, DFID issued a White Paper emphasising the need for research to focus on the poorest of the poor, and for the emphasis to move from a commodity focus to a people focus. In the light of this paper, the LPP decided to refocus its work in a number of ways: a) changing the focus of research from production systems to keeper groups; b) deciding to increase the amount of research funding spent on looking at the problems facing small stock keepers; c) placing more emphasis on landless farmers, including women, pastoralists and urban livestock keepers.

This change did not happen overnight, but the workshop we are holding today (and its three predecessors) should demonstrate our belief in the importance of small stock as a way out of poverty for a large number of people.

Why small stock?

Describing the benefits of small stock keeping to an audience already working in this field (whether as NGOs or other service providers, or researchers) is preaching to the converted. We are all aware of the potential benefits of small stock for resource-poor people; they cost less to purchase and take care of than cattle; less land is required for them and they can be used to scavenge; less physical strength is required for looking after them (particularly appropriate with the increase in older-headed, women-headed and children-headed households due to HIV/AIDS). Consequently, small stock (goats, sheep, poultry, pigs, rabbits, bees) are very widely owned by the resource-poor in the developing world and represent a major contribution to subsistence and money-earning activities.

Purpose of the meeting

These proceedings contain a wide range of papers; some focus on a single species, whereas others look at a more integrated system of small stock.

The focus of this workshop is not just the sharing of information between researchers; instead we want to learn from the service providers and farmers, many of whom are represented here, as to how best we can communicate with each other. In particular, we need to ensure that the research carried out is that required by resource-poor livestock keepers and the information generated is relevant and presented in a manner appropriate for their needs.

Outcomes

As indicated in the Introduction to the workshop, four outputs were foreseen for the four day workshop:

Output 1 Presentation, discussion and dissemination of research products

In all, over 25 presentations were given and discussed during the workshop. It was encouraging to see the increase in the number of presentations from recently commissioned poultry projects (see papers by Mupeta *et al.*, Okantah *et al.*, Sparks *et al.* and Conroy *et al.*) to complement the traditional emphasis of the link project on goats and sheep (see papers by Ahuya *et al.* Max *et al.*, Sikosana *et al.*, Mlambo *et al.*, Rymer *et al.*, and Vatta *et al.*). It was also good to hear the outputs from projects on the relationship between smallstock and the social and economic status of women, the landless and the resource-poor (see papers by Banstola, Saadullah, Paterson and Oluka). Furthermore, the invited papers on pigs and bees (by Mutetika *et al.* and Kangawe *et al.*) provided a new dimension to the Link project; the inclusion of these two species more or less completes the major species of smallstock kept by the poor, at least in Africa and Asia. Finally, complementary papers on the utilisation of indigenous forages and forage transport (Kabrizi *et al.* and Massawe *et al.* respectively) and on information management (by Conroy et al) completed a very interesting and diverse series of papers during two days of the workshop.

Compared with presentations in earlier years of this Link Project, their quality was extremely high in terms of pro-poor content, quality and scientific rigour; they were also well crafted in terms of relaying relevant messages clearly to a mixed audience of scientific, practitioner and policy stakeholder communities. It is not easy to achieve this happy medium; the organisers felt that regular attendance at these workshops by project staff over the five year life of the Link Project (and the occasional guidance given on dissemination methods and strategies) has contributed to this. I think you will agree that the rapporteurs have done an excellent job in capturing much of the discussion related to each paper and the open debates on wider issues.

Regarding dissemination of project outputs at the field level, this is clearly an on-going activity being undertaken by the individual research teams. Most of these comprise, or have very close relationships with, dissemination specialists from public/private extension agents, civil society or farmers' organisations so we are hopeful that dissemination activities will continue even after the projects cease to receive donor funding. While accepting that the movement of researcher-derived *information* to become farmer-used *knowledge* may take several years to achieve, we are satisfied that this point is now well understood by members of the Link Project and that research they undertake in the future will be fully integrated with the information 'messengers', the beneficiaries and other non-livestock specialists such as policy makers, marketing specialists, health, credit, environment and other associated sectors. The pursuance of animal science research for development has moved on considerably over the last decade and we are hopeful that the 'disciples' of this new movement will now 'preach' this philosophy wider within their national research systems. It is encouraging to note that the newly commissioned CGIAR Challenge Fund programme managed by the Forum for Agricultural Research in Africa (FARA) foresees a fully integrated approach for agricultural research, not only across the traditional agricultural disciplines and complementary sectors such as social development, human health and education but also to include processed commodities, improved access to markets and environmental sustainability.

Output 2 Generation of joint dissemination material

The concept here was to encourage individual project teams dealing with a particular smallstock species to try and combine the outputs of their research across the regions into comprehensive dissemination products. These might then be included as material for wider promotion, adaptation for local conditions, inclusion in the LPP smallstock toolbox etc. Whereas the concept was generally accepted, the management of the LPP programme and the Link Project need to chase up past and present smallstock project teams to collate this material. We plan to undertake this work during the remaining phase of the LPP.

Output 3 Impact assessment from different perspectives – farmers, public/private extension groups, civil society groups, researchers, policy makers, donors

Our early enthusiasm to commission work in this sector was somewhat dampened by DFID's decision to undertake its own independent impact assessment of all the RNRRS programmes, including the LPP. Consequently LPP was advised by DFID not to use its resources to undertake its own impact assessment exercise. The DFID evaluation was conducted between October 2004 and end-January 2005 and several of you reading this document were asked to collaborate with the reviewers for which we would like to thank you. Whereas the review document has not been cleared for open publication at the time of writing (August 2005) pending the signature of the UK's Secretary of State for International Development, the draft document (for LPP) paints an encouraging picture of achievement although it is not strong on hard evidence. It is, therefore, our intention still to undertake an independent assessment of impact by keeper group through a questionnaire which we will be sending out to past and present project leaders and associated teams in the near future (and discuss at the next Link meeting).

Output 4 Consortia for new research – addressing the gaps

In order to collate information on single smallstock species generated by LPP research and encourage greater collaboration between research teams, we encouraged those attending the workshop to form themselves into single smallstock species or other convenient working groups. The groups were asked to consider the information they had already generated per smallstock species, to identify the main issues that were outstanding with respect to resource-poor smallholder systems, to prioritise the researchable components of these issues and to compose draft concept notes for possible funding by LPP. A six to twelve month research period was foreseen, delivery date being the end of December 2005. Subsequently, a number of submissions were made and the following four projects were commissioned:

1. **Development of dissemination materials for improving production and marketing of chickens by small-scale and resource-poor poultry producers**
   S Okantah (consortium leader), P Aboe, G Ameleke, D Bayrugaba, J Manzi, N Massawe, G Mukiiba Muka, B Mupeta, D Mutetika, D Shindey

2. **Dissemination of goat improvement best practices in the Eastern Africa Region**
   C Ahuya (consortium leader), D Dowdy, C Kalemba, L Mtenga, J Muwanga, O Mwai, G Nadiope, P Nakatudde, E Ssewannyana

3. **An integrated approach to the control of gastrointestinal nematodes of small ruminants raised under small-scale systems in Tanzania**
R Max (consortium leader), P Buttery, C Conroy, J Dowdy, F Ejobi, M Jayaswal, A. Kassuku, A Kimambo, L Mtenga, M Saadulaah, J Sikosana, A Vatta

4. **The importance of indigenous tree pods/fruits in goat diets**
J Sikosana (consortium leader), B Banstola, C Conroy, F Ejobi, M Ekoi, M Hossain, J Kabirizi, A Kitalyi, V Mlambo, I Mueller-Harvey

The progress made by these new projects will be reported at the Southern African Link workshop in September 2005.

In general

The workshop succeeded in attracting over 60 people representing a broad community of stakeholders. Whereas the majority of attendees were active researchers, it was particularly pleasing to see so many NGOs and other service providers as well as a handful of farmers, other private sector representatives and the public sector. In the final workshop planned for South Africa in September 2005, we will endeavour to broaden the stakeholder group even more – e.g. invite other donor representatives that support research on smallstock in development and the media.

The structure of the workshop worked well. Of the four days allotted - one given over to host country activities, two given to presentations of outputs of research pursued over the previous year, and the one remaining day on future activities and summing-up- appeared to be the right balance. One representative was honest enough to complain about the long hours each day. It will be a challenge for the organisers of the next workshop to try and ensure that the working day is shorter, or else so stimulating, that such comments don't arise! We want to resist the idea of a five day workshop.

One of the successes of the workshop was the poster session. In view of the large number of papers, those presenters who had in previous years been given the opportunity to present at plenary sessions were asked to prepare poster papers. Often times in international meetings such as this, poster sessions are given a secondary place in the agenda. In Masaka however, each poster was given five minutes in the plenary session to highlight the new/major output or outcome of the research conducted since the previous meeting. Subsequently, adequate dedicated time was given for the participants to view the posters. To spice up interest in the posters and plenary papers, presenters were informed that prizes would be awarded for the best poster and presentation, and their defence. The names of those who won 'best' poster and paper are given below.

One of the other major highlights of this workshop was the diversity of the nature of research conducted and the species investigated. It is our aim to continue with this diversification in the next meeting and it is encouraging to see the interest among the delegates in broadening the species base. Whereas this breadth is important, one other vital issue in need of donor support is greater research into optimum systems of mixed species of smallstock which can be raised under different systems, climate and agro-ecology. To date, the vast majority of research has addressed single species and, whereas this might be useful for intensive systems of production, it bears little relationship to the realities of subsistence agriculture where several species are maintained under apparently haphazard conditions. Clearly, there remains an opportunity to address and improve the

efficiency/productivity of such mixed small stock enterprises through a more systems orientated approach and address such questions as what balance of local species are complementary to other crop/animal enterprises on subsistence/semi-commercial enterprises under different conditions of climate, soil type, farm size, location, communication, access to credit and to markets etc. This topic could well be a focus for a future research initiative to be discussed and formulated at the next meeting.

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Non-governmental organisation (NGO) presentations

Workshop participants included a number of non-governmental organisation (NGO) representatives. In order to enhance communication between the research suppliers and research users, the workshop started with the NGO representatives giving a background to the work of their NGO, so that following presentations could be tailored accordingly.

CARITAS MADDO – Represented by Charles Luswata

CARITAS MADDO is the development arm of the Catholic Church in Masaka District. They work with up to 240 households, which are comprised of 20-30 families. Each group is given a male goat and three females. CARITAS provides veterinary support to each of the groups for up to three months. Other support involves producing cross-breds for passing on to individual families. CARITAS also does similar work with pigs and chicken. There is collaboration with research stations and extension workers for the provision of germ plasm. CREATE networks with the VI Tree-Planting Project and World Vision. There has been some impact, measured by the number of community members, who are beginning to use goats' milk.

Joy Children's Centre – Represented by David and Jacqui Dowdy

JOY Children's Centre is a farm, with 250 zero-grazed goats, used as a job-creation scheme to allow orphans to earn money for secondary and vocational education.

This programme manages its projects by employing older children to help take them back into school. It generates money and saves it for the children so that they can pay their tuition fees. Milk was identified as an intervention output because 25 per cent of the people only drink milk once a week. Now with the introduction of the dairy goats, people have become more receptive to drinking milk.

Kayunga Dairy Goat Project

Kayunga Dairy Goat Project (KDGP) is a collaborator of Joy Children's Centre and it distributes pure-bred dairy goats to resource-poor farmers, who in turn pass on two female off-spring to other farmers.

JOVIAL Programme

The JOVIAL programme, in collaboration with VI Agro-forestry Project and the Joy Children's Centre, is generating a population of F1, dairy X indigenous, goats with 200 farmers' groups, who are being trained in selective breeding techniques.

FARM-Africa, Kenya – Represented by Camillus Ahuya

FARM-Africa has been working with goats in Meru, Kenya for the past eight years. The approach is helping farmer-based groups develop sustainable goat projects. They have developed farmer-led and farmer-managed programmes to improve their goats. The goats now produce 3 litres of milk per day. The goats have also created employment opportunities and contributed to improved household livelihoods. A similar project has now started at Mbale in Uganda, around Mount Elgon, where 20 groups have been

formed. The Toggenburg milk goat, successful in Kenya, is being used to cross-breed with the indigenous goats to improve productivity.

Farm Network, CREATE Kumi, Faith Action Development Organisation and Dolen Ffermio

Farm Network, in Busoga, and CREATE-Kumi and Faith Action Development Organisation, both in the Teso region, are three Ugandan NGOs with livestock projects which became linked through friendship with a farmer orientated rural community group, Dolen Ffermio, in Wales. This Uganda-Wales link has two-way benefits. Firstly, there has been some provision of equipment, technical books and a little financial support. Secondly, but very importantly, it is a means of exchanging ideas on farming and community development, and creates personal solidarity, and encouragement in difficult times between the Ugandan and Welsh communities, which although widely separated by distance, climate and culture, do have many things in common. The four organisations were represented at the workshop by Gideon Nadiope, Jude Okeria, Moses Ekoi, and Lorna Brown, respectively.

Farm Network – Represented by Dr. Gideon Nadiope

This NGO developed from an initiative in 1993 to increase milk production in Busoga, (population now 2 million) by cross-breeding local cows with exotic dairy semen using artificial insemination (AI). The network of veterinary assistants and inseminators trained to do this throughout Busoga was then inundated by requests from the poorest sections of the communities to introduce a goat meat and milk improvement scheme. Plans are in progress to link the cattle inseminators to village groups to train them in management and to supervise 'improved buck stations' to cross-breed local goats with meat breeds, such as the Boer, or dairy breeds, initially by natural service and then through introducing AI. Boer goats are still in very short supply in Uganda, and most of those imported from South Africa came without breeding records. Farm Network will start a breeding unit with frozen embryos from South Africa to maintain a source of good quality pure-bred animals and to supply village groups in Busoga, and Teso with 50 per cent or 75 per cent pure Boer bucks.

Farm Network has so far sponsored training and equipped 12 artificial insemination technicians and also set up 12 cattle artificial insemination centres. They have also set up village poultry production programmes, reaching over 10,000 farming families, and participated in research studies in collaboration with various agencies.

CREATE – Represented by Jude Okeria

The Centre for Recreation, Education and Appropriate Training for Everyone (CREATE) provides training and support to young people and vulnerable groups through small stock interventions. This NGO has a most interesting and effective approach to livestock and community development in an area of extreme poverty, frequent drought and famine, with the added threat of rebel and cattle raider incursions. Young disadvantaged people are trained as 'peer educators' in social and health issues, especially related to HIV/ AIDS prevention, and in simple livestock health and production measures. Initially they are helping the poorest people, especially orphans, with chicken enterprises and planting of citrus trees. The plan is that they will proceed to provision of goats and upgrading with Mubende Elite or BoerX bucks, linking in with Farm Network, Busoga.

Faith Action Development Organization (FADO) **– Represented by Mr Moses Ekoi**

FADO is based in Kumi district, which is in Eastern Uganda. It works in partnership with Serere Agricultural and Animal Production Research Institute (SAARI) in targeting the rural poor. It is working in a number of sectors including Agriculture, Health and Education. FADO is involved in improvement of local breeds, especially of goats and cattle. These are given to communities as revolving assets.

Between 1987 and 1992, the Karamojong rustled all livestock from Teso. In 1993 donors started restocking Teso and Dr Lorna Brown (from the Dolen Ffermio NGO) and Dr Ssewannyana (SAARI) were instrumental in guiding the goat improvement project, which is now proving successful.

Goat improvement projects linked with Dolen Ffermio involving cross-breeding with Mubende Elite and BoerX have expanded into many groups. Initially they targeted women's and orphans' groups, but now the wisdom of involving all types of family groups, whether headed by men or women, is being implemented. Veterinarios sin Fronteras (VSF) has also supported the goat projects and the link with Farm Network in buck provision and management training will strengthen the structure. So far there are 488 mature local goats and 700 cross-breds (Boer x local) produced in the communities. It has recently started a smallholder cattle dairying enterprise, supported by VSF. A milk cooling plant with a capacity of 2,000 litres is helping with marketing the milk, by increasing its shelf-life. The project has also benefited deprived and orphaned children, largely through the sale of cross-bred goats.

Discussion following the NGO presentations

Question: *Where do the NGOs source the information on livestock production? Do they have adequate information to advise farmers in resolving their problems? What kind of linkages are there between the research community and extension workers?*

Answers:

- Joy Children's Centre reported that they have been doing informal research (and have written research books), but have also contacted Makerere University and talked to vets, have met Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) staff and linked up with the British Goat Society. However, dissemination of information is a major problem and the Centre has learnt most things through trial and error.

- Linkages between government (MAAIF) and farmers*:* the Department conducted a study to improve the productivity of small ruminants and rabbits. The study identified both potential and constraints and laid down strategies for developing the subsector. MAAIF has made germ plasm available. It has imported Boer goats and distributed them to farmers for cross-breeding with local goats to improve growth and productivity.

- Linkage between MAAIF and NGOs: there are close linkages with NGOs, such as Link Project International, FARM-Africa and Send a Cow.

- Areas of collaboration include: making exotic breeds available, using government staff for extension activities, networking through seminars with government staff.

- Showing the linkage between government and farmers: a farmers' leader reported that goat farmers had received Boer meat goats from government to boost indigenous goat herds to improve output. Pigs, however, are not favoured because of the food constraints and health hazards.

Question: *Does MAAIF have plans to export goats and, if so, when?*

Answer: If MAAIF were to export goats they must first of all increase the number of goats and their quality. Cross-breeding should result in greater numbers and improved productivity, thus giving the capacity and quality to export.

Question: *Virtually all the NGO presentations have referred to goat cross-breeding programmes. Have any of the NGOs been involved in improving the productivity of local goats through improvement of feeding, management, health care etc. And if not, why haven't they attempted to do so?*

Answers: Most NGOs are concentrating on dairy production. It would take decades for local dairy goat productivity to be improved, even through

better management practices. Most benefactors are short-term in their thinking because of funding constraints. Cross-breeding and selection are the best approaches to improving the quality of the goats, because in the highlands numbers of goats are already excessive.

In Nepal, the scenario is different to Uganda because the emphasis is on local breeds rather than exotics. The latter are more susceptible to disease, long kidding intervals, and fewer numbers of kids/kiddings.

Comment: The management of healthy cross-bred and exotic breeds of goats requires identification of both diseases and deficiencies which occur at different stages of growth. The effect of climatic stress also needs taking into account. Where possible, causes of death should be determined as this will assist in developing management packages relevant to a given system and area.

The utilisation of low-fibre sunflower residue in the diet of hybrid and village chickens raised in pens and on free-range[1]

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Abstract

Low-fibre sunflower residue (SFR) included in the diet is a viable option for improving production in smallholder-owned poultry. Four hundred day-old broiler chicks (200 hybrid + 200 village chicks) were given broiler starter (1-28 days) and a low-fibre sunflower residue diet (29-84 days). On day 29 the chicks were randomly allocated to four treatments (2 types of chicks, 2 systems of housing): Hybrid, in pen and free range; Village in pens and free range; replicated on 10 farms and managed by women. Weight gain, feed and water intake were significantly lower (P<0.05) in village chickens (0.70–0.72 kg) at eight weeks and (1.05 kg–1.19 kg) at 12 weeks compared with hybrid chickens (1.96–2.43 kg) at eight weeks and (2. 54–3.37 kg) at 12 weeks. However, the breast meat tissue of the village chickens was high in crude protein (CP, 74 per cent) and low in ether extract (EE, 33 per cent) compared with 69 per cent CP and 50 per cent EE in hybrids. At eight weeks, feed efficiency in free-range village chickens (2.7) was similar to hybrids in pen (2.6) and free-range hybrids. This was better than village chickens in pen (3.2). Interestingly, at 12 weeks, feed efficiency declined in hybrids (4.0 penned, 4.2 free-range), while there was an improvement in village chickens (3.0 penned, 2.6 free-range). A low water: feed ratio was observed in village chickens (1.6 free-range, 1.7 penned) compared with free-range hybrids (2.1) and hybrids in pen (2.2) at eight weeks. However, at 12 weeks the differences in water: feed ratio between hybrid and village chickens were not significant (P>0.05), being 2.2 in pen and 2.1 in free-range hybrid compared with 1.9 in penned and 1.8 in free-range village chickens. At eight weeks the gross margin per bird for hybrids (equivalent to US$ 2.30-3.19) was high compared to village chickens (equivalent to US$ 54-0.79). But at 12 weeks village chickens showed improved gross margin (equivalent to US$ 1.21-1.27) compared with hybrid chickens (equivalent to US$ 1.27-2.33). Return per dollar of village chickens in pens (1.30) was lower than village chickens on free-range (1.55), which was similar to hybrid chickens on free range (1.60). At 12 weeks, return per dollar significantly improved (1.48–1.61) for village chickens compared with 1.20–1.30 for hybrid chickens.

Key words: low-fibre SFR, village chicken, hybrid chicken, free-range, value added, feed efficiency

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Introduction

The availability of feed, both quantity and quality, at affordable cost is a major factor limiting poultry production in Zimbabwe and as a result, the demand for low-cost feed is high. Sunflower (*Helianthus annus*), is a potential source of protein for inclusion in poultry diets. It is high in fibre, rich in sulphur-containing amino acids, cystine and methionine but low in lysine. The high fibre content limits the utilisation of the sunflower residue in poultry (Smith, 1968). The presence of high fibre and associated polyphenolic compounds (chlorogenic acid), in sunflower hulls limit intake and digestibility and may cause adverse effects on poultry performance (Singleton and Kratzer, 1969). Mupeta, *et al.* (2001), demonstrated a sieving technique, consisting of passing sunflower residue through 1.4 mm screen and produced low-fibre sunflower residue, which could improve the utilisation of sunflower residue and, thus, poultry performance. There is a double benefit in reducing the fibre fraction since chlorogenic acid is found in association with the sunflower seed hull (Luhaloo, 1996).

Approximately 80 per cent of poultry in Africa are raised in rural areas where they contribute substantially to meat and egg production (Sonaiya, 1997). In Zimbabwe, about 50 per cent of the birds from the commercial poultry breeders are marketed in the rural areas, where they are generally raised on a free-range system, surviving as scavengers.

The potential of low-fibre sunflower residue for inclusion in poultry diets and the performance of hybrid and village chickens raised in pens and on free-range has not been evaluated on-farm. Therefore, the objective of the present study is to evaluate the utilisation of low-fibre sunflower residue included in poultry diets on the performance of hybrid and village chickens, raised in pens and on free-range under participatory management by women farmers at household level.

Materials and methods

Three hundred and fifty eggs (1-7 day-old) were collected from village chickens. The eggs, weighing 23 ± 1.6 g, were kept at room temperature for 24 hours and then transferred to an incubator. At the 18th day of incubation the eggs were transferred to hatching trays. Hatching started during the 18th hour of the 21st day of incubation. Two hundred and thirty chicks were hatched by the 23rd day of incubation (66 per cent hatchability). The 23rd day coincided with the arrival of 228 day-old hybrid chicks.

Two hundred hybrid chicks (42 ± 2 g) and 200 village chicks (38 ± 1.5 g) were divided into 16 groups of 25 chicks and transferred to 16 brooder boxes and reared for 28 days. The brooder boxes, measuring 6 m^2 with mesh floors and raised 20 centimetres above ground were housed in a thatched house. Natural light was used in the daytime, with no supplementary lighting at night during brooding. On day 29, the chicks were randomly grouped into 40 groups of 10 birds and allocated to four treatments, which were replicated at 10 households, and managed by women. The treatments included: hybrid chicks in pens; hybrid chicks on free range; village chicks in pens; and village chicks on free range. (Free-range is defined as scavenging for food; village chicken are indigenous chicken). Broiler starter feed and water were offered *ad libitum* to both hybrid and village chicks during this period.

The low-fibre sunflower residue diet was offered *ad libitum* to hybrid and village chickens raised in pens (29-84 days), while those on free-range received 75 per cent of the weekly intake of SFR diet of chickens in pens. The finisher diet consisted of low-fibre sunflower residue (SFR), broiler concentrate and maize meal, in the ratio 1.36: 1: 2.18, respectively. About 2,500 kg of sunflower seed was compressed using a ram press and yielded 600 kg of oil and 1,800 kg of sunflower residue. The sunflower residue was passed through a sieve with a 1.4 mm screen to recover a low-fibre, high protein fraction and retain a high fibre, low protein fraction. The low-fibre sunflower residue was used as a protein source in the poultry diet. The maize meal was a product of white maize grain, milled to pass through a 1.0 mm screen using a hammer mill. All feed was mixed in bulk to ensure uniformity. Mixing was done on a concrete floor using shovels, after which the feed was distributed to the participating farmers. Tubular metal hoppers, 40 cm in diameter, carrying 10 kg of feed were used as feeders. Round plastic basins, 15 cm deep and 25 cm diameter wide, were filled with clean water each morning. Feed troughs were cleaned and filled with feed once a week, while the birds were being weighed.

Measurements

Chickens were weighed weekly, on the same day and time, using a hanging balance scale. Daily feed intake was recorded as the difference of feed offered and feed remaining in the feed hopper, and daily water intake as the difference of water offered and water left. Daily temperatures were recorded in the morning at 0600 h, at noon and evening at 1800 h. Two chickens from each of the treatments were slaughtered at eight and 12 weeks to measure dressing percentage, lean, bone, and protein and fat value of meat. Profitability was calculated using prevailing variable input costs and the revenue from sale of chickens at eight and 12 weeks

Chemical analysis

Samples of the experimental diets were analysed according to the methods of the Association of Official Analytical Chemists (1990), Table 1). Analysis was conducted for dry matter (DM), crude protein (CP; N x 6.25), crude fibre (CF), ether extract (EE), calcium and phosphorus. Metabolisable energy (ME) contents of the diets were calculated from the chemical analysis data using pre-established formulae (Wiseman *et al.* 1991):

$$ME\ (kcal/kg) = 4.26X_1 + 9.5X_2 + 4.23X_3 + 4.23X_4$$

The calculated digestible crude protein, fat, fibre and nitrogen free extractives (g/kg feed) are represented by X_1 through X_4 respectively.

Statistical analysis

Data on various parameters of broiler performance were subjected to statistical analysis using analysis of variance (ANOVA); General Linear Model procedure of GENSTAT 5 Release3.2 statistical software.

Results

Feed

Table 1 shows the chemical composition of the local feed ingredients, commercial starter and SFR diets. Compared with the original sunflower residue, the low-fibre SFR fraction contained 28 per cent less fibre and 14 per cent more protein. There were no differences

in the content of oil (EE), ME (MJ/kg), minerals (Ca and P) and amino acids (methionine and lysine). Protein content of the SFR diet (196 g/kg DM) was within the recommended level of 180 g/kg DM for the finishing phase (29-56 days; NRC, 1977). The SFR diet was high in fibre (70 g/kg DM) and oil (120 g/kg DM) compared to levels of 50 g/kg DM fibre and 30 g/kg DM fat, formulated by Agrifoods (Pvt) Ltd, a commercial feed manufacturing company in Zimbabwe.

Table 1 *Chemical composition (g/kg DM) of feed ingredients and experimental diets fed to village and hybrid chickens raised in pens and on free-range*

Feed Ingredient	Feed Ingredient. (%)	CP*	CF	EE	Ca	P	ME Mj/kg)	Methionine	Lysine
Sunflower residue (SFR)		203	202	326	2	10	11.3	8.1	7.2
Diet Ingredients									
Sieved SFR fraction	30	231	145	322	2	10	11.6	8.3	7.3
Maize meal	48	80	36	40	0.2	2.5	14.2	3.6	2.7
Broiler concentrate	22	390	42	29	7.5	9	10.4	14	30
Experimental diets									
Low-fibre SFR	100	196	69	121	6.1	8.7	12.4	0.76	1.04
Commercial starter	100	224	30	28	9.4	8.8	12.3	0.69	1.16

*CP = crude protein; CF = crude fibre; EE = ether extract; ME = metabolisable energy

Table 2 revealed that hybrid chickens in general consumed 64 per cent more feed at eight weeks and 65 per cent at 12 weeks than village chickens ($P<0.001$). At eight and 12 weeks hybrid chickens raised in pens consumed 25 per cent more feed than those raised on free-range, while village chickens in pen consumed 23 per cent more feed at eight weeks and 34 per cent more at 12 weeks than those on free-range ($P < 0.05$).

Table 2 *Performance of hybrid and village chickens fed a low-fibre sunflower residue (SFR) diet, raised in pens and free-range up to 8 and 12 weeks of age*

Up to 8 weeks of age

	Hybrid chickens		Village chickens			
Parameters	Pen	Free-range	Pen	Free-range	s.e.m	Sig*
Live weight (kg/bird)	2.43[a]	1.96[b]	0.72[c]	0.70[c]	7.760	***
Feed consumption (kg/bird)	6.31[a]	5.28[b]	2.32[c]	1.9[d]	1.768	***
Feed efficiency ratio	2.6[a]	2.7[a]	3.2[b]	2.7[a]	1.64	*
Water consumption (litres/bird)	13.70[a]	10.91[b]	4.0[c]	3.43[d]	2.609	***
Water: Feed ratio	2.2[a]	2.1[a]	1.7[b]	1.6[b]	0.25	*

Up to 12 weeks of age

	Hybrid chickens		Village chickens			
Parameters	Pen	Free-range	Pen	Free-range	s.e.m	Sig
Live weight (kg/bird)	3.37[a]	2.54[b]	1.19[c]	1.05[c]	0.833	***
Feed consumption (kg/bird)	13.48[a]	10.66[b]	3.56[c]	2.88[d]	1.925	***
Feed efficiency ratio	4.0[a]	4.2[a]	3.0[b]	2.6[c]	1.05	*
Water consumption litres/bird	29.41[a]	20.85[b]	6.88[c]	5.18[d]	6.573	***
Water: Feed ratio	2.2[a]	2.0[a]	1.9[a]	1.8[a]	0.25	NS

*NS, $P>0.05$; * $P<0.05$; ***$P<0.001$

[abcd] Values with different superscripts in the same row are significantly different.

FER Feed intake: live weight gain ratio

Water: Feed ratio = Relationship between water consumption to feed intake

Water

Hybrid chickens consumed more water than village chickens ($P<0.01$), the increase being 70 per cent and 76 per cent at eight and 12 weeks, respectively (Table 2). The water: feed ratio was significantly high ($P<0.05$) in hybrid chickens compared with village chickens at eight weeks. However, at 12 weeks, there were no significant differences in the water to feed ratio between village and hybrid chickens. The difference in daily water consumption at 12 weeks was higher in hybrids than village chickens ($P<0.05$). At eight

weeks the difference between village chickens in pens and on free range was 29 per cent, while it was 20 per cent between hybrid chickens.

Live weight

Weight gain of village chickens in pens and on free–range was low compared with the hybrid chickens ($P<0.001$) (Table 2). While hybrid chickens in pens were significantly heavier (25 per cent) than those on free-range ($P<0.05$), the differences between village chickens in pens and those on the free-range was small, 3 and 11 per cent) at eight and 12 weeks respectively ($P>0.05$). At eight weeks, feed efficiency (FER) in free-range village chickens was similar to that of hybrids in pen and hybrids on free-range. This was significantly more efficient than in village chickens in pens. However, at 12 weeks FER in hybrid chickens decreased for hybrids in pens and hybrids on the free-range, while the FER in village chickens improved in pens and on the free-range.

Carcass quality

Carcass characteristics of hybrid and village chickens are given in Table 3. Both, plucked dead weight and dressing percentage were high ($P<0.05$) in hybrid chickens compared with village chickens at eight weeks. However, at 12 weeks the difference in dressing percentage was small and not significant ($P>0.05$). The meat to bone ratio was high ($P<0.05$) in hybrid chickens compared with village chickens. Meat yield at eight weeks was less in village chickens due to differences in the shape of their growth curves. Village chickens significantly ($P>0.05$) accumulated more protein in the breast meat tissue, while hybrid chickens consistently accumulated more fat.

Management effect

Table 4 shows the effects of the farmer (management) on the performance of chickens raised in pens and on the free-range, given the low-fibre sunflower residue diet. There were significant differences ($P<0.05$) in mortality between some of the farms. Farm 4 experienced the highest mortality (per cent) followed by Farm 3 and Farm 9, while Farms 1, 5, 6 and 7 recorded zero mortality. Significant differences in live weight were observed during week 5, with farms 4 and 3 producing lighter chickens, while Farms 7, 6, 1 and 2 showed better performance in water and feed consumption.

Table 3 *Carcass characteristics (kg) and nutrient composition (g/kg DM) of lean in hybrid and village chicken raised either in pens or on free-range*

	Hybrid chickens		Village chickens		
At 8 weeks	Pens	Free-range	Pens	Free-range	s.e.m
Plucked dead weight[1]	1.85	1.48	0.67	0.66	0.566
Dressing[2] %	72.9	73.6	60.0	59.8	1.23
Bone	0.25	0.20	0.10	0.10	0.023
Lean	1.10	0.88	0.30	0.29	0.057
Dry matter (DM, g/kg)	975	976	978	977	12.5
Crude protein	692	695	743	739	29.1
Ether extract	491	476	338	334	38.8
Ash	74	69	101	99	19.8
At 12 weeks					
Plucked dead weight	2.58	1.86	1.11	1.00	0.613
Dressing %	66.0	68.6	65.3	65.0	2.51
Bone	0.31	0.23	0.18	0.16	0.031
Lean	1.40	1.05	0.54	0.49	0.059
DM (g/kg)	974	975	973	974	12.3
Crude protein	689	691	745	742	29.3
Ether extract	514	511	340	338	42.4
Ash	83	86	103	102	23.1

[1] Plucked dead weight = live weight of bird less the weight of feathers

[2] Dressing % = percentage of carcass weight (live weight less feathers and offal) (offal = head, heart, lungs, liver, intestine, feet)

Table 4 *Effect of farm (management) estimated by performance of hybrid and village chicken*

Live weight (kg/bird/wk)	**Farm number**											
	1	2	3	4	5	6	7	8	9	10	s.e.m	***Pr >F***
4 weeks	0.37	0.36	0.36	0.34	0.36	0.36	0.36	0.35	0.36	0.36	0.010	***0.469***
5 weeks	0.64	0.69	0.51	0.41	0.67	0.59	0.69	0.56	0.63	0.64	0.083	***0.050***
8 weeks	1.55	1.53	1.43	1.28	1.42	1.52	1.64	1.57	1.51	150	0.098	***0.295***
12 weeks	2.14	2.10	1.93	1.70	2.04	2.18	2.11	2.06	2.11	2.05	0.118	***0.070***
Feed intake (kg/bird/wk	**Farm number**											
	1	2	3	4	5	6	7	8	9	10	s.e.m	***Pr >F***
5 weeks	0.75	0.78	0.51	0.54	0.58	0.49	0.52	0.38	0.50	0.50	0.074	***0.016***
8 weeks	1.00	1.00	1.01	0.84	0.97	1.01	0.98	0.91	0.96	0.97	0.037	***0.05***
12 weeks	1.17	1.16	1.21	1.09	1.17	1.18	1.19	1.10	1.17	1.16	0.036	***0.597***
Water intake (litres/bird/day)	Farm number											
	1	2	3	4	5	6	7	8	9	10	s.e.m	***Pr >F***
5 weeks	0.18	0.26	0.25	0.22	0.23	0.25	0.25	0.20	0.23	0.24	0.067	***0.001***
8 weeks	0.35	0.38	0.28	0.36	0.34	0.37	0.37	0.41	0.37	0.37	0.021	***0.021***
12 weeks	0.54	0.40	0.34	0.41	0.40	0.31	0.41	0.45	0.37	0.36	0.037	***0.001***
Mortality (%)	0.0	2.5[a]	7.5[a]	10.0[a]	0.0	0.0	0.0	2.5[a]	5.0[c]	2.5[a]	0.113	***0.041***

Profitability

The profitability of feeding a low-fibre SFR diet to hybrid and village chickens raised in pens and on free-range is given in Table 5. Hybrid chickens showed a higher gross margin at eight and 12 weeks ($P<0.001$) compared with village chickens. But, at 12 weeks, the return per dollar was better in village chickens compared with the hybrid chickens ($P<0.01$). At eight weeks return per dollar was low in village chickens in pens and high for hybrid chickens in pens, while no difference was observed between village and hybrid chickens on free-range. Within hybrid chickens, gross margin and return per dollar were lower on free-range than in pens. In contrast, village chickens on free-range showed higher gross margins and return per dollar ($P<0.05$) than village chickens in

pens. At 12 weeks compared with eight weeks, the gross margin in hybrid chickens declined, while an increase was observed in village chickens.

Table 5 *Profitability of feeding low-fibre sunflower residue (SFR) to hybrid and village chickens raised in pens and on the free-range at eight and 12 weeks of age*

	Gross Income* (US$ equivalent/bird)	TVC** (US$ equivalent/ bird)	GM*** (US$ equivalent/ bird)	Return per $ Invested****
At 8 weeks of age				
Hybrid birds in pens	7.27[a]	4.08 [a]	3.19 [a]	1.80 [a]
Hybrid birds free-range	5.87[b]	3.57[b]	2.30 [b]	1.60 [b]
Village birds in pens	2.29[c]	1.75 [c]	0.54 [c]	1.30 [c]
Village birds free-range	2.23[c]	1.43 [d]	0.79 [d]	1.55 [b]
CV %	38.3	50.9	32.2	15.5
Pr > F	*0.001*	*0.016*	*0.001*	*0.001*
At 12 weeks of age				
Hybrid birds in pens	10.11 [a]	7.78 [a]	2.32 [a]	1.30 [a]
Hybrid birds free-range	7.61 [b]	6.35[b]	1.27[b]	1.2[a]
Village birds in pens	3.76[c]	2.54[c]	1.21[c]	1.48[b]
Village birds free-range	3.33[d]	2.07[d]	1.27[c]	1.61[b]
CV %	10.2	9.3	46.5	9.2
Pr > F	*0.001*	*0.001*	*0.001*	*0.046*

[Abc] Means in the same column with different superscripts differ significantly ($P<0.005$)

*Gross Income = X*Y

[***]GM = Gross Margin = (X*Y) – (TVC)

[****]Return per dollar invested = Gross Income/ TVC)

X = Live weight of chickens (kg)

Y = Price of chickens $/kg ($900 and $950 hybrid and village birds respectively)

[**]TVC = Total variable costs (Costs directly related to production e.g. feed, water, labour)

CV Co efficient of variation

Discussion

In the present study, the low-fibre SFR diet was given to hybrid and village chickens raised in pens or on free-range, and managed by 10 women at their homesteads in Zimbabwe. The low-fibre diet was achieved by passing SFR through a 1.4 mm screen to recover the low-fibre, high protein fraction for inclusion in poultry diets. Reduction in fibre content was important, since fibre causes negative utilisation of energy. The corresponding reduction of chlorogenic acid, a phenolic compound associated with sunflower hulls is also important since it is known to interact with the amino group of lysine and thus decrease its availability (Sen and Bhattacharyya, 2000).

Live weight

Indigenous chickens are genetically slow growing and tend to have a low mature body weight at the same age as hybrid chickens. This was demonstrated in the current study where hybrid chickens were heavier in pens and on free-range than village chickens in pens and free-range. However, these weights were higher when compared to village chickens and hybrids when a standard commercial diet was given (Mupeta *et al.*, 2002).

At eight–12 weeks, hybrid chickens in pen were 19 per cent heavier than hybrid chickens on free-range ($P<0.05$), while village chickens in pen and those on the free-range showed a small difference of 3 per cent ($P>0.05$). The small difference could be linked to the natural instinct and ability of village chickens to scavenge under free-range. Village chickens raised on free range showed a high content of insects in their crops after slaughter, including grasshoppers, earthworms and fly larvae, while the crops of the hybrid chickens contained mainly the SFR diet. These insects are rich in protein ranging from 42 per cent CP in fly larvae, 60 per cent CP in earthworm to 76 per cent CP in grasshoppers (Newton *et al.,* 1977; Gohl, 1981; Sugimura *et al.*, 1984). Gohl, (1981) showed that the amino acid content of protein from insects was similar to that of fishmeal, an exceptionally good source of high quality protein. The better performance in village chickens on free range is supported by a good FER at 12 weeks compared with hybrid and village chicken in pens. These findings agree with Ayorinde (1991), who reported poor feed conversion when local fowl in Nigeria were kept intensively. The FER of hybrid chickens decreased in weeks eight-12 by approximately 54 per cent, while that of village chickens increased by 1.8 per cent with chickens on free-range being more efficient (Table 2). The above argument is supported by the difference in daily feed intake between village chickens on free-range and those in pens of 23 per cent at eight weeks and 34 per cent at 12 weeks respectively. It may be speculated that at 12 weeks, village chickens on free-range were substituting the concentrate diet for scavenged feedstuffs. It is reasonable to assume that being summer, the chickens were eating more insects as illustrated by the contents of the crops of slaughtered chickens. Thus, it may be suggested that compared with hybrid and village chickens at eight weeks, village chickens utilise feed more efficiently at 12 weeks when they are allowed to scavenge on free-range but given a concentrate diet as a supplement. However, the disadvantage of free-range is the fluctuation in the nutritive value and variability of feedstuffs, which may be influenced by the seasonal pattern. The high performance of hybrid chickens observed in the current study is in accord with the standard practice of marketing hybrid chickens at eight weeks, when efficiency of feed utilisation is high. Beyond eight weeks, profit is diminished due to inefficient feed utilisation. On the other hand it may still be profitable to keep village chickens beyond 12 weeks due to the improved feed utilisation efficiency. The slow growth in village chickens may be viewed as an advantage, as it

ensures a regular supply of fresh meat to the household over a longer period. However, the subject is beyond the scope of the present study.

Carcass characteristics

The mean dressing percentage in village chickens was low at eight weeks compared with hybrid chickens. But the difference tended to diminish at 12 weeks, in penned and free-range hybrids compared to village chickens in similar treatments. This confirms previous findings (Mupeta *et al.,* 2002) that up to eight weeks of age, offal (digestive tract, feet, head and neck) in relation to carcass, grow at a higher rate ($P<0.05$) in village chickens compared with hybrid chickens. The carcass yield in village chickens was lower ($P<0.05$) compared with hybrid chickens at 12 weeks and at eight weeks. However, the quality of breast meat tissue of village chicken appeared more favourable in terms of high protein and less fat compared with fat in hybrid chickens. The high protein in village chicken breast meat tissue is likely to be due to the increased muscle development required for scavenging and, at times, flight (Ayorinde, 1991). Similarly, the low percentage of body fat may be a consequence of the arboreal or feral mode of living. High dietary fat intake is linked to incidences of cardiovascular disease and cancer and high body fat deposition is associated with inefficient energy metabolism, representing an economic loss to the producer (Pasternak and Shaley, 1983).

Water consumption

Many factors are known to affect water intake: genetic, dietary salt concentration, source and concentration of dietary protein and physical form of the diets (Marks, 1979). In the present study, hybrid birds in general consumed 74 per cent more water than village chickens, with hybrids in pen consuming 26 per cent more water than those on free-range, while village chickens in pen consumed 21 per cent more water than those on free-range. Water intake was related to feed consumption. Although hybrid birds consumed more feed and more water, no significant differences in water: feed ratios were found at 12 weeks between hybrid and village chickens. However, at eight weeks, the water: feed ratio was significantly lower in village chickens compared to hybrid chickens. The reliability of the empirical rule suggests that a bird will drink twice the weight of its feed intake (NRC, 1977). This concurs with the present study, where, at 12 weeks the water: feed ratio ranged from 1.8 to 2.2 in hybrid and village chickens, respectively. Gardiner and Hunt (1984) reported a water: feed ratio of 1.75 in the ninth week of feeding in meat–type chickens and showed a positive correlation coefficient ($r^2 = 0.97$) between water and feed intake. Water intake is more dependent on the availability of feed than feed is on the availability of water (Marks and Brody, 1984). It may be speculated that the observed difference between village chickens could be due to water economy, a survival mechanism developed by village chickens on free-range.

The ability to estimate the amount of water consumption of growing chicks is important because water supply is a limiting resource among most of the smallholder farming areas especially those located in the marginal agroecological regions of Zimbabwe.

Management effect

Live weight, feed intake, water intake and mortality were used as indicators of management ability between farms. The effects of the different treatments for each of the indicators were pooled together in order to facilitate comparisons. There were significant differences in management related to mortality, feeding and watering the chickens. However, difference in management only approached significance at five and

12 weeks. Week five coincided with a change of diet from commercial starter to the low-fibre SFR diet. Farm four experienced the highest mortality and consistently showed low management for all parameters. Farms one, five, six and seven experienced zero mortality and appeared to apply reasonable management practices. Successful poultry management requires the application of factors including skills, labour, feed and water management, record keeping, aptitude, hygiene and health. Patullo (1987) reported output between farms to be influenced by differences in farmer's working knowledge of animal nutrition, disease and aptitude. Aptitude may be expressed as the ability of the farmer to decide on certain critical operations in order to take corrective measures before major problems arise. All the farmers kept records as a requirement to participate in the study, but the use of these records as a reference tool for budgeting and planning tended to vary with farm.

Profitability

Gross margin analysis and return per dollar invested were employed to evaluate the profitability of feeding a low-fibre SFR diet. Gross margins in village chickens increased with age, being higher at 12 weeks than eight weeks, while gross margins in hybrids decreased. At 12 weeks, return per dollar from village chickens was significantly higher ($P<0.05$) compared with hybrid chickens. Up to eight weeks, it was more profitable to feed hybrid chickens ($P<0.001$) as both gross margins and returns per dollar were significantly higher compared with village chickens. Previous experiments showed similar results of hybrids out-performing village chickens under improved management when a commercial diet was fed (Mupeta *et al.,* 2002). Village chickens on free-range, but supplemented with a low-fibre SFR diet showed superior gross margins and returns per dollar compared with village chickens raised in pens. These results show that low-fibre SFR may be a viable option in poultry diets to feed both hybrid and village chickens in pens or as supplements on free-range.

Conclusion

Low–fibre sunflower residue included in the diet is a viable option for improving production in smallholder–owned poultry. No adverse effects on performance, from feeding sunflower seed residue were observed. Hybrid chickens reared on free-range showed limited scavenging ability. Village chickens are poorer feed converters in pens than on free-range. However, the performance of village chickens improved with age, with improved feed efficiency, gross margin and return per dollar at 12 weeks compared to eight weeks. The meat of village chicken contains more protein and less fat than hybrids, indicating possible market advantages for village chickens.

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Discussions, questions/comments on the presentation

Question: *The free-range poultry tended to do better than caged poultry despite the many challenges of free-range poultry production. Why was this?*

Answer: Free-range village chickens had a higher feed conversion ratio than the village chickens in pens. Those on range tended to eat nutritious grasshoppers in addition to concentrate supplementation. Hybrid chickens on range performed poorly because they had limited scavenging habits.

Question: *What were the major disease problems in the village chicken?*

Answer: The major disease was Coccidiosis. Newcastle disease was no longer a disease problem since birds were vaccinated at a day old.

Question: *In some countries, e.g. Bolivia, people generally prefer village chickens over broilers because of taste, appearance etc. and are prepared to pay more for the local birds. Is this so in Zimbabwe? If so, it gives an important advantage to local birds, which have shown their potential in your work.*

Answer: There is a demand for local birds and many people seem to prefer them but the marketing system is not well developed and often access for the smallholder producer is limited.

Question: *What is the difference in price between local chicken and hybrid broilers in prices?*

Answer: The average broiler price is Z$ 23,000/Kg (November 2004; US$ 4). The average price of local chicken is US$ 3.

Small-scale poultry production in peri-urban areas in Ghana[1]

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Abstract

Smallholder poultry production, where highly selected birds are managed under relatively intensive conditions for production of meat or eggs, is one of the livestock enterprises associated with peri-urban agricultural systems in Ghana. This constitutes a means of livelihoods and supplies food to city dwellers. This study was conducted in peri-urban Accra and Kumasi Metropolitan areas to identify the role and importance of backyard poultry production to peri-urban livelihoods, to examine the business decision making process, and to identify constraints to backyard poultry production. A semi-structured interview schedule, including topics such as ownership, feeding of chicken, health of chickens, labour and business records, was used. Responses were compared between variables by chi-squared analysis.

There were 135 respondents in the survey data set. The typical respondent (86.5 per cent) was owner of the enterprise. The majority had some education although 43 per cent had no or only primary education. Poultry keeping was the main occupation (44 per cent), although only a minority of respondents (11 per cent) relied solely on chicken keeping for their livelihoods. A majority (36 per cent) kept layers, broilers and cockerels. Significantly larger bird populations occurred in Kumasi area compared to Accra (Chi square=12.3, P=0.03). The majority of farmers collected records on a daily basis but tended to refer to them on a weekly or monthly basis.

Constraints were identified in the areas of husbandry, feeding and health, availability of inputs, information and credit. Small-scale poultry farmers also encountered problems in marketing produce. Only a limited range of feedstuffs namely, maize, wheat bran and fishmeal were used by respondents as major components of the diet for all classes of birds. Most farmers had limited knowledge or access to ration formulations. Access to public extension service support was only 58 per cent overall and varied significantly between the Accra and Kumasi sites (Chi square = 14.6, P = 0.001). Similarly, just 52 per cent of respondents belonged to a local poultry producers association. More respondents in Accra belonged to associations than in Kumasi (Chi square =4.1, P=0.04). The poor extension coverage and low patronage of associations imply limited access to information, goods and services for peri-urban poultry producers.

It was concluded that backyard poultry production played an important role as the main or secondary occupation for peri-urban livelihoods in the survey. However, small-scale

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poultry producers are confronted with several constraints associated with inputs, cost and quality, and marketing of produce. It is important to assist these farmers with training and information. In particular empowerment in the areas of feed formulations, formation of marketing groups and business management information would help to sustain small-scale production of commercial backyard poultry in peri-urban environments.

Introduction

The peri-urban environment in Ghana, as in other developing countries, occurs at the interface between rural and urban areas. A rapidly increasing population and dwindling agricultural lands characterize these areas. Smallholder poultry production, where highly selected birds are managed under relatively intensive conditions for the purpose of producing either meat or eggs, is one of the livestock enterprises associated with peri-urban agricultural systems that have become a feature of urbanisation in many countries in the developing world. This constitutes a means of improving livelihoods and suppling food for the cities (Ghana Poultry Farmers Association, 2000). Few studies have been made of these businesses (Boa-Amponsem and Sackey 1993; Essien, 1994; Brepulo *et al.*, 1995). This study was conducted in peri-urban Accra and Kumasi Metropolitan areas with the following objectives:

1. To identify the role and importance of backyard poultry production to peri-urban livelihoods

2. To examine the business decision making process for improvement of the system

3. To identify the constraints to backyard poultry production and the interventions required to eliminate them.

Materials and methods

The study was carried out in the Accra-Tema and Kumasi Metropolitan areas. The administrative districts in Accra were Ga and Awutu-Afutu-Senya (AES) where 61 farms were surveyed. The districts covered by the study in the Kumasi administrative area were Atwima, Sekyere West, Kumasi Metropolitan area (KMA) and Kwabere where 149 farmers were interviewed. The small-scale farmers in each district were identified with the aid of Agricultural Extension Agents and purposive sampling employed to establish the study group.

Two methods were employed for data collection: 1) a rapid rural appraisal (RRA), involving focus group discussions followed by; 2) a sample survey or participatory rural appraisal (PRA). For the RRA, a semi-structured interview schedule including topics such as ownership, feeding of chicken, health of chickens, labour and business records was used. The responses were used to design the survey questionnaire, which was tested, and modifications made for use in the PRA. Ten enumerators were involved in the administration of the questionnaire. All were given a one-day training session when they were introduced to the objectives of the study and taken through the questionnaire. The questionnaire was administered in the local languages that were predominantly Twi, Fante and Ga-Adangme. Descriptive statistical analysis was performed on the data. Responses were compared between variables by chi-squared analysis, using contingency tables where there were several possible outcomes.

Results and Discussions

There were 135 respondents in the survey data set after editing; the majority (93 per cent) were male. The typical respondents (86.5 per cent) were largely the owners of the enterprises. The majority had some education although 43 per cent had no or only primary education.

Peri-urban livelihoods

With regards to peri-urban livelihoods, poultry keeping was claimed as the main occupation (44 per cent), although only a minority of respondents (11 per cent) relied solely on chicken keeping for their livelihoods. Means of livelihoods of respondents other than poultry keeping were: farming (42.2 per cent), trading (22.9 per cent), and miscellaneous (23.7 per cent). Hiring labour for poultry enterprises was comparatively common (Figure 1). Forty eight per cent claimed to hire labour. While a majority hired one or two workers only, the 134 farms in the sample provided employment for 158 workers. Figure 1 shows the relationship of total flock size to mean number of hired workers employed per production unit. Farms within size categories varied markedly in the number of staff employed; however, as can be seen from Figure 1, the number of workers increased exponentially with total flock size. The result clearly underscores the importance of small-scale poultry keeping in the livelihoods of these peri-urban dwellers. Downstream, marketing of eggs and poultry provide employment for women.

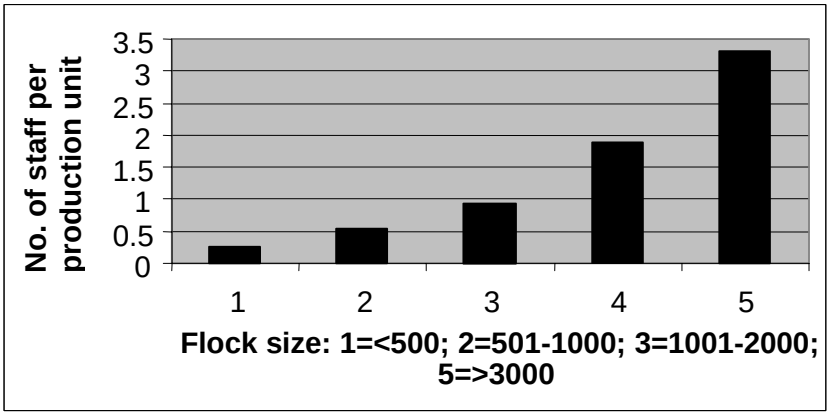

Figure 1 *Mean number of hired workers per production unit by flock size category (total number of birds)*

Respondents kept various populations and combinations of chickens types (Figure 2), including layers, broilers and cockerels (males of layer lines). A majority of respondents kept laying birds, and most producers kept more than one class of poultry. Over a third of respondents (36 per cent) kept all three classes of poultry. Very few producers (10 per cent) were without laying birds, whereas an appreciable proportion (28 per cent) had no meat birds and specialised in egg production.

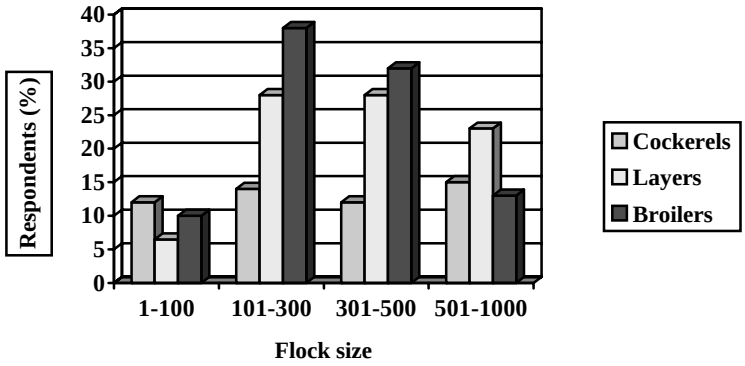

Figure 2 *Flock sizes*

Significantly larger bird populations occurred in Kumasi area compared to Accra (Chi square=12.3, P=0.03).

Record keeping and business decision making

In order to examine the basis of business decision making a number of questions were asked on the collection and use of records. One-hundred-and-three out of 127 respondents (81 per cent) claimed to keep written records. However, the number increased when farmers were asked if they kept production records and financial records, with 96 and 95 per cent, respectively, answering positively. Farmers were asked if they kept a series of both production and financial records. The numbers answering positively are shown in Table 1.

Table 1 *The number of farmers (out of 127 respondents) keeping specific production and financial records*

Record	Number of keeping records
Production records	
No. of eggs produced	107
Weight of birds produced	32
Feeds/drugs/vaccines given	84
Mortality	101
Inventory of birds	69
Financial records	
Income from sale of eggs	103
Income from sale of birds	107
Expenditure on feed/feed ingredients purchased	107
Expenditure on drugs/vaccines	102

Most records were apparently kept by a majority of farmers, although not all records were relevant to all farmers. However, comparatively few farmers (32) kept records of the weight of birds sold, and the amounts of feeds, drugs or vaccines given. Record keeping and its use were investigated further with a series of questions about the frequency with which farmers collected, inspected, analysed and referred to records.

Most farmers collected records on a daily basis but tended to refer to them on a weekly or monthly basis (Figure 3). Thus records were not likely to have an immediate influence on the daily business decision making process. Twenty per cent of farmers claimed never to analyse or refer to the records (Figure 3).

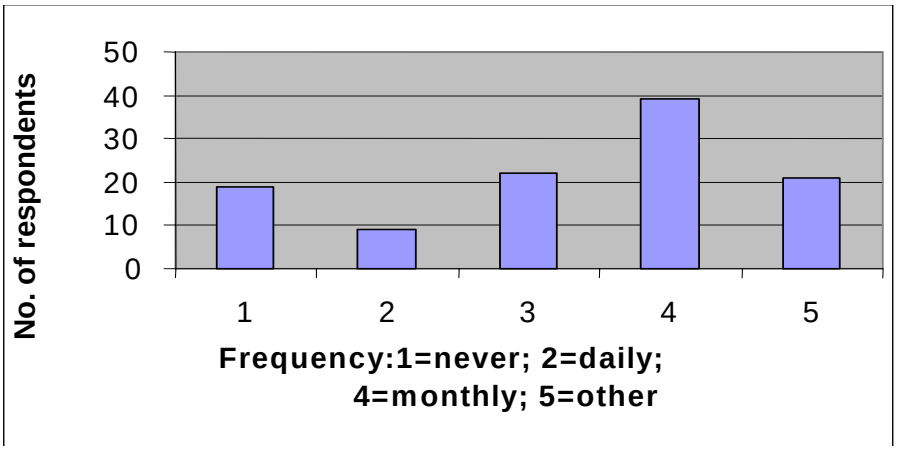

Figure 3 *Number of respondents (n=110) referring to records daily, weekly, monthly or never*

When asked how they determined the profitability of their poultry enterprise, the majority of the farmers identified the option of deducting the cost incurred from the income. Thus while record keeping was widespread, it was not the basis for business decisions. Motives relating to income generation appeared the more important basis for business decisions. Participatory exercises involving budgeting and a longitudinal survey reported elsewhere suggested that the majority of farmers either did not keep records or, if they did, did not use them for calculating profits, or in planning and evaluation of their businesses (Aboe *et al.,* 2003).

Farmers were asked about their motives for keeping different classes of poultry, broilers, layers or cockerels. A number of options were proposed and farmers were asked to give a score for each poultry class (Figure 4). Not surprisingly, producers keeping broilers, layers and cockerels identified all three classes of poultry as a means of supplementing their income and there were no significant differences between classes of poultry (Chi square = 10.98, df=8, P=0.203). However, while producers keeping broilers and cockerels identified keeping such stock as being a means of providing a quick income, producers with layers recognised that egg production was a longer-term investment (Chi square = 119.638, df=8, P<0.001).

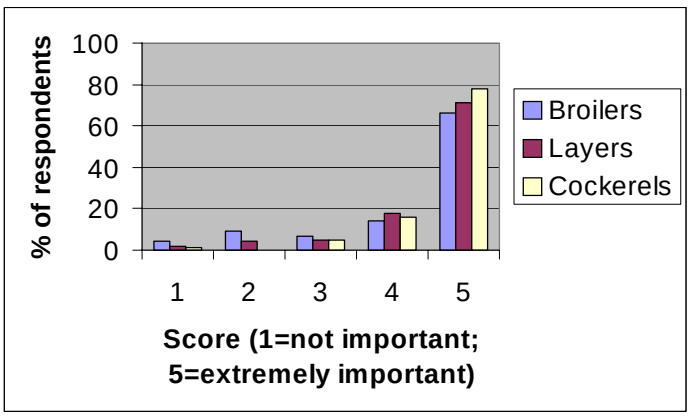

Figure 4 *Percentage of respondents awarding scores 1-5 for the importance of keeping broilers, layers and cockerels as a means of supplementing income*

There were differences between producers of different classes of poultry in their attitude towards supplying seasonal markets (Chi square = 138.162, df=8, $P<0.001$). Whereas broiler producers recognised the need for marketing to coincide with a major festive season, this was not important to the producers of cockerels. Keepers of laying birds showed some acknowledgement of the importance of seasonal festivals. However, it is likely that the importance was related to the disposal of spent hens rather than eggs.

The three groups of producers also differed in their attitudes to the importance of their product being easy to sell (Chi square = 57.793, df=8, $P<0.001$). Keepers of laying birds were generally in agreement that the ease of selling eggs was important in influencing their decision to keep layers. Broiler producers were generally ambivalent about the question, there being no clear opinion, apart from the fact that very few respondents ranked the reason as worthy of score 5. On the other hand, there did seem to be some consensus among keepers of cockerels, with 54 per cent of respondents awarding scores 4 and 5 to the question.

Clearly three types of chickens: broilers, cockerels as well as layers were kept. Layer production appears to be the core poultry activity and a long-term, steady business where the product can be marketed with reasonable assurance of making a profit.

The large-scale production of cockerels is an interesting development. Elsewhere in the world, males of layer strains are usually killed at birth. Such day-old chicks can, therefore, be bought very cheaply. A further advantage is that husbandry of cockerels is more or less like that of free range indigenous chickens (Aboe *et al., 2003*) and less exacting. The fact that cockerel production seems to be a year-round activity, with little emphasis on seasonal production for festivals, suggests a steady demand for this type of bird.

Constraints

Constraints were identified in the areas of husbandry, feeding and health, availability of inputs, information and credit. Small-scale poultry farmers also encountered problems in marketing produce (Okantah *et al.,* 2003). In this paper attention is focused mainly on the feed constraint. Farmers were asked a series of questions related to problems associated with feeding chickens. The perception of respondents was that the cost of feed was high (65 per cent), its quality changed frequently (50 per cent) and it was sometimes not available (55 per cent). A majority (60 per cent) of respondents claimed to purchase compound feed while 34 per cent mixed their own. The remainder did both. The relationship between the percentage of producers practising home-mixing, buying compound feed, or doing both, and total flock size is shown in Figure 5. No particular trend emerges, except that producers with between 2001-3000 birds seem to favour home mixing to a greater extent than other categories of total flock size. Chi square analysis (where 'home-mix' and 'both' categories were pooled) confirmed that this is a significant difference (Chi square = 13.143, df = 4, $P=0.011$).

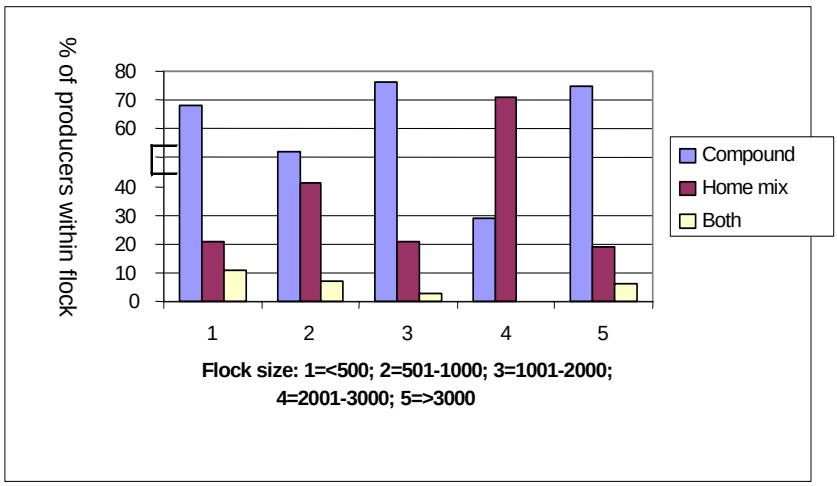

Figure 5 *The percentage of producers buying compound feed, home mixing or doing both within flock size categories (total number of birds)*

Possible differences in the use of home-mixing between the Accra and Kumasi study sites were also investigated. The percentages of producers practising home-mixing, buying compound feed or doing both in Accra and Kumasi are shown in Figure 6. As can be seen, home-mixing was more frequently found in the Accra compared to the Kumasi study site. A chi square test (where 'home-mix' and 'both' categories were pooled) shows the difference to approach statistical significance (Chi square = 3.569, df=1, *P*=0.059).

When asked about ration formulation, 50 respondents, in addition to those claiming to home mix admitted to adding a purchased concentrate to other feed ingredients. Therefore, the numbers of producers that practice home-mixing rises to 104, or 78 per cent of respondents.

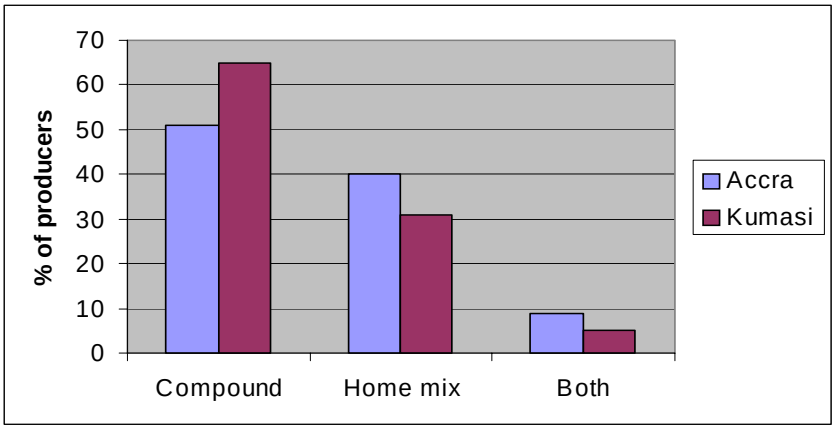

Figure 6 *The percentage of producers buying compound feed, home-mixing or doing both within the Accra and Kumasi study sites*

Few respondents were prepared to disclose the sources of ingredients used in home-mixing. However, seven out of 11 respondents providing answers bought their ingredients on the open market. A greater number of respondents were prepared to

disclose the source of feed formulations used for home mixing (Figure 7). About 2 per cent of respondents calculated their own diet formulations, while approximately the same percentage relied upon friends. Less than 20 per cent of respondents obtained feed formulations from agricultural extension agents.

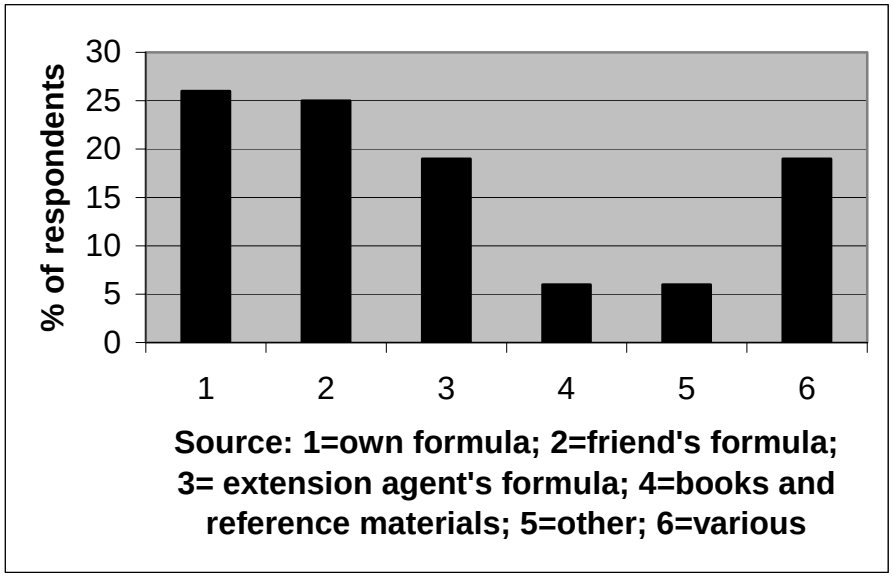

Figure 7 *Source of feed formulations for home mixing poultry diets (n=53)*

The ingredients used in home-mixed diets are shown in Table 2. All respondents, for broiler, layer and cockerel diets, used maize as the main ingredient. Wheat bran was also used in most diets. A large percentage (79, 72 and 81 per cent of respondents mixing broiler, layer and cockerel diets, respectively) used a commercial concentrate. Thus a simple diet given to broilers, layers and cockerels by a number of producers was 50 parts maize, 25 parts wheat bran and 25 parts commercial concentrate. Locally available sources of vegetable protein (copra cake and groundnut cake) were not favoured. Cassava was used infrequently and in very small amounts.

Table 2 *The number of respondents volunteering information on various ingredients included in broiler, layer and cockerel diets*

Ingredient	Broiler	Layer	Cockerel
Maize	61	78	54
Wheatbran	58	78	50
Fishmeal	15	22	9
Copra cake	6	10	3
Groundnut cake	2	5	3
Soya bean	4	7	2
Spent malt	0	1	1
Premix	10	20	8
Cassava	3	2	1
Salt	12	20	7
Shell	9	16	6
Concentrate	48	56	44
Other	7	8	12

Almost all respondents offered feed as a mash. A majority (82 per cent) fed their chickens twice daily, the remainder feeding once or three times per day. Surprisingly, only 53 per cent of farmers fed their chickens *ad libitum*. In general, respondents were satisfied with the service and quality of feed provided by commercial feed mills.

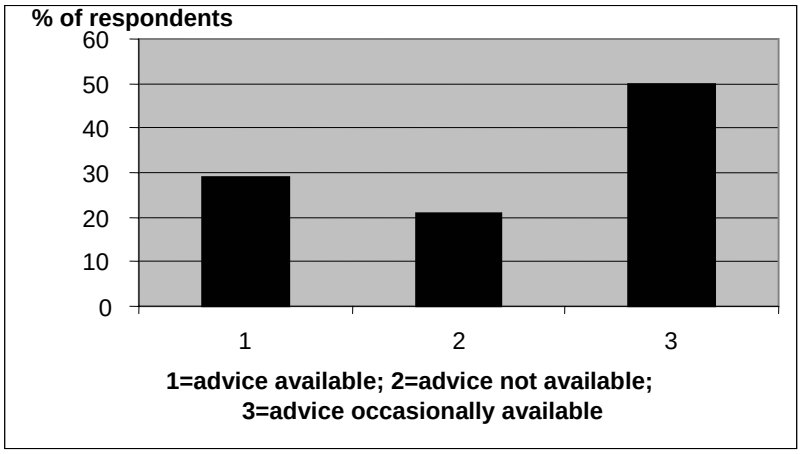

Figure 8 *Respondents' (n=124) perceptions of the availability of advice on feeding*

Responses to questions about the availability of feed confirm previous findings. Few farmers found feed to be unavailable but a majority (55 per cent) experienced occasional difficulties in obtaining supplies. Rather predictably, a majority (65 per cent) of respondents found feed to be expensive or to rapidly escalate in price (29 per cent). While few farmers complained about the quality of feed (again confirming previous findings), 50 per cent considered feed quality changed frequently. However, 45 per cent of farmers were satisfied with feed quality. When questioned about the availability of

advice on feeding poultry, 21 per cent said that advice was never available while exactly half considered that advice was occasionally available (Figure 8).

As advice on feeding was only 'occasionally' available it can be inferred that backyard chicken producers may lack access to vital information for efficient and sustainable production. Relatively few producers who were home-mixing obtained feed formulations from their agricultural extension agent. About 50 per cent had their own formulation or used a friend's. Clearly, the limited range of feed ingredients, lack of feed advice and farmers' limited knowledge or access to ration formulation would result in poor feeding of chickens and poor productivity

Availability of day old chicks (DOC) from seven different sources was affirmed by 47 to 100 per cent of respondents. The high quality of DOC was affirmed by 61 to 100 per cent of respondents. The three most important diseases mentioned by respondents were gumboro (infectious bursitis), coccidiosis and Newcastle disease. Access to public extension service support was only 58 per cent overall and varied significantly between Accra and Kumasi sites (Chi square=14.6, P=0.001). Similarly, just 52 per cent of respondents belonged to a local poultry producers association. More respondents in Accra belonged to associations than in Kumasi (Chi square =4.1, P=0.04). The poor extension coverage and low patronage of associations imply limited access to information, goods and services for peri-urban poultry producers.

Marketing, Extension and Producer Associations

The marketing concerns of the producers were clearly identified as the low prices offered by middlemen and the competition offered by imported products. A very large percentage (83 per cent) of farmers sold from the farm gate. Marketing is clearly an area that deserves attention from producers. Studies of marketing broilers in Accra that form part of this project confirm that caterers and supermarkets are the most promising outlet for home-produced birds (Ameleke *et al,* 2003). Farmer associations (Okantah, 2003) would seem to be a way forward to improve farmer share of the final product price, replacing the present middlemen. There was evidence of the availability of limited extension advice, including health care, from government sources, private practitioners, and farmer co-operatives. Difficulties with marketing, particularly marketing poultry meat, have already been referred to. Farmer associations should be a means of empowering small farmers, giving them greater influence not only in obtaining inputs but also in terms of obtaining satisfactory prices for their products. Extension services and non governmental organisations (NGOs) could well play a part here, helping associations to develop the necessary skills to undertake this important role.

Conclusions

Perhaps one of the most important changes that could be achieved by small-scale poultry producers is to organise themselves effectively into producer associations and to acquire the skills required to effectively market their products, thus achieving a greater share of the final product price. Such organisation might also lead to improvements in the supply of inputs such as vaccines and day-old chicks, both of which are a concern to some of the farming community. Large, powerful associations may also be able to hire specialist advisors, or provide the incentive for the development of private practitioners. The state sector is perhaps best placed to encourage and hasten this development by advising and helping small farmers to set up and organise such associations. Given that such

associations have not always been successful in the past, firm guidance from the state sector would seem to be essential.

Backyard poultry production plays an important role as the main or secondary occupation for the peri-urban farmers participating in this survey. Small-scale poultry producers are confronted with several problems. Constraints associated with inputs such as availability of day old chicks, feed availability, cost and quality and marketing of produce among others, post a gloomy and uncertain future for the industry. It is important to assist farmers with training and information. In particular, empowerment through training in the areas of feed formulations, formation of marketing associations and business management information would go a long way to sustain small-scale production of commercial poultry as a backyard activity in peri-urban environments. Other aspects of this Project R7631 (Yates *et al., 2004)* addressed some of these needs.

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Discussions, questions/comments on the presentation

Question: *How do you define peri-urban farmers, since the concept of 'peri-urban' is continuously changing?*

Answer: They are resource-poor smallholder families, with limited land holdings, living around the periphery of cities and towns and deriving their livelihood from their land.

Question: *What is the difference in price between local and broiler chicken?*

Answer: Broiler hybrids attract a higher price than village chicken, because the price of broilers is related to prices in the supermarkets. The price of village chickens is negotiable but is usually fair to producer and consumer.

Question: *Is a flock size of 101-300 regarded as small-scale poultry production?*

Answer: The official definition of a small-scale poultry flock in Ghana is less than 2000 birds. Flock sizes below 100 are generally not economically feasible.

Question: *Is it right that extension messages on feed mixing reach only 30 per cent of farmers?*

Answer: Seventy per cent of farmers, or more, have poor accessibility to advice on feed formulations.

Question: *Should the marketing system used in Bangladesh be promoted elsewhere?*

Answer: The middlemen exist in Ghana but offer very low prices. It would be interesting to see the Bangladesh model.

Question: *Is the 93 per cent response by men to the survey a reflection of the gender split in the Ghanaian backyard poultry industry or is it because of bias in the sample selection?*

Answer: The sample selection was not biased. Men are the main income-earners for the family. But their wives are involved in the poultry enterprise.

Improving productivity of scavenging poultry in Indian villages by the use of improved hatching egg management[1]

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Abstract

So-called village or scavenging poultry systems are characterised by low-inputs. However they are often an important source of income for the poultry keepers, particularly for the poorest of the poor and more specifically women. Village poultry products (i.e. eggs and meat) may be consumed by the poultry keepers or their family or used for sacrifice, but invariably the products will be traded in one form or another. Losses may occur at several stages of village production but data from an earlier study indicated that there was considerable scope to improve the percentage of chicks that hatched from each clutch of eggs incubated in the summer months and, to a lesser extent, the winter months also. Two interventions were evaluated in the Indian state of Rajasthan; candling and a modified egg storage container that used evaporative cooling to try and reduce the temperatures experienced by the eggs when they were stored prior to being incubated. Candling eggs during the cooler winter months showed 28 per cent of the eggs to be apparently infertile. Eggs were also candled during the summer months of two consecutive years. The increased summer ambient temperatures were associated with an increase in apparent infertility (to 41 and 43 per cent in the first and second summer respectively). The percentage hatch of all eggs laid from the summer control treatment ranged from 39 to 40 per cent, whereas the comparable figures for the cooled storage treatment ranged from 59 to 61 per cent. Notably the comparable winter figure was 59 per cent - very similar to the figure achieved for the cooled storage treatment. The biological mechanisms that may underpin these data are discussed, as are the implications for these findings.

Introduction

Scavenging poultry systems tend, as the name implies, to be low-input systems and in part because of this they can be found in most African and Asian villages (de Haan, 1999, Rangnekar and Rangnekar, 1999; Kumtakar and Kumtakar, 1999). Poultry have an innate ability to scavenge for feed and, unlike goats or cattle, are relatively inexpensive to

[1] 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. R7633, Livestock Production Research Programme.

purchase, reproduce easily and have a relatively short reproductive cycle (~6 months to sexual maturity and a three-week incubation period). Consequently the poorest, landless people can own poultry (Conroy *et al.*, 2004). Indeed it is notable that irrespective of the relative wealth of the poultry keeper's family it is often the women in a family that will be responsible for the poultry. Unlike some animal products poultry also benefit from the relatively few cultural restrictions that affect the consumption of poultry products. Thus there is a ready market for the eggs and the meat from the hen, either as a commodity to be sold or for use by the family as a gift, sacrifice or as a source of food (and, in the case of eggs, feed for oxen etc). It is not surprising, therefore, that many agencies have sponsored projects aimed at improving the productivity of these 'walking banks' (Rangnekar and Rangnekar, 1999).

The size of traditional scavenging poultry flocks owned by both African and Asian poultry keepers appear to be very similar, suggesting that the limits to flock expansion are similar on both continents. While factors such as the feed resource are likely to influence flock size it is probable that disease is one of the main constraints. Thus when flocks are routinely vaccinated against diseases such as Newcastle disease the average flock size increases (Alders and Spradbrow, 2001). Attempts have been made to enable village poultry keepers to produce poultry under semi-intensive systems of production. In essence members form a cooperative with themselves taking on specialists roles and forming structures not dissimilar to those seen in an integrated company (e.g. pullet rearer, egg producer, feed seller, vaccinator, egg seller). This approach, pioneered and developed by Danida (the Danish International Development Agency), has come to be known as the Bangladesh model – named after the country in which most of the development was undertaken. While this model has many advocates it is the view of the authors that there is still a role for the traditional scavenging poultry model and that in some circumstances it is preferable to the Bangladesh model (Conroy *et al.*, 2004). This paper focuses, therefore, on the traditional system, however, many of the issues addressed are equally applicable to the semi-intensive system.

While the focus is on the traditional scavenging system, that is not to say that there is nothing to be learned from the best exponents of commercial poultry production, be it extensive or intensive. A sentiment often expressed by these producers is that it is 'attention to detail' that will make the difference. This is, however, arguably at odds with the view of many scavenging poultry keepers who consider their poultry to be of little or no value until they reach the point of use, be it for trade or home use (Rangnekar and Rangnekar, 1999). This attitude may stem from the sporadic outbreaks of disease that affect scavenging poultry, many of which can decimate a flock. Unfortunately this can make it difficult to persuade poultry keepers to make even small investments in their poultry, including not vaccinating their birds against the main diseases, such as Newcastle Disease, and not using an anthelmintic to reduce the number of endoparasites carried by the bird.

It is appropriate, therefore, to consider where in the production system the biggest losses occur and to identify those that may be addressed by simple low input (in terms of both finances and time) interventions.

Having gathered detailed production data over a period of 18 months on many flocks (down to and including the level of the individual bird) in the Indian State of Rajasthan we have identified that hatchability during the summer months falls significantly. Hatchability data are important because they are a key indicator of the success with which farmed poultry reproduce. Hatchability is normally expressed as a percentage of

the total number of eggs incubated that produce a viable chick, or the percentage of the fertile eggs incubated that produce a viable chick. These two measures are often referred to as 'hatch of all eggs set' and 'hatch of all fertile eggs set' respectively. It is important when considering hatchability data to be clear about which of these two data sets is being considered, as they are influenced by different criteria. The 'hatch of all eggs set' figure is determined by both the fertility of the egg (a flock management issue) and the success of the incubation process. In contrast the 'hatch of all fertile eggs set' figure should be solely an indicator of the success of the incubation process. Under typical commercial conditions the average hatch of all eggs set and all fertile eggs would be 84 and 90 per cent respectively (Cobb, 1997). The poor hatchability associated with the summer months resulted in poultry keepers placing fewer eggs for incubation. In addition, of the eggs that were placed a significant number failed to produce a viable egg and represented a waste of resource and time.

It was decided, therefore, to investigate the way in which the hatching eggs were handled prior to incubation because it is common practice for Indian village poultry keepers to store eggs before they are incubated. This was considered to be important because the conditions under which an egg is stored can have a significant effect on its hatchability (Walsh *et al.*, 1995). Optimal storage conditions for hatching eggs are 15°C at 75 per cent relative humidity with the egg being stored for no more than seven days. Of these three parameters it is the control of temperature (i.e. maintaining storage temperature below the physiological zero (27°C)) that is the most important factor. However, for most village poultry-keepers, the storage of eggs under controlled environmental conditions is not possible and in the warmer months of the year the ambient temperature will regularly exceed the critical, as far as egg storage is concerned, temperature of 27°C. Our hypothesis, therefore, was that 'the poor hatchability associated with eggs stored during the warmer months of the year could be improved by storing the eggs under conditions that provided a lower and more stable temperature than the ambient temperature'.

The opportunity was taken to evaluate another intervention, candling. Candling is a technique that is used widely as a means of assessing fertility and embryo development (Delany *et al.*, 1999). The only equipment that is essential to candle eggs is a bright light source (such as is provided by a good quality torch) and a darkened room or similar in which the eggs can be assessed. Candling allows eggs that will not produce a viable embryo (e.g. infertile eggs, eggs that contain an embryo that has died during the first hours of incubation and eggs that have cracked shells) to be removed after the first week of incubation so that they may be used as food, livestock feed or sold. If eggs are not removed at this stage they often become contaminated with spoilage organisms or pathogens and even if uncontaminated the internal quality will have deteriorated such that these eggs are almost always thrown away.

Materials and methods

The study was undertaken in Udaipur District of Rajasthan, India. This district was chosen because village poultry keeping is an important livelihood activity for many households in this location and a non-governmental organisation (NGO), BAIF, has, for many years, been involved in working with the villagers in this district. The initial egg handling study was undertaken with 10 poultry keepers from Jaganathpura village who were trained in candling using a locally designed battery operated candler. During the period 15 November 2002 to 15 February 2003 hatching eggs were candled and marked with different colours to signify either fertilised or unfertilised eggs. All eggs were

incubated to allow the accuracy of the candling to be assessed. A further two candling trials were carried out between the months of February and June 2003 and March and July 2004.

A study using a modified egg storage container was undertaken in the summer months of 2003 and 2004, with 12 and 40 poultry keepers, respectively, to see if the summer hatchability figures could be raised to that of the winter figures (data from the winter period of 2002-2003).

Eggs were either stored in the traditional way (control group) or, for the modified storage treatment group, in a half-moon shaped bowl (*Tagari/Gamela*). The traditional method of storage would consist of eggs being placed in a covered storage area in a bowl or similar receptacle. Modified storage involved the use of evaporative cooling to both reduce the air temperature around the eggs and to reduce the variability in temperature fluctuations. Evaporative cooling was achieved by filling a bowl (later modified by the poultry keepers to a woven basket lined with a jute sack) with a mixture of earth and sand that was kept moistened with water. A piece of jute bag was placed on the sand, the eggs being placed on the bag and then covered with a cotton cloth or a woven basket. The bowl was suspended from the roof supports inside a building or placed on a shelf or ledge in a building. The temperature in the vicinity of the eggs and in the egg store room (ambient) was recorded daily from 08.00 to 10.00 h with a maximum and minimum thermometer. When the hen stopped laying all the eggs were incubated under the hen, as per existing traditional practice. All eggs were candled to confirm fertility. The numbers of eggs that hatched viable chicks, that contained dead-in-shell embryos or that had spoiled (infertile or bacterial rot) were recorded.

Results

In the first candling study 72 per cent of all the eggs laid were fertile while the remainder (28 per cent) were infertile (Table 1). The error associated with the candling (i.e. the number of eggs misidentified as either fertile or infertile) was less than one per cent. In the second and third trials, which took place in the warmer summer months (unlike the first study that took place during the cooler winter months), the number of infertile eggs increased to 41 and 43 per cent respectively.

The incubation data are presented in Table 2 with data being presented according to intervention, season and year. It is apparent from Table 2 that the data for the summer (2003) are unbalanced (with data for only two 'control' birds being available compared to 10 for the cooled storage treatment). The data for the following year are more balanced with data for 34 and 40 birds being included for the control and intervention respectively. The percentage hatch of all eggs laid from the summer control treatment range from 39 to 40 per cent, whereas the comparable figures for the cooled storage treatment ranged from 59 to 61 per cent. Notably the comparable winter figure was 59 per cent - very similar to the figure achieved for the cooled storage treatment. The hatch of all fertile egg data is less consistent, with the summer (2003) control treatment achieving a relatively high hatch rate compared with the control treatment for 2004.

Table 1 *Effect of candling and season on the number of eggs recovered from the incubation process*

Treatment	No. of birds	No. of eggs laid	No. of eggs unsuitable for incubation (infertile or early embryo death, cracked shell)	% of eggs unsuitable for incubation (no or early embryo death, cracked shell)
Winter (2002-03)	8	106	30	28
Summer (2003)	10	122	50	41
Summer (2004)	34	368	158	43
Mean Summer	-	-	-	42

Table 2 *Effect of cooled storage during the summer months on hatchability*

Treatment	No. of birds	No. of eggs laid	No. of fertile eggs laid	% eggs laid that were fertile	No. chicks hatched	% hatch of all eggs incubated	% hatch of all fertile eggs incubated
winter (2002-03)	8	106	76	72	63	59	83
summer control (2003)	2	28	12	43	11	39	92
summer modified (2003)	10	122	72	59	72	59	100
summer control (2004)	34	368	210	57	146	40	70
summer modified (2004)	40	437	318	73	268	61	84

Discussion

There were two key findings from the candling studies. The first notable point was that between approximately 20 and 40 per cent of all eggs incubated were unsuitable for incubation and could be potentially removed from the process for sale, barter, consumption or similar. Secondly, it seems (based on limited data) that the level of infertility increases significantly during the summer months.

The implications of this first point are relatively straightforward – candling presents an opportunity to significantly increase the number of eggs available for purposes other than hatching. In addition, by removing eggs unable to hatch after the first week of incubation the number of eggs under the hen can be reduced. At worst this should not have a negative effect, however, it is likely that there will be positive benefits, including:

1. The hen will be better able to cover those eggs that remain, so providing a more uniform temperature profile

2. There will be fewer eggs in the nest and hence

3. There should be less egg-to-egg contact

4. The hen will not be distracted at the end of the incubation period by eggs that will not hatch when time would be better spent by the hen with her chicks.

This technique was relatively easy for the poultry keeper to carry out and in the present study would have allowed the recovery of a significant proportion of the eggs laid for use either as a food or feed source or for sale or barter. The use of candling as a means of recovering eggs for human consumption and as a mean of improving hatchability should be vigorously promoted. It has the advantage of being simple, relatively inexpensive and, potentially, could make a significant contribution to nutrition and income generation through selling of infertile eggs by the poultry keeper and family.

If our hypothesis regarding hatchability rates in the hot season was correct we would expect to see two effects. Firstly the cooled egg storage treatment would have a higher apparent fertility compared with the control - the cooled storage possibly approximating to the fertility recorded during the cooler winter months. Secondly we might expect to see similarly different hatchability data, again with the cooled storage data approximating to the winter data.

It can be seen that in any one year the cooled storage treatment was associated with apparently better fertility and hatchability data when compared with the comparable control treatment. There was also a tendency for the winter fertility and hatchability levels to be higher than the summer control treatments though the data sets for the winter and summer (2003) are relatively small.

It is appropriate to reflect at this point that candling, while used across the world as a measure of fertility, is more accurately an indication of embryo development post 48 h. Embryos that die within ~48 h of incubation commencing are not detectable by candling. This is because candling relies upon the disruption of transmitted light by the embryo and its extra-cellular membranes and these structures are relatively insignificant during the first few days of incubation. If, therefore, the seasonal effect is real then there are three possible explanations. Firstly the warmer ambient temperatures have a negative effect on the mating process (e.g. frequency of copulation is reduced, sperm quality is reduced); secondly the percentage of fertile eggs laid is unaffected but there is increased embryo mortality between the time the eggs are laid and days 2-4 day of incubation and an associated higher mortality later in the incubation period. The third possibility is a combination of one and two. From the data above, and given that fertility is fixed before the egg leaves the bird and cannot be affected by treatment, it seems probable that the second scenario may explain our data. That is to say that the cooled storage technique is protecting the blastoderm during the storage period from temperatures in excess of 27°C (i.e. physiological zero). At temperatures above physiological zero the embryo continues to develop and, unless this temperature is maintained the embryo may die as it can only survive storage in a relatively undeveloped (some 60,0000-120,000 cell stage) state. The trend towards an improved hatchability of fertile eggs (which eliminates the apparent fertility effect) would be consistent with the embryo being stored under better conditions and as a consequence less embryo abnormalities occurring during the incubation process.

Conclusion

It appears from the data presented that cooled egg storage has the potential to have a significant effect on the number of chicks hatched during the warmer summer months and consequently can improve productivity. Unlike candling, the cooled storage technique is a new concept but it has the advantage of being a relatively simple and low-cost intervention and hence it should be evaluated more extensively.

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Understanding livestock keepers' agricultural knowledge and information systems: a case study from India[1]

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Abstract

A research project funded by the Department for International Development (DFID) through the Livestock Production Programme (LPP) has been investigating the production problems facing backyard poultry keepers in two locations in rural India, Udaipur district in Rajasthan and Trichy District in Tamil Nadu, and seeking to work with poultry keepers to address some of them. A survey of poultry keepers' agricultural knowledge and information systems, using a combination of informal semi-structured group methods and a structured interview schedule for individual interviews, identified their main sources of information and the most useful media for reaching them. By identifying the information needs, sources and preferred media of the poorer groups and women, communication research of the kind described can increase the likelihood of extension messages reaching them; and reduce the likelihood of dissemination and extension strategies reinforcing existing socio-economic differences within rural communities, and marginalising the poor and women yet again.

Introduction

Effective dissemination strategies for crop and livestock technologies require a sound understanding of the agricultural knowledge and information systems (AKIS) of the intended users. A poultry research project working in India, and funded by the Livestock Production Programme (LPP), organised a communications survey to identify poultry keepers' sources of agricultural information and their preferred media for receiving information. The project team was aware that relying solely on conventional (mainly government) extension services to disseminate information about project findings to resource-poor poultry keepers (especially women) would not be an effective approach; and that it would be necessary, therefore, to develop a more broadly based strategy,

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tailored to the preferences and circumstances of the poultry keepers. This is because of five biases that characterise livestock extension services in India (Matthewman *et al.*, 1997):

1. Government extension organisations tend to follow the top-down 'transfer of technology' approach and tenets of traditional extension theory: they rely heavily on interactions with 'progressive' farmers, and assume that others will learn from the experiences of these farmers and will subsequently adopt the technology in question.
2. Most extension organisations focus on large ruminants 'almost to the complete exclusion of other species' (ibid).
3. They also tend to focus primarily on intensive systems (particularly milk production) to the neglect of low-input extensive systems like scavenging poultry.
4. Services are usually concentrated in higher potential areas, whereas the project areas are semi-arid and relatively low potential.
5. Livestock extension is generally provided by men for men, despite the key roles that women play, particularly in goat keeping and backyard poultry.

Previous research has shown that there are often distinct gender and socio-economic differences in the degree and nature of access to information within and between communities (Subedi and Garforth, 1996). In particular, work in many countries has shown that the resource poor also tend to be information poor (Garforth, 2001b). Thus, the survey was designed to take account of the fact that different groups of livestock keepers (e.g. farmers v. landless, men v. women) may have different AKISs.

By identifying the information needs, sources and preferred media of the poorer groups and women, communication research of this kind can reduce the likelihood of dissemination and extension strategies reinforcing existing socio-economic differences within rural communities, and marginalising the poor and women yet again.

An AKIS can be defined as:

> "…the organisations, individuals and processes involved in the generation and modification of knowledge, and in the transmission and exchange of information, relating to agriculture…" (Garforth *et al.*, 2003).

The survey collected three types of information, concerning:

- Farmers' individual use and assessment of information sources and channels
- Structures, institutions, organisations and processes for obtaining, transferring and exchanging agricultural information
- A history of agricultural changes in the project area.

Materials and methods

The survey used a combination of group PRA methods and structured individual interviews. This was similar to the methodology used in another AKIS study in Eritrea (Garforth, 2001a; Garforth *et al.*, 2003). The individual interviews were carried out first, and then the group methods were used. The two PRA methods used were:

- Information mapping and linkages diagrams; and
- Agricultural timelines.

Selection of villages

The project has been working in one district (Udaipur) in the state of Rajasthan, and one district (Trichy) in the state of Tamil Nadu. The survey covered two villages in each project district: one of these was a relatively remote village and the other a well-linked one. Another selection criterion was that both villages should be ones in which there were poultry keepers.

Udaipur

The following two villages were selected in Udaipur: Saradit (remote) and Baghpura (well-linked). Both are ones where the non-governmental organisation (NGO), BAIF has been working for several years, and hence where it has a good rapport with the villagers. Both villages are in Baghpura block, Jhadol district. Baghpura village is about 1.5 hours drive from the city of Udaipur.

Trichy

The two villages selected were Ayyanar Kovil Salaikadu (AKS) and Peruganur, which are poorly and well connected respectively. The project team had been undertaking research and development on scavenging chickens in Peruganur for three years before the AKIS survey was undertaken, and hence had developed a rapport with many of the villagers. The research had included a baseline survey (Conroy *et al.*, 2003), a one year monitoring programme, and (most recently) de-worming of chickens and vaccination against Newcastle disease.

Ayyanar Kovil Salaikadu is the largest hamlet in its village, comprising nearly 200 households with a mixture of backward castes (BCs) and most backward castes (MBCs). Peruganur is also the largest hamlet in its village, comprising nearly 300 households with a mixture of backward castes (BC), most backward (MBC) and scheduled castes (SC). The MBCs are the largest of these three groups. The village is located in the middle of T. Pettai union and is about 6 km west of the T.Pettai union office on the Namakkal road. Peruganur villagers have access to more facilities than AKS villagers due to their close proximity to T.Pettai.

Selection of farmers

The survey covered men and women, in equal numbers, as both are involved in poultry keeping activities. For two of the three methods (information diagrams and individual interviews) men and women were covered separately, as their information sources might differ in some ways. For individual interviews respondents were selected on the basis of stratified random sampling. For group exercises there was some stratification, but individual members of the groups were not selected randomly.

Udaipur

It was agreed that the survey should focus on resource-poor tribal farmers (BAIF wealth categories 1 and 2), and that these do not have to be poultry keepers. To maximise the value of their contributions, all men selected were at least 25 years old (and all women at least 30 years old). In BAIF's experience, people younger than this may not be very knowledgeable about agricultural activities and information sources. It was agreed that in

each of the group discussions there should be 10-15 resource-poor tribal people. In each village 10 men and 10 women were selected for individual interviews, giving a total of 40 respondents.

Trichy

The situation in the Trichy villages was more complicated than encountered in Udaipur, as three categories of poultry keepers (code-named C1, C2 and C3) had previously been identified by the project in this district. The three categories of poultry keepers were:

- Category 1 = small and marginal farmers whose home and poultry are adjacent to their agricultural land
- Category 2 = small and marginal farmers whose home and poultry are separate from their agricultural land, i.e. in a nucleated settlement
- Category 3 = landless people who live in a colony (hamlet), with poultry kept in and around the house.

Given the existence of these three types of poultry keepers, if we had required the same numbers of individuals per category in Trichy villages as in Udaipur villages 120 (40 x 3) interviews would have been needed altogether. This was considered to be too time-consuming, given the project's limited resources, and hence the number of interviews was reduced to the level shown in Table 1, i.e. 48 in total. The C1 and C2 farmers were combined on the grounds that C1s and C2s are quite similar in that both categories are farmers, whereas C3s, being landless, are a more distinct group. C1/C2s are hereafter referred to as farmers, and C3s as landless.

Table 1 *Scaled Down Number of Respondents in Trichy*

	Village A		**Village B**	
[1]Category	**C1/C2**	**C3**	**C1/C2**	**C3**
Men	6	6	6	6
Women	6	6	6	6

[1]See text for details

It was decided that all the landless (C3) individuals selected for interview should own ruminants and backyard poultry, otherwise they would not need to have access to agricultural information of any kind.

Information mapping and linkages diagrams

This method produces a list of all the organisations, institutions and individuals with which farmers are linked, and which are, therefore, actual or potential communication channels through which information can flow. The organisations etc. are grouped at different levels on the diagram. The survey teams were advised that the diagrams should be constructed by the villagers on the ground. This is because it can be difficult to fit the diagram onto an A3 sheet of paper, and it would have been difficult for all 10-15 people to participate if the diagram were that small. Symbols were to be used, rather than writing, so that illiterate people could participate fully.

In each Trichy village, the information mapping exercise was conducted with four groups (male farmers, female farmers, male landless and female landless). The number of people in each group was between six and 10.

Agricultural timelines

A timeline is one way of recording the history of agricultural innovation and change in an area. A horizontal line is used to represent a period of time. Key events during that period are then marked on the line with a symbol and date. Further information about each event is recorded in a box or table. This gives a detailed description of the sources of new ideas and technologies in the area. This method was used with a mixed group of men and women.

In each Trichy village, two mixed-sex groups, one of people from farming households and the other landless people, were involved in the preparation of the Agricultural Timelines. The number of people in each group was between 6 and 10.

Individual interviews

A draft interview schedule was tested in Udaipur and then revised.

Udaipur

Ten men and 10 women from each village were selected randomly and interviewed.

Trichy

Using stratified random sampling, individual interviewees were selected. The survey team prepared a map of all houses in the village and asked a group of villagers questions relating to land availability and poultry keeping. The survey team then selected randomly: (a) six households (i.e. farmers) that owned land (C1/C2); and (b) six landless (C3) households that owned livestock.

Feedback Meetings

When the survey had been completed in both villages, the data were summarised and subjected to a preliminary analysis by the survey teams in each district. Information from the individual interviews was summarised for men and women separately, and compared and contrasted. The survey teams then re-visited the survey villages, and presented the findings and asked the villagers to comment on them. In Udaipur they organised a group feedback meeting, whereas in Trichy they talked with each of the previous respondents individually. This enabled mistakes or misunderstandings to be corrected. The Trichy team repeated some of the questions again, in an attempt to check what the respondents had said earlier; and found that the second answers virtually always matched the earlier ones.

Results

The survey found that there were substantial gender differences in information sources and preferred media for receiving agricultural information, as is evident in the following sections. In Trichy there were also differences between farmers and landless poultry keepers. One factor contributing to this was differences in literacy rates. In the Udaipur villages, 85 per cent of men were literate (defined as able to sign their own name), but only 40 per cent of women. In the Trichy villages, 10 out of 12 men and women from

farming households were literate, but literacy rates were lower for landless people, especially women.

Information diagrams

An example of an information diagram from Trichy District is given in Figure 1.

Table 2 provides a summary of the number of information sources accessed by each of the four groups in this district. Some clear patterns are evident, including the following:

- Men have access to more information sources than women belonging to the same group (i.e. farmers, landless)
- Farmers have access to more agricultural information sources than landless people
- Most information sources are at the village level for all four groups
- Generally speaking, the higher the level, the less the number of information sources accessed at that level.

Table 2 *Quantitative Summaries of Information Diagrams for Trichy District*

Level	Male farmers	Female farmers	Male landless	Female landless
District	3	1	2	1
Block	11	5	4	2
Panchayat	8	6	4	2
Village	17	14	14	13
Total	39	26	24	18

Timelines

Table 3 summarises information from the timelines for three of the villages regarding new technologies and technical knowledge. It shows that these have been obtained by farmers in the survey villages from a variety of sources, which can be broadly categorised as informal, government and commercial. For some enterprises the government agricultural extension system has been the main source, while for others it has been informal or commercial sources. When products (e.g. pesticides, inorganic fertilisers, tractors, animal breeds) become available (from whatever source) only one or two farmers decide to experiment with them, but they are more widely adopted if they are perceived to be an improvement on conventional practices, technologies or enterprises. For example, the cultivation of Tur (pigeon pea) has become widely practiced in the Udaipur project area.

Figure 3.1 AKS: Information Mapping and Linkage Diagrams – Male Farmers
District Level

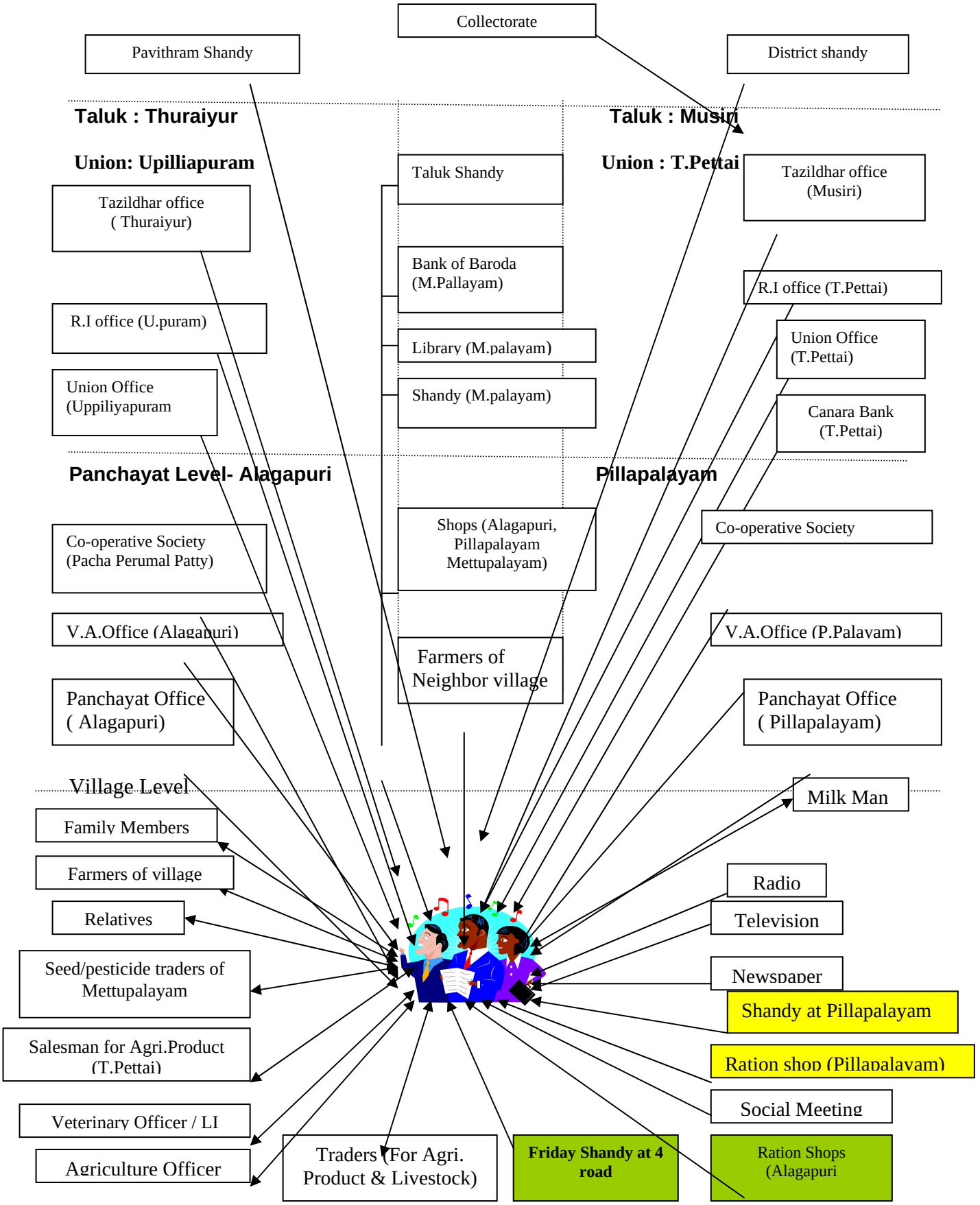

Figure 1 *Ayyar Kovil Salaikadu (AKS): Information Mapping and Linkage Diagrams – Male Farmers**

*Footnote: The district is the principal administrative subdivision within a state, whose top official is the Collector who heads a collectorate of district officials. The Collector heads the district revenue department and coordinates the efforts of line departments, such as agriculture. Within each district there are several taluks, whose top official is the Tazildhar or Tehsildar and whose responsibilities correspond to those of the Collector at the district level. At the next level down, the union level, the Revenue Inspector (R.I.) is the principal official. Within each taluk there are numerous Panchayats (village councils) that cover one or more villages. Each panchayat has a Village Accountant (V.A.) who is part of the local government bureaucracy, coming under the RI.

A local market is called a Shandy.

Table 3 *Sources of Innovations in Agricultural Practices and Technologies*

Enterprises by Village	Sources		
	Informal	**Government**	**Private sector**
Baghpura			
Tur (pigeon pea)	Started in 1970s with seeds and training obtained from relatives in another village. Techniques then passed on from farmer to farmer.		
	In 1990s farmers started inter-cropping Tur with maize		
Wheat		Agriculture dept. promoted changes by providing new varieties and training	
Goat	New, faster-growing breeds were introduced to area by *Rebaris*, a pastoralist caste		
Peruganoor			
Paddy		New varieties provided by extension centre in 1973 & 1984	Harvesting machine rented in 1995
Black and green grams		New varieties from Agric. Office in 1993 and 1995 respectively	
Groundnut			New variety purchased from traders in 1993
Turmeric	Cultivation of this crop copied from farmers in nearby village – Oorakarai		
Dove rearing	Copied from Thuraiyar village farmers in 1958		
Turkey rearing	Eggs purchased from Oorakarai village		
Dairy cow			Cross-breds bought at cattle market
Goat	Ramnathapuram breed introduced in 1989		
Multi-crop machinery			Hiring of electric motor pumpset (1969), tractor (1979) and planter (2000) possible. Tractor purchase (1993)
Ayyanar Kovil Salaikadu			
Paddy	Varieties obtained from nearby farmers in 1920 and 1984	New variety from Agric. Office in 1979	

Enterprises by Village	Sources		
	Informal	**Government**	**Private sector**
Grapes		Cultivation started in 1978 – from agric. Farm in Trichy	
Groundnut		New variety from Agric. Office in 1982	
Cow			1985
Goat			'Exotic' breed purchased at local market
Onion	Hybrid variety obtained from farmers in Mahadevi village		
Sunflower		Cultivation promoted by Agricultural office	
Chicken	'Improved' Indian breed obtained from farmers in Sergudi village		
Multi-crop			Similar to Peruganoor experience
Machinery			

Main sources of agricultural and livestock information

Tables 4, 5 and 6 summarise this information for different groups, drawing on information obtained through individual interviews. Table 4 shows that almost all (11 out of 12) landless women in Trichy saw other family members as their main source of livestock information, whereas half or more of the landless men in AKS and Peruganur saw farmers and radio, respectively, as their main source. Table 5 shows that family members were also a main source for agricultural information for half of the farming women in the two villages, whereas radio was the most frequently mentioned main source for landed men and women combined.

Table 4 *Main Sources of Livestock Information for Trichy Landless livestock keepers*

	Radio	Family members	Farmers in village	Veterinary officer
*AKS women	1	5	0	0
AKS men	1	0	4	1
Peruganur women	0	6	0	0
Peruganur men	3	2	1	0

*AKS = Ayyanar Kovil Salaikadu

Table 5 *Main Sources of Agricultural Information for Trichy Farming Households*

	Radio	Family members	Input suppliers	Farmers in village	Agric/Vet officer	Books
*AKS women	3	3	0	0	0	0
AKS men	1	1	2	1	1 (Agri)	0
Peruganur women	2	3	0	0	1 (Vet)	0
Peruganur men	4	0	1	0	0	1

*AKS = Ayyana Kovil Salaikadu

In the Udaipur villages BAIF was the main source of agricultural information for both men and women in Saradit (the remoter village), and also for women in Baghpura, as can be seen from Table 6. In Baghpura, the most frequently mentioned source by men was the agriculture department; and the other frequently mentioned source, for both women and men, was local traders.

Radio was not mentioned as a main source, despite the fact that it was considered a useful medium by almost all men and women (Table 6). This suggests that radio stations in Udaipur are broadcasting little, if any, useful agricultural information; or they are broadcasting it at times that are not convenient for resource-poor tribal people.

Table 6 *Main Sources of Agricultural Information for Udaipur Households*

	BAIF	Local traders	Family member	Agriculture Department	Other NGOs
Baghpura women	6	3	1	0	0
Baghpura men	2	3	2	5	0
Saradit women	10	0	0	0	0
Saradit men	8	0	0	0	1

Ratings of different media – comparison of districts

Respondents were asked whether or not they found particular media useful for conveying agricultural information. Table 7 provides a comparative summary of the findings for farmers in the two districts. Respondents had three possible responses: useful, not useful, or do not know. The table records the numbers of people responding 'useful' or 'don't know' for any given medium. Thus, the number of respondents not finding a medium

useful can be deduced by subtracting the 'usefuls' and 'don't knows' combined from the total (20 in Udaipur and 12 in Trichy). For example, the number of women in Udaipur who did not consider leaflets to be useful is 6 (20-(1 + 13)).

District comparison of written media

It can be seen from Table 7 that in Udaipur posters were the most popular medium for both women and men; whereas in Trichy 5 of the 12 women, and two of the men, were not familiar with this medium as a source of agricultural information. In Udaipur, most men also found wall paintings useful. In Trichy the most popular written medium for men was newspapers, which was also cited quite often in Udaipur. In both districts, more men than women found written media useful, which is partly due to: (a) fewer women having been exposed to certain written media and hence not having a view on them; and may also be due to (b) higher literacy rates among men.

District comparison of electronic media

Radio was the most popular electronic medium for men and women in both districts, followed by television. More men than women mentioned television. Videos and/or films were as frequently cited in Udaipur as television, by both men and women; whereas in Trichy they were not cited at all. This was because the Udaipur villagers had experienced videos and/or films (probably through BAIF's work), whereas the Trichy villagers had not experienced them and hence did not know whether they were useful of not. Women were generally as familiar with the electronic media as men were.

District comparison of trainings etc.

In both districts 50 per cent or more of the men rated all four training-related media as useful; whereas women were generally not positive about these kinds of media. Only a small minority of Trichy women rated any of the media as useful; and in Udaipur only two of the media, farm visits and puppet shows, were cited by more than half the women. These two media were also the ones most frequently cited by the Udaipur men as being useful. A substantial number of women and men did not know whether field days and trainings were useful or not.

Table 7 *Ratings of Different Media as Useful in the two Districts*

Media	**Udaipur**				**Trichy Farmers**			
	Women (out of 20)		Men (out of 20)		Women (out of 12)		Men (out of 12)	
Written	**Useful**	**DK***	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**
Leaflets	1	13	8	7	2	6	7	2
Posters	19	0	18	0	2	5	7	2
Booklets	2	12	8	4	2	6	7	2
Newspapers	6	0	9	0	3	5	9	0
Wall paintings	5	0	12	0	1	5	7	1
Electronic	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**
Radio	19	1	19	0	10	2	10	2
Television	12	1	16	0	6	4	8	4
Video/film	12	1	16	0	0	12	0	12
Trainings, etc.	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**
Farm visit	15	5	19	1	2	0	8	3
Field day	1	15	14	6	1	2	8	3
Training	6	12	10	9	1	4	7	4
Puppet show (U)/theatre(T)[1]	20	0	19	1	0	0	7	3
Meetings	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**
Self-help group	15	1	13	5	7	0	3	3
Village org'n/ Panchayat[2]	12	3	18	1	4	0	10	0
Co-operative	1	16	7	11	3	0	11	0
Social meeting	18	0	20	0	5	0	10	0

* = Don't know

[1] The questionnaires for the two districts were slightly different, in that 'puppet show' was included in Udaipur, but replaced by 'theatre' in Trichy. This is because there is a tradition of puppet shows in Udaipur, but not in Trichy.

[2] In Udaipur people were asked about village organisations, whereas in Trichy they were asked about the local panchayat.

District comparison of meetings

In general, more men than women were positive about meetings. The one exception was self-help group (SHG) meetings, about which more women than men were positive. This is probably because the membership of most SHGs is women only. A few men in each location did not know whether SHG meetings were useful or not. The vast majority of men in Trichy regarded the other three types of meetings as useful. The same was true of their counterparts in Udaipur, except that only a minority were positive about cooperative meetings.

Ratings of different media – comparison of Trichy villages

Table 8 compares the responses of all respondents (farmers and landless) in the remote versus well-connected villages in Trichy. In order to simplify this table, the only responses included are for those who said the medium was useful. Where people did not rate a medium as useful it could either be because they thought it was not useful, or because they did not know.

Table 8 *Ratings of Media as Useful in Trichy – Comparison of Remote and Well-connected Villages (Farmers and Landless combined – out of 12)*

Media	Remote (Ayyanar Kovil Salaikadu)		Well-connected (Peruganur)	
	Women	Men	Women	Men
Written				
Leaflets	0	3	2	6
Posters	0	3	2	6
Booklets	0	3	2	6
Newspapers	1	9	2	4
Wall paintings	0	3	1	6
Electronic				
Radio	7	7	7	8
Television	7	7	2	3
Video/film	0	0	0	0
Trainings, etc.				
Farm visit	0	2	3	9
Field day	0	2	5	12
Training	0	1	5	11
Puppet show	0	1	3	6
Meetings				
Self-help group	2	0	9	5
Village organisation	0	7	5	6
Co-operative	0	7	4	7
Social meeting	0	4	6	10

Remote/well-connected comparison of written media

It can be seen from Table 8 that a higher proportion of people in the well-connected village considered written media to be useful. For men in the remote village, newspapers were by far the most frequently cited medium, whereas it was the least cited in Peruganur. This suggests that men in AKS may be far more reliant on newspapers than their Peruganur counterparts due to a lack of other written media; and that when those other media are available newspapers become relatively less useful.

Remote/well-connected comparison of electronic media

There were no gender differences with respect to these media**.** Radio was easily the most popular electronic medium in the well-connected village, and was cited almost as often in AKS. In AKS, however, unlike Peruganur, television was cited as often as radio. This is the opposite of what one might have expected, and is almost certainly due to the fact that AKS had two communal televisions that had been provided by the panchayat, whereas Peruganur did not.

Remote/well-connected comparison of training, etc.

These media were cited far more often in the well-connected village than in the remote one. This reflects a lack of exposure to these media in the remote village. The well-connected one had been a 'project' village of the poultry research project, and the research team had organised various training courses there.

Remote/well-connected comparison of meetings

There was a marked difference in the responses of women in the two villages, with several women in Peruganur considering that each of the four types of meeting was useful, whereas in AKS only SHG meetings were seen to be useful, and those only by a minority of two. There is more of a gender difference in AKS than in Peruganur, and one gets the impression that women in AKS may be more socially isolated or marginalised than those in Peruganur.

General summary

The survey findings show that the vast majority of farmers, women in particular, do not regard government extension workers as their main source of agricultural information. The most frequently cited main sources were radio, family members, other farmers and the private sector (input suppliers, traders); and, in the two Udaipur villages, BAIF was the main source for most people, particularly women.

As far as written media were concerned, most women did not regard them as useful, with the exception of posters. In Udaipur, the same applied to most men, plus a majority also thought that wall paintings were a useful medium. Low literacy rates, particularly among women, are an important factor here. A second very popular medium was radio, followed quite closely by television. Puppet shows were a third highly popular medium, but only in Udaipur, which shows that there can be significant cultural variations from one place to another.

Trainings of various kinds, and meetings, were generally more popular with men than with women: an exception being self-help groups, which were cited more often by women than by men. This could be because women are marginalised in mixed sex meetings/fora; and also perhaps because women have less time to spare for meetings, trainings, field days etc. Self help groups have been widely promoted in India during the last decade or so, particularly among women. They tend to be single-sex groups, with 10-19 members, and have primarily been used as a medium for promoting savings and credit. It is likely that, among the respondents, more women than men were members of SHGs; and that a higher percentage of the women were SHG members in Udaipur than in Trichy, given that BAIF had been promoting SHGs there.

In Trichy, generally speaking less people in the remote village considered any kind of medium useful, which is probably largely due to their lack of exposure to most media.

The only exceptions were: for women, the electronic media (radio and television); and, for men, these two media plus newspapers and meetings of the village organisation and the co-operative.

Discussion and implications for the poultry research project

The research findings confirmed what previous studies (Matthewman *et al.*, 1997) had suggested, namely that government extension services generally make only a limited contribution to meeting the technology information needs of resource-poor small stock keepers. The findings also show that most written media for disseminating agricultural information either do not reach resource-poor farmers and livestock keepers, or are regarded by them as not being useful. This is hardly surprising in situations where such groups have low literacy rates.

The survey showed that there are significant variations in information sources and media preferences, both between villages and between the two districts. This was also found to be the case in similar studies in Eritrea (Garforth, 2001a), Kenya (Rees *et al.*, 2000) and Uganda (Ramirez and Quarry, 2004). This finding highlights the need to have a flexible extension and dissemination strategy that takes account of such variations, rather than relying on the kind of uniform 'one size fits all' approach that some extension services and systems have taken in the past.

The survey, like previous studies, also found marked gender differences in people's access to information sources, and in their preferred media for receiving agricultural information. Radio was one medium to which most men and women had access, and which was favoured by both. This was also a finding of studies in Eritrea and Uganda (Garforth *et al.,* 2003).

The survey was designed - in its selection of districts and states (less developed v. more developed), villages (remote v. well-connected) and individual respondents (farmers v. landless, men v. women) - to cover as broad a range of groups and situations as the project's limited resources allowed. Clear patterns and differences have been found in relation to most of these parameters. Nevertheless, we cannot say that these findings are representative of the two states, or even of the two districts. In fact, the Udaipur findings are probably not representative, because the villages covered have clearly been strongly affected by the presence for several years of an agricultural and rural development project (managed by BAIF and funded by the European Union).

The purpose of the survey was to guide the project in designing its dissemination strategy and products, and to make sure that they are tailored to the requirements of poultry keepers and intermediaries (government veterinarians, NGOs, etc.). It has served this purpose well, and we recommend that other livestock research projects undertake similar surveys, unless relevant information is already available for the areas concerned. The survey has shown that there is a need for flexibility in communication and extension strategies to take account of differences (e.g. between districts, villages and groups): a 'one size fits all' approach is not appropriate.

The project has developed plans to disseminate messages about the considerable potential for improving the hatchability of eggs, and about two technologies that it has developed for this purpose: a battery-powered candler, and an egg cooling technology for use in the hot season (Sparks *et al.*, 2004). It is also seeking to convey the importance of

predation as a cause of mortality, and the need to protect birds, especially chicks, from predators. The project's baseline survey found that predation was more important than disease in both project locations (Conroy *et al.*, 2003). The ways in which the project is taking account of the survey findings in designing its dissemination strategy are described in the following sections. The project's dissemination plans have sought to use media and information sources that are suitable for poor rural people, especially women.

The project is producing a number of booklets for extension workers in the two project states. In addition, it is planning to reach poultry keepers directly through a combination of materials.

Udaipur

Poultry keepers

In Udaipur the findings suggest that the only form of written extension material that should be produced for direct use by poultry keepers is posters. Posters are being prepared for distribution to villagers and also to other NGOs with an interest in poultry development: they will rely primarily on pictorial content rather than words, so that they are meaningful to illiterate people. Careful consideration will be given to where the posters should be located in the villages, and how they would be distributed. For example, they could be distributed through the SHGs.

Radio

The project is considering organising meetings with the villagers to find out which radio stations are most popular; which times of day would be most convenient; and whether there is any particular programme that they listen to on a regular and frequent basis that provides agricultural information. Meeting(s) may be arranged with the relevant radio station(s) to discuss arrangements for making one or more programmes about good practices in poultry keeping.

Farm visits

The survey also showed that farm visits are a popular medium. BAIF is considering making arrangements for poultry keepers (or their representatives, such as *jankars* (village specialists or SHG secretaries) to visit the project villages and talk with participating poultry keepers who have been using the project's improved technologies (battery-powered candler, cool egg storage).

Puppet shows

BAIF is considering whether this would be an appropriate medium for disseminating information about good poultry keeping practices. If it is, a suitable show will be developed, and a programme of performances in villages in BAIF's operational area will be drawn up.

Extension workers

Leaflets and booklets would be useful for extension workers, in both NGOs and government, who are interested in supporting improved poultry keeping. They in turn might also want some posters to distribute in the villages where they work.

Dissemination by BAIF outside Udaipur District

It is well known that keeping scavenging poultry is an important livelihood activity for poor tribal people elsewhere in semi-arid western India, for example other districts of southern Rajasthan. Constraints facing poultry keepers are likely to be broadly similar in these districts to those experienced in Udaipur and the technologies developed by the project should, therefore, be equally relevant. BAIF works in other parts of Udaipur District (Kotra, Sarada and Salumber blocks), and in other districts of southern Rajasthan where family poultry is important (Banswara, Dungarpur and Chittorgarh). It has drawn up plans to disseminate information about the project's findings in these locations by: (a) using the media and other sources mentioned above; and (b) providing training to NGOs, government officials and SHG representatives. Tribal, rural and watershed departments of government have funds for farmer training that could be used.

Trichy

The project team (in Namakkal and in the UK) is considering which technologies it would be useful and appropriate to disseminate in Trichy, and elsewhere in Tamil Nadu, and which organisations to collaborate with in this process. These are: (a) the feed technology (sorghum) tested on station; (b) the low-cost egg technologies that have been tested in Udaipur; (c) conventional technologies already being promoted in Trichy/Namakkal by government veterinarians (e.g. vaccination against Newcastle disease, de-worming); and (d) other low-cost technologies being disseminated in Tamil Nadu by NGOs.

Poultry keepers

In the Trichy villages women will be much more difficult to reach than men, particularly landless women in AKS: in fact, it seems that the only practical ways of reaching these women and others like them are through their husbands and other adult male family members.

Radio was another medium that was regarded as useful by almost everyone, with the notable exception of AKS's landless poultry keepers. As a result, the project team in Tamil Nadu worked with the local All India Radio station to produce a series of 20 programmes on various aspects of backyard poultry, each lasting 15 minutes. The programmes were broadcast in autumn 2004, and had a potential audience of several million people in nine of the state's 30 districts.

Extension workers

Leaflets and booklets would be useful for extension workers in both NGOs and government, who are interested in supporting improved poultry keeping.

Meetings were regarded as useful media by a lot of poultry keepers, including the women of Peruganur. Self-help group meetings were popular with both women and men in Peruganur, particularly women, and hence are a potentially effective medium. In addition, at least 50 per cent of landless men and women in Peruganur regarded panchayat and co-operative meetings as useful, whereas in AKS only a minority of men regarded them as useful. The project team needs to investigate how they could distribute information through these media so that it is discussed in meetings.

In Tamil Nadu, funding is being sought to promote the project findings further, in five of the southern districts there, through a federation of NGOs and the Livestock Improvement Federation (LIFE).

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Discussions, questions/comments on the presentation

Question: *Was the sample size too small to be used for drawing significant conclusions.*

Answer: The sample size was small mainly due to limited resources. A larger sample size would have been better but some implications can be derived from the data.

Question: *How did family members learn the information to pass on to other members?*

Answer: This was through farm visits and interactions.

Question: *With the ENRECA (Programme for Enhancement of Research Capacity in Developing Countries) project, there was a political decision to stop the project. Should politicians be included in project planning?*

Answer: Yes, politicians should be included in the formulation of projects.

Question: *What steps, if any, are being taken to improve women's literacy as a result of your survey? It seems vital if they are to make full use of information sources, newspapers, training booklets, etc.*

Answer: The LPP poultry project does not have the resources to improve women's literacy, although it is an important objective.

Question: *Training in the remote village was rated very low compared to the connected village. Was this due to low literacy levels leading to lack of understanding of written information?*

Answer: It was primarily because men in the remote village did not know whether training was useful or not.

Productivity of cross-bred goats under smallholder production systems in the Eastern highlands of Kenya[1]

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Abstract

Dairy goats have become increasingly popular among smallholder mixed crop-livestock farmers. Their profitability will determine their growth within smallholder production systems. A survey was carried out in 114 farmer groups, representing 435 goat herds and 1676 goats. Data on reproductive and growth performance, milk production and flock dynamics (deaths, births, and sales) were collected between October 2001 and September 2003. The genotypes involved were the local East African goat, pure Toggenburg (T) and their crosses (F1) and 3/4T. Using the Livestock Productivity Efficiency Calculator (LPEC) as an input framework, herd structure, gross margins and herd growth were calculated based on feed efficiency. The parameter used was the annual total value of off-take per carrying capacity unit (CCU), which was defined as a standard livestock unit consuming 100 Mega joules of metabolisable energy (ME) per day. The goat enterprise proved to be profitable Annual gross margins of over US $259 were recorded indicating that dairy goat enterprises under smallholder production systems can be profitable, (the USD exchange rate at March 2005 was 77 Kenya shillings to US $1).

Introduction

Goat rearing is becoming increasingly popular among smallholder mixed crop-livestock farmers. Goat production is regarded as a feasible means to improve the income and nutrition of rural communities and to bring these communities into commercial marketing systems (Braker *et al.*, 2002). With the increasing human population and diminishing land sizes, it is becoming difficult for small-scale farmers with very small land holdings (many as small as 0.25 ha, including the homestead) to keep large ruminants. The goat has become very popular in recent years as a pathway out of poverty (Ahuya *et al.*, 2004). Currently, many non-governmental organisations (NGOs) working with resource-poor livestock keepers in medium to high potential areas are encouraging farmers to keep improved goat genotypes, which are mainly cross-breds between the exotic temperate and the indigenous tropical breeds.

[1] 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. R7634, Livestock Production Research Programme.

Cross-breeding is a way of realising quicker genetic improvement than by selection, matching genotype with the environment and benefiting from the complementarity of the breeds involved. The benefits that farmers enjoy include faster growth rates and more milk from the cross-bred goats. There are many goat cross-breeding programmes in Kenya and the eastern Africa region (Ahuya, 1997; Gichohi, 1998; Ayalew *et al.*, 2003;) which have been implemented with varying degree of success; but except for the FARM-Africa project in Ethiopia, very little attempt has been made to demonstrate comparative productivity of the genotypes involved. FARM-Africa, an international non-governmental organisation (NGO), introduced the British Toggenburg dairy goat, into the Eastern Highlands of Kenya through the Meru Dairy Goat and Animal Health Care Project, which has been used in upgrading the local goats for improved milk production and growth. A study (through the Livestock Production Programme (LPP, project R7634) was carried out to establish the profitability of goat enterprises in the Eastern Highlands of Kenya.

Productivity when applied to livestock refers to either level of production or efficiency of production (James and Carles, 1996). In any production system, productivity will be uniquely influenced by complex interactions of environmental, biological and socio-economic variables (Omore, 1998). The variables are interrelated and, therefore, should be looked at holistically to determine their relative importance and how changes in components affect the whole system. In terms of the efficiency of a production system, productivity is a ratio of units of outputs per unit of inputs to the system. This implies that all outputs must be reduced to the same units although the terms used for outputs might be different.

The most important factor hampering the determination of efficiency of ruminant livestock production in the past has been the difficulty of quantifying the economic value of feed, which is the most important input (James and Carles, 1996). Feeds available to ruminant livestock include crop residues and pastures which in most cases have no alternative uses. One approach to comparing the efficiency of livestock production, across different production or grazing systems, is to compare outputs per standardised energy input. The livestock productivity efficiency calculator (LPEC) (PAN Livestock Services, 1990) is a deterministic model developed to calculate output per unit of energy, taking into account other determinants such as reproduction and mortality rates. There are three important attributes of LPEC that make it appropriate in determining livestock productivity: it is a deterministic model developed to calculate output per unit of energy (does not include the effects of chance variation); it is a static model, in that it describes the state of a herd that is in equilibrium, but will indicate whether the herd is increasing or decreasing; it can be used across production systems and across genotypes. Variable and fixed costs of inputs, other than forage, can be subtracted from LPEC output to obtain both gross and profit margins respectively.

Materials and methods

Data on reproductive and growth performance, births, milk production, survival, deaths, and sales were collected from 435 herds of goats, of various genotypes, from the farm records of participating farmers, who were all members of one of 114 farmers' self-help groups, (Table 1). Monitoring was carried out monthly, between October 2001 and September 2003. The farmers' groups are voluntary self-help groups, with each group sharing a breeding buck. The buck is maintained by one of the group members at his/her home, which is referred to as a buck station, and is used to mate with the does belonging

to both members and non-members. The farmers and their groups are participating in a community-based dairy goat genetic improvement and health care project that was undertaken by FARM-Africa in collaboration with the government of Kenya, in Central and South Meru Districts of Central Kenya. The farmers belong to the Meru Goat Breeders Association (MGBA), which is a community- based farmers' member organisation that supervises and coordinates the breeding activities of the improvement programme.

The goat genotypes involved in this study were the exotic dairy Toggenburg (T) breed, the indigenous meat breed, the East African (EA), and the F1 cross-breds arising from mating Toggenburgs with the EA, as well as the 3/4T x ¼ crosses that were obtained from backcrossing the F1s (TxEA) females to the Toggenburg males. The detailed mating plan and the project's approach are described by Ahuya (1997). Flock productivity parameters were calculated from the data collected from the 435 flocks comprising 1676 animals (Table 2). Discussions were held with farmers, MGBA officials and community leaders to identify the goat genotypes and breeds that the farmers preferred, including the breed standards, physical and productivity characteristics

Animals are managed under confinement or zero-grazing. They are fed indigenous and established fodders in a cut-and-carry system. The farmers have established forages such as *leucaena*, *sesbania*, mulberry (*Morus alba*) and *calliandra*, which are used mainly as supplements. The cross-bred animals are owned by the farmers, while the pure Toggenburgs belong to MGBA. There are also farmer groups that are outside the project area but have bought goats from MGBA members and are implementing an upgrading scheme alongside MGBA members, setting up their own breeder units and buck stations.

Each group meets and agrees on how the bucks should be managed, especially feeding policy. They are either fed individually or by all members of the group. Where the animals are fed by the group, a feeding-duty roster is operated. Nearly half the groups collectively feed the bucks, while the others rely on the buck keepers, for which they are paid. Minerals and water are provided daily. Veterinary treatment is carried out as necessary by the Community Animal Health Worker, (CAHW), who is a farmer chosen by the group. The CAHWs are trained and receive payment for their services, thus ensuring that veterinary help is available for livestock belonging to the resource-poor.

Table 1 *Goat genotypes monitored during the study*

Genotype	Female	Male	Total	Farmer groups
East Africa (EA)	388	70	458	
Pure Toggenburg (T)	189	129	318	
F1 (TxEA)	511	184	695	
Three-quarter T	110	95	205	
Total	1198	478	1676	114

An evaluation of cross-bred dairy goat productivity was carried out to assess the profitability of the dairy goat enterprise under a smallholder production system. Four genetic groups were involved in the study, but the majority of the herds were a mixture of pure and cross-bred goats. The genetic groups were: indigenous goats; cross-breds (T x Indigenous); ¾ T x ¼ Indigenous); and pure Toggenburg. The production parameters

considered were mortality and culling rates, birthweight, mature weight and sales, kid survival rates, buck/doe ratio and lactation yield.

The LPEC was used as a framework for inputting production parameters and estimating the value of output per unit of forage input or carrying capacity unit (CCU)/year, where one (CCU) is equivalent to the feed supply providing 100 mega joules (MJ) of metabolisable energy (ME) per day. The economic indices calculated were gross margins (total output value less variable costs) per CCU and per goat.

Goat flocks used were grouped in six different classes: 1) suckling females (<4 months); 2) weaned females (>4 months); 3) Breeding females (after first kidding); 4) suckling males (<4 months), 5) weaned males; and 6) Breeding males (bucks over 12 months). For each class of goat, production parameters, mortality, culling rates and kidding rates were calculated on an annual basis. Net sale rates were calculated by subtracting the number of goats bought from the numbers recorded as sold. The net sale rates for does and bucks were considered as culling. Goat prices were determined by MGBA members after considering the demand for goats and the prevailing market prices.

Results and discussion

Flock sizes and reasons for keeping goats

The average flock size was four goats (range 1-22) of mixed genotypes, with the majority of farmers indicating their desire to keep only cross-bred goats. The main reason for this was the cross-breds' potential for higher milk production compared to indigenous goats. An earlier study (Ahuya *et al.,* 2003) showed that cross-breds, both F1 and ¾ Toggenburgs, produced 2.6 and 3.6 litres per day respectively, compared to the 300 ml produced by the indigenous East African goat. For the majority of the farmers interviewed, this trait was the reason for wanting to join or start a dairy goat enterprise. Table 2 shows the reasons why farmers kept goats.

Table 2 *Reasons given by farmers for keeping cross-bred goats*

Traits	Percentage (n= 386)
Milk Production	54
Growth rate (increased income)	25
Manure	19
Other (traits mentioned were, docility, udder size, good, well-placed teats)	2

Survival rates and health problems

The survival rates up to weaning of the cross-bred and pure Toggenburgs were very good, attributed by farmers to the training they received to improve their management skills. Most farmers indicated that they had been worried that the animals, especially the Toggenburgs, might not survive. The Toggenburgs had the lowest survival rate at 92 per cent while F1 and three quarter Toggenburgs were 94.83 per cent and 94 per cent respectively, and similar to earlier results, (Ahuya *et al.*, 2002). The farmers also attributed this relatively high survival rate to the availability of animal health services provided by the CAHWs. The major diseases attended to by CAHWs (Table 3), were worm infestations, pneumonia and coccidiosis, the first two controllable by providing adequate housing. A raised slatted floor will drastically reduce worm burdens, by allowing

contaminated faeces to fall under the floor, while a well positioned and properly ventilated house can reduce the incidence of pneumonia.

Table 3 *Types of disease treated by community animal health workers (CAHWs)*

Disease	Percentage of total cases treated	Remarks
Worms	70	Mainly *Haemonchus*
Pneumonia	8	
Diarrhoea	3	
Coccidiosis	5	
Parasites	3	
Others(mineral deficiencies)	11	Mainly giving advice

Herd structure and annual profitability

Tables 4 shows the herd structure, which is typical of that seen locally, with weaned males tending to outnumber females, especially in the breeding units. Table 4 also shows the number of each type of animal per carrying capacity unit (CCU). It is clear that replacement stock is adequate to sustain an annual herd growth of 25 per cent.

Table 5 shows annual profitability, excluding the value of the manure that is used on the farm, contributing to improved crop yields from goat keepers' fields. Both net profit and gross margins were calculated directly from the LPEC output. In calculating these, cost of purchased feeds was ignored, since most farmers indicated that they rarely purchased any feed for their animals, except for mineral licks. However, most farmers admitted that before the goat project was introduced their goats were not properly managed.

Table 4 *Herd structure, metabolisable energy (ME) requirement and output values for dairy goats on smallholder dairy farms in Meru Central ands South Districts, Kenya*

***Class of stock** (see text for details)	Percentage of herd	ME/Day	No/CCU	Value/Animal (US $)	*CCU (US $)
Breeding females	29	14.84	2.91	33.5	23.7
Suckling females (replacements)	2	4.17	0.23		
Weaned females (replacements)	15	7.83	1.58	52	33.9
Suckling females (surplus)	2	4.17	0.17		
Weaned females (surplus)	12	7.82	1.18	39	1.36
Breeding males	1	11.51	0.09	26	.68
Suckling males (replacements)	0	5.01	0.06		49.26
Weaned males (replacements)	0	9.20	0.07	39	.71
Suckling males (surplus)	4	4.7	0.09		187.3
Weaned males (surplus)	3	8.3	2.57	26	8.8
Total	100		3.34		298

* CCU = carrying capacity unit (see text for details)

Table 5 *Gross margins and annual net profit per carrying capacity unit (CCU, see text) for dairy goats on smallholder farms in Meru Central and South Districts, Kenya*

	Value per unit (US $)	Off-take units/CCU year	Value (US $/CCU/Year
Output			
*Culled breeding females	33.5	0.69	27
Mature surplus females	52	0.71	55
Mature replacement females	26	0.03	1.45
Culled breeding males	39	0.01	.84
Mature surplus males	33	0.20	90.6
Milk (kg)	.25	721	177.8
Costs			
Other costs per animal[a]			29.5[a]
Purchased feed costs per animal[b]			
Net profit per CCU/year	259.5	(29.5)	323.19
Gross margin per CCU/year	295.6		

*See text for goat classes.

[b] These costs include veterinary inputs, goat investment, buildings and labour

[b] these costs only include variable veterinary inputs (drugs and fees)

Using the above information, herd growth was calculated as shown below and the result indicate a growth of 26%.

$$\text{Herd Growth} = \frac{\text{off take value of surplus heifers}}{\text{CCU of breeding does/yr}} \quad \frac{0.18}{0.70} = 0.26$$

Conclusion

Dairy goat enterprises are profitable and can contribute significantly to the improvement of livelihoods of the rural communities in medium to high potential areas of Eastern Kenya, and elsewhere with similar agro-ecological conditions. Goat rearing under the 'cut-and-carry' system of feeding can be successful under smallholder production systems, especially where farmers can grow improved tree fodders, often to mark boundaries and as live hedges.

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Discussions/suggestions and comments on presentation:

Question: *Is water a constraint at any time of the year?*

Answer: No.

Question: *How do you verify measurements of production of the feed on-farm?*

Answer: We train farmers in data collection, e.g. milk recording. We visit the farm, every other day, early in the morning, to measure milk output and check feed inputs.

Question: *What is the feeding regime for lactating goats?*

Answer: The farmers are relatively resource-poor with no form of supplementation available apart from *Calliandra*, beans and *Leucaena* species. Milk yield is largely dependent on these supplements,

Question: *Has/will the socio-economic success of milk and meat production from goats increase negative effects of goat keeping, e.g. land degradation.*

Answer: Most goats are stall-fed, thus environmental effects are minimal. Goat meat has become very popular. The testing of goats' milk and its products was done at the local agricultural show; no one could tell the sample of cheese that had goat's milk as an ingredient.

Comment: Communities should be persuaded to try goats' milk. After persuading some individuals to take goats' milk, one goat farmer admitted that currently she cannot meet the demand in her village.

Question: *How much browse (fresh weight/dry weight) is needed to produce 3 litres of milk per day?*

Answer: This is not established. Farmers are advised to keep the trough full throughout the day. Fresh water should be available at all times. However, it is known that a litre of goat's milk requires about 5 MJ of metabolisable energy to produce.

Question: *Milk production has increased. Is there a danger of saturating the market, thus reducing the price?*

Answer: The amount of milk in Meru won't affect the market price. The market is there, especially in Nairobi where there is a belief that goats' milk limits the spread of HIV/AIDS. Farmers prefer to keep the goats' milk for the family and to sell cows' milk.

Question: *The concept of community-based goat production is spreading rapidly in Tanzania and NGOs are importing goats of different breeds and ages. A major problem is that unregulated imports of older goats are being distributed to farmers. Is this a problem in Kenya?*

Answer: Yes, this is a problem in Kenya. Most donors do not liaise with those who have experience in goat production, neither do they seek advice

before making the importation. As a result, goats of different breeds and ages are imported. FARM-Africa never imports goats that are over seven months old.

The effect of wattle tannin drench or an *acacia* meal supplement on faecal egg counts and total worm burdens of tropical sheep with an experimental nematode infection[1]

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Abstract

Following on from our studies on the potential use of tannins to control intestinal parasites in small ruminants we recently conducted two further trials to investigate the effect of a wattle tannin oral drench (WT), or supplementation of the diet with *acacia* (AMS), on faecal egg counts (FEC) and worm burdens of growing tropical Black Head Persian (BHP) sheep with an experimental intestinal nematode infection. In trial 1, 28 rams infected with a single dose of 1,500 mixed nematode larvae per 20 kg body weight were used. Faecal egg counts (FEC) were monitored regularly throughout the study. On day 30 post-infection, the infected sheep were blocked on the basis of their egg numbers and randomly assigned into two equal groups. For three consecutive days one group received a tannin drench at 1.5 g WT/kg body weight, and the remaining group received a placebo. All sheep were humanely slaughtered on day 42 post-infection and their worm burdens were assessed. Worm burdens and FEC were reduced ($P<0.001$) by the drench administration. Faecal mucus and water contents were increased. Trial 2 used another 28 infected growing BHP rams and had an identical design to trial 1, except that from day 30 post-infection animals in one group of 14 rams were offered 150–170 g of AMS daily, whereas in the other group they were offered *Pannicum* meal as control. On day 60 all animals were slaughtered for worm burden estimation. There was only a slight reduction in FEC (19 per cent) but none in the worm burdens.

The first trial demonstrated that the WT drench had significant activity against important nematodes of tropical sheep, as opposed to its small effects in infected tropical goats reported previously, suggesting that there are species differences between the two hosts. Feeding the *acacia* meal (trial 2), which is high in tannins, appeared to have little effect.

Introduction

One of the important constraints to small ruminant productivity is infection caused by parasitic nematodes of the gastrointestinal tract (Parkins and Holmes, 1989; Gill and Le Jambre, 1996). These infections cause significant losses in terms of poor growth, reduced

[1] 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. R7424, Livestock Production Research Programme.

reproductive performance and mortality. Nematode control has traditionally been through using synthetic anthelmintics. However, over-dependency and even misuse of the anthelmintics has resulted in the emergence and spread of nematode populations that are resistant to most anthelmintics (Prichard, 1994). This has led to increases in the cost of control through higher dosages and frequency of treatments (Over *et al.*, 1992). Moreover, anthelmintics are expensive and not affordable to many resource-poor farmers in the developing countries. There is, therefore, a need to search for cheap and sustainable nematode control alternatives. One such alternative could be the use of plants and plant products with anthelmintic activities. Some field studies in the temperate region have shown that forages rich in condensed tannins (CT) can improve the general performance of sheep with nematode infestations (Niezen *et al.*, 1993). These promising results have stimulated considerable research interest on the effect of tannins on different nematodes, particularly those of small ruminants. Previous studies have shown that dietary inclusion of the CT in quebracho extract (QT) could significantly reduce FEC and worm burdens of temperate sheep infected with *Trichostrongylus colubriformis* (Butter *et al.*, 2000; Athanasiadou *et al.*, 2000). Administration of QT as an oral drench was shown to be effective in reducing worm burdens of temperate sheep infected with *Haemonchus contortus* and *T. colubriformis* (Max *et al.*, 2002). However, similar studies with tropical goats using wattle tannin (WT) (Max *et al.*, 2003) revealed no significant reduction in FEC or worm burdens. It was argued that the apparent differences between sheep and goats could either be a species difference or rather an adaptation of the animals to tannins prior to the experimental study. A survey of local plants was undertaken in Tanzania and *Acacia polyacantha* was found to contain significant quantities of condensed tannin. In another study, (Max *et al.*, 2003) supplementation of worm-infected Small East African (SEA) goats with 130 g of tanniniferous browse (*A. polyacantha*) meal for 20 days gave 27 per cent and 13 per cent reduction in FEC and worm burdens respectively. It was suggested that the anthelmintic effect could be further enhanced if the animals were offered more of the *acacia* leaf meal. Two trials were, therefore, carried out with to investigate the effect of WT drench or *ad libitum* access to *acacia* leaf meal on FEC and worm burdens of growing tropical sheep experimentally infected with mixed nematodes.

Materials and methods

Study site and experimental animals

The two trials were carried out concurrently at Sokoine University of Agriculture, Morogoro, Tanzania. Sixty growing Black Head Persian (BHP) rams, 12 to 14 months of age and weighing 18.7 ± 2.1 kg, were purchased from a ranch in West Kilimanjaro, Northern Tanzania and were housed in individual wooden pens with raised floors. The sheep received a single oral dose of anthelmintic (Levacide®, Norbrook Africa Ltd., Kenya: Levamisole, at 7.5 mg/kg body weight) to clear any nematode infestations. An oral coccidiostat (Trisulmix®, Coophavet Ltd, France: Sulfadimethoxine–trimethoprim, at 20 mg and 4 mg/kg body weight respectively) was given weekly as a prophylaxis since coccidiosis was endemic in the trial area. The sheep were offered *ad libitum* a chopped mixture of *Chloris gayana* and *Brachiaria brizantha* hay and supplemented with 120 g/day of a maize bran-based concentrate (75 per cent maize bran, 24 per cent cottonseed cake and one per cent minerals). Body weights were monitored weekly throughout the trial.

Experimental infection

Faeces from a naturally infested goat were cultured by a standard Baermann technique to give infective stage larvae (L_3). The latter were suspended in distilled water at 4 °C before

they were identified to genus level and the proportion of each genus per unit volume of suspension was determined. Four nematode genera were identified as *Haemonchus* (76 per cent), *Oesophagostomum* (16 per cent), *Trichostrongylus* (6 per cent) and *Cooperia* (2 per cent). This proportion agrees well with the epidemiological distribution of these worms within a tropical environment (Urquhart *et al*., 1987), which indicates *Haemonchus* as the most predominant genus. On a day referred to as Day 1, 56 sheep were orally infected with a single dose of 1500 L3 per 20 kg body weight. The FEC were monitored regularly using the modified McMaster technique from Day 14 to the end of the trial. The sheep were blocked using FEC taken on Day 29 and then randomly assigned to four equal groups (n=14/group). Twenty eight sheep (2 groups) were used for the wattle tannin drench trial and 28 (2 groups) were used for the *acacia* feeding trial. Four sheep were left as an uninfected control that would help to monitor any extraneous source of worm infestation. No eggs were observed in the faeces of the four negative control sheep, a proof that there was no extraneous worm infestation.

Wattle tannin drenching trial (trial 1)

Two groups were used in the WT drench trial. One part of WT powder (Tanzania Wattle Co. Ltd.) was dissolved in two parts of lukewarm water to make a drenching solution. On Day 30, one group (drenched) received the drench orally at 1.5 g WT kg^{-1} body weight daily for three consecutive days, whereas the other group (infected control) received water as a placebo. Any feed refusals were collected and weighed; the data were used for determination of feed consumption. Faecal material consistency and water content were estimated by visual examination and overnight drying of a sample of faecal material respectively. All 28 sheep were humanely slaughtered ten days later (Day 43) for estimation of worm burdens, as described by Dawson *et al*., (1999).

Acacia meal supplement trial (trial 2)

Starting from Day 30, one infected group (14 sheep) was supplemented daily with a mixture of the concentrate and 150–170 g of dried leaves of *Acacia polyacantha* (CT=175 g/kg DM, determined using the acid butanol method, see Porter *et al*., 1986). The infected control group (14 sheep) was supplemented with dried green *Panicum trichocladum* grass (CT=3 g/kg DM); the latter was chosen because it contains a very low concentration of CT and its crude protein content is comparable with that of *A. polyacantha*. Feed refusals were collected for determination of feed consumption. Faecal samples were collected for determination of faecal egg counts. The trial was terminated after 30 days of *acacia* meal supplementation (i.e., on Day 60) by slaughtering all the animals, from which samples were taken for estimations of worm burdens.

Data analysis

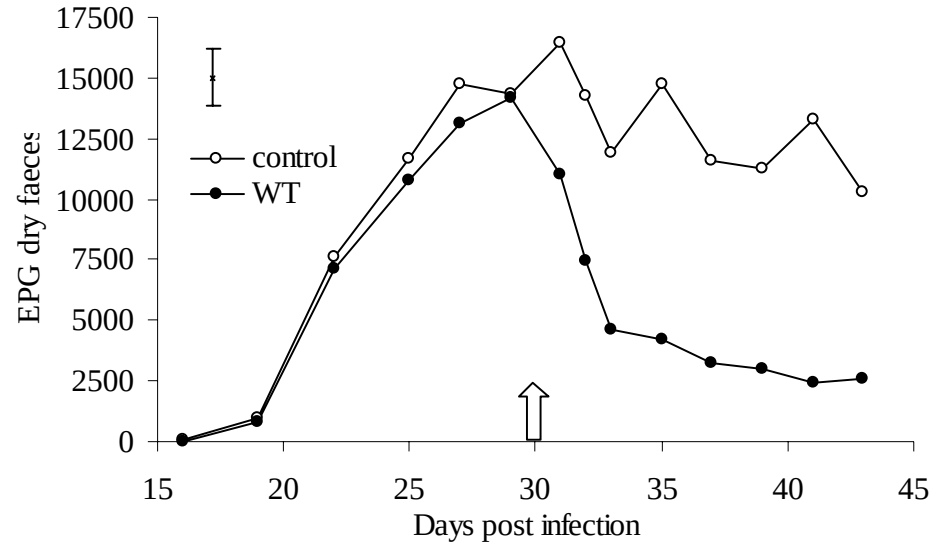
For both experiments, the data were analysed using a statistical package, Genstat 6.1 (Lawes Agricultural Trust, 2002). The FEC were square-root transformed to normalise the data prior to analysis. All the data were analysed as a completely randomised experiment using one-way analysis of variance (ANOVA) for repeated measures where individual animals were used as blocks. The impact of the drench on FEC, feed consumption and faecal water content was measured using data taken a day after the onset of treatment to the day of slaughter inclusively. Where results are presented as percentage change in egg counts, these are based on the back-transformed means from the analyses of the square root transformed data.

Results and discussion

Effect of WT drench on FEC and worm burdens

The effect of WT drench on FEC and worm burdens in the sheep is shown in Figures 1a and 1b, respectively. The FEC of sheep drenched with WT solution was significantly (P<0.001) reduced and the effect was recorded within 24 hours of the first dose and remained low to the day of slaughter (Day 43). Comparison of FEC between the drenched and control group on the day of slaughter showed a reduction of 75 per cent.

a)



b)

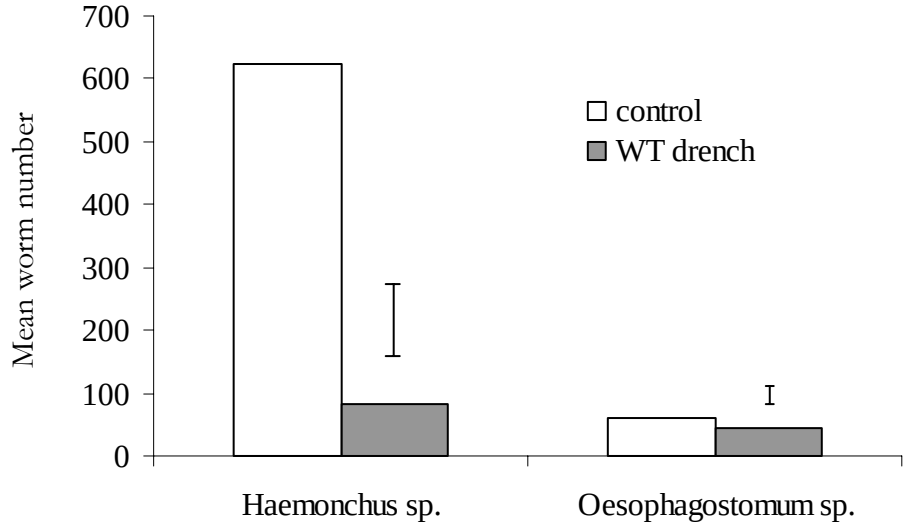
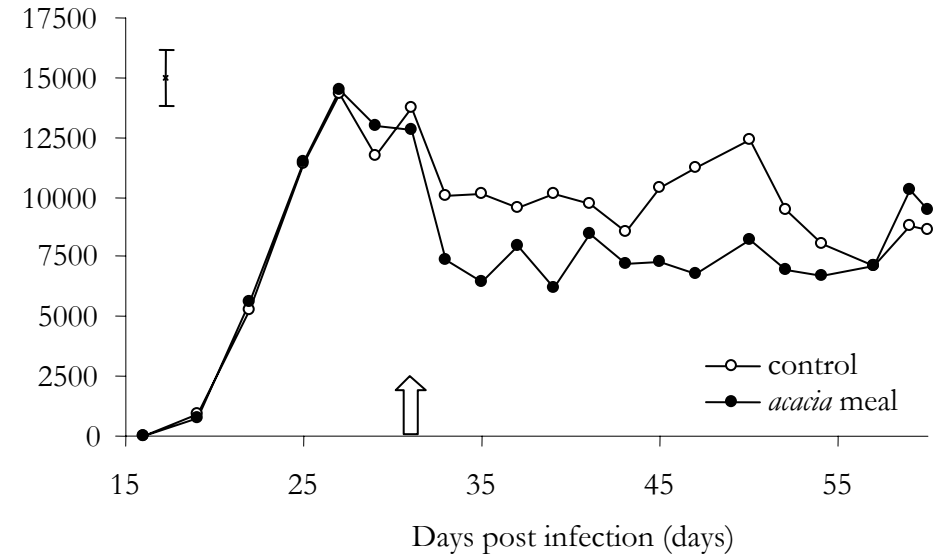


Figure 1 *The effect of wattle (WT) drench on faecal egg counts (FEC) (a) and worm burdens (b) of tropical sheep following its administration for three consecutive days at a dose of 1.5 g WT/kg body weight. The arrow (in Figure a) indicates the onset of WT drench administration on Day 30 post-infection. (Error bars represent s.e.d., EPG=eggs per gram).*

a)



b)

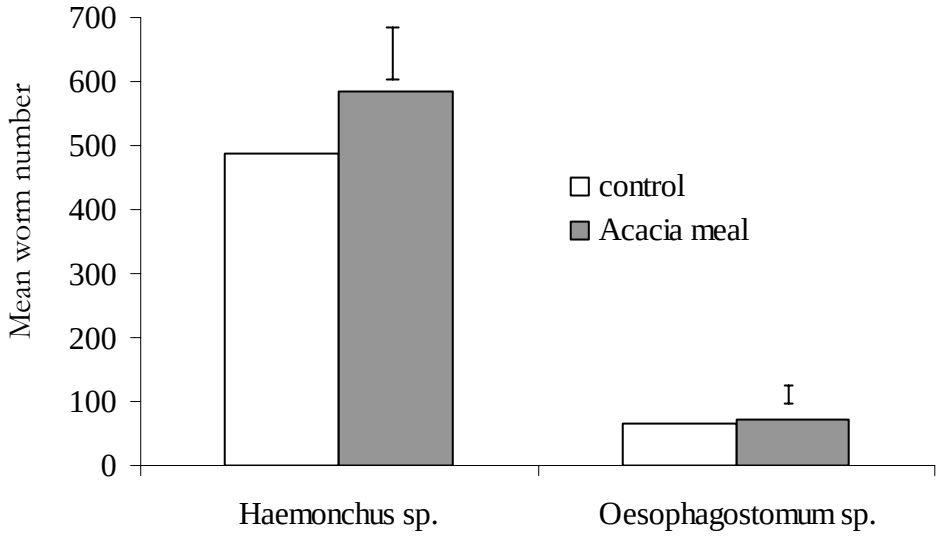


Figure 2 *Effect of acacia meal supplement (150–170g acacia/day for 30 days) on faecal egg count (FEC) (a) and worm burdens (b) of tropical sheep with mixed experimental infections. The arrow (Figure a) shows the onset of treatment on Day 30 post-infection). (Error bars represent s.e.d.; EPG=eggs per gram).*

The effect of the drench on worm burdens was also significant ($P<0.001$); the populations of *Haemonchus* and *Oesophagostomum* were reduced by 87 per cent and 28 per cent, respectively. The recovery of the small intestinal species, *Trichostrongylus* and *Cooperia* was too low for any meaningful statistical comparison (data not shown). The current results contrast with previous findings (Max *et al.*, 2003), in which WT drench did not affect FEC or worm burdens of Small East African (SEA) goats even though a higher WT dose rate was used. This is a strong indication that as far as the effect of tannins on

gastrointestinal nematodes are concerned, a species difference does exist between sheep and goats, and differences are not just an adaptation to dietary tannins. Goats, deer and antelopes are among several browsing animal species which can be induced by dietary tannins to produce tannin-binding saliva (Mehansho *et al*., 1983). This mechanism is lacking, or poorly developed, in other species including sheep, cattle and hamsters (Austin *et al*., 1989). It has also been suggested that goats are more adapted than sheep to the detrimental effects of CT because of microbial tanninase enzymes in their rumen (Perez-Maldonado and Norton, 1996). Goats are also known to harbour tannin-tolerant bacteria in their rumen; for example *Streptococcus caprinus* have been isolated from feral (Brooker *et al*., 1994) and SEA goats (Odenyo and Osuji, 1998). The *S. caprinus* was shown to grow in media containing at least 2.5 per cent w/v tannic acid or CT and able to degrade mimosine, tannic acid-protein complexes as well as hydrolysable tannins (Brooker *et al*., 1994). With these mechanisms in action, it is possible that tannins administered to goats were neutralised or inactivated before they can reach, or act, on the nematodes. As in goats, the WT drench also significantly reduced feed consumption and increased faecal water and mucus contents. This suggests that the effect of drench was not largely resulting from the physiological gut change as previously thought (Max *et al.,* 2003), but rather a direct toxicity to the worms.

Effect of AMS on FEC and worm burdens

Results of the *acacia* meal trial are shown in Figures 2a and 2b respectively. The meal, dried leaves of *A. polyacantha* (CT=175 g/kg DM) was generally accepted by the sheep with the exception of four sheep that consumed an average of 30 to 50 per cent of the supplemented meal throughout the trial. Supplementing the sheep with *A. polyacantha* for 30 days did not significantly reduce (P>0.05) FEC. However, as the egg profiles indicate, sheep receiving the supplement shed fewer eggs than the control sheep; this was equivalent to an average reduction of 19 per cent between days 31 and 60. Unexpectedly, this slight reduction was not reflected by the worm burden results since the *acacia*-fed sheep had, on average, higher worm burdens. This could possibly be an indication that *acacia* meal compromised the egg lying capacity (fecundity) of the worms. The effect of *acacia* meal supplement on nematode infection did not seem to differ much between tropical sheep and goats (Max *et al*., 2003) despite the fact that the sheep had *ad libitum* access to the supplement for 10 days longer and were very much more responsive to the WT drench.

Conclusions

The WT drench showed significant anthelmintic activity against parasitic nematodes of sheep raised in a tropical environment. When similar studies were conducted previously (Max *et al*., 2003) with goats little anthelmintic activity was noted. Further on-farm work is required to validate the use of tannin preparations in reducing nematode infections of sheep and other domestic ruminants known to have no tannin-neutralising mechanism, for example cattle. The practical implication of these observations on the effect of tannins on nematodes of small ruminants is that tannin preparations, which are cheap and readily available in the tropics, could be used to supplement the use of expensive drugs to control intestinal nematode infections in sheep.

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Discussions/suggestions and comments on presentation:

Question: *Do you have any experience in Tanzania with Calliandra; this is a high tannin feed that is of growing importance in Kenya for both cattle and goats.*

Answer: No, not at present

Question: *If goats have a tannin neutralising mechanism, is there a limit to the amount of tannin it can deal with? Is there proof that the mechanism exists or is it an assumption?*

Answer: The ability of goats to neutralise wattle tannins has not been measured. Drenching too much wattle tannins could adversely affect the goats, up to the point of killing them. Ability of goats to neutralise tannins is not an assumption but a proven observation and is well-documented. They produce protein rich saliva without affinity for tannins in the gut, which can grow in a medium containing up to 25 per cent weight for weight (w/w) bacteria and tannic acid. Enzymes like tanninase have also been located in the goat rumen.

Question: *People in Teso (Uganda) believe that Neem leaves can be used to treat worms.*

Answer: Neem tree leaves are also used in India as a de-wormer.

Comment: In Ghana papaya leaves and seeds have been (are) used successfully as de-wormers in small ruminants including poultry.

It should also be noted that several plant materials have anti-helmintic properties, which may be due to tannins but also to other compounds. In addition tannins can protect dietary protein from degradation in the rumen and it is known that infected animals can respond positively to an increased supply of protein to the duodenum.

Live weight gains and carcass characteristics of indigenous Matabele goats fed browse fruits[1]

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Abstract

A feeding trial with 66 castrated indigenous goats (initial body weight 20.0±1.13 kg) was conducted to evaluate the nutritive value of tree fruits as protein supplements: *Dichrostachys cinerea, Acacia erioloba, A. erubescens, A. nilotica* and *A. tortilis* were compared with a commercial feed, for growth performance and carcass traits of indigenous goats. Goats were randomly assigned to one of the six treatments (11 animals /treatment) and were individually fed for 60 days. Diets offered had an effect ($P<0.05$) on growth performance and carcass traits. A second experiment was undertaken to assess intake, digestibility and nitrogen retention of the six diets. Lowest levels ($P<0.05$) of intakes, digestibility and nitrogen retention were recorded in animals receiving *A. nilotica* fruits (pods). Although animals were restricted to receiving a maximum of 200 g of supplement per day, results indicate the potential of pods as affordable alternative protein sources for livestock.

Introduction

There is a dearth of information on the use and value of non-conventional feeds as pen-finishing supplements for local goats. Dry and mature fruits from *Acacia* and other tree species are potential protein sources for goats in semi-arid areas of Zimbabwe (Mlambo *et al.*, 2002). Although goats have the advantage that they can survive under harsh environments there is need to develop finishing strategies using non-conventional feed for use in the smallholder sector. Goats are important as a source of meat and other products, including milk, skins and manure. A lot of interest is now being directed towards utilization of non-conventional natural feed resources for supplementing livestock on rangelands in the semi-arid areas.

The present study was undertaken to evaluate nutrient utilization of tree fruits as protein supplements. The fruits were compared with a commercial feed. A metabolism trial was also undertaken to assess intake, digestibility and nitrogen retention of the diets.

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[1] 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. R7351, Livestock Production Research Programme.

Materials and methods

The study was carried out at Matopos Research Station (20°23′S and 28°28′E) in south-west Zimbabwe. The natural vegetation is dominated by thorny *Acacia* species and ground cover comprises perennial grasses with occasional annuals (Ward *et al.*, 1979).

Experiment one

A feeding trial, in which 66 indigenous castrated male goats were allocated to six treatments, was conducted. Average age of animals was 17 months. Animals were fed for 60 days. Animals were randomly allocated to one of the six diets (supplements), consisting of fruits of: *Dichrostachys cinerea; Acacia erioloba; A. erubescens; A. nilotica; A. tortilis;* and a commercial feed (a positive control). Animals were given the supplement of 200 g air-fresh material per day in two equal feeds, together with hay *ad libitum*. Animals were fed individually in crates. Water was available at all times. Slaughter procedures and carcass data collection were done as described by Baffour-Awuah, Matika and Sikosana (2000).

Experiment two

In the second experiment intake was measured. Thirty indigenous castrated goats (average weight 26 kg, age about 17 months) were allocated at random to one of six treatment (supplement) groups (five animals each*)*. The supplements were: cottonseed meal, *A. erioloba* fruits*; A. erubescens* fruits*; A. nilotica* fruits*; D. cinerea* fruits*;* and a commercial feed (goat meal). Animals were individually penned and fed. Half the feed was offered at 0800 hours and the other half at 1400 hours. Refusals were recorded daily and sampled, and then bulked for each animal over seven days.

Total faeces and urine were collected in days 21-28, for digestibility, and nitrogen retention (NR) determination. Daily samples for each animal was bulked over the seven days and stored at –4° C.

Samples were analysed using procedures described by AOAC (1990).

Results

Experiment one

Diets offered had an effect ($P<0.05$) on animal performance (Table 1). Final weights ranged from 18.5 kg to 21.2 kg resulting in cold carcass weights between 6.3 kg to 7.9 kg. Three diets led to a reduction ($P<0.05$) in daily gains. Goats receiving a commercial feed performed better ($P<0.05$), in all parameters measured, than those receiving tree fruits. Goats receiving *A. nilotica, A. erioloba and A. erubescens* fruits had significantly lower growth rates ($P<0.05$) compared to other treatments. Results show that tree fruits can be used in finishing diets for young animals.

Table 1 *Growth and carcass characteristics in young goats fed tree fruits or a commercial feed in experiment one*

Treatments	*Acacia Erioloba*	*A. Erubescens*	*Dichrostachys cinerea*	*A. nilotica*	*A. tortilis*	*Commercial feed*	*s.e.d.*
Initial weight (kg)	20.1	20.3	20.0	20.1	20.1	19.4	1.13
Final weight (kg)	19.9^{ab}	20.2^{ab}	20.3^{ab}	18.5^{b}	20.9^{ab}	21.2^{ab}	1.10
Hot carcass weight (kg)	7.0^{ab}	6.8^{ab}	6.8^{ab}	6.5^{b}	7.4^{ab}	8.0^{ab}	0.24
Cold carcass weight (kg)	6.8^{ab}	6.7^{ab}	6.7^{ab}	6.3^{b}	7.3^{ab}	7.9^{a}	0.24
Carcass length (cm)	50.3^{a}	51.0^{a}	49.7^{a}	49.4^{a}	50.8^{a}	51.15^{a}	1.16
Daily gain (g)	-3.3^{a}	-1.9^{a}	4.8^{ad}	-27^{c}	13.3^{d}	27.7^{b}	6.02
Dressing percentage	41.5^{c}	41.1^{c}	40.1^{c}	41.8^{bc}	42.3^{abc}	45.5^{a}	1.34

^{ab} Means within rows with different superscripts differ significantly (P<0.05)

Experiment two

Table 2 *Live weights (kg), daily intakes (g DM) of hay and supplements (tree fruits, cottonseed meal or goat meal), dry matter (DM), organic matter (OM), neutral detergent fibre (ADF and acid detergent fibre (ADF) digestibility (g/kg DM) and N retention (*NR, *g/d) of the whole diets offered to castrated male goats in experiment 2*

	Cottonseed meal	***Acacia erioloba***	***A. erubescens***	***A. nilotica***	***Dichrostachys cinerea***	**Goat meal**	**LSD**
Live weight	26.4	26.8	26.0	24.4	26.7		
Fruit intake	183	183	138	44	82	183	
Total intake	719^{a}	731^{a}	669^{ab}	491^{b}	844^{a}	774^{a}	187.7
Dig.							
DM	551	545	510	501	571	598	7.23
OM	733^{ad}	725^{ac}	697^{ab}	667^{b}	762^{cd}	747^{ad}	5.01
NDF	513	515	483	472	548	579	7.72
ADF	484	494	500	452	494	636	8.25
NR	5.8^{c}	2.1^{ad}	1.3^{d}	-0.5^{b}	3.0^{a}	5.8^{c}	1.31

^{ab} Means within rows with different superscripts differ significantly (P<0.05)

Goats receiving *D. cinerea fruits,* cottonseed meal and goat meal had the highest (P<0.05) hay intakes. *Acacia nilotica* fruits reduced intake. (P<0.05). The lower intakes of *A. nilotica* compared to other fruits may be due to anti-nutritional factors (Tanner *et al.*, 1990; Sikosana *et al.,* 2001; Ncube *et al.,* 1994). Nitrogen retention was significantly different (P<0.05) across treatments with goats receiving cottonseed meal or a commercial feed having the highest retention. Goats receiving *D. cinerea* fruits had the highest retention of

those receiving fruits. Animals receiving *A nilotica* had the lowest (P<0.05) nitrogen retention.

Conclusions

Low growth rates across treatment where goats received tree fruits could have been due to anti-nutritional factors found in the fruits. The limited amounts of air-fresh feed (200 g/head/day) could have had an impact on growth and carcass traits. The potential to replace commercial feeds with tree fruits as a protein source is demonstrated. More research is needed on the optimum quantities of tree fruits to include in pen-finishing diets. Usually fruits have been used to provide supplements to grazing animals in the dry season. More research is needed before recommending the use of *A. nilotica* fruits, which are the most abundant in most semi-arid areas of Zimbabwe. Smallholder farmers are interested in reducing feed costs by using recommended tree fruits as goat feed, in meat and milk production to increase marketable products. Conservation and added value of browse species will result in a stable ecosystem, which will be able to sustain livestock in drier areas. In drought years, in drier areas of Zimbabwe, farmers can expect a bumper harvest of a 'protein source' from tree fruits, for their livestock.

Acknowledgements

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Discussions/suggestions and comments on presentation:

Question: *We have been told that farmers collect acacia leaves and fruits from commercial farming areas. Are there possibilities of conflict among the farmers?*

Answer: There are bye-laws that govern the use of the land and people are collecting fruits without conflict.

Investigating the potential utility of the goat's ruminal adaptation strategies to tannins present in *Acacia* and other tree fruits[1]

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Abstract

This study investigated the potential of the goat's ruminal adaptation mechanisms to reduce the negative effect of tannins on *in vitro* fermentation. Rumen fluid from goats fed for 85 days on tannin-containing tree fruits (adapted rumen fluid) or a tannin-free commercial diet (unadapted rumen fluid) was used to ferment tannin-rich substrates. Dry and mature fruits of *Acacia nilotica*, *A. erubescens*, *A. erioloba*, *Dichrostachys cinerea* and *Piliostigma thoningii* were used as substrates for the *in vitro* fermentation. The effectiveness of adapted rumen fluid was measured against a known tannin-binding agent, polyethylene glycol (PEG). Although adapted rumen fluid significantly ($P<0.05$) increased the fermentation of tannin-rich substrates, it was no match for PEG. When PEG was added to adapted rumen fluid a further improvement in extent of fermentation was observed, suggesting that detannifying tannin-rich feedstuffs may still be necessary even when these are offered to adapted animals.

Introduction

Dry and mature tree fruits from *Acacia* and other tree species are potential protein sources for goats in semi-arid areas of Zimbabwe. However, the fruits contain high levels of phenolics, which may limit their utilisation. Many types of tannin are known as anti-nutritional, protein-binding secondary plant compounds, which may reduce availability of dietary protein. To improve the utilisation of tree fruits as protein supplements, tannin-inactivation treatments may be required. However, several researchers have presented findings that suggest that upon prolonged exposure to tanniniferous diets, some rumen microbes acquire mechanisms to deal with tannins. Such mechanisms include secretions that reduce the effect of tannins on microbes (defence) (Chiquette *et al.*, 1988) and ability to produce tannin-degrading enzymes (Brooker *et al.*, 1999; Wiryawan *et al.*, 1999; McSweeney *et al.*, 2001). Such microbes become adapted to the presence of tannins in the diet and hence their fermentation activity is less inhibited, allowing better utilisation of tannin-rich feedstuffs. Jones and co-workers (1994) identified *Prevotella ruminicola* and *Ruminobacter amylophylis* as tannin-resistant rumen bacteria. While the degradation of

[1] 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. R7351, Livestock Production Research Programme.

hydrolysable tannins in the rumen has been demonstrated (McSweeney *et al.*, 2001), breakdown of condensed tannins is not a confirmed feature of the fore stomach. Ruminal adaptation to condensed tannins is likely to be in the form of defence mechanisms, such as secretions, rather than tannin breakdown. As goats in semi-arid areas of Zimbabwe are continuously exposed to tannin-rich forage they may be considered to be adapted to tannins. It is, therefore, possible that there is little, or no, need to control the amount of tannins they consume through tannin inactivation treatments. However, in addition to the fact that tannin adaptation mechanisms are poorly understood, the same mechanisms may not be sufficient under a semi-intensive feeding regime of tree fruits (200 g/day for a mature goat). The objective of this experiment was to evaluate the effectiveness of adapted rumen fluid in reducing the biological activity of tannins using an *in vitro* tannin bioassay.

Materials and methods

The study tested the hypothesis that adapted rumen fluid is more potent in degrading tanniniferous fruits than unadapted rumen fluid. The second hypothesis was that treatment with polyethylene glycol (PEG) to inactivate tannin does not improve fermentation of tree fruits incubated with adapted rumen fluid.

Six rumen fistulated, castrated male Matebele goats were randomly allocated to supplements (200 g/animal/day) of either a tannin-free commercial protein supplement (CPS) or a fruit mixture (*Dichrostachys cinerea*, *Piliostigma thonningii*, *Acacia nilotica*, *A. erubescens* and *A. erioloba*, in equal proportions). Standing grass hay was offered at the rate of 600 g/animal/day as a basal diet while drinking water was available throughout the experiment. Animals were fed for a period of 85 days after which rumen fluid was collected and used to ferment tree fruits, in the presence and absence of PEG (200 mg/g DM), for 96 h using the Reading Pressure Technique (RPT) (Mauricio *et al.*, 1999). The animals offered a mixed fruit supplement provided adapted rumen fluid while those offered CPS provided unadapted rumen fluid.

The change in gas production in response to source of rumen fluid and PEG inclusion was measured. Dry and mature fruits used in the RPT fermentation procedure were collected from *D. cinerea*, *P. thoningii*, *A. nilotica*, *A. erubescens* and *A. erioloba* tree species. Gas production data were subjected to the analysis of variance using the GLM procedure for a completely randomised design (CRD) with a 5 (species) * 2 (rumen fluid) * 2 (PEG) factorial treatment arrangement. The model for cumulative gas production at 24 and 36 h post-inoculation was:

Y = *Overall mean* + *Species* + *PEG* + *Rumen fluid* + *Species*PEG* + *PEG*Rumen fluid* + *Rumen fluid*Species* + *Species*PEG*Rumen fluid* + *Residual error*,

where Y represented cumulative gas production. Treatment means were compared by applying the probability of difference (PDIFF) option of the least squares means statement in the GLM procedures of SAS (SAS/STAT, 1996).

Results

Table 1 shows the chemical composition of the basal diet and supplements offered to rumen fistulated goats. The grass hay offered to fistulated goats as the basal diet was, typically, low in nitrogen (4.62 g kg^{-1} DM) and high in both NDF and ADF (786 and 562

g kg^{-1} DM, respectively). The mixed fruits and CPS did not differ significantly in N content (Table 1). Mixed fruits supplement, however, had significantly ($P<0.05$) higher levels of both NDF and ADF.

Table 1 *Dry matter (g/kg) and chemical composition (g/kg DM) of basal diet and supplements (see text for details) fed to rumen fistulated goats*

Constituent	Grass hay	CPS	Mixed fruits	s.e. mean
Dry matter	934[a]	929[b]	923[c]	1.0
Ash	79.7[a]	93.6[b]	49.3[c]	0.97
Nitrogen	4.62[a]	23.5[b]	20.8[b]	1.76
Neutral detergent fibre	786[a]	449[b]	479[c]	9.3
Acid detergent fibre	562[a]	246[b]	337[c]	1.0

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

Table 2 *Effect of PEG on cumulative gas production (ml/g OM) of tree fruits incubated with adapted and unadapted rumen fluid*

		24 h incubation		36 h incubation	
Species	Rumen fluid	Without PEG	With PEG	Without PEG	With PEG
Acacia erioloba	Unadapted	82.9[a]	87.8[b]	120.7[a]	129.9[b]
	Adapted	108.7[c]	115.3[d]	146.1[c]	154.2[d]
A. erubescens	Unadapted	75.9[a]	74.8[a]	106.6[a]	105.1[a]
	Adapted	87.9[b]	86.0[b]	115.0[b]	113.7[b]
A. nilotica	Unadapted	42.9[a]	70.2[b]	64.3[a]	106.3[b]
	Adapted	74.5[b]	106.6[c]	132.3[c]	158.8[d]
Dichrostachys cinerea	Unadapted	53.2[a]	96.1[b]	73.2[a]	134.4[b]
	Adapted	77.6[c]	110.9[d]	103.9[c]	139.8[d]
Piliostigma thoningii	Unadapted	80.9[a]	122.6[b]	112.9[a]	154.8[b]
	Adapted	100.3[c]	136.4[d]	132.7[c]	165.0[d]
s.e. mean		2.11		2.33	

Within species and within incubation time, means with different superscripts differ significantly ($P<0.05$)

Table 2 shows the effect of source of rumen fluid and PEG on cumulative gas production from tree fruits. All comparisons were made using 24 and 36 h incubation data. Adapted rumen fluid was consistently more potent than unadapted rumen fluid across all tree species. The largest increase in gas production between unadapted and adapted rumen fluid was observed with *A. nilotica* fruits (73.7 per cent). The PEG treatment significantly ($P<0.05$) improved the fermentation of tree fruits in adapted

rumen fluid in all tree species except *A. erubescens*. Adapted rumen fluid plus PEG generated more gas than unadapted rumen fluid plus PEG for all tree species except *D. cinerea*. In *D. cinerea*, there was no significant difference between the gas production values for these two treatments.

Discussion

The hypothesis that rumen fluid from adapted animals is more potent in fermenting tanniniferous tree fruits than fluid from unadapted animals was confirmed by the results obtained. However, the hypothesis that PEG inclusion does not improve gas production from tree fruits incubated with adapted rumen fluid was not supported. The ability of rumen microbes to adapt to dietary phenolics has been reported by several workers (Lowry *et al.*, 1996; Odenyo *et al.*, 1997; Saarisalo *et al.*, 1999; McSweeney *et al.*, 2001). However, the mechanisms through which microbes adapt to the presence of phenolics in the diet of the animal are poorly understood. Polyethylene glycol has been used to investigate the biological effect of tannins on *in vitro* fermentation thus largely ignoring the effect of low molecular weight phenolics, which may not bind to PEG. These phenolics may affect microbial growth and some even act as nutrients (Lowry *et al.*, 1996), and thus adaptation of the microflora may protect the animal from the harmful effects of these phenolics in the rumen.

The higher potency of the adapted rumen fluid is supported by the observation made by Smith (1992), that microbial populations change with prolonged exposure to toxic substances, thus allowing ruminants to increase their tolerance to some potentially poisonous plants. As expected, the PEG effect was higher when applied to unadapted rumen fluid compared to adapted rumen fluid. This suggests that the rumen microbes, either through tannin degradation or through other adaptive mechanisms, are able to inactivate some of the tannins, which in unadapted animals would have been inactivated by PEG (McSweeney *et al.*, 2001; Acamovic and Stewart, 1999; Wiryawan *et al.*, 1999).

The fact that the increase in cumulative gas production due to the application of PEG is higher than the increase due to the use of adapted rumen fluid for *D. cinerea* and *P. thonningii* fruits may indicate a strong *in vitro* effect of condensed tannins in these tree species. For *A. nilotica*, it appears that hydrolysable tannins, epigallocatechin gallates (Ayoub, 1985), play a much bigger role as anti-nutritive factors. Interestingly, adapted rumen fluid increased gas production by 74 per cent over unadapted rumen fluid when *A. nilotica* fruits were fermented for 24 h post-inoculation. This was higher than the increase in gas production when PEG was used to ameliorate tannin effects in unadapted rumen fluid. However, adapted rumen fluid plus PEG always gave higher cumulative gas production values suggesting an additive effect of the two methods with respect to alleviation of toxicity of phenolics. There is, therefore, evidence to support the observation that PEG may not bind efficiently to all types of tannins (our unpublished data) in the *in vitro* evaluation of forages, such as *A. nilotica* fruits, except in situations where such forages are to be offered to adapted animals. Adapted animals are expected to metabolise low molecular weight phenolics and hydrolysable tannins. Indeed, Distel and Provenza (1991) reported that 'experienced' goats excreted more uronic acids (an indicator of phenol detoxification in animals) per unit body weight than 'inexperienced' goats fed blackbrush (*Coleogyne ramosissima* Torr.). As expected the fermentation response of *A. erubescens* fruits to both PEG and adapted rumen fluid was limited due to its high fibre and low phenolic content. The fermentation pattern of *A. erioloba* fruits followed

that of *A. nilotica*, with higher gas production values being obtained with adapted rumen fluid than with PEG treatment.

Although this study focused on ruminal adaptations to tanniniferous forages it is important to note that there are other defence mechanisms that enable goats to utilise tannin-containing forages. Tannin-binding salivary proteins were first discovered by Mehansho *et al.* (1983) and comprise proline rich proteins (PRPs), which have a strong affinity for tannins and may be the first line of defence against dietary tannins (Wróblewski *et al.*, 2001).

Conclusions

Adapted rumen fluid and the addition of PEG alleviated the inhibitory effects of phenolics on *in vitro* fermentation of tree fruits in an additive manner. Because PEG further increased fermentation with adapted rumen fluid, it is suggested that detannifying of fruits may still be necessary even when being fed to 'adapted' goats. It should be noted that feeding equal mixtures of tree fruits might have helped in alleviating anti-nutritional effects of phenolics through dilution caused by co-feeding fruits with high levels and different types of phenolics and those with very low levels. In fact, recent research by a few authors showed that a mixture of tanniniferous browses produces less deleterious effects than sole feeds (Dube & Ndlovu 1995; Patra *et al.*, 2003; Ben Salem *et al.*, 2002; Melaku *et al.*, 2004). Fruits of *A. nilotica* and *A. erioloba* may require treatments that inactivate low molecular weight phenolics when being fed in large quantities or as a sole supplement. Alkaline treatments are potential candidates for this role. Fruits from *D. cinerea* and *P. thonningii* contain appreciable quantities of condensed tannins, which may not be metabolised in the rumen and may thus require treatments. It is important to check, *in vivo,* to what extent the condensed tannins compromise the protein value of fruits from these two species. The role of alkaline treatment in inactivating phenolics and enhancing the protein value of fruits should be evaluated *in vivo*.

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Interventions to increase the contribution that goats make to the livelihoods of landless and land-constrained livestock keepers in the Gangetic plains of Nepal[1]

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Abstract

Four communities (villages) in the Dhanusha district of southern Nepal took part in an experiment lasting one year, which was aimed at developing appropriate strategies to enhance doe productivity and thereby increase the contribution goats make to the livelihoods of landless and land-constrained livestock keepers. In each village, 20 households keeping between three and eight goats participated. Households were divided randomly into one of three groups and managed their goats throughout the experiment according to normal practice. Does' diets were supplemented with one of the following three treatments: 1) DMZ: Does' diets were supplemented with 100 g/d ground maize for two weeks before and six weeks after kidding (n=7 per community); 2) DSE: Does' diets were supplemented with 500 mg selenium and 50 mg Vitamin E for two weeks before and six weeks after kidding (n=7 per community); 3) CON: Does were managed according to normal practice, but finishing goats were supplemented with ground maize (100 g/d) for three weeks before sale (n=6 per community).

A villager recruited by the project to act as a facilitator visited the households every two weeks and maintained individual records (entries, exits, services, incidences of disease and live weights) of all goats, as well as records of household income and debt. The effects of treatment on doe performance and annual potential income (sum of the change in asset value of the flock and income from all sales of goats) were estimated by analysis of variance. Does in DMZ kidded more often (0.85, 0.72, 0.59 kiddings/doe for DMZ, DSE, CON respectively, s.e.m. 0.069, $P<0.05$) and produced more kids (1.6, 1.0, 1.2, s.e.m. 0.17, $P<0.05$). They also gained more live weight in the first two recordings after kidding (2.15, 1.35, 1.29, s.e.m. 0.862 kg, $P<0.001$) as did their kids (1.52, 1.15, 1.08, s.e.m. 0.071, $P<0.001$). This resulted in an almost significant ($P=0.053$) increase in the annual potential income from the goat flock (NRs 4,453, 2,352, 2,669 s.e.m. 803.3 or US$ 68.5, 36.2, 41.1 s.e.m. 12.36). The net benefit of the DMZ treatment (taking into account the cost of treatment) is equivalent to 19 per cent of mean household debt and 69 per

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cent of mean monthly household income. Farmers were positive about both treatments, although the level of adoption of DMZ was greater. It is concluded that energy is limiting in the diets of does, and supplementation with maize, other cereals, or other energy-rich feed resources that might be identified will have a positive impact on the contribution goats make to the livelihoods of resource-poor livestock keepers in Nepal.

Introduction

Goat keeping is widely practiced in Nepal, with 85 per cent of households in rural Nepal keeping at least one goat. Work with four communities (Jamunibas, Kemalipur, Baluwa Bhiman and Birendra Bazaar) in Dhanusha District, Central Development Region of southern Nepal, situated in the Gangetic plain about 100 m above mean sea level, identified two key constraints to goat keeping in this area. These were the high incidence of disease in the wet season (July-September), and infertility in does. The commonest cause of disease in goats in the wet season was identified as infection by helminths (Thakuri *et al.*, 1994), and a range of interventions were investigated with these communities to reduce the incidence of disease and the number of enforced sales of sick goats. The findings from this investigation have been reported previously (Rymer *et al.*, 2004). While evaluating these interventions, it became apparent that doe infertility was another key constraint to goat keeping in this area. Does that failed to conceive after two services are sold, and 21 per cent of households did not keep a multiparous doe, presumably because of difficulties encountered with getting their does into kid a second time. A survey of the does' nutrient balance indicated that energy was limiting, particularly in early lactation when attempts to get her back in kid may begin as the target kidding interval is six months. There was also some evidence that selenium may be a limiting nutrient in this geographical area. The objective of this study was, therefore, to develop appropriate interventions to overcome these two potential nutritional constraints, and determine what effect this might have on the contribution the goat flock makes to goat keepers' livelihoods.

Materials and methods

As in the experiment reported by Rymer *et al.* (2004), 20 households from each community were involved. Each household kept between three and eight goats, the number of adult does being on average 2.8. All goats were treated with broad spectrum anthelmintics (fenbendazole and oxoclozanide) in May and September (at the beginning and end of the wet season) and vaccinated against peste des petits ruminants (PPR). Other than this, goats were managed according to normal practice throughout the experiment apart from the use of the intervention that was being investigated.

Households were randomly divided into three treatment groups. It was assumed there was no carry-over effect from the previous experiment. The treatments investigated were:

1. DMZ: Does' diets were supplemented with 100 g/d ground maize for two weeks before and six weeks after kidding (n=7 per community)
2. DSE: Does' diets were supplemented with 500 mg selenium and 50 mg Vitamin E for two weeks before and six weeks after kidding (n=7 per community)

3. CON: Does were managed according to normal practice, but finishing goats were supplemented with ground maize (100 g/d) for three weeks before sale (n=6 per community).

Individual records of all goats (entries, exits, incidences of disease, reasons for exit and the price obtained (if sold) were maintained by facilitators in each community visiting participating households at fortnightly intervals. Live weight was recorded at monthly intervals, except in the case of pregnant does. In addition, regular records of household income and sources of that income were kept, as were records of the level of household debt. The mean prices obtained from the sale of adult (more than 8 months) male and female goats and young (less than 8 months) male and female goats were used to calculate the asset value of each goat flock at the beginning and end of the experiment. The effects of treatment, community and interaction between treatment and community on doe productivity, live-weight gain of does and kids post-partum, income from goat sales and asset value of the goat flocks were estimated by analysis of variance.

Results

Data relating to the economics and structure of the participating households were reported by Rymer *et al.* (2004). Thirty-three per cent of the households were landless and unable to grow any of their own food. These households were always reliant on either purchased food, or receiving food in part payment for labour. However, food self-sufficiency was only for five months per year across all the households in the study. Goat sales constituted about 11 per cent of household income, and in some months as much as 56 per cent. Mean household debt was NRs 8,468 (US$ 130), which ranged from NRs 0 to 30,286 (US$ 0 to 466), and mean monthly income was NRs 2,392 (US$ 37), ranging from NRs 597 to 9,143 (US$ 9 to 141).

No interactions between community and treatment were observed. The effect of treatment on doe productivity and live-weight gain of kids and does is summarised in Table 1. Does that were supplemented with maize kidded more frequently and produced more kids during the experimental period (one year) than does that received either no supplement or were fed supplementary selenium. Does, and the kids they produced, gained more live weight in the month after kidding if they were supplemented with maize compared with does kept on the other regimes.

Table 1 *Effect of treatments on doe productivity and live-weight gain of kids and does (see text for treatment details)*

	Treatment				
	DMZ	**DSE**	**CON**	**s.e.m.**	**Significance[1]**
Kiddings/doe	0.85	0.72	0.59	0.069	*
Kids/doe	1.6	1.0	1.2	0.17	*
Live-weight gain, kg (difference between the first and second recording of live weight after kidding):					
Kids	1.52	1.15	1.08	0.071	***
Does	2.15	1.35	1.29	0.862	***

[1]* = $P<0.05$; *** = $P<0.001$.

The effect of treatment on the asset value of the flock, income from goat sales and potential income from the goat flock is summarised in Table 2. There was no significant difference between treatments in the asset value of the flocks at the start or end of the experiment, but the change in asset value was affected by treatment ($P<0.05$) with DMZ being associated with a 10 per cent increase in the value of the flock, whereas CON was associated with a 29 per cent decrease in asset value. This was in part offset by the tendency for sales income from goats to be higher with CON than DMZ, but this effect was not significant ($P>0.05$). The net benefit (change in asset value plus sales income) was affected by treatment ($P=0.053$) with DMZ being associated with a 64 per cent return on mean asset value while CON and DSE were associated with returns of 41 and 35 per cent, respectively. This increased potential income from DMZ compared with CON amounted to NRs 1,784 (US$ 27.45). The cost of treatment, with mean adult doe numbers of 2.8 per household, kidding 0.85 times a year, amounted to NRs 133 (US$ 2.05) resulting in a net benefit of NRs 1,651 (US$ 25.40). This is equivalent to 19 per cent of mean household debt and 69 per cent of mean household monthly income.

Table 2 *Effect of treatment on the asset value and sales income from goats (see text for treatment details)*

	Treatment				
	DMZ	DSE	CON	s.e.m.	P[1]
Asset value at start (NRs)[2]	6637	6964	7483	778.7	ns
Asset value at end (NRs)	7370	6314	5608	845.8	ns
Change in asset value (NRs)	733	-650	-1876	736.9	*
Income from goat sales (NRs)	3720	3003	4545	663.5	ns
Potential income from goat flock, NRs (sum of change in asset value and goat sales)	4453	2352	2669	803.3	0.053

[1]ns = not significant, $P>0.05$; * = $P<0.05$

[2] Exchange rate at time of writing is 69.8960 NR to 1 USD

The farmers' evaluations of the different treatments are presented in Tables 3-5. Farmers' evaluation of DMZ was that it had increased doe fertility, halved the kidding interval and increased the value of the kids produced. In all communities, except Birendra Bazaar that reported a shortage of maize, participating farmers, and some of their neighbours, had adopted this technology, although many fed maize less frequently than in the experiment and many used cereals other than maize, which were often cooked with water (*khole*). Although there was no evidence that selenium affected doe fertility, the farmers' evaluation was that it had caused previously infertile does to conceive and they were keen to adopt this technology.

Table 3 *Farmers' comments on supplementing kidding does with maize*

Village	Comments on treatment	Comments on adoption
Baluwa Bhiman (comments from 5 farmers)	Liked treatment because fertility, kid performance and live-weight gain improved, and milk yield increased.	Continued feeding maize to does; one participant said they weren't doing this regularly but were feeding forage *ad libitum*. One participant buys maize to feed her doe. Most are feeding maize (100 g/d) or khole; neighbours are adopting as well. Leftover rice is given to the goats.
Birendra Bazaar (comments from 7 farmers)	All liked the treatment; 2 said this was because kid numbers and live-weight gain increased, 4 said because kidding interval had decreased from 12 to 6 months. Kid price from does fed maize increased (from NRs 600 to NRs 1,000).	Most have not adopted because maize was not available. Will feed does maize when it is available. Neighbours (5 of the 7) are positive about treatment, but they have not adopted it. Some neighbours do not know because results have not been communicated. Message should be extended.
Kemalipur (6 farmers present, 1 absent because of bereavement)	All liked the treatment because it increased prolificacy and growth, and the number of pregnancies doubled (twice a year instead of once). Five of the 13 farmers in group ate the maize rather than giving it to their goats.	Now feeding maize flour with water, one is feeding maize bran. One is feeding flour mixed with water to make a ball. No longer separating does from khassi (castrated males). One (landless) farmer is giving leftover rice, forage and grazing. One giving khole and salt water. Majority of neighbours have adopted.
Jamunibas (comments from 5 farmers)	Liked treatment because goats grew well and does became pregnant. Kidding interval 7-8 months. Good kid performance and goats came back on heat quickly.	Adopted, but not as regularly as in the experiment. Does now fed every 2-3 (or 3-4) d, although one was feeding daily. Does fed every 3-4 d get more (about 2 kg). Lack of time, and maybe feeding leftovers that are not available every day prevent daily feeding. Neighbours have adopted as well. Good message for extension.

Table 4 *Farmers' comments on supplementing kidding does with selenium*

Village	Comments on treatment	Comments on adoption
Baluwa Bhiman	Liked treatment because 19 d after kidding, one doe conceived. Goats became fatter and were ready for the buck quickly.	Want to buy this 'medicine' but don't know where it is available. Message should be extended.
Birendra Bazaar	Kid health improved with treatment, and kidding interval decreased. No problems with infertility, and fertility increased with treatment.	Message should be extended.
Kemalipur	Liked treatment because does became strong, robust and fat. Increased fertility.	Shopkeeper does not know (and, therefore, does not stock) selenium.
Jamunibas (5 present)	Liked treatment.	All want to continue feeding selenium but can't get it. Asked local facilitator about it, who said it was very expensive. Neighbours know about treatment. Facilitator's wife took some and gave it to one of her infertile does which then conceived.

Table 5 *Farmers' comments on supplementing finishing goats with maize*

Village	Comments on treatment	Comments on adoption
Baluwa Bhiman (18 present)	Good; it made the goats healthy. Good because goats were fed the same, small amount each day.	Will adopt (already normal practice) but will revert to feeding irregular amounts of different cereals. Not worth extending, because it is obvious that if you feed goats cereals they will grow and be healthier.
Birendra Bazaar	Beneficial because goats live weight increased. Became active and strong and fattened.	
Kemalipur (3 present)	Liked treatment because goats became strong and healthy. Five of the 13 farmers in group ate the maize rather than giving it to their goats.	
Jamunibas (5 present)	Liked treatment because although goats were already fed, they were not given measured amounts.	Discussed with neighbours, but they have not adopted - all are feeding irregular amounts. Message should be extended.

Conclusions

There was no objective evidence that selenium was a limiting nutrient in this experiment, but energy clearly was. Supplementing goats' diets with energy (in the form of ground maize) improved doe fertility and increased the potential income of the goat flock. In a previous experiment (Rymer *et al.*, 2004), it was observed that maize supplementation also reduced the incidence of disease in the wet season, and there was again a tendency for the potential income from the goat flock to be increased. The supply of dietary energy is clearly a key constraint to goat production by resource-poor livestock keepers in

this area, but finding an affordable means of overcoming this constraint can be a challenge. Providing supplementary energy (in this case in the form of maize) at key times in the goats' life cycle is probably the best means of maximising returns on such an investment. The strategic use of supplementary maize (or another energy source) in the does' diet at times of peak requirements (late pregnancy and early lactation) is affordable by many of the participating farmers, as they have adopted the technology, albeit with some modifications. The effect of this strategic supplementation is a measurable increase in the contribution that the goat flock makes to the livelihood of the household. The level of adoption by one community (Birendra Bazaar) was lower because maize was not available there. Further work needs to be done to identify alternative sources of supplementary energy in these situations, and to communicate the effectiveness of this technology to target institutions working with very poor and landless livestock keepers in Nepal and elsewhere.

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Discussions/suggestions and comments on presentation:

Question: *In East Africa refined maize meal is a human food. Only maize bran is cost effective for animal feeding. Why do you suggest whole maize meal as a feed for animals in Nepal?*

Answer: In Nepal, rice is the most important staple crop, maize as human food is secondary and is, therefore, relatively cheap.

Relative economic benefits of strategic anthelmintic treatment and urea-molasses block supplementation of Boer goats raised under extensive grazing conditions at Onderstepoort, Pretoria, South Africa[1]

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Abstract

The potential economic benefits of combining strategic anthelmintic treatment for gastrointestinal nematodes and nutritional supplementation with urea-molasses blocks were examined in Boer goats, raised under extensive grazing conditions in the summer rainfall area of South Africa. Eight groups of nine goats were monitored over a 14-month period from August 2002 to October 2003. Nutritional supplementation with urea-molasses was carried out in the summer (wet season), from December 2002 to February 2003, and, or, the winter (dry season), from June 2003 to August 2003. All of the goats received symptomatic treatment for *Haemonchus contortus* infection when it was considered necessary as determined by clinical examination of the ocular mucous membranes for anaemia (according to the FAMACHA© system). Four of the groups received a strategic treatment for gastrointestinal nematodes in the middle of the summer (28th January 2003) while four did not. Under the climatic and extensive grazing conditions encountered during the trial, supplementation in the winter had the greatest economic benefit. Provided the nematode challenge is low and individual goats are treated when symptoms of nematode infection are noted, winter supplementation with urea-molasses blocks is recommended for extensively reared goats in the summer rainfall area.

Introduction

Disease caused by gastrointestinal parasites is considered to be amongst the top conditions that impact on the livelihoods of poor livestock keepers (Perry *et al.*, 2002). Anthelmintics are currently the most commonly used method of control for the parasites, but the emergence of anthelmintic resistance threatens the drugs' long-term efficacy. Protein supplementation has been identified as an alternative approach in the management of nematodes (Coop & Kyriazakis, 1999). The aim of the current study was

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to obtain quantitative data on the economic benefits of symptomatic and, or, strategic anthelmintic treatment and nutritional interventions against gastrointestinal nematode (*Haemonchus contortus*) infections in Boer goats. Information on the interaction of strategic drug and nutritional interventions, goat productivity and parasites is currently almost totally lacking but is required before rational decisions can be made on the application of such interventions in the field.

Materials and methods

Seventy-two male Boer goats were housed under worm-free conditions, fed a commercial pelleted feed and hay *ad libitum* and castrated if intact. The animals were intensively dewormed until faecal flotations (Reinecke, 1983) were found to be negative. Each animal was then artificially infected on 23rd August 2002 with approximately 3000 *H. contortus* larvae of a susceptible strain (Moredun strain) which had been stored in liquid nitrogen. The animals, 7-8 months old, were then moved to the Onderstepoort Veterinary Institute (OVI) experimental farm ('Kaalplaas'). The goats were grazed extensively in a field of approximately 150 ha. of mixed grazing and browse, which was judged to be of good quality. During an adaptation period of four weeks, the goats' ration of pelleted feed was reduced from 50 kg for the herd to 12.5 kg. The amount of pellets fed was further reduced to 10 kg on 14th October 2002 for ease of weighing and the latter amount was then fed for the remainder of the study. The pellets were fed to lure the animals back into the sheds at night and their effect on the animals' nutrition was considered negligible.

The design of the experiment proper is shown in Table 1. On 1st October 2002 the animals were randomly allocated based on live weight into eight groups of nine animals each. The goats were housed by feed group at night when urea-molasses supplementation was provided as appropriate. The goats were treated symptomatically with ivermectin (Ivomec liquid for sheep and goats, Merial South Africa, 400 µg/kg) if they were judged to be anaemic according to the FAMACHA© system (Vatta *et al.*, 2001). This method allows the animal's mucous membrane colour to be classed in one of five colour categories from 1 (non-anaemic) to 5 (severely anaemic). Salvage anthelmintic treatments were given to those animals scored in categories 3, 4 or 5. In addition they were either treated strategically with ivermectin on 28th January 2003 or not. On a weekly basis, the goats were weighed and sampled for faecal nematode egg counts (Reinecke, 1983). The study ran until 9th October 2003, whereafter the animals were slaughtered and their dressed-out carcase weights determined. Finally, the most economically viable option was determined by cost-benefit analysis.

Table 1 *Experimental design – Urea-molasses block supplementation and strategic drug intervention regimens for the eight groups of nine Boer goats*

Groups of 9 goats	Time of urea-molasses block supplementation	Symptomatic treatment with (+) or without (-) strategic treatment
1	Controls – no feed supplementation	-
2		+
3	Wet-season supplemented (December 2002 – February 2003)	-
4		+
5	Dry-season supplemented (June – August 2003)	-
6		+
7	Wet-and-dry season supplemented (December 2002 – February 2003 and June – August 2003)	-
8		+

Results

It was unusually dry from March to September 2003, with no rain at all from April to September (Figure 1), which may have been detrimental to the survival of *Haemonchus* larvae on the pasture. While the goats were infected (Figure 2), the egg counts were low throughout the study (<400 eggs per g of faeces). The strategic treatment was effective, with the mean egg count dropping to almost zero in the treated groups. After May, probably owing to the exceptionally dry winter conditions, all the groups had very low egg counts (<150 eggs per g of faeces). Regardless of type of supplementation, there were no statistically significant differences in the weight gain between the 36 strategically and symptomatically treated goats and the 36 goats given symptomatic treatment only (Figure 3).

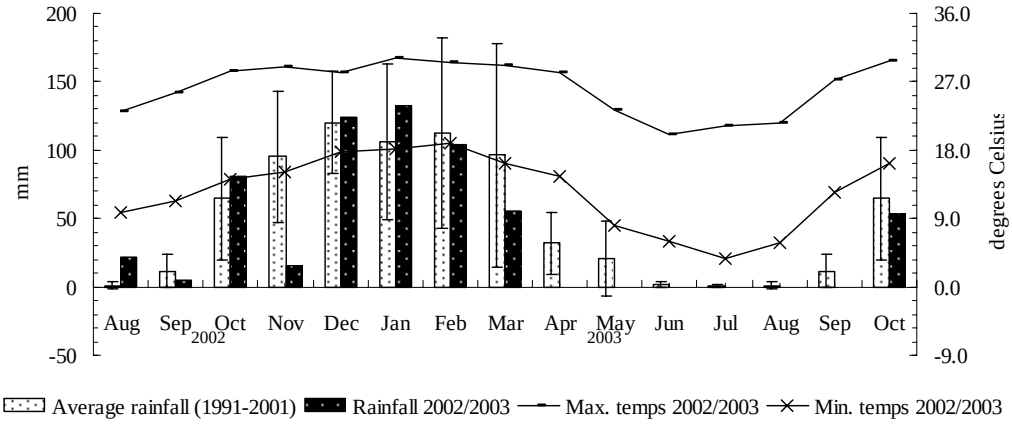

Figure 1 *The rainfall (compared with the average for 1991-2001) and temperature data for the Onderstepoort Veterinary Institute (OVI) experimental farm over the experimental period. (Rainfall data measured on OVI farm; temperature data for Pretoria as supplied by South African Weather Services.)*

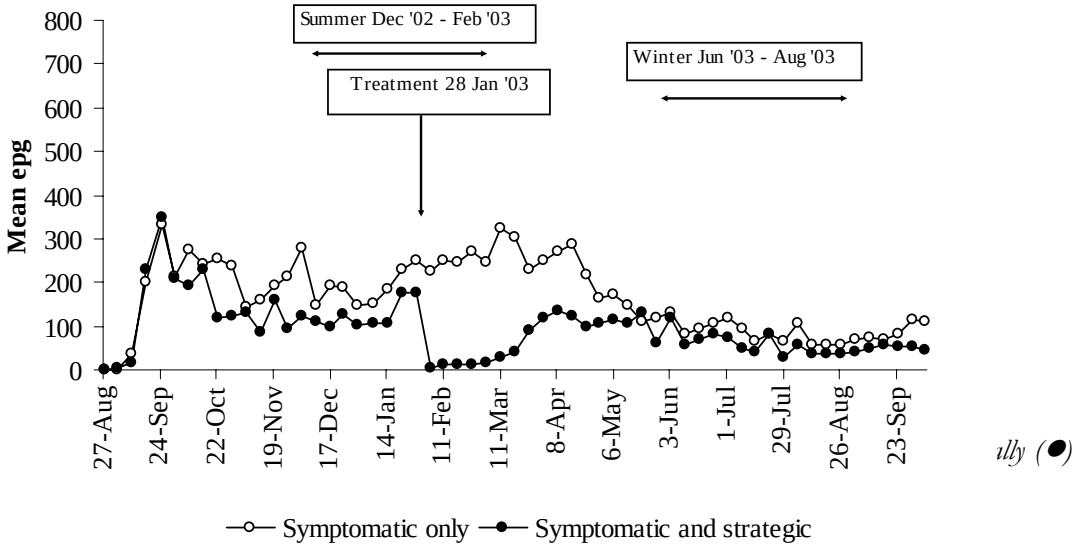

Figure 2 *The mean faecal egg counts for the 36 Boer goats treated strategically and symptomatically (●) with the anthelmintic ivermectin compared to the 3 goats given symptomatic treatment only (o)*

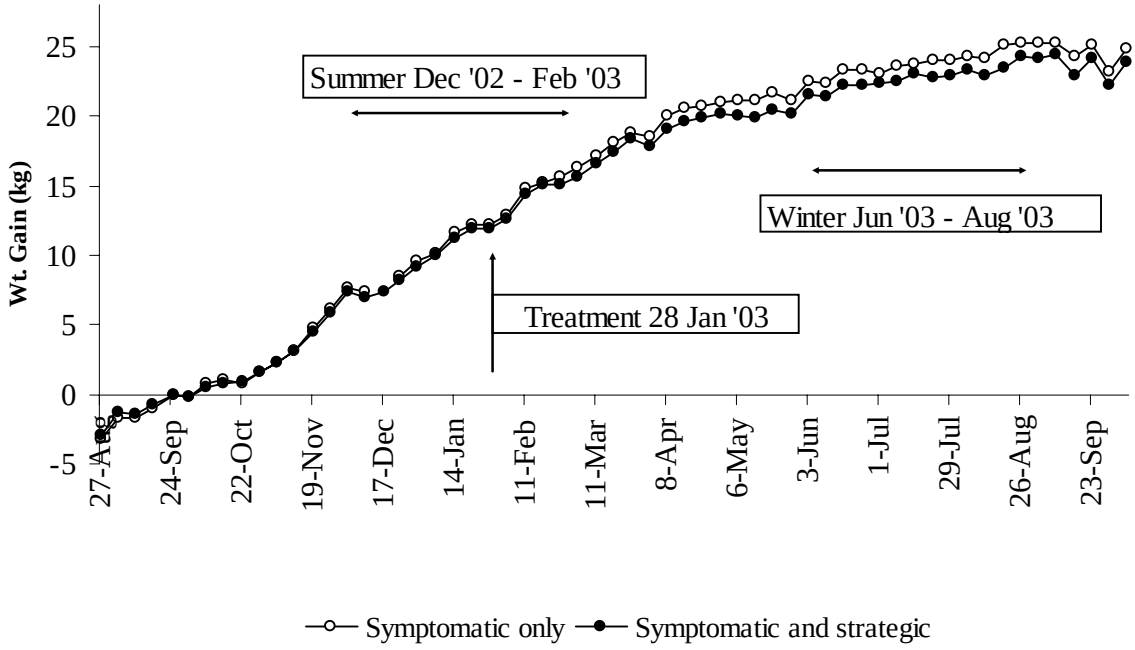

Figure 3 *The mean weight gain for the 36 Boer goats treated strategically and symptomatically (●) with the anthelmintic ivermectin compared to the 35 goats given symptomatic treatment only (o)*

The dry-season supplemented goats showed the greatest weight gain overall (Figure 4), while the wet-season supplementation appeared to have a detrimental effect on weight gain. The mean cold dressed-out carcase weight of the dry-season-supplemented group was greater than those of the other groups (P=0.025, 10 per cent level of significance, Figure 5). However, when the cost-benefit analysis was carried out, and the cost of

strategic drug treatment and urea-molasses block supplementation considered, only dry-season supplementation without strategic treatment proved economically viable (Group 5, Figure 6).

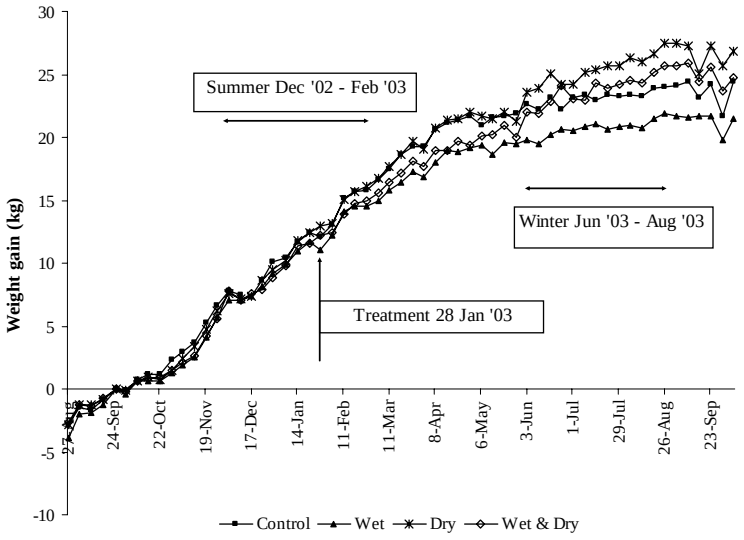

Figure 4 *Weight gains for the four different feed groups of 18 Boer goats. One group received no urea-molasses block supplementation (Control, ■), one group received urea-molasses block supplementation in the summer (Wet, ◢), one group received urea-molasses block supplementation in the winter (Dry, ✳) and one group received urea-molasses block supplementation in the summer and winter (Wet & Dry, ◇)*

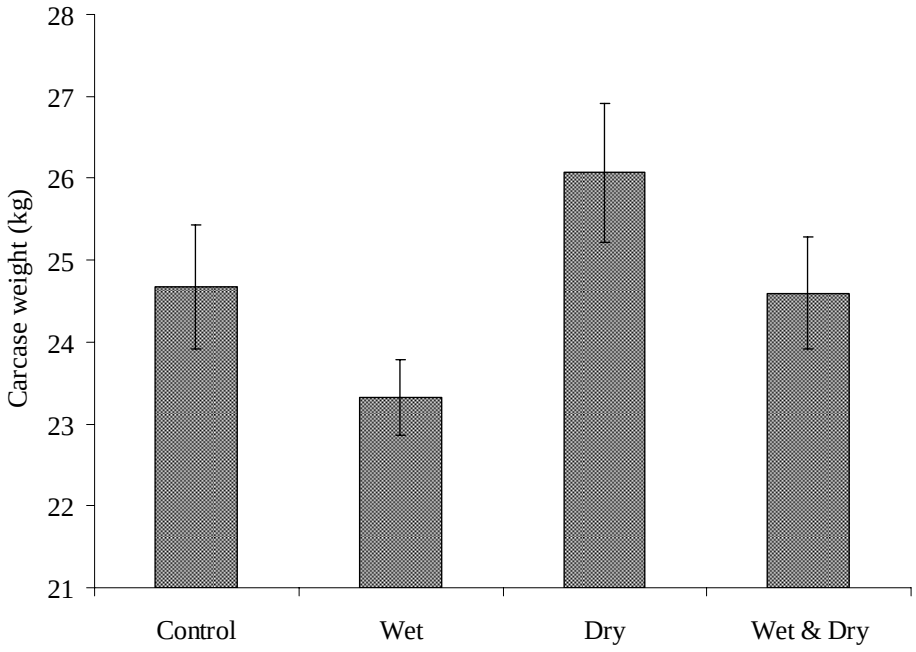

Figure 5 *Cold dressed-out carcass weights for the four different feed groups of 18 Boer goats. One group received no urea-molasses block supplementation (Control), one group received urea-molasses block supplementation in the summer (Wet), one group received urea-molasses block supplementation in the winter (Dry) and one group received urea-molasses block supplementation in the summer and winter (Wet & Dry)*

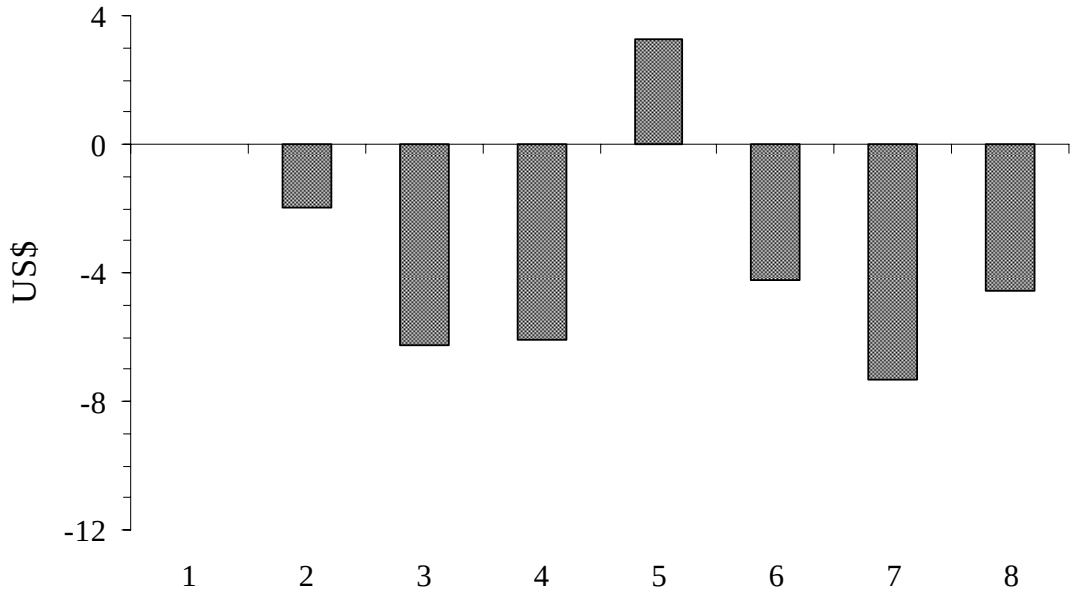

Figure 6 *Cost-benefit analysis – a comparison of the market value per goat for each of the eight experimental groups of nine Boer goats, as detailed in Table 1, corrected for the cost of urea-molasses block supplementation and/or strategic anthelmintic treatment as appropriate and normalised on group 1 (control) values. Only the winter-supplemented group without strategic anthelmintic treatment (group 5) was associated with an increase in carcase value over the corresponding controls.*

Discussion

The cost-benefit analysis indicated that dry-season, winter supplementation of Boer goats with urea-molasses blocks from June to August without strategic anthelmintic treatment, was associated with a six per cent increase in carcase value over the corresponding controls. This equated to US$ 3.24 per animal which was considered economically viable and worthwhile. This strategy is, therefore, recommended for use in extensively reared goats in the summer rainfall area of South Africa, provided nematode challenge is low and individual goats are treated when symptoms of nematode infection (anaemia) are noted. A simple practical way of assessing whether or not an animal is anaemic is through the application of the FAMACHA© system.

Acknowledgements

R.L. Coop, Moredun Research Institute, Scotland, is thanked for his scientific input to the study and M.D. Chipana, R.F. Masubelle, L.M. Michael, M.W. Shima, M.O. Stenson and E.F. van Wijk, Onderstepoort Veterinary Institute, South Africa, are thanked for technical assistance. M.F. Smith and L. Morey, ARC Biometry Unit, South Africa, are gratefully acknowledged for statistical assistance. This paper is an output from Project R8151 funded by the Animal Health Programme of the UK Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID.

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Discussions/suggestions and comments on presentation:

Question: *How much does your deworming treatment cost?*

Answer: It depends on what type you use. When the trial was planned, we felt that Ivomec Tablets for Sheep and Goats (ivermectin, Merial) might be an appropriate remedy for the farmers in the target area to use because of ease of calculating the dose per animal (½ tablet for an animal weighing less than 25 kg; one tablet for an animal 25-50 kg in weight; one and a half tablets for an animal weighing 50-75 kg). These tablets had also been used in a resource-poor community where we had carried out previous work, in the same region as the present study. When we started to carry out the actual on-farm work, it became apparent that the ivermectin products were amongst the most expensive deworming remedies available to the farmers. For example, the cost of drenching a goat weighing 30 kg with one of the ivermectin products is approximately US$ 0.24 per dose compared with $US 0.17 per dose when treating the goat with one of the albendazole products. However, for comparison between on-farm and on-station work, we persisted in using an ivermectin product, but in an oral formulation for accuracy of determination of dose.

Question: *You have produced many pamphlets for distribution to farmers. How effectively have the farmers used the information?*

Answer: There is a great demand for information on diseases, as much information is still unknown to farmers. However, we have made some attempts at disseminating information.

Indigenous forage trees and shrubs as feed resources for intensive goat production in Uganda

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Abstract

A study was conducted to explore farmers' knowledge relating to indigenous forage trees and shrubs (IFTS) in intensive goat production systems in Uganda. Previous studies on IFTS were reviewed. This was followed by key informant interviews and farmer verification in Masaka, Mbarara, Kabale, Jinja, Mbale and Soroti districts. The results of the study showed that farmers' preferences for IFTS were based on availability, palatability, forage yield, tree growth characteristics (fast regrowth), medicinal value, and other economic issues.

The ten major IFTS preferred by farmers (in order of importance) in the six districts were *Vernonia amygdalina*, *Ficus natalensis*, *Mangifera indica*, *Sapium ellipticum*, *Artocarpus heterophyllus Mimusops bagshawei*, *Trema orientalis*, *Securinega virosa***,** *Manihot esculanta* and *Sesbania seban*. The results revealed that IFTS are an important year-round feed resource and they are used for treatment of livestock and human diseases as well as other economic and cultural uses. Goats are fed IFTS in limited quantities (<10 per cent of the total diet) to supplement the basal feeds. However, the quantities are increased (>15 per cent of the diet) during the dry season when other feeds are in short supply.

One non-governmental organisation (NGO), Joy Children's Centre (a goat project helping orphans) in Masaka district, uses about four tons per day of IFTS. The project has contracted farmers to supply IFTS and, in return, farmers are given free IFTS to plant more trees. Therefore, IFTS provide a basis towards resolving the twin problems of shortages of feed and veterinary inputs which the farming communities in Uganda face.

The main source of IFTS is the wilderness, although a few species such as *Ficus* are planted. The major sites for planted IFTS are hedgerows, farm boundaries and random plantings in the fields. Major methods of propagation are cuttings and seedlings, while the major sources of planting materials are from the wilderness and fellow farmers. Major developmental constraints are slow rate of growth together with thorny and low forage yields. It is, therefore, recommended that research-extension and farmers work collectively to build a sustainable livestock production system which includes efficient utilisation of IFTS, their adaptation to the local environment, ensuring planting material is abundant, and disseminating appropriate information to farmers. Many species contain high levels of protein making them suitable supplements for low protein feeds. If their foliage can be shown to increase goat production when fed in conjunction with low quality roughages, farmers would have a reason to grow IFTS alongside their crops. Further analysis of feeding value should be carried out. More strategies for future research on IFTS for sustainable livestock production under intensive goat production systems are proposed.

Key words: forage trees, goats, indigenous; intensive, livestock, shrubs

Introduction

Uganda lies astride the equator, between latitudes 4^0 12' North and 1^0 29' South and between longitudes 29^0 34' West and 35^0 0' East. More than two-thirds of the country is between 1,000 to 2,500 metres above sea level. Rainfall varies from 500 mm in the pastoral areas in the North East to 2,000 mm per annum, in the highland areas and along the shores of Lake Victoria. Temperatures range from 15 to 30^0C. The country's human population is about 25.6 million with an annual population growth of 2.3 per cent (MFPED, 2003). Livestock accounts for 17 per cent of the total gross domestic product (MFPED, 2003). The livestock population in Uganda is about 12.8 million and is comprised of approximately 42 per cent cattle, 8 per cent sheep, 46 per cent goats, and 4 per cent pigs (MFPED, 2003). There is a huge potential for goat production in Uganda. Both high and low-income farmers can afford to keep goats. Goats, therefore, play an important role in food security, providing both food and cash, as there is a ready market for meat and they are also exchangeable. The number of improved goats is expected to gradually constitute a larger percentage of the national herd over the next thirty years (Ebong *et al.,* 2001).

Many smallholder farmers in Uganda have adopted intensive feeding management practices where improved goats are stall-fed. This has increased the demand for feed due to the high genetic capacity of the breeds. Development of the smallholder goat industry could be a major catalyst to economic development through: i) generating significant regular income for producers; ii) creating employment through the production, processing and marketing of meat; and iii) improving the diets of rural and urban consumers. However, previous studies have shown that due to land shortage and a scattered distribution of their fields, grazing land is very limited and for most farmers not suitable for grazing their goats (LSRP, 2000).

Elephant grass forage (*Pennisetum purpureum*) is the most popular forage for stall-fed animals in Uganda (Kabirizi, 1996). With rapid growth, and re-growth after harvesting, the quantity of forage is not a limiting factor to forage production. However, the quick maturing of elephant grass during the dry season leads to a rapid deterioration in its nutritive quality (less than 7 per cent crude protein).

The last two decades have seen vigorous promotion of exotic or foreign species of forage trees and shrubs, e.g. *Calliandra calothyrsus* (*calliandra*), *Leucaena leucocephola* (*leucaena*) and *Gliricidia sepium* (*gliricidia*) for forage (Kaitho, 1997; Roothaert *et al.*, 1997). Recent surveys show that since the late 1990s these species have been adopted by over 40,000 farmers in East Africa, most widely in Kenya and Uganda (Roothaert *et al.,* 2003). These trees are easy to propagate, are ready for harvest within one year after planting and, unlike grasses, maintain their green foliage and protein content during the dry season (Kaitho, 1997). However, there are two important issues to consider. Firstly, farmers need to diversify the tree species they use, both to enrich livestock diets and to reduce the risk of a tree species succumbing to pests or disease. For example, *Leucaena* succumbed to the *physillid* (*Heteropsylla cuban*) pest while *calliandra*, now being widely promoted in East Africa, is being threatened by a die-back disease that has reduced biomass yields in Uganda. Secondly, there is a need to assess the potential of the many indigenous forage species that are now being promoted as livestock feed. There is little recorded information of the yield of forage trees on-farm in Uganda.

According to Roothaert *et al.* (1997), indigenous forage trees and shrubs (IFTS) have advantages over exotic species because they are well adapted to the local environment, farmers know them and planting material is abundant. But to be successfully produced on small farms, suitable tree and shrub species need certain characteristics including being nutritious, palatable, persistent and compatible with other crops (Roothaert *et al.*, 1997). The major objective of this study, therefore, was to explore farmers' knowledge relating to IFTS in intensive goat production systems in Uganda. The specific objectives of the study were:

1. To identify the most common IFTS species contributing to goat feeding in Uganda
2. To assess farmer knowledge of the most common IFTS and their potential use as supplementary forage source
3. To identify major IFTS development constraints
4. To identify strategies for research and development of IFTS in Uganda.

Methodology

Discussions and consultations were held with key informants (extension staff, project leaders, project staff, research scientists and knowledgeable persons), individual farmers and farmer groups from six districts (Masaka; Mbarara; Kabale; Jinja, Mbale and Soroti). The districts were selected because of accessibility, importance of intensive goat production in the district and the farming systems. Informal interviews using a checklist were used to obtain basic information. Direct observations (through farm walks) and secondary information were also made during data collection. Farmers in each district scored each IFTS and the ten IFTS with the highest mean scores were selected for study.

Results

Indigenous forage trees and shrubs as livestock feed

The study showed that farmers appreciated that IFTS play an important role in bridging the gap in forage supply during the critical dry months (May to August and November to March). Being perennials, IFTS are better able to withstand prolonged periods of moisture stress than grasses and herbaceous forage legumes. Before the rains, IFTS are the only source of green forage available. In addition, farmers believe that forage from trees and shrubs has a high nutrient value that supplements the often poor quality elephant grass and crop residues, the normal dry season feeds. Farmers reported that animals supplemented with ITFS were able to maintain good body condition during the dry season. Farmers noted that goats owe their continuing good health, or indeed survival, to IFTS supplements. Many IFTS, including cassava, *Vernonia* spp., mango and jackfruit leaves and twigs are valuable feed resources for livestock. Fresh cassava roots, sliced, chopped or finely ground are consumed by goats. Due to shortages of other feeds, lopping is done during the dry season, thus providing a green supplement. Farmers estimated that IFTS contribute over 15 per cent of the total diet during the dry season. However, very little IFTS is fed to goats during the wet season because there is plenty of green forage.

Many farmers reported that they were not aware of the exact quantities of IFTS they fed to their animals. In Masaka district, however, a non-government organisational (NGO) Joy Children's Centre, has contracted farmers to supply IFTS to the farm. The main aim

of the founders is to assist orphans return to education through a rural and agricultural approach. The project is non-residential but provides day work gathering forage and managing the goats. Using a 'learn and earn scheme' the project takes on orphans who are taught simple goat husbandry skills for stall-fed goats. There are more than 100 farmers and orphans in Masaka district who have benefited from the project through sale of forage and, or, have received a goat. The centre has 250 cross-bred and pure goats (milk and meat) and three cross-bred dairy cows, which are all stall-fed. The orphans manage the animals and in return the project pays their school fees. The IFTS contribute over 80 per cent of the forage used on the farm. About four ton/day of mixed forages are fed, comprising one third each of herbaceous legumes (*centro*, *siratro*, *desmodium* and, or, *glycine* spp.), IFTS and forage grasses (elephant grass, *Panicum maximum, Chloris gayana* and, or, *setaria* spp.]. The farm has contracted nearby farmers to supply IFTS, consisting of branches and leaves of mangoes, jackfruit, avocado, *Ficus* and various weeds. The project distributes seedlings to farmers to plant more IFTS. The target is to supply 10,000 introduced and indigenous tree seedlings per season.

Farmers reported that they normally feed IFTS once per day, in the afternoon. For the rest of the day, the animals feed on grasses (*Setaria* spp., giant *Panicum*, *Chloris gayana*, *Pennisetum purpureum*), crop residues or they are allowed to graze. The frequency of harvesting from the trees depends on the species and the season. Most trees are harvested every 90 days during the wet season and every 4-6 months during the dry season.

Treatment, value adding and conservation of IFTS

In all the districts visited, there was no mention of treatment of IFTS before use, except for wilting of Manihot spp. and *Vernonia* by farmers. Farmers believe that some IFTS such as *Vernonia* are bitter because of anti-nutritional compounds, the effects of which are reduced by wilting the leaves. Wilting also improves their palatability and intake. All farmers reported that they feed IFTS in mixtures. The combination of several IFTS help them to overcome possible side effects that could result from feeding species, known to be poisonous, such as *Phytolaca* and *Lantana camara* in large quantities. The major parts that are fed to animals are the leaves and twigs although some farmers reported feeding immature fruits, seeds of jackfruits, avocado and mangoes. Animals feed on the bark of *Ficus* and *Morus alba* (mulberry).

In Mbale district, farmers removed seeds and fruits from *Lantana camara* and *Sodom* spp. before feeding them. Farmers reported *Lantana camara* to be toxic to animals if fed when it has seeds. It is also not a very good feed if fed frequently and in large amounts as it causes blisters on the lining of the intestines and the leaves and twigs do damage to the animal's teeth. It was clear that animals were adapted to feeding on IFTS. This is an advantage, when forage is left to be browsed without close supervision of the animals or the forage has to be harvested and fed immediately. The only conservation method associated with IFTSs was not harvesting in the wet season those forages which persisted into the dry season (preservation as 'standing' forage). No other conservation method (cultural or modern) was mentioned.

From the discussions, it was noted that it is mainly the women and children who search for IFTS in the wilderness, when they are searching for firewood, weeding or preparing land for planting.

IFTS as a medicine for livestock

The importance of traditional medicine for humans, as well as goats, is difficult to ascertain in most parts of Uganda. It would be an understatement to say that traditional medicine plays a significant role in the health care system, since this is the only affordable and accessible health care available. Farmers revealed that some IFTS have medicinal uses, with leaves, roots and bark providing the raw materials for medicinal and veterinary products (Table 1). Farmers are aware that IFTS do not offer a 100 per cent solution but they said that it is a means of administering first aid to animals and family members, especially in rural areas where veterinary and medical services are either not easily accessible or are very expensive. Other IFTS, such as *Entanda abyssinica*, are used to prevent abortion in goats.

Plant material is used either singly or in combination. Farmers reported that the combination of several IFTS increases the chance of recovery. Moreover, a disease can be cured by one or more medicinal formulae and one formula can be used for the treatment of several diseases.

Other uses of IFTS in the farming systems

Farmers have been able to generate some income by selling firewood, poles, fruits, seeds, fibres and medicine. Shade and shelter, for people and animals, environmental protection, and enhancement of rural and scenic surroundings are other reasons cited by farmers for leaving trees such as *Ficus* spp. standing in their fields. Bushy, thorny hedgerows are planted to mark boundaries and channel herd access and movements in Mbarara district. *Ficus* trees are planted very close together to form living fences, and their clippings are used as forage. Territorial boundaries, a first stage in land appropriation, can be demarcated by IFTS.

Many IFTS provide products that enhance food security and also help to promote dietary balance, diversity and good health. Trees such as paw paws, avocados, mangos and guavas are rich in Vitamin C. They also provide simple snacks during work or travel. Women, responsible for providing household food, possess the skills to store and process the leaves and fruits so that they will be available to feed the family throughout the year. The IFTS also play a key environmental role. Firewood is the main source of energy for rural households, especially for cooking in rural areas of Uganda. In urban areas charcoal from IFTS, such as *Acacia* spp., is used extensively for household cooking and also in restaurants and hotels.

Table 1 *Uses of some indigenous forage trees and shrubs in smallholder goat production systems*

Scientific name	English name	Part used as forage	Medicinal and veterinary uses
Vernonia amygdalina	Bitter leaf	Leaves/twigs; goats and cattle	Used to stimulate the digestive system, treat fever and against leeches, which transmit bilharzia.
Mangifera indica	Mango tree	Leaves/twigs and fruits; goats and cattle	Leaves and bark used to treat coughing; the fruits used as food.
Sapium ellipticum		Leaves/ twigs and bark; goats and cattle	The bark is used to treat general body pains and tuberculosis. Roots are used as medicine for chronic coughs and colds. The latex is poisonous but is used as medicine for constipation.
Sesbania sesban	Riverbean, *Sesbania*	Leaves/twigs; goats and cattle	The roots are used to treat fever and as a contraceptive.
Persea americana	Avocado pear	Leaves and fruits	Boiled leaves cure dehydration in humans. Avocado oil is used for hair and skin care
Carica papaya	Pawpaw	Leaves and fruits	Seeds are used to deworm livestock and humans. Food fruits provide vitamin C for humans. Leaves are used to treat whooping cough, malaria, typhoid, colds, stomach ulcer, kill germs and worms. They also tenderise meat and provide soap.
Moringa oleifera	Horse-radish tree	Leaves; goats and cattle	Used to treat high blood pressure in humans, and for food, poles, posts, shade, bee forage, live stakes, soil conservation, windbreaks and water purification (seeds).
Entanda abyssinica		Leaves; goats and cattle	Prevents abortion in cows
Securinega virosa		Leaves/ twigs; goats and cattle	Prevents abortion in cows, treatment of malaria, snakebite, diarrhoea and pneumonia.
Psidium guajava	Guava	Leaves and fruits	Leaves used to treat coughs.
Morus alba	Mulberry	Leaves	Provide an antidotal, bactericide used as an expectorant, fungicide, stomach conditioner and cough medicine.
Ficus ovata	*Ficus*	Leaves; goats and cattle	Latex used to treat against ringworm
Senna occidentalis	Coffee senna, septicweed	Leaves; goats and cattle	Treatment of constipation, worms, nervous asthma, high blood pressure, skin disease and a substitute for coffee (seeds)
Indigofera arreca		Young leaves; goats and cattle	Used to deworm cattle and humans

In most rural and urban areas, IFTS are still the main source of materials for constructing houses, fences etc. All men responding to the question concerning the most important uses for trees indicated timber (Table 2). Production and marketing of timber is a male dominated activity.

Table 2 *Farmers' perceptions (by gender) of the uses of indigenous forage trees and shrubs (IFTS)*

Ranking	Uses	
	Men	**Women**
1	Timber	Forage
2	Forage	Medicinal
3	Cultural (bark cloth)	Firewood
4	Medicinal	Fruits
5	Fruits	Cultural (bark cloth)
6	Firewood	Timber

For women, while timber is also important, they ranked forage and medicinal properties as the most important uses of IFTS, because they own over 85 per cent of the goats. The women, therefore, play an important role in forage production and utilisation.

The importance of firewood was ranked lower among men than women because women are responsible for its collection and the preparation of food. Raw materials from IFTS are used to make a wide range of products that can broadly be classified as household utensils, tools, and equipment. Many different species, such as *Sapium allipticum,* are used to make tools and utensils. Traditional beekeepers make their living from IFTS, by placing hives in carefully selected trees such as *Moringa oliefera* and *Acacia gerradai.* Honey is a unique product in that it does not compete with other land uses or cause land degradation, although burning has been mentioned as an adverse effect of traditional bee-keeping practices.

Many IFTS have been, and are still, an integral aspect of the social structure, religion, art, history, medicine, and politics of a community. In Masaka District, *Ficus* spp. is used to make bark cloth used in cultural functions, including witchcraft, death and funerals. In rural areas, the cloth is used to make bed sheets and traditional costumes. The cost of bark cloth ranges between UGSH 5,000-10,000 (US$ 3-6) per piece (about three metres) depending on its quality. Some IFTS are viewed as both sources of, and protectors against, evil and as providers of fortune and power. In Masaka District, certain trees, such as *Ficus ovata* and *Commiphora* spp., are used to link the living with their ancestors. Sometimes gifts are given as a means of showing ancestors that they have not been forgotten. Gifts such as flowers or alcohol are placed at the foot of the tree as an offering which is symbolic of giving food to the ancestors through the tree. *Dracaena afromontana* is known as a 'peace' plant and mostly used to mark graveyards, begging for forgiveness and for decorations during public ceremonies.

Sources of planting materials, propagation and farm niches

Information from farmers and key informants showed that in all the districts visited very few farmers (less than 5 per cent, n=78) planted IFTS for animal feed. Farmers were not inclined to plant IFTS because they believe that, being indigenous, these trees would grow naturally. At the same time farmers in the hilly areas of Kabale and Mbale districts also pointed out that IFTS that used to grow around their homes have now receded further into the mountain forests. They now need to travel further and spend more time gathering tree forage. Many IFTS do not produce seeds. They have to be propagated from cuttings. All farmers and extension staff reported that a number of trees begin their life as epiphytes. The seeds are carried by birds to the host trees where they

germinate. However, the seeds also germinate in the ground. The main reason given for paying little or no attention to planting IFTS is their slow growth and, or, lack of planting material. Many farmers in Masaka and Mbale districts have planted *Ficus natalensis* around their homesteads. An average household owns 5-20 trees, planted either on boundaries or scattered in the fields. Other IFTS such as cassava and *Cajanus cajana* are planted for food while leaves and peels are fed to livestock after harvesting the tubers. Major source of planting materials for IFTS are from the wilderness. Other sources are from fellow farmers. Major methods of propagation are natural regeneration (*Vernonia*), cuttings (cassava and ficus) and direct sowing (pawpaws, mangos and *sesbania*).

The main sites for planting were farm boundaries, edges of terraces to control soil erosion (e.g. in Kabale District), live fences, hedgerows or scattered in the fields. Sometimes IFTS were found scattered among crops in an area (e.g. in Soroti District, Ficus spp. is left scattered in the cassava fields). This is a form of intercropping. Major IFTS used in live fences are *Ficus natalensis* and *Acacia* spp. Ficus poles are used in fencing, where they regenerate easily thus forming permanent fencing poles that are cheaper than Eucalyptus poles. The trees are also planted in paddocks or compounds to provide shade to livestock and humans. Some trees such as *Acacia senegal* and *Ficus* spp. are planted at the boundary of houses and fields and for demarcating land boundaries.

Farmers' preferences for IFTS species

From discussions with farmers and key informants, it was noted that farmers' preferences for IFTS were based on palatability, high forage productivity, coppicing, ease of propagation and establishment, tree growth characteristics (fast regrowth), medicinal value, longevity, tree management issues and other economic issues. It is important that the trees are tolerant of frequent cutting and the cut herbage is easy to handle. Based on mean scores (for the six districts), the ten major IFTS preferred by farmers (in order of importance) are shown in Table 3.

Table 3 *Preferred indigenous forage trees and shrubs(IFTS) used in intensive goat and cattle production systems in Uganda*

IFTS species			Masaka & Jinja (Banana/ Coffee system)	Mbale (Montane system)	Soroti (Teso system)	Mbarara (Pastoral, Banana/ Coffee and Montane systems)	Kabale (Montane system)	Mean score
Scientific name		Local name	District/Agroecological zone					
			Scores					
1.	*Vernonia amygdalina*	Bitter leaf tree	10	9	10	10	10	9.8
2.	*Ficus natalensis*	Fig tree	9	9	9	9	9	9
3.	*Mangifera indica*	Mango	8	7	8	8	8	7.8
4.	*Sapium ellipticum*		7	5	7	7	6	7.4
5.	*Artocarpus heterophyllus*	Jack fruit	7	8	6	6	6	7.0
7.	*Trema orientalis*	Gunpowder tree	7	7	4	3	5	6.8
8.	*Mimusops bagshawei*	Mimusops kummel	5	6	4	2	4	6.3
9.	*Securinega virosa*	White-berry Bush	4	5	2	2	2	6.0
10.	*Manihot esculant*	Cassava tree	4	3	2	3	3	5.7
11.	*Sesbania sesban*	River bean	3	3	1	3	3	5.0

(1= not very important, 10 = very important)

Comparative analysis of scientists' and farmers' knowledge about the nutritive value of IFTS and its implications on future research

Information from farmers showed that there is some equivalence between the way in which farmers use the terms 'leaf bitterness' and 'sour', for example *Vernonia* spp., and laboratory analysis of tannin content, in that species with a high tannin content tended to be described by farmers as bitter or sour. Farmers were also aware that leaf bitterness was associated with lower palatability and nutritive value (both common characteristics of tannin-rich feeds). Farmers did, however, articulate detailed knowledge about how leaf bitterness varied in a large number of tree species throughout the season. This demonstrates complementarity between farmers' and scientists knowledge that should be exploited in designing appropriate research (farmers' understanding of intra-species variability has already led researchers to revise strategies for sampling tree material for analysis of its nutritive value). Clearly, because of the complementarity, the combination of farmers' and scientists' knowledge represents a more powerful resource than either

knowledge bank alone. Appreciation of the sophistication of this local knowledge base could have a profound impact on research and development priorities.

Developmental constraints

Few constraints were connected with IFTS, with farmers saying they have used the plants for a long time without problems. Big trees, like *Ficus* spp., can grow to a great height, making their forage difficult to harvest. Farmers also cited slow growth of big trees. Also noted was the danger of creeping and climbing trees and shrubs overwhelming other crops. Other developmental constraints identified by farmers were:

1. Variation in forage availability (quantity) across seasons
2. Difficulty of integration into the cropping system
3. Bitter taste (e.g. *Vernonia* spp.)
4. Competition between humans and animals
5. Difficulty in propagating planting material.
6. Thorns and spines (e.g. *Acacia)* affecting intake.
7. Pests and diseases
8. Low forage yields

Some IFTS are poisonous (e.g. *Phytolaca* and *Lantana* spp.).

Proposed Research and Development Strategy for IFTS

Farmers were asked to suggest research and development strategies to improve the utilisation of IFTS. The following were suggested:

a) Evaluation of the nutritional content of the plants. Farmers were aware of the plants' palatability and had observed improvements in health and production but they knew little of how to optimise use of the forages. Analysis of medicinal properties of IFTS is also needed to optimise their value in health care.

b) On-station and on-farm feeding trials to determine the effects on animal productivity of supplementing goats with IFTS (meat quality, body condition and reproductive efficiency).

c) Studies to develop optimum planting niches, establishment methods and management techniques to optimise promising forage yields of IFTS.

d) How best to establish and maintain the plants, especially in reference to collection of adequate quantities of seeds, seed viability and germination.

e) Reducing the toxic effects of some plants used by the animals, for example *Phytoloca* and *Lantana camara*, both used especially during drought periods.

Conclusion

The multiple uses of IFTS in different agro-ecological zones of Uganda have led to both negative and positive effects. The negative effects are related to the disappearance of IFTS that are palatable to livestock or used for medicinal purposes, firewood, poles and charcoal. The positive effect is the need to explore farmers' knowledge on the use of

IFTS and incorporating this knowledge into research projects to improve the availability of IFTS (quality and quantity). It is, therefore, recommended that research-extension institutions and farmers work collectively to build a sustainable livestock production system through efficient utilisation of IFTS. There is also a need to intensify use of promising IFTS because of their multiple roles across farming systems. Many species are endowed with high levels of protein and hence are suitable as animal feed supplements, especially for dry season feeding. Further analysis of feeding value is required.

Acknowledgments

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Discussions/questions/comments on the presentation

Question: *Earlier studies have indicated that farmers do not offer a choice of forages in order to rank them, because goats tend to eat from whatever is available. Is ranking necessary?*

Answer: In addition to studying the chemical composition the response of animals to the different forages should be studied to help plan forage programmes.

Question: *Is the contribution of indigenous forage trees as low as 10 -15 per cent?*

Answer: This study is restricted to arable farming zones. However, in rangeland areas indigenous forage trees make a bigger contribution.

Question: *Is there a detrimental effect on the environment from the lopping of forage from trees?*

Answer: The cutting of branches can be helpful in keeping the trees pruned.

Question: *At the Joy Centre we saw tree forage being delivered, but nobody was collecting seedlings – why is this?*

Answer: Farmers do not collect seedlings every day; they have an annual target for planting.

Question: *How much forage can you harvest from a tree during the year?*

Answer: The figures are not available. However, there is a need to identify existing knowledge, on this issue and other aspects of the utilisation of indigenous forage trees, so that gaps are also identified and can be addressed.

Action research on improved small livestock keeping with landless poor in two communities of Terai, Nepal[1]

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Abstract

The raising of goats and pigs appears to offer income-generating opportunities for resource-poor landless households in the Nepal Terai, as in other regions of the country. This paper describes the first stage of an initiative to develop, validate and disseminate improved technologies for raising goats and pigs, through a participatory self-learning approach with landless farming communities.

Participant groups were formed as a first stage in the process. Initially these undertook planning of the initiative; subsequently they served as savings groups and to manage the funds raised by project activities.

Project support took the form of training, and a grant in the form of stock, concentrate feed and a small cash payment for housing materials. Housing was of local materials, and feed rations made up from locally-available ingredients, with the aim of testing and demonstrating systems which were capable of scaling-up.

Growth and reproduction rates of goats have been encouraging: kidding rates exceeded 130 per cent, some does have kidded a second time within the eight months since the start of the project, while male kids reached up to 25 kg and female kids up to 14 kg at eight months from birth. Fattening pigs reached live weights of some 80 kg over an eight month period, yielding a projected gross margin (over feed and other direct costs but excluding labour) of Rs 3,000-plus per animal.

The participatory approach adopted and the growth and reproductive performance of the animals, provide a model for improved small stock husbandry by very poor people. While interest has been shown by non-participant members of the communities in the achievements of the participant groups and their stock it is too early to assess whether the model is 'scaleable' in the sense of likely to be replicated widely.

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Introduction

Nepal is one of the least developed and poorest countries in the world with a per capita annual income of US$ 233. Nearly 66 per cent of the total population is engaged in agriculture. Of this, 42 per cent are below the poverty line. Poverty and food insecurity prevail across the country. Average land holdings per farm household are 0.79 hectare and the number of rural landless households is 27,000 (CBS 2004). Rural landless resource-poor farmers have to struggle hard for their survival. They lack access to agricultural land, are mostly illiterate, lack technical knowledge and access to micro credit. Their sources of income are typically daily wages and sometimes raising livestock on a sharing basis. Some of them raise a few small animals like goats, pigs and chicken.

Goats are raised under traditional management with an open grazing system from the Trans Himalayan range to the Terai. The system of rearing is extensive, characterised by low investment, natural grassland, forest land and crop residues. Goat-raising appears to provide an income generating opportunity for landless households providing that they can get access to fodder from the sources mentioned above. Pig keeping is limited to certain socially deprived ethnic groups in Nepal who raise them as scavengers. Improved pig keeping could be an important source of income for the resource-poor landless people if management costs are low.

This paper outlines an action research (AR) initiative to develop, validate and disseminate improved technologies for the raising of small livestock, through a participatory self-learning technique, by landless farming communities with the aims of enhancing their livelihoods. It forms a component of DFID/LPP project R8109 (Using livestock to improve the livelihoods of landless and refugee-affected livestock keepers in Bangladesh and Nepal.

The Action Research started in February 2004 and has continued to date (October 2004) with the intention that it should continue for at least a full 12 months. The results presented here are preliminary. Although the husbandry systems have been adopted enthusiastically by participants and the growth and health of stock has been good, it is early to assess the economic and livelihood benefits.

Materials and methods

Two sites, in Bara and Rautahat Districts, were selected after a survey of 20 locations with the Participatory Learning Approach (PLA) which aimed to explore poor rural people's aspirations and constraints with regard to livestock keeping. In an approach to the two locations, a participatory approach was again used to identify the poorest households within the community, and to select participants from among members of these households who expressed their interest in, and commitment to, the action research project.

In both sites, livestock raising groups were formed, which also served as savings groups and as means of managing the funds raised by project activities (described in more detail below).

Action research site A: Bakulahar, Bara

Twelve does, at an advanced stage of pregnancy, were provided to 12 participants. Does were allocated to two treatment groups consisting of six in each group. Treatment 1

(TR1) does were given 300 g of supplementary ration based on mustard oil cake, containing 14 per cent crude protein (CP) and 2700 Kcal ME/kg of feed. Does in treatment 2 (TR2) were provided with the same nutrients from a diet based on lentil husks. Feed was provided to the farmers in advance on a weekly basis by the project local motivator throughout the project period. Before the initiation of the experiments, on-the-spot two days training in improved husbandry practices (including construction of stock housing) were conducted for participants as well as for neighbouring livestock keepers. The trainers were from the Nepal Agricultural Research Council (NARC), Nepal Agroforestry Foundation (NAF) and District Livestock Service Office (DLSO) facilitated by NARC. In addition to 12 participating farmers another eight farmers from the same locality were also included in the training. During the training, farmers were also provided with one packet of oat seeds, one packet of maize seed, a plastic bucket and a mug. Along with the research animals, another 169 goats belonging to 75 villagers were also vaccinated against PPR (Peste des Petits Ruminants) and drenched against liverflukes and worms.

One adult breeding buck was also provided to the Participatory Action Research group. One Burdizzo castrator was provided to the group and the local motivator was trained on its proper handling and efficient use. The project provided NRs 300 to each farmer for construction of a shed and feeding stall in addition to farmers' contributions of materials and labour. The sheds were entirely constructed from local material like bamboo, wooden planks and local vines.

Recording of growth performance, feeding, breeding, animal health and management were maintained regularly with the help of two local motivators and technical staff from the Livestock Service Centre of Dohari VDC, Bara. Coordination, consultation and experience sharing meetings were organised with local non-governmental organisations (NGOs) and community based organisations (CBOs) and the District Livestock Service Office (DLSO) as and when needed. The Action Research period was from February to October 2004

Action research site B: Santapur, Rautahat

At Santapur -Rauthat, selected landless farmers wished to have two types of livestock (a) Goats and (b) Pigs. One pregnant doe was provided to each of eight participants and assigned into one of two treatment groups, consisting of four in each group. The treatment given to each group was the same as in the Bakhulahar, Bara (described above). All animals in the experiments and a further 132 goats of 51 neighbouring farmers were vaccinated against PPR and drenched against internal parasites.

The eight selected farmers who had chosen to keep pigs each received a 5-week old piglet. Again, the piglets were allocated to one of two treatment groups. Treatment 1 consisted of a diet based on mustard oil cake and the treatment 2 was based on lentil husks. Both the diets initially contained 17 per cent CP, although this was later reduced to 14 per cent, and 2800 Kcal ME/kg of feed. Each piglet received 300 g per day up to eight weeks of age and thereafter a 25 g increment every week. This concentrate ration was a supplement to other local feeds which the farmers provided like kitchen garbage, colocasia, rice bran, green forage, etc.

Before starting the experiment, on-the-spot two days of training in improved husbandry practices were conducted for both goat and pig keepers, as well as for a similar number of neighbouring farmers. As in Bara, trainers were from the NARC, NAF and DLSO. All

training participants were provided with two packets of forage seed (one kg oat seed and one kg maize seed), a polythene bowl and a mug. Experimental animals as well as animals of neighbouring livestock keepers were vaccinated against PPR and drenched against internal parasites. Financial support of NRs 300 was provided to each participating farmer for shed and feeding stall construction.

Body weight of does, kids and piglets were taken at 15 day intervals. Breeding, feeding and health records were also maintained regularly. For comparison purposes, the same number of does, kids and piglets of neighbouring farmers under their traditional management was used as a control group. Statistical analysis of growth rate of kids and pigs was done using a Minitab package through the General Linear Model.

Preliminary results

Technical aspects

Growth trends of goats in two sites

The body weight of does (Table 1) was increased in both treatments (TR1 and TR2), in the eight month period in Bara and Rautahat (Table 1). This preliminary observation indicated that the body weight gain of does at Rauthat was higher than in the does at Bara. However, the difference was not statistically significant ($P>0.05$). Neither was there any significant difference in the body weight gain between the treatment groups in both sites. Shrestha (1994) reported 23.32±0.024 kg average body weights for farmer-owned does in the Terai region, which is slightly lower than the average weight of does in this study and is a result consistent with the enhanced nutrition of animals in the project.

Table 1 *Adult body weight of doe*

Location	Treatment	Initial body weight (kg)	Final body weight (kg)
Bara	Mustard oil cake based diet	25.17±1.768	26.53±2.713
	Lentil husk based diet	25.13±1.581	26.02±1.653
Rautahat	Mustard oil cake based diet	25.53±4.098	28.60±0.567
	Lentil husk based diet	24.63±1.421	27.33±2.134

Kidding and kid growth rates

In Bara, all experimental does kidded (six does produced seven kids in TR1 and six does produced nine kids in TR2). The birthweights of kids were 2.52±0.158, 2.10±0.214 and 2.16±0.155 kg in TR1, TR2 and the control group respectively. Weight gain of kids up to four months of age was significantly different ($P<0.05$) depending on the type of birth (inversely related to the number of kids in the litter). Daily weight gains of kids up to four months in Bara were 89.57±7.54, 82.56±5.33 and 45.00±1.40 g in T1, T2 and control group respectively, whereas at the same period in Rautahat, the daily weight gain of kids were 82.33±9.53, 81.00±9.55 and 47.00±6.33 g in T1, T2 and control group respectively. Treatment 1 kids and Treatment 2 kids grew faster than the kids in the control group ($P<0.05$).

The average daily weight gains of kids from 4-6 month in Bara were 44.44±10.55 and 40.00±10.66 g in T1 and T2 respectively, whereas at the same period in Rautahat the

weight gain of kids were 28.22±18.35 and 48.66±2.06 g in T1 and T2 respectively. The growth rate (4-6 months period) between the treatment groups was not statistically significant. The cumulative body weight of kids in Bara was 25.00±4.90 kg and 17.85±2.370 kg in eight and seven and a half months in TR1 and TR2 respectively (Figure 1). Three does from treatment 1 and one doe from treatment 2 have now kidded for the second time since the project started. In comparisons to the first kidding, the number of kids per kidding and birthweight of kids has increased. In Rauthat, all experimental does have kidded (In TR1 four does produced six kids and in TR2, four does produced five kids). The birthweights of kids were 1.42±0.063, 1.90±0.084 and 1.30±0.082 kg in TR1, TR2 and the control group, respectively. The birthweight of kids was significantly different (P<0.05) in the two locations irrespective of treatments. Body weight gain was 14.75±0.612 and 13.85±2.735 kg in TR1 and TR2, respectively, in the eight month period (Figure 2), which was statistically non-significant. Three does on TR1 have kidded for the second time since the project started.

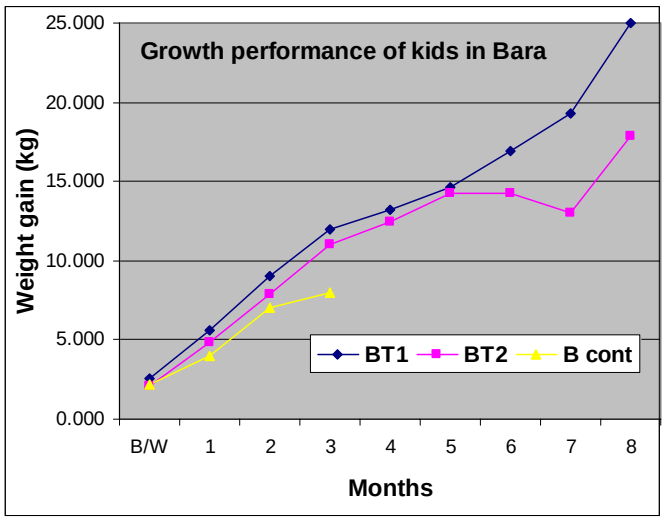

Figure 1 *Growth performance of kids in Bara*

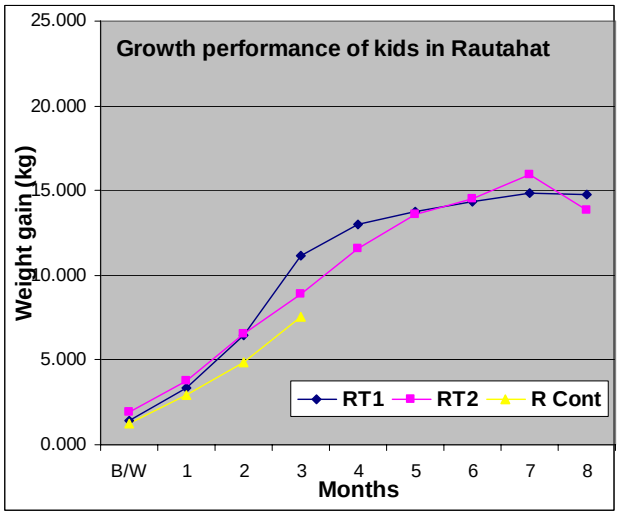

Figure 2 *Growth performance of kids in Rautahat*

The daily average weight gains of kids in the first four month period were higher than the growth during the four to six month period (Figure 3)

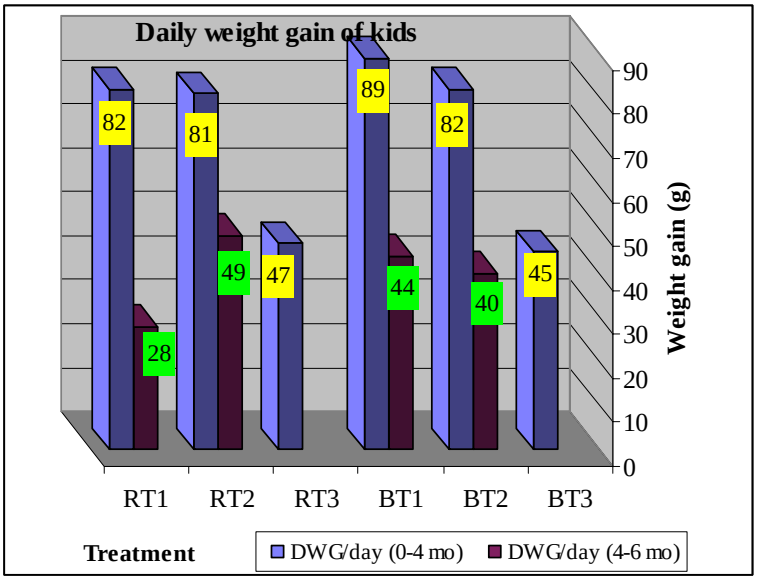

Figure 3 *Daily weight gain of kids*

Breeding service

In addition to the trial does, over 200 does have been served at the two locations by a breeding buck provided to each participant group as part of the project. A service fee charged to non-group members generates an income for the groups and has formed the basis of the group fund, which is being added to member savings.

Growth performance of pigs

In the eight month period, the body weight gain of the piglets was 87.50±6.614 and 75.25±10.757 kg in TR1 and TR2, respectively (Figure 4). On average, the daily body weight gains were 351±0.026 and 309±0.034 g in TR1 and TR2, respectively. There was no significant difference in body weight gain between treatments. Joshi *et al.* (2002) reported from a study at the Outreach Research Site that Landrace and Yorkshire pigs gained 109 kg and 84 kg in a ten month period – a broadly similar result to this.

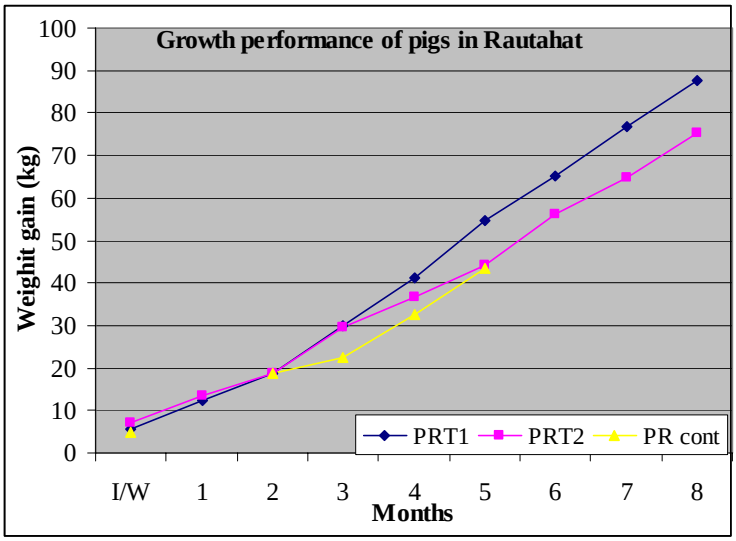

Figure 4 *Growth performance of pigs in Rautahat*

Economic, social and livelihood aspects

Group formation

An executive committee of participants was formed at each selected site (of 14 members at Bakuklahar and 17 members at Santupur). Rules were formed to raise a group fund, namely: monthly saving of NRs 15 per member; a deposit of NRs 100 for each time a doe kidded; NRs 10 as a buck mating charge; and NRs 5 as a castration charge for outsiders. The total fund raised up to last of October was NRs 4,600 (US$ 62) at Bakulahar and NRs 3,100 (US$ 41) at Santupur. This fund was mobilised and used by the group members with a low interest rate to finance investment or other activities to enhance their livelihood.

Economic analysis of pig rearing

The cost benefit analysis of pig rearing by the resource-poor farmers is presented in Tables 2 and 3. The major cost incurred in pig rearing was feed. In the eight month rearing period, the pigs attained an average weight of 80 kg (mean of two treatments) live-weight and fetched NRs 8,000 in the local market. The use of household labour and agricultural by-products made a substantial contribution in the livelihood of farmers through pig rearing. On average US$ 50 and US$ 40 were realised as benefit per pig from TR1 and TR2 respectively in the eight month period.

Table 2 *Composition and cost of additional ration (NRs) per day/pig*

Description	Quantity	Rate (NRs)	Total Amount (NRs)
Colocasia	4 kg	0.5	2.00
Rice bran/ Beverage grain spent	0.5/2	7.5	3.75
Green forage	2 kg	0.25	0.50
Labour cost		LS	3.50
Total			9.75

Table 3 *Economic analysis of pig rearing (per pig)*

***Treatment group	Ration description				Total Live wt (Meat)	Rate (NRs)	Total Amount	Net profit (Rs)
	Quantity (kg)	Amount (NRs)	Additional. Ration amount	Total				
RT1	175	2016.00	2291.00	4307.00	85.5	70.00	5485.00	1678.00*
	@11.52							3969.00**
RT2	165	1777.00	2291.00	4065.00	68.5	70.00	4795.00	730.00*
	@10.75							3021.00**
RCo	137		2291.00	3319.00	43.5	70.00	3031.00	-288.00*
	@7.50							2004.00**

1 US$=NRs 75 at time of writing

***See text for details

** If labour cost and additional feeds from household by-products were not accounted

* Labour cost and additional feeds from household by products cost included

Livelihood impact of goat rearing

In the case of goats the economic benefits cannot be so simply quantified. However, the productivity of goats in the trials is clear. Body condition of does improved, male kids reached up to 25 kg and female kids up to 14 kg live weight in an eight month period. Some does produced triplets and the rest are ready to kid for the second time. It indicates that frequent kidding, with eight month intervals, or three kidding in two years, is possible. Farmers noted improved fertility of does, with an increase in the number of kids born at each kidding, compared to does kept under traditional management. Castrated males now could be sold, for additional income.

Non-participant resource-poor landless farmers perceived the goat enterprise is an appropriate source of income generation requiring limited cash investment. The community formed a goat-raising group, and non-participant, resource-poor landless farmers showed interest in building improved sheds and using agricultural by-products for making cheap balanced rations to feed their animals. Participants and others became aware of hygienic conditions, improved housing, balanced rations and proper disposal of urine and excreta produced from pigs and goats.

Conclusions

A participatory approach is an effective way of promoting technology adoption in resource-poor communities. The group approach plays a key role in problem solving and fund generation. Non-participant farmers started to adopt the technologies being tested by the trial participants. The landless poor also realised the benefits. With hindsight it would have been better if only one improved feeding management with feed ingredients easily available in local market (instead of two treatments) had been compared with the farmers' traditional management practices.

The indications are positive in improving the livelihoods of resource-poor landless livestock keepers through improved husbandry techniques, which help to improve productivity of goats (reproductive and growth performance). The growth of goats and pigs under both improved feeding managements were better than in the goats and pigs reared under traditional management. The action research provided the means of livelihood to some of the resource-poor landless farmers while other neighbouring farmers also became familiar with the importance of improved management techniques for small livestock, which ultimately helps to improve their living conditions with increased household income. This study needs further extension and replication of the research work into new areas.

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Discussions questions/comments on the presentation

Question: *What diseases were you vaccinating the goats against.*

Answer: *Pests des petits ruminants* (PPR) and rinderpest.

Question: *Kids in Bahaural were almost half the weight of their contemporaries in Bara at eight weeks. Is there an explanation for this?*

Answers: i) Differences in immature size of the two populations of goats

ii) Goats in Bahaural kidded one month earlier than those in Bara.

Question: *Is there funding for participatory rural appraisals (PRA), rapid rural appraisals (RRA) and participatory learning and action (PLA)?*

Answer: Yes, there is funding for the initial fact finding, prioritising and implementation.

Question: *The data presented were comparing the growth rates of goats and pigs under different feeding regimes and yet the conclusions drawn related to the social processes of the project. The conclusions seem to be anecdotal compared to the PLA data.*

Answer: Feeding experiments are still on-going, making conclusions impossible at this time. Both technical and social aspects will be covered in the final project document.

The role of poultry and goats in poverty alleviation in Bangladesh[1]

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Abstract

This project, starting in 2001, has been examining the role livestock play in the livelihoods of resource-poor landless households in Bangladesh. Bangladesh is one of the poorest countries in the world and livestock provide a potential route out of poverty for very poor households**.** Many non-governmental organisations (NGOs) provide micro-finance for livestock enterprises. Action research examined the impact on livelihoods of livestock provided by the project to farmers who had not previously benefited from micro-credit for livestock or other enterprises (hard-core poor or extreme poor). Farmers (33 women) were provided with hens, ducks or goats. The average daily income of participating households before the distribution of livestock was US$ 0.94. Preliminary conclusions suggest that goats may be a better option than poultry due to their inherent disease resistance. Some households have been very successful with poultry but overall ducks and chickens have not performed as well as goats as mortality has been relatively high. Identification of potential beneficiaries, who are likely to succeed, may be crucial to success in the longer term. Very poor households are able to manage livestock enterprises within their family budgets, using locally available, usually free resources and labour availability is not a problem for the majority of them. Consumption of livestock products has increased. Marketing is not difficult as egg buyers visit most villages and marketing problems for goats are not anticipated. Provision of veterinary training and services is essential for the success of poor households' livestock enterprises.

Introduction

The project entitled 'Using livestock to improve the livelihoods of landless livestock keepers in Bangladesh and Nepal' (LPP Project R8109) started in 2001 and has been examining the role livestock play in the livelihoods of poor landless households in Bangladesh. This paper provides some interim conclusions from action research undertaken in partnership with poor landless households over the past nine months. The paper by Banstola *et al.* (these proceedings) relates to the Nepal component of this project.

[1] 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. R8109, Livestock Production Research Programme.

Background

Bangladesh remains one of the poorest and most disaster-prone countries in the world. The United Nations Human Development Index places it at 144th, while World Bank GNP per capita statistics suggest a rank of 175th out of 210 countries (World Bank, 1999). Approximately 50 per cent of its 130 million population may be categorised as poor, and of these 23 per cent (or about 29 million) are labeled extremely poor (those with 40 per cent or less of the income of those classified as poor). A further 20 per cent are tomorrow's poor; people who given current trends will soon fall into poverty (Rahman, 1998). Women are disproportionately affected with 95 per cent of female-headed households living in poverty (Lawson-McDowall, 2001). Despite the significant gains in the last decade (Rahman, 1998), social indicators paint a grim picture, with mortality in children under-five at 10 per cent, a life expectancy of 58 years and the adult literacy rate at 27 and 50 per cent for women and men, respectively (World Bank, 1998). The depth and severity of poverty is worse in rural areas with 80 per cent of the poor living there.

Many rural people are both poor and landless. In Bangladesh, land pressure is increasing with population growth and, therefore, landlessness has been a permanent feature of the rural landscape over the past three to four decades. Traditional inheritance laws divide land among the male children of a family, so that land holdings become smaller over generations. The population is large and land extremely scarce so the opportunities for buying more are very limited. Regular flooding means that families can be temporarily deprived of their land, perhaps for a cropping season, and it can be eroded by floodwater.

Poverty trends

There has been a decline in poverty in recent years, with rural poverty declining from 61 per cent in 1991/2 to 53 per cent in 2000, a fall of 1.6 per cent per year. However, poverty reduction was slower in the second half of the 1990s, which can be attributed to slower agricultural growth, and deterioration in income distribution. This is despite a relatively high rate of economic growth in the late 1990s, with GDP increasing by 5.6 per cent per year between 1998 and 2000, compared with only 3.2 per cent in the 1991-97 period. Annual GDP growth rates of the order of 5 per cent are below the level of 7 per cent needed to significantly reduce poverty.

Women are more affected by poverty than men, although support from non-governmental organisations (NGOs) and access to micro-credit have improved their position. However, fewer women have formal sector jobs, with 75 per cent of employed women over 15 years of age being unpaid family workers, compared with 13 per cent of men. Women are significantly disadvantaged in a patriarchal society with their roles and rights being defined in terms of gender. Between 10 and 30 per cent of households are female headed, and the number is growing due to the erosion of family support. Over 90 per cent of such households are below the poverty line, and 37 per cent fall within the category of extremely poor, compared with 22 per cent of households headed by men.

The destitute, ultra-hardcore poor and hardcore poor (see Table 1) are the groups in most need in Bangladesh and some of these are beneficiaries of a government scheme (supported by donors) known as Vulnerable Group Development (VGD). Local government departments (Union Parishads) are provided with wheat which is distributed to these households in return for labour (food for work). Part of the rationale for this

project was to investigate whether livestock could provide benefits to this group as means of poverty alleviation and the accumulation of assets and income, thereby providing a degree of self-reliance.

Table 1 *Categories of the Poor (from SLDP, 2002)*

Classification	Poverty level, indicators and causes	Coping actions
Destitute 3% - 5% of rural population	**Desperate** Disabled, chronically sick, elderly Abandoned children	Begging Informal social safety nets Charitable relief
Ultra-hardcore poor 10% of rural population	**Extreme** – under 1600 kcals/head/day no assets, no homestead or land, floating population, disaster victims, long-term illness, few able-bodied household members	Informal social safety nets Scavenging, domestic service, Sell possessions to buy food. Share harvesting Little access to credit, even moneylenders.
Hardcore poor 10% of rural households	**Severe**: under 1805 kcals/head/day Land ownership: less than 0.1 acre, or live on other's land. Poultry and goats Debt burden	Casual wage labour, seasonal migration VGD* programme support Sharecropping and share harvesting Shared livestock Some able to join NGO** micro-credit groups
Moderate poor 28% of rural households	**Moderate**: under 2,112 kcals/head/day Land ownership: less than 0.5 acre Livestock	Wage labour, migrate to cities Limited agriculture and sharecropping Self-employment supported by NGO credit
Neo-poor 20% of rural households	**Just above poverty line** Land ownership: 0.5 to 1.5 acre Vulnerable to falling into poverty	May not qualify for NGO micro-credit (or not wish to join) Access to moneylenders

*VGD = Vulnerable Group Development
**NGO = non-governmental organisation

Opportunities for Livestock Development

A livestock revolution is occurring in much of South East Asia, including Bangladesh, because a combination of population growth, urbanisation and income growth is increasing demand for products of animal origin, principally milk, meat and eggs, (Delgado *et al.,* 1999). Further population growth is forecast along with increased urbanisation during the next two decades, all of which will lead to further demand for animal products. There is a positive relationship between national per capita income and consumption of livestock products. Food prices have been in decline for a number of years as output expands and livestock products have become cheaper which in turn fuels more consumption.

Capital intensive, industrial production systems (particularly for poultry) based on European technology and breeds have been introduced to Bangladesh in response to growing demand. However, the growth in demand is such that poor farmers or landless households may also benefit by investing in livestock enterprises. Livestock are,

therefore, viewed by some (Delgado *et al.*, 1999) as a potential means of lifting the poor from deprivation to self-sufficiency.

Poor landless households in Bangladesh commonly keep livestock, although the contribution to livelihoods of this activity is not clear. Unanswered questions include:

- How do livestock help these households to achieve their livelihood aspirations?
- How do poor landless households benefit from livestock production and projects designed to assist them develop these enterprises?
- Do they contribute to the well-being of poor households and lead to accumulation of assets?
- What is the role of micro-finance in livestock development?
- What proportion of income is generated by livestock?
- Can the extremely poor benefit from livestock production?
- To what extent does livestock production lead to more consumption (within the producing household) of livestock products?
- Is marketing a constraint for poor producers?
- Is it possible to identify good practice in the design of livestock projects for poor landless households?

The role of micro-finance in poverty alleviation and livestock development

Bangladesh's micro-finance programmes which began in the 1970s (Grameen Bank) have been internationally acclaimed for their success in providing poor people with access to credit and the development of sustainable enterprises. Around half of all rural poor households now use the services of micro-finance institutions (MFI). Of an estimated 10 million micro-finance clients worldwide, 8.6 million are in Bangladesh. Studies have shown that borrowing a series of four of five micro-credit loans can lift a household out of poverty and, with over 90 per cent of loans being to women, leads to considerable empowerment and an improvement in the strategic position of women at the household level (GoB, 2001).

However this success is bringing new challenges, including:

- The need to link financial services with other support to alleviate poverty
- The need to develop new financial services and products, including open access savings and loans to small and medium enterprises
- The need to widen coverage to include more of the poorest households, most of who do not now participate.

Of the rural poor households, less than half are receiving micro-credit. Many of those who do not participate are the poorest households (the *hard core poor*, see Table 1) who find it difficult to make savings and keep up with loan repayments. This group tend to get excluded, of their own choice or through being rejected by existing groups and NGO staff as bad credit risks. A growing proportion (around one third) of NGO-MFI members are just above the poverty line.

Project activities

The project has three major activities:

- A Participatory Learning and Action (PLA) exercise
- An Impact Assessment study, and
- An Action Research phase.

Participatory Learning and Action

The PLA exercises were conducted in three locations in Mymensingh, Tangail and Netrokona Districts. The objective was to establish the role that livestock play in poor landless household livelihoods and to assess the aspiration of livestock keepers (i.e. what were their objectives regarding livestock production and to what extent were these aspirations met by different species and enterprises). Briefly the PLA phase concluded that:

- Many poor households keep some livestock and the poorest keep mostly poultry and the less poor keep goats
- Very poor households do not have sufficient resources to purchase or maintain cattle
- Poultry provide some regular income (eggs) but also can be sold when the family needs money
- Few livestock products are consumed on a regular basis but are important for entertaining relatives and other visitors
- Women prefer livestock production as it does not interfere with religious and social norms such as purdah, which prevent many women from leaving the homestead (livestock can be cared for either in or close to the homestead).

Impact assessment

The second phase of the project examined the impact (Table 2) of the use of micro-credit for livestock production by 60 poor landless households in the same three locations. The objective was to assess these enterprises in both male and female headed households, asking the following questions:

- Did micro-credit help them fulfill their livelihoods expectations?
- Could poor households access further loans for livestock or other enterprises?
- Did livestock contribute to the well-being of the household?
- Were the capital assets of the household improved?

Table 2 *Benefits generated by livestock enterprises (total no. of farmers)*

Benefits	No. reporting (%)
Increased income	41 (68.3%)
More food	32 (53.3%)
Improved social status	31 (51.7%)
More savings (in form of livestock)	28 (46.7%)
Afford medicine	22 (36.7%)
Manure for fuel and fertiliser	20 (33.3%)
More clothes	19 (31.7%)
More livestock products (to consume)	16 (26.6%)
Afford education	14 (23.3%)
Better furniture	14 (23.3%)
Improvements to house funded	13 (21.7%)
Better access to land (ownership and tenancy)	10 (16.7%)
More cash savings	9 (15.0%)
Provided female employment	9 (15.0%)
Other goods (savings)	7 (11.7%)
New tube-well	2 (3.3%)
Improved knowledge	1 (1.7%)

The impact assessment concluded that:

- Livestock can assist poor households (75 per cent of the sample generated benefits)
- Loans are often repaid from other income (not livestock income) (the exception may be cows that are already giving milk and laying hens)
- Most households need regular income (employment) to be able to access loans
- Few NGOs (micro-credit providers) offer training in livestock health or management
- Some households received training for poultry but these enterprises still failed (high mortality)
- Some NGOs provide insurance for livestock (only 4 reported in sample)
- Most households don't understand saving schemes (loan beneficiaries are required to make regular weekly savings with the provider)
- NGO credit is much cheaper than using moneylenders
- The success rate for livestock enterprises could be improved if more NGOs offered extension advice, insurance and veterinary services.

A further important conclusion was that those households that are not considered credit-worthy by NGO micro-credit providers, or are unwilling to access loans because of the

risks involved are excluded from this type of development. The action research phase (see below) worked with households that fell into this category.

Action Research (AR)

Selection of farmers

The criteria for farmer selection for the action research phase included those households:

- Who had not been beneficiaries of micro-credit for livestock or other enterprises (hard-core poor or ultra poor)
- Were able to provide the labour required (i.e. were not disabled or unable to work) and had or were able to construct some rudimentary housing for livestock
- Had some knowledge of livestock production (or previous experience) but limited livestock resources
- A general interest in livestock keeping and a willingness to participate.

Several meetings with potential participants were held prior to selecting 9-13 female farmers from each of the three locations: Thakurakona (Netrakona District); Chariswardia (Mymensingh District); and Charbogra (Mymensingh District). Poultry (ducks and hens) and goats were considered to be the most appropriate species of livestock because of the scale (small size) of the enterprises and the limited amount of investment required in housing and inputs.

Some baseline socio-economic information was collected from participating households. Their average monthly income was Taka 1,700 and average household size was 3.56 persons. Thus daily income per household was in the region of US$0.94 and daily income per capita was US$ 0.26.

Training of farmers and distribution of livestock

Two-day training programmes and workshops were organised in each location. Participating farmers were given training in feeding, health care and housing of goats, ducks and chickens. A brochure in Bengali on raising goats, ducks and chicken was also prepared and distributed among the AR farmers.

Pullets of the Fayomi and Sonali breeds, aged 1.5 months, were purchased and distributed to the AR participants (14 hens and one cock to nine participants). Cross-bred ducks and drakes, aged three months, were collected from private farms and distributed to ten farmers (ten ducks and one drake) (see Table 3).

Goats were procured from local livestock markets. Healthy does, preferably with two kids, 1-2 months old, were purchased if available, but if not pregnant does were purchased. Does were distributed to 13 participants.

Livestock were distributed to farmers within one to two days of being procured, towards the middle of January 2004. The health status of the animals could only be determined by a visual examination and one goat died 12 days after distribution and was replaced. Some poultry also died before monitoring could begin and these were also replaced (Table 3).

Table 3 *Numbers of farmers and number of livestock in the Action Research locations*

Area	Goats		Chickens		Ducks		Total farmers
	Nos.	Farmer nos.	Nos.	Farmer nos.	Nos.	Farmer nos.	
Chariswardia	13	5	45(+15)	3(3)	11	1	9
Charbogra	22(+1)	8	30(+5)	2(1)	-	-	10
Thakurakona	-	-	60	4	99	9	13
All areas	25(+1)	13	135(+20)	9(4)	110	10	32

Note: Figures in parentheses indicate the number of chickens (*Nera Brown*) and goats replaced due to mortality in the early stages of the action research.

Vaccination of livestock

All poultry and goats supplied to participants were vaccinated. Chickens and ducks were vaccinated for Baby Chick Ranikhet Disease (BCRD), also known as Newcastle disease, and Fowl Cholera. Booster vaccinations against Duck Virus Enteritis, also known as Duck Plague (DP), were undertaken either by the Directorate of Livestock Services (DLS) or, if DLS was not available, project personnel. Booster doses for Fowl Cholera in chicken and ducks were given in all locations. Vitamins, antibiotics and other drugs were supplied on the advice of veterinarians. If considered necessary, goats were given veterinary treatment.

Table 4 shows livestock mortality that has occurred up to mid-October 2004. There were high losses (as expected) of chickens and ducks, but very few losses of goats (the data in the table includes kids, one of which was taken by a predator). All poultry farmers have experienced some stock mortality (exacerbated by conflicts with neighbours in Netrakona). Only two mature female goats died.

Data collection

Data was collected from farmers on a bi-weekly basis and included:

- Animal performance (live weight) and feed inputs
- Other inputs including veterinary drugs and labour
- Consumption and sale of livestock products
- General household consumption and income
- Reproduction of goats and poultry (hatching)

Table 4 *Mortality rates of all species (mid-October 2004)*

Area	Lost/sold	Killed by predator or neighbour	Disease	Total	No. farmer affected
Goats					
Charbogra		1(2)	4(9)	5(11)	5 (11)
Chariswardia			1(2)		1(2)
Thakurakona					
All areas		1(2)	5(11)	6(13)	6(13)
Ducks					
Charbogra					
Chariswardia	2(2)	3(3)	3(3)	8(7)	1(100)
Thakurakona	11(10)	6(5)	32(29)	49(45)	9(100)
All areas	13(12)	9(8)	35(32)	57(52)	10(100)
Chickens					
Charbogra		4(3)	23(15)	27(17)	2(100)
Chariswardia			42(27)	42(27)	3(100)
Thakurakona	4(3)	28(18)	9(6)	41(26)	4(100)
All areas	4(3)	32(21)	74(48)	110(71)	9(100)

Note: Figures in the parentheses indicate the percentage of total.

Preliminary results

Data for 31 weeks are currently available and some preliminary results are presented below. Data collection will continue for another year.

It was not anticipated at the beginning of the AR phase that all households would succeed with livestock production as management skills differ, labour may not be always available and there was always the possibility of conflict with neighbours. Landless households have very limited areas on which to keep livestock (homestead only) and, therefore, need to allow them to graze/scavenge beyond the boundaries of the homestead.

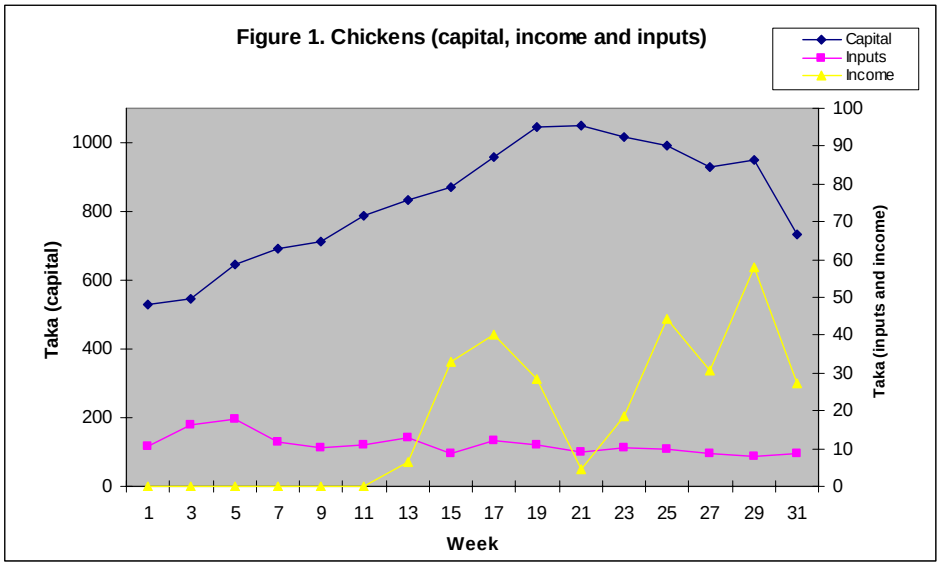
Data on the capital value of the livestock, the input costs (including labour) and income generated are presented in Figures 1-3. While both hens and ducks increased in value initially, mortality and the onset of laying (reduced body weight) resulting in a decrease in total value. Some farmers have performed better than others but average data is presented in this paper.

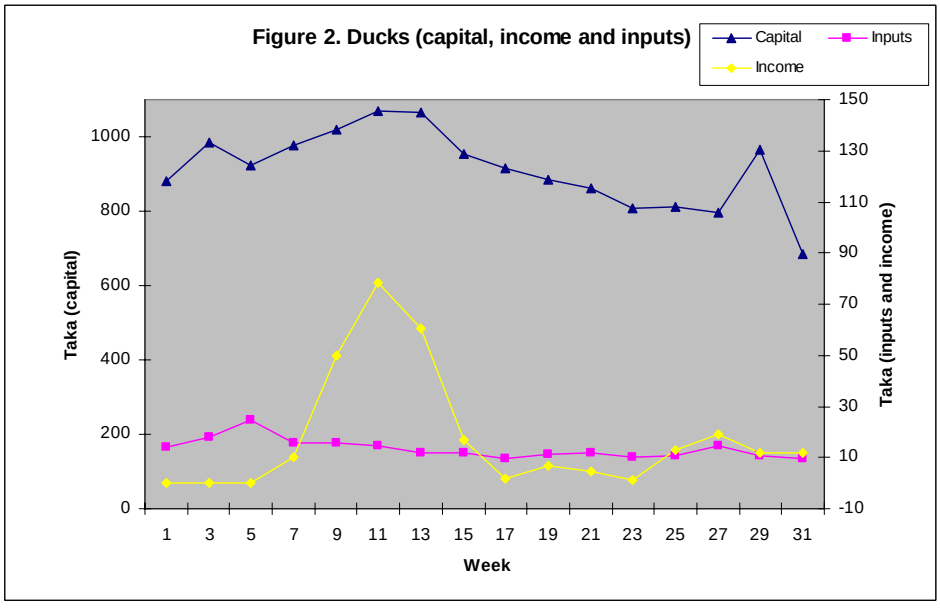
Although it is too early to draw firm conclusions about the appropriateness of poultry for very poor landless households, their susceptibility to disease and predators may be insurmountable challenges. At least half the mortality in chickens has been caused by predators. Social conflict between households has led to some vindictive activities (slaughter of ducks) by neighbours in one location (Netrakona).

Little hatching of chicks and ducklings has taken place to date as farmers have been waiting for the end of the monsoon (mid-October) to undertake this activity. This is likely to have a major impact on the capital value of livestock holdings and income.

Although goats do not provide a regular income (like sales of eggs) they seem to be much less susceptible to disease and predators and their capital value has increased steadily since the beginning of the AR phase.

Inputs costs are low for all species. Although output and capital growth could be improved with the provision of more feed this is beyond the means of most households. The advantage of poultry and goats is that much of their daily needs can be found without major expenditure on inputs. Labour costs are included in the calculation of input costs. Again labour use is minimal (a maximum of one hour per day) and its opportunity cost is low, particularly for women, who in a Muslim society are expected to remain in or near the homestead.





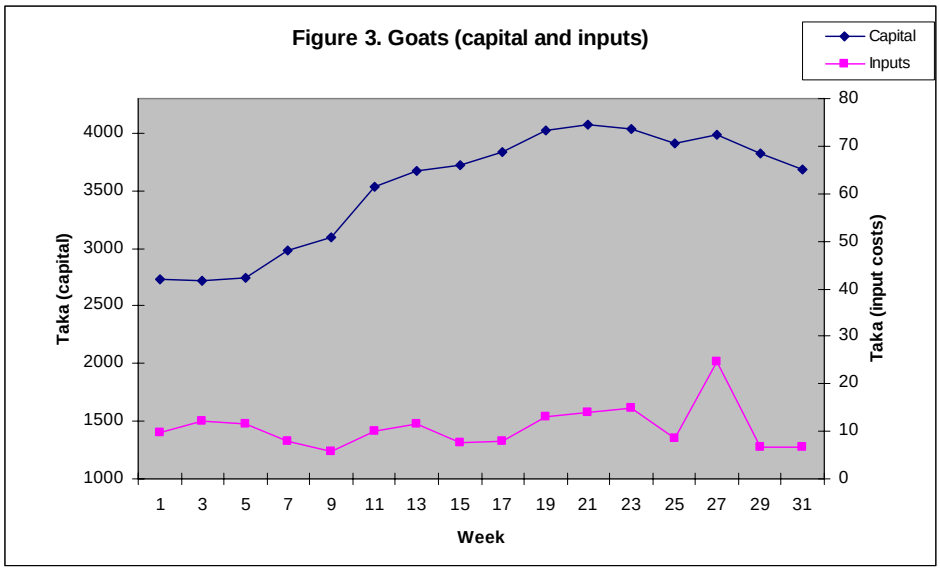


Photo 1 *Maya with eggs from her ducks*

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Photo 2 *Jamila with her 5 goats. Jamila of Chariswardia wants to get more kids from present stock (fortunately all are female goats) so that she can get more money to buy a milking cow in the future*

Semi-structured interviews were conducted with participants in mid-October to explore the impact of livestock on livelihoods. Those household who have done better than average (approximately half the sample) described the following benefits from the sale of eggs (ducks and chickens), which produced sufficient income to allow the purchase of:

- A sari and books for children
- Two extra ducklings
- Extra rice for the household
- Two extra hens
- Tiffin (lunch) for children to take to school
- Extra vegetables and salt for the household
- Doctors' fees.

In addition eggs have been consumed by children and other members of the family. Previously eggs were rarely eaten in these households as there was little income available for their purchase. Capital (savings) has increased (particularly with goats). Some goat owning households intend to sell male goats at the festival of Eid-ul-Ahzar in January 2005 and hope to raise Taka 2,000 (US$ 26.7). This income will be used to repair houses and to buy a new female goat for breeding.

Providing labour for livestock production is not a problem as most is provided by women. They are now busier than previously and men and children are also helping.

Feed is provided for both poultry and goats (rice bran, broken rice, leftover rice, and rice gruel). Finding forage is not normally a problem (except during flood): tree leaves (banana and jack fruit) are available in the homestead, grazing on bunds and roadsides is utilised, and small quantities of wheat bran are purchased if it is affordable.

Marketing is not a problem as buyers come to the homestead to purchase eggs. The current price is around Taka 16 for 4 eggs (US$ 0.21) (October 2004). Being part of the group has helped participants develop confidence. There is some competition within the group to produce the most eggs etc. Income has increased and people involved in the project say "we are no longer beggars", thus social status has also increased. This is manifested in NGOs offering loans as the AR farmers now have some assets, whereas previously they had not been considered creditworthy.

Knowledge has also increased, particularly regarding the importance of vaccinations, management of internal parasites and an understanding of the nutritional needs of livestock. The majority of households intend to continue keeping livestock after the project finishes although they are already concerned about the availability of inputs such as vaccines (currently supplied by the project).

Some problems associated with livestock keeping were also expressed:

- At times it is difficult to manage five goats as tethering requires labour and time. Farmers would prefer one larger animal (bull calf for fattening) which would provide more profit if sold at the Eid-ul-Azhar festival. Straw can be purchased and roadside grasses cut and carried (goats cannot be managed in this way as they prefer to browse

and will not readily eat cut and carried grass, although they will eat cut and carried browse).

- Mortality remains a problem with poultry despite vaccination programmes, because of predation and, to a lesser extent, disease
- There is some conflict with neighbours (ducks using their ponds and hens straying on to their land)
- Two group members dropped out, one sold all her ducks and the other lost all her hens to disease, although she admitted that she had not taken good care of them
- In one case intra-household conflicts arose (between beneficiary and mother-in-law) over control of the income from livestock.

Conclusions

Although it is too early to make firm conclusions about the potential role of livestock in poverty alleviation, early indications are that:

- Goats may be a better option than poultry due to their inherent disease resistance. Goats do not provide a regular daily or weekly income but they do provide capital growth (savings) which can be called upon when needed
- Some households have been very successful with poultry but overall ducks and chickens have not performed as well as goats
- Identification of potential beneficiaries, who are likely to succeed, may be crucial to success, although it is not yet clear how this can be done
- Further monitoring is essential if useful results are to be gained from the project; this is particularly the case for poultry. Many households are planning to increase their flocks during the dry winter season (November–March)
- On the whole very poor households are able to manage livestock enterprises within their family budgets, using locally available, usually free, resources. The only large outlays necessary are for veterinary drugs or assistance.
- Availability of labour is not a difficulty for the majority of households
- Marketing is not difficult as egg buyers visit most villages although slightly higher prices can be realised at local markets
- The Muslim festival of Eid-al-Ahzar provides an opportunity for goat keepers to realise a premium for their livestock (prices are about 30 per cent higher than normal).

Discussions were held with a local NGO (CYSA) in Mymensingh District to investigate the possibility of this organisation providing micro-credit to project beneficiaries, particularly those who have accumulated sufficient capital for them to be eligible for a loan (some farmers have expressed interest in selling goats to buy bull calves for fattening). Any loans will be made on the normal terms of CYSA (repayment in weekly installments) and will not be subsidised by the project. If this occurs in the next few months the results will be monitored by project staff.

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Discussions/suggestions and comments on presentation:

Comment: The lesson learned from this presentation is that resource-poor farmers keep small stock for income generation, not home consumption. This has been observed in similar studies in Uganda, although children are now given eggs to eat.

Question: *It is interesting to note that the small stock keepers use credit. Is the same credit available for crop enterprises? If so how do you compare the rate of return between livestock and crop enterprises?*

Answer: This comparison has still to be made. In Bangladesh a mixture of chicken and goats is the best combination of livestock enterprises.

Comment: From the results of the study, it is recommended that livestock should be housed according to species in Bangladesh.

Question: *What caused a drop in the income curve at 21 weeks?*

Answer: This was as a result of heavy flooding due to the monsoon.

Poultry, pigs, hair sheep and guinea pigs in the livelihoods of small-scale, subsistence farmers in tropical Bolivia[1]

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Abstract

In forest margins in the Sara and Ichilo provinces of tropical Bolivia, a participatory programme of research was undertaken by a multi-disciplinary team of biological and social scientists and extensionists, working with participating farm families (parents and school-aged children), nominated by their communities. The objectives were to determine the problems faced, and the productivity of the principal, scavenging small animal species found in the largely subsistence farming systems, typical of the region. High levels of mortality of young animals were seen in all species, where natural predators and preventable accidents were responsible for many losses. In poultry, readily controllable diseases were important, while in pigs and sheep, internal parasites were implicated in losses and poor animal performance. Guinea pigs had few problems, except for losses due to predators and theft. During a validation period, farmers recognised that improved nutrition would be advantageous, but were unwilling to incur the regular costs of improved feeding. They chose instead to provide their animals with simple night shelters, vaccinations and improved hygiene. These simple measures increased the gross margin (cash and kind) of chickens, ducks, pigs and sheep by 30, 98, 16 and 63 per cent respectively. With guinea pigs, better housing made management easier, but this was not reflected in improved animal performance. On average, the improvements resulted in an annual increase of over US$ 200 in family income, which was normally in the range of US$ 1,000–1,200. The results attracted the attention of local authorities and similar work has been initiated in neighbouring areas.

Introduction

In the Bolivian Department of Santa Cruz, the Provinces of Sara and Ichilo lie some 100 km north-west of the city of Santa Cruz de la Sierra, where they occupy an area of about 21,000 km^2. Most of the region is a flat, alluvial plain, 350-450 m above sea level, with young soils prone to localised, seasonal waterlogging, although the land becomes undulating and rises to 800 m as it approaches the foothills of the Andes to the west. The soils are moderately fertile with pH values often in the range of 4.5 to 5.5. Rainfall increases from about 1,400 mm in the east to over 1,800 mm in the west, about three

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quarters of which falls between October and May. The natural vegetation is mostly tall, evergreen forest (Paterson *et al.*, 2001).

Some 55 per cent of the total population of 90,000 people live in about 300 rural communities in groups of 25 to 150 families (Roca, 1998). The farm families come from two quite distinct ethnic groups of almost equal size. The local lowland people make up just over half of the present population and are descended from Spanish immigrants, usually with some degree of genetic influence from the original lowland Indian population. The other group (46 per cent of the present day total) is composed of almost pure-blood Indians who have migrated into the area in recent decades, from the highland Departments of the country, mainly Cochabamba and Potosí. These ethnic origins are important in terms of attitudes, aspirations and lifestyles. Lowlanders tend to grow a wider range of subsistence crops than their neighbours, including native fruit trees and local vegetables. They are less market-orientated than the highlanders, favouring a more varied diet and a less hectic lifestyle over attempts to maximise their incomes (Román, 1999).

Within designated colonisation areas, usually after removal of the best, high-value tropical hardwood timber, the state assigns blocks of 30-50 ha of forest land to individuals or families, for agricultural use. The recipients are usually extremely poor, with access only to a few hand tools. They initially clear small areas of land to produce subsistence crops (rice, maize, vegetables, etc.) under a slash-and-burn (swidden) farming system, rotating the cropping area around the farm when falling fertility or increasing weed problems lead them to abandon the original area back to bush fallow. The farmers generally lack the capital to work more than a few hectares of their land at any one time (Thiele, 1991). Some of the immigrants from the highlands have experience of animal traction in their areas of origin, but the heavy soils and the presence of roots and trunks make these techniques impracticable in the lowlands, even if enough capital were available to finance the use of oxen. The agricultural activities are largely concerned with subsistence farming, although excess production, destined for the city, is sold locally.

In 1992, it was estimated that 74 per cent of the farming families in the region had total annual incomes below US$ 1,100, with 25 per cent of them receiving less than US$300 (Roca, 1998). Prices for farm produce have increased over the past decade, but casual labour is still paid at a rate of about US$ 5 per day and total family cash income is frequently in the range of US$ 1,000–1,200 per year (Román, 1999).

The heavy agricultural work on the farm (land clearance, land preparation) is usually undertaken by adult males, but in both ethnic groups, the whole family is involved in lighter field work (planting, weeding and harvesting). When present, cattle are generally managed by men, but milking of the cows and caring for small animal species are duties usually undertaken by the women and children. Small animal species appeared on the farms of members of both ethnic groups at a very early stage in the development of the system. These animals generally contribute to food security, although, in times of need, excess production not required for home consumption, is sold. Scavenging, local breed chickens are present on over 90 per cent of farms in the region (Román, 1999) and local ducks are common on farms where there are natural streams or ponds. Under traditional management, all poultry and most other small animal species scavenge for almost all of their feed, eating leaves, seeds, worms and insects. They receive very small amounts of supplements, usually cracked grain, surplus and over-ripe fruits and household scraps.

The lowlanders maintain a wider range of animal species than the immigrant highlanders, sometimes including native animals such as armadillos, which are captured in the surrounding forest and grown on to slaughter weight in captivity. Amongst their poultry, they often keep several varieties of chickens, together with ducks, geese and guinea-fowl. In contrast to this, the highlanders usually keep only chickens. The latter group do, however, have guinea pigs and tropical hair sheep, species which are seldom found on the farms of lowlanders. Prior to the mid 1990s, livestock research and development work in the region concentrated on cattle, since all the farmers of both ethnic groups repeatedly expressed their desire to become involved in either dairy or beef production. It was noted, however, that the poorest members of society were usually unable to afford the investment needed to establish a herd of more than one or two cows. Because of their long gestation period and low calving rates associated with poor nutrition and the presence of tick-borne diseases, these animals made little contribution to family income and consumption (Breinholt, 1982). The programme of work discussed in the following pages was undertaken to define the role of small animal species in the households in the region; to identify the major production limitations; and to promote their use in the farming operations conducted by poor people on small-scale farms in the forest margins.

Materials and methods

The work took place in a fully participatory manner, where farm families (both adults and children of school age) and local extension staff worked in full collaboration with a multi-disciplinary team of researchers in both biological and social sciences. When the research started, there was an almost complete absence of technical information on the performance of small animal species and the problems facing them in the target area. A programme of many months work was necessary to generate this vital information and so a conscious decision was taken to start the biological research first and to then follow this up with the socio-economic studies that would be necessary to complement the biophysical information.

Initial informal surveys in the target area identified chickens, ducks, pigs, hair sheep and guinea pigs as the most common livestock and subsequent work concentrated on these species. Monitoring of representative farms took place over a complete year (18 months for sheep), where all events (births, deaths, sickness, accidents, utilisation, sales, feed offered, etc.) were carefully recorded. This was done on 11 farms, located in the four distinct communities of Barrientos, San Rafael, San Miguelitos and Potrerito. Initially, technical staff visited each farm on a weekly basis to ensure that the records were kept up-to-date, but as the families became used to the routine, the period between visits was increased to two weeks. School-age children were often involved in the recording of the data, particularly where their parents were illiterate, or lacked confidence in their writing abilities. As far as possible, technical interventions were avoided during this period, to establish the production patterns of the chosen species under traditional management. The major production problems were determined, using, where appropriate, the assistance of a local diagnostic veterinary laboratory. The methodology employed during this phase of the work has been fully described by Paterson *et al.* (2001).

At the conclusion of this period, possible interventions were discussed in open meetings, held in each of the four communities, with the farming families and their neighbours. At the conclusion of a presentation of the results obtained in the initial stages, the technical staff withdrew to allow the communities to freely discuss the findings and to choose which animal species and interventions would be tested in a subsequent programme of

on-farm validation. The communities themselves nominated the individuals who would participate in this phase of the work, and neighbours were free to oversee the activities and to suggest modifications as they saw fit.

In parallel with the technical work on animal production, sociological and economic studies were also conducted in the same communities, using a range of participatory techniques, including semi-structured surveys, participatory rural appraisals, farm walks, maps, transects, resource flows and SWOT (strengths, weaknesses, opportunities, threats) analysis and wealth ranking (Román, 1999). This allowed an assessment of attitudes and aspirations in the communities, while measuring the contribution of traditionally managed small animal species to family livelihoods. The socio-economic methodology developed for this work was published for the benefit of other groups that may be interested in conducting similar work in other parts of the country or elsewhere (Chamón *et al.*, 2000).

Workshops and farm visits were arranged to publicise the findings and to confirm that the results, which had been obtained in a small sample of communities, were applicable to the region as a whole. During the course of the work, results were published in a range of media, including technical fact-sheets, newspaper articles, extension booklets and scientific papers for submission to conferences and journals.

Results

Average holdings of breeding animals varied widely between farms and over time, in response to family preferences and needs for cash and meat, but typically consisted of about 15 chickens, 6 ducks, 1 or 2 sows, up to 10 ewes and 15 guinea pigs. However, no single farm had all of these species. Chickens and pigs were kept by both highland immigrants and lowlanders, while ducks were only kept by lowland people and sheep and guinea pigs only by highlanders.

Attempts were made to identify cultural differences in the management practices used for small animal species on farms belonging to either highlanders or lowlanders. These failed to define large differences, although, because of access to accumulated knowledge, the lowlanders made more use of traditional and household remedies to treat disease problems than did their neighbours. The highlanders had lived in a harsher environment in their original areas and possibly because of this, they were more inclined to provide rustic shelter for their animals. This was noted particularly with sheep and guinea pigs, species that are not normally kept by lowlanders. In the sections that follow, no attempt is made to distinguish between the ethnic groups in terms of the management practices employed for their animals.

Under traditional management, poultry scavenge around the home compound for the bulk of their feed, receiving only occasional supplements of household scraps and cracked grain. Pigs also scavenge, while receiving occasional supplements of chopped cassava, etc., while sheep graze and browse along roadsides, in fallow-lands, or in small fields established for use by cattle. Guinea pigs are the exception, since they are usually kept in sheds, or in the family kitchen, where they receive their food as cut fodder and household scraps. None of the animals receive either vaccinations or veterinary treatment and most find their own shelter where they can.

As a result of the use of almost zero inputs, apart from the labour of women and children, which has a very low opportunity cost, any production in terms of eggs and meat from small animal species can be considered as profit, whether they are sold or eaten by the family. Under these conditions, calculations based on a series of in-depth interviews and a sound understanding of the incomes, yields and budgets of representative families showed that the return from small animal species can represent up to 30 per cent of annual family income, when home consumption is costed at the prevailing local market prices. This figure varied greatly between farms and even between seasons, since the holdings of small animal species were subject to large changes during the course of the study, but in view of their importance to family income and welfare, it was clear that any increases in their productivity would have a major effect on the small-farm sector.

Chickens

On most farms, eggs were collected for home consumption and occasional sale in almost all months of the year, with a peak in the period from August to November. Chicks hatched throughout the year, with the greatest numbers from May to July. Overall, the annual productivity was 5.8 chicks per mature hen, although there was great variability between farms, due to the trade-off between egg collection and the emergence of chicks. Typically, the annual sum of eggs collected and chicks observed (net egg production after losses to weather and predators) was in the range of 20-40 per breeding female. A number of native predators took both eggs and newly hatched chicks, but losses of older birds in this way were minimal. The heaviest mortality of chicks resulted from diseases such as Newcastle disease, fowl pox, infectious coryza, fowl cholera and pullorum disease (bacillary white diarrhoea), and the losses seemed to be aggravated by cold, wet weather. Both internal (roundworms) and external parasites (mites, mange) were common and although they did not normally lead directly to mortality, they had an effect on the general health and welfare of the birds.

Few mature birds were sold, but young males and older females were slaughtered throughout the year for home consumption. In most cases, two to four birds were consumed each month but holiday periods or family celebrations could increase this number.

During the on-farm validation period, farmers agreed to provide their poultry with rustic housing made of poles and palm thatch cut from the farm, together with purchased chicken wire. The adult birds rapidly accustomed themselves to sleeping in the shelters and laying eggs in the nest boxes provided, although they continued to scavenge during the day for the bulk of their food. Vaccination was practised against Newcastle disease and fowl pox, while antibiotics and traditional remedies were used to treat diarrhoea when it occurred. These measures increased the numbers of chicks observed and reduced losses, so that productivity per breeding female was increased by about 30 per cent (Table 1).

Table 1 *Annual productivity of small animal species in tropical Bolivia*

Species	Traditional management			Improved management		
	Live young per breeding event	Mortality before maturity (%)	Gross return per breeding female (US$/year*)	Mortality before maturity (%)	Gross return per breeding female (US$/year*)	Increase in productivity (%)
Chickens	7.1	30.5	13.29	18.2	17.21	29.5
Ducks	6.7	54.1	12.05	27.4	23.82	97.7
Pigs	8.1	38.2	260.34	28.3	302.05	16.0
Hair-sheep	1.2	30.8	13.82	19.5	22.51	62.9
Guinea pigs	2.3	10.5	8.91	11.0	9.30	4.4

* Returns calculated at constant 1999 prices, US$ 1.00 = Bs5.50

Ducks

Ducks are not kept by immigrants from the highlands, because they are considered to be dirty birds that foul the home compound with their droppings. Under traditional management, no eggs were laid during the colder months (May to July) and females bred only once per year, with most eggs hatching in the period from October to March. On average, 6.7 ducklings hatched from each clutch of eggs, but more than half were lost to diseases, usually involving diarrhoea (Table 1). No losses to predators were recorded during a monitoring period of a full year, although on one farm, two older birds died after being accidentally trampled by cows. There was no routine home consumption of either eggs or meat, but occasionally, a bird was slaughtered for a family celebration. Instead, there was a ready market for live or dressed birds, which often found their way, through intermediaries, to restaurants in the urban centres. Most birds were sold at a price set on sight, rather than by weight.

During the on-farm validation period, ducks were allowed entry into the shelters provided for the chickens and they received appropriate vaccinations and veterinary treatment with antibiotics as necessary. This resulted in a halving of the mortality rate of the ducklings and a doubling of the productivity of the species (see Table 1). During the course of the work, there was a growing trend towards setting the sale price by body weight, although this may have been a result of increasing sophistication in the market, rather than to any increase in the levels of production.

One urban farmer, in a small town in the region, developed a semi-intensive, back-yard system of duck production, which produced excellent technical and financial results, even though it was based on purchased, rather than home-grown feed. Immediately after hatching, the ducklings were removed from the mother and kept inside the family house for two days, to avoid any possible adverse effects of cold and damp conditions. They were then placed outside in a small, sheltered enclosure of their own, where they were provided with clean water and a commercial poultry ration, together with vegetable scraps obtained cheaply from the local market. As they grew, they were removed to larger enclosures and in this way, they reached a live weight for slaughter of about 2 kg in a period of 3-4 months. They were then sold, by weight, to intermediaries. Under this system, diseases were not a problem, as there was no ready source of infection and any sick duckling was separated from the rest as soon as symptoms were observed. All of the breeding females, kept with a drake in their own enclosure, laid two clutches per year and

although fairly variable, losses of ducklings were kept to a maximum of about 10 per cent. Annual returns per breeding female were estimated at about US$ 48 after taking the costs of purchased feed into consideration. The owner considered that her flock of 8-10 breeding females provided more profit for much less effort than she could earn by the alternative of taking in laundry. This is a low-cost management system that could readily be copied by other families in the region. The profit margin could be increased by replacing the purchased feed with a largely home-grown ration, based on commonly available feed resources such as maize, rice bran and a protein source, such as a meal made from soya or from the legume *Mucuna pruriens*.

Pigs

Many small farms run by both ethnic groups in the region kept one or two sows which scavenged for most of their food. They were free to roam around the home compound and nearby water courses for most of the year, although they tended to be tethered close to the house when nearby annual crops were at a vulnerable stage of their development. They received no veterinary treatment and, at best, only small amounts of chopped cassava tubers, chopped whole sugar cane and vegetable wastes to supplement what they could find for themselves. The fallen fruits from naturally occurring palm trees (*Attalea* and *Scheelea* species) formed an appreciable proportion of the diets of scavenging pigs, together with earthworms and roots obtained from low-lying areas or the banks of water courses.

Only one or two farmers in each community kept a boar, which was readily lent to neighbours when required. Under these conditions, the average period between farrowings was calculated at 265 days. Litters were concentrated in the period from April to June, and again from September to November, with an average of 8.1 live piglets per litter, irrespective of the month of farrowing. Losses of piglets were generally high (up to 67 per cent) and were attributed by farmers to accidents (crushing, drowning), cold weather and the lack of maternal milk. Research showed that where internal parasites were routinely controlled in mothers and offspring, losses over the first few months of life could be reduced to about 10 per cent (Table 1).

Young animals of up to 40 kg live weight were in great demand, particularly at times of public holidays (Carnival, Easter and Christmas) and for major family celebrations. Typically, of a litter of six pigs surviving to slaughter weight at from four to six months of age, one or two would be consumed by the family, but most would be sold locally, usually to intermediaries. Where sows farrowed twice in a year, an annual cash income of up to about US$ 400 could be derived, equivalent to the income from over three months of casual, daily paid work.

During the on-farm validation period, rustic enclosures were built, using poles and palm thatch, cut on the farm. A separate, shaded farrowing pen was included, to protect the newly born piglets from contact with other, larger animals. The pigs were vaccinated against classical swine fever and routinely treated to control both internal and external parasites. The result was to reduce the mortality of the piglets and to increase their growth rates (Table 1), although the improvements were limited by the unwillingness of the owners to provide adequate amounts of supplementary feed, particularly while the animals were confined in their pens. Although mortality of piglets was reduced in the first two weeks of life, losses continued after this initial period as a result of accidents and an apparent lack of milk. More attention to the feeding of the dams in mid-lactation should allow a greater proportion of the litter to reach slaughter weight.

Hair sheep

Tropical hair sheep were kept only by highland immigrants, many of whom had a tradition of raising conventional wool sheep in their original homelands. Lowland people have never been used to sheep, nor have they developed a taste for the meat, since wool sheep are poorly adapted to life in the humid tropics. For lowlanders, sheep are a totally new species and only a few families have recently started to express an interest in learning to care for them. Sheep are normally grazed and browsed on poor quality, volunteer pasture on fallow land and along roadsides, although occasionally, they are given access to better quality pastures which have normally been established for cattle. These planted pastures are usually sown to *Brachiaria decumbens*, *B. brizantha* or *B. humidicola*, although occasionally, areas are planted to a mixture of *Panicum maximum* with the pasture legumes *Macrotyloma axillare* cv. Archer, or *Pueraria phaseoloides* (tropical kudzu). The sheep receive neither veterinary attention nor supplementary feeding, except for occasional access to a salt lick. Under this traditional management, where rams are constantly with the ewes, twinning is common, but mortality in the lambs prior to maturity is about 30 per cent (Table 1). On four farms monitored over the course of 18 months, a total of 16 ewes lambed more than once. The average *inter partum* period was 251 days (range 144-424 days), including three ewes with more than a year between births. The average was 1.30 live young born per lambing.

The high level of lamb mortality was attributed by the farmers to accidents and lack of maternal milk, although technical staff was convinced that internal parasites were implicated in the problem. Diarrhoea also caused some losses, as did infections contracted by new-born lambs through an untreated navel. Some animals were slaughtered for consumption at times of family celebrations, although most were sold. Some farmers complained of difficulties of marketing animals for slaughter, because of the limited demand for mutton in the region, although others stated that there were no problems in selling young stock for breeding purposes.

Interventions included the provision of pens with a sheltered area to protect the animals at night from wind and rain, together with simple, veterinary treatments. These included: the application of iodine to the navels of the new-born lambs; the treatment of diarrhoea with rehydrating salt (sugar and common salt in clean water); the use of anti-biotics to treat footrot; and routine treatments to control internal and external parasites. These measures reduced the mortality of young animals to about 20 per cent, with a consequent increase in productivity and profitability of the flock (see Table 1). There appeared to be a reduction in the average *inter partum* period since ewes seemed to come into season faster after lambing, but the validation period was too short to provide the data needed to confirm this suggestion.

Guinea pigs

Guinea pigs are traditionally kept in the Highlands of Bolivia and many immigrant families continue to raise these animals for home consumption in their new environment. Lowlanders have shown little interest in the species, because of their perceived similarity to rats. They are usually allowed to run free in the kitchen building of the house, although on some farms, they are confined in a separate, small shed. As well as receiving household scraps, they are also regularly given freshly-cut, or partially wilted forage, often of tropical kudzu, or of leaves of the mulberry tree (*Morus alba*).

When monitored, the average *inter partum* period for guinea pigs was 190 days, with an average of 2.28 live births per litter and mortality of 10.5 per cent. No diseases were recorded and the low level of losses was attributed to accidents, sometimes involving dogs of neighbouring families. Theft of semi-mature animals was an occasional problem.

Suitable designs for pens were made available, which were raised to keep the animals 90-100 cm above the ground. This provided them with ventilation, while protecting them from dogs and other potential predators. Internal divisions in the pen separated the sire from the growing animals and so reduced the danger of injury through fighting. The provision of pens made management of the animals easier and allowed them to grow slightly faster in more secure surroundings, but had little effect on the productivity or profitability of the enterprise (Table 1). No veterinary practices were considered necessary, because diseases and parasites did not appear to have a measurable effect on the productivity of this species.

Discussion

Monitoring showed that the productivity of chickens and ducks was reduced largely by the attacks of a range of controllable diseases and natural predators, while losses from pigs and sheep were mainly due to avoidable accidents and to the effects of internal parasites. Guinea pigs had few identifiable problems, with low levels of losses.

Although it was recognised that inadequate nutrition was probably limiting the growth rates of all species, farmers were reluctant to adopt improved feeding regimes as part of their strategy of better management, since this would substantially increase their production costs. Instead, they opted for the provision of rustic, night-time shelters, which would protect poultry and guinea pigs from attack by dogs and wild predators. Chickens were to be vaccinated, particularly against Newcastle disease, and hygiene measures and treatments would be employed to lessen the impact of problems such as diarrhoea in both chickens and ducks. Pens would be constructed to confine pigs during times when they could damage crops and farrowing bays would be included in the design, to reduce the danger of piglets being crushed by their mothers, or by larger animals in the herd. Pigs and sheep would be regularly dosed or injected to control internal parasites. Participatory evaluation showed the positive impact of these measures through reduced losses of eggs (leaving more to be harvested by the family) and young animals, together with a suggestion of decreased intervals between births for all species except guinea pigs.

When home consumption was valued at market prices, simple improvements in the management of existing animal resources resulted in increased average annual incomes of about US$ 213 and 207 for lowland and highland families respectively. These sums are equivalent to about two months of casual work at the normal rate of US$ 5/day and represent a large increase over the typical family annual income in the region of US$ 1,000-1,200. The increases do not tell the whole story, however, since they were used differently by the two distinct ethnic groups. Lowlanders used most of the additional product to increase their consumption of animal protein, in terms of both eggs and meat. The numbers of chickens slaughtered on a regular basis increased from two or three, up to four or more each month, while both duck meat and pork, usually reserved for family celebrations, figured more prominently on the family menu. It could be suggested that an improved diet in terms of both quantity and variety of animal protein would contribute not only to family satisfaction, but also to an improvement in health, although it was

beyond the scope of the project to attempt to quantify this. In contrast, the diets of highlanders suffered little change, since they sold most of the increased production, generally in order to invest, either in other productive enterprises on the farm, or in better health care or education facilities for members of the family. As a group, they are often prepared to forego increased present consumption and satisfaction in favour of future family welfare.

In neither group was there a tendency to increase the size of their holdings of small animals, since almost all of the increased production was either consumed or sold. As productivity of the existing animals increased, a few lowland families chose to experiment with new species, such as guinea pigs or sheep, although this was the exception, rather than the rule. No changes were noted amongst the immigrant families, either in terms of animal numbers or species.

During the course of several workshops conducted amongst farmers in the target area as part of project activities, participants claimed that improved productivity of small animal species made it less necessary for the males of the family to hunt in the surrounding forest in order to provide meat for the table. It was claimed that the stability of the farming enterprise was improved by better small animal production, since there was less competition for time between hunting and agricultural activities. More timely completion of land preparation, weed control and harvesting gives better crop yields and an improved standard of living. Although not formally measured as part of the project, this could be an important aspect of the improved productivity of small animal species. For years, it has been recognised that lack of capital and income has led to the sale of small farms and the movement of families further into the forest to start again (Thiele, 1991). These new settlements are usually beyond the reach of health and educational facilities, resulting in greater hardship and sacrifice. Improved stability of the small farm sector would reduce pressure on the remaining virgin forest and make it easier for the state to provide needed infrastructure (clinics, schools, roads, public utilities, etc.) to the residents at the forest margin.

Small animal species are almost exclusively managed by the women and children of the family. Increases in the availability of foods of animal origin in the family diet are immediately obvious and this tends to improve the social status of women and children, both in the family and in the wider community. In immigrant families, the women tend to sell all farm produce and to administer the income generated, but amongst the lowlanders, the men generally undertake most sales and purchases. The traditional viewpoint in the former group is that there is no income to be had from small animal species, so the men tend to ignore them, being content to leave their management to the women. At present, the sale of a small surplus provides the more marginalised members of the family with a modest income that they can dispose of as they see fit. It is not known if this will continue, but at the present time, it provides women and children with a measure of independence that has not previously existed.

Increased productivity from small animal species, which has previously been ignored by agricultural research and development bodies in the tropical regions of South America, has been shown to be easily achievable and this has attracted attention from local and national authorities and from foreign aid organisations. Demand for work with small animal species has spread into the drier areas of Bolivia and even into the Salta region of northern Argentina, where goats are an important species.

At the conclusion of the work, mindful of the limited reading ability of many of the target farmers, CIAT (International Centre for Tropical Agriculture) published (in Spanish) a series of three extension booklets on small animal production. These were based on illustrations and drawings, with a minimum of text, so that school-age children would be able to help their parents to understand the information presented. These booklets discussed the prevention and control of common diseases (Choque *et al*., 2002a), the construction of simple, rustic installations to protect the animals from predators and the elements (Choque *et al*., 2002b), and the use of commonly available feed resources (Lizárraga *et al*., 2002). These have recently been translated and their expected publication in English will enable them to be used in other parts of the developing world with similar conditions and production systems.

Conclusions

The implementation of simple, cheap, readily available recommendations for vaccination and parasite control and the provision of simple, rustic shelters, largely built from materials available on the farms, were shown to reduce losses of young animals and to increase the productivity and profitability of the holdings. This, in turn, increased the stability of the farming enterprises and reduced the need to hunt in the forest. In general, lowland families consumed more of the animal products, thus enjoying a better and more varied diet, while immigrant families tended to sell more produce to provide for an increased cash income. This was often treated as capital to be invested in other productive activities on the farm. Small animals are cared for almost exclusively by women and children and their social status was improved as a result of their increased contribution to family welfare.

The programme of research has attracted much attention, leading to requests for promotional work with small animal species in a number of other provinces of Bolivia and elsewhere. The possibility of an international impact cannot be ignored, since similar conditions and problems occur in neighbouring countries, particularly in Brazil, Argentina and Peru, as well as in parts of Africa and the Indian sub-continent.

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Discussions/questions/comments on the presentation

Comment: The East African community should attempt to learn from small stock farmers in Bolivia who are able to raise an income that is almost equivalent to the GDP of our countries.

Question: *Is cysticercosis a problem in humans in the area in which you have worked? Is tapeworm an important zoonotic hazard of the area?*

Answer: No, cysticercosis was not identified as a problem in pigs. But roundworm was a problem.

Question: *What indicators did you use to arrive at the conclusion that women had gained a higher status or that they had become more affluent in the community*

Answer: We used a sociologist who carried out an informal survey, but this fact is obvious to anyone visiting the community. Furthermore, in the Bolivian Highlands the women are the ones who do all the selling and administering of money. However, in the lowlands the men control the sale of goats while the women are responsible for growing and selling the crops, and looking after the funds generated by this activity. Women now have some financial independence.

Note: *The process of the engagement of the researcher with the resource-poor farmers is now being taken up as shown in the participatory nature of the project highlights in Bolivia. This is now a new trend that is encouraging the participation of the resource-poor farmers.*

Question: *You said that the small stock seek their own feed. Was this true for pigs as well?*

Answer: Yes, the pigs scavenge a lot – they eat fallen fruits. When we intervened and introduced supplementation the mortality rate fell markedly, but rose again when supplementation was withdrawn.

Clarification *It is important to note that the project aspect that is being replicated is the research approach and the process.*

Small stock and women in livestock production in the Teso Farming System region of Uganda[1]

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Abstract

A grass-roots study involving 205 households was conducted to assess the production and policy issues affecting women in livestock production in the Teso Farming System (TFS) in the Ugandan districts of Kaberamaido and Katakwi. Information from focus group discussions, key informant interviews and workshops indicated that 44 per cent of the households were female-headed and 56 per cent male-headed, although 17 per cent of married women claimed headship status. Small stock, especially goats and chickens, are owned by women, children and the landless while cattle, of higher economic value, are owned by men. Though women have the same authority as men to dispose of their goats, and more decision making powers over poultry, men dominated on decisions to dispose or sell cattle. Restocking programmes availed women an opportunity to enter the livestock production sector but they face many challenges. Livestock production is culturally male dominated, where men own a disproportionately large number of livestock, especially cattle, while women, who provide the main source of labour for all livestock production activities, as well as being the custodians of food security and family livelihoods, are denigrated to ownership of small stock only, with minimal benefits from livestock production accruing to them. There is gender bias against women leading to conflicts in livestock ownership and decision making, with women providing much of the labour needs yet lacking credit, which have influenced restocking/stocking. Women restock goats and chickens through self-purchase from income obtained from sale of crops and crop products such as beer. Small stock owned by women receive more attention than cattle, but use of indigenous knowledge underpins their management, resulting in low productivity and highlighting lack of knowledge and skills associated with modern management practices. While women felt more constrained by this lack of knowledge, men cited disease and rustling as major constraints. Small stock are, thus, an important livestock resource to women in the system due to their easy acquisition, adaptive characteristics and faster growth and reproductive rates. Women's acquisition of small stock from crop sales, ownership and authority over their sale is an important and viable entry level for them to become owners of cattle. However, gender sensitive policies are needed so that there is a reduction in the continued male dominance over the livestock sector through policy initiatives, and to ensure that research, extension, credit services and other facilities are equally accessible to women and men. Women in the TFS region should be empowered to have equal access and ownership of land and all livestock species, both indigenous and improved, with full back-up of essential services,

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to allow them to move from subsistence to commercial livestock production with access to national, regional and global markets for their livestock and livestock products.

Key words: Gender, goats, chickens, policies, and technologies

Introduction

The Teso Farming System (TFS) region comprises the semi-arid north-eastern districts of Soroti, Katakwi, Kumi, Kaberamaido and parts of Pallisa. The system is agro-pastoral with rural communities heavily dependent for their livelihoods on subsistence mixed annual cropping and livestock production. It is a unique system, principally due to the characteristic predominance of ox-cultivation favoured by the existing gently undulating topography (Awa *et al.,* 1999). The crop-livestock interaction gives an important synergism as animals provide draught power for land tillage and manure for crop production, while crop residues and stovers are consumed by the livestock. However, in the 1980s, rustling drastically reduced livestock numbers in the region, lowering livelihoods to disabling levels. Small stock, especially goats, pigs and chickens, barely survived while cattle were totally lost. With the depleted livestock numbers, restocking was essential and was introduced by government when security was restored. Restocking programmes availed women, who are the key actors and custodians of food security and family livelihoods in the region, an important opportunity to enter the livestock production sector. However, women faced many challenges in the restocking process because livestock production is a culturally male dominated sector, where men own a disproportionately large number of the livestock, especially cattle. Although women provide the main source of labour for all livestock production activities, they own few animals and these are mostly small stock. As a result, only minimal benefits from livestock production accrue to them. In spite of this, small stock keeping and ownership by women is an important socio-economic activity. Women are able to acquire small stock through the sale of crop produce and locally made beer, the cash raised allowing them to make their initial purchases or restock. Small stock rapidly multiply and the sale of 4-5 chickens will buy a goat, the sale or exchange of 5-6 goats will acquire a cow. Goats and chickens can thus lead to wealth accumulation through the acquisition of cattle. Goats and chickens are also highly valued in customary marriages and various socio-cultural functions (Okello and Obwolo, 1984).

This study aims at assessing and documenting production and policy issues affecting women in livestock production in the TFS. The skills, roles, constraints, challenges and opportunities women face in livestock production are documented, as a basis for formulating appropriate recommendations for interventions towards improving the role and productivity of women in the livestock sector. This paper is a synthesis of the production and policy issues as they relate to the role of women in livestock production from small stock.

Materials and methods

A grass-roots needs assessment study was conducted in Kaberamaido and Katakwi Districts during the period of December 2001 to March 2003. Using semi-structured questionnaires, a survey was conducted across 205 households randomly selected from the rural areas. Focus group discussions, key informant interviews and workshops were also conducted. The information collected included household bio-data, production resources, livestock ownership, roles and skills, constraints and challenges in livestock production across gender categories and the role of women in the restocking process.

Data were compiled and analyzed using an SPSS package. Comparisons were made based on differences by sex, age and gender categories using frequency distributions, percentages, and correlations in relation to the roles, skills, challenges and opportunities open to women in livestock production.

Results and discussion

Out of 205 households surveyed, 44 per cent were female-headed while 56 per cent were male-headed, although 17 per cent of married women assumed that they had headship status as their husbands were not providing for household needs as was expected of them.

Gender roles in livestock production and importance of small stock in rural livelihoods

This study has shown that, although men generally dominated in most activities, women participated in all livestock management activities and dominated in tethering, kraal cleaning and watering of animals (Figure 1). An important aspect was that children who were a major source of labour in all livestock management activities, prior to the introduction of universal primary education (UPE), now make a limited contribution. This has led to labour shortages, leading to the hiring of labour with the result of increasing production costs (Figure 1). The hitherto strong relationships known to exist between women, children and small stock, have been lost and shifted the labour burden of managing small stock to women. This finding agrees with the findings of similar studies on women in livestock production in many Saharan countries where women have been largely relegated to the ownership of small stock, tillage of land and provision of labour with minimal benefits accruing to them. In Ethiopia, over 60 per cent of families kept chickens with women being the major owners and managers and controlling the limited cash income from sales (Dessie and Ogle, 2001). On Ghanaian small family farms, women are major tillers of land (Acheampong, 1992). In Nigeria, 77, 73, 25, and 19 per cent of the women were involved in chicken, goat, duck, and sheep production, respectively, and their main activities were pen cleaning (89 per cent) and feeding (83 per cent) (Oji and Ekumankama, 2002).

Indigenous small stock, especially goats and chickens, are much better adapted to local conditions than exotic stock, and require far fewer inputs for survival (Lebbie, 2004). Small stock provide an important resource for women, landless and the resource-poor being, cheaper to acquire, and require little labour, space and feed. Small stock provide a readily available source of protein from meat, eggs and milk (Devendra and Chantalakhana, 2002). While poultry production was found to be an income generating activity, predominantly run by women in Zimbabwe (McAinsh *et. al.,* 2004a), goat production is most popular in Nigeria due to the popularity of the meat (Shoremi and Wodi, 1997). Goats thus play a significant role in the food chain and overall livelihoods of rural households where they are largely the property of women and their children (Lebbie, 2004). Increased restocking/stocking of small stock could act as an important economic and social activity for women and children. Increased consumption of livestock products would improve the nutritional status of women and children, as well as HIV/AIDS sufferers, possibly being a factor in prolonging their lives (Ayele and Peacock, 2003).

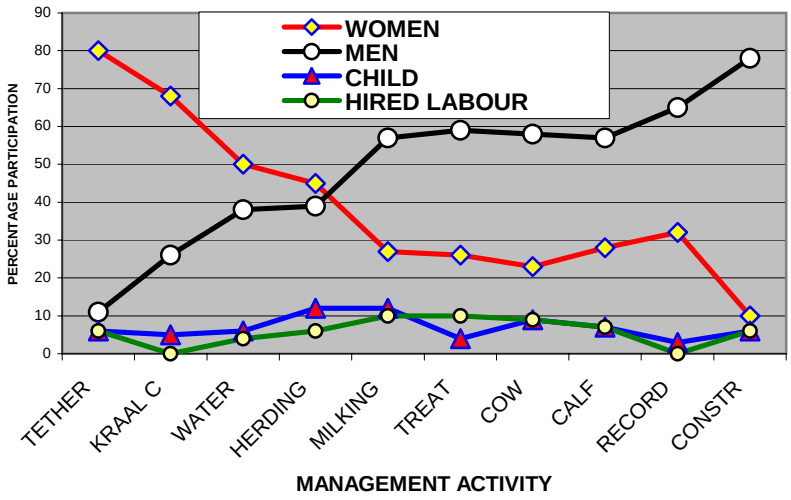

Figure 1 *Gender roles in livestock production activities*

Ownership, control and access to production resources and benefits from livestock

The study shows gender disparities in livestock ownership, with women owning only 14, 21, 22, and 20 per cent, and men 62, 52, 39 and 48.5 per cent of cattle, goats, poultry and pigs, respectively (Figure 2). Women own fewer cattle but relatively more small stock than men. Children are more associated with small stock while joint ownership of all livestock species is a significant feature. Similar findings have been reported in the Gambia, where women own 67 per cent of goats and 52 per cent of sheep (Jaitner, *et al.,* 2001). Another study also showed that women play an important role as keepers of small stock, sustainers of household food security and in improving health and livelihoods of families, although they faced more difficulties than men in gaining access to resources such as land, credit and other productivity enhancing inputs and services (Sinn *et al.,* 1999).

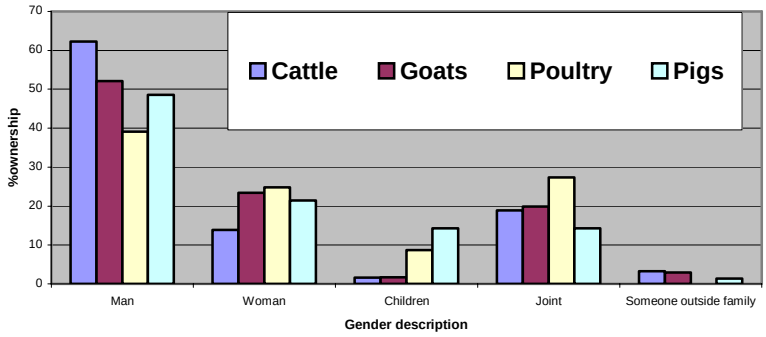

Figure 2 *Gender livestock ownership pattern in at household level in the Teso Farming System region*

In male headed households, men dominate and control the decision making to dispose of all types of livestock and livestock products, except for goats, chickens, eggs and milk

where a joint decision is made between man and woman (Table 1). In the majority of female-headed households, women play a key role in the disposal of all livestock species and their products. However, in 32 per cent of female-headed households, men still wield much control over disposal of cattle compared to only 3 per cent of women who have the same control among the male-headed households.

In the majority male-headed households, men play a dominant role in controlling the decision over the use of benefits from livestock and livestock products, while in female headed households domination is shared between men and women (Table 2). However, in 23 per cent of the female headed households, males control decision making over the use of benefits from livestock and its products for home consumption, compared to 4 per cent of the male-headed households where women are in control. This indicates that men have a disproportionate control over access to livestock resources and benefits. Joint decisions to dispose of livestock and livestock products are more evident in male headed households than in female-headed households. Children generally play a greater role in decisions to dispose of livestock and livestock products in female-headed households compared to male-headed households. In Tanzania, women were up to 57 per cent of the agricultural labour force, and were involved with looking after cattle, pigs, goats, sheep, rabbits and poultry as well as their domestic responsibilities, but a majority of the benefits from their labour accrued to the men in the household (Tesha, 1999). In summary, women are usually relegated to ownership and control of the relatively low value small stock while being denied ownership, access and control over large stock, land and other production resources and services which are the domain of men.

Table 1 *Control over disposal of livestock and livestock products in female and male-headed households*

	Male headed households (%)				Female headed households (%)			
Livestock	Men	Women	Joint	Children	Men	Women	Joint	Children
Cattle	59	3	38	0	32	50	14	4
Goats	47	9	44	0	15	55	18	12
Poultry	35	14	45	6	9	62	22	7
Pigs	49	9	38	4	6	53	18	23
Milk	46.	8	46	0	5	74	16	5
Eggs	33	25	40	2	4	65	20	11
Meat	52	4	43	1	13	61	22	4
Hides/ skins	64	2	33	1	11	66	17	6
Draught power	62	5	33	0	31	46	15	8

Table 2 *Control over use of benefits of livestock and livestock products for consumption in male and female headed households*

	Male Headed households (%)				Female Headed households (%)			
	Men	Women	Joint	Children	Men	Women	Joint	Children
Cattle	52	4	44	0	23	55	23	0
Goats	42	9	48	1	17	52	19	12
Poultry	35	11	51	4	5	65	15	15
Pigs	33	15	45	7	4	59	30	7
Milk	34	14	51	1	6	61	22	11
Eggs	30	23	46	1	6	76	12	6
Meat	54	5	41	0	13	73	7	7
Hides/ skins	50	3	46	1	12	69	13	6
Draught power	54	6	40	0	33	57	0	11

Constraints and challenges to women in livestock production - restocking and diseases

In restocking and stocking for livestock production, challenges due to natural forces, such as disease incidence and prolonged periods of drought, and insecurity, were common to both female and male livestock farmers and tended to affect them similarly (Figure 3). The majority of women reported conflict in ownership and control of benefits from livestock, especially cattle, as the most common challenge. The major constraints to livestock production included poor access to extension services, disease prevalence and lack of improved livestock breeds. The greatest concern of men was the prevalence of animal disease, which reduces animal productivity and increases the cost of animal rearing. In a similar study in Western Kenya, women involved in goat production cited constraints such as taboos on eating goat meat and the traditional dominance of livestock husbandry by men (Noble and Nolan, 1982). Other studies have shown constraints due to disease prevalence (87 per cent), culture (67 per cent), capital (29 per cent) and religious beliefs (27 per cent) (Shoremi and Wodi, 1997). Recommendations on the use of a unified extension service and the intensification of extension activities for delivery of information on livestock production technologies to women have been advocated (Shoremi and Wodi, 1997).

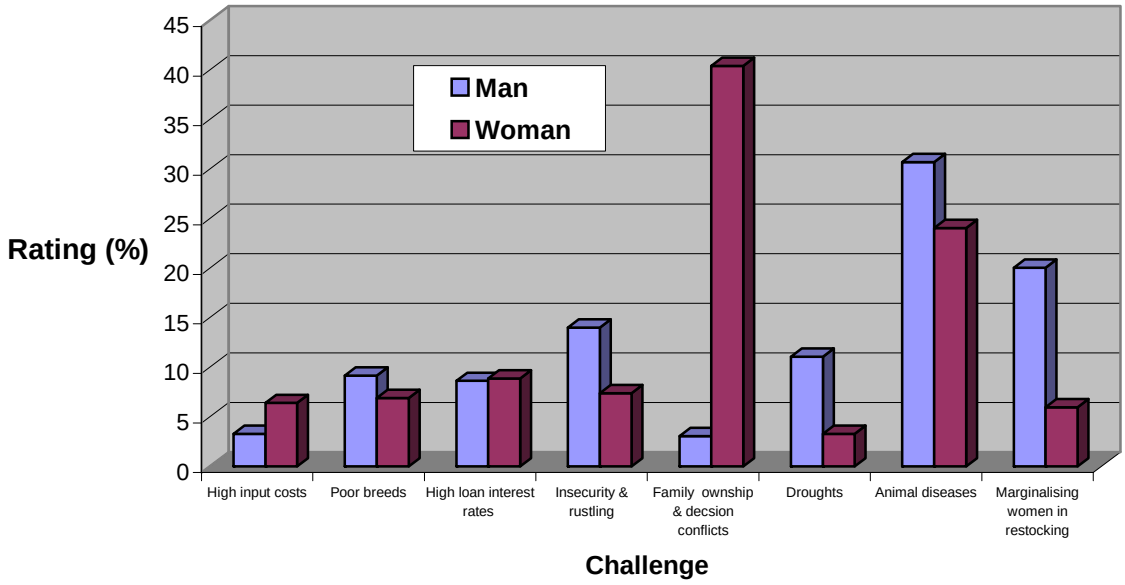

Figure 3 *Restocking and stocking challenges as perceived by gender*

Research and extension services and credit and market facilities

Women felt more constrained by lack of knowledge and skills in modern livestock production practices and access to improved breeds, and, therefore, resorted to use of indigenous knowledge in their management of livestock, thus undermining potential improvements in livestock productivity. In Nigeria, a survey showed that although women participated extensively in agricultural tasks and livestock rearing, agricultural extension agents did not address delivery of services to women. Home economics extension agents were too few and not competent to teach women agricultural technical skills (Olayiwole, 1984). The TFS region has a good opportunity to access developed technologies for improving the productivity of indigenous cattle, goats and chicken, generated at the Serere Agricultural and Animal Production Research Institute (SAARI) (e.g. NARO, 2000). The National Agricultural Advisory Services (NAADS) is operational in the TFS region and is responsible for packaging these technologies, and devising an efficient delivery system to farmers. The role of National Agricultural Research Organisation (NARO) and NAADS is crucial in the implementation of dissemination of livestock technologies to women. Goat rearing is now largely seen as an appropriate intervention in capital scarce situations and contributes significantly to household income (Saadullah, *et al.*, 1997). In several countries, including Indonesia, Sumatra, Bolivia, Kenya and Peru, an increase in the welfare of rural poor families was achieved through their involvement in small stock production, combining provision of appropriate production technologies and improved goats. Training women in goat management and cross-breeding the East African and Anglo-Nubian breeds led to increased animal numbers and performance. Small ruminants have been found to be largely under the control of women, either through production or marketing, thus contributing to in-kind consumption or, as liquid assets, to household welfare (Valdivia, 2001). Formal knowledge about traditional free-range chicken production in tropical countries is increasing, but is still limited, although production has shown it to be a very important income generating activity, predominantly run by women. McAinsh *et al.* (2004b) found

that women owned most chicken flocks and that income generated from chicken production was spent to improve nutrition, health and education of the family.

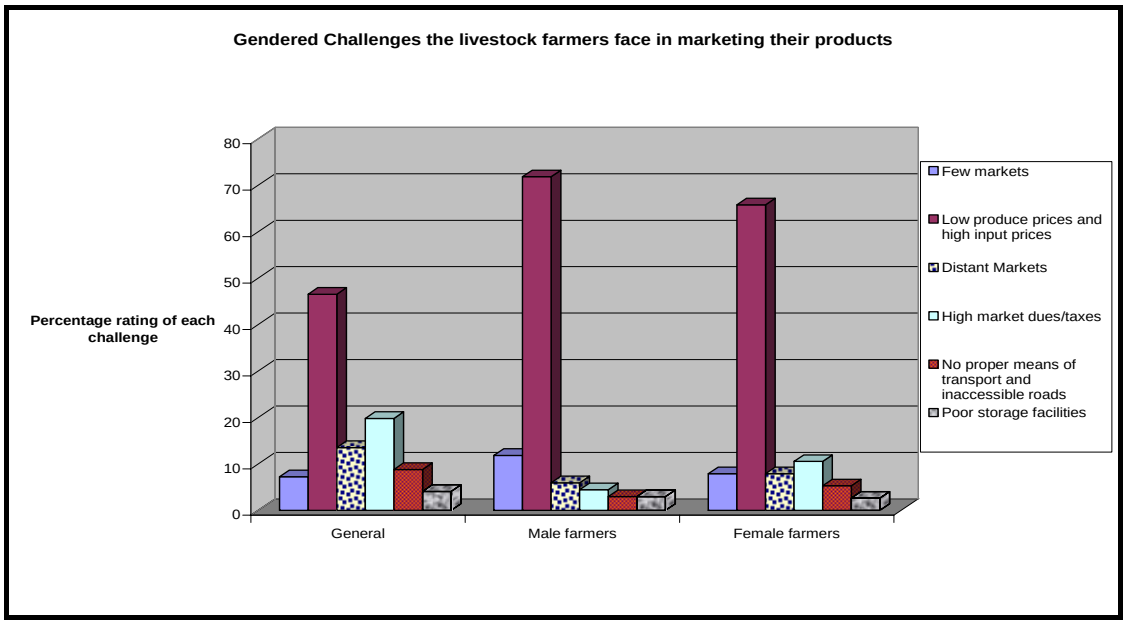

Figure 4 *A gender perception of the marketing challenges faced by farmers in the Teso Farming System region*

Livestock farmers in the TFS face a number of marketing challenges, the greatest being that of low output and high input prices as perceived by 70 per cent of men and 65 per cent of women (Figure 4). High market dues constituted the second key marketing challenge. Others included few and distant markets, lack of good transport and poor storage facilities (Figure 4). Most of these factors interact and have been observed in case studies where development projects used group or community approaches to disseminate and apply new technologies. Internal processes are crucial in understanding technology transfer where an individual's ability to access and manage information is crucial. Often meeting a group that has previously been exposed to a technology and sharing their experiences, helps resolve perceived difficulties (de Haan, 2001). Such approaches, in Pakistan, popularized poultry farming as a supplementary source of income for women after they received appropriate training. The women's training programme led to a reduction in chick mortality, increased poultry meat and egg production and improved marketing, possibly due to existing marketing facilities being better utilised than previously (Bhatti, 1991). An understanding of the specific role of livestock, competition from other farm enterprises and the risks faced by families in rural areas are necessary prerequisites to increasing participation of women in livestock production (Valdivia, 2001).

In general, improving livelihoods requires that the role of livestock is seen as a major part of development, and extension of new technology is essential if the potential of this sector is to be realised (Devendra and Chantalakhana, 2002). Small animals (goats, sheep, chickens, pigs and ducks) are particularly important for nutritional and household security; improvement in production can make a significant contribution to improved human welfare, rural sector growth and in reducing poverty. Towards the achievement of this, more investment is needed in agricultural research and development coupled with application of participatory and interdisciplinary approaches, effective public and private sector partnerships, and commitment to purpose (Devendra and Chantalakhana, 2002).

Conclusion

The status of women in the TFS region indicates that they play a major role in livestock production and participate in all its associated activities. However, men dominate ownership of cattle while women own the low-value small stock, such as goats, pigs and chickens, to which they have reasonable authority over disposal. Because of this, women provide more detailed management to small stock compared to cattle. The lack of cattle ownership and equal access to land and other production resources have made women poor and socio-economically insecure. Small stock, especially goats and chickens, are a major livestock resource for women, children and landless livestock keepers. Small stock are suited to the resource-poor smallholder system due to their high growth and reproductive rates and adaptive characteristics to high ambient temperatures, feed and water scarcity and disease tolerance. However, streamlining is required in the restocking process to enable women to have equal access to production resources, extension, education and other services to gain skills on modern livestock production technologies. Women should be sensitised, and empowered to demand the provision of essential services, such as access to, and use of, improved animal breeds and breeding practices. The opportunities offered by small stock in the provision of protein-rich food and income for resource-poor and vulnerable groups, such as families affected by HIV/AIDS, should be strengthened. Women should be enabled to have access to diverse national, regional and global markets for both livestock and produce. Targeting gender insensitive policies is an important pre-requisite for policy makers and implementers in order for women to effectively contribute to the livestock sector and move from subsistence to market-oriented production. This is achievable by reducing continued male dominance, sensitising development partners, in both the public and private sector, including non-governmental organisations, to be more effective and gender balanced in offering extension, education, other services, credit and savings facilities, at reasonable interest rates, to women involved in livestock production.

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Discussions/questions/comments on the presentation

Questions: *Did you categorise the age group of the children in your studies?*

Answer: No, there was no categorisation of the children's age group.

Question: *How do you define a 'female headed household' in a patriarchal society where normally the man is the head of the household?*

Answer: In most cases, the man is polygamous and has several wives. In this situation the women assume the responsibilities for running the household.

The use of recommendation domains and GIS as a tool in out-scaling livestock technologies for resource-poor livestock keepers

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Abstract

Dissemination of information about agricultural and livestock technologies to farmers and intermediary organisations has tended not to be very effective. One reasons for this is weak identification of the number and spatial location of potential users of any particular technology; as a result of which dissemination initiatives have sometimes lacked focus and been somewhat 'scattergun' in nature. A more refined and detailed approach to identifying potential users and where they are concentrated geographically would enable a more focused approach to be taken to dissemination. This paper describes how the 'Recommendation Domain' (RD), a tool developed by farming systems research, can be used for this purpose, in conjunction with computer-based geographical information systems (GIS). In Phase 1 of the research preliminary estimates were made of the potential number of users, with reference to case studies of three goat technologies, two developed in India and one in Kenya.

In Phase 2 computer-based GIS was used in analysing the geographical distribution of potential users of a fourth livestock technology in the state of Karnataka, India, with a view to identifying priority districts for dissemination efforts. The estimates from the three cases analysed in Phase 1 of this research strongly suggest that the RDs for certain technologies developed for, and with, resource-poor households can be large, i.e. more than one hundred thousand households. The Phase 2 study identified five priority districts. It showed that the recommendation domain tool, combined with computer-based GIS, is well-suited to this purpose. The GIS enables mapping and spatial analysis of the distribution of variables, makes direct comparisons between factors easy and allows visualisation of results to better communicate and disseminate outputs. It would, however, be preferable to use a smaller administrative unit than the district, as there can be significant heterogeneity within a district with respect to one or more variables.

Introduction

Dissemination of information about agricultural and livestock technologies to farmers and intermediary organisations has tended not to be very effective. There are various reasons for this, of which a major one has been inadequate resources. Other reasons include weak identification of the number and spatial location of potential users of any particular technology; as a result of which dissemination initiatives have sometimes lacked focus and been somewhat 'scattergun' in nature. A more refined and detailed approach to identifying potential users and where they are concentrated geographically would enable a more focused approach to be taken to dissemination.

The recommendation domain (RD) is a tool that can be used in developing a technology dissemination strategy. The concept and tool of the RD was developed in the 1970s and used by the Farming Systems Research and Extension (FSRE) community (Harrington and Tripp, 1984; Perrin *et al.*, 1976; Tripp, 1986). Recommendation domains were developed and used for two inter-related purposes. Firstly, at the initial stages of planning research, RDs were advocated to assist with allocating scarce research resources. Planning may have included deciding on research for a particular commodity or technical issue, or identifying the geographical mandate area of a particular research project, programme or institute. The RDs identified at the planning stage are necessarily tentative, and should be regarded as such until a specific technical recommendation has been made. The second use of RDs, which is the one on which this paper focuses, is as a means of enabling relative precision in targeting those farmers or livestock keepers for whom a particular technology, once it is developed, is likely to be appropriate and adoptable. In some ways this is similar to market research on potential buyers or users of a product.

When FSRE went out of fashion in the 1990s, the use of RDs declined, but continued at a reduced level in various national agricultural research institutes and CGIAR centres. Recommendation domains appear not to have been used much in national livestock research institutes, although the International Livestock Research Institute (ILRI) has been doing some related work. However, in recent years the potential for combining them with computer-based Geographical Information Systems (GIS), which are increasingly widely used in less developed countries in numerous applications, has stimulated renewed interest in their use.

It is now being recognised that computerised GIS can be used to facilitate the processing, and enhance the presentation, of information related to RDs. For example, it has been noted that "tools such as computational modelling and applications of geographical information systems, in combination with participatory methods, offer opportunities for pinpointing new geographical areas for scaling-up" research findings from natural resources research (Gündel *et al.*, 2001). Computer-based GIS was used in the second stage of this research.

Materials and methods

The principal method used was the RD, which has been defined as "a group of farmers [who] have similar circumstances, resources, problems, and, [hence], solutions to these problems" (Norman *et al.*, 1995). The phase 1 study on which this paper is based (Conroy and Sutherland, 2004) looked at the potential numbers of adopters for three technologies that had been developed and tested through a process of participatory research and had been well-received by resource-poor people. All three of the technologies are goat-related, and two of them were developed by a project in India funded by the Department for International Development, UK, (DFID) through the Livestock Production Programme (R6953).

A phase 2 study (Hoppenbrouwers, 2004) used GIS to identify the RD for a fourth technology (use of *Prosopis juliflora* pods as a feed supplement for female goats around the time of kidding, to reduce kid mortality) in the Indian state of Karnataka. The software used was *ArcGIS*, produced by ESRI, which can be run on a standard personal computer. (See Table 1 for a brief description of the technologies and the constraints they addressed.)

Table 1 *Goat constraints and technologies covered by the research*

Constraint	Technology developed for use by resource-poor livestock keepers
High kid mortality in the rainy season (due to gastro-intestinal parasites)	1. Drenching with trichomes (hairs) of *Mucuna pruriens* pods and sugar
Sarcoptic mange	2. Tamarind fruit and crushed roast castor seed mixed in paste in equal proportions
Low conception rates in dry season (due to feed scarcity)	3. 250 grams/day of *Prosopis juliflora* pods for 10 weeks as a supplement
High kid mortality in the rainy season (due to gastro-intestinal parasites)	4. Supplement of *Prosopis juliflora* pods (250 g/day) in last month of pregnancy and first after kidding

Four factors that may determine the size of the recommendation domain for targeting the dissemination of a successful technology are:

1. How widespread the production constraint or opportunity is
2. The number of households involved in producing the relevant commodity (in this case goats) or with a similar problem (e.g. soil erosion)
3. The resources (land, labour and money) available to the farmer or livestock keeping household producing the commodity
4. The likely availability of the inputs needed (in the case of technologies based on locally available materials, the geographical distribution of the local material).

Information about these four factors was obtained through a combination of primary (e.g. project surveys) and secondary (e.g. census data, other project's reports and scientific papers) sources. Further details for each phase of the research are given below.

Phase 1: Determining the size of recommendation domains for livestock technologies

Phase 1 considered three technologies (numbers 1, 2 and 3 in Table 1) developed with goat keepers that have been shown, through *in situ* participatory trials (including on-farm and landless farmers), to be effective in addressing priority constraints in a particular location. They are drawn from two applied research projects with which two of the authors were involved, one in India and the other in Kenya, details of which are given in Table 2.

Table 2 *Two case study projects, one in Kenya and one in India*

	Kenya	**India**
Project title	Dry land Applied Research and Extension Project	Easing Seasonal Feed Scarcity for Goats, through a Process of Participatory Research
Locations	Mbeere, Tharaka-Nithi and Central Isiolo Districts	Five districts, including Bhilwara (Rajasthan) and Dharwad (Karnataka)
Country	Kenya	India
Principal Agencies involved	1. Kenya Agriculture Research Institute, Regional Research Centre – Embu. 2. Department of Extension (Veterinary Officer). 3. Natural Resources Institute	1. BAIF Development Research Institute 2. Natural Resources Institute
Donor	DFID's Natural Resources Systems Programme	DFID's Livestock Production Programme
Duration	1993-1997	1997-2002

Dryland Applied Research and Extension Project

The Dry land Applied Research and Extension Project (DAREP) covered approximately 70,000 smallholder farming families in semi-arid areas of Embu, Tharaka-Nithi and Central Isiolo Districts in Kenya. During implementation, DAREP followed a process of farming systems characterisation, diagnosis of priority constraints, trial planning, technology testing, evaluation and extension and dissemination. These were undertaken with farmers and in close collaboration with extension workers. The project framework had a pre-defined target group (resource-poor farmers) and target area (the semi-arid parts of three districts).

BAIF/Natural Resources Institute (UK) (NRI) Goat Research Project

BAIF Development Research Foundation (India), a rural development non-governmental organisation (NGO), and NRI jointly managed a research project to identify and address feed-related constraints affecting goat production in semi-arid India. The project worked in various regions, including South Rajasthan and Dharwad District, Karnataka, primarily with resource-poor people, who either had small/marginal farms or were landless. It aimed to develop technologies to ease or remove the constraints identified, through a process of participatory technology development (PTD).

Tables 3-5 describe three of the constraints identified by the two projects, and the three technologies that were developed to address these constraints. In Case 1 a locally available anthelmintic material was as effective as a commercial veterinary product in reducing mortality in young goats, and in accelerating their growth. In Case 2, a concoction of two locally available materials was as effective as a commercial drug in treating sarcoptic mange in goats. In Case 3, the use of tree pods as a supplement during a period of feed scarcity significantly increased kidding rates (numbers of kids produced) in goats, mainly by increasing the percentage of does that conceived, but also by increasing the incidence of twins.

The cases described have a common technical focus on the use of locally available natural products, two of them as an alternative option to pharmaceuticals. This focus

was thought to be justified based on a diagnosis of the main socio-economic constraints surrounding the technical problems identified. These included insufficient cash resources for purchase of veterinary products, and general unavailability of such products in the small quantities used by resource-poor households. In the three cases analysed, all of the plant and tree species tend to be found on common lands where there is open access. Their only cost was the labour needed to collect and process them. The cash outlay required for commercial products was seen by the participating livestock keepers as more of a constraint than the labour requirements of the locally occurring products, which were quite small.

The Phase 2 Study

The Phase 2 study (Hoppenbrouwers, 2004) sought to identify districts in the state of Karnataka that should be given the highest priority in promoting one of the technologies developed by the BAIF/NRI research project. The technology (number 4 in Table 1) was the use of *Prosopis juliflora* pods as a supplement for does around the time of kidding, to reduce kid mortality.

The information sources are summarised in Table 6. It was envisaged that data on the distribution of the constraint would be obtained through a survey of livestock keepers in at least one third of the districts of Karnataka. However, it was decided not to implement the survey when it was realised that it could not be completed in time for its results to be included in the study. The study used human census and livestock census data to find districts in Karnataka with a high average number of goats per household (factor 1); a high proportion of Green Cardholders (used as an indicator of levels of poverty, green cards are issued to identify those regarded as living in poverty) (factor 3); and temperature, rainfall and altitude data to determine the districts with suitable environmental conditions (Dagar, 1998) for *Prosopis juliflora* (factor 4). The recommendation domain was determined as districts where all these factors were present.

Table 3 *Description of Case 1 and information used to estimate the recommendation domain*

Production constraint	*High kid mortality in the rainy season due to gastrointestinal parasites in does and their kids*	
Main sources of information	Conroy and Thakur, 2002; Conroy *et al.,* 2002; Thakur *et al*., 2002	
Recommended technology	Drenching with trichomes of *Mucuna pruriens* pods and jaggery (sugar)	Drenching with *Fenbendazole*
Initial location	Dharwad district, Karnataka, India	
1. How widespread is constraint in original project location and country?	Project surveys only covered 6 villages in 2 locations about 70 kms apart. There is a need for further analysis based on surveys, talking to key informants, analysis of secondary information etc. (Also see point 6 below.) The level of annual rainfall may have a strong influence on the importance of the constraint. Variations in the timing of the principal kidding season may also determine whether the constraint exists in particular areas or groups of livestock keepers, i.e. where few kids are born during the rainy season there may not be a mortality problem.	
2. How widespread is the commodity (goats)?	A survey in 1997 found that there were 64,639 goats in Dharwad district; and there were 3,838,000 in Karnataka in 1990 (livestock census). A project survey suggests that average herd size in the project villages is 4-5. There are about 120 million goats in India, which are kept by about 12-30 million families.	
3. Farmer resources required for adoption	This technology does not require private land or cash. The only resource involved in its utilisation is the labour to harvest and process the pods. This is very little. The pods occur in bunches and only 4-5 bunches are needed to meet the requirements of goat keepers with small herds. In Karnataka, pods are harvested in late February and in March.	This technology requires cash. The price of purchasing enough of the drug to treat one animal would be Rs 6 (14 US cents) for a goat weighing 20 kg (3 rupees per dose). The market for drugs to control the helminths of sheep and goats is relatively small, which suggests that price is a serious deterrent.
4 (a) Availability and (b) accessibility of raw materials in project country	(a) *Mucuna pruriens* may only be found in particular agro-ecological zones, (e.g. within a certain range of annual rainfall, perhaps 600-1500 mm. p.a.). Data on its distribution are lacking, but it is known to be present in parts of Orissa, and Rajasthan, as well as Karnataka. (b) In India *M. pruriens* is commonly found growing uncultivated by roadsides, in forest areas and on private land, making it accessible to everyone in these areas. It would not be accessible outside of areas where it grows, unless the material could be *purchased* at low cost by goat keepers in such areas.	(a) *Fenbendazole* is produced by numerous companies and is widely distributed in major rural centres in India. It tends not to be available in relatively remote areas. (b) At these centres it is accessible to anyone who can afford to purchase it commercially (see below).
5. Any evidence of its adaptability?	The technology is used by buffalo keepers, which gave researchers the idea of using it on goats. It could, therefore, be effective in deworming large ruminants, with appropriate modifications to dose rates.	*Fenbendazole* has a broad spectrum of activity in cattle, buffalo and sheep as well as goats (www.vetcareindia.com).
6. Any evidence of relevance outside district, state or country of origin? (a) constraint (b) technology	(a) Nematode infestations of does and their kids are "one of the main causes of death among kids" in the tropics (Peacock, 1996). (b) *M. pruriens* is also found in Mexico, the Caribbean and Nigeria (Kiff, Pound and Holdsworth, 1996).	(a) Nematode infestations of does and their kids are "one of the main causes of death among kids" in the tropics (Peacock, 1996). (b) Fenbendazole is used in many tropical countries.

Table 4 *Description of Case 2 and Information Used to Estimate Recommendation Domains*

Production constraint	Sarcoptic mange in goats	
Main sources of information	Sutherland and Kang'ara, 2000	
Recommended technology	Tamarind fruit paste mixed with oily paste of crushed roasted castor oil seed in equal quantities – applied weekly for four weeks.	Ivermectin, an injectable drug that is commercially available. Injection is repeated 7 days after the initial dose: each dose is 1 ml.
Initial location	Tharaka-Nithi and Mbeere Districts, Kenya	
1. How widespread is constraint in original project location and country?	Project survey found that mange is the second most important cause of mortality in goats in the districts. The survey covered four sub-locations in Tharaka district and four in Mbeere district. Mange occurs in most arid and semi-arid lands (ASAL) of Kenya, including Kajiado, Kitui, Makueni, Machakos, Mwingi and Narok.	
2. How widespread is the commodity (Goats)?	At least 75% of the 50,000 households in the project districts, and in other mange-endemic areas, keep goats. There are c. 344,195 goats in the project districts, so average herd size is about 9. There are about 10 million goats in Kenya. About 20 % of Kenya's human population of 31 million live in ASAL areas, and about 80% of meat goats are found in ASAL areas.	
3. Farmer resources required for adoption	This technology does not require land or cash, unless the fruit is purchased. The only resource required to utilise it is the labour required to harvest and process the raw materials. Nevertheless, it would be important to check whether the harvesting time coincides with a seasonal labour peak.	Ivermectin is "quite expensive" (Peacock, 1996). In the project area, a 50 ml bottle of Ivomec cost about Ksh 5000 (equivalent to US$ 62), and was enough to treat 25 mature goats. A farmer would have had to sell 4-6 healthy goats to save 25 sick goats, which was not seen as attractive, and it was difficult to sell a goat from a sick flock even if it was healthy.
4 (a) Availability and (b) accessibility of raw materials in project country	(a) *Tamarindus indica* is quite widespread in the villages where the trials were conducted, and in much of semi-arid Kenya. It was less common in a second area, Gategi, leading livestock keepers to plant it there. The fruit is also sold in local markets, where it is cheap in season. Castor (*Ricinus comunis*) is also widespread. (b) Both ingredients are reasonably accessible (even to resource-poor people), particularly castor, which has become a weed in some places.	(a) Ivermectin is available in towns in the project districts, under the trade name Ivomec®. (b) At these centres Ivomec is accessible to anyone who is prepared to purchase it commercially (see below).
5. Any evidence of technology's adaptability?	Sheep and calves were also infected with mange, and were treated effectively by the project.	The technology is effective in treating other ruminants.
6. Any evidence of technology's relevance outside district or country of origin? (a) constraint (b) technology	(a) Sarcoptic mange is by far the most important mange of goats in the tropics, and in some systems it can be the most important cause of death (Peacock, 1996). 10% of Kenya's ASAL area is mange-endemic. (b) *Tamarindus indica* is found in many semi-arid regions of sub-Saharan Africa and India. Castor grows in a very wide range of environments in the tropics (Peacock, 1996).	(a) Sarcoptic mange is by far the most important mange of goats in the tropics, and in some systems it can be the most important cause of death (Peacock, 1996). 10% of Kenya's ASAL area is mange-endemic. (b) Ivermectin is used in many tropical countries.

Table 5 *Description of Case 3 and Information Used to Estimate Recommendation Domain*

Production constraint	Low conception rates in goats in the dry season (February-June inclusive)
Main source of information	Conroy *et al.* (2002)
Recommended technology	Supplementation with 250 g/day of *Prosopis juliflora* pods for 10 weeks around the desired time of breeding
Initial location	Bhilwara District, Rajasthan, India
1. How widespread is constraint in original project location and country?	*Bhilwara district* is semi-arid, with a mean annual rainfall of 700 mm. A Project survey, covering 6 villages in the district, identified feed scarcity as a constraint in all of them. In 5 villages feed scarcity in the dry season was specified, and in some June was identified as the worst month. The latter part of the dry season is the preferred breeding season, as kids are then born after the rainy season, when there is less disease but plenty of forage. Trials in 4 villages all resulted in higher conception rates. *Other districts* In similar surveys, in villages in three other semi-arid districts (one each in Rajasthan, Gujarat and Karnataka), goat keepers also identified this constraint as a serious one. However, in another district (in Madhya Pradesh) it was not seen as a constraint. *General observation* The surveys suggest that feed scarcity in the dry season is a constraint where access to browsable material on private lands and common lands near the village is limited, i.e. there is a lack of forests and/or shrubs to which goat keepers have usufructary rights. It may also decrease in importance as mean annual rainfall increases. Seasonal migration may overcome the problem, but this is only practised by a minority of agropastoralists, mainly ones who have large flocks/herds of small ruminants. It is not known how widespread the preference for breeding in the dry season is. More villages need to be surveyed and secondary data analysed to answer this question.
2. How widespread is the commodity (goats)?	In 1997, there were about 16.9 million goats in Rajasthan and 700,000 in Bhilwara (livestock census). Average herd size, excluding kids, is about 10 (Sagar and Ahuja, 1993), so number of households owning goats may be about 1.7 million and 70,000 for the state and district respectively. There are 120 million goats in India as a whole (livestock census), kept by about 12-30 million households (author's guesstimate). It is not known what proportion live in areas where *P. juliflora* is found, but goat ownership does tend to be higher in dry land regions.
3. Farmer resources required for adoption	This technology does not require land or cash. The only resource required to utilise it is the labour needed to harvest and process the pods. Nevertheless, it would be important to check whether the harvesting time coincides with a seasonal labour peak. If it does, this could deter people from using the technology. In Bhilwara district, harvesting occurs when demand for labour is low.
4 (a) Availability and (b) accessibility of raw materials in project country	(a) *Prosopis juliflora* is the most dominant and widespread tree species in India's arid and semi-arid regions, supplying 75% of fuel wood needs in these regions (Tewari *et al.*, 2000). It is also widespread in sub-humid regions. In four states of India (Andhra Pradesh, Gujarat, Maharashtra and Rajasthan) at least 20% of the land area is arid/semi-arid (*ibid.*). (b) *Prosopis juliflora* is commonly found growing uncultivated by roadsides, and on common lands, making it accessible to a large proportion of households in arid/semi-arid India.
5. Any evidence of technology's adaptability?	In Karnataka, *P. juliflora* pods have been used as a supplement for does around the time of kidding. This improved the health of pregnant does and increased their milk production, and hence their kids were healthier and grew faster. In this case, because the tree pods are being stored for use in the rainy season, pest damage appears to be a greater threat, and the technology has been adapted through the introduction of fumigation.
6. Any evidence of technology's relevance outside district or country of origin? (a) constraint (b) technology	(a) Its original use and point 5 above suggest that it may be effective in addressing a number of constraints on goat productivity. (b) *P. juliflora* is a native of Venezuela and Colombia. It is an exotic weed in parts of Sudan, Eritrea, Iraq, Pakistan, Australia, South Africa and the Caribbean (Pasiecznik *et al.*, 2001). It is also found in North-East Brazil, where its pods are used as an ingredient in commercial cattle feed.

Table 6 *Information Sources Related to Phase 2 Karnataka Study*

The Four Factors	Sources
1. Mean no. of goats per household (by district)	1997 National Livestock Census 2001 National Census (human population)
2. Extent of production constraint	Specially commissioned study (not available from secondary sources)
3. Distribution of poor households (by district)	Percentage of poor households was calculated using: the no. of Green card holders (obtained from the website of the Directorate of Economics and Statistics of Karnataka); and population data (2001 National Census)
4. Likely availability of inputs (tree pods)	Proxy indicators on distribution of *Prosopis juliflora* were: • Altitude (0-1500 m) • Rainfall (150-850 mm) • Temperature (4-48^{o}C) Source: USGS Land Cover Characterization Program:

Each district was scored against three (1, 3 and 4) of the four variables listed in Table 6, using the scales shown in Table 7, with higher numbers indicating higher incidence of the factor. Four categories were constructed of the incidence of poverty per district, measured in percentages of green cardholders, namely: 0-5, 6-10, 11-15 and 16-20. Similarly, four categories of mean levels of goat ownership per household were constructed: by co-incidence these were also 0-5, 6-10, 11-15 and 16-20. The score for the presence of *P. juliflora* depended on how many of the three proxy indicators (altitude, rainfall and temperature) were satisfied/applicable within the district concerned. A higher priority was assigned to districts with particularly high levels of factors 1 (goats), 3 (poverty) and 4 (presence of *P. juliflora*). Thus, for example, a district in which 16-20 per cent of the population were green cardholders would score four points against this variable; and one in which the mean level of goats per household was less than five would score one point against that variable. The highest possible total score for the three variables was 11 (i.e. 4+4+3), as indicated in Table 7.

Table 7 *Scoring of Districts against Each Variable*

Variable/Factor	Range of Scores
Average goat ownership per household	0-4
Incidence of poverty	0-4
Presence of *Prosopis juliflora*	0-3

Results

Points 1-4 in Tables 3-5 provide qualitative and quantitative information corresponding with the four factors mentioned in the methods section, and illustrate how these factors can be taken into account in estimating RDs. Points 5 and 6 in the tables go further and describe the potential relevance of the technology, or a slightly modified version of it, to other constraints or commodities, within or outside the country of origin. Two of the tables (Tables 3 and 4) also include information about commercial products that were available to address the constraint, and that were tested along with the technology based on locally available materials. The tables distinguish between the availability and

accessibility of inputs associated with the technologies. Availability refers to the physical presence of the materials, whereas accessibility refers to whether or not resource-poor households (RPHs) have entitlements (effective claims) to the materials.

Quantitative estimates of the recommendation domains

Preliminary estimates of the RDs for the three technologies are given in Tables 8-10. The assumptions are based on the information given in Tables 3-5 respectively.

Table 8 *The Size of the Recommendation Domain for Mucuna pruriens trichomes as a Goat Dewormer (see also Table 3)*

Assumptions	Dharwad	Karnataka	India
No. of goat-owning households	14,400	852,900	20,000,000
% of owners whose goats are experiencing constraint	40	20	10
% of owners having access to *M. pruriens* pods	25	15	10
% of owners having labour to collect the pods	90	90	75
Result			
Size of domain (no. of households)	1296	23028	150,000

Table 8 contains specific assumptions, based on the information in Table 3, and also, where information was lacking, on judgements made by key informants in the relevant countries. Based on different sets of assumptions for Dharwad, Karnataka and India, it shows the sizes of the recommendation domains for each. Using the Dharwad example, the size of the RDs has been estimated as follows:

Dharwad RD = 14,400 x 40% x 25% x 90%

= 1296

The assumptions used are more conservative as the geographical unit increases in size, because the degree of uncertainty is also increasing and there is a growing likelihood that conditions (e.g. regarding the prevalence of the constraint, and the labour situation) may differ from those in the original project district.

Table 9 contains comparable information for the mange control technology. The specific assumptions in it are based on the information in Table 4, and some judgements made by key informants, where information was lacking.

Table 9 *The Size of the Recommendation Domain for Treating Mange-infested Goats with Castor and Tamarind Paste*

Assumptions	**Tharaka, Mbeere and Central Isiolo-**	**Kenya**	**East Africa**
No. of goat-owning households	75% of 50,000	40% of 6 million	40% of 15 million
% of owners whose goats are at risk* of experiencing constraint	80	50	50
% of owners having access to Castor and *Tamarindus indica.*	50	30	30
% having labour to collect and process them	60	60	60
Result			
Size of domain (no. of households)	9,000	216,000	540,000

* While less than 10 per cent of herds may be badly affected at any one time, the risk of getting infected over a period of 3-5 years is high

Finally, Table 10 contains information from which the RD for the *P. juliflora* pods technology (Table 5) has been estimated.

Table 10 *The Size of the Recommendation Domain for Prosopis juliflora Pods as a Supplement to Improve the Productivity of Does*

Assumptions	**Bhilwara**	**Rajasthan**	**India**
No. of goat-owning households	70,000	1,700,000	20,000,000
% of owners whose goats are experiencing constraint	75	25	15
% of owners having access to *P. juliflora* pods	25	10	15
% of owners having labour to collect the pods	75	50	25
Result			
Size of domain (no. of households)	9844	21,250	112,500

These RD estimates are conservative in two respects. Firstly, in Cases 1 and 3 no attempt has been made to include RPHs outside of India in the RDs, but the co-existence of goats and *P. juliflora,* and goats and *M. pruriens,* in several other countries suggests that the global RDs for both of these technologies could be considerably larger than the Indian one. The same applies to case 2, in that the co-existence of goats, castor oil plants and Tamarind trees is found in the semi-arid and sub-humid parts of many other African countries, and also in South Asia. Secondly, no assumptions have been made about the applicability of the technologies to other types of ruminants, although there is evidence that all of them may have a broader relevance. It should be borne in mind, however, that, if the technologies are applicable to other types of ruminants, the beneficiaries could be different and hence the RD could be different.

Phase 2 Study

When scores were applied to the three variables for which data were available, (see Table 7), five of Karnataka's 26 districts scored 10 out of a possible 11. These are shown in Table 11. Another eight districts received a score of 9, with a score of 3 for each of the three criteria.

Table 11 *The Highest Scoring Districts (see text for details)*

District	Poverty (% of Green cardholders)	Goats (No. per household)	Presence of *Prosopis juliflora*	Total
Charmrajnagar	4	3	3	10
Bangalore	4	3	3	10
Bellary	3	4	3	10
Gulbarga	3	4	3	10
Tumkur	4	3	3	10

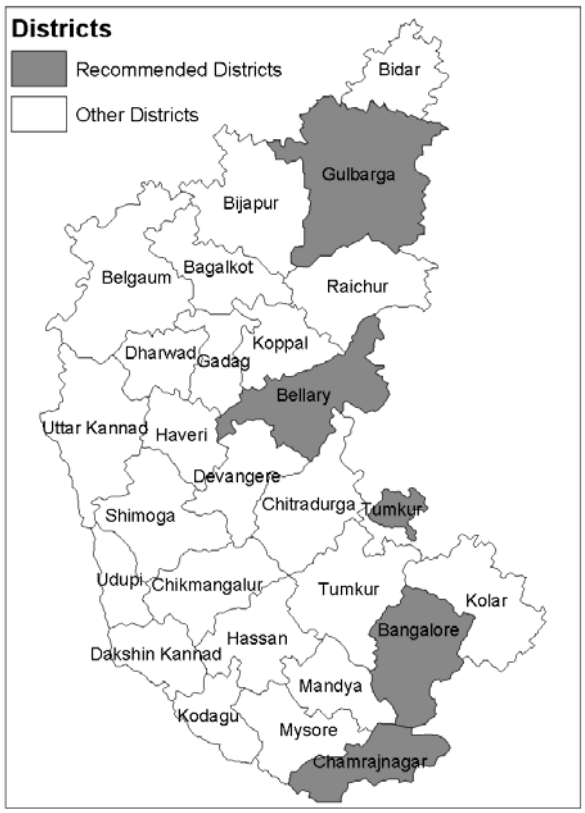

Figure 1 Priority Districts for *Prosopis juliflora* Technology in the Phase 2 Study in Karnataka

Discussion and conclusions

Some of the information on which the RD estimates in Tables 8-10 are based is uncertain. For example, there is a lack of information as to how widespread the constraints are; and some constraints (e.g. low conception rates in the dry season) are less

visible than others (e.g. mange), making it relatively difficult to detect their presence. In addition, regarding case 3, the opportunity cost of labour could vary significantly from one part of India to another. Another uncertainty is to what extent goat keepers outside of the initial project locations might already be using the technologies developed, or variants of them, given that the technologies draw on indigenous knowledge. Nevertheless, they do contain strong *prima facie* evidence that the RDs for the three technologies analysed in Phase 1, all of which are based on locally available materials, could involve tens of thousands of resource-poor livestock keepers, if not a hundred thousand or more, in each case.

With commercial veterinary drugs the major barriers to their adoption by resource-poor households appear to be cost, packaging size and - perhaps in some cases - availability. Private sector agencies have been able to ensure that the drugs are physically available in major rural centres. By contrast, for technologies that do not involve the private sector and are knowledge based, such as those described in this paper, the major barrier is access to information about them, so getting that information to the RPHs is the challenge that needs to be addressed.

The Phase 2 study demonstrated that GIS is well-suited to facilitating the identification of priority areas for dissemination activities. However, it would be preferable to apply it at a higher level of resolution, using a smaller administrative unit than the district, so that a higher level of precision can be achieved. There can be significant heterogeneity within a district with respect to one or more variables (e.g. incidence of poverty, or agro-ecological factors, such as climate). There may also be a case for adjusting the weightings attached to each of the factors.

Reasons for limited promotion of technologies

There has been a general failure in participatory livestock research projects to combine breadth with depth. Greater breadth could relate to technological change (the subject of this paper) or empowerment, and the latter is much more difficult to achieve than the former (Farrington, 1998). There may be several reasons for the limited coverage achieved in relation to technological change (see also Gündel *et al.*, 2001).

Firstly, agencies that are primarily concerned with empowerment may not attach high priority to promoting technologies outside their operational area. Whilst not underestimating the importance of empowering research approaches, we would argue that wider impact can be achieved more easily through promoting technological change than by out-scaling the PTD process. The latter is difficult, because PTD is about partnership between researchers and producers, and the ratio of researchers to producers is very low.

Secondly, in the case of a small or medium-sized NGO or a state/province agricultural university, the agencies concerned could have a small operational area, and hence not be well equipped to promote the technologies.

Thirdly, development agencies with smaller operational areas may only be concerned with adoption of technologies by resource-poor people in those areas, such as a few dozen or hundred villages in a particular district. Their mind-set may be somewhat parochial, and they may not be used to thinking how they can achieve impact over a much larger area and RD.

Nevertheless, agencies involved in livestock research, if they are genuinely interested in poverty reduction, should be asking themselves how they are going to maximise the benefits from the technologies they have developed with RPHs, if necessary by encouraging intermediary organisations to promote them to relevant RPHs.

A serious attempt should be made to identify which RPHs would find the technologies useful, and where they are located. The Phase 2 study showed that the recommendation domain tool, combined with computer-based GIS, is well-suited to this purpose. The GIS enables mapping and spatial analysis of the distribution of variables, makes direct comparisons between factors easy and allows visualisation of results to better communicate and disseminate outputs (see Figure 1).

Practicalities of using recommendation domains

It appears that the recommendation domain tool has not been widely used by agencies involved in livestock research. There are several possible reasons for this. Firstly, some agencies, particularly NGOs, may not be familiar with the literature on RDs. Secondly, although estimating RDs is a conceptually simple process, the necessary data are sometimes lacking or difficult to obtain. Thirdly, livestock research projects and programmes usually fund research but not widespread dissemination. Hence the researchers are not challenged to think further than successful research with a local group of producers.

Fourthly, the recommendation domains can be so large that they can extend well beyond the operational area of the lead agency that was involved in developing the technology, particularly when that agency is only covering a district or a small area within a district. Recommendation domains may include households located in a large area of a country, or of more than one country. Thus, effective promotion of a technology throughout the RD may require the involvement of at least two, and perhaps several, agencies. In the case studies, the lead agencies were large ones, with the potential to promote technologies over a huge area. BAIF works in six Indian states and has distributed dissemination materials for technologies 1, 2 and 4 in all of those states; while Kenya Agricultural Research Institute (KARI) has a national mandate and presence.

In this context KARI has recently taken on direct responsibility for some technology dissemination activities (including providing seed of some crops). At the same time, the importance of improving the existing linkages of KARI with extension services and NGOs is recognised. What is not yet in place in Kenya and many other countries (developed and developing) is a coherent, clearly articulated and sustainable strategy to promote promising research outputs to the appropriate agencies in order to improve the returns from research investment. Experience suggests that to rely only on demand for information and advice is not enough, particularly when the agencies involved in knowledge transfer are not well resourced and are ill-equipped to convert research information into tangible benefits for marginalised rural producers. Donors should consider taking a more pro-active approach to promoting promising technologies, including support for 'product champions' who have the expertise and motivation to promote the technology vigorously.

The definition of the recommendation domain may affect the choice of intermediary organisations. For example, if the livestock research project or organisation concludes that one or more of its recommendations are relevant outside of the districts where it has an operational presence or mandate, it could identify relevant organisations that work in

other locations within the RD to promote the recommendation in that area; and then develop a strategy for reaching them effectively.

In the case of relatively small livestock research projects, with limited resources, the presence of potential intermediary organisation(s), with the capacity to disseminate findings on a larger scale, could be a criterion for selecting the area in which the project is going to work. (This would be the first use of the RD concept – see Introduction.) If communication is established with intermediary organisations early on in the project, and then sustained over time, the likelihood of them taking an interest in the project's findings will be greatly enhanced. In the case of larger projects (or programmes) a consortium of collaborating organisations may be formed in the early stages. This was done, for example, by a Kenyan project on the validation of ethnoveterinary knowledge, which brought together NGOs, national research institutes, veterinary practitioners and local healers (Wanyama, 1999).

The use of RDs in priority-setting

As mentioned at the start, the first use of RD is as a research planning tool, helping decision making about targeting research activities and prioritising the use of scarce research resources. This is appropriate for agencies that are thinking about embarking on new research activities, and that need to prioritise in terms of technical, geographical and socio-economic focus. This process can begin at the needs assessment stage, before technologies have been identified, since RDs are more likely to be large when: (a) the relevant commodity (or commodities) is produced by a large number of RPHs; and (b) the constraint or opportunity is widely experienced. The examples given above also suggest that low or zero cash requirements may be another condition to consider when screening which technologies to field test with RPHs. Some technologies will be more sensitive than others to variations in conditions – for example, the suitability of a particular type of plough may be strongly affected by soil conditions and topography, so if these were highly variable the RD would be small or patchy.

A more common situation is that of agencies (NGOs, public research institutes, universities) who have undertaken some livestock research successfully, but have done relatively little in terms of promoting the technical findings beyond their operational research areas. Agencies that have done successful livestock research should give careful consideration to prioritising the promotion of technologies that appear to have large RDs and that include substantial numbers of RPHs.

In addition to being used by researching agencies, RDs can also be used in priority-setting by disseminating agencies. Where a large organisation or programme (such as DFID's Livestock Production Programme) has developed several effective technologies, and where resources for dissemination are scarce, priority can be given to those technologies with the largest RDs. Alternatively, where an agency with a mandate for dissemination (e.g. public extension services) has a large number of technologies to choose from, and the mechanism for effective articulation of demand is weak, RD analysis along the lines demonstrated in this paper can be used in determining priorities.

Conclusions and recommendations

The estimates from the three cases analysed in Phase 1 of this research strongly suggest that the RDs for certain technologies developed for, and with, RPHs can be large. However, in order to maximise the cost-effectiveness of participatory technology

development (PTD) it is necessary to identify who the potential adopters are, and where they are concentrated spatially. The Phase 2 study showed that the identification of RDs, in conjunction with computer-based GIS, is an ideal approach for doing this. The results generated can provide a sound basis for designing and implementing a dissemination strategy for reaching the resource-poor. However, it would be preferable to apply GIS at a higher level of resolution, using a smaller administrative unit than the district, so that a higher level of precision can be achieved, as there can be significant heterogeneity within a district. In future work it will also be essential to include information on the distribution of the constraint. In addition, to improve sustainability and use of RDs and GIS in less developed countries, the nodal point should be in-country; and the host organisation should be committed to dissemination of livestock technologies and well-connected to other potential users of the information.

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Discussions/questions/comments on the presentation

Question: *How much GIS information is available in Uganda?*

Answer: Isolated cases of GIS information can be identified. For example, the soil science programme has made attempts at developing a database. CIAT has a database on soil and related crops and the Livestock Department is also attempting to zone livestock in Uganda. The National Biomass study has a big database with different agro-ecological zones. The CG centres have information on the Lake Victoria Basin. However, attempts should be made to consolidate all this GIS information.

Question: *In view of the potential importance of recommendation domains and GIS to policy makers, researchers and NGOs, the availability of GIS data in East Africa is a critical issue. Is there a case for including marketing issues because of their importance in livestock management?*

Answer: Market access and price have a bearing on the production technologies to be adopted. ILRI is working on milk production, including marketing. Marketing of milk is not a factor in this study and, therefore, it is not included as a factor in the GIS information.

Restricted suckling and split weaning as strategies for improving the performance of sows and their progenies under smallholder farm conditions

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Abstract

The effect of restricted suckling and split weaning on the reproductive performance of the dam and subsequent performance of their litters was studied in an experiment involving 48 Landrace x Large white sows of second and third parity. The sows and their litters were allocated to four treatments as follows: separation to allow either one or two 30 minute periods of suckling per day; reduction of litter size by weaning all piglets attaining 6 kg body weight; and a control in which suckling was not restricted. Treatments commenced when piglets attained four weeks of age and piglets were weaned at eight weeks. Restricted suckling resulted in increased creep feed intake by piglets: those which suckled once a day consumed a total of 8.76 kg compared to 8.49, 8.35 and 8.21 kg for split weaning, twice a day suckling and the control respectively. All intakes were different ($P<0.05$). No differences were observed in total weight gain over the four week period ($P>0.05$). Sows on the control treatment had an average wean to oestrus interval (WEI) of 17 days. Restricting piglets to suckling once, twice a day or split weaning had a positive effect of significantly reducing ($P<0.05$) the WEI. A number of sows exhibited oestrus during lactation, with twice a day suckling having a larger percentage than other treatments. Restricting suckling and split weaning had an advantage as they improved sow reproductive performance.

(Key words: Sow, reproduction, suckling, wean, oestrus)

Introduction

Under smallholder production conditions in Uganda, early weaning is not a recommended management practice given the high costs of the specialized diet for early weaned pigs (Nelssen, 1990), coupled with lack of infrastructure to handle them. The long lactation period results in a thin sow condition at weaning with sows taking in excess of three weeks post-weaning before returning to oestrus. In a management system where the recommended lactation lengths as long as eight weeks, a reduction in the wean to service interval would increase the number of litters per sow per year and, providing the other determinants of sow efficiency remained unchanged, would improve sow output. Management practices, which would reduce the intensity of suckling, have been known to reduce weight loss in sows during lactation (Xue *et al.*, 1993) and the wean to oestrus period (Mahan, 1993). Partial separation of the sow and litter is known to initiate oestrus in lactation (Crighton, 1961; Smith, 1961; Miti'c *et al.*, 1966; Saihlira *et al.,* 1991; Saihlira-Dutta and Borgohain, 1991) or decreasing the interval to re-mating after weaning (Smith, 1961). Smith (1961) reported that separation beginning three to four weeks post-partum was sufficient to induce oestrus during lactation in sows. Separation of sows from their litters leads to a reduction in milk consumption by the piglets and consequently a substantial reduction in milk production by the sow. Reducing milk production would lead to a reduced nutrient depletion of the sows and hence limit their weight loss. This study aimed at assessing the effect of restricted suckling and split

weaning as management practices that reduce suckling intensity and weight loss during lactation, on the performance of sows and their litters under smallholder conditions in Uganda.

Materials and methods

A total of 48 Landrace x Large white sows of second or third parity from two different farms, the Makerere University Agricultural Research Institute, Kabanyolo and a private farm at Seeta, Mukono District, were used. The experiment was conducted from June 2003 to September 2004.

Experimental design and treatments

A randomized complete design consisting of four treatments was used. The sows were divided into four groups of 12 animals each and randomly allocated to the management treatments as follows: 1) separation of sows from their litters allowing 2-30 minute periods of suckling per day; 2) separation to allow 1-30 minute period of suckling per day; 3) reduction in litter size by weaning every piglet attaining 6 kg body weight, beginning 4 weeks post-partum; and 4) a control treatment where piglets were left with their mother for the entire eight-week lactation period. The treatments commenced whenever piglets attained 4 weeks of age.

Experimental procedure

Feeding practice

The sows and litters were fed a concentrate mixture consisting of maize and sorghum. Sows were fed sow and weaner meal, containing 14 per cent crude protein (CP), at a daily rate of 2 kg plus an additional 0.25 kg per piglet suckled. The daily ration was divided into two equal meals, one in the morning, and the other in the afternoon. The composition of the experimental diets is provided in Table 1. The litters were given *ad libitum* access to a creep feed containing 21 per cent CP.

Table 1 *Percentage composition of experimental diets*

Ingredients	Sow & weaner meal	Creep meal
Maize	--	68.21
Sorghum	81.20	--
Fish	15.00	29.79
Shells	3.00	1.00
Salt	0.50	0.50
Vit-Mineral Premix	0.30	0.50
Total	100.00	100.00

Management system

During pregnancy, the sows were kept outdoors on pasture in paddocks equipped with water troughs and ample shade. The sows were group fed on open-air concrete pads and remained together until late gestation, when they were moved to a farrowing and rearing house. The house consisted of partially open pens with sleeping, exercise and creep areas.

The sleeping area fitted with a feed trough and a guard rail had grass bedding and was roofed. The exercise area had incomplete walls with a water trough. The creep area was connected to the sleeping area through a 30 cm square opening and was covered with a corrugated asbestos roof. Any sow exhibiting oestrus during the experiment was mated in an attempt to establish pregnancy during lactation.

Data recording and analysis

Creep feed intakes were recorded daily and the riglets were weighed weekly during the trial. Piglet mortality was recorded. Sow body condition at the onset of trial and at weaning was scored on a 1-10 scale. Days from weaning to oestrus were recorded. Where sows exhibited oestrus before weaning, the dates were recorded, as was the litter size at the subsequent farrowing. Data were subjected to ANOVA, using Statistical Analysis Systems (SAS, 2001) general linear models procedure, and means compared by least significant difference (LSD).

Results and discussion

Feed Intake and live weight gain

Suckling regime of piglets significantly ($P<0.05$) affected both creep feed intake (Table 2) and live weight at all pre-weaning ages (Table 3). Feed intake increased with age and averaged 1.0, 1.8, 2.5 and 3.3 kg for week 5, 6, 7 and 8, respectively. Piglets that were suckled once a day had the highest total intake (8.76 kg) significantly higher ($P<0.05$) than those suckling twice a day (8.35 kg), *ad libitum* (8.21 kg) and split weaning (8.49 kg). This could have happened to redress the short fall in nutrient uptake due to the reduction in the amount of milk obtained from the dam. The similarity of the weaning body weight in piglets following restricted suckling to those in the control litters supports the finding of Grinwich and McKay (1985), that body weight two weeks after weaning of piglets subjected to suckling restriction is equal to that of piglets not restricted but weaned after five weeks. The total weight gain of the piglets over the four week trial period was 2.48, 3.45 and 3.32 kg when suckled once, twice a day and *ad libitum* (control), respectively. Piglets that were split weaned gained 2.73 kg but did not significantly differ ($P>0.05$) from all the other treatments. Our results confirm other reports where reduced litter size resulted in either earlier post-weaning returns to oestrus or an increased proportion of sows in oestrus at specific post-weaning intervals (Stevenson and Britt, 1981; Britt and Levis, 1982; Cox, *et al.,* 1983).

Table 2 *Weekly creep feed intake by piglets on different suckling regimes*

Treatment	Feed intake (kg) during week				Total
	5	6	7	8	
Once a day	1.06^{a}	1.73^{a}	2.53^{a}	3.44^{a}	8.76^{a}
Twice a day	1.01^{b}	1.71^{b}	2.34^{b}	3.29^{b}	8.35^{b}
Split weaning	0.89^{c}	1.79^{c}	2.60^{a}	3.20^{c}	8.49^{c}
Control	-	-	-	-	8.21^{d}
$LSD_{0.05}$	0.02	0.03	0.09	0.01	0.09

Means with different superscripts differ significantly ($P<0.05$)

Table 3 *Body weight and mortality in piglets on different suckling regimes*

Treatment	Body weight (kg) at week					Piglet mortality
	5	6	7	8	Total gain	
Once a day	6.09[a]	6.68[a]	7.74[a]	8.19[a]	2.48[a]	0.3[a]
Twice a day	6.40[a]	7.82[b]	8.61[b]	9.22[b]	3.45[b]	0.0[b]
Split weaning	5.52[b]	5.56[c]	6.17[c]	6.42[c]	2.73[ab]	0.0[b]
Control	6.24[a]	6.90[a]	7.75[a]	9.30[b]	3.32[ab]	0.0[b]
$LSD_{0.05}$	0.405	0.381	0.740	0.895	0.895	0.08

Means with different superscripts differ significantly ($P< 0.05$)

Table 4 shows the weaning to oestrus period, body condition score at weaning, and subsequent litter size of sows from the restricted suckling and split weaning treatments. Sows whose litters were restricted to suckling twice a day came to oestrus before weaning (Table 4), while those which suckled *ad libitum* 17 days after weaning, came to oestrus. Body condition of the sows differed significantly ($P<0.05$) across all treatments with the highest being recorded for split weaning. Sows that suckled their litters once a day had the highest subsequent litter size while split weaning gave the lowest size (Table 4).

Table 4 *Wean to oestrus period, body condition, and subsequent litter size in sows subjected to different suckling regimes*

Treatment	Days from weaning to oestrus	Body condition score at weaning	Litter size at subsequent farrowing
Once a day	3.2[a]	7.1[a]	11.8[a]
Twice a day	-2.8[b]	6.4[b]	8.0[b]
Split weaning	1.2[a]	8.8[c]	7.9[c]
Control	17.0[c]	3.7[d]	9.5[d]
$LSD_{0.05}$	2.4	0.46	0

Means with different superscripts differ significantly ($P<0.05$)

Conclusions

Restricting piglet suckling intensity and duration positively affected creep feed intake, implying that intake of feed was proportional to quantity of milk suckled. When piglets suckled for a short time, they compensated by eating more creep feed. The treatments did not affect weaning weight indicating that compensatory creep feeding met the shortage of nutrients due to short suckling periods. Restricting suckling and split weaning shortened the weaning to oestrus period, ensured a high body condition score for the sows at weaning, and did not affect their subsequent litter size. We, therefore, recommend restricting piglet suckling to twice a day, and weaning of piglets when they attain a live weight of 6 kg.

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The apiculture industry in Uganda

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Abstract

Uganda's climatic conditions produce diversified ecological zones which favour bee farming. Bee products and services include honey, beeswax, propolis, royal jelly and transfer of pollen. Bee farming (apiculture) in Uganda is an important seasonal activity that has enormous potential for widening the country's agricultural export base. The bee races present in Uganda are: *Apis mellifera scutellata A. mellifera adansoni* and *A. mellifera monticala.*

The majority of bee-keepers in Uganda are small-scale producers and most of them use traditional hives and indigenous management practices to maintain the bee colonies. It is estimated that there are about 80,000 bee-keepers with 700,000 bee hives producing about 5,000 tons of combed honey annually. Much of the bee products are consumed locally. Bees also play an important role in increasing agricultural production through pollination The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is responsible for promoting the apiculture industry through the department of livestock health and entomology. Extension services for the industry are offered by entomologists in the districts. In line with the required International standards for honey, MAAIF has formulated the following:

- The national apiculture policy
- The chemical residue monitoring plans for honey
- The statutory instruments on apiculture.

Several honey collection centres have been established in various districts and are involved in the buying, processing, packaging and marketing of bee products.

Introduction

Uganda's climatic conditions produce diversified ecological zones which favour bee farming. The exploitation of bees provides a sustainable environmentally beneficial food and income source for people in Uganda.

Honey bees are the only insects that produce a food consumed by humans. The bee races present in Uganda are *Apis mellifera monticala, A. mellifera scutellata* and *A. mellifera adansoni.*

The majority of bee-keepers in Uganda are small-scale producers and mainly use traditional hives and indigenous management practices to maintain the bee colonies. A colony contains one queen, 500 to 1,000 drones and about 30,000 to 60,000 workers.

Production

It is estimated that there are about 80,000 bee-keepers with 700,000 beehives producing 5,000 tons of combed honey annually. In Uganda there are two harvesting seasons; March to June and August to October. The most common hives are the traditional

woven hives (676,000), followed by the Kenya Top bar hive (16,105). The Langshroth hives are beginning to be introduced in most districts of Uganda.

Benefits of bee-keeping

Bee-keepers in Uganda are able to harvest honey, beeswax and propolis. Royal jelly and pollen have not yet been harvested.

- Beeswax is used in making candles and in the textile industry
- Propolis, due to its high medicinal value, is used in skin ointments and tincture for treatment of oral infections
- Honey has been valued as food and as medicine; it soothes coughs and sore throats. Because of its antimicrobial properties, honey is used in beauty products and in dressings for wounds and burns
- In addition to gathering nectar to produce honey, honey bees perform the vital function of pollination. They transfer the pollen from plant to plant, thus fertilizing the plants and enabling them to reproduce.

Government framework

Apiculture falls under the department of livestock health and entomology in the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The Ministry has two offices based in Entebbe with full time responsibility for bee-keeping, and in each district there is an entomologist with responsibilities for apiculture, tsetse control, ticks and sericulture.

MAAIF has facilitated the following developments:

- A National Apiculture Policy has been formulated and is ready for submission to cabinet for debate and approval
- The Animal Disease (Declaration of Bees as Animals) Instrument 2004 and the Animal Disease (Control of Bee Diseases) Rules 2004 have been signed by the Minister of Agriculture, Animal Industry and Fisheries (MAAIF) and are in the process of publication and gazetting
- A Draft Residue Monitoring Plan
- A Draft National Uganda Honey Standard is available
- A Draft National Apiculture Strategic Plan
- A bee-keepers apex body known as The Uganda National Apiculture Development Organisation was put in place in April 2002.

Organisations involved in apiculture include:

- *Connoisseur Honey*, located in Bushenyi district, was established seven years ago. It was supported by the UK (Oxfam, Farmer Overseas Action Group (FOAG))
- *Uganda Bee-keepers' Association* based in Wandegeya: its main activity is training
- *Uganda Honey Bee-keepers' Association* occupies the honey refinery at Nalukolongo and with support from the German Government has put up an apiculture vocational school in Nakasongola district

- *UWESO-Uganda*, The Uganda Women's Effort to Save Orphans (UWESO) is supported by UWESO UK Trust and is assisting bee-keepers in five districts, providing training and assistance with running three collection centres
- *Bee Natural Products* is based in Arua. It has a honey collecting centre with European Union standards and packs for the local and regional markets, as well as exporting to Malaysia
- There are several associations engaged in promoting bee-keeping and offering services to their bee-keeper members, e.g. Kabarole Bee-keepers' Association, Bunyagabu Bee-keepers' Co-operataive, Bulemezi Bee-keepers' Association, and Nakasongola Bee-keepers' Association (MAAIF, 2003).

Honey marketing

Table 1 shows some prices for both comb and liquid honey.

Table 1 *Some prices for comb and liquid honeys*

Area	Comb honey (Honey and broken comb mixture)	Liquid honey (Comb strained out)	Buying price per kg, UGSH	Equivalent US$ price (July 2005)
Bee-keeper, Kitgum	UGSH 24,000 per jerry can (28 kg)		857	0.49
Bee-keeper, Atoka	UGSH 2,500 per litre		Approx. 1500	0.87
Kitgum Women Bee-keepers' (buying in Kitgum)	UGSH 800 per kg dark comb UGSH 1,000= per kg light comb UGSH 24,000= per jerrycan comb honey (28kg)		800 1,000 857	0.46 0.58 0.49
Connoisseur honey, buying in Bushenyi		UGSH 48,000= per jerrycan of liquid honey (30kg)	1,600	0.92
UWESO (buying at centres)		UGSH 1700 (depending on quality)	1,700	0.98
Kenyan trader (buying in Jinja)		UGSH 20,000= per jerrycan (semi-refined)	800	0.46
United Women's Apiary, Luwero		UGSH 35,000 – 40,000 per jerrycan (semi – refined)	1166 to 1333	0.67-0.77
Arua honey trader (selling in Kampala)		UGSH 50,000= per jerrycan (semi – refined, approx 25kg)	2,000	1.15
'Alimag' trader (buying in Kampala)		In January 2004: UGSH 60,000= per jerrycan (semi-refined, approx. 30kg). In March – June: UGSH 35,000 – 40,000= per jerrycan.	2,000 1166 to 1333	1.15 0.67-0.77
UHA (buying in Kampala)	600= per kg dark comb 800= per kg light comb		600 800	0.35 0.46
Uganda Authorised Honey Agents (trader in Kampala)		UGSH 60,000 per jerrycan (semi-refined, 20 litres)	1,600 to 1,800	0.92-1.04
Tropical Quality Honey (Kampala)		UGSH 30,000 - 50,000 per jerrycan (30kg) Honey from Arua: UGSH20,000= - 30,000 per jerrycan.	1,000 to 1,666 666 to 1,000	0.58-0.96 0.38-0.58
Bee natural products			1,000	0.58

From the information above, it is not easy to derive a standard price. The supply chain may be long, with people at different stages along the chain adding value by filtering to separate honey from beeswax. A jerrycan full of liquid honey contains about 30 kg honey (20 litres). In Kampala, this sells for around 60,000 UGSH (US$ 34.60) (2,000 UGSH per kg) (US$ 11.53). Jerrycans containing honey still in the comb, or coarsely filtered, will contain less honey (but more beeswax) and prices are lower. Farmers in remote areas selling their comb honey may receive 20,000 UGSH or less per jerrycan. They usually have no access to transport and must sell their honey at whatever price is offered by visiting traders. Traders visiting rural areas to collect honey are believed to offer very low prices and, as they are few in number, have a monopoly. . If they carry honey to the local town, they must sell it before they return home and accept low prices in return for an immediate cash payment.

Buyers control the market for bee-keepers' products. As can be seen from Table 2, there are already several strata of society benefiting from bee products. A fairer return to the producer could encourage increased production by this sustainable rural industry.

Table 2 *Some wholesale and retail prices for packed honey*

Area	**Origin**	**Wholesale UGSH**	**Retail price UGSH**	**Weight kg**	**Retail price per kg UGSH**	**Equivalent US$ price (July 2005)**
Bushenyi	Private bee keeper		5,000	1.0	5,000	2.88
Kiboga	Bee-keeper		30,000 per bucket comb honey	10	3,000	1.73
Kitgum	Kitgum Women bee keepers	2200	2,500 – 3,000	0.5	5,000 – 6,000	2.88-3.46
Kitgum	Bee keeper		500 'per cup' (buyer brings own cup)	0.2?	2,500	1.44
Masindi	Masindi Honey Bee-keepers' Environmental Association		500 2,500	0.06 0.5	8,333 5,000	4.81 2.88
Kampala	UHA	2000	2,500	0.5kg	5,000	2.88
Kampala	Connoisseur honey, Bushenyi	2500	3,000	0.5	6,000	3.46
Kampala	Reco industries		3,200	0.5	6,400	3.69
Kampala	Tropical Quality Honey (Kampala)		3,000	0.5	6,000	3.46
Kampala	Uganda Authorised Honey Agents (trader in Kampala)		2,500		5,000	2.88
Arua	Bee natural products		2,500	0.5	5,000	2.88

Local bulk prices (Table 2) for honey are near to the world price and local retail prices. Therefore, the priority is to satisfy the local market, estimated at around 100 tonnes, before considering export.

Constraints

Constraints for farmers

- Lack of training and technical advice
- Poor quality training
- Lack of training materials
- No access to suitable containers
- No access to protective clothing and smokers
- Poor market access
- Low product prices

Constraints for traders

- Lack of access to products of sufficient quality and quantity
- Non–availability of credit
- Poor diversity of retail packaging materials.

Constraints for the industry as a whole

- Few extension materials
- Lack of appropriately-skilled trainers
- No linkages between producers and buyers
- No coordination between bee-keeping and other sectors: horticulture, forestry, health, environment
- No product promotion
- No research
- Increasing international trade rules making it difficult for Ugandan bee products to enter the world market.

Recommendations

- Production of appropriate training materials.
- Training of trainers and training of farmers
- Establishment of honey and beeswax collecting centres.
- Provision of credit to buyers.
- Research on various aspects of bee-keeping.

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Dissemination of low-cost technology for handling crop residues and dry forages for dry-season feeding in Northern Tanzania[1]

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Abstract

Livestock feeding is one of the most expensive components in the livestock production system. To maximise profit in any livestock enterprise (milk, beef or dual purpose) needs close management to ensure that feed resources are obtained at the lowest possible price. Investigation on the possibilities of increasing profit from milk production from cows and goats on smallholder farmers was carried out in Tanzania from 1996 to 1999 under a Livestock Production Programme (LPP) Project (R6619). The LPP Project hypothesised that feed resources were a major limiting factor to milk production in the high-potential areas of Tanzania and that by taking a farmer-oriented approach to technological research, practical solutions to pressing constraints could be developed and promoted. The project identified with farmers that crop residues and dry forages were important feed resources especially during the dry season, but these resources were constrained by high costs of transportation and storage of loose forage. Project R6619 developed, with farmers, the optimal size of the wooden box for baling maize stover. An economic evaluation of using the technology was undertaken and compared with the traditional method of handling loose maize stover and dry roadside grasses. Results showed a wooden box measuring 75 x 50 x 40 cm to be the most appropriate size, and hence considered as a low cost technology for handling feed resources for dry season feeding in Northern Tanzania. The low cost technology was then disseminated to farmers under a Tanzania Government funded project undertaken from 2001 to 2003. Preliminary impact assessment revealed an overall maximum adoption rate (MAR) of 78 per cent, of which 80 per cent was for the Highlands and 70 per cent for the Lowlands. The Business-Oriented Farmers had the lowest rate of adoption. The overall conclusion was that manual box baling technology gave greater economic returns than the traditional methods of handling loose, dry forages. Farmers concentrating on crop and livestock production adopted the technology to a greater extent than those involved in off-farm activities. It is recommended that a study be undertaken to quantify the amount of crop residues that should be removed from fields, for feeding animals, and how much should be incorporated into the soil as organic manure. Such a study would help resolve the existing conflict between the use of crop residues for livestock feeding and their use in conservation agriculture.

[1] 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. R6619, Livestock Production Research Programme.

Introduction

The Livestock Production Programme (LPP) Project R6619 **'**Husbandry strategies for improving the sustainable utilisation of forages to increase profitable milk production from cows and goats on smallholder farms in Tanzania' was undertaken from 1996 to 1999. The project hypothesised that feed resources were a major limiting factor to milk production in the high-potential areas of Tanzania and that by taking a farmer-oriented approach to technological research, practical solutions to pressing constraints could be developed and promoted.

Participatory rural appraisal (PRA) techniques were used with farmers to identify and prioritise constraints to using available forages (crop residues and other dry forages) for profitable milk production. Project R6619 also identified, from grey literature, technologies that could help smallholder farmers make more efficient use of feed resources available on-farm. Using PRA tools, the technologies were presented for participatory evaluation by farmers. Among the technologies presented for evaluation was the wooden box for manual baling of dry forages, reported by Onim *et al.* (1992). Farmers gave the wooden box technology a high ranking as a possible solution to the constraint of transporting and handling crop residues such as maize stover. The technology was also deemed feasible for women and children selling roadside grasses in the lowlands of Northern Tanzania. However, the grey literature did not specify the appropriate size of the wooden box nor indicate the economic implications of using the technology. Project R6619, therefore, developed, with farmers, the optimal size of the wooden box for baling maize stover. An economic evaluation of using the technology was undertaken and compared with the traditional method of handling loose maize stover and dry roadside grass. Results showed a wooden box measuring 75 x 50 x 40 cm to be the most appropriate size. Compared with traditional transporting (i.e. loose stover in a one-tonne pickup), box-baled stover increased the payload by 66 per cent and reduced transportation costs by 33 per cent. Baled stover also reduced the space required for storage and also facilitated feed budgeting. Towards the end of Project R6619 an extension message for farmers was prepared in the form of a leaflet entitled '*Cut costs of feeding stover*'*;* 18,000 copies in Swahili and 2,000 copies in English were distributed to farmers, non-governmental organisations (NGOs) and government extension officers. An extension poster, bearing the same title, was also produced; 13 copies in Swahili and 12 copies in English were distributed to disseminating organisations (including churches, for displaying on church notice boards).

The box-baling technology is used by dairy goat farmers belonging to the FARM-Africa project in Dareda Division of Babati District, Northern Tanzania The technology is also currently being used in LPP Project R6610 (2003-04) in Bangladesh for baling *Lathyrus sativus* hay and rice straw.

In March 2001 Tanzania Agriculture Research Project (TARP II) phase two considered the outcome of R6619 to be appropriate technology for farmers and agreed to fund a two-year project, NZ/TARP/LP 05 '*Dissemination of low cost technology of handling feed resources for dry season feeding in Northern Tanzania*'. The methods used and results of project NZ/TARP/LP 05 are presented in the remainder of this summary.

Materials and methods

Project site

The highlands of Northern Tanzania are described as areas with high dairying potential. Smallholder farmers in the highlands keep improved dairy cows and dairy goats in a stall-fed, zero-grazing system. This is necessary because farms are small and the area is densely populated. Feed resources in the highlands are limited and there is a high dependency for feeds from the lowlands. Feed resources from the lowlands include crop residues (maize and beans) and roadside grasses. The lowlands are 20 - 25 km from the highlands. As the available feed resources are bulky, they pose problems in transportation and storage. Project R6619 (Massawe,1999) developed with farmers a low cost technology of manual box baling of crop residues and dried forages, such as roadside grasses, that showed economic benefits. The technology was recommended for adoption by farmers in Northern Tanzania.

Project activities

The project (NZ/TARP/LP 05) had six major activities:

i) Selection of target villages in Hai, Moshi Rural and Rombo Districts

ii) Demonstrations of manual box baling of maize stover and grasses, the low-cost technology that was described in the leaflets which had been distributed

iii) Training of farmers on thinning, stripping and topping of maize as a tool for maximizing feed resources from the maize crop

iv) Dissemination workshop, allowing farmers an opportunity to express their views about the technology

v) Sensitise and encourage formation of farmer working groups to promote dissemination, and also facilitate the groups to transport baled stover in shared 7.0 t lorries, an activity unaffordable for individual farmers

vi) Impact assessment to evaluate the uptake and adoption of the technology.

Methodology

Selection of target villages was done in a participatory manner involving extension officers in Hai, Moshi Rural and Rombo Districts of the Northern Zone of Tanzania (Project Activity 1). Dissemination of the technology was carried out in a series of demonstrations. These were followed by farmer training on techniques for maximizing forage feed coming from the maize crop (Project Activities 2 and 3). Dissemination workshops and sensitisation meetings were held in each of the participating villages (Project Activities 4 and 5). Finally, an impact assessment (Project Activity 6) was carried out to evaluate the uptake of the technology.

Impact assessment to evaluate the uptake of the technology was done with two-dimension functions to calculate the adoption rate, as described by Hildebrand and Russell (1996) using the equation:

$MAR = [C_{f(1,n)} \times E_{f(1,n)}]/100$, where:

MAR = Maximum adoption rate (%); $C_{f\ (1,n)}$ = Frequency of farmer category; $E_{f\ (1,n)}$ = Frequency of production environment.

The equation is applicable when there are two farmer categories with three production goals. In the present study the farmer categories were:

i) Highlands (livestock keepers) and

ii) Lowlands (sellers of roadside grasses).

The three production goals were:

i) Off-farm activities like shops, transport or small businesses in town (business-orientated farmers),

ii) Growing of crops such as maize, banana and coffee (crop growers)

iii) Milk production from dairy cows and dairy goats (livestock keepers).

Results

Demonstrations and dissemination workshops showed that farmers liked the technology. Calculations of cost savings were carried out with farmers selling roadside grasses in the lowlands. One head load of grass costing Tsh 500 to 800/= (USD 0.5 – 0.8) yielded two bales which were each sold for Tsh 500, giving a surplus of Tsh 200 – 500/ per head load (Table 1). The grass sellers commented that the low purchasing-power of people and the lack of confidence of buyers were the only problems. Baled forage was easier to store for future selling.

Table 1 *A comparison of the costs of transporting equal weights of traditionally handled and box-baled forages in two areas of Northern Tanzania and the likely savings Tsh 100 = US$1)*

Transportation type	Highlands		Lowlands	
Bulky transportation	2 trips using a 2-tonne Toyota Stout pick-up	Tsh 55,000	1 head load	Tsh 650
Baled	1 trip using 2-tonne Toyota Stout pick-ups	Tsh 27,500	2 bales	Tsh 1000
Net profit gain in baled form		Tsh 27,500		Tsh 350/= (54%)

Preliminary impact assessment revealed an overall maximum adoption rate (MAR) of 78 per cent, of which 80 per cent was for the Highlands and 70 per cent for the Lowlands. The Business-Oriented Farmers did not adopt the technology (Table 2).

Table 2 *Analysis of the maximum adoption rate (MAR) of box baling by three groups of farms (% adopting in brackets) in two areas of Northern Tanzania*

	Highlands	Lowlands
No	80	20
Business-orientated farmers	16 (0)	6 (0)
Crop producers	28 (100)	12 (100)
Livestock keepers	36 (100)	2 (100)
MAR (%)	80	70
Overall MAR (%)	78	

The adoption analysis shows that the technology was not appreciated by business-oriented farmers but was found suitable by crop producers and livestock keepers.

Conclusions and recommendations:

Manual box baling technology gave greater economic returns than the traditional methods of handling loose, dry forages. Farmers concentrating on crop and livestock production adopted the technology to a greater extent than those involved in off-farm activities.

However, it is recommended that a study be undertaken to quantify the amount of crop residues that should be removed from fields for feeding animals and how much should be incorporated into the soil as organic manure. Such a study would help resolve the existing conflict between use of crop residues for livestock feeding and use in conservation agriculture. Scientists in conservation agriculture advocate soil-incorporation of all crop residues for better nutrient cycling, but crop-livestock farmers practising stall-feeding cannot accept this philosophy. In the case of maize, stripping the leaves and sheath, and manually box-baling them would allow about 50 per cent of maize stover (i.e. stems) to remain in the field for soil-incorporation. The question is, would this be sufficient? Another option that would allow more residues to be harvested for livestock feeding and yet leaving sufficient biomass for soil conservation would be to grow cover crops such as *Lablab* and *Mucuna.*

Box baling has been introduced to farmers in Bangladesh. Competitions (e.g. make the best bales) are used to train farmers in box baling techniques. Credit: Emyr Owen

Acknowledgements

This publication is an output from two closely related projects. The UK Department for International Development (DFID) funded Project R6619 which developed the technology; dissemination to farmers was done with financial support from the Tanzania Agricultural Research Project (TARP II). The views expressed are not necessarily those of DFID or TARP II.

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Discussions questions/comments on the presentation

Question: *This technology is popular with dairy farmers in the Northern Highland zone of Tanzania, but a bale weighing 18 – 20 kg is required. Is this possible, as it may encourage scaling-up of the technology?*

Answer: A prototype has been developed with greater compression of the forage. The 'Jua Kali' group in Tanzania is making an improved manual baler based on this prototype.

Comment: A high-tech baler, costing approximately US$ 700, was developed by the Caribbean Agricultural Research Development Institute (CARDI). The metal hay baler has a wheel so that it could be used like a wheelbarrow, and a lever mechanism to increase the pressure applied to the conserved material.

Question: *Box balers are being used in Uganda but sisal string is expensive. What do farmers in Tanzania use to tie the bales?*

Answer: Farmers use sisal strings but the overall cost of the bale is still low.

Question: *Why do roadside forage traders in the Northern part of Tanzania not sell baled forage? If the buyers of forage demanded baled material to reduce transport cost, traders would have to supply it.*

Answer: Traders are being made aware of the technology and demand is increasing.

Uganda Day – an opportunity to visit small stock enterprises and discuss associated issues with small stock keepers in selected sub-counties of Masaka district

Introduction

The workshop organisers had arranged a field visit for participants to four different sites: one run by a non-governmental organisation (NGO); one a farm involved with research; one run by a wealthier farmer and one practising crop farming as well as livestock farming. The workshop participants split into two groups and visited the four sites. At each site, a presentation was given by a representative of the site, on the small stock keeping practices at that site.

Background to the field visits/sites and feedback from the field:

Field visit: Site I

Household Head/Farm Owner - Wamala Ismail

This farm is located in Byembogo – Katovu – Malongo Sub-county and the farmer practises the free-range goat rearing system.

Research is being carried out on this farm on the performance of indigenous and cross-bred goats grazing pasture, supplemented with protein and energy.

The implementers are: Makerere University, Faculty of Agriculture, Department of Animal Science and Veterinary Science, Masaka. Funding is provided by NORAD. Masaka was selected because the district has a large budget for livestock.

Questions

Question: *The local Ugandan meat goats are small, how do you compete in the world market?*

Answer: The Middle East markets we are targeting prefer small white-coated goats, with a carcass weight of between 12 – 15 kg. However, there is a market for a wide range of carcass weights.

Question: *What is the average weight of a Mubende goat and is anything being done to improve it?*

Answers: The average weight of a mature goat is around 35 kg (range 12–65 kg). Selection of breeding stock is aimed at increasing the size of this breed.

The Boer is being promoted vigorously in Uganda, however, the Galla goat, because it is readily available and very hardy, should also be considered for meat production.

It was observed that when a local goat is confined its growth rate falls. Grazing and supplementation is preferable to pen-feeding.

Field visit: Site II

Household Head/Farm Owner - John Sekatawa

This farm is based in Katovu B Village, Katovu Parish, Malongo Sub-county and the farmer practises the free-range system.

Mr Sekatawa rears goats to raise fees for the children. He is one of the farmers given a Boer buck by the district under the Plan for Modernisation of Agriculture (PMA). He hopes that by the year 2006 he will be exporting goats.

However, drought causes the goats to walk long distances and there is also need to fence the land to avoid destruction of neighbours' crops.

The market for goats is readily available; they are sold at between two to three months of age. Local goats fetch 80,000/=–100,000/= (US$ 47-58) at one year; cross-breds at two to three months fetch 150,000/= (US$ 88).

Once in a while there are disease problems but the vet. is readily available.

The farmer buys the ear tags and the vet. does the ear tagging. This is to help identify goats which stray.

Note: It was generally observed that in the rural areas people mainly prefer meat goats and rear very few milk goats.

Field visit – Site III

JOY Children Centre: NGO under the Deliverance Church, Uganda

Implementers: David and Jaqui Dowdy

Location: Kayunga village, Kalagala Parish, Mukungwe Sub-country

The farm has been in existence for 11 years. They mainly keep Toggenburg goats with just a few Boer goats. There are 250 goats most of them being cross-breds of over 75 per cent exotic inheritance. The children recruited to work on-site are mainly orphans. The goats are fed on maize bran which has improved lactation performance and body size.

Question: *Local breeding records of goats are virtually non-existent. Could this result in in-breeding?*

Answer: At JOY Children's Centre we have the breeding history of each animal, going back for 4-5 generations. This is complemented by tagging of all animals and recording details of all live sales.

Question: *Why haven't farmers been involved in breed improvement through Breeders Associations?*

Answer: The trend is now changing and breeders associations have, and are, been formed to ensure farmers 'own' the breeds and the breeding programmes.

Question: *Is it true that local breeds of goats have shorter kidding intervals?*

Answer: No, especially where management of improved goats is adequate.

Question: *Improved goats, because they are usually larger than local breeds, need more feed. All NGOs are trying to involve more farmers in improvement programmes. Is the increase in forage production sufficient to feed more and bigger goats; is it sustainable?*

Answer: Yes, is sustainable but it is important to note that other factors, such as disease control, are taken care of.

Field visit: Site IV

Household Head/Farm Owner - Amina and Ibrahim Kasiga

Location: Bukulula Sub-county

An intensive goat rearing system is being practised. The goat rearing business began in 1996, starting with one goat crossed to an exotic, eventually the nearly pure-bred kids were produced.

In 2002 the PMA gave a Boer buck to rear on behalf of the whole sub-county. Since 2002 the buck has performed 800 services. Amina's goats have had 120 services, at a cost of 1500/= (US$ 0.88) each, paid only after the doe conceives. Amina is able to get manure from her goats. She is able to educate her children from the income raised and to put up a better iron-roofed, bricked, house; she also obtains firewood from the trees she has planted.

The challenges Amina is facing include: the two km she has to walk to fetch water; the cost of drugs for her animals; and providing better housing for her goats.

Amina and her husband use 2.5 acres of land for goat rearing and growing forage crops and on the remaining land she grows bananas/matooke, moringa, vanilla and some vegetables.

She feeds her goats on elephant grass, goat phycas, *Calliandra* and mango tree and other leaves. Most of the forage is from her own piece of land but once in a while she acquires forage from other village/community members.

Amina said that out of 144 kiddings on her farm she had lost six kids due to GIT infections.

To prevent inbreeding, she plans to change her buck in two to three week's time.

She is also maintaining lactating dairy goats; a Toggenburg, Alpine and Saanen. The goats give her one to two litres of milk each on a daily basis. However, she doesn't sell any of it due to the conservative attitude in the area concerning goat milk.

Amina gets 75 per cent of her household income from goat rearing. A goat/kid of three months old costs 100,000/= (US$ 58). She is assured of the demand for kids since here the biggest customers are other NGOs.

Since her buck performs three to 20 services depending on the season, she is also assured of this source of income. Besides this, she sells moringa, vanilla and coffee. However, she is not able to sell any food crops (matooke) since the productivity had dropped in the last few years.

In response to a question on the sustainability of her goat rearing as the number of goats locally increases, Amina and her husband said they had diversified their income base, also saving in preparation for a future fall in demand.

On the issue of labour, Amina said that her main source of labour is her husband and children, since she cannot afford hired labour. The workload, however, cannot be underestimated since she has to tend the goats, garden, and other house chores.

Amina sources information on goat rearing from the Sub-county local government, and NGOs. However, the most effective source of information is the farmer exchange visits followed by the trainings received. The information from farmers exchange relates to feedings legumes and how to establish forage.

However, she said besides her household, there were only three other households that so far had reached her level of farming.

Note: All farmers are interested in more productive animals. Unfortunately development and donor agencies have tended to shy away from breeding.

General comments

JOY Children's Centre could be supported by inputs from animal breeders. Involvement of smallholder goat keepers affords an opportunity for group breeding schemes and clarification of breeding and economic objectives.

From the field trips it was noted that a large number of cross-bred goats are being traded without accompanying records. A system of traceability is needed, to control breeding and disease, and to promote desirable production traits.

Conventional views on research tend to concentrate on technology interventions, information management and policy change. However, other themes also fall under research, which the Ugandan scientists should also consider, including:

1) Impact assessment of promotion of information

2) Impact assessment on goats which are released into the field.

While it may be necessary to introduce exotic blood into dairy animals, there are opposing views regarding cross-breeding for meat production. Local animals should be fully assessed, both under current and improved management systems. Unnecessary and indiscriminate cross-breeding runs the risk of losing important national genetic resources.

Researchable issues:

- Cost of labour. Now that all children are attending school the amount available and cost of labour is a major management consideration.

- Marketing issues
- Pathways for exchange of technology, especially farmer-to-farmer exchanges

The following also need addressing:

- The quality of information and its point of origin (indication of relevance)
- The criteria farmers use to judge the quality of information and advice. This would complement LPP research on farmer-to-farmer extension in Kenya, based on institutional and accessibility issues.
- Characterisation of local and cross-bred goats, including economic aspects
- More information is needed on the disease tolerance of local compared to improved goats, including possible economic advantages
- Research should be done on more than eight farms in different eco-environments, under the supervision of qualified research staff.

Performance of indigenous and cross-bred goats grazing natural pastures supplemented with different sources of protein and energy in Masaka District, Uganda

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Abstract

This paper reports an on-going project aimed at developing a sustainable increase in goat productivity to ensure production of quality goat meat on a regular basis and promotion of an export commodity for Uganda. The study was initiated to assess on-farm growth performance and carcass characteristics of 24 indigenous Mubende and 24 Boer x Mubende goat kids. The experimental design was a 2 x 3 factorial arrangement with breed and dietary treatments as the main factors (each group of kids consisted of eight, three groups from each breed each receiving a different supplementary regime). Preliminary results show that daily weight gains were different among the dietary treatments, with the groups receiving a mixture of maize bran and cottonseed cake (MC) having the highest gains and the non-supplemented (control) groups having the lowest. Within the Mubende kids, supplementation with a mixture of calliandra and gliricidia (MPT) slightly improved weight gains when compared with the control group (35.8 v 30.7 g/d). At slaughter the Mubende goat kids averaged 23.3 kg while the cross-breds averaged 25 kg body weight. Supplementation significantly improved slaughter weight with the kids supplemented with the MC concentrate with both breeds having the same weight (30 kg) at slaughter. Similarly, carcass weight was greatly improved with supplementation but the effects were more pronounced in the Mubende goat kids. There was not much treatment variation due to supplementation in the dressing percentage, although the preliminary results show that supplementation with MPT slightly reduced the dressing percentage for the two breeds (42 and 44 per cent for the Mubende and cross-breds, respectively) when compared to the mean of 44.7 and 45.7 per cent for the Mubende and cross-breds, respectively.

Introduction

New trends in human preferences in food consumption and markets, especially in developed countries, are emphasising qualitative aspects of animal products (e.g. organic products, low saturated fatty acids and low cholesterol). These trends have not been seriously addressed in the evaluation of indigenous goat breeds and their cross-breds with exotic breeds, which are being promoted in Uganda, aimed at commercial production for both the local and export markets. In order to invest in commercial goat farming aimed at capturing the export market, there must be breeding and feeding programmes responsive to market forces.

The current development strategy of the Uganda Government in order to eradicate poverty by transforming subsistence agriculture to commercial agriculture is the Plan for Modernisation of Agriculture (PMA). Through the PMA, a strategy for increasing overall

productivity of meat from goats will be based on stratification and subsequent intensification through fattening operations. Meat off-take could be improved by strategic supplementation of young goats in feedlots, located in agro-ecological zones endowed with adequate feed resources to sustain commercial meat production to meet the specifications for domestic and export markets.

The overall objective of the project is to develop feeding packages for adoption by goat producers and to attract feedlot operators into fattening programmes.

Materials and methods

Location

The study is currently being undertaken on two selected farms in Masaka district, Uganda. The district was chosen because of the high concentration of goats and initiatives by the district administration to promote commercial goat production as a means of improving the livelihoods of resource poor communities.

Animal management

Twenty-four indigenous (Mubende) and 24 cross-bred (Boer x Mubende) goat kids (3-4 months old) were selected on each farm and subjected to three growth and fattening rations. Eight kids from each breed only grazed natural pastures to reflect the traditional goat feeding management system (Treatment 1, control). In addition to grazing, another eight of the kids from each breed received a daily supplement of a concentrate, containing agro-industrial by-products (maize bran and cottonseed cake) mixed on-farm (Treatment 2, MC). The remaining eight kids from each breed received a multipurpose tree based supplement produced on-farm and containing *Calliandra* and *Gliricidia* (Treatment 3, MPT). The supplements were formulated, using a computer based linear programme, to obtain a growth rate of 150 g/day. Details of the supplements are given in Table 1.

All the kids were grazed as one group during the day for a period of 7 to 10 hrs depending on the weather. At night the goats were penned according to treatment, the supplements being offered on a group basis after grazing. Supplements were offered at the rate of 0.3- 0.5 kg dry matter per animal per day. All the kids had free access to water and animal health care, including regular de-worming every four months and routine hand spraying against ecto-parasites (tick control).

Experimental design

Kids of each breed were stratified into eight weight groups of three animals according to body weight, and one animal from each group of three was randomly allocated to one of the three feeding treatments. This resulted in eight animals of each breed per feeding regime, in a 2 x 3 factorial arrangement.

Body weight measurements

The kids were weighed fortnightly (between 07.00 and 08.00 h, before grazing commenced) during the feeding period. The average daily gain was estimated by regressing the fortnightly body weights on the number of days of feeding.

Table 1 *Ingredients and Composition of the Supplementary Feeds*

Ingredients	Amounts (kg)	Crude Protein (g/kg)	Metabolisable Energy (MJ/kg)	Ca (g/kg)	P (g/kg)	Mg (g/kg)	Cost/kg (UGSH)
Treatment 2 (MC)							
Maize bran	77.0	110.0	10.0	1.0	5.0	0.5	150
Cottonseed cake	21.5	350.0	10.9	1.5	10.0	4.0	320
Salt	1.5	0.0	0.0	0.0	0.0	0.0	320
Nutrients in feeds	100	160	10	1.1	6.0	1.2	189.1
Animal requirements	-	160	8.4	7.0	3.2	1.3	-
Treatment 3 (MPT)							
Maize bran	51.0	110.0	10.0	1.0	5.0	0.5	150
Gliricidia	10.0	180.0	8.0	7.7	3.0	3.5	400
Calliandra	37.5	230.0	8.0	8.0	3.0	3.5	400
Salt	1.5	0.0	0.0	0.0	0.0	0.0	320
Nutrients in the feed	100.0	160.4	8.9	4.3	4.0	1.9	271.3
Animal requirements	-	160.0	8.4	7.0	3.2	1.3	-

Blood metabolites

Blood samples were collected and stored at the beginning of the trial, at the end of each season and on the day of slaughter. The blood samples were analysed for lipid profile, total protein, albumin, globulin, blood urea nitrogen (BUN) and glucose.

Rumen fermentation characteristics

At the point of slaughter rumen fluid will be collected and used to determine rumen Ph, ammonia nitrogen, and volatile fatty acids (VFAs).

Carcass yield and meat quality

At the end of the feeding period (one year), all the animals will be weighed, and transported to the Uganda Meat Industries abattoir and slaughtered for carcass yield and meat quality to be assessed. Meat samples were collected from prime parts of the carcass and analysed for fat, including the lipid profile, protein and dry matter content.

Preliminary results

The growth performance of the kids from the two genotypes during the nine months of the trial is summarised in Tables 2 and 3. The mean body weight of Mubende goat kids increased by 11.6 kg and that of the cross-breds by 10.6 kg during the nine months supplementary period (Table 2). Mubende kids increased their weight by 37, 42 and 76 per cent when on no supplement (control), MPT or MC, respectively. The cross-bred

kids increased their live-weight by 29, 37 and 70 per cent when on control, MPT or MC, respectively (Table 2).

Average daily weight gains were different among the treatments, with both breeds of kid supplemented with MC having the highest, and the non-supplemented kids having the lowest gains . Within the Mubende kids, supplementation with MPT slightly improved weight gains when compared to the control (35.8 v 30.7 g/day). Weight of the Mubende kids at slaughter was 23.3 kg and of the cross-breds was 25.0 kg. Supplementation with MC improved slaughter weight in both breeds, compared to control and MPT (Table 4), and the effects were more pronounced in the Mubende, compared to cross-bred, kids (Table 4). This was attributed to a reduction in growth in the cross-bred kids at the outset of the trial. Dressing-out percentage was not not markedly affected by treatment although the preliminary results show that supplementation with MPT caused a slight reduction in both breeds, compared to the other two treatments (Table 4).

Because this trial is in its preliminary stages the import of the results will not be discussed here.

Table 2 *Growth performance of Mubende and Boer X Mubende cross-bred kids receiving supplements for nine months (see Table 1 for details)*

Treatment	Mubende	Boer x Mubende
Initial weight, kg	11.0 ±3.2	12.8±3.8
Live weight at end of trial (kg)	22.6	23.4
Change in body weight, kg (all kids)	11.6	10.6
• grazing alone (control)	8.3	6.8
• grazing + Concentrate (MC)	17.1	16.3
• grazing + MPTS mixture (MPT)	9.5	8.7

Table 3 *Daily live-weight gains (g/day) of kids grazing natural pasture from two breeds (Mubende or Mubende x Boer) and receiving supplements (see Table 1 for details)*

Treatment	Mubende	Boer x Mubende	All animals
Overall, g/day	44.8	43.6	44.2
• grazing alone (Control)	13.7-53.3 (30.7)	10.7-38.5 (24.2)	27.5
• grazing+MPTS mixture (MPT)	13.7-47.8 (35.8)	20.0-81.5 (46.1)	41.0
• grazing + Concentrate (MC)	40.4-95.6 (68.0)	34.1-79.3 (60.5)	64.2

* The figure in brackets is the overall average for the group

Table 4 *Carcass weight and dressing out percentage for Mubende and Boer X Mubende cross-bred kids, receiving supplements (see Table 1 for details)*

	Carcass characteristics		
Treatment	Live-weight at slaughter kg	Hot carcass weight, kg	Dressing percentage
Mubende kids			
• Control	18	8	46
• Graze + MPTs mix.	22	9	42
• Graze + MC	30	17	46
• Mean	23.0	11.3	44.7
Cross-breds			
• Control	21	10	47
• Graze + MPTs mix.	24	10	44
• Graze + MC	30	15	46
• Mean	25.0	11.6	45.7

Acknowledgements

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Variation of milk yield with time for exotic and cross-bred dairy goats in Central Uganda: implications for breed development

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Abstract

Daily milk yields have been analysed for 195 goats with levels of European dairy (ED) blood of 0, 50, 75 and 100 per cent. Under tropical conditions, kidding intervals can be short and variable, making the total milk yield for the lactation an unreliable indicator of performance. For this reason, indexes representing the total milk yield for the first five months are introduced. To assess the value of individual goats, the daily yields are weighted in favour of the later times, to compensate for the lack of data after five months. Milk yields vary greatly between individuals, such that for a given grade the standard deviation is typically 45 per cent of the average yield for that grade. However, there is a still a clear difference between the performance of the different grades. This difference is particularly noticeable in the later stages of the lactation. For Small East African (SEA) goats the production at five months is only 7 per cent of its initial value, whereas for pure European Dairy goats it is 65 per cent of the initial value. The cross-breds are intermediate between these extremes. Plans are described for the eventual development of a synthetic breed combining the disease resistance of SEA goats with the milk production of the ED goats. The milk production of the F1 crosses is below the theoretical limit based on the estimated nutritional content of green forage. There is, therefore, scope for applying selective breeding to increase the production, especially in the later stages of the lactation.

Introduction

Social and geographical context

JOY Children's Centre is in Masaka District, at an altitude of 1,200 m. The mean annual rainfall is around 1,000 mm, mostly in two evenly spaced wet seasons. The main agricultural activity in the area is the cultivation of bananas and smaller quantities of other subsistence cash crops, such as coffee. The population density is fairly high, such that the average land holding is about 1.0 hectare per household. However, there is great variation and many families only have 0.2 to 0.4 hectares. The area is hilly and there is increasing awareness of the need for erosion control.

Because land holdings are generally small, especially in the case of the poorer families, keeping a cow is not feasible for most people. This means that the price of milk is very high and that over 75 per cent of the population fail to drink milk even once per week. Although goats' milk is not traditionally drunk, there is no explicit taboo against it. We have successfully promoted dairy goats in the villages immediately surrounding the Centre, and there is increasing interest from other areas and other organisations.

Feeding regimes

Traditionally, goats are tethered on fallow land: they are not allowed to browse freely at any time of year because of the predominance of perennial crops such as bananas. Increasingly, households are finding that there is no fallow land available within a reasonable distance of the homestead and so cut-and-carry feeding is becoming common. We are promoting the use of erosion control bunds, to simultaneously improve crop production and to provide forage for goats. This results in a year-round supply of good quality green forage, composed of a mixture of grass, leguminous shrubs and bulk tree leaves, supplemented with crop residues. At the end of the dry seasons, a higher proportion of tree leaves is used, whereas more grass is available at the end of the rains.

Breeding programmes

Initially, the Centre kept a mixture of local Small East African (SEA) goats, 50 per cent dairy crosses, and a few pure dairy goats. With time the SEA goats and low-grade crosses have been replaced by higher grade crosses and increasing numbers of pure dairy goats. It is likely that this trend towards higher levels of exotic blood will be continued. In the community there is a daughter-project, Kayunga Dairy Goat Project, which promotes the use of pure dairy goats among smallholders. One of the issues of concern to both these programmes is the high feed requirement of goats producing large quantities of milk. The results presented here will address the extent to which this is a significant constraint to productivity.

The keeping of high-grade or pure exotic animals has been shown to be feasible where there is good access to training and extension services. However, it seems likely that the introduction of such animals in many areas will be hampered by the poorer management levels applied, whether this is through lack of knowledge, lack of facilities and resources, and other environmental or economic factors. For this reason a village-based breeding programme has been set up to establish a large population of approximately 50 per cent cross-breds. Selective breeding will then be applied to improve the performance of the cross-bred population. The results presented here will enable the productivity of the initial population to be predicted, as well as providing guidance for the selection criteria.

Materials and methods

Daily milk yields have been recorded for 10 years from a wide variety of goats. The results shown here are from SEA, pure European dairy goats, and the 50 and 75 per cent dairy grades. Between 21 and 64 animals were studied in each category (Table 1). Few goats were available of a distinct European breed: most were mixtures of Saanen and Toggenburg, with smaller contributions from British Alpine and Anglo-Nubian blood.

All the goats were kept at JOY Children's Centre under zero-grazing. In the first years of data collection, feeding was primarily with fresh greenstuffs; supplementation with dairy meal was only used for the best milkers. Recently, as the numbers of goats have increased, all goats have been given some maize bran or dairy meal. Although the initial intention had been to feed a balanced mixture of grasses, legumes and bulk tree leaves, forage availability has to a large extent restricted this. Legume use is currently increasing sharply, as the tree-planting programme takes effect. However, for most of this study, tree leaves have been the major source of forage, along with some grass.

Results

Figure 1 shows the variation of milk yield with time, for the four grades of goats studied. The data has been smoothed by taking 10-day averages. In Figure 2, the same data has been re-presented with the daily milk yields expressed as a proportion of the production during the first week.

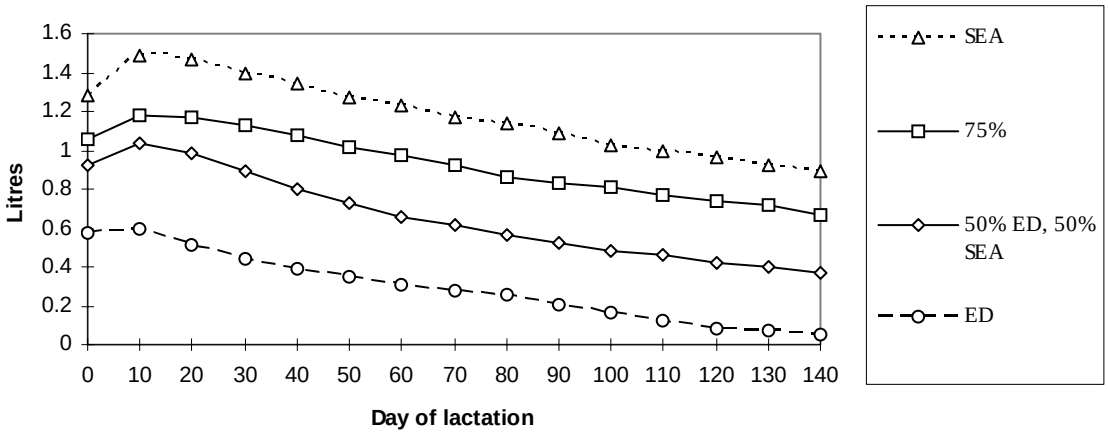

Figure 1 *Averaged daily milk yield for European Dairy (ED), Small East African (SEA) goats and their crosses*

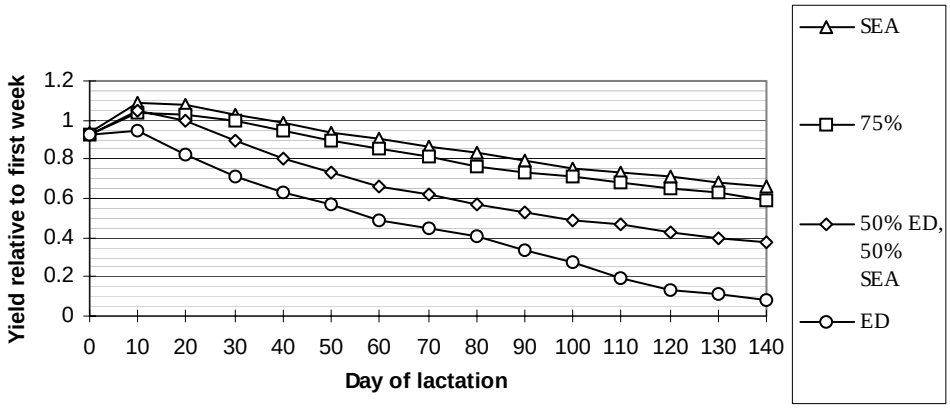

Figure 2 *Daily milk yield relative to the average for the first week for European Dairy (ED), Small East African (SEA) goats and their crosses*

The Centre is very near the equator, and so there is virtually no variation in day length in the course of the year. As a result, photoperiodism is not a constraint to breeding and goats can come on heat at any time of year resulting in short and variable kidding intervals. In turn this means that lactations can be as short as four months; not necessarily because of inherent poor persistence of milk production, but simply because the goat is in late pregnancy. Consequently, the conventional measure of lactation, milk summed over the whole lactation, could give misleading results. For this reason we have been forced to only consider the first five months. Even so, a few lactations have had to be excluded because the data for the fifth month has been influenced by the doe being in late pregnancy. Table 1 shows how the total milk production varies with grade.

Table 1 *Total milk production for the first five months of lactation for various grades of goat (0 = Small East African (SEA); 100 = pure-bred exotic; 50 and 75 indicate percentage of exotic dairy blood)*

Grade	sample size	5-month Aggregate* (litres)	standard error of mean (litres)
0	21	44	4
50	64	99	5
75	50	139	6
100	60	177	10
Total	195		

*See discussion below. Includes milk fed to kids.

The averages shown in Figure 1 and Table 1 disguise a very large variation between individuals, which is illustrated by Figure 3.

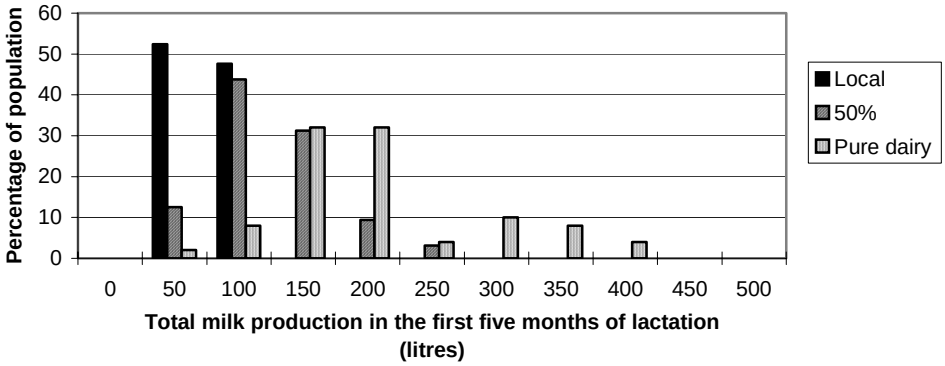

Figure 3 *Population distribution according to 5-month total milk production, for various grades for European Dairy (ED), Small East African (SEA) goats and the F1 cross-bred*

Figure 3 shows that there is a lot of overlap between the grades when total production is compared. However, Figure 2 suggests that the grades of goats can be differentiated by comparing the length of the lactation. In Figure 4 this is done using the ratio of milk production in the 5th month of lactation to that in the first month.

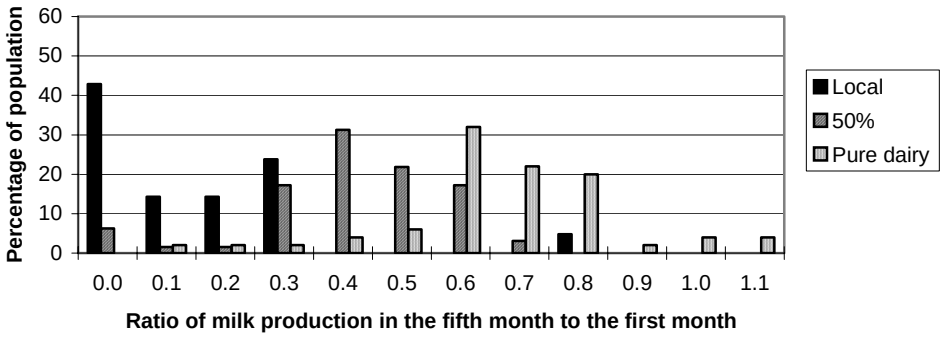

Figure 4 *Population distribution according to the ratio of milk production in the fifth month to that in the first, for various grades for European Dairy (ED), Small East African (SEA) goats and the F1 cross*

Discussion

Feed requirements as a limitation to production

It is widely considered (Peacock 1996) that the dry-matter consumption of tropical goats feeding on fresh vegetation is 3 per cent of body weight, although European dairy goats may substantially exceed this. Anecdotal evidence from our own community programme, as well as Kenyan experience, suggests that the milk production from well-fed goats exceeds what is possible from a dry matter intake of 3 per cent. We have assumed a dry matter intake of 4 per cent and have used the nutritional content of forage reported by Peacock 1996 (Table 2) to estimate nutrient uptake. After allowing for maintenance requirements, the maximum amount of milk that a goat could produce is given by Table 3. The figures in column 2 of Table 3 assume no growth or change in body condition. Table 3, therefore, does not apply to the first lactation, which is normally accompanied by some growth, but is a useful guide to the potential for subsequent lactations. Body condition is often lost early in the lactation, (when milk yields are high), but regained in late lactation (when yields are lower). In this case, Table 3 gives a reasonable measure of the average potential lactation.

Table 2 *Estimated nutritional value of available forage (Peacock, 1996)*

	grass	tree leaves
Proportion of feed	33%	66%
Basic analysis		
Dry matter (DM, g/kg)	200	250
Metabolizabe energy (ME, MJ/ kg DM	9	9.5
Crude protein (g/kg DM)	130	200
DM Digestibility	0.50	0.50
Nutrients in fresh forage		
MJME per kg	1.80	2.38
Protein (g per kg)	12.5	25.0

Table 3 *Maximum expected milk production (litres) from goats of different live weights receiving a diet of fresh forage (from Peacock, 1996)*

Goat weight (kg)	milk production
25	0.93
30	1.16
35	1.40
40	1.64
45	1.89
50	2.14
55	2.40
60	2.66

Time-dependence of milk production

For each grade of goat, total milk production is very variable. The standard deviation of the 5-month totals is typically 40 to 45 per cent (Table 1 and Figure 3). In practice this means that for a given grade the best goats can produce four times as much as the worst performers. However, we have observed that the shape of the lactation versus time (Figure 1) is much more consistent: pure dairy goats maintain their production for a long time; SEA goats always have short lactations; and cross-breds are intermediate. This can be clearly seen in figures 3 and 4. Figure 3 shows that there is considerable overlap between the grades of goats when the first five months of lactation are considered. A good measure of the shape of the lactation versus time curves is the ratio of milk production in the fifth month to that in the first month. Figure 4 shows that there is much greater separation between the grades using this parameter than when the total lactation is considered.

Weighted 5-month total yield

The principal use of the total lactation yield is to compare animals for the purpose of making breeding and culling decisions. Although kidding intervals may be short, there is a wide variation, so that many animals have lactations of up to 10 months. If only the first five months are considered, then those with good late yields will be unfairly

discriminated against. To compensate for this we give the later days of lactation a greater weighting than the earlier ones, such that:

$$\text{Weighted average} = 0.552 \times \Sigma(\text{daily\_yield} \times (1 + 5 \times (\text{day\_number}/150)^3)$$

The factor of 0.552 at the beginning was chosen so that, for an average 50 per cent cross, this weighted aggregate has the same value as the 5-month total.

Pure dairy goats

The average performance for pure dairy goats at the Centre is disappointing (Figure 1). Production from village goats appears to be similar to that reported here, both in magnitude and variation. The average production is well below the potential from green-feed (Table 3). However, the wide variation means that many individual goats do in fact produce enough milk to require supplementation with concentrates. This is not a problem close to town, because there is a developing market for goats' milk for infant feeding and for making yoghurt. The cost of the concentrate can, therefore, be recovered from the sales of milk. The relatively low levels of lactation could in part be due to problems of management, and this is being addressed. However, it is also likely that European breeds, which are reared entirely on greenstuffs in a hot and humid climate, will under-perform relative to those in their 'native' environment. There is, therefore, a need to selectively breed from those individuals whose health and high milk yield demonstrate their tolerance of wet tropical conditions. To some extent this aim is hindered by limited numbers of goats from which to select, and the need to retain females within the village distribution programme.

On the positive side, the sustained production is of great benefit to farmers in marketing their milk. Often the milk is sold directly to an individual customer who requires it for infant rearing, and an assured, regular supply for six months or more is very important.

Local goats

Within Masaka District it is very rare to find instances of local goats being milked. Since the inception of the dairy goat programmes a few people have attempted it as an experiment, but the quantities obtained have never made it worthwhile continuing. This is entirely consistent with the results shown in Figure 1, which indicate that the milk produced is only sufficient for the goat's own kid(s). Even in the rare individuals that produce one litre or more, the production starts to reduce within one week from the date of delivery, making them poor candidates for dairy animals.

Case for a synthetic breed: 1) dairy considerations

The poor performance of the local goats makes them unsuitable as a basis for developing a dairy breed, unless a substantial amount of exotic blood is introduced. On the other hand, the 50 per cent cross-breds show a reasonable peak production and persistence (Figures 1 and 2). They are, therefore, promising candidates for developing a synthetic breed which combines the disease resistance and climatic adaptation of SEA goats with the higher milk production of the European breeds. Because they are likely to be used where marketing of the milk is erratic, concentrates are not economic as a component of the feed. A daily milk production of 2.5 litres at the start of lactation, dropping to 1.5 litres at five months would, therefore, be ideal. Only the very best 50 per cent crosses have achieved this ideal initial production, but none have been found which can sustain 1.5 litres after five months. For this reason it is important to select not just for a high

initial yield, but more importantly for high yields over an extended period. In this regard, the weighted average described above is a very useful selection criterion.. At present (May 2005) there are stud males in 110 villages; this will be increased to 200 over the next two years. Assuming that there are 40 active goat breeders in each village (out of a total of approximately 120), and that each household has an average of two breeding females, then the total population of breeding females will be 16,000. According to the current level of interest, we anticipate that around 10,000 of the cross-bred females will actually be milked. This represents a significant achievement in its own right. However, this will also provide the initial population from which a synthetic breed can be developed. Not every farmer or village will be involved, but we are confident that between 2,000 and 5,000 breeding females will be part of the selection process. The selection criterion outlined above will be our primary guide, but additional considerations are given below.

Case for a synthetic breed: 2) non-dairy considerations

In Masaka and other arable-farming areas the price of milk is very high. This means that the economics of milk production are more favourable than meat production for both cows and goats. However, goats have traditionally been considered as meat animals, so this aspect cannot be ignored. The cross-breds do not exhibit the excessive leanness of pure dairy breeds, and so can be reasonably considered as dual-purpose animals. Regarding the selection process, growth rate will need to be included as a subsidiary selection criterion.

Short kidding intervals are also important, but these are already satisfactory for the 50 per cent crosses, and this will, therefore, not need much emphasis in the selection process. For meat production, a high kidding rate would be important, but the low heritability of this trait means that it will not be feasible to include it. Furthermore, as goats' milk becomes popularised, it is likely that the economic benefits of twinning will be strongly offset by the consequent reduction in available milk.

Disease resistance is the major reason for starting with cross-breds - higher levels of exotic blood lead to unacceptably high management requirements, but lower than 50 per cent exotic blood results in unacceptably low milk production. Explicit selection for disease resistance or climatic adaptation is very difficult, but we expect this to occur implicitly - non-resistant or poorly adapted goats will have poorer lactations and growth rates, and will, therefore, be selected against automatically.

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PEACOCK, C. (1996). Improving Goat Production in the Tropics: A Manual for Development Workers, OXFAM/FARM-Africa, London, UK.

Editors' comment

While acknowledging the views expressed in this paper, we support the objectives of the cross-breeding programme undertaken by the Farm-Africa Project at Meru as being a practical solution to increasing the milk potential of local goats.

Discussion on research papers including posters, drawing out common features, dissemination issues and gaps

Session introduction

In his introduction, the Chairman emphasised the link between observations from the field visits and conclusions from the scientific presentations. He further stated that in January to December 2005, there will opportunities for funding joint dissemination projects that result in an impact on livelihoods for small stock keepers. The field visit had reminded us that farmers' information sources are interactive: they seek and obtain information from other farmers, and through training, exchange visits and interaction with vets. Trust is a key factor in these interactions: have farmers learned they can trust the source of information? Discussions with farmers in the field also showed us that livelihood benefits depend not only on science and technology, but also on policy and infrastructure (such as credit and markets). The visit also raised issues about the design and process of farmer participatory research.

The chairman suggested that the discussion should focus on three things: how to get new knowledge into the networks and processes from which farmers access advice and information; what ideas and information to promote to policy makers, and how to do it; and what lessons should be shared with other researchers.

Session outputs

The purpose of the session was to identify common lessons and themes from the scientific presentations, posters and field visit, from which groups could then work up proposals for developing dissemination products. The outputs expected from the session were:

- priority themes for the sharing of information and knowledge with various categories of stakeholders, including researchers, policy makers and intermediaries

- ideas on what kinds of products are needed for the different stakeholders, and on how to generate them.

Session discussion and content

The discussions on the presented research papers, posters and field visit drawing out common features, dissemination issues and gaps are presented below.

Worms in goats

The problem of worms in goats was emphasised during the field visit. There should be collective approaches on appropriate and sustainable control in all small livestock (sheep, goats and pigs).

Nepal has developed some extension materials on worm infection in goats for dissemination. Outcome from this study and from other researchers should be consolidated and disseminated widely.

Demand driven research

So-called 'participatory' livestock research is often not as demand-led as it should be. There is need for a better understanding of why this is so. Is demand-driven research based on the farmers' perceived needs or the needs of the researchers? How can scientists convince the farmers that their perceived need may not be the actual need? Similarly, how can farmers convince scientists that the scientists' perception of need may not be what farmers need? This is a question of the nature and quality of dialogue between researchers and farmers. It was noted that, generally, extension and communication methods are more crop than livestock-oriented. Support is needed for livestock extension approaches to strengthen dialogue about technology through 'researcher – farmer collaboration'.

A key question is how researchers can empower the community (policy makers, NGOs, farmers and others) to become involved with and contribute to proper livestock research. It was noted that there is little by way of training and practical guidelines available to help researchers in using participatory methods in arriving at solutions. It was suggested that local political leaders should be involved with formulation of research projects.

Project benefits must be targeted at the needy. There is a need to find a way of developing extension materials for resource-poor farmers, rather than only for commercial farmers who are profit orientated.

Nutrition

Suggestions for nutrition research and dissemination included:

- Develop annual feeding calendars based on the predicted feed resources and the number and expected production of the livestock to be fed
- Feed information packages are required for ruminants and pigs
- Pasture management and agro-forestry should be regarded as an aspect of animal nutrition. There is a wealth of information on these topics which could be disseminated to farmers.
- Indigenous knowledge of feeds and local feeding systems should be acknowledged, and, where appropriate, validated. It is unlikely that one feeding system will suit all situations.
- Research into options for feeding goats is in progress, much of it being participatory.

Poultry

For the poultry sector, technology for increasing egg hatchability, developed in India, should be disseminated. Also, a bio-economic model as a decision tool for smallholder-owned free-range poultry should be developed. Research into the disappearance of local chicken early in life should be carried out.

Farming systems

Production systems should reflect availability of livestock species in the different locations/regions of the country: for examples: 1) goats; 2) chicken; 3) ducks; 4) mixed

(goat, chicken, duck). The Bolivia presentation emphasised the role of the pig in smallholder livestock production.

Housing

From field observations it is clear that advice is needed for building adequate animal housing and fencing, using, where possible, local materials.

Breeding

Cross-breeding programmes should go hand in hand with strategies to safeguard the existence of indigenous breeds. Exotic breeds or crosses need more attention in terms of feeding and health if they are to realise their potential. As land decreases due to urbanisation and climatic change, indigenous breeds could withstand the environmental challenges better than introduced breeds, even though their production potential will be lower. Selection for specific traits within the indigenous breeds, although slow, should be considered. Breeding programmes should include open nucleus herds to provide F1 offspring to farmers.

Gender

We need to identify gender differences in access to knowledge and information which can be alleviated by dissemination. There is also a need to differentiate between roles of men and women in livestock production based on small animal species: these differences should be taken into account in both research and dissemination.

Environment

Long-term effects of harvesting and feeding technology on the environment need to be considered. Nutrients should be returned to the soil to maintain ecological balance. Farmers should consider the need for soil conservation as a major issue.

LPP knowledge toolbox for small stock

Wyn Richards, LPP Programme Manager, encouraged participants to have a look at the LPP toolbox on compact disc (CD). It is based on the results of research projects that have generated generic products (technical interventions and policy change). The CDs also contain guidance on how to transform this information into various media – posters, radio programmes, manuals, CDs, drama etc. It was noted that the software used to develop CDs and to read or use them should be indicated on the CD.

Summary of lessons and themes

These broad issues/comments and observations made were summarised into a) animal husbandry issues, and b) wider issues (see the table 1 below).

Table 1 *Summary of dissemination issues identified*

Animal husbandry issues	**Dissemination issues identified**
Nutrition	Decision support on economics
	Nutrition budgeting
	Decision tools to assist with planning
	Forage management
Disease	Mortality of chicks
	Predation
	Dehydration
	Hatchability
Housing	Stall fed/housed compared to grazing for goats
Breeding	Record keeping
Wider issues	**Dissemination message or medium**
Gender issues in applying livestock interventions	Journal papers
	Policy briefs
	Intermediaries
Policy	Ways to ensure the poor are aware of the results of research
	Listening to farmers
	Empowerment of stakeholders
	Breeding policy
Environment	Environmental impact of livestock interactions

Generation of joint dissemination material and local impact assessment

The participants were divided into three working groups to consider goats, poultry and mixed species (all other species). Each group was asked to address three questions for their species:

- What information to disseminate to intermediaries, policy makers, and researchers
- How to disseminate it, i.e. through what type(s) of product
- Next stages, how to produce them.

The group work was presented in a plenary session, followed by a discussion.

Group I: Poultry projects

Members:

Dr S. A Okantah	Ghana - Chairperson
Dr Bart Mupeta	Zimbabwe - Secretary
Dr D.N. Shindey	India
Jude Okeria	Uganda
Dr David Mutetika	Uganda

This Committee expressed willingness to network to produce sample dissemination manuals and documents.

Q1. What information to disseminate

Target groups include:

- Intermediaries (non-governmental organisations (NGOs); community-based organisations (CBOs); farmer-based organisations (FBOs); extension agents)
- Policy Makers
- Researchers

1. Nutrition

- Dissemination material needed for:
    - Free-range chickens
    - Smallholder commercial intensive
- Information should include:
    - Feed budget
    - Economics of supplementation

- Indigenous knowledge

2. Housing

- Appropriate housing structures

3. Disease (Control and Prevention)

- Reduced mortality
- Increased hatchability

4. Environment

- Use of manure to maintain soil fertility

5. Gender

- Sensitisation
- Women's empowerment

Q2. How to disseminate and types of products

- Training Manuals – (Intermediaries)
- Posters and leaflets (Intermediaries)
- Radio programmes (Intermediaries)
- Sensitisation workshops (Intermediaries, Policy Makers, Researchers)
- Reports and Memoranda (Intermediaries, Policy Makers, Researchers)

Q3. How to produce them

- Cross-country-drafting Committees
- Networking
- Setting targets (SMART objectives)

Funding is likely to be a constraint: budgetary control will therefore be necessary.

Group II: Mixed stock projects

Issue	Audience	How / what to disseminate?
Nutrition	Intermediaries	o Feeding strategies o Dry season feeding o Budgeting/economics, etc. o Decision support Currently the necessary support is not available, products such as the LPP decision support tool box are needed.
	Policy makers	o Policy briefs on contribution of small stock to poverty alleviation and sustainability of livelihoods in relation to the poor
	Researchers	o Evaluation of locally available feeds o Use indigenous knowledge of farmers o Simple and improved technologies o All recommended interventions should be economically sustainable
Housing	Intermediaries	o Appropriate and affordable structures o Species should be housed separately o Standard plans for specific structures should be available o Livestock should not be housed in the same structures as people
	Policy makers	o Byelaws must provide security for livestock keepers, especially from theft o Construction materials should be subjected to quality control and taxation
Diseases	Intermediaries	o Vaccination (low cost vaccines that are easy to handle and administer) o Work in groups and recommend small sized packages o Use LPP's disease control interventions already practised in various areas
	Policy makers	o Encourage vaccines packaged in small doses that are affordable to small resource-poor communities o Enforce laws regarding vaccinations
	Researchers	o Study disease-nutrition interactions, e.g. the role of tanniniferous forages.
Policy	Intermediaries	o Study and know all the policies and regulations o Should be able to empower/guide farmers o Capacity building
Environment	Intermediaries	o Encourage nutrient recycling (use of manure) o Promote selling unutilised manure to raise some money o Planned tree felling and replanting o Sustainable and affordable environmental packages
	Policy makers	o Policy makers need to be aware of environmental issues and ensure the necessary regulations are in place
Gender	Intermediaries	o Sensitise the farmers about existing gender issues o Should deal with households/families rather than individual farmers

Group III: Goat projects

Five main areas were identified as groupings into which research results and current knowledge could be classified. These were:

1. Worms
2. Breeding
3. Demand-led approach to research
4. Nutrition, including the use of tree fruits as supplements
5. Decision-support information for researchers carrying out nutrition trials

1. Worms – Conroy, Jayaswal, Max, Dowdy, Vatta

Two products were identified as being needed:

a) The first is a manual that includes research results of LPP work with reference to worms. The language of the manual should be able to be understood by intermediaries. Work to be included: that done in Tanzania on tannin drenches in sheep (and goats); the use of tree fruits in India; the FAMACHA© system from South Africa. A need for some ancillary technical references was expressed to be used in conjunction with the basic information of the manual.

b) The second is a technical brief for veterinarians (particularly those employed by the state) on the existence and development of anthelmintic and acaricide resistance. This has particular relevance to the frequent deworming and dipping of animals without apparent consideration of the epidemiology of parasites.

2. Breeding – Ahuya, Dowdy, Mtenga, Nadiope, Ssewannyana, Muwanga

a) A policy briefing by the Ugandan government in relation to the need to establish farmer-driven breeding programmes. There is a need for breeder associations rather than government control. The document should take note of the Meru goat project in Kenya.

b) A manual is needed for farmers involved in breeding of goats.

3. Demand-Led Research – How to do research with resource-poor communities – Conroy, Mtenga

There is a need for a briefing paper for researchers who do not have experience with research in communities. The paper should outline general principles, e.g. do one experiment that works rather than any number of different combinations of options on-farm.

4. Nutrition – Use of tree fruits as supplements – Conroy, Mlambo, Sikosana

There is a need for a short paper for researchers – an electronically available leaflet – giving information on pod-producing trees. This would be based on the work from Zimbabwe, giving a partly generic message; readers elsewhere would be able to identify gaps for attention in their own countries.

The second need is to produce a policy brief for forestry policy makers on the importance of considering planting indigenous trees rather than exotics.

A third paper should be written to allay the fears of environmentalists that the use of the tree fruits would be detrimental.

5. Nutrition – Decision-Support – Ahuya, Buttery, Conroy, Owen, Smith

A decision-support leaflet on how to conduct nutrition trials, and avoid unnecessary replication is needed.

Discussions on group work

Comments

The five groups have each produced a series of suggestions for dissemination projects. There is an overlap between these lists and there is scope for consolidation.

LPP-funded work from South America presented at the BSAS occasional meeting in Merida and work in Bolivia presented by Dr Paterson suggest there are critical improvements which can be made to traditional management which can lead to substantial improvement in production and livelihoods.

Ideas on dissemination products of processes

In response to a query on what output LPP wished to be generated, Dr Richards explained that currently LPP projects have generated single project outputs. We now need to collate related issues into thematic/customised information packages for defined audiences such as civil society and extension groups, policy makers and researchers. Such information should enable intermediaries to provide suitable advice for resource-poor farmers and policy makers to effect appropriate policy change; and for researchers to know what has been done and avoid duplication of effort.

With respect to how it might be done, Dr Richards suggested the establishment of consortium (or consortia) of LPP research project teams, with a lead coordinator, and agreement on suitable/agreeable timelines, etc.

Impact Assessment Issues

Wyn Richards led the discussion. He said that poverty exists at different levels: individual; family; community; district and national. He defined the terminologies used in explaining what poverty was. He said that there was going to be an evaluation of the LPP projects by DFID either as an external evaluation or self-evaluation.

A discussion on the parameters that will be considered in assessing the success of a project took place. A summarised list of indices for impact assessment was generated, in respect to different stakeholders as shown in the table below.

Table showing impact assessment indices as viewed by different stakeholders:

Donor	Researchers	Intermediary (NGO, extension)	Farmers
• Value for money • Millennium Development Goals (poverty alleviation)	• Research papers (quality and quantity) • Technology development • Extended product • Capacity building • Autonomous diffusion • Extension messages (no of extension groups targeted and uptake pathways) • Managing research better and in new ways	• Clarity of message • Has it changed process? • Have I adopted? • Relevance of research message and numbers • Impact of research to farmers • Capacity building of NGO • Contribution of beneficiary community • Innovation success • Number of farmers for how long • Horizontal uptake • Enabled access to information • Involvement in planning • Acceptable research pathway • Uptake by other NGOs etc • Credibility of organisation	• Feedback from recipients (affordable / relevant / involvement) • Environmentally friendly • Primary consequences of environment • Sustainability of the intervention (training?) • User-friendly (gender?) • Income/other benefits • Participatory monitoring • Riskiness / compatibility with other farming activities • Community benefits • Input / output relationship • High demand for technology transfer • Resolution of problem • Formation of special interest groups

Farmer impact assessment would consider:

- The repeatabilities of the technology and how easily it would be replicated.

- Whether the technology is environmentally friendly.
- Whether the project is sustainable.
- The appropriateness, affordability and sustainability of the technologies and whether the technology addresses the farmers' need.
- The ease of the technology and its compatibility with the family farming system and gender

Presentation of prizes and closing remarks

Presentation of prizes

Prizes were awarded to the best oral and poster presentations. Selection committees for the best oral presentation comprised of independent observers: two researchers, one donor representative and one non-governmental organisation (NGO) representative. Judgement was on clarity, content and how much the presentation stimulated discussions by the participants.

The prize for the best oral presentation went to Dr Jolly Kabirizi from Uganda whose presentation was on indigenous forage trees and shrubs as feed resources for intensive goat production in Uganda.

For the best poster presentation, the selection committee also consisted of independent people: a farmer representative, a researcher, a donor representative and an NGO representative.

The committee failed to identify just one presenter and thus two presenters were nominated:

(a) Mr M.L Jayaswal from Nepal whose poster was on an intervention to increase the contribution that goats make to the livelihoods of landless and land-constrained livestock keepers in the Gangetic plans of Nepal; and

(b) Dr Robert Max from Tanzania described the effect of wattle tannin drench or an *acacia* meal supplement on faecal egg counts and total worm burdens of tropical sheep with an experimental nematode infection

Closing remarks

Professor Peter Buttery, the Leader of the Link Project, closed the workshop by thanking all those who had contributed to its success. In particular he gave special thanks to:

1) the audience for affording their time to contribute so actively to the papers, posters, debates and research concept notes. It was heartening to see how the body of the workshop - farmers, NGOs, academics, researchers, consultants, private and public sector extension agents and policy makers/planners – took the opportunity to openly exchange views on issues which affect resource-poor communities around the world who keep livestock . He also congratulated the presenters for the continued improvement in the scientific quality of the research, its relevance and its presentation. Each participant and organiser was awarded official certificates of attendance.

2) the organisers, particularly the Uganda group, so ably chaired by Dr Edward Ssemwanyana. It is no easy task to coordinate all the necessary elements which make up a successful workshop, particularly when the venue is some distance away from your own institution. As a mark of appreciation to Dr Ssewannyana and his committee, Dr Ssewannyana was presented with a gift and was also invited to attend the next workshop in S Africa.

Prof Buttery also announced that two invitations to host the next (and last) workshop of the Link Project had been submitted and that a decision would be determined very soon. We now know that this will be held near Pietermaritzburg, S Africa between 12-15th September, 2005. We hope to see you there.

International workshop on 'Enhancing the contribution of small livestock to the livelihoods of resource-poor communities'

15-19 November 2004

Hotel Brovad, Masaka, Uganda

Monday 15th November

0800-0830	**Registration**	
Session i	**Chaired by Edward Ssewannyana, Serere Agricultural and Animal Production Research Institute**	
0830-0845	Housekeeping and logistics of meeting	Edward Ssewannyana
0845-0900	'The Link Project – bringing researchers, informers and users together'	Peter Buttery
Session 1	**Official opening**	
0900-0915	Welcome Remarks	Dr G.W. Otim-Nape, Director General, NARO
0915-0930	The Livestock Production Programme (LPP) and the 4 specific outputs foreseen from this workshop	Wyn Richards
0930-1000	Official Opening	Mrs Mugyenyi, Minister of State for Animal Industries
1000-1010	Vote of Thanks	Iwelda Mirembe, Livestock Farmer
1010-1045	Tea and Coffee	
Session 2	**Chaired by Camillus Ahuya, FARM-Africa**	
1045-1115	NGOs present each to give short presentations on their work with emphasis on smallstock/livelihood issues in an East African context.	
Output 1	**Presentation, discussion and dissemination of research products**	
1115-1315	Presentations of poultry projects with 20 minutes each for presentation plus 10 minutes for discussion	

The utilization of low-fibre sunflower residue by hybrid and village chickens in pens and free-range Bart Mupeta

Small-scale poultry production in peri-urban areas in Ghana Sam Okantah

Improving productivity of scavenging poultry in Indian villages by the use of improved hatching egg management techniques and technology transfer Dinesh Shindey and Czech Conroy

Rural backyard poultry Eli Katunguka Rwakishaya

1315-1415 Lunch

Session 3 Chaired by Emyr Owen, University of Reading (Emeritus Professor)

Poster Session on Goat projects (see below) and direct interaction with authors

1415-1425 Introduction to poster session Emyr Owen

1425-1525 Viewing of posters with authors present – opportunities for questions

1525-1600 Coffee/Tea

1600-1745 Sheep/goat project cluster scientists to each give a 10 minute update on new findings to complement poster; additional10 mins per project for questions

Tannins: a method of controlling intestinal parasites in ruminants? The effect of wattle tannin drench or an acacia meal supplement on faecal egg counts and total worm burdens of tropical growing sheep with a challenge nematode infection Robert Max

Increasing the productivity in smallholder owned goats on *acacia* thornveld Joe Sikosana and Victor Mlambo

Community-based goat productivity improvement in Central and South Meru Districts of Kenya Camillus Ahuya

Interventions to increase the contribution that goats make to the livelihoods of landless and land-constrained livestock keepers in the Gangetic plains of Nepal M L Jayaswal

Relative economic benefits of strategic anthelmintic treatment and urea-molasses block supplementation of Boer goats raised under extensive grazing conditions at Onderstepoort, Pretoria, South Africa Adriano Vatta

1745-1815 Research derived information to farmer knowledge pathways and products-

LPP Knowledge Banks and Toolboxes for Smallstock – need for more inputs Wyn Richards and Sarah Godfrey

1900 Welcome reception/dinner with LCV Chairman giving after-dinner speech

Tuesday 16th November

Session 4 'Uganda Day'-an opportunity to visit smallstock enterprises and discuss associated issues with smallstock keepers in the Masaka area

0700	Breakfast at Hotel Brovad
0900	Departure for field
1000	Estimated arrival at site I
1100	Departure for site II
1130	Arrival at site II
1230	**Packed lunch**
1300	Departure for site III
1430	Arrival at site III
1530	Departure for site IV
1600	Arrival at site IV
1700	Departure for Hotel
1800	Arrival at Hotel
1810	Feedback from site visits - researchable issues (technologies/advice/policies) Chair Edward Ssewannyana
1900	Barbecue with entertainment from Masaka Drum Beat/Hotel music
2200	End

Wednesday 17th November

Session 5 Chaired by Aichi Kitalyi, ICRAF

0800-1300 **Presentations of mixed projects with 20 minutes each for presentation plus 10 minutes for discussion**

The role of poultry and goats in poverty alleviation in Bangladesh M Saadullah and M Hossain

Action research on improved small livestock keeping with landless poor in two communities of Terai, Nepal Babu Ran Banstola

Poultry, pigs, hair sheep and guinea pigs in the livelihoods of small-scale, subsistence farmers in tropical Bolivia Rob Paterson

Smallstock and women in livestock production in the Teso Farming System Brian Owoyesigire

The use of recommendation domains and GIS as a tool in out-scaling livestock technologies for resource-poor livestock-keepers Czech Conroy

1030-1100 Tea and coffee

1100-1300 Linking the demand for, and supply of, agricultural production and post-harvest information in Uganda – focus on the use of goat de-worming using mucuna trichomes Francis Ejobi

Dissemination of low-cost technology for handling crop residues and dry forages for dry-season feeding in Northern Tanzania Nicholaus Massawe

Apiculture industry in Uganda A. Kangave and E. Ssewannyana

Indigenous fodder trees and shrubs as feed resources for intensive goat production in Uganda J.M. Kabirizi and E. Ssewannyana

1300-1400 Lunch

Session 6 Chaired by Chris Garforth, University of Reading, LPP Adviser

1400-1500 Discussion on research papers including Posters, drawing out common features, dissemination issues, gaps.

1500-1530 Tea and coffee

Session 7 Chaired by Dan Kisauzi, DFID East Africa Regional Co-ordinator

Output 2 Generation of joint dissemination material and local impact assessment

1530-1700 Introduction Chris Garforth

	Participants to split into 2-3 working groups to share lessons learnt and plans for the future on joint dissemination activities and how to better effect local impact	
1700-1800	Working groups to report back to plenary and agree on next steps re joint dissemination/promotion activities and wish list for support funding.	
1800-1815	Summary of sessions 6 and 7	Chris Garforth
1815-1830	Award for best theatre presentation/poster	

Thursday 18th November

Session 8 Chaired by Louis Mtenga, Sokoine University of Agriculture

Output 3 Impact assessment issues

0830-1000	Update DFID and the LPP's plans for impact assessment activities	Wyn Richards
	Open discussion on impact assessment approaches from perspectives of donors, research implementers, extension institutions and farmers	
	Coffee/Tea	

Session 9 Chaired by Tim Smith, independent consultant

Output 4 Consortia for new research – addressing the gaps

1030-1300	Introduction of the topic	Wyn Richards
	Division into working groups to discuss potential new work	
1300-1400	Lunch	
1400-1530	Working groups to report back to plenary	
1530-1600	Tea	
1600-1630	Summary of day four	

Session 10 Chaired by Peter Buttery, University of Nottingham

1630-1700	Summary of workshop, arrangements for Proceedings and next steps	
	Thanks and end of meeting	
	Social Evening	

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LPP projects

Project number	Project title	Research venue
R6619	Husbandry strategies for improving the sustainable utilisation of forages to increase profitable milk production from cows and goats on smallholder farms in Tanzania	Tanzania
R7351	Increasing the Productivity in Smallholder Owned Goats on Acacia Thornveld	Zimbabwe
R7424	Can Feeding Locally-Available Plant Material Rich in Tannins Reduce Parasitic burden in ruminants and hence improve their Productivity.	Tanzania
R7524*	The use of oilseed cake from small-scale processing operations for inclusion in rations for peri-urban poultry and small-ruminant production	Zimbabwe
R7631	Strategies to strengthen bird productivity and business decision making in peri-urban small-holder poultry flocks	Ghana
R7632	Increasing the contribution that goats make to the livelihoods of resource poor livestock keepers in Himalayan forest region	Nepal
R7633	The use of alternative, tanniniferous, saponin and antioxidant containing materials as a means of improving the health and production of scavenging (desi) poultry	India
R8108	Strengthening the Contribution of Women to Household Livelihood Through Improved Livestock Production Interventions and Strategies in the Teso Farming System Region	Uganda
R8109	Using livestock to improve livelihoods of landless and refugee-affected livestock keepers in Bangladesh and Nepal	Bangladesh and Nepal
R8151**	Improving the livelihood of resource-poor goat farmers in Southern Africa through strategic drug and nutritional interventions against gastro-intestinal nematode infections	South Africa
R8281***	Linking the demand for, and supply of, agricultural production and post-harvest information in Uganda	Uganda

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** fully funded by DFID's Animal Health Programme
*** also funded by DFID's Crop Protection Programme

These proceedings summarise the events, action points and conclusions of the United Kingdom's Department for International Development's Livestock Production Programmes (LPP) funded workshop on '**enhancing the contribution of small livestock to the livelihoods of resource-poor communities**' held at the Hotel Brovad, Masaka, Uganda, from 15-19 November 2004.

The meeting consisted of presentations of findings from research projects based in Bangladesh, Bolivia, Ghana, India, Kenya, Nepal, South Africa, Tanzania, Uganda and Zimbabwe, and considered small livestock ranging from bees to pigs to goats.

This was the fourth in a series of workshops on small stock, the fifth will be held in South Africa in September 2005.

The DFID Livestock Production Programme is managed by NR International

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