Research and Training Strategies for Goat Production Systems in South Africa

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at

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Eastern Cape
South Africa

Edited by
E.C. Webb, P.B. Cronjé & E.F. Donkin
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FOREWORD

Research and Training Strategies for Goat Production Systems in South Africa

The aim of the workshop was:
To improve capacity for training and research in South Africa and facilitate networking with the University of Queensland.

The objectives of the Workshop were to:
1. Identify and prioritise the matrix of problems related to goat production which needs to be researched.
2. Identify areas of expertise relevant to the solution of problems.
3. Define research objectives and initiate collaborative networks,
4. Identify tertiary curriculum objectives and components needed for the training of graduates working in areas where goats are a prominent component of animal agriculture.

Project Background
The aim of the project is to initiate an institutional development programme to promote agricultural transformation in the rural communities of arid/semi-arid South Africa through university level training and research. This programme will concentrate on:
1. Staff training
2. Curriculum development
3. Enhancing skills in specific areas such as agricultural research with a focus on rural community needs.
4. Facilitating staff and student exchanges between universities in the network.

These objectives will support development of the Universities of Pretoria, The North and Fort Hare, and encourage links between them so that they can more productively manage their contribution to the Reconstruction and Development Programme (RDP). The desired outcome is the development of productive and sustainable farming systems for the arid and semi-arid lands of South Africa, and thereby to improve the standard of living of all members of the rural communities through productivity, growth and equity.

The conduct of short courses and workshops is part of the on-going activities. A series of eight have been designed, of which the goat workshop is one and will form the basis of continuing collaboration between the South African universities and the University of Queensland.

Goat Production Workshop
The workshop on Goat Production was developed by Prof Pierre Cronje (University of Pretoria), with the assistance of Dr Barry Norton (University of Queensland). The programme included Dr B.J. Restall (Honorary Consultant, UQ) from Australia, Prof Jan Raats (University of Fort Hare), Prof Lindela Ndlovu (University of the North) and representatives of various provincial Departments of Agriculture, the Universities of the Free State, Pretoria, Rhodes and Medical University of South Africa Veterinary Faculty, Agricultural Research Council and Council for Scientific and Industrial Research (Textek).
Welcoming address

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This workshop is the result of a grant by the Government of Australia as part of its aid package to South Africa in recognition of this country’s transition to democracy. The expectation is that this workshop, focusing on goats, will derive a blueprint for scientific research and extension that will contribute to both the upliftment of impoverished rural communities and the improvement of those primary and secondary industries that rely on the goat farming enterprises.

Goats are farmed throughout South Africa. In regions where bush encroachment is rife goats are farmed together with cattle. The robust Boer goats and hardy African goats fare well in these combined production systems. In the dry North West region, extensive ranching of goats is done together with Karakul, Persian and Dorper sheep. Angora goats are an important industry in the Eastern Karoo. Farming with Angoras extends into the temperate regions and to the Lesotho highlands. Milch goat farming is not a major industry. However, given the high occurrence of cow milk allergy, there are considerable opportunities for this industry to expand.

Goats make a valuable contribution to the livestock industry in southern Africa. In the rural, economically deprived regions goats are a ready source of cash-income and food and social security. The greatest need for research into the constraints in livestock production lies in these regions. Agriculture can no longer afford inefficiency in any form. Whilst traditional livestock production is a part of cultural life, inefficiency can no longer be part of it and cannot be afforded.

This workshop is being co-ordinated by Professor Pierre Cronjé of the Department of Animal and Wildlife Sciences, University of Pretoria, But it is a joint undertaking between the University of Queensland, the University of Fort Hare and the University of Pretoria. In this regard, I welcome Professors Barry Norton and Barry Restall, two renowned scientists with vast experience in teaching students on various aspects of goat husbandry, doing fundamental and applied research and in transcribing their research successfully into rural development programmes.

We have a formidable collection of specialists here at this workshop, from academia, extension services and industry. The outcome of these four days is sure to have a long term beneficial effect on the people of South Africa who rely on goats for their livelihood and to fulfil their social obligations in one way or another.
Perspectives on the constraints, opportunities and issues surrounding research on goat production in Southern Africa

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The resolution of issues (i.e. questions or disputes) represents the only valid motivation for research (the endeavour to discover facts by study or investigation), and is the cornerstone for the null-hypothesis upon which the scientific method is based. The impact and usefulness of research findings will, therefore, be determined by the relevance of the issue that is addressed. Unfortunately, in many cases far too little time is spent defining what the critical issue is. Because of ill-defined perceptions of what the relevant issues actually are, it is not unusual to find that entirely disparate perspectives exist with regard to research priorities. It is not the intention of this paper to add to the list of research priorities, but rather to define some of the issues that may or may not be relevant as departure points for the prioritisation of research related to goat production in South Africa.

For the purposes of this paper, it is accepted that the ultimate issue that should be addressed by goat research should be the quality of life of all the peoples of South Africa. The term >quality of life< includes social, economic and biological dimensions. The dimension most frequently addressed by animal scientists is that of biology, and within this context the issue most frequently used as a departure point for prioritisation of animal science research is that of food production.

South Africa is reasonably self-sufficient in terms of the amount of food of animal origin that is produced and consumed on a per capita basis. Although the relative consumption of different types of meat has changed over the last 35 years, the total per capita consumption of meat has remained constant despite a substantial population growth. In addition to this, with the exception of beef, the real prices of all animal products have either declined (poultry, pork, milk, eggs) or remained relatively constant (mutton) over the last 29 years (Nieuwoudt, 1998). If greater food production is the real issue, research priorities should be directed towards increasing the output and efficiency of intensive animal production systems. The advances in productivity have been achieved over the past 30 years can be mainly attributed to the mass-production of anabolic hormones and their use to increase growth and milk production rates, as well as improved genetic selection methods. In the future, further improvements in productivity are likely to be achieved using gene technologies which would allow critical genes to be switched on or off as desired, and also by the cloning of genetically modified animals (Etherton, 1998). While these technologies may represent appropriate research priorities for the more developed countries, it is wise to consider whether the issue being addressed is applicable to South Africa.

In the past, research priorities in South Africa have been dominated by efforts to increase food production and per capita consumption. However, an increasing appreciation of the fact that 5.8% of the population account for over 40% of total consumption has lead to the adoption of food security (i.e. the access of all people to enough food for a healthy and active life) as a more appropriate issue for research prioritisation than food production. Since some 30% of the population of South Africa are classified as the ultra-poor (i.e. those do not obtain sufficient food) and of these, 80% are blacks living in rural areas, it is
understandable that the efficiency of animal production in rural communal farming systems has been perceived by some as the most important issue for animal production research. The plight of the rural black residing in communal systems is well illustrated by a recent study of the Mgwalana district of the Eastern Cape region of South Africa (Mahanjana 1999): It was found that 38% of the respondents ate meat less than once monthly, 68% consumed meat from animals which had died from unknown causes, and the majority relied either on state pensions (38%) or on remittances from their children (30%) as sources of cash income. Unlike cattle, which are mainly held for reasons such as milk, savings, wealth, prestige, investment and security, and are rarely slaughtered or sold, 23% of the reasons given for keeping goats were associated with cash sales and 15% with slaughter for meat production. This, together with the fact that 35% of reasons were related to ritual slaughters (during which the meat is also consumed) indicates that improved goat production would improve community health and economic status, and suggests a priority ranking for goat research projects directed at resolving the issue of food security.

When asked in which enterprise they would invest if granted a farming loan, however, only 10% of respondents indicated goat farming as first choice. This unexpected finding was related to labour constraints: Goats were perceived as >naughty=, >unmanageable= and >difficult to control=, and farmers felt disinclined to increase goat numbers, as many had already had to enlist the help of their children (37%) or had hired extra labour (19%) to herd goats. This indicates that the issue of food security in rural communal systems is unlikely to be resolved by research aimed at increasing the reproductive efficiency of goats (i.e. increasing goat numbers). On the other hand, replacement of existing numbers of goats with more productive breeds of goats is also unlikely to be successful, as figures from experiments conducted at an experimental farm in the vicinity indicate that the amount of meat weaned as kids from Indigenous goats is higher that obtained from the Boer goat under these conditions. This was mainly due to excessive pre-weaning mortalities for Boer goats (especially from heartwater). Indigenous goats appear to have an innate tolerance to many diseases and parasites which more than compensates for their smaller size and weaning mass. Although this situation would be reversed by better nutrition and management, this is unlikely to occur under the communal system of farming.

In the communal system of land tenure, all land not set aside for houses or cropping is available as grazing land to all members of the community. As there are no restrictions on livestock numbers, available nutritional resources are severely limited and all animals in this system are probably performing as well as the available nutritional resources permit. From a biological perspective, the major constraint to more efficient animal production in the communal farming system is inadequate nutrition. From the sociological perspective, the labour constraints discussed above derive directly from the fact that animals must be herded for considerable distances to obtain sufficient nutrients in an overgrazed pasture ecosystem. Taken together, these facts indicate that animal science research is not likely to have much impact within the communal system, and that the sociological aspects of communal land tenure represents the most important issue that needs to be dealt with.

Another issue of relevance to goat research is that of urban poverty. Urban poverty is an increasing problem in South Africa: 55% of the population lives in urban areas, and migration from rural to urban areas is expected to increase in future. At present the poverty rate for urban dwellers is 15% in metropolitan areas surrounding the large cities, 27% in
secondary cities and 35% in small towns (Rogerson, 1998). This is partially due to high levels of unemployment in these areas: metropolitan areas: 21%, secondary cities: 27%, small towns: 28%. Of particular concern are the unemployment statistics for the economically important 15-24 year old age group: metropolitan areas: 36% (males) and 43% (females); secondary cities: 48% (males) and 59% (females); small towns: 47% (males) and 54% (females). As these communities are free of the labour and land tenure constraints which apply to rural communal areas, the issues of unemployment and poverty may represent opportunities for research aimed at establishing and improving small-farmer animal production enterprises. Small farmer systems have been established elsewhere in the world with much success (notably so in Kenya) and represent a range of opportunities for the animal scientist. There is no reason why the products of research developed for intensive and first-world farming systems should not be implemented in small-farmer systems; in fact the implementation of technologies such as artificial insemination, hormone administration and specialised nutrient supplementation would be far easier in the case of the small-farmer with 6 stall-fed cows than in the case of the intensive commercial farmer with 600 cows at pasture. Similarly, it is not hard to envisage that future technologies such as the strategic administration of compounds which regulate gene expression at particular physiological stages would be safer and easier to apply in a small-farmer system than in any other system.

Conclusions
In conclusion, it is proposed that the lack of any real improvement in the efficiency of animal production in communal areas (despite many research projects) indicates that the real issue to be addressed in this situation relates more to research directed at the sociology of land tenure systems than to animal science research. In an assessment of animal agriculture in Sub-Saharan Africa, it was concluded that A Strategies for pastoral systems should focus on the acquisition of land use rights for grazers and the establishment of locally managed and controlled land and water management systems (Winrock International, 1992). In contrast, the latter report states that a most of the successful projects have been mixed crop-livestock projects such as smallholder dairy development (Kenya) and smallholder systems of fattening (Cameroon, Nigeria, and Senegal). It is proposed that the real issue for prioritisation of animal science and goat research in South Africa relates to small-farmer enterprises among the urban poor.

References:


Improving goat production from village systems in tropical climates: An experience from Southern Thailand

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Introduction
The University of Queensland (UQ) was responsible for the management of an AusAid programme for development of infra-structure, staff training and research in the Faculty of Natural Resources at the Prince of Songkla University in southern Thailand. This contract followed earlier experiences in Laos Cambodia and Thailand in which UQ managed university based agricultural development projects. The Thai-Australia Prince of Songkla Project involved developing programmes to study and improve goat production in the villages of southern Thailand. This programme was complemented by on-going research at Mt Cotton farm at the University of Queensland, and at Wollongbar Research Centre (NSW Agriculture). The stimulus for research in Thailand arose from the need to improve goat production in the village systems, and it was usually the poorest farmers who owned goats. The broad plan was to find out what the constraints to goat production in the villages were, and in the process of providing solutions, to train Thai academic and technical staff in the Animal Science Department at the Prince of Songkla University (PSU) in the biology and practice of raising goats and improving productivity in this environment. An outcome of this programme was the establishment of a Small Ruminant Research and Development Centre for Thailand at PSU by the Thai government in 1990, and this Centre continues to function today as a focus for research and development activities for goats in Thailand.

Background to goat production in Thailand
The region has a tropical climate with an annual rainfall of 1200 - 2800 mm/year and distinct dry season between January and April. The hottest month is February (26 - 35°C) and the coolest month is December (20 - 25°C). Daylength varies annually by only 53 minutes. The major crops grown are rice, rubber, oil palm and fruit trees with animals being only subsidiary to the main cropping systems. The following topics are relevant to the development of a plan for improving goat production in this environment:

♦ Profile of a village system.
♦ Socio-economics and marketing of village goats.
♦ Productivity and management systems.
♦ The need for research.

A programme of development
The following plan of action was determined after considerable discussion with Thai scientists, local government officers and farmer groups:

1. Establish the productivity of and limitations to village goat production systems in southern Thailand from a base-line survey.

2. Establish a representative herd of Alocal goats at one location, and develop a management system which maximises productivity.
3. Investigate the potential benefits of cross-breeding local goats with an improved breed (e.g. Anglo-Nubian) under optimal management conditions. Determine effects of different levels of improved breed inclusion (25, 50, 62.5, 75%) on performance of F1, F2 and stabilised crosses.

4. Develop relevant strategies from the above information for improving reproduction, health and nutrition of village goats. Develop simple management packages for housing, feeding and breeding.

5. Compare the performance of crossbred and village goats under minimal care systems and improved management systems.

6. Encourage adoption of management packages by demonstrations, field days and training of local officers in goat health and management.

**Developing goat management systems for the tropics**

The intention of this programme was to develop a system which firstly minimised stress so that the genetic potential of both local and cross-bred goats could be expressed to animals in an improved environment, and to develop simple, cheap and effective management strategies which could be used in the more hostile village systems. A testament to the success of this programme was the following outcomes:

1. A breeding herd of 70 - 120 does and their progeny were maintained on 6 hectares of improved pastures over a 6 year period. Annual stocking rate was 50 dry goats/ha, and 35% of feed requirements were met from local concentrates.

2. Annual kidding rates of over 150% were realised (see Table 1), with low mortalities of kids and adults over the period.

Some of the important modifications that had to be made to sustain high productivity of goats from pasture in southern Thailand included the following (Milton et al., 1991):

- Security and housing.
- Pastures and their management.
- Supplementary feeding.
- Herd health and parasite management.
- Mating and reproduction management.
- Kidding and pre-weaning management.
- Post-weaning management of does and kids.

**General conclusions**

Goat management involves exercising control over reproduction, health and nutrition through good pasture management and husbandry practices. Good managers are astute and frequent observers of animals. Detailed records formed the basis of management in the system which was developed and all staff were trained to be involved in all aspects of managing goats. Kidding time was the time of most intense activity, and rainfall incidence
determined many management decisions. The development of a good management programme using local materials and skills led to the successful extension of management packages, first by farmers coming to see what was happening, then by project staff demonstrating similar techniques and technologies in villages.

Reference

Table 1  Performance of indigenous and cross-bred (Thai Native x Anglo-nubian) goats raised under village and improved management systems

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<th>Improved management</th>
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<tr>
<td></td>
<td>Indigenous</td>
<td>Indigenous</td>
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<tr>
<td><strong>Production (females)</strong></td>
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<tr>
<td>Birth weight (kg)</td>
<td>NA</td>
<td>1,7</td>
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<tr>
<td>Weight at: 6 months</td>
<td>6,8</td>
<td>9,2</td>
</tr>
<tr>
<td>Weight at: 12 months</td>
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<td>12,4</td>
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<td>Weight at: 18 months</td>
<td>13,0</td>
<td>20,0</td>
</tr>
<tr>
<td>Weight at: 24 months</td>
<td>17,3</td>
<td>24,1</td>
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<tr>
<td><strong>Reproduction</strong></td>
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<tr>
<td>Kidding rate (%)</td>
<td>190</td>
<td>161</td>
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<tr>
<td>Pre-weaning kid mortality (%)</td>
<td>29,1</td>
<td>5,0</td>
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<tr>
<td>Annual adult mortality (%)</td>
<td>7,2</td>
<td>4,7</td>
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<td><strong>Body composition (males)</strong></td>
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<tr>
<td>No. goats</td>
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<td>Dressing %</td>
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<td>Saleable %</td>
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<td>Muscle %</td>
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<tr>
<td>Bone %</td>
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<td>Total fat %</td>
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<td>8,4</td>
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<tr>
<td>Muscle:bone ratio</td>
<td>4,0</td>
<td>3,8</td>
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The Australian goat industries

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Australia has a feral goat population of 4 - 5 million animals, originating from European Landrace types brought in by early settlers. These animals have been exploited commercially such that there is:

♦ a large goat meat export industry (largest in the world)
♦ small but lucrative cashmere and mohair industries

A small but lucrative dairy goat industry exists around the major cities, based on milk breeds imported in the 1920's. Recently dairy goats have been exported to Taiwan.

The meat industry
The Australian goat meat industry is based on the harvest of feral animals; over one million were slaughtered and exported, as frozen carcasses, from NSW alone in 1997. The feral harvest is worth about A$20 million per year, while hides and hair are valued at A$3.5 million (1993/94).

The fibre industries
Although Angora goats were imported as early as the 1860's, modern exploitation began only in the 1960's. Cashmere was found in feral goats in the late 1970's and commercial exploitation began shortly after. Both cashmere and mohair breeders drew heavily on feral goats for base breeding stock and domestic goat numbers grew rapidly in the 1980's peaking in 1989. Severe drought and economic problems with other agricultural commodities have lead to a recent downturn in numbers.

Domestic goat numbers have stabilised around 300,000 generally on mixed grazing enterprises. Interest in fibre goats has waned, but interest in meat production has increased due to the importation of the Boer goat (released in 1995). There is interest in dual purpose animals producing meat and fibre. Boer goats are being crossed over cashmere herds, and Texan and South African Angora goats are reported to increase mohair quality and quantity as well as meat yield in the Australian Angora. Australia currently produces 350 tonnes of mohair and 18 tonnes of cashmere annually.

Indirect benefits of goat enterprises
Considerable research has been done on using goats for pasture and range management, and the valuable role of goats is widely recognised. The major benefits of using goats for weed control include:

♦ increased efficiency and effectiveness of weed control
♦ reduced use of chemicals
♦ increased use of all herbage
♦ reduced costs of weed control
♦ improved animal production

It is difficult to quantify the indirect benefits of using goats for weed control but it is
estimated that savings of A$400 million annually are possible due to the reduced vegetable contamination in wool. Other indirect benefits of direct financial interest include improved carrying capacity and production from complementary grazers.

The future
The goat industries appear to be recovering from the effects of drought and economic downturn of the early and mid-1990's. Expansion is constrained by a downturn in cashmere and mohair prices, marketing and infrastructure problems and the difficulty in disposing of surplus stock. While the potential for goat meat exports is well recognised, domestic production cannot compete with feral harvesting. Commercial meat goat breeders are seeking different, more specific markets. Pressure to reduce the feral population in the fragile environments of outback Australia should encourage the trend towards farmed goats, and goats will remain an important tool for range management and weed control.
The farming systems approach: the case of goats in communal farming systems

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Introduction
Researchers have often viewed agricultural research from a technical perspective only. However, this approach has been shown to have some shortcomings with respect to the needs of the smallholder managers. The first point is that communal farmers hardly ever use purely technical knowledge in managing their farms and, as a result, they do not apply this approach in evaluating novel technologies introduced on their farms by the extension services. In addition, recommendations are usually presented in the form of “final” solutions or “best” options for production which generally seek the full exploitation of biological potential of biological materials under specific production conditions. However, farmers may be willing and ready to handle only partial or intermediate solutions because of their managerial limitations and limited resources. Some of the recommendations do not take into consideration the structural, socio-economic and ecological circumstances that dictate farmers decisions. Hence, the need for on-farm research which employs a managerial or systems approach to review the results of technical research and to identify and possibly modify, where necessary, those technologies most relevant to the pressing needs of the specific groups of farmers.

The objectives of the farming systems approach are, therefore, to (1) identify technical knowledge which will enable farmers to solve key managerial problems or to better exploit important managerial opportunities, (2) identify technical problems vital to improved management, (3) develop techniques and products that fully meet the demands of specific groups of farmers, and (4) bring researchers, extension officers and farmers together for the sole aim of identifying opportunities and constraints within the diverse systems of production. The ultimate goal is to move away from the top-down approach of solving farmers’ problems to a participatory one and to enable extension staff to develop confidence in research recommendations, which are arrived at in a multi-disciplinary setting. This presentation reviews the farming systems approach.

Identification and diagnosis of target groups
There is a sequence of steps to accomplish the farming systems approach (FSA). The FSA will require a selection of groups of farmers operating within the same farming conditions (a homogeneous group). The selection will be followed by execution of an on-farm research and development (OFR & D)/FSA sequence in each of the target groups in multidisciplinary research teams.

The OFR & D/FSA sequence requires a diagnostic phase that involves diagnosing problems among the target farmers using a participatory rural (PRA) or rapid rural (RRA) appraisal. It also entails identification of current farmer practices which are appear weak and thus fail to fully exploit the biological potential of resources in the locality and pests and diseases affecting farming. The diagnostic phase is expected to enable the multi-disciplinary research team to gain a better insight into farming systems in rural communities, especially the pattern of farmer allocation (budgeting) of land, labour and cash to different farming practices and off-farm activities, the priorities farmers seek to satisfy, farmers management
of the local ecological and economic environment, their perceptions of different farming practices (e.g. dairy farming) and their beliefs and value systems with respect to certain diets (e.g. goat milk).

**Screening of technological interventions and identification of leverage points**
All the technical problems and technically weak practices identified in the diagnostic phase are used to make an estimate of the losses in production that might result from maintaining the system as it is. It is also important to diagnose the economic and technical causes of these poor practices, as this exercise will help in identifying new technologies. The poor practices might be related to the local natural environment, the deliberate management of local conditions by the farmers to satisfy family priorities and/or resource constraints, which may require technical compromises. Once the strengths and weaknesses of the system have been documented, it is advisable that a wide range of possible improved technical practices for more efficient production be identified. The resulting inventory of improved materials (goats) and practices (management) should be screened on a technical and economic basis and, if possible, their relationships assessed. The packages are now ready for testing under various farming conditions.

**On-farm experimentation**
The on-farm research team designs, implements and evaluates on-farm experimental programmes. The type of experiment is determined by the degree of confidence the technical staff has that the relationships identified previously are applicable on local farms and that the climate, soil and farmers managerial practices may modify these relationships. If there is a high degree of confidence, then verification (demonstration) experiments are implemented which should involve comparing improved technologies with current farmer technologies. Extensive participation of farmers and extension workers is necessary during this verification stage.

The improved materials and practices should be selected on the basis of potential contribution to the system, ease with which farmers can assimilate them and the amount of research effort needed to implement them. Such selected technologies should also take into account the scope of resources (land, labour, technical know how, capital, etc.) available on the farm. These technologies are ranked and the highest ranked intervention is given priority. Some interventions that can be moved directly into the verification phase of the trial should be included in the formal experimentation phase in order to offer local farmers immediate results at the same time.

Evaluation of these experiments should be carried out jointly with the farmers and extension workers. However, the final interpretation of results is the responsibility of the research team. This should be done on the basis of a balance of statistical and economic analyses and farmers assessments of the experiments and their outcomes.

**Dissemination of technologies**
The farming systems approach is designed to allow for continual interaction between farmers, extension officers and researchers. This interaction should allow for a consensus on when an improved technology is ready for dissemination. This will occur when the host farmers begin to use the experimental techniques on their own animals and crops of their own initiative and the extension staff have an intimate knowledge of the managerial implications of new techniques and are able to lay out demonstrations on farmers fields and
expose others in the community to the new techniques.

**Conclusions**

It is evident that for any goat project to succeed in the communal areas the inhabitants must be committed to the project. For this commitment to be possible, the farmers should be active participants in the various stages of the farming systems approach. As a result of the participatory approach, whatever technology is diagnosed as appropriate will be willingly and readily accepted into the local farm situations regardless of the specifics of the locality.
Socio-economic aspects of sustainable goat production

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Sustainable agriculture means that a person can farm infinitely on a piece of land and that the three components of sustainable agriculture are balanced. The three components are: natural resources, economic resources and human resources. Sustainable agriculture is not possible if one of these components is missing. In planning an agriculture enterprise the human factor is often neglected. The best management programme will fail if the person who is responsible for it is not sufficiently committed to it. It is estimated that meat production can be tripled if the currently available knowledge of animal production is applied properly. Why is the average calving percentage for South Africa so low? Is it not partly due to the human factor? In other words, do we apply what we know properly and are we sufficiently committed?

Statistics from SAMIC for 1997 show that there are 6.6 million goats in South Africa in total. Of these 64% are in rural areas.

Table 1  Total goat numbers 1997: Commercial and rural (SAMIC, 1997)

<table>
<thead>
<tr>
<th>Province</th>
<th>Commercial</th>
<th>Rural</th>
<th>Total</th>
<th>% in Rural areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Cape</td>
<td>263 238</td>
<td>0</td>
<td>263 238</td>
<td>0</td>
</tr>
<tr>
<td>Northern Cape</td>
<td>446 114</td>
<td>0</td>
<td>446 114</td>
<td>0</td>
</tr>
<tr>
<td>Free State</td>
<td>65 949</td>
<td>9 600</td>
<td>75 549</td>
<td>13</td>
</tr>
<tr>
<td>Eastern Cape</td>
<td>1 290 214</td>
<td>857 451</td>
<td>3 147 665</td>
<td>59</td>
</tr>
<tr>
<td>KwaZulu Natal</td>
<td>117 929</td>
<td>740 186</td>
<td>858 115</td>
<td>86</td>
</tr>
<tr>
<td>Mpumalanga</td>
<td>34 550</td>
<td>49 118</td>
<td>83 668</td>
<td>59</td>
</tr>
<tr>
<td>Northern Province</td>
<td>49 837</td>
<td>876 059</td>
<td>925 896</td>
<td>95</td>
</tr>
<tr>
<td>Gauteng</td>
<td>13 286</td>
<td>0</td>
<td>13 286</td>
<td>0</td>
</tr>
<tr>
<td>North West</td>
<td>112 984</td>
<td>717 412</td>
<td>830 396</td>
<td>86</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2 394 101</strong></td>
<td><strong>4 249 826</strong></td>
<td><strong>6 643 927</strong></td>
<td><strong>64</strong></td>
</tr>
</tbody>
</table>

Most of the goats presented for slaughtering are from commercial farmers. Very few black farmers send goats to abattoirs. The total number of goats slaughtered at abattoirs for 1997 was 36 511.
Table 2  Total slaughtering during 1997 as a percentage of the total number of goats available

<table>
<thead>
<tr>
<th>Province</th>
<th>Number of goats</th>
<th>Number of slaughterings</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Cape</td>
<td>258 059</td>
<td>10 381</td>
<td>4.02</td>
</tr>
<tr>
<td>Northern Cape</td>
<td>446 925</td>
<td>656</td>
<td>0.15</td>
</tr>
<tr>
<td>Free State</td>
<td>74 815</td>
<td>3 273</td>
<td>4.37</td>
</tr>
<tr>
<td>Eastern Cape</td>
<td>3 220 618</td>
<td>20 712</td>
<td>0.64</td>
</tr>
<tr>
<td>KwaZulu Natal</td>
<td>833 129</td>
<td>871</td>
<td>0.10</td>
</tr>
<tr>
<td>Mpumalanga</td>
<td>81 814</td>
<td>201</td>
<td>0.25</td>
</tr>
<tr>
<td>Northern Province</td>
<td>1 017 024</td>
<td>21</td>
<td>0.00</td>
</tr>
<tr>
<td>Gauteng</td>
<td>13 986</td>
<td>81</td>
<td>0.58</td>
</tr>
<tr>
<td>North West</td>
<td>727 733</td>
<td>315</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Total RSA</strong></td>
<td><strong>6 674 103</strong></td>
<td><strong>36 511</strong></td>
<td><strong>0.55</strong></td>
</tr>
</tbody>
</table>

Of the greatest concern is the fact that only 0.55% of the total goat population are slaughtered at abattoirs. How many goats are being slaughtered for home consumption is not known. It is obvious that goats are available, but are not marketed. From the information it is clear that the demand for goat meat is poor mainly due to poor marketing. Gross income from the sale of goat carcasses generated R3 578 443 in 1997 (Table 3). According to SAMIC the average weight per carcass was 13.5 kg and the average selling price per kg for 1997 was R7.26.

Table 3  Gross income from slaughtered goats in 1997 (SAMIC, 1997)

<table>
<thead>
<tr>
<th>Number of goats Slaughtered</th>
<th>Average carcass mass (kg)</th>
<th>Average price/kg (R)</th>
<th>Gross income (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 511</td>
<td>13.5</td>
<td>7.26</td>
<td>3 578 443</td>
</tr>
</tbody>
</table>
Table 4  Possible income from increasing goat slaughtering

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Carcasses increase</th>
<th>Kg meat</th>
<th>Income/year (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.55</td>
<td>36 511</td>
<td>492 898</td>
<td>3 578 443</td>
</tr>
<tr>
<td>5</td>
<td>332 196</td>
<td>4 484 651</td>
<td>32 558 564</td>
</tr>
<tr>
<td>10</td>
<td>664 393</td>
<td>8 969 301</td>
<td>65 117 128</td>
</tr>
<tr>
<td>15</td>
<td>996 589</td>
<td>13 453 952</td>
<td>97 675 692</td>
</tr>
<tr>
<td>20</td>
<td>1 328 785</td>
<td>17 938 603</td>
<td>130 234 257</td>
</tr>
<tr>
<td>25</td>
<td>1 660 982</td>
<td>22 423 254</td>
<td>162 792 821</td>
</tr>
</tbody>
</table>

Approximately 65% of the people interviewed indicated that they do not eat goat's meat or that they will only eat it if nothing else is available. Some reasons for not eating goat meat are:
- Goat meat smells (the majority offered this reason).
- Beef and mutton are more tasty.
- Meat fibres are too coarse.
- Goats are only used during traditional ceremonies.
- You can not eat your pet!

Small-scale farmers evidently do not see goats as a saleable commodity. They see them as animals of financial security. There is also a perception that goats are a poor man's animals. If we want to establish a goat industry, it is very important that we must embark on an educational approach and show the financial value of the goats to the farmers. Furthermore, we must acknowledge the fact that insufficient family labour and unreliable hired labour are a reality. The majority of people in the rural areas are women, old people (50 years and older) and children, younger than 15 years of age. They are responsible for the farming activity. They share their time between crop production and livestock production of various types and non-farming activities. According to research done at the University of the North, each farmer requires a total of 210 man-days (126 man-days for crops and 84 man-days for livestock). During the peak months, each family has an average of eight members but only three adult equivalents are available during the year and usually only two for part of the day. They can only devote 5% of their time to animal production and spend 63% of their time on household chores. This results in poor management and the accompanying low animal performance. Also, hiring labour is the exception rather than the rule.
In the Northern Province a major constraint to goat farming is heartwater. Many goat improvement schemes have collapsed because of heartwater. The objections of potential customers should be changed. Aggressive marketing of goat meat is a prerequisite for success. For example, goat meat is 50 - 65% lower in fat than similarly prepared beef, but has the same protein content. Goat meat is also lower in fat than chicken, even with the skin removed. Obviously, there are many factors in favour of goat's meat, but no one has exploited them. Products from goat's milk must be propagated. Convincing farmers that they can make money from goats is important. Failure to do so will result in maintaining the status quo, with the continuation of the current problems such as over-grazing. Before any research projects are launched, it is critical that a needs assessment is done. Is there really a demand for goat's meat and how big is it? What does the consumer want and in what form?
The condition, productivity and sustainability of communally grazed rangelands in the central Eastern Cape Province

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Introduction
It has been predicted for many decades that the Ciskei - similar to other communally grazed rangelands (CGR’s) - will soon end up in the Indian Ocean. Despite the many popularly held perceptions about the poor productivity and sustainability of communal systems, all we know for certain is that very little empirical research has been done on these systems (Shackleton, 1993).

The amount of debate and controversy surrounding the subject testifies to our lack of understanding. Recently the sacredly held links between overstocking and degradation in arid environments (also known as disequilibrium systems) and communal systems have been questioned (Behnke, Scoones and Kerven, 1993).

For resource poor rural people, the rangeland constitutes a valuable yet inexpensive resource. Utilising it in a sustainable manner is the social responsibility of the land users although concepts such as soil erosion and maintenance of biodiversity have very little emotional appeal. Even to a lesser degree does the proposed solution of destocking (overstocking being the prime evil of communal rangeland use) warm the hearts of the communal livestock owners. It is the responsibility of rangeland scientists to clarify the matter.

I present two case studies from CGR’s in the central eastern Cape with some data which will hopefully contribute to clarify the murky waters. The broad objectives of the research were to (i) describe differences in vegetation structure and (ii) quantify rangeland productivity as affected by range condition (species composition) between communal and commercial systems.

Materials & Methods

Study sites
The studies were conducted in the former Ciskei homeland of South Africa that has a long
history of communal land use. The veld is classified as False Thornveld of the Eastern Cape (Acocks, 1975), a savannah vegetation type. Rainfall occurs mostly in summer as thunderstorms (and seasonally exhibits a bimodal pattern with small peaks in October and February/March and a dry spell in January). The long-term average is 620 mm per annum with a CV of 24%. Soils are extremely heterogenous but are predominantly sedimentary (sand - and mudstones) with some variation when intrusions of igneous rock (doleritic dykes and sheets) result in red soils occurring in some areas.

Two villages where communal grazing occurs, were selected (Melani in good and Dyamala in poor condition). For comparative purposes - as a benchmark - the University of Fort Hare Research Farm’s livestock section, Honeydale, was selected to represent commercial or “optimum” land use. The villages are both very near the University which made comparisons feasible.

University of Fort Hare Research Farm
The University of Fort Hare Research Farm’s livestock section, Honeydale (32°47’37”S, 27°06’58”E) is 1113.6 ha in size. The Farm is stocked at 4 ha AU⁻¹ and veld management practices centre around applying correct stocking rates and rotationally grazing the livestock in paddocks of which one third is rested annually. Fire is applied (in conjunction with goats) when paddocks are deemed to be encroached by trees.

Melani village
Melani (32°43’29”S, 27°07’35”E) is a village that has been communally grazed since 1866 (Manona, this issue) and is 771.6 ha in size. It is located 5 km north of the other two research sites and was selected to represent communally grazed veld in good condition (Table 3). This village was planned under the Betterment schemes of the 1950’s. There were fences and some form of rotational grazing but it appears that in the late 1980’s the management system broke down. At the time of the experiments animals were continuously grazing the range and there appeared to be inter-village movement of livestock from neighbouring villages since access control was becoming increasingly difficult due to fences that were cut or damaged and not repaired.
Dyamala village

Table 1  Comparison of land use (in hectares) in the two villages

<table>
<thead>
<tr>
<th></th>
<th>Melni</th>
<th>Dyamala</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing land</td>
<td>649.4</td>
<td>255.3</td>
</tr>
<tr>
<td>Cropping*</td>
<td>12.5</td>
<td>-</td>
</tr>
<tr>
<td>Old lands**</td>
<td>70.9</td>
<td>282</td>
</tr>
<tr>
<td>Residential***</td>
<td>38.8</td>
<td>34.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>771.6</td>
<td>571.9</td>
</tr>
</tbody>
</table>

* In Dyamala cropping has become a very erratic activity and no area in Dyamala is classified as such. This is dissimilar to Melani where the cropping area is adjacent to a perennial river which makes irrigation possible, resulting in complete utilisation of that area (and hence no grazing).

** See footnote. Even though large areas were classified as old lands, there was some scattered cropping activity on a small area in Dyamala even though a large area had been cultivated earlier. By far the majority of old lands are presently used for grazing in Dyamala.

*** The grazing area is increasingly encroached upon by an ever-expanding residential area. This is exacerbated by the fact that houses are built erratically and no planning takes place, leading very often to prime grazing land invaded by houses. This phenomenon naturally increases pressure on the available grazing and is common in all CGR’s.

Dyamala village is 571.9 ha (32°47’36”S, 27°06’35”E), borders on Honeydale and is in relatively poor condition (Table 3). Betterment was also implemented here but little evidence remains in terms of grazing management systems. There is no rotation of animals or range management system in place and animals graze continuously. Access to grazing of livestock from neighbouring villages is better controlled than in Melani since most of the perimeter borders on Fort Hare Farm.
Table 2  The livestock ownership patterns between the two villages*

<table>
<thead>
<tr>
<th>Village</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no</td>
<td>155</td>
<td>392</td>
<td>149</td>
</tr>
<tr>
<td>Average/owner</td>
<td>5.3</td>
<td>13.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Melani</td>
<td>342</td>
<td>13</td>
<td>326</td>
</tr>
<tr>
<td>Average/owner</td>
<td>7.6</td>
<td>2.8</td>
<td>7.2</td>
</tr>
</tbody>
</table>

* Numbers as recorded on dipping days.
** All these “livestock owners” do not own all species of livestock; these “averages” therefore reflect the average per species of those villagers engaged in livestock production. By determining livestock masses during dipping days in this study, stocking rates were found to be 0.37 AU ha⁻¹ in Dymala and 0.41 AU ha⁻¹ in Melani. Compared to the recommended stocking rate in each of 0.19 AU ha⁻¹ and 0.27 AU ha⁻¹ respectively, they were “overstocked” by 95% and 52% respectively.

Sample sites
Two sample sites were identified in each of the three research sites in order to have some measure of experimental error.

For this paper the data of one full growing season, namely September 1997 to May 1998, will be reported.

Rainfall
Rainfall data is collected continuously on Honeydale and these records were used.

Vegetation variables

Bush: botanical composition, structure and density
The bush structure and density (methodology as described by Teague, Trollope and Aucamp, 1981) was determined since these authors showed that the browse component affected herbaceous yields.

Grass: botanical composition
This was determined repeatedly throughout the experimentation period and followed the methodology of Trollope and Willis (1984). The botanical composition was also expressed relative to a “benchmark”, and expressed as the Veld Condition Score (VCS) of the area. The technique was developed for commercial pastoralism and is probably inappropriate for communal land use (which has different objectives). However, because of the comparative nature of this study it was felt that it would be an appropriate measure for the intended comparisons. Presently a technique is being developed to determine veld condition for the multiple purposes of communal land use.

Basal cover
Basal cover was determined by measuring the distance (in cm) from a survey point to the nearest tuft.
Vegetation structure
Herbage intake of grazing animals is affected by nutritional factors like digestibility, but also by non-nutritional factors of the sward which could influence grazing behaviour such as the amount and distribution of herbage, sward structure, leaf:stem ratios, etc. (Hodgson, 1981). Hence the grazing height and leaf:stem ratios were determined in order to quantitatively describe the structure of the vegetation available to livestock.

Grazing height
This was determined by measuring the height of the grazing sward (average height of leaf material) during botanical composition surveys.

Leaf:stem ratios
Samples of grass species were collected, dried at 60°C and the leaf and stem fractions separated by hand. The two fractions were then weighed and expressed as a percentage of the total dry mass.

Standing biomass
The amount of DM available to grazing animals is of critical importance for animal production (Engels, 1983). The pasture disc meter developed by Bransby and Tainton (1977) was used and a regression equation developed by Trollope (1983) to convert disc readings to kg ha⁻¹. One hundred measurements per site in different seasons were done to determine the standing biomass.

Range productivity
Standing biomass (as measured above) expresses the amount of forage at a given time in a rangeland and is not a measure of the production of grazable material through a growing season. Net primary production (herbaceous yield) was measured continuously through the growing season as described by McNaughton, Milchunas and Frank (1996). This method requires that moveable enclosures be employed with a movement frequency timed to reflect both the intensity of herbivory and plant growth rate, measuring plant biomass and moving enclosures accordingly. The biomass in caged and uncaged, grazed plots are estimated and net primary productivity is then calculated as follows:

\[
\text{Consumption by grazers} = (\text{Caged biomass} - \text{uncaged biomass})\text{ at the end of each period.}
\]

The estimates of consumption of all the periods are added to the final harvest of residual vegetation in the grazed area and corrected for initial standing biomass. This method does not measure total productivity since senescence and decay are not accounted for (which will be more important in mature swards). It does, however, measure the net production of grazable material in a season.

Measurements were conducted throughout the growing season, starting approximately September and ending in May (after first frost). Twenty movable enclosure plots of 1 m² each were placed in each research site (10 per sample site) together with permanent enclosures of 4 m² which were harvested only at the end of the growing season to account for site differences in potential production.
Data analysis
Data was analysed using the REML procedure of GENSTAT (version 5.1) for repeated measures in unbalanced data sets. Site and season were main effects and a probability level of 95% was used to determine significance of differences.

Results
Rainfall
The cumulative 12 monthly rain until April 1998 was 541mm, well below the long term mean of 622 mm. The winter was mild and good rains were recorded in April and June 1997 with a frost-free winter. The result was uncommonly green vegetation in late winter. In early spring (November 1997) some rain fell resulting in early grass growth but a hot, dry spell in December and January was responsible for scorched, moribund vegetation.

Range condition

Table 3  The range condition of the three sites as a veld condition score (%)

<table>
<thead>
<tr>
<th>VCS (%)</th>
<th>Dyamala</th>
<th>Melani</th>
<th>Univ. of Fort Hare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal cover (cm)</td>
<td>1.4 ${}^b$</td>
<td>1.1 ${}^a$</td>
<td>2.2 ${}^c$</td>
</tr>
</tbody>
</table>

${}^a,b,c$ Values with different superscripts are significantly different (P<0.05).

Range condition differed significantly between all sites (Dyamala being the lowest as expected). Considering that 100% is considered to be rangeland in optimal condition for commercial livestock production, the Research Farm is clearly in excellent condition. The VCS for Melani is also considered to be rangeland in excellent condition.

Basal cover differed between all sites but was lower in the two communal sites and poorest in the Research Farm site, although the basal cover there is still considered to be good.

Table 4  The average species composition of the three sites as an averaged over various seasons

<table>
<thead>
<tr>
<th>Species</th>
<th>Dyamal</th>
<th>Melani</th>
<th>Univ. of Fort Hare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Themeda triandra</td>
<td>8</td>
<td>41.3</td>
<td>55.5</td>
</tr>
<tr>
<td>Digitaria eriantha</td>
<td>40</td>
<td>17.25</td>
<td>4</td>
</tr>
<tr>
<td>Sporobulus</td>
<td>13</td>
<td>4</td>
<td>9.5</td>
</tr>
<tr>
<td>Cymbopogon</td>
<td>2.8</td>
<td>1.5</td>
<td>17.5</td>
</tr>
<tr>
<td>Aristida congesta</td>
<td>2.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eragrostis spp</td>
<td>4</td>
<td>12.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Cyperus dactylon</td>
<td>9.3</td>
<td>3.5</td>
<td>0</td>
</tr>
<tr>
<td>Panicum spp</td>
<td>5.8</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>Others*</td>
<td>21.8</td>
<td>12.3</td>
<td>9.5</td>
</tr>
</tbody>
</table>

*Includes Forbs, Karoo shrubs and grass species such as Eustachys muticus, Michrochloa caffra, Sporobulus africanus, etc.

$D.~eriantha$ was the most common species in Dyamala, whereas $T.~triandra$ dominated in both Melani and the Research Farm. There was a very low percentage of undesirable
species (*C. plurinodis* and *A. congesta*) in the communal villages, as opposed to the Research Farm where there was a high proportion of *C. plurinodis*. This reduces the effective amount of grazing since *C. plurinodis* has a high standing biomass but is of little value due to terpenes which renders it unpalatable.

**Vegetation structure**

**Table 5  The structure of the vegetation**

<table>
<thead>
<tr>
<th></th>
<th>Dyamala</th>
<th>Melani</th>
<th>Univ. of Fort Hare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bush density</td>
<td>2608 b</td>
<td>3506 c</td>
<td>1717 a</td>
</tr>
<tr>
<td>BU’s ha⁻¹</td>
<td>2330 b</td>
<td>3069 c</td>
<td>1067 a</td>
</tr>
<tr>
<td>Grazing</td>
<td>2.6 a</td>
<td>3.5 a</td>
<td>14.5 b</td>
</tr>
<tr>
<td>Grass leaf</td>
<td>69.7 b</td>
<td>76.2 b</td>
<td>57.4 a</td>
</tr>
</tbody>
</table>

a,b Values with different superscripts are significantly different (P<0.05).

Melani had the highest bush density and the Research Farm the lowest with Dyamala intermediate. *Acacia karroo* constituted approximately 53% and 78% of all species present in Dyamala and Melani respectively which is considered to be an indication of encroachment by that species. The Research Farm, in contrast, had only 20% *A. karroo*. Very significant differences in the structure of the herbaceous layer were observed. Both communal areas had a very shortly cropped grass layer as opposed to the Research Farm where tall grass was to be found. The grass leaf content was, however, the highest in the communal areas. Leaf content between Melani and Dyamala was not significantly different (P < 0.08).

**Standing biomass (BM) and rangeland productivity**

Compared with the communal areas, the Research Farm carried significantly higher amounts of forage through all seasons. There were no differences between the communal areas in standing BM. The disc pasture meter appears to overestimate the amount of standing BM at these low levels of BM since yields of grazable forage from clipped enclosure plots rarely exceeded 500kg ha⁻¹.

It was interesting to note that range productivity in Melani was not different from the Research Farm, indicating that productivity had not been affected in that village. Dyamala, however, had lower productivity than both the other sites. The lower productivity was probably due to different species present (Table 4) since Snyman and Fouché (1993) showed that species composition (and veld condition score) was highly correlated to productivity in semi-arid areas.

The amount of total grazeable material was higher on the Research Farm due to lower grazing pressure which results in more material available to bridge the winter gap, the period most critical for animals in the communal areas. At that time there is no residual forage remaining as is the case on commercial farms where rested camps have sufficient fodder to sustain animals through winter.

**Table 6  The amount of standing forage and range productivity during the 1997/8 growing season of the three sites is presented**
<table>
<thead>
<tr>
<th></th>
<th>Dyamala</th>
<th>Melani</th>
<th>Univ. of Fort Hare Research Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing BM (kg ha(^{-1}))</td>
<td>1154(^a)</td>
<td>1174(^a)</td>
<td>4227(^b)</td>
</tr>
<tr>
<td>Total BM prod (kg ha(^{-1}))</td>
<td>767(^a)</td>
<td>922(^b)</td>
<td>915(^b)</td>
</tr>
<tr>
<td>Total BM avail (kg ha(^{-1}))</td>
<td>925</td>
<td>1098</td>
<td>4182</td>
</tr>
</tbody>
</table>

\(^a,b\) Values with different superscripts are significantly different (P<0.05).

**Discussion and Conclusions**

It can be concluded that there are significant differences in vegetation structure between commercial and communal rangelands: with more bush, lower grazing height and a higher leaf content in the communal rangelands. The higher basal cover in communal areas was significant but Research Farm basal cover was certainly not poor. It does emphasise the ease with which false perceptions are created and maintained since communal areas are generally believed to be in poorer state of health. In this study the communal rangelands did have poorer veld condition but there was still a high presence of desirable species.

Differences in range condition between Dyamala and Melani could probably be attributed to the greater number of sheep in the former (Table 2). Sheep have been shown to have a much greater impact on the vegetation than other grazers, which could lead to changes in species composition (O'Reagain and Turner, 1992). The slightly higher stocking rate in Dyamala is probably not sufficiently higher to explain these differences.

The lower standing biomass in the communal areas clearly does not equate to lower productivity. That is perhaps the key finding of this study, namely that communal areas are equally as productive as their commercial counterparts, despite differences in species composition and vegetation structure. The data presented here therefore challenges the assumptions and perceptions about the productivity and sustainability of CGR's. But what is sustainable resource use (or when is it unsustainable?). Sustainability, as it applies to grazed ecosystems, is mostly discussed in terms of the definition of degradation of Abel and Blaikie, 1989 (irreversible vegetation changes or reduced secondary productivity\(^2\)).

In this study there were clear impacts of similar land uses (grazing) on the rangeland (species composition and productivity, e.g. between the Research Farm and Dyamala which are separated by a fenceline but have vastly different rangeland dynamics). Does that imply degradation and hence unsustainability of communal land use? Is it reversible? What interventions are required to reverse the vegetation in Dyamala to the same state of the Research Farm? What of the superior basal cover in both communal areas, a very desirable attribute for preventing soil erosion? And the high productivity in Melani? Which indices...  

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\(^2\) The difficulties in measuring degradation and the inadequacies in the definition of degradation have been discussed elsewhere (sensu Illius & O’Connor, in press). Problems with measuring changes in secondary (i.e. livestock) productivity, are numerous. Livestock records are often inaccurate, or deduced from various sources. With regard to vegetation change, showing that changes are either permanent or reversible is difficult since it depends on the sacrifices or inputs land users are prepared to make. For example: "reversible vegetation change" suggests that if “degraded” rangelands are rested for decades and the vegetation is restored to its “original” state, that it was then never in a degraded state. In such a case resting would clearly be an impractical option (both for commercial and communal livestock owners). Showing that degradation has occurred under any particular form of land use is difficult at the best of times. Equating any such evidence to lack of sustainability is, therefore, not recommended.
of degradation are appropriate under which conditions?

These rhetorical questions serve to illustrate the point that it is hard to measure degradation and hence sustainability. Equating evidence of degradation to unsustainable land use is the common approach but should be treated with caution. There is insufficient agreement on measuring either and until robust, universally accepted and measurable definitions are found it is probably unwise to make statements about sustainability (or the lack of it) in communal areas.

It is clear from this study that all is not as bad as it appears in the communal rangelands. However, it is not the intention to create the impression that all is well, because some areas are indeed in a poor or degraded condition. This may indicate that in some instances the ecosystems could be gradually deteriorating. However, the data presented here may contribute to preventing people from making sweeping and often unfounded statements about systems which are healthier than we perceive them to be, although they may not always be aesthetically pleasing. It does appear that a number of holy cows may have bitten (the communal rangeland?) dust.

The social responsibility of sustainable resource use by rural land users needs no apology or explanation. All users of the natural resources of the country share it with previous, present and future generations and do not have exclusive rights to it. The challenge to scientists is to determine the sustainability of communal land use and, if necessary, then to develop sustainable community-friendly land use options.

Acknowledgements
The Foundation for Research Development and UK Royal Society for funding and Wellington Sibanga, Mweli Nyanga and Dumi Pepe for technical support.

References


Milk production from goats for households and small-scale farmers in South Africa

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Abstract
Milk production is important as a component of primary health care, in the prevention of protein malnutrition in South Africa. Milk production from goats is more appropriate than from cows, for householders and small-scale farmers. The Milch Goat Project in the Department of Animal Health and Production at MEDUNSA was established in 1987. The aim was to investigate the feasibility of using goats for the production of milk by householders and smallholder farmers in developing areas. Milk goats are scarce in South Africa, but when bred with Indigenous goats, the resulting Crossbred goats have been shown to give sufficient milk for subsistence or household purposes. In addition, Indigenous goats have been shown to have a genetic resistance to heartwater, a major tick-borne disease; and a proportion of Crossbred goats inherits this resistance. These milk goats have been kept successfully by farmers in developing areas. Research and extension activities are constrained because of limitations of funding.

Introduction
Milk has always been an important component in the normal balanced diet, providing energy, protein, calcium, other minerals and vitamins. As the population in Southern Africa continues to grow, milk will become more important as a source of high quality protein to reduce malnutrition, especially in children. As such milk production is a vital form of primary health care in both rural and peri-urban areas.

Milk production in commercial enterprises is usually from cows, because of the economies of scale. However the cow has disadvantages as a source of milk for the householder or smallholder farmer. Dairy cows are expensive, require large amounts of food, produce large amounts of milk (more than household needs), have a relatively long generation interval, and when slaughtered have large carcasses (posing problems of storage and distribution). In contrast, dairy goats are less expensive, are easily handled by women and children, eat less, produce appropriate quantities of milk for a household, have a short generation interval, produce more progeny, and when slaughtered give a carcass of manageable size. In addition goat's milk is of benefit to children who are allergic to cow's milk.

The number of goats in South Africa has been given as 5 858 807 in 1994/95 (Directorate of Animal Health, 1996), but this cannot be a precise figure, as numbers fluctuate from year to year, and an accurate census is difficult. Defined breeds of goats in South Africa include Angoras and Boergoats. If a rough estimate of the numbers of these breeds is two million and one million respectively, there are probably about three million goats of other (Indigenous) breeds, some with degrees of crossbreeding. The Boer goat is also an indigenous breed, developed in South Africa specifically for meat production.

The increase in human population will put pressure on resources, and means of intensification and greater efficiency must be found to increase food and other products, in order to improve the quality of life for all people of the country. The herds of goats are a resource to be developed, and there are many examples where improvements in productivity have been
achieved in other parts of the world.

Economic benefit arises:
* when an animal fulfils a perceived need; or
* when an opportunity for marketing is available.

Where the need for milk is clearly perceived, in the context of subsistence or small-scale production, goats may often be more appropriate for supplying milk than a cow (Devendra, 1992). This principle has been accepted by many developing communities throughout the world, but has not yet found much application in South Africa. A good example of an effective programme has been documented by Miller & Mwangi (1996), where 1300 Kenyan farmers were reported to be participating in the development of milk production from goats. This has followed the comprehensive research and development programme which resulted in the Kenyan Dual Purpose Goat (Semenye et al., 1989).

Development of a breed to ensure utilisation:
A breed or type of animal identified as having potential for sustainable economic productivity can be developed through the following processes:

1. **Characterisation:** The breed or type must be identified and the numbers assessed. Important characteristics or desirable traits must be documented.
2. **Applications:** Appropriate technology or systems must be developed to allow the successful development of the breed in a wider context. Relevant economic or social applications must be established.
3. **Programme of Development:** A programme of extension and development must be worked out with those who will benefit from the process, and adequate support services must be available. This should include assistance with marketing development.

The Milch Goat project at MEDUNSA has used indigenous goats in a new way, and the most important aspects of the first two items have been investigated. Now a programme of development is required.

Results of crossbreeding goats for milk production
This is the main aspect investigated in the Milch Goat Research Project by the Department of Animal Health and Production at MEDUNSA.

Rationale
There is a perceived need for milk production in the rural developing areas, and this is the main use attributed to cattle where people can afford to own them. However, many people do not own any cattle at all (Bembridge, 1987). Milk goats are scarce in South Africa, but indigenous goats are plentiful. The research at MEDUNSA has aimed to assess crossbreeding as a means of introducing milk production from goats for smallholder farmers in the developing areas of South Africa. Preliminary results of productivity of these goats in terms of fertility, kidding rate, and milk production have been reported (Donkin, Boyazoglu, Els, Macgregor, Ramsay and Lubout, 1996); and subsequently more fully (Donkin, 1997). Results of research into the genetic resistance to heartwater were reported in 1992 (Donkin, Stewart, Macgregor, Els and Boyazoglu, 1992).

These can be summarised as follows:
1. Fertility
Data on fertility in the first three years are shown in Table 1. These results were confirmed by information from subsequent years (Donkin, 1997).

Conception rates were high (in excess of 93%) for Saanen and Crossbred goats. However, for indigenous goats in the first year, where the goats were bred at seven months, conception was only 50%. The kidding percentages for Saanen and Crossbred goats were similar, varying from 123% in the first year to 200% in mature goats. Indigenous goats had a lower rate of twinning in yearling goats, but had also achieved a kidding percentage of 200% at three years of age.

2. Milk Production
Data on milk production for the first three years are shown in Table 2. These results were confirmed by information from subsequent years (Donkin, 1997).

Milk production from indigenous goats was very low and difficult to measure. Their lactations were short, and barely sufficient for their kids' needs, in spite of the generous diet. Saanen and Crossbred goats produced much larger amounts of milk, and sustained milk production for a 9 or 10 month lactation. Indigenous goats showed very high levels of milk fat and protein, whereas Saanen goats showed much lower levels. The milk composition of Crossbred goats was higher than that of the Saanens, but considerably lower than that of the Indigenous goats.

In summary, this research has shown:
- Milk can be produced efficiently and economically by goats.
- Indigenous goats give barely enough milk to provide for the needs of their kids.
- Crossbred goats give less milk than Saanens, but of a much richer quality. The yield of crossbred goats is nevertheless sufficient for subsistence or household purposes.

3. Resistance against Heartwater
Heartwater is a major tick-borne disease in many parts of Southern Africa and is fatal to many types of goats and other livestock. Saanen, Indigenous and Crossbred goats were reared tick-free, and at the age of eight months were given the virulent Ball 3 strain of heartwater blood. All goats showed the same temperature reaction, with a peak of approximately 41°C on Day 10 or 11, but the Saanen goats showed more severe clinical signs. All eight Saanens succumbed to the disease, but only two of the eight Crossbred goats, and one of the Indigenous goats. This indicated that the Indigenous goats had a genetic resistance against heartwater, and that this resistance was transmitted to a good proportion of the Crossbred goats. These results were confirmed in a subsequent phase of the research (Donkin, 1997).

This experiment has established:
- Saanen goats show no genetic resistance to heartwater.
- Indigenous goats do have a genetic resistance to heartwater. They get sick, but do not die from heartwater.
- A good proportion (approximately half) of the Crossbred goats show genetic resistance to heartwater, and have apparently inherited this characteristic from the Indigenous goats.
- It will be possible to keep goats for milk production in areas where heartwater is endemic.

4. Other Diseases
The main disease identified was coccidiosis, accompanied by pneumonia, which caused unacceptably high mortality among goat kids: 31% of Saanen, 24% of Crossbred, and 28% of Indigenous female kids. It is believed that this problem was largely management related, and worsened by overcrowding and consequent poor hygiene; but the presence of rotavirus might also have been significant. The main disease problem affecting adult goats was mastitis, which caused deaths from peracute cases. Another important problem that became apparent after four years of age in Saanens, was the incidence of squamous cell carcinoma on the udder. Reduced exposure to the sun, by the provision of adequate shade should alleviate this problem; but the crossbreeding programme was seen to be of benefit, since no cases occurred in Crossbred goats.

5. Outreach and Extension
Outreach and extension activities for promoting the keeping of milk goats by householders and smallholder farmers in the developing areas have been limited by lack of funds. Nevertheless, a number of small-scale farmers have purchased Crossbred goats, and have successfully kept them. Constraints identified included the cost of purchased feeds, and the lack of support from government extension agencies. Training and support should be aimed firstly at increasing the competence of extension staff, primarily through practical experience, rather than being given directly to the farmers, at least initially.

Acknowledgements
The Milch Goat Project has received support from the following donors, and we gratefully acknowledge their assistance:

- Janssen Pharmaceutica supported this project for a number of years during its development.
- The British Council assisted in the planning stages.
- The Department of Development Aid supplied the indigenous goats.
- S.A. Breweries have supplied feed ingredients in recent years.

In addition, it is important to acknowledge the assistance given by numerous colleagues in the Faculty of Veterinary Science at MEDUNSA over many years.

References


Table 1 Parturitions of Saanen, South African Indigenous and crossbred goats. (First three years)

<table>
<thead>
<tr>
<th>Breed</th>
<th>Age (yr)</th>
<th>Bred (No.)</th>
<th>Kidded (No.)</th>
<th>K kidded (%)</th>
<th>Kids born Total</th>
<th>Kids Born (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saanen</td>
<td>1</td>
<td>55</td>
<td>51</td>
<td>93</td>
<td>71</td>
<td>139</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>33</td>
<td>31</td>
<td>94</td>
<td>56</td>
<td>181</td>
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<tr>
<td></td>
<td>3</td>
<td>22</td>
<td>21</td>
<td>95</td>
<td>42</td>
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</tr>
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<td></td>
<td>All</td>
<td>110</td>
<td>103</td>
<td>95</td>
<td>169</td>
<td>164</td>
</tr>
<tr>
<td>Indigenous</td>
<td>1</td>
<td>64</td>
<td>42</td>
<td>50</td>
<td>46</td>
<td>110</td>
</tr>
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<td></td>
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<td></td>
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<td>128</td>
<td>105</td>
<td>82</td>
<td>157</td>
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</tr>
<tr>
<td>Crossbred</td>
<td>1</td>
<td>23</td>
<td>22</td>
<td>96</td>
<td>27</td>
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<td>2</td>
<td>9</td>
<td>9</td>
<td>100</td>
<td>17</td>
<td>189</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>32</td>
<td>31</td>
<td>97</td>
<td>44</td>
<td>142</td>
</tr>
</tbody>
</table>
Table 2  Milk yields and milk composition of Saanen, South African Indigenous and crossbred goats.

<table>
<thead>
<tr>
<th>Category (Lact. No. and Breed)</th>
<th>Lactation (kg) Mean±SE</th>
<th>Mean Days*</th>
<th>Milk fat Mean±SE</th>
<th>Protein (%) Mean±SE</th>
<th>Lactose (%) Mean±SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>First, 1988</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saanen Indigenous</td>
<td>614 ± 142 23 ± 13</td>
<td>285 94</td>
<td>2.88 ± 0.31</td>
<td>2.63 ± 0.26</td>
<td>4.61 ± 0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.06 ± 1.84</td>
<td>5.44 ± 0.69</td>
<td>4.64 ± 0.44</td>
</tr>
<tr>
<td>First, 1989</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saanen Crossbred</td>
<td>558 ± 87 337 ± 63</td>
<td>290 282</td>
<td>3.91 ± 0.40</td>
<td>3.15 ± 0.26</td>
<td>4.47 ± 0.14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.31 ± 0.61</td>
<td>3.77 ± 0.28</td>
<td>4.82 ± 0.12</td>
</tr>
<tr>
<td>Second, 1990</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saanen Crossbred</td>
<td>743 ± 118 463 ± 122</td>
<td>300 266</td>
<td>3.73 ± 0.40</td>
<td>3.12 ± 0.28</td>
<td>4.47 ± 0.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.13 ± 0.63</td>
<td>3.77 ± 0.26</td>
<td>4.82 ± 0.12</td>
</tr>
</tbody>
</table>

* Milk production beyond 300 days not included
A comparison of goat growth performance in a communal and commercial farming system in the Central Eastern Cape Province, South Africa.

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\textsuperscript{b}ARDRI, University of Fort Hare

Abstract
There exists a dichotomy in the farming systems, in the Eastern Cape Province, namely communal and commercial farming systems. These systems are characterised generally by “poor” and good management practices, respectively. There exists a perception that the performance of animals from the communal farming system is below that of animals from a commercial system. A lot of information is available concerning various aspects of livestock production in the commercial farming system, but, such information on the communal farming system is lacking. The aim of this study was to compare animal performance in a communal area, with performance on a commercial farm. Data on live weights of indigenous goats was obtained by monthly weighing of goats from a village in a communal farming system. These data were compared with goat data obtained retrospectively from the University of Fort Hare Research farm, which in this study is used to represent the commercial system. The mean weights of goats ± SD, (corrected for age) from the commercial system were 1.2 times higher than those of goats from the communal system (P<0.01). The mean weights of male goats from both sites, were 1.1 times greater than those of females (P<0.01). Generally, goats from the commercial farm had 1.1 times higher average daily weight gains (ADG) than those from the communal system, except in Autumn 1996, when both male and female goats from the communal system gained better than those from the commercial farm. Females from the commercial farm lost weight at this time of the year (-80.00g ± 127.00), compared to females from the communal system, which were gaining weight at a rate of 50.00g ± 60.01. Male goats from the commercial farm also gained least (30.00 ± 46.00g) in Autumn, compared to their counterparts from the communal system (40.00g ± 20.00g). The decline in ADG in Autumn, of goats from the commercial farm could be managerial in that the farm practices Autumn kidding. Nutrition could also be a factor because, the available herbage on the veld is of a low crude protein content, low digestibility and at a mature stage of growth, compared to that in the communal system which could be of a higher crude protein content and digestibility, at an actively growing stage.

Introduction
There exists a dichotomy in the farming systems, in the Eastern Cape Province, namely communal and commercial farming systems. This dichotomy is also noted in the aims for farming, whereby the majority of farmers in the communal system keep livestock for a number of purposes; e.g. milk, meat, and ceremonial slaughtering (Duvel. and Afful, 1994). In comparison with the aims of the commercial farmers which is to achieve faster growth, less mortality, high turnover which all translate into higher profits. Productivity from goats in the communal farming system, which is based on the extensive system, is said to be poor with a low weaning rate, a high mortality rate and low turnover (Bembridge and Tapson (1993).

The commercial system is characterised by “good” management practices, like feed
supplementation in the form of lucerne hay, mineral licks and concentrates. Periodic treatment against gastrointestinal worms with anthelmintics, and specific breeding periods are used which result in a correspondingly short kidding period. Goats are dipped to control tick infestation and tick borne diseases. Live body weight of each animal is taken once a month, and these are used to determine growth rates, on the basis of which, selection for replacement stock is made.

Due to the unconventional production practices in the communal farming systems, there exists a perception that the performance of animals from these areas (communal farming system) is below acceptable levels, with the commercial system being used as the gauge. There is lack of information to prove otherwise. This study will give insight into the general performance of goats in the communal farming area.

The aim of this study was to compare goat performance in a communal area with that of goats from a commercial farm.

**Materials and Methods**

**Study site**
The study was conducted at Koloni, Middledrift district, Eastern Cape province, South Africa (32°53’50”S, 27°04’50”E). The livestock production system is of a communal type. It is situated in veld type number 7, which is the Eastern Cape thorn veld (Acocks, 1975), and receives about 500mm of rainfall per year (CV 22.7%) (Goqwana, 1998). The stocking rate for 1997 was 330 SSU/658 ha (Goqwana, 1998). Vegetation is dominated by *Acacia karoo*, which contributes more than 70% of the botanical composition. Other species include *Coddia rudis, Grewia occidentalis, Scutia myrtina, Rhus* and *Maytenus* species (Goqwana, 1998).

**University of Fort Hare Research farm**
The University of Fort Hare Farm’s livestock section, Honeydale (32°47’37”S, 27°06’58”E) is 1113.6ha in size and represents a commercial farming system. The farm is stocked at 4 ha/AU and veld management practices are based on applying correct stocking rates and rotationally grazing the livestock in paddocks of which one third is rested annually. Fire is applied when some paddock are deemed to be encroached by trees or shrubs and goats are kept to control bush in conjunction with fire. The veld type is the False Thornveld of the Eastern Cape (Acocks, 1975), and the average annual rainfall is 620mm (CV 24%).

**Management of the goats**

**Koloni (Communal system)**
Animals are kraaled in the night, and let out to graze midmorning at around 10.00 am. In the evening, 4.00-5.00pm, the animals are collected from the veld, to be kraaled. No specific breeding season is followed, leaving animals to breed whenever possible, this results in a prolonged kidding period. No specific feed supplementation is given to the goats and other stock, but they are allowed access to stover. All live stock are not weighed. There is minimal use of anthelmintics to control gastrointestinal worms, and a number of owners use herbal medications to treat their goats. Selection and culling of animals on the basis of their live weight gain, as replacement stock, is not practised, and there is a high degree of inbreeding in their stock.
Honeydale (Commercial system)
Animals are kept in a night paddock, and let out to graze at about 7.30 am, and are brought back to base at about 3:00 pm. A specific breeding season from 15th October to 30th November (6 weeks) is used. As a result, the kidding season takes place in March and April, after a gestation period of 5 months. No feed supplementation is given to the goats, except that protein blocks are given during droughts. Periodic treatment against gastrointestinal worms is done with anthelmintics. Goats are dipped to control tick borne diseases and ectoparasites. Live body weight of each animal is taken once a month, and this is used to determine growth rates, on the basis of which, selection for replacement stock is made.

Data collection
Communal system
A total of 70 goats of various age groups and sexes were selected and ear tagged at random on a dipping day at the village dipping tank. There after, goat owners with tagged animals were requested to avail the tagged animals on specific days on which the animals were to be weighed. On each weighing day, goats were collected in one kraal where weighing was done, using a dial scale hooked at the end of a lever, that was mounted on a vertical steel pipe, which had been inserted in a hole in the ground. A leather strap was used to hoist the goats, legs down on to the scale. Body weights were recorded once a month.

Estimation of the age of the goats was made, by determining the stage of eruption of the permanent incisor teeth. All goats with no permanent teeth were taken to be less than one year of age, those with one, two, three or four pairs of permanent incisor teeth erupted, were 1.5, 2, 3, or 3.5 years of age, respectively.

From a total of 70 goats that were tagged initially, data for only 39 goats is reported on in this article. This is as a result of many missing data, due to some owners not bringing their animals to be weighed on days when it was very cold (Winter), or when it was drizzling. Some of the goats died and others were slaughtered or sold.

Commercial system
Data for 109 Nguni type goats, were obtained retrospectively from the University of Fort Hare Research farm, which, in this study, is used to represent the commercial system of farming.

Seasons are grouped as follows: Summer (December – February); Autumn (March –May); Winter (June – August) and Spring (September- November).

Data analysis
Data were analysed for Anova, F and t-tests using the Genstat for Windows 3.2 programme.
Results

Mean weights of goats from the communal and commercial systems

The mean weights of goats (corrected for age) from the commercial system were 1.2 times higher (Table 1), than those of goats from the communal system (P<0.01).

<table>
<thead>
<tr>
<th>System</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communal</td>
<td>28.31</td>
<td>29.85</td>
<td>31.68</td>
<td>32.16</td>
</tr>
<tr>
<td>Commercial</td>
<td>36.64</td>
<td>39.02</td>
<td>37.33</td>
<td>37.84</td>
</tr>
</tbody>
</table>

Mean weights of male and female goats

Generally, the mean weights of male goats from both sites were 1.1 times greater than of the females (P<0.01), however, there was no significant difference in live weight between the two sexes in summer. (Table 2)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>35.42</td>
<td>9.57</td>
<td>40.52</td>
<td>42.36</td>
</tr>
<tr>
<td>Females</td>
<td>34.44</td>
<td>35.88</td>
<td>34.31</td>
<td>34.31</td>
</tr>
</tbody>
</table>

Mean body weights of male and female goats from the communal and commercial farming system in the various seasons

Male goats from the communal system had a slight increase in body weights, with a peak in spring (Table 3). Male goats from the commercial system showed a linear increase in body weight, with a maximum weight in spring. Female goats from the communal system showed a linear increase in weight with a peak in winter, which then reduced in spring. Female goats from the commercial system showed a peak in body weight in autumn.

<table>
<thead>
<tr>
<th>System</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communal</td>
<td>26.99 (11.50)</td>
<td>29.34 (10.80)</td>
<td>29.10 (8.20)</td>
<td>30.47 (6.80)</td>
</tr>
<tr>
<td>Commercial</td>
<td>30.29 (11.10)</td>
<td>32.65</td>
<td>33.48 (10.30)</td>
<td>31.33 (10.50)</td>
</tr>
<tr>
<td></td>
<td>29.45 (15.50)</td>
<td>34.31 (13.50)</td>
<td>35.31 (11.30)</td>
<td>36.74 (10.40)</td>
</tr>
<tr>
<td></td>
<td>38.56 (15.00)</td>
<td>40.29 (13.00)</td>
<td>37.80 (9.50)</td>
<td>38.05 (8.70)</td>
</tr>
</tbody>
</table>

Mean average daily gain

Generally, goats from the commercial system had 1.1 times higher average daily weight gains (ADG) than those from the communal system (Table 4), except in Autumn, when both male and female goats from the communal system gained better than those from the commercial farm. In autumn, female goats from the commercial farm lost weight,
compared to females from the communal system, which were gaining weight during the same period. The bucks from the commercial farm also gained in autumn compared to their counterparts from the communal system. Females from the communal system lost weight in summer and spring, whereas their counterparts from the commercial system gained weight in summer, and slightly so in Spring.

### Table 4  Mean ADG (g/day) ± SD of male and female goats from the communal and commercial system, in the various seasons.

<table>
<thead>
<tr>
<th>System</th>
<th>Season</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
<td>43.69+</td>
<td>52.30+</td>
<td>59.90+</td>
</tr>
<tr>
<td>Communal</td>
<td>34.97+</td>
<td>12.85+</td>
<td>11.30+</td>
<td>6.94+</td>
</tr>
<tr>
<td>Commercial</td>
<td>82.73+</td>
<td>28.57+</td>
<td>44.75+</td>
<td>97.66+</td>
</tr>
<tr>
<td></td>
<td>83.48+</td>
<td>26.25+</td>
<td>106.00</td>
<td>3.86+</td>
</tr>
</tbody>
</table>

### Discussion

The difference in body weight of goats from the communal compared to those from the commercial system could be due to several factors:

- The first is management. The goats are allowed to forage at different times in the different systems. Normally, goats and sheep in the communal farming system, are released at about 10.00 a.m. This is due to a belief that dew on the grass contains some disease causing organisms, which could infect the animals if they were to graze very early in the morning. Another reason for letting the small stock out late is fear of vermin like jackals and foxes, which will have moved deeper in the bushes and forests by midmorning.

- Goats have been recorded to start foraging on their own about 30 minutes before sunrise in summer and 40-45 minutes after sunrise in winter (Sharma, Saini, Singh and Ogra, 1998). The morning feeding period commences at daylight and continues until midmorning (10:00 - 11:00) and a second major meal begins 2-3 hours prior to sunset. This diurnal pattern of foraging shows that goats in the communal system start grazing at a time when they should be resting, possibly to avoid heat stress. The grazing practice in the communal system, most likely affects feed intake of these goats. Diurnal feeding pattern in goats may be modified by factors such as forage availability, environmental stress such as heat and rain, frequency of feeding and amount of feeding (Sharma et al., 1998).

- Malnutrition is the other possible reason, and it is known to be the most important cause of low production rates in communal systems (Bembridge and Tapson, 1993). Malnutrition could be caused by the late release of the goats from kraals, coupled with the long distance walked from the residential sites to the foraging camps. At the end of the day, the animals will have inadequate feed intake. This in itself drains the animals energy reserves. Locomotion associated with foraging and increased amount of time spent obtaining food is important as it can account for a significant part of the total energy requirement in goats (Sharma et al., 1998).

- A possible gastrointestinal nematode parasitism in goats from the communal system could also have led to their being lighter. The adverse effects of undernutrition on the
productivity of ruminants, is further exacerbated by infection with gastrointestinal parasites, particularly when climatic conditions are warm and moist (Anindo, Toe, Tembely, Mukasa-Mugerwa, Lahlou-Kassi and Sovanil (1998). However, a high level of nutrition can mitigate the effect of endoparasitism (Mukasa-Mugerwa, Kasali and Said, 1991).

- A lack of selection and culling of poor performing stock in the communal area, as practised in the commercial system, leads to a more heterogeneous flock which could have masked the performance of good performers, thus resulting in the general lower weights. The practice of inbreeding in the goat flocks from the communal system could also have contributed to the lower body weights.
- Male animals were heavier than females (Table 2). Males are in the majority of cases born heavier than females, this also translates in heavier weaning weights and growth rates for the male. The steroid hormone levels could have a role in this aspect, where by, testosterone has a higher anabolic effect than estrogen. On the other hand, females face greater physiological stress in the form of pregnancy, kidding and nursing the kids, which drains the female’s body reserves, thus lowering their body weights.
- The reasons for body weight differences seen in Table 3, could have possibly been due to presence of a more nutritive source of grazing as a result of the beginning of the rainy season. Male goats from the communal system showed a slight lowering in their body weight during winter, which could be due to the colder weather at this time of the year, however, their female counterparts did not show this trend. So the cause could not have been the weather. Another possibility could have been the breeding season. As is the case with many other seasonal breeders, goats exhibit a seasonal growth cycle independent of available nutrition and driven by changes in voluntary feed intake (Walkden-Brown, Norton and Restall, 1994b). This cycle is characterised by a depression in voluntary feed intake and growth during the autumn and early winter months when testosterone concentrations are highest, suggesting that it may be mediated in part by gonadal steroids (Walkden-Brown, Restall, Scaramuzzi, Martin and Blackberry, 1997).
- Male goats from the commercial system, showed a linear increase in body weight, with a maximum weight in spring, which could be due to the male goats being at a stage of linear growth (growth curve), on average, male goats were 1 year old. But could also be due to their being supplemented with concentrates before, during and just after the breeding season.
- Female goats from the communal system showed a linear increase in weight with a peak in winter, which then reduced in spring. Goats in the communal system start breeding in autumn, which could explain the peak increase in live body weights in winter. This is the time when the goats were heavily pregnant. The decrease in body weight in spring could be due to the female goats nursing their kids at this time of the year and in some cases, being milked by the owners. It could also be due to an increase in the internal parasite load, which tend to increase during the time when the body is under stress. Female goats from the commercial system showed a peak in body weight in autumn. This is the time when they could have been heavily pregnant, since the commercial system practices spring mating - Autumn kidding, this results in a corresponding reduction in body weight in winter, which is the time when they would be nursing the kids.

A possible explanation why goats from the commercial system had a higher ADG (Table 4) could be that, in the commercial system, animals with a faster growth rate are selected to
become replacement stock, whereas, animals with a slower growth rate are selected against and are eventually culled. Selection per se is not practised in the communal system. As a result, goats from the communal system have a more heterogeneous growth rate than goats from the commercial system, which could have led to their having a lower ADG than those from the commercial system.

The commercial farm in this study practices autumn kidding, during this time, the does are under stress caused by kidding and suckling of the kids, this goes to explain the negative ADG shown by the females from the commercial system. However, the physiological stress of the nursing does, could have been confounded by the quality of available herbage on the veld. Whereby, the practice of controlled stocking and grazing in the commercial system, leads herbage to grow to mature stage where it contains low crude protein and digestibility, coupled with frost at this time of the year, which leads to excessive defoliation of available browse.

The decrease in ADG of male goats from the commercial system in Autumn, could have been influenced by the poor quality herbage available on the veld, which could also have been confounded by the possibility of the bucks having had a depressed voluntary feed intake and growth during autumn, when testosterone concentrations are at their peak (Walkden-Brown et al., 1997). The high testosterone concentration during the breeding season is reported to directly inhibit voluntary feed intake (Walkden-Brown et al., 1997).

The negative ADG exhibited by the female goats from the communal system, during spring and summer seasons, could have been due to the fact that kidding takes place at this time of the year. As there is no specific breeding period practised in the communal system, the kidding season expands over a wide period, which coincides with a loss of weight. Coupled with this is the fact that some of the goats are milked by their owners, which might increase body demands for nutrients that are of low quality and quantity at this time of the year. Proteins and digestible nutrients decline after the rainy season with the onset of winter in natural pastures, and this causes major constraint to ruminant productivity as a whole (Sharma et al., 1998).

**Conclusion**

Goats from the communal farming system were lighter and had a lower average daily weight gain compared to similar goats in a commercial farming system. This difference in goat performance could be due to a number of factors like, management, nutrition, health, breeding practices, selection to mention but a few. Improvement in growth performance of flocks from the communal system could be effected by implementation of basic management practices used in the commercial systems. However, one should not forget the purpose why farmers in the communal system keep livestock. For them it would appear, their aim is to increase numbers as opposed to individual animal performance (Duvel and Afful, 1994). On a production per unit area basis, however, communal systems could perform better than the commercial systems due to the high number of livestock kept per unit area in the communal areas, which could be at the expense of the veld.

**References**


The potential of leather production from goats

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The concept
Leather offers an opportunity for benefaction through crafting resulting in real profit to leathercrafters and others. Successful crafting underwrites a great string of potential further jobs and benefits to allied participants in the form of raw product procurers, tanners, craft material distributors, beaders, marketers, product promoters, designers, materials producers, etc.

Value Addition
There is good potential for resource benefaction.

A goat skin, properly flayed and cured is worth approximately - R4.00
After tanning, (at a cost of some R25.00), its value increases to some - R40.00
As finished leathercraft items it could readily be worth as much as - R400.00

At the workshop held at the Irene Animal Nutrition and Animal Products Institute of the Agricultural Research Council of 24 June 1997 it was speculated that, of the estimated seven and a half million goats of all types, (indigenous and the milch goat, boerbok and etc.), in southern Africa, (and the speaker was at pains to point out the difficulties of arriving at accurate national figures), some 40 000 goats (just more than half of one per cent) are slaughtered monthly, mostly for ritual purpose. It has also been estimated that less than 10% of the skins resulting from these slaughters find their way to a tannery. This is a huge loss to the country, and in particular the rural areas.

Extrapolated to annual terms this translates to approximately 400 000 goats.

The lost goat skins could be worth as much as - R1 600 000.00
After tanning the loss would increase to approximately - R16 000 000.00
And, as finished leathercraft items, they could be worth as much as - R160 000 000.00

This represents a truly staggering loss to the goat owners, rural tanners, leathercrafters and to the multitude of people who might be involved in the distribution and marketing of these products and the supplying of goods and services to the crafting trade. While the above figures do not take into account the basic costs of materials and labour, as a community

\[3\] NOTE: There has been a recent collapse in the price paid for the skins of goats, hair- and wool-sheep and small game due to oversupply in the face of the problems being encountered in the Asian and Russian economies. However, the price of the raw skin is the least factor in the above calculations and is to the benefit, in a small way, of the tanner and the crafter.
project and driven by effective design, the benefaction and resulting value to communities all over the country cannot be over estimated.

**Design stimuli**
The most important factors in the successful implementation of a leathercraft development programme to address this potential, are:

1. the level of research into and quality of the design and manufacture of goods,
2. the successful training of participants,
3. the correct marketing infrastructure and, it must be added,
4. the enthusiastic support and participation of the delegates to this Workshop.

Present day South Africa’s peoples are distinguished by racial groups with good ethnic and artistic design identity. Ndebele house painting, Zulu beadwork, Xhosa grass weaving, Khoisan leatherwork, Cape Malay parade and dance costumes, wood carving from the north, terra cotta pottery from the east, bone carving, metal working, the list is long and impressive.

Much of the present day craft output comes from producers who are highly skilled and artistic. There is no reason why leather cannot be another highly viable craft raw material and, if good tanning methods are used, leather is an environmentally friendly and continuously renewable resource. As long as humans continue to eat meat, leather will be a by-product. It does not offer the same threat to resources as wood carving, Baobab fibre weaving, even soap-stone carving and, indeed, undertaking the tanning and crafting of discarded skins is better for the environment than leaving them to rot.

Southern Africa is also blessed with one of the world’s great and outstanding artistic heritages in the form of San Rock Art. This is an invaluable design resource and a potent means of attracting visitors to sites where crafters can gather.

It is a sad fact that over the past hundred years African leather has largely been neglected and forgotten. Most existing examples of ethnic leathercraft are only to be found in museums. Research by the writer and the subsequent recreation of some African leather items has been received with enthusiasm by visitors to South Africa. These designs, some of which are on display here today, now await funding for transfer to potential crafters.

**The market**
At the annual National Festival of the Arts in Grahamstown the foreign craft on offer outnumbers locally produced goods and, I regret to have to admit, often outclasses it as well. However, the effort made by foreign craft makers to come and sell their produce in South Africa should be seen as a challenge not a threat, because it indicates the strength of the local market and therefore the potential it offers for local expansion of craft development and training.

The close association of leather and man is very true of African leather and the constant theme of decorative/functional appears at every turn. Foreign tourists are fascinated by the association of craft items with social position and the dance and are willing customers of samples that remain a reminder of their southern African visit.

I believe that there is potential to create a useful (even modern) item, such as a key pouch, and to decorate the same basic design in the typical style of each ethnic or language group. This would have several important consequences:
1. A tourist travelling throughout SA could purchase the same item but with distinct ethnic differences in decoration from each area visited. (Much as the world traveller collects teaspoons). This would also apply to designs that carried local decor that depicted Aliwal North, Bapong, Sterkstroom, Kommas, Xhosa or Zulu custom, steam railways, skiing, sports events etc., etc., etc. Each, with its swing tag giving the story of the group, would be a potent reminder of the trip or participation in the activity, would not cost a very large sum of money and would make lovely presents for family and friends back home.

2. A large number of crafters could make and market a relatively small number of basic designs, but ring the changes by each using their own groups ethnic designs. Some would decorate with paint, others would use beads, others plaits and thongs, etc.

3. A central distribution agency, looking for exports, would not be flooded with identical goods from every part of the country.

4. Crafters, working together in craft clusters, would soon develop variations of local designs that would keep the market competitive and healthy.

I repeat the assertion that good design and high standards of production of South African craft will ensure its place as a top competitor for both local and export markets. At present we enjoy unprecedented interest in our lovely country and the tourist market is set to continue with huge growth.

**Leather**

Much has already been said about goat leather. The major points in its favour are:

1. It is readily available throughout most parts of South Africa and particularly in the rural areas of the Eastern Cape, Kwazulu/Natal and the Northern Province.

2. It is thin enough not to require specialised machinery to bring it to a workable state. (Splitting and shaving machines for bovine leathers cost hundreds of thousands of rands.)

3. It can be readily tanned in both vegetable and mineral tannage, in both hair-on and hair-off forms.

4. It simulates the types of leathers used when small mammals (e.g. gennets, dassies, etc.) were easily available and therefore lends itself to the development and reintroduction of traditional leather items.

5. The southern African indigenous goat is a hardy creature and, in spite of the rigours of Africa, often produces a very fine and largely unblemished skin. The boergoat skin is also a highly desirable commodity, but the indigenous goat, with its handsome colour markings, makes a very fine leather.

6. It is not, at present, looked on with much favour by the shoe, motor trade and even small goods industries, because individual skins are small and too much is cut to waste. Therefore crafters would not be seen to be competing with established industry for scarce resources.

As a result of the above, LIRI Technologies has developed a five day home tanning course, which is available for rural tanners. LIRI is also developing craft designs appropriate to the leather that would be produced. Allied to the five day tanning opportunity is a parallel beginners crafting training opportunity. Basic tanning and crafting kits are offered as part of the same initiative. While participation is not cheap, (R2 800.00 for the full tanning/crafting course, including tanning and crafting kits), it allows potential tanners and crafters to become involved and to begin to take responsibility for making decisions about their futures, from an informed base. Rural farmers, with subsidisation, could make use of the course to keep the
profit from skins on the farm. It must be noted that just two tanners, working to capacity, could probably keep up to 30 crafters busy, particularly if the crafters undertook some of the finishing aspects of the leather which was being supplied to them. This means that the better potential for job creation lies in the training of more crafters than tanners.

**Training**
Training has started in a small way in Grahamstown through the Department of Labours initiative and some 80 Eastern Cape people have received 15 days of basic leatherwork instruction. Nine of those trainees, under the auspices of the local GADRA Training scheme, have returned for a further 10 days of advanced training and will now work in an incubator under the care of GADRA until they are ready to strike out on their own.

The concept of initial training followed by skills polishing is costly but essential because, until basic training is followed by a period of trial-and-error crafting, the more advanced techniques are not absorbed. Furthermore, unless a parallel programme of financial and stock controls, marketing and market development and general awareness of running a small business is followed, trainees are doomed, except in the case of rare exceptions, to waste their resources and their training, and rapidly go out of business.

A further consequence of a realisation of the value of a goat skin would be better animal husbandry methods, greater care of the goats to minimise skin damage and better flaying and curing care.

**Marketing**
I have already covered aspects of the need for market development and the teaching of marketing skills and look forward to hearing much more on this essential subject from other speakers, but because LIRI recognises both the huge export potential and the relative unsophistication of its trainees, it has been developing swing tags to accompany every article and these are made available to trainees as part of the development package. These give details of the product and the maker and a social history of these links.

In collaboration with the Department of Animal Nutrition of the Agricultural Research Council in Irene, aspects of:

1. cashmere production and resultant spinning, weaving and cashmere products production
2. milk and cheese production and
3. fermented meat products production, are also available to interested goat owners.

The National Corridors development along many of the countries main tourist routes is an exciting concept and worthy of great support. LIRI Technologies Leathercraft Division offers its expertise and facilities in support of this fine initiative.
Potential of goats in the arid sweet bushveld of the Northern Province

Izak du Plessis
Mara Agricultural Development Centre

Introduction
Small stock at present plays a small but important role in agriculture in the Northern Province. Apart from few farmers with large flocks of goats (mainly Boer goats) most other farmers also keep small flocks of goats (≪ 15 - 20 goats). Communal farmers keep these small flocks for rations for their labourers for a number of other reasons (religion, rituals, own consumption, etc).

Reproduction
A trial with Boer goats and indigenous goats were conducted at Mara ADC from 1988 to 1991. The two flocks were managed as to simulate the management that they are traditionally subjected to. The Boer goats were manage intensively, having a breeding season (1 July to 15 August), treated when ill and had dosing, dipping and inoculation programmes. The Indigenous goats were mated throughout the year. Originally, they received no treatments but later on they were treated to lower the mortality rate and rather increase the output (production and economic outputs) of the flock. Animals that were treated, were culled as well as the kids if the ewe was treated before the kids were weaned. They also did not have dosing, dipping and inoculation programmes. The following are some of the results from this trial.

The data for the different years were pooled (Table 1) and suggests that the Boer goats have more multiple births (11.2%) than the Indigenous goats.

<table>
<thead>
<tr>
<th>Breed</th>
<th>% Single</th>
<th>% Multiple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boer goat</td>
<td>34.4</td>
<td>65.6</td>
</tr>
<tr>
<td>Indigenous goat</td>
<td>45.6</td>
<td>54.4</td>
</tr>
</tbody>
</table>

From Tables 2 and 3 it can be deducted that both breeds have a high fecundity rate and that the Boer goats have a moderate conception rate. With a kidding interval of less than 240 days the Indigenous goats were able to compensate for the lower number of multiple births that occurred.

<table>
<thead>
<tr>
<th>Year</th>
<th>n Mated</th>
<th>n Kidded</th>
<th>n Born</th>
<th>n Weaned</th>
<th>n Kidded/ n Mated</th>
<th>n Born/ n Kidded</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>35</td>
<td>21</td>
<td>27</td>
<td>25</td>
<td>0.60</td>
<td>1.29</td>
</tr>
<tr>
<td>1989</td>
<td>36</td>
<td>24</td>
<td>37</td>
<td>32</td>
<td>0.67</td>
<td>1.54</td>
</tr>
<tr>
<td>1990</td>
<td>30</td>
<td>12</td>
<td>17</td>
<td>13</td>
<td>0.40</td>
<td>1.42</td>
</tr>
<tr>
<td>1991</td>
<td>26</td>
<td>21</td>
<td>39</td>
<td>24</td>
<td>0.84</td>
<td>1.86</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>78</td>
<td>120</td>
<td>94</td>
<td>0.62</td>
<td>1.54</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Breed</th>
<th>% Single</th>
<th>% Multiple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boer goat</td>
<td>34.4</td>
<td>65.6</td>
</tr>
<tr>
<td>Indigenous goat</td>
<td>45.6</td>
<td>54.4</td>
</tr>
</tbody>
</table>

Table 3  Reproduction performance of the Boer goats
It seems that both breeds are reproductively adapted and will be able to contribute significantly to goat production.

**Intake**
A small stock comparison trial started in February 1997 that included the two goat breeds as well as Pedi and Dorper sheep. All flocks are managed the same. As all the flocks were not at the same reproductive stage, all flocks had been synchronised for the period February 1997 to July 1998. In July 1998 all flocks were mated at the same time. In February 1998 an intake study started. The frequency at which the different plant species is selected is determined through direct observation. Four animals per breed are observed for 100 bites on a monthly base. The results are summarised for February to October and are divided into a summer and a winter period. No forbs are mentioned, because such a wide range was selected that it was only *Heliotropium ciliatum* that was selected at a significant frequency.

### Table 4  Frequency of intake of the different grazing components

<table>
<thead>
<tr>
<th></th>
<th>Boer goat</th>
<th>Indigenous goat</th>
<th>Pedi sheep</th>
<th>Dorper sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
<td>Winter</td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td>Grasses</td>
<td>12.3</td>
<td>36.2</td>
<td>6.4</td>
<td>30.6</td>
</tr>
<tr>
<td>Trees and shrubs</td>
<td>44.3</td>
<td>44.9</td>
<td>46.6</td>
<td>54.4</td>
</tr>
<tr>
<td>Forbs</td>
<td>43.4</td>
<td>18.8</td>
<td>47.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Unlike a previous intake study at Mara ADC, early results of the current intake study suggests that the selection patterns of the Boer goats and the Indigenous goats do not differ significantly (Table 4). In the previous study it was reported that the Boer goats selected 22% of their diet as grass species and that the indigenous goats selected 49% grass species. Although the previous study did not take seasonal variations into account, the present study clearly indicates that all breeds involved alter their selection pattern during winter by decreasing their frequency at which forb species were selected and by increasing the frequency at which grass species were selected. The sheep breeds also increased the frequency at which tree and shrub species were selected.

During summer the tree species *Commiphora pyracanthoides* was selected most by the goat breeds, while the sheep mainly selected the grass species *Urochloa mosambicensis* (Table 5). During winter both goat breeds selected *Boscia albitrunca* most frequently. The sheep breeds also increased the frequency at which they selected *Boscia albitrunca* significantly. It is apparent that
all breeds increased the number of species that they selected during the winter months compared to the summer months.

The preferences for the different plant species changed dramatically from summer to winter (Tabled 6). It is interesting that the selection preference for *Ehretia rigida* remained high even though the leaves were dried out. The high preference for *Boscia albiteruna* during winter is expected, as it is the predominant evergreen species. At the rate that *Boscia albiteruna* and *Commiphora pyracanthoides* were selected, it seems that they may be important indicator species to determine browsing pressure.

Although quite a few species were selected during summer, it was only *Panicum coloratum* that had a high preference value for most breeds. *Eragrostis rigidior* is widely regarded as an unpalatable species. For most small stock breeds this species was frequently selected during winter and became one of the more preferred species. Although the *Grewia* spp. were preferred during winter, they did not play an important role in terms of the frequency of selection.

**Conclusion**

A thorough understanding of the feeding behaviour of the different small stock breeds will help in the development of proper management programmes for optimum utilisation of the forage resources on the farm. The integration of large and small stock enterprises can also be done more comprehensively.

Although goats play a relatively small role in terms of animal production in the Northern Province, both Boer and Indigenous goats have the potential to form an important aspect in maximising the output of a farm as well as in optimising the utilisation of the natural resources.

**Table 5  Grass, tree and shrub species most frequently selected**

<table>
<thead>
<tr>
<th></th>
<th>Boer goat</th>
<th>Indigenous goat</th>
<th>Pedi sheep</th>
<th>Dorper sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
<td>Winter</td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Urochloa mosambicensis</em></td>
<td>7.50</td>
<td>4.94</td>
<td>5.28</td>
<td>8.87</td>
</tr>
<tr>
<td><em>Panicum coloratum</em></td>
<td>8.96</td>
<td>4.29</td>
<td>5.10</td>
<td>15.53</td>
</tr>
<tr>
<td><em>Schmidtia pappophoroides</em></td>
<td>3.68</td>
<td></td>
<td>5.53</td>
<td>1.06</td>
</tr>
<tr>
<td><em>Eragrostis rigidior</em></td>
<td>7.41</td>
<td>6.58</td>
<td>3.68</td>
<td>8.83</td>
</tr>
<tr>
<td><em>Digiteria eriantha</em></td>
<td>7.35</td>
<td>4.58</td>
<td>2.41</td>
<td>4.13</td>
</tr>
<tr>
<td><em>Panicum maximum</em></td>
<td>4.82</td>
<td>4.88</td>
<td>0.71</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Trees and shrubs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Commiphora pyracanthoides</em></td>
<td>36.62</td>
<td>4.14</td>
<td>27.68</td>
<td>6.09</td>
</tr>
<tr>
<td><em>Ehretia rigida</em></td>
<td>5.35</td>
<td>3.96</td>
<td>6.01</td>
<td>10.86</td>
</tr>
<tr>
<td><em>Acacia tortilis</em></td>
<td>10.12</td>
<td>10.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Boscia albiteruna</em></td>
<td>34.52</td>
<td>1.61</td>
<td>27.05</td>
<td>8.33</td>
</tr>
<tr>
<td><em>Grewia</em> spp.</td>
<td>1.95</td>
<td>4.53</td>
<td>4.82</td>
<td>5.19</td>
</tr>
<tr>
<td><em>Dichrostachys cinerea</em></td>
<td></td>
<td></td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td><em>Ximenia americana</em></td>
<td></td>
<td></td>
<td></td>
<td>5.17</td>
</tr>
</tbody>
</table>
### Table 6  Most preferred grass, tree and shrub species

<table>
<thead>
<tr>
<th></th>
<th>Boer goat</th>
<th>Indigenous goat</th>
<th>Pedi sheep</th>
<th>Dorper sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses</strong></td>
<td>Summer</td>
<td>Winter</td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td>Panicum coloratum</td>
<td>0.010</td>
<td>0.663</td>
<td>0.229</td>
<td>4.908</td>
</tr>
<tr>
<td>Digitaria eriantha</td>
<td>0.385</td>
<td>0.188</td>
<td>0.484</td>
<td>0.336</td>
</tr>
<tr>
<td>Urochloa mosambicensis</td>
<td>0.086</td>
<td>0.045</td>
<td>0.031</td>
<td>0.132</td>
</tr>
<tr>
<td>Tricholeana monachne</td>
<td>0.072</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schmidtia pappophoroides</td>
<td>0.057</td>
<td></td>
<td></td>
<td>0.071</td>
</tr>
<tr>
<td>Panicum maximum</td>
<td>0.159</td>
<td></td>
<td>0.129</td>
<td></td>
</tr>
<tr>
<td><strong>Trees and shrubs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commiphora pyracanthoides</td>
<td>0.528</td>
<td></td>
<td>0.408</td>
<td></td>
</tr>
<tr>
<td>Ehretia rigida</td>
<td>0.333</td>
<td>0.184</td>
<td>0.343</td>
<td>2.387</td>
</tr>
<tr>
<td>Acacia tortilis</td>
<td>0.012</td>
<td>0.324</td>
<td></td>
<td>0.670</td>
</tr>
<tr>
<td>Boscia albitrunca</td>
<td>3.444</td>
<td>0.212</td>
<td>3.295</td>
<td>1.080</td>
</tr>
<tr>
<td>Grewia spp.</td>
<td></td>
<td></td>
<td>0.517</td>
<td>0.014</td>
</tr>
<tr>
<td>Dichrostachys cinerea</td>
<td>0.055</td>
<td></td>
<td>0.026</td>
<td>0.195</td>
</tr>
</tbody>
</table>

### Table 7  Most important grass, tree and shrub species

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eragrostis rigidior</td>
<td></td>
<td>22.9</td>
</tr>
<tr>
<td>Urochloa mosambicensis</td>
<td>B,I,P,D</td>
<td>18.2</td>
</tr>
<tr>
<td>Schmidtia pappophoroides</td>
<td>D</td>
<td>5.0</td>
</tr>
<tr>
<td>Panicum maximum</td>
<td>P,D</td>
<td>4.8</td>
</tr>
<tr>
<td>Panicum coloratum</td>
<td>P,D</td>
<td>3.7</td>
</tr>
<tr>
<td>Digitaria eriantha</td>
<td>P</td>
<td>2.4</td>
</tr>
<tr>
<td>Aristida spp.</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td><strong>Trees and shrubs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commiphora pyracanthoides</td>
<td>B,I,P</td>
<td>5.9</td>
</tr>
<tr>
<td>Rhigosum zambesiacum</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Acacia tortilis</td>
<td>I</td>
<td>1.7</td>
</tr>
<tr>
<td>Grewia spp.</td>
<td>B,I,P,D</td>
<td>1.2</td>
</tr>
<tr>
<td>Ehretia rigida</td>
<td>B,I</td>
<td>0.8</td>
</tr>
</tbody>
</table>

---

Each table provides a comparison of grass, tree, and shrub species preference among different livestock species and seasons.
The potential utilisation of South African indigenous goats for cashmere production

Albie L Braun
CSIR Division of Textile Technology, PO Box 1124, Port Elizabeth 6000, South Africa

Abstract
In this paper, reference is made to the fibre properties of luxury fibres, such as cashmere, and to the ability of South African indigenous goats to produce cashmere type of fibres. Against this background, the paper discusses Textek/CSIR's involvement in the utilisation and promotion of fine down (cashmere type) fibre production from indigenous goats in a joint project with Grootfontein and Döhne Agriculture Development Institutions. This paper report on the progress that has been made that records the results obtained on samples received during the past two years of harvesting. Reference is made to the down fibre quality, yield and profile of the samples compared to those of Chinese cashmere. This paper concludes with the reasons why cashmere production is ideally suited for subsistence farmers and the importance for South Africa to utilise and improve the fine fibre production potential of indigenous goats.

Introduction
Rare, luxury or speciality animal fibres have an exclusivity that is rarely associated with other fibres. Their scarcity is due to the fact that they are difficult to produce on a large scale, because of climatic conditions and/or genetic factors. These fibres are characterised by their high quality, particularly in terms of fibre properties, such as fineness, softness, warmth, lightness, lustre etc. which make them unique in processing and wear performance, notably comfort and softness. Such fibres include goat hair (mohair, cashmere), camel hair, Llama hair (Alpaca), Vicuna and Angora hair from the Angora rabbit.

During the past two decades, consumers have exploited these unique fibre properties to their limit, causing the world textile industry to go through a revolutionary change, moving towards more comfortable, lighter, casual, and easy care type of garments. Manufacturers have had no alternative but to go for lighter fabrics with finer fibres (e.g. micro fibres) with a soft appealing handle and added comfort. For this reason cashmere, being the second finest animal fibre produced in fairly large quantities, has become one of the world's most sought after animal fibres today.

Pilot project
Even though cashmere is defined as 18.5 Φm and finer there are world-wide several goat breeds, rather than one distinct breed, which possess the ability to produce cashmere. This has led to numerous studies in various countries in search of goats that possess the ability to produce this highly wanted durable fibre as an undercoat or down and South Africa is no exception. Studies carried out in South Africa indicated that indigenous goats such as the South African Boer Goat, have two coats - the one comprising the coarse guard hair, and the other the fine or cashmere type of fibre. Nevertheless, the quantity of down or cashmere fibre produced per goat was generally not at a level commercially acceptable. However, recognising South Africa's rich resource of approximately six million goats such as the Boer, Savannah and other traditional goats (owned by small farmers), it was felt that if the highly priced cashmere type of down fibre yield could be increased and exploited, this could lead to the possibility of creating a viable cashmere industry in South Africa, thereby adding value to existing animals. For this reason, the CSIR, Division of the Textile Technology (Textek) joined hands with Grootfontein and Döhne Agriculture Development Institutions in a pilot project in which the cashmere producing potential (quantity and quality of
the hair) of the various breeds is being investigated throughout the country.

Grootfontein and Döhne Agriculture Development Institutions concentrate on the breeding and genetic side (selection, upgrading etc.) whereas Textek concentrates on rapid techniques for analysing the fibre quality (fineness and down yield), fibre evaluation, processing techniques, product development and marketing.

**Progress**

The cashmere project represents a national programme and is guided by the Cashmere Working Group which comprises the following organisations:

- CSIR Division of Textile Technology (TEXTEK)
- Agricultural Research Council (ARC): Animal Nutrition and Products Institute, Irene
- Grootfontein Agriculture Development Institute (ADI)
- Döhne Agriculture Development Institute (ADI)
- Halesowen Experimental Farm-Cradock
- Cedara Agriculture Development Institute (ADI)
- Vredendal Agriculture Development Institute (ADI)
- Towoomba Agricultural Development Centre (ADC)
- Mara Agricultural Development Centre (ADC)
- Potchefstroom Agriculture Development Institute (ADI)
- Agricultural and Rural Development Institute (ARDRI)
- Department of Agriculture, University of Fort Hare
- Fort Cox Agricultural College
- Boer Goat Breeders' Association
- Cashmere Breeders' Society (Gorno Altai)
- Emerging Disadvantaged Farmers' Union (EDFU)

The Cashmere Working Group also receives support from the National Department of Agriculture and Provincial Agriculture Departments in various provinces.

Significant progress has been made during the two past seasons to identify the relevant role players, such as the Directors of Extension, Extension Officers and animal scientists of the various regions, the foundation and first National Strategic Meeting of the Cashmere Working Group (August, 1997) to determine the goals and objectives of the project.

Various avenues, such as Agriculture Extension Officers in various goat producing provinces, Farmers' Associations, Community Leaders, Boer Goat Association members, magazines such as Agriculture News, Farmer's Weekly, Landbouweekblad, Land, Agriforum (TV programme) and brochures in various languages were used to communicate information as widely as possible and to motivate farmers to become involved in the project and to harvest the fine down (i.e. cashmere) of their goats for within breed evaluation purposes.

Workshops were also set up in the various provinces for training interested farmers and Agricultural Extension Officers who play a key role in the cashmere project and who act as consultants and organise the fibre harvesting and collection of combed hair in rural areas. Approximately 280 combs were constructed at Textek during the past two seasons and distributed countrywide, free of charge, to interested parties.

During the past two seasons, a total of about 2500 samples (from ≈ 3000 goats) with a total mass
of 97 kilograms from some 280 goat owners were collected and then evaluated by Textek. The harvested fleeces collected were sent to Textek for evaluation in terms of down fibre quality (fineness) and yield. The results were reported to the producers.

An accurate and rapid method, using the advanced image analysis Optical Fibre Diameter Analyser (OFDA) instrument, for the simultaneous determination of down fibre fineness and yield (ratio of down fibre to guard hair) without prior physical separation of the fractions, has been developed by Textek and used for evaluating the samples.

Results to date
Table 1 gives a summary of the down fibre characteristics (quality and quantity) of the different goat breeds or strains over the past two seasons, as determined by means of the OFDA instrument and also subjectively.

Table 1  Down fibre quality and quantity in various double-coated goat breeds

<table>
<thead>
<tr>
<th></th>
<th>South African Boer goats</th>
<th>Savannah goats</th>
<th>Traditional goats</th>
<th>Russian Gorno Altai goats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down diameter (Φm)</td>
<td>16,0 - 18,5</td>
<td>16,0 - 18,5</td>
<td>14,0 - 16,5</td>
<td>18,5 - 19,0</td>
</tr>
<tr>
<td>Down length (mm)</td>
<td>20 - 31</td>
<td>20 - 31</td>
<td>15 - 30</td>
<td>28 - 31</td>
</tr>
<tr>
<td>Down crimp</td>
<td>Good</td>
<td>good</td>
<td>good</td>
<td>Poor</td>
</tr>
<tr>
<td>Down style</td>
<td>Good</td>
<td>good</td>
<td>good</td>
<td>Poor</td>
</tr>
<tr>
<td>Down weight (g)</td>
<td>10 - 50</td>
<td>10 - 50</td>
<td>5 - 15</td>
<td>100 - 500</td>
</tr>
<tr>
<td>Down yield (%)</td>
<td>50 - 70</td>
<td>50 - 70</td>
<td>60 - 80</td>
<td>50 - 70</td>
</tr>
<tr>
<td>(combed fleeces)</td>
<td></td>
<td>white and coloured</td>
<td>white and coloured</td>
<td>Brown</td>
</tr>
<tr>
<td>Other comments</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>silky handle very matted intermediate fibres</td>
</tr>
</tbody>
</table>

In summarising the results, it is clear that the down fibre form the three indigenous breeds or strains (Boer, Savannah and traditional goats) are superior to the Gorno Altai goats in terms of crimp, style, down fibre diameter and a good diameter profile (i.e. without indications of intermediate fibres) but not in terms of down fibre production. The short down fibre length (less than 40 mm) would be problematic in terms of fibre loss and waste during dehairing. Although the Gorno Altai goats have commercially acceptable down fibre weights, the down fibre diameter of most of the fleeces tested to date, exceed the commercially accepted value of 18,5 micron and finer for cashmere. Furthermore, the poor crimp and style of the down fibres together with the presence of an intermediate or third fibre component (Cashgora type) does not allow the Gorno Altai to be classified as cashmere of good quality.

The presence of intermediate fibres in fleeces is undesirable because it is difficult to remove the fibres during the dehairing process. Consequently, the value of such fleeces is adversely affected. For this reason, industrial dehairing of raw cashmere requires a strong distinction between the two fibre populations (fine and coarse) to enable easy and effective dehairing. It is generally desirable that the ratio of the diameter of the guard hair to that of the down fibre be 4:1 and that the guard hair has a mean fibre diameter greater than 60 Φm.
The down fibre diameter profile of the South African indigenous goat breeds/strains generally compares very favourably with that of Chinese cashmere as shown in Table 2 for the Boer goat.

### Table 2  Down fibre diameter profile in fleeces of male and female SA Boer goats and Chinese Liaoning goats

<table>
<thead>
<tr>
<th>Down fibre diameter class</th>
<th>Percentage of fibres per diameter class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SA Boer goat</td>
</tr>
<tr>
<td></td>
<td>Males</td>
</tr>
<tr>
<td>&lt;10 μm</td>
<td>2,1</td>
</tr>
<tr>
<td>10 - 20 μm</td>
<td>88,9</td>
</tr>
<tr>
<td>20 - 30 μm</td>
<td>8,8</td>
</tr>
<tr>
<td>&gt;30 μm</td>
<td>0,2</td>
</tr>
</tbody>
</table>

The proportion (%) of animals producing cashmere type of down fibre in the different yield classes is given in Table 3.

### Table 3  Proportion (%) of animals producing cashmere type of down fibre in the different yield classes

<table>
<thead>
<tr>
<th>Yield</th>
<th>&lt;10 gm</th>
<th>10 - 50 gm</th>
<th>50 - 100 gm</th>
<th>100 - 150 gm</th>
<th>150 - 200 gm</th>
<th>&gt;200 gm</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Boer and Savannah goats</td>
<td>0,6</td>
<td>76,3</td>
<td>17</td>
<td>4,5</td>
<td>1,1</td>
<td>0,5</td>
</tr>
<tr>
<td>% Traditional goats</td>
<td>46</td>
<td>41</td>
<td>11,7</td>
<td>0,8</td>
<td>0,5</td>
<td>-</td>
</tr>
<tr>
<td>% Gorno Altai goats</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>95</td>
</tr>
</tbody>
</table>

The Boer- and Savannah goats showed an average down weight of \(\forall 25 \text{ g/goat}\) whilst traditional goats averaged \(\forall 12 \text{ g/goat}\), with a coefficient of variation as high as 55%, indicating a considerable variation in down weight within breed/strain, and therefore a good genetic pool for future improvement by selective breeding. Goats with a woolly neck are generally good cashmere producers and down fibre yields of up to 150 g/goat and even as high as 400 g/goat have been encountered. Such goats could be used as future breeding stock.

Small quantities of the high quality Boer and Savannah goat hair received by Textek during the past two seasons were scoured, dehaired (using a Shirley Analyser laboratory machine) and processed successfully into two qualities and blends thereof with wool. Knitted garments were produced and many people were most impressed with the fine, soft handle of the garments.

The results obtained to date from the pilot project provides a good indication of the present cashmere quality and production in South Africa.

### Conclusion

Owing to global trends in apparel, a large growing market exists for the finer and high quality
textile fibres. It is therefore imperative for South Africa to utilise its existing potential of indigenous goats to the fullest. The vast number (∄ 6 million) of indigenous goats which possess the ability to produce a double coated fleece, provides a way of diversification of existing agricultural resources without a large capital outlay. The utilisation of the fibres as an additional source of income (value addition) would make the goat flocks more profitable. Furthermore, the establishment of small agro-industries which convert the fibre into the final products, with specific emphasis on tourist textiles, provides a golden opportunity for creating employment in rural areas.

The release of approximately 500 Gorno Altai cashmere goats in 1997 by Sentrachem, Australian Feral goats by a private owner in early 1999 and the selection and upgrading programme by Grootfontein/Döhne Agriculture Development Institutions will, no doubt, provide further momentum to the project.

Textek is also offering local farmers similar prices to those obtained internationally for the 1998 season for combed hair for experimental purposes. It is hoped that this will further stimulate the interest of goat owners in South Africa.

The cashmere production capacity must be seen in the light that, at present, the goats are primarily bred for their meat and milk - the cashmere type of down fibre they produce not being utilised at all. For this reason, it is important to find a balance between meat and fibre production.

Cashmere production is ideally suited for subsistence farmers who have a small number of goats and have close contact with their animals, enabling them to identify those animals with good cashmere producing potential and to know exactly when optimum shedding takes place at which stage the goats should then be combed.

This project supports the whole process of rural and economic development in South Africa, aiming to provide a potential source of supply of this high quality, high priced sought after fibre locally, together with the associated value addition industry, largely in the form of SMME'S.
Biological constraints and opportunities for the production of meat, milk and fibre from Australian cashmere goats

Barry W. Norton
School of Land and Food, University of Queensland, Australia

Introduction
Goats were introduced into Australia with settlement in the early nineteenth century, and most of the breeds of the world are represented in the Australian feral goat population. These goats have adapted to our semi-arid and arid zones, and together with feral pigs, horses, donkeys and cats are causing major damage to our Outback zone. Although there is little local demand for goat meat, feral goats are harvested from the wild and exported to Asia and the Pacific. Australia is the world's largest exporter of goats. However, interest in goats arose mainly from their potential for cashmere production, and when coupled with meat production, was seen to be a new grazing industry for Australia. It was in this context that our studies into goat biology were initiated, in anticipation of a need for management programmes for the intensive raising of cashmere goats. The following paper describes some selected aspects from our studies of meat, milk and fleece production in Australian goats.

Herd statistics for Australian feral goats
Goat research was commenced at the University of Queensland in 1981, when 100 does and 100 bucks were brought in from various areas of western Queensland. There was little known about the productivity of these feral goats, and records were kept of their productivity over the first 5 years of domestication. Records for unselected but domesticated feral goats raised at Mt Cotton farm from 1983 to 1988 have been collated to describe herd characteristics. It was observed during this time that more than 90% of goats grew some cashmere in their fleece, and that these animals were small in size, prolific and easily domesticated. Since that time, male goats have been selected for growth rates to weaning, and used in a breeding programme to increase body size. At a later time, goats selected for cashmere growth from Wollongbar have been used to increase cashmere yields in these goats. Pedigree records back to their feral ancestors are available for all goats in our breeding flock.

The nutrition of the doe
Understanding the effects of nutrition on the fertility, live weight and milk production of the doe is central to developing management strategies which optimise herd productivity. The following aspects of doe nutrition have been studied with this end in mind:
- Doe nutrition and conception.
- Nutrition and doe live weights.
- Pre-natal nutrition and effects on kid birth weights.
- Doe nutrition, milk production and kid growth.
- Protein and energy requirements for lactating does.
- Supplementary feeding and milk production.

Although each study has drawn some important conclusions, I will address only two aspects of these studies. It was noted that the milk production of does was low, and we were interested to know, firstly, whether kid growth rates were limited by doe milk production, and secondly, whether milk production might be increased by supplementary feeding. Studies with kids offered ad libitum intakes of artificial milk between birth and 12 weeks of age showed declining milk energy intakes and growth rates with age, and their were no differences in growth between single
and twin-born kids. When kid growth and milk production had been measured in the field, single-born kids usually grew faster than twin-born kids but not always. When we related our pen studies to the field studies, it was found that kid growth was maximum (52 g/kg<sup>0.75</sup>/d) when milk production exceeded 1100 kJ milk energy/kg<sup>0.75</sup>/d. When milk production falls below this value, milk availability is limiting kid growth and supplementary feeding is indicated. These effects are clearly shown in experiments when does were supplemented with copra meal during the first 3 weeks of lactation.

**Kid nutrition and growth from birth to maturity**

The above studies clearly show that doe nutrition can affect kid growth rates to weaning, and the continued high growth rates can only be maintained if there is no check in weight gain at weaning, and if weaners are provided with high quality diets after that time. The following studies have investigated the effects of nutrition on growth at various stages:

- Growth potential of kids from birth to weaning.
- Milk production and kid growth.
- Managing the weaning transition.
- Post-weaning growth patterns and photo-period.
- Protein and energy effects on growth and carcass composition.
- Comparative utilisation of forages by sheep and goats.
- Comparative utilisation of concentrates by cattle, sheep and goats.

We have found that the feeding of concentrate rations to kids both before and after weaning prevents a weaning check in young kids. However, our most important finding has been that weaner growth and feed intakes are significantly depressed between April and June, presumably related to the declining photoperiod at that time. It was also noted that growth rates are greatest in times of increasing photoperiod (October to December), and these findings have significant implications when developing goat production systems. Studies of the effects of protein and energy intakes on growth and body composition have produced a table of requirements for Australian goats, and indicated that the fat content of goat carcasses increased as the protein/energy absorbed decreased. Goats were found to utilise low quality roughages better than sheep, but sheep and goats utilised high quality roughages and high concentrate diets with similar efficiency.

**Fleece biology in Australian cashmere goats**

**Follicle development and fibre growth**

The following topics on cashmere and hair growth in goats have been studied in our laboratories over the past 10 years, and while each study adds to our understanding of the biology of fleece growth in goats, only a few selected topics will be discussed now:

- Comparative anatomy and skin follicle populations in goats.
- Distribution and variability of cashmere growth in goats.
- Fleece growth from birth to first shearing.
- Development of the mature fleece cycles.
- The measurement of cashmere production.
- Effects of age and sex, and pregnancy and kidding.

It is important to realise that the pattern of skin follicle development in cashmere goats is different to those in sheep. In general, the primary follicles are initiated at 60 days post-conception and are mature at birth. Secondary follicles initiated at birth and kids have mature profiles of fibre bearing secondary follicle by 12 weeks of age. Post-natal nutrition does not seem to affect this
development, although there is evidence that pre-natal nutrition might. The normal growth patterns of cashmere, techniques for measurement and the effects of age, sex and pregnancy have all been studied in Australian goats. This information has been essential for developing an understanding of the biology of cashmere and hair growth in goats.

**Nutrition, photo-period and cashmere growth**

The normal patterns of cashmere growth are controlled by the photoperiod experienced, with initiation of cashmere growth in November - December, fibre elongation throughout times of decreasing photoperiod (December - June) with fibre shedding occurring between June and August. The following information has been gathered on the effects of nutrition on follicle development and cashmere growth, and on the moderating effects of photoperiod and melatonin on cashmere production:

- Pre- and post-natal nutritional effects on follicle development.
- Effects of protein and energy intake on cashmere and hair production.
- Effects of feeding level and genotype on cashmere growth.
- Manipulation of photoperiod affects on cashmere production.
- The hormonal basis of photoperiod response.
- Melatonin and the regulation of cashmere growth.

There is some evidence that pre-natal nutrition of the doe can affect follicle development and potential for cashmere growth. Unlike sheep and Angora goats, increasing protein (and energy) intake does not increase cashmere growth, but did stimulate hair growth. This is true for goats either maintaining weight or growing, but cashmere growth is depressed when goats are offered the same diets in amounts, which result in weight loss. It is also possible to manipulate cashmere growth by changing photoperiod, supplementing with melatonin or by immunising goats against melatonin. This information and that on the basic biology of cashmere growth may now be used to optimise all aspects of production in goats, or direct production specifically towards meat, milk or fibre production.

**Conclusions**

Although there is much information contained in the studies mentioned above, the following general conclusions may be drawn about maximising the growth of does and their kids:

1. The timing of kidding has a significant effect on kid growth, and these effects are not only related to doe nutrition.

2. Supplementary feeding of lactating does for the first 6 weeks of lactation improves milk production and kid growth. No benefit supplementing before kidding.

3. Kids have a high potential for growth that may be limited by milk supply. Supplementary feeding of twin bearing does is indicated.

4. Growth rates of kids are often poor in autumn, and this is related to low intakes associated with declining photo-period. Do not supplement or do feeding experiments on goats at this time.

5. High potential for growth when adequate nutrition is supplied. Greatest returns to supplementation is in late spring - early summer.
6. Carcass composition varies with nutrition, sex and genotype. Fat content can be manipulated by adjusting protein in the diet.

7. Cashmere growth is cyclical, and patterns of growth may be modified by photo-period, age, sex, pregnancy and lactation.

8. There is no effect of increasing protein or energy intake on cashmere growth or fibre diameter of goats who are at maintenance or growing. Cashmere growth is depressed when goats lose weight for a significant period during the period of cashmere growth.

9. Cashmere growth in does is maximised when kidding and lactation falls outside the growth period, when does are gaining weight and when they are shorn twice during the growth phase.
Feeding behaviour of free range goats

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Introduction
The ability of goats to adapt to a wide range of climatic and nutritional conditions could possibly be accounted for by their higher tolerance for bitter substances (Goatcher and Church, 1970), their relative unspecialised grazing habits (French, 1970), and their ability to assume a bipedal stance. As a result, goats have developed a unique feeding behaviour. Goats utilise a considerably wider range of plant species than either sheep or cattle (Fraps and Cory, 1940). The normal spectrum of plants selected as well as the preference for certain plants or plant parts within this range, is a function of many, and as yet poorly understood factors. These factors include environmental (temperature, topography, availability or abundance of various plant species), animal related (genetic makeup, prior experience or conditioning, prevailing nutritional and physiological state of the animal etc.) and managerial factors (stocking rate, period of occupation, supplementation etc.). It is also known that substantial differences in behaviour exist between different breeds and within breeds. Because these factors influence the quantity and quality of food consumed and therefore the net amount of nutrients available for metabolism, it can be expected to have an effect on the performance and adaptability of the free-range goat in different environments. Wilson (1969), Van Dyne et al. (1980), Malechek & Provenza (1981), McCammon-Feldman et al. (1981), Merrill and Taylor (1981), Malechek and Provenza (1983) and Raats & Tainton (1992) published reviews on the browsing behaviour of goats. The objective of this paper is not to provide an updated review, but rather to relate current knowledge on browsing behaviour to animal performance and range management.

A. Diet selection and plant preference

Browsing:Grazing Ratio: Van Soest (1981) classified goats as intermediate selector feeders. Although goats have definite plant preferences, they show high variability in feeding habits in different ecological zones as well as seasonal variation within the same region (McCammon-Feldman et al., 1981). On average, goats select about 60% shrubs, 30% grass, and 10% forbs on a year-long basis (Van Dyne et al., 1980). Similar results (Figure 1) were found at Fort Hare with Boer goats on False Thornveld of the Eastern Cape which spent on average 61 % and 39 % of their active feeding time browsing and grazing (grass and forbs), respectively (Raats et al., 1996). Depending on season, however, the percentage browse in this study varied from as low as 27 % in June to as high as 86 % in January.

In a recent study (Grova and Bjelland, 1997) conducted on rested False Thornveld during Winter, goats were found to spent 2½ times as much browsing than grazing when forage was abundant (0-22 goat browsing days/ha) but this ratio was reversed when forage became limited (148-205 goat browsing days/ha). As was the case with browsing, non-feed activities also decreased with a reduction in available forage which was due mainly to less time spent lying down (Table 1).

Diurnal (morning vs. afternoon) variation is a major factor affecting the feeding behaviour of goats and has a significant influence on both browsing and grazing activities (Grova and Bjelland, 1997). In general, morning feeding periods are dominated by browsing while grazing is the dominated activity during the afternoon. These workers found that on average, goats spent almost twice (1.8:1) as much time on browsing than on grazing during the mornings while this ratio is
reversed during the afternoons (0.7:1). With abundant forage, time spent browsing during the mornings is more than four times that of grazing (4.2:1) and decrease to equal time spent on browsing and grazing when forage is limited. During the afternoon these ratios changed from 1.7:1 to 0.5:1 with a decrease in the availability of forage. Results obtained from studies at Fort Hare (Raats et al., 1996) and Norway clearly indicate that browsing behaviour of goats is affected by time of day. The direct effect of temperature and rain on the feeding behaviour of goats has also been reported (Garmo and Rekdal, 1986).

Table 1  Average time (%) spent on browsing, grazing and non-feed activities by goats on False Thornveld of the Eastern Cape during July (Grova and Bjelland, 1997)

<table>
<thead>
<tr>
<th>Behavioural activities</th>
<th>Period 1 (0-22 goat b-days/ha)</th>
<th>Period 2 (23-53 goat b-days/ha)</th>
<th>Period 3 (148-205 goat b-days/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Browsing</td>
<td>42.4</td>
<td>37.2</td>
<td>31.0</td>
</tr>
<tr>
<td>Grazing</td>
<td>17.4</td>
<td>29.0</td>
<td>46.0</td>
</tr>
<tr>
<td>Non-feed activities</td>
<td>40.3</td>
<td>33.8</td>
<td>23.0</td>
</tr>
<tr>
<td>Browse:Graze ratio</td>
<td>2.44</td>
<td>1.28</td>
<td>0.67</td>
</tr>
<tr>
<td>Lying down</td>
<td>20.3</td>
<td>10.7</td>
<td>1.8</td>
</tr>
<tr>
<td>Standing</td>
<td>26.2</td>
<td>35.6</td>
<td>36.8</td>
</tr>
<tr>
<td>Walking</td>
<td>53.6</td>
<td>53.7</td>
<td>61.5</td>
</tr>
</tbody>
</table>

Church (1979) has demonstrated differences between breeds in taste sensation. Plant species selection differ between different goat breeds: Spanish goats select a higher quantity of browse than Angora goats (Warren et al., 1984); Indigenous goats (South Africa) were found to select more grass and less forbs and browse than Boer goats (Badenhorst, 1991, unpublished data); Aucamp (1979) reported a consistently higher browse content in fistula samples collected from Boer goats to that of Angora goats over a period of one year. Even within a species, each animal shows preference for certain plant species, individual plants, parts of plants, and plants in certain growth stages (Heady, 1975). Studies at Fort Hare (Grova and Bjelland, 1997) could not show any significant differences in feeding behaviour between Boer and Indigenous Ciskeian goats. However, the indigenous goats seem not to vary their feeding behaviour as much as the Boer goats. The browsing: grazing ratio varied from 2.2:1 to 0.76:1 for the indigenous goats and from 2.68:1 to 0.60:1 for the Boer goat with diminution forage availability.

The recent identification of different “feeder-types” amongst both indigenous and Boer goats at Fort Hare may enable the selection of browsers or grazers and therefore facilitate the selection of animals to best suit their food resource. This new development is of particular importance in southern Africa with its highly diversified vegetation types. This would allow a much greater measure of control in terms of the efficiency with which mixed vegetation is utilised by different livestock species and also in the control of problem plant species. Grova and Bjelland (1997) showed that feeder-type had a significant influence on time spent browsing, grazing and bi-pedal stance (hind legs). “Browsers” spent on average 41.8 % browsing and 28.2% grazing (browsing:grazing ratio = 1.48:1) while “grazers” spent 30.8 % browsing and 37.4% grazing (browsing:grazing ratio = 0.82:1). “Browsers spent more than three times as much on their hind legs (17.2%) than do grazers (5.3%). The browsing : grazing ratio varies also more for “browsers” (3.2:1 to 2.27:1) than for “grazers” (1.93:1 to 1.49:1) from high to low feed availability.

**Plant species selection:** Diet selection by goats is primarily determined by the variety of plant species and the relative abundance of each (Merrill and Taylor, 1981). Most studies on browsing
habits of goats have demonstrated a significant correlation between species selection as well as chemical composition of the diet and season of use (Taylor and Kotmann, 1990). Preference for any one, or combination of shrubs, grass and forbs is normally influenced by the availability of these plants which in turn is affected by season (Figures 2 & 4) and rainfall.

Substances like tannins, lignin, alkaloids, terpenes and numerous others have been demonstrated to influence or rather reduce intake of plants or plant components. Except for *Scutia myrtina*, an evergreen bush and highly preferred during winter, tannin levels of bush species in the False Thorn Veld of the Eastern Cape are generally low (P. Scogings, unpublished data; University of Fort Hare). The high level of lignin (ca. 30%) found by the same worker in *Diospyros lycioides* which is unpalatable for most part of the year, seems to be of greater importance than tannins as an anti-nutritional factor in a number of plants. Nutrients such as nitrogen (crude protein), fibre and fat also relate to palatability, but probably in an indirect or correlative sense (Holechek and Provenza, 1981). Woodward (1989) reported that goats preferred plants high in nitrogen content but low in tannins. Further complicating factors may be the adaptation to certain odours, which has been demonstrated in sheep (Arnold et al., 1980) and conditioned flavour aversion (Provenza et al., 1990).

Grova & Bjelland (1997) found that *A. karroo, R. lucida, S. myrtina, G. occidentalis, E. rigida, M. heterofila* and *C. rudis* (in order of preference) accounted for 78.8% of the time spent browsing. Due to differences in techniques plant based techniques applied during the same experiment showed a different order of preference, i.e. *G. occidentalis, A. karroo, C. rudis, R. lucida, E. rigida and S. myrtina.* (Gøthesen, 1997) Time spent on the consumption of leaf litter increased with a decrease in available forage as indicated in Table 2.

<table>
<thead>
<tr>
<th>Period of Occupation</th>
<th>Period 1 (0-22 goat b-days/ha)</th>
<th>Period 2 (23-53 goat b-days/ha)</th>
<th>Period 3 (148-205 goat b-days/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf litter</td>
<td>7</td>
<td>5.4</td>
<td>24.1</td>
</tr>
</tbody>
</table>

**Table 2** Proportion (%) of browsing time spent on the consumption of leaf litter by goats on False Thornveld in the Eastern Cape during July (Grova and Bjelland, 1997)

**B. Feeding behaviour and animal performance**

Theoretically, as the preferred plant material and/or species are removed from a paddock, it is expected that the animals would have to modify their diet and/or feeding behaviour in order to sustain an acceptable level of nutrition (Figure 5). McCammon-Feldman et al. (1981) argued that because goats were found to reduce their dry matter intake instead of consuming forage of higher fibre content, nutritive quality is an important part of the goat's feeding strategy (Figures 6 & 7). This is of particular importance to lactating or young growing animals. Several important factors of the animal's physiological status affect not only the total nutrient requirements, but also the proportions of different nutrients. Because pregnancy, lactation and growth result in an increased demand on the animal for nutrients and thus for food, it is logical to conclude that feeding behaviour and forage selection may also be affected. Furthermore, young animals on rangelands are at a disadvantage to older animals (other than lactating females) because they do not only have higher nutritional requirements per unit body mass, but they also lack foraging experience (Provenza and Malechek, 1986). In addition, young browsers have potentially less browse to select from than mature animals due to the difference in "reach". Notwithstanding these arguments, limited supportive evidence could be found. Zeeman, Marais and Coetsee (1984) reported a small but significant difference in nitrogen between the forage samples selected by dry
female and castrated male goats. Provenza and Malechek (1986) found that on lightly stocked range, ewes selected a diet different in species composition, lower in vitro organic matter digestibility (IVOMD), but similar in crude protein (CP) and leaf:stem ratios than kids.

Raats (1988) reported that period of occupation per camp/paddock, irrespective of level of supplementation, seems to be a major factor affecting milk yield of Boer goats on natural grazing (Figure 8). In this study, maximum milk yield was sustained for a period of only 36 goat browsing days per ha. This is supported by the nutritional value of oesophageal fistula samples collected from goats on False Thornveld during winter as shown in Table 3.

From Table 3 it is clear that goats have a limited period (± 30 goat browsing days/ha) during which time they are able to select a diet of superior quality. This period seems not more than 1/6th of the recommended stocking intensity of the False Thornveld.

Mogorosi et al. (1996) determined the harvesting rates from different bush species by goats during winter at Fort Hare. From these estimates it is possible to calculate the average amount of dry matter harvested from different bush species based on the time spent browsing as indicated in Table 4.

<table>
<thead>
<tr>
<th>Period of occupation (Goat browsing days/ha)</th>
<th>CP (%)</th>
<th>NDF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>9.20(^a)</td>
<td>34.50(^a)</td>
</tr>
<tr>
<td>22</td>
<td>8.47(^a)</td>
<td>34.50(^a)</td>
</tr>
<tr>
<td>40</td>
<td>7.28(^b)</td>
<td>44.53(^b)</td>
</tr>
<tr>
<td>53</td>
<td>7.22(^b)</td>
<td>44.68(^b)</td>
</tr>
<tr>
<td>174</td>
<td>5.63(^c)</td>
<td>51.10(^{cd})</td>
</tr>
<tr>
<td>192</td>
<td>6.76(^bc)</td>
<td>48.37(^{bc})</td>
</tr>
<tr>
<td>205</td>
<td>5.86(^c)</td>
<td>54.65(^d)</td>
</tr>
<tr>
<td>227</td>
<td>5.74(^c)</td>
<td>51.64(^{cd})</td>
</tr>
</tbody>
</table>

Means followed by the same letter do not differ significantly.

The average amount of DM harvested per goat from bush species decreased from just over one kg per day when forage was abundant to about 660g when forage was limited. The largest amount of DM was obtained from *A. karroo*; average is 251g with a maximum of almost ½ kg on the first day of the experiment and declined sharply to 150g per goat per day. On the other hand, DM harvested from *S. myrtina* and other less preferred species increased over time.
Further evidence of the effect of veld management practices on the feeding behaviour of goats was published by Du Toit (1972) who reported considerable more time spent browsing when range was continuously browsed, compared to rotational browsing by Boer goats. Furstenburg and Kleynhans (1996) reported a change in the vertical utilisation pattern of bush with an increase in stocking rate; more browse above the 60 cm mark was used at the higher stocking rates. On the contrary, however, Malechek and Leinweber (1972) found that average annual diets of Angora goats were similar on lightly and heavily grazed ranges, though periodic differences were observed. Göthesen (1997) found no statistical difference in the utilisation by goats of marked branches at 1m and 1.5m heights on eight different bush species in the False Thornveld.

C. Application
Managerial influences: The feeding behaviour of goats can be manipulated through management. Goats would predominantly browse if sufficient browse is available. During winter or when goats are confined to an area for too long in order to control bush, they will utilise progressively more grass as the bush disappears and therefore compete with grazers. In spite of this, however, the use of goats in the controlling of bush encroachment remains one of the most effective measures. Goats should be seen as utilisers and controllers of bush rather than eradicators of bush.

Productive animals (lactating ewes and growing kids) should be allowed to “cream” the bush (< 40 goat browsing days/ha) while less productive animals (dry ewes and castrates) used for the control of bush encroachment. A “browse line” is normally visible after about 150 goat browsing days per ha while the normal recommended stocking intensity of False Thornveld is about 180 goat browsing days per ha. If the vegetation is “lightly” browsed (less than 40 goat browsing days/ha), the same area can be browsed after a shorter rest period than the recommended 180 days.

Within and between breed variation in feeding behaviour exist and seems likely to be exploited through selection. Predominantly “browsers” are characterised by frequent use of the bi-pedal stance (hind legs) and seems to be amongst the heavier animals.

Because the different bush species are utilised in order of preference, high stocking pressure is required for the effective utilisation and control of less palatable bush species. Although the seasonal change in species selection by goats is to a large extent related to the availability of browse it has important implications for veld management. Certain bush species are “preferred” by goats for only a short period of the year, e.g. *Diospyros lycioides* during February/March when it’s fruit ripens. Rotational grazing would restrict the utilisation of this plant to only one or two paddocks, stocked during February/March each year, while a continuous grazing system would allow a more uniform pattern of utilisation. Based on current knowledge, continuous browsing at the correct stocking rate with rotational resting is recommended.
References


Raats, J.G., 1982. MSc thesis, UOFs:


The short-term effect of fire, boer goats and cattle on the woody component of the Sourish Mixed Bushveld in the Northern Province of South Africa.

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Abstract
A trial was conducted on the Towoomba Agricultural Development Centre near Warmbaths, South Africa during the period 1990 to 1992 to determine the short-term effect of different browsing and grazing treatments in the presence and absence of fire on the woody component of the Sourish Mixed Bushveld. Treatments involved continuous browsing, rotational browsing and grazing, rotational browsing and zero browsing or grazing in the presence of a hot September burn and continuous browsing, rotational browsing and grazing, zero browsing or grazing, rotational grazing and rotational browsing in the absence of fire. No treatment could control bush in the short term. Fire reduced tree height, but stimulated tree production in the lower strata and led to bush seedling establishment. Grazing had no effect on the woody component. Lower tree strata of the woody component were utilised where goats were incorporated in the absence of fire. Continuous browsing by boer goats in combination with fire was the only treatment that partially suppressed bush encroachment. Rotational grazing and browsing in combination with fire suppressed bush to a lesser extent.

Introduction
The use of boer goats as bush utilisers and bush controllers have been well documented by researchers in the Eastern Cape (Du Toit 1972; Aucamp 1976; Teague et al., 1981; Trollope 1983; Trollope 1984; Trollope 1989). On the other hand, research regarding boer goats in the Northern Province was undertaken by single researchers such as Donaldson (1979), who supplied data regarding the use of goats as bush utilisers. Since work by Trollope (1984) indicated that bush encroachment was one of the main factors that depressed carrying capacity, new interest developed in the use of goats and fire as a method of bush control in the Northern Province. Negative publicity, the misuse of fire and post-fire mismanagement of veld in the past however led to a large percentage of farmers still blaming goats and fire for veld degradation. This trial was thus started as a demonstration trial in which the influence of goats, cattle and fire on the woody component could be studied and illustrated.

Experimental site
The trial was conducted at the Towoomba Agricultural Development Centre, situated near Warmbaths, South Africa (28°21'E, 24°25'S; 1184m elevation), during the period September 1990 to September 1992. The long-term annual rainfall for the experimental site is 630mm per annum. The rainy season usually extends from October to March, but rainfall distribution is irregular and unpredictable. The long-term daily average maximum and minimum temperatures vary between 30.2°C and 17.6°C for December and 21.0°C and 3.0°C for July respectively. The vegetation type is classified as Sourish Mixed Bushveld by Acocks (1988). The woody layer of the plant community is dominated by Dichrostachys cinerea and Acacia gerrardii, and the grass layer by Eragrostis rigidior, Panicum maximum, Themeda triandra and Heteropogon contortus. The soil is of the Hutton form (Shorrocks series) (MacVicar et al., 1977).

Procedures
Treatments involved different combinations of burning, grazing and browsing of eight sites, each 1.5 ha in size. Three adjacent sites were burned with a moderately hot head fire during September 1988. The influence of this fire on the woody component was described by Jordaan (1995). The same sites were rested during 1988 and 1989 and again burned with a head fire during late September 1990. A pre-burn grass fuel load of 2.2, 2.8 and 3.8 tons ha⁻¹ was respectively estimated on the different sites by clipping 20 1m x 1m randomly placed quadrates per site during early September 1990. The sites were burned at noon. An air temperature of 30.7°C, relative humidity of 34% and wind speed of 17 km h⁻¹ was recorded during burning at the weather station, which was situated within 200 m of the experimental sites. Fire intensities were calculated as 2484 (hot), 3372 (extremely hot) and 4496 kJ s⁻¹ m⁻¹ (extremely hot) for the three sites respectively (Trollope and Potgieter 1985). A 20m x 5m goatproof enclosure was erected on each of the burned sites after the fire. The other five sites were rested during 1988 and 1989. The eight sites were then subjected to the following nine browsing and grazing treatments during the 1991 and 1992 seasons:

- Burned plus continuous browsing by Boer goats (F+G(c)).
- Burned plus rotational browsing by Boer goats and cattle (F+G(r)+C(r)).
- Burned plus rotational grazing by cattle (F+C(r)).
- Burned plus zero grazing or browsing (enclosures) (F).
- Unburned plus continuous browsing by Boer goats (G(c)).
- Unburned plus rotational browsing by Boer goats and cattle (G(r)+C(r)).
- Unburned plus rotational grazing by cattle (C(r)).
- Unburned plus rotational browsing by Boer goats (G(r)).
- Unburned plus zero grazing or browsing (Z).

Grazing and browsing treatments were applied during the growing season only. Sites were grazed and browsed from the first week of January till the last week of May. In the continuously browsed treatments, four mature goats per site were used. Rotational browsing was applied by a flock of 20 mature Boer goats to the point where major diet changes from the woody component to the grass component were observed. Rotational grazing was applied by a herd of 30 steers to the visual point of more or less 60% defoliation of palatable grass species \(\text{(Panicum maximum, Brachiaria nigropedata and Schmidtia pappophoroides)}\) (Jordaan, 1991)). Browsers and grazers were readmitted after visual confirmation of full recovery of the woody and grass components. Two randomly placed, 50m x 2m strip transects were permanently marked per site. Bush density, evapotranspiration tree equivalents (ETTE), tree volume, leaf volume, leaf mass, available browse and tree height were determined by using the BECVOL-model, developed by Smit (1989a and 1998b), during September 1988 (pre-burn), October 1988 (post-burn), September 1989 (post-burn) and September 1990 (post-burn). All trees were monitored in the enclosures.

**Results and discussion**

The influence of the fire on the woody component was similar to the results encountered by Jordaan (1995). The fire resulted in immediate post-burn decreases in ETTE, tree volume, leaf volume, leaf production, available browse and tree height in all four burned treatments. Recovery of the woody component of burned treatments thereafter depended on the grazing or browsing treatments that followed.

In the absence of goats in unburned treatments, grazers had no effect on the woody component and tree growth continued normally.
Overall, ETTE, tree volume, leaf volume, leaf production and available browse decreased in all treatments where goats were present. Decreases in ETTE, tree volume, leaf volume, leaf production and available browse that were encountered in treatments where goats were present and fire absent were due to the utilisation of browse within the reach of goats. The woody component above the browse line was not affected.

Decreases in abovementioned tree characteristics were enhanced where goats were used in combination with fire. The F+G(c) treatment led to severe degeneration of the lower strata of the woody component. This was the only treatment where continuous downward trends in ETTE, tree volume, leaf volume, leaf production and available browse were observed. Other treatments that involved fire were less destructive. Although the F+G(r)+C(r) treatment depressed regrowth to a bigger extent than the F+C(r) and F treatments, trees of the lower strata of this treatment remained vigorous.

Post-burn recovery of the woody component of burned treatments where goats were absent was similar to results as obtained by Jordaan (1995). In these treatments, unutilised regrowth after the initial fire resulted in volume and production increases in the lower tree strata as post-burn recovery commenced. Tree height was however not affected to such an extent than where goats were present.

Different trends in regeneration rates of the woody component were observed between the F and F+C(r) treatments. Where grass layer competition was reduced through grazing (F+C(r)), regeneration was much faster than where grass layer competition was maintained (F).

Bush density increased in all treatments. High increases were encountered in treatments where fire was present. Where fire depressed bush in the short-term, seedling establishment was propagated (Jordaan, 1995). Tree seedlings on burned treatments were partially controlled where goats were present in the absence of grazers, but propagated where goats were absent (F treatment) or where the grass layer was removed (F+G(r)+C(r) and F+C(r) treatments). Minor increases in bush density occurred in treatments where fire was absent. In these treatments, grass layer competition was maintained through the early part of the growing season and no compensatory growth was needed to overcome the effect of the fire.

None of the treatments resulted in total control of smaller trees in the short term. However, partial bush control was obtained by the F+G(c) treatment during the two-year trial period.

Conclusions
Results indicate that fire must be used in combination with goats in the long term if bush control is the objective. In this sense, a well-planned post-burn management system, with special reference to stocking rate, the continuation of the burning and browsing programme and a seasonal post-burn rest period of the grass layer is of utter importance. Removal of goats or fire out of such a programme would promote re-encroachment.

A combination of fire, cattle and goats would promote red meat production form both the grass and woody component, the last being a disadvantage rather than an advantage in the Northern Province. This type of management programme could thus be of great value as an after-care
programme following chemical bush control, or as a long-term means of biological bush control.

**References**


Trollope, W.S.W., 1983. Control of bush encroachment with fire in the arid savannas of South-eastern Africa. Phd-tesis, University of Natal.


Trollope, W.S.W., 1989. Veld burning as a veld management practise in livestock produc-

Potential of some agroforestry shrubs and tree legumes in communal goat farming systems

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Private Bag X 1106, Sovenga 0727

Introduction
Goat production is mainly found in the subsistence sector in most of Southern Africa. In this sector, feed availability and quality are a major constraint to livestock production because of almost complete dependency on rain-fed natural range. Browse is thus an important feed resource as it maintains a high nutritive value throughout the year. However, some browse species may contain anti-nutritive factors that reduce intake and digestibility of nutrients such as protein (Reed, 1995) and may be toxic (Jones, 1979). It is thus essential to evaluate different species for suitability in smallholder systems where resources for external inputs to counteract negative effects are not readily available. The experiments described here, previously reported by Ndlovu and Sibanda (1996) and Nherera et al. (1998), investigated the effect of exotic and indigenous shrub and tree legume on intake and productivity of indigenous goats in semi-arid areas of Zimbabwe.

Materials and methods

Experiment 1
Sixteen castrated kids of the indigenous small East African type (also referred to as Mashona) with an average live weight of 13.2 kg (se = 0.2) were randomly allocated to four diets in a completely randomised design with four kids per treatment. The diets consisted of maize stover (N = 6.1 g/kg DM; NDF = 800 g/kg DM) as the basal diet and treatment consisted of one of four tree legumes: *Leucaena diversifolia*, *L. esculenta*, *L. pallida* and *Calliandra calothyrsus*. The legumes were offered from 08:00 h to 12:00 h when they were removed and any leftovers weighed and sampled whilst maize stover was offered from 12:00 h to 08:00 h the following morning. The trial ran for 77 d but intake was measured on days 42 – 77 whilst digestibility and nitrogen balance were measured on days 65 – 72. Analysis of variance was done using the SAS general linear model for a completely randomised design which accounted for effect of diet and initial liveweight was used as a covariate.

Experiment 2
Twelve (12) male (mean weight 11.6 ± 0.36 kg) and 12 female (mean weight 11.4 ± 0.40 kg) goat kids were randomly allocated to three supplement treatments, within each sex. The kids used were of the Matebele goat breed which is indigenous to Southern Zimbabwe and stands at 65 cm withers height at maturity with mature weights of more than 35 kg. *Dolichos lablab* leaves (N = 11.5 g/kg DM, NDF = 557 g/kg DM) and *Acacia tortillis* (N = 24.5 g/kg DM, NDF = 361 g/kg DM) pods were the supplements and the third treatment was a control in which no supplement was fed. The kids were offered the supplements individually at 200 g/d each for the first 5 weeks and this was increased to 300 g/d each for dolichos lablab leaves and 400 g/d each for *A. tortillis* pods for the subsequent weeks, based on previous intakes. The supplements were offered in the morning and the kids were let out in the afternoon to graze the scrubland around the kraal. Intake of the supplements was measured daily and live weight changes were monitored weekly for 12 weeks.

Rate of gain was determined by regressing weight on weeks and the rates obtained were then subjected
to analysis of variance using a model that accounted for diet and sex, with initial weight as covariate.
Intake data were analysed using models that accounted for diet, sex and initial weight.

Results

Experiment 1
The content of nitrogen in browse varied from 34 in *C. calothyrsus* to 39 g/kg DM in *L. esculenta* (Table 1). Content of fibre and soluble condensed tannins were highest in *L. esculenta* whilst *C. calothyrsus* had the highest content of insoluble condensed tannins and total phenolics. Voluntary feed intake of browse, stover and total dry matter and total nitrogen is shown on Table 2. Goats offered *L. pallida* had significantly higher intakes of total DM than goats on the other treatments. N intake was highest in goats fed *L. esculenta* and least in goats fed *C. calothyrsus* (Tables 2 and 3). However the goats fed *L. esculenta* voided most of this N, mainly in the faeces, and thus N retention did not vary across treatments (Table 3). Rate of gain was highest in the goats that were fed *C. calothyrsus* and least in those that were fed *L. esculenta* (Table 3).

Experiment 2
There was no sex by supplement interactions (P>0.05) and results are presented as means for the main effects (sex and supplement). Both male and female kids had equal total intakes of supplement (P>0.05) but males grew 25% faster (P<0.05) and gained 63% more live weight (P<0.05) than females (Table 4). The kids on the control treatment gained very little weight (16.7 g/d) compared to those fed acacia pods (67.4 g/d) and those fed dolichos lablab (39.7 g/d) (Table 4).

Discussion

Experiment 1
The low total DM intake in goats fed *C. calothyrsus* was probably due to the combined effect of high content of total phenolics and condensed tannins. Condensed tannins have a negative effect on fibre digestion (Wiegand *et al.*, 1995) which in turn results in reduced intake of feeds high in fibre. Insoluble condensed tannins did not appear to influence intake in the present study. Goats fed *L. esculenta* failed to achieve the target growth rate of 35 g/d despite having moderate levels of tannins while those on *C. calothyrsus* (which had high levels of tannins) had the highest growth rate. This differential effect of tannins from different browse species emphasises the need for determination of chemical and functional structures of these compounds in addition to quantitative assays in order to develop useful strategies for managing their use in animal diets.

Experiment 2
Pods of acacia were consumed in higher quantities than *Dolichos lablab* leaves (31.2 vs 12.8 kg) and resulted in higher growth rates (67 vs 39 g/d). The presence of condensed tannins (189.5 Absorbance Units at 550 nm/g Dm) in acacia pods did not adversely affect intake by kids in agreement with results of Tanner *et al.* (1990) and Coppock (1993). Acacia pods as a supplement have the advantage of being low cost with no external input requirements. Where resources allow, *Dolichos lablab* could be grown, harvested, dried and ground for use in feeding kids.

Conclusions
Shrubs and tree legumes have a potential as forage legume supplements in goat diets. There is a need for more studies on characterisation of tannin structures if tannin containing feeds are to be better integrated into small-holder feeding systems.

References


Tanner, J.C., Reed, J.D. and Owen, E., 1990. The nutritive value of fruits (pods with seeds) from four acacia species compared with extracted noug (*Guizotia abyssinica*) meal as supplements to maize stover for Ethiopian Highland sheep. *Anim. Prod.*, 51: 127 - 133.


Table 1  The content of dry matter (DM, g kg\(^{-1}\)), organic matter (OM), nitrogen (N), acid detergent fibre (ADF), neutral detergent fibre (NDF), neutral detergent insoluble nitrogen (NDIN), acid detergent insoluble nitrogen (ADIN) in g kg\(^{-1}\) DM, insoluble proanthocyanidins (IPA, AU\(_{550}\) nm g\(^{-1}\) NDF), soluble proanthocyanidins (SPA, AU\(_{550}\) nm 100mg\(^{-1}\) DM), soluble phenolics (SP, g kg\(^{-1}\) DM) and protein precipitating capacity, (PPC, mm g\(^{-1}\) DM) of forages fed to goats

<table>
<thead>
<tr>
<th>Component</th>
<th><em>Leucaena esculenta</em></th>
<th><em>Leucaena diversifolia</em></th>
<th><em>Leucaena pallida</em></th>
<th><em>Calliandra calothyrsus</em></th>
<th>Maize stover</th>
<th>s.e.m(^{#})</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>913(^{a})</td>
<td>921(^{a})</td>
<td>911(^{b})</td>
<td>920(^{a})</td>
<td>918(^{a})</td>
<td>1.2</td>
</tr>
<tr>
<td>OM</td>
<td>953(^{c})</td>
<td>947(^{d})</td>
<td>948(^{c})</td>
<td>956(^{c})</td>
<td>966(^{b})</td>
<td>1.0</td>
</tr>
<tr>
<td>N</td>
<td>38.8(^{a})</td>
<td>36.3(^{b})</td>
<td>34.8(^{b})</td>
<td>34.0(^{c})</td>
<td>6.1(^{a})</td>
<td>0.42</td>
</tr>
<tr>
<td>ADF</td>
<td>307(^{c})</td>
<td>355(^{b})</td>
<td>326(^{b})</td>
<td>279(^{d})</td>
<td>493(^{a})</td>
<td>7.2</td>
</tr>
<tr>
<td>NDF</td>
<td>437(^{a})</td>
<td>398(^{b})</td>
<td>378(^{a})</td>
<td>385(^{c})</td>
<td>802(^{a})</td>
<td>5.4</td>
</tr>
<tr>
<td>IPA</td>
<td>19.6(^{b})</td>
<td>19.7(^{b})</td>
<td>18.7(^{a})</td>
<td>29.9(^{a})</td>
<td>ND</td>
<td>0.22</td>
</tr>
<tr>
<td>SPA</td>
<td>172(^{a})</td>
<td>179(^{a})</td>
<td>84(^{c})</td>
<td>101(^{b})</td>
<td>ND</td>
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</tr>
<tr>
<td>SP</td>
<td>178.6(^{b})</td>
<td>181.8(^{b})</td>
<td>156.8(^{c})</td>
<td>232.4(^{a})</td>
<td>ND</td>
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<tr>
<td>PPC</td>
<td>7.8(^{b})</td>
<td>9.1(^{a})</td>
<td>7.8(^{b})</td>
<td>9.6(^{a})</td>
<td>ND</td>
<td>0.27</td>
</tr>
</tbody>
</table>

\(^{#}\) standard error of the least square means (LSmeans); df=10

LSmeans in a row with the same superscript are not significantly different (P>0.05)

AU\(_{550}\) nm - absorbance units at 550 nanometers; ND- not determined

Table 2  Intakes per metabolic liveweight of dry matter (DM, g kg\(^{-1}\) W\(^{0.75}\) day\(^{-1}\)), organic matter (OM) and neutral detergent fibre (NDF) in g kg\(^{-1}\) DM kg\(^{-1}\) W\(^{0.75}\) day\(^{-1}\) by goats during the digestibility trial
### Table 3  Effect of supplementing maize stover with leguminous shrub forages on nitrogen intake, excretion, retention and rate of gain in g kg⁻¹ W₀.75 day⁻¹

<table>
<thead>
<tr>
<th>Component</th>
<th>Leucaena esculenta</th>
<th>Leucaena diversifolia</th>
<th>Leucaena pallida</th>
<th>Calliandra calothyrsus</th>
<th>s.e.m#</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nitrogen Intake</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Browse</td>
<td>0.72a</td>
<td>0.64b</td>
<td>0.62c</td>
<td>0.62c</td>
<td>0.004</td>
<td>*</td>
</tr>
<tr>
<td>Stover</td>
<td>0.24</td>
<td>0.23</td>
<td>0.24</td>
<td>0.22</td>
<td>0.005</td>
<td>n.s</td>
</tr>
<tr>
<td>Total</td>
<td>0.96a</td>
<td>0.87b</td>
<td>0.86c</td>
<td>0.84c</td>
<td>0.006</td>
<td>***</td>
</tr>
<tr>
<td><strong>Nitrogen excretion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faeces</td>
<td>0.51a</td>
<td>0.375b</td>
<td>0.38b</td>
<td>0.37b</td>
<td>0.011</td>
<td>***</td>
</tr>
<tr>
<td>Urine</td>
<td>0.024d</td>
<td>0.050e</td>
<td>0.047f</td>
<td>0.040c</td>
<td>0.0006</td>
<td>***</td>
</tr>
<tr>
<td>Total</td>
<td>0.53a</td>
<td>0.43b</td>
<td>0.43c</td>
<td>0.41f</td>
<td>0.01</td>
<td>***</td>
</tr>
<tr>
<td><strong>Nitrogen retention</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of gain</td>
<td>0.43</td>
<td>0.45</td>
<td>0.43</td>
<td>0.43</td>
<td>0.009</td>
<td>n.s</td>
</tr>
<tr>
<td></td>
<td>3.60d</td>
<td>5.11c</td>
<td>5.40b</td>
<td>5.95a</td>
<td>0.02</td>
<td>***</td>
</tr>
</tbody>
</table>

* P<0.05; ** P<0.01; *** P<0.001; n.s not significant

#- standard error of the least square means (LSmeans); df = 107
LSmeans in a row with the same superscript are not significantly different (P>0.05)
Table 4  Total supplement intake (kg), total live weight gain (kg) and rate of live weight gain (kg/week) in Trial 2

<table>
<thead>
<tr>
<th>SEX</th>
<th>SUPPLEMENT</th>
<th>Control</th>
<th>Acacia pods</th>
<th>Dolichos lablab</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>s.e.</td>
<td>Mean</td>
<td>s.e.</td>
</tr>
<tr>
<td>Male</td>
<td>Total intake</td>
<td>15.2</td>
<td>0.46</td>
<td>14.2</td>
</tr>
<tr>
<td></td>
<td>Total gain</td>
<td>3.9</td>
<td>0.37</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>Rate of gain</td>
<td>0.4</td>
<td>0.03</td>
<td>0.3</td>
</tr>
<tr>
<td>Female</td>
<td>Total intake</td>
<td>14.2</td>
<td>0.36</td>
<td>15.2</td>
</tr>
<tr>
<td></td>
<td>Total gain</td>
<td>2.4</td>
<td>0.30</td>
<td>14.2</td>
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<tr>
<td></td>
<td>Rate of gain</td>
<td>0.3</td>
<td>0.02</td>
<td>0.4</td>
</tr>
</tbody>
</table>

a,b,c Means in the same row within sex or supplement with different superscripts differ (P<0.05).
Impacts of browsing on woody plants in African savannahs

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Abstract

Little is known about the responses of woody plants to browsing in savannahs. Most of what is known is from African savannahs. Literature on the responses of woody plants to browsing in African savannahs is therefore reviewed here to look for general patterns and provide a framework for research in savannah systems. The emphasis of this review is placed mostly on browsers other than African elephant, for which a large body of literature already exists. Problems with experimental designs are identified and recommendations are made for future research.

For most woody species reviewed here, especially the *Acacia* species, summer browsing stimulates browse production during the growth season because the rate of recovery is quickest then. Anything more than light (25%) defoliation of *Acacia* during the leaf flush phase at the beginning of the growth season does not stimulate shoot production. Winter browsing generally has no effect on production. This contradicts observations in boreal systems. Frequent, heavy browsing of woody plants in African savannahs does not stimulate shoot production, but infrequent, heavy browsing does. Prolonged browsing, however, reduces plant growth and increases mortality rate. The stimulatory effect of browsing subsides sooner than the recovery of plant growth rate after cessation of browsing. Nothing is known of the effect of browsing on root growth, but browsing-stimulated shoot production is likely at the expense of root production and plant growth.

Increased spinescence accompanies browsing-induced changes in shoot morphology and demography. In many cases, changes in the components of nutritional quality have not been detected, but when changes do occur, they are variable, depending on many factors, and have been explained in terms of the carbon/nutrient balance of the plant. Increases in carbon-rich secondary metabolites in palatable, deciduous species are related to browsing intensity, while decreases in evergreen and unpalatable, deciduous species are not. Reduced concentrations of these compounds may be accompanied by increased nutrient concentrations and they persist for longer than the increased concentrations do. Nitrogen-rich secondary metabolites in woody plants have not been well-studied in African savannahs.

Repeated browsing reduces canopy cover of woody plants well before plant populations are affected. Plant population densities are unaffected, increase or decrease, depending on many factors. Altered plant populations lead to plant community changes. The most studied demographic processes in relation to browsing are seedling survival, mature plant recruitment and mature plant mortality. Seedlings are most sensitive to browsing that decapitates the seedling below the cotyledons. When clipped above the cotyledons, seedlings are most sensitive at the time when they are switching dependence for nutrients from the cotyledons to the roots. Otherwise, seedlings are quite tolerant of browsing and are more susceptible to drought than browsing. Browsing alone, unless it involves the felling of the plant at the base, seldom causes the direct mortality of woody plants in African savannahs, but can cause mortality indirectly. The ability to coppice after felling is important for woody plant survival in savannahs subjected to many disturbances.

An integrated approach, that uses multifactorial experiments to understand the physiological
functioning of the whole plant and the dynamics of plant populations, in response to browsing and resources, is essential for a better, predictive understanding of the browse-browser interaction in African savannas.
Management of goats at pasture

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Introduction

In Australian and most Asian production systems, goats are held continuously at pasture for their productive life, and housed only to avoid environmental stress or for management operations. In these systems, native or improved pastures are the major source of feed, and the supply is seasonal according to rainfall and temperature limitations. Management of goats in these systems is largely a matter of fitting the cycle of animal growth and reproduction into an environmental context, and this involves matching animal production to the availability of feed and other resources. The resources available are pastures, animals and strategic inputs of resources (feed, drugs, technology), and the level of strategic input will depend on the socio-economic significance of improved production in the system. The development of effective goat management systems depends on an understanding of how the environment impacts on goat growth, reproduction and health. The following paper identifies some of the environmental and biological limitations to improved production of goats from tropical and sub-tropical pasture systems in Australia.

Herd management

The climate of south-east Queensland (24 - 28 degrees south) is sub-tropical with cool (7 - 14°C) dry winters (June - August) and hot (19 - 35°C) wet summers (December - February). As for South Africa, the summer solstice falls on December 21 - 22 and the winter solstice on June 21 - 22. The annual rainfall is highly variable in both amount (800 to 2000 mm/year) and distribution. Tropical pastures grow rapidly over spring and summer, but stop growing in winter due to both temperature and water limitations. At this time, temperate pastures can be grown (oats, rye-grass) as annual crops to supplement available forages, and fodder trees may be used for supplementary feeding.

The annual cycle of management is determined by the environment, and joining (mating) date determines the annual pattern of events. Does are joined in mid-March (bucks in for 5 weeks only), shorn and vaccinated in mid-July prior to kidding in mid - late August, kids weaned in early November at 10 - 12 weeks of age and goats culled/sold in late February. Weighing, sorting, health care and parasite control measures are carried out at these times each year, and all breeding and management records maintained as book records initially, which are then transferred to a computer data base management system.

Stocking rates for intensive management systems

The number of animals per unit area of pasture or rangeland (stocking rate) is the major determinant of animal productivity from pasture. It is important to know how production changes with stocking rate over the season of pasture growth, so that animal numbers can be manipulated to optimise the health and annual productivity of the herd. Issues such as, how does pasture type, time of year, animal status, species and production expectations affect the stocking capacity of pastures in different environments, require answers if good management practices are to be developed. The following information has been generated from our studies of cattle, sheep and goats managed on tropical pastures:

- Comparative stocking rates of sheep and goats on improved tropical pastures.
- Comparative use of pastures and concentrate feeds by sheep and goats.
- Selective grazing behaviour on improved legume-grass pastures
on native pastures.
- The use of goats for weed control.

**Supplementary feeding for production**
The vagaries of the environment create times when feed quantity and/or quality limits the productivity of goats maintained as pasture. In these circumstances, the strategic feeding of supplements may be indicated, depending on the severity of the deficiency and on the likely economic returns to additional feeding. We have investigated the potential for improving productivity in bucks, does and their kids at all stages of the growth and reproduction cycle. The results from some of these studies are described below:

- Feeding the bucks - effects on fertility and libido (see Walkden-Brown *et al.*, 1993).
- Feeding the does - effects on fertility (see Restall *et al.*, 1994)
  - effects on kid birth weights and follicle development
  - effects on milk production and kid growth to weaning
  - effects on cashmere and hair growth
- Feeding the kids - effects of feeding before weaning on weaning stress
  - protein and energy supplements
  - supplementary feeding of goats

**Fodder trees and special purpose pastures**
- grazing management studies
- comparative value of different fodder trees for goats

**Intestinal parasites and their management**
The maintenance of herd health is a major component of any animal management system. In Australian goats, clostridial diseases and intestinal parasites have proved to be the most important. While routine vaccinations have effectively controlled clostridial disease, intestinal parasite control have proved to be more difficult to control. The climate of sub-tropics provides a continuously favourable environment for intestinal parasites, and frequent treatment with anthelmintics is required to control infection. In some areas, there is a high level of resistance of goats to most anthelmintics, and in some cases, even to the ivermectins. Effective control requires a broad approach, and techniques such as pasture spelling or grazing with cattle, strategic use of anthelmintics, resistant animals and use of fodder trees are being developed as management packages for the intestinal parasite control. There also appears to be evidence that goats metabolise anthelmintics differently to sheep, and that the acquisition of immunity to infection occurs over a shorter period than in sheep.

**Conclusion**
Effective management of goats at pasture requires that environmental limitations for growth and reproduction be recognised and ameliorated by appropriate strategic intervention(s).
Reproductive status of goats in communal systems in South Africa

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Introduction
Goats in South Africa can be grouped into four major categories (Figure 1). Indigenous goats are extremely popular in communal areas (Mamabolo, 1999). They serve as an important source of milk, mohair, hides and meat to people in subsistence agriculture. These hardy animals adapt well to harsh environments and require less handling compared to cattle. They appear to be resistant to diseases such as blue tongue, pulpy kidney and gall sickness and are less susceptible to internal parasites compared to sheep. Unfortunately, indigenous goats are often poorly managed and there is very little information available on the reproductive status of indigenous goats in subsistence farming systems. This information is of vital importance in order to improve goat production and ensure sustainable livestock production in subsistence farming systems.

Figure 1: Different types of goats in southern Africa.

Reproduction efficiency
Any measure of reproductive efficiency must take into account allowances for management. In this regard, the number of kids reared to weaning is of great practical importance. Other important indicators of reproductive efficiency include:

- Puberty, oestrus
- Size and age at first mating or AI
- Litter size
- Kidding rate / percentage
- Kidding interval
- Non-return rates
- Age and size vs. scrotal circumference and semen production

<table>
<thead>
<tr>
<th>Fertility</th>
<th>An animal is fertile if it produces normal spermatozoa / ova capable of fertilisation or regular production of offspring (e.g. service / conception; litter size; kidding rate; conception rate; kidding interval; non-return rates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolificacy</td>
<td>An animal is prolific if it produces numerous offspring (e.g. number of kids born / doe / 100 does / year; or kids / birth)</td>
</tr>
</tbody>
</table>
Communal goat production
In communal goat production systems the focus is generally on free ranging goats, grazing around the village, old cultivated fields, or areas of regrowth or harvest (area ca 0.5 to 2ha). The goats are usually kept in pens at night. Mating is anarchic and may result in inbreeding. Animals seldom receive supplementary feeds and no records are kept of individual animals or animal performance.

Characteristics of indigenous goat production systems
Heard sizes vary between 2 to 120 animals and there are large variations in heard structure (buck, ewe, kid ratios). Women and children mostly do herding. In many cases migrant labourers own the goats. The most important constraints of sustainable production systems include the land tenure system and poor resources e.g. fencing, roads, electricity and water. It is important to get the consent of the local chief and co-operation of the extension officers before a survey is done in a communal farming area.

Bucks in Mpumalanga
Bucks are often the most neglected animals in a heard, but they are expected to breed and produce offspring. Poor buck management directly effects the flock reproductive performance. Fertilisation success depends on a range of factors including semen quality and mating behaviour. Testes and semen characteristics can be of great value in selecting males. Estimates of reproductive efficiency are required for goats studied in their natural habitat. Unfortunately values obtained at experimental stations often depict “potential” rather than “actual” values.

Since the fertility status of goats in communal areas is not well documented, goats were studied in Mpumalanga (Moutse East and West districts). In this area 82.32% of land is entrusted to chiefs, while farmers own 17.68% of the land. All goats are penned at night, but the breeding management is poor. Bucks and does run together and they mate as soon as puberty is reached. Mating occurs throughout the year.

Table 1 Herd composition and body measurements of bucks

<table>
<thead>
<tr>
<th>Herd Composition (bucks)</th>
<th>Herd composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Bucks</td>
<td></td>
</tr>
<tr>
<td>1-2 yrs</td>
<td>10%</td>
</tr>
<tr>
<td>2-3 yrs</td>
<td>30%</td>
</tr>
<tr>
<td>3-4 yrs</td>
<td>10%</td>
</tr>
<tr>
<td>5+</td>
<td>50%</td>
</tr>
<tr>
<td>% Males in herd</td>
<td>8.78%</td>
</tr>
</tbody>
</table>

| Body measurements | Shoulder heights | 51 to 75 cm |
|                  | Hind quarter heights | 46 to 68 cm |
|                  | Body length          | 56 to 98 cm |

| Mortality rates   | < 5%               |
Table 2  Seasonal variations in body condition scores of indigenous goats (buck)

<table>
<thead>
<tr>
<th>Season</th>
<th>Body condition score (1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn</td>
<td>2.95 ± 0.28&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Winter</td>
<td>1.80 ± 0.35&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spring</td>
<td>2.30 ± 0.26&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Summer</td>
<td>2.35 ± 0.34&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>A,b,c,d</sup> Averages differed significantly (P<0.05).

Graph 1  Seasonal effects on scrotal circumference (SC, cm) and body condition scores (BCS, on a scale of 1 to 5)

Reproduction status of does (Mpumalanga)

Table 3  Reproductive performance of indigenous goats (does)

<table>
<thead>
<tr>
<th>Puberty (Does)</th>
<th>Oestrus</th>
<th>Size/age at first Mating</th>
<th>Litter size</th>
<th>Kidding rate</th>
<th>Kidding Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies between and within types: Ca.5-7mths age or Ca. 10-30 kg live weight</td>
<td>Oestrus ca.21d Metestru 2-3d Diestru 13-15d Proestru 2-3d Estrus 30-40h Ovulation = few hours after estrus (Goats in tropics = Aseasonal)</td>
<td>Affected by month of birth. Underfeeding &amp; poor health can delay puberty.</td>
<td>Not good indicator of fertility – function of breed and environmental factors. ca. 1.5</td>
<td>No of kids born (weaned) / does mated</td>
<td>Tropics = 90 to150days Europe = 165-327d Gestation length = 145 to 148days</td>
</tr>
</tbody>
</table>

Breeding is not restricted to any particular season. Kidding peaked in spring and autumn and was lower in winter and almost negligible in summer. Does appear to be polystrous year round and aseasonal, in contrast with goats in temperate areas. The age at first kidding is between 16 to 18 months of age. This is slightly later compared to West African goats and earlier compared to
Rwandan goats (21 months). The delayed age at first parturition is probably due to poor management and nutrition. Does generally reproduce at a relatively low condition score (Table 3).

**Table 4** Relationship between age (years) of doe and body condition score (scale of 1 to 5)

<table>
<thead>
<tr>
<th>Age</th>
<th>Body condition score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>1.68 ± 0.25</td>
</tr>
<tr>
<td>2.0</td>
<td>1.50 ± 0.26</td>
</tr>
<tr>
<td>2.5</td>
<td>1.55 ± 0.32</td>
</tr>
<tr>
<td>3.0</td>
<td>1.83 ± 0.28</td>
</tr>
<tr>
<td>3.5</td>
<td>2.00 ± 0.26</td>
</tr>
</tbody>
</table>

**Table 5** Effect of age (years) of doe on kidding interval (days)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Kidding interval (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>258</td>
</tr>
<tr>
<td>3.5 to 5.5</td>
<td>ca. 328</td>
</tr>
</tbody>
</table>

Kidding interval of indigenous goats is generally longer compared to Sudan goats (238 days) and Mali goats (265 days). Intervals of 220 to 300 days are typical of tropical goats.

**Litter size**

The average litter size of indigenous goats in the former KwaNdebele is approximately 1.7. These goats appear to be one of the most efficient tropical goat breeds. Their average litter size is similar to goats in South Western Nigeria (1.65) and India, larger than West African Dwarf goats (1.3-1.5) and smaller than goats in temperate areas (1.85-1.9). The average litter size of Boer goats is ca. 1.93.

**Table 6** Effect of age (years) on prolificacy of does (indigenous goats in Moutse, KwaNdebele).

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Prolificacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>56.1 to 77.3%</td>
</tr>
<tr>
<td>3.5</td>
<td>71.3 to 98.2%</td>
</tr>
<tr>
<td>4.5</td>
<td>133.4 to 183.7%</td>
</tr>
<tr>
<td>5.5</td>
<td>106.2 to 146.3%</td>
</tr>
</tbody>
</table>

Maximum fertility is reached at ca. 4.5 years of age. Boer goats reach maximum fertility at ca. 3.5 years, while maximum fertility is achieved later in Angora goats.
Table 7  Seasonal effects on the incidence of single and twin births in indigenous goats

<table>
<thead>
<tr>
<th>Season</th>
<th>Single births</th>
<th>Twin births</th>
<th>Proportion of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn</td>
<td>4%</td>
<td>96%</td>
<td>54%</td>
</tr>
<tr>
<td>Winter</td>
<td>68%</td>
<td>32%</td>
<td>24%</td>
</tr>
<tr>
<td>Spring</td>
<td>7%</td>
<td>93%</td>
<td>22%</td>
</tr>
<tr>
<td>Summer</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

High autumn lambing indicate summer breeding which coincides with optimum feed quantity and quality.

Mortality rates of kids
Mortality rates of indigenous goats (kids) in the tropics are extremely high e.g. Dialonke goats (44.2%) and West African Dwarf goats (51%). Mortality rates of goats in KwaNdebele vary between 3.75 and 40.62%. Mortalities appear to be due to poor management, theft, poor flock hygiene (coccidiosis) and predators. No mortalities were recorded due to dystocia, stillbirths or abortion.

Semen quality
Seasonal variations in semen quality were studied in goats obtained from the Moutse district (KwaNdebele, 10 bucks) and Loskop South experimental station (ARC, 10 bucks). The results suggest that significant seasonal variations occur in the fertility status of bucks.

Graph 2  Seasonal effects on semen motility
Seminal motility (on a scale of 1 to 5) also differed between seasons. Significant differences were also observed in seminal motility between goats obtained from Moutse and Loskop south experimental station (p<0.05, Graph 2). The motility of semen obtained from Loskop goats was higher compared to Moutse goats. Scrotal circumference was also higher for Loskop goats (26.3 cm) compared to Moutse goats (17.3 cm). However, the frame size of Moutse goats was significantly smaller compared to Loskop goats. The ratio of scrotal circumference to body weight was higher for Moutse goats compared to Loskop goats, which suggest that sexual development occur at a lower body weight and condition score in Moutse goats.

Table 8  Seasonal variations in % live spermatozoa in indigenous goats (n = 20)

<table>
<thead>
<tr>
<th>Season</th>
<th>% Live spermatozoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn</td>
<td>72.18 – 77.35%</td>
</tr>
<tr>
<td>Winter</td>
<td>37.64 – 42.50%</td>
</tr>
<tr>
<td>Spring and summer</td>
<td>Improves to 68%</td>
</tr>
</tbody>
</table>

The frequency of semen with deviant morphology was low regardless of season or type. Sperm morphology was generally normal (Acrosome, midpiece, tail, loose-heads, Dag D, Proximal droplets, Distal droplets).

Conclusions
Goat production has an enormous potential to ensure sustainable agriculture in rural areas of southern Africa. However, only hardy, tick resistant goats and their crosses survive in these areas. Indigenous goats are generally well adapted, but produce low due to the environment. They are rather prolific, despite poor herd composition, nutrition and inbreeding. Does reproduce at
relatively low body condition scores, but the kidding intervals are relatively long (interactions with season of birth). Inbreeding was detected, particularly the bucks in certain herds were between 12.25 and 25% inbred. The effects of inbreeding significantly affected the anatomy (size, legs and hooves) and scrotal circumference, but with minor effects on semen quality.

References

Acknowledgements
The authors express their sincere gratitude to the Foundation for Research and Development (FRD) for the financial support for this project.
Cervical insemination of indigenous does with frozen-thawed goat semen during the non-breeding season

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Introduction
We received a request from the owner of a communal flock of indigenous goats in the Northern Province to inseminate some of his does with Gorno Altai semen. The only income he derived from this flock was through the sale of live goats at Christmas. He wanted to embark on a cross-breeding programme in an attempt to create an additional source of income from the fibre that would potentially be produced by the Gorno Altai x indigenous crosses.

Flock Profile
The flock consisted of approximately 150 goats. An assortment of males, some breeding bucks, others castrated or partially castrated, accompanied the does throughout the year. Goats were penned in two Dichrostachys cinera kraals at night while they were shepherded on communal grazing during the day. The smaller of the two pens contained 20 does with young kids while the larger held the rest of the flock.

Although no records were kept of birth dates, mortalities or the sale of live goats the stockman in charge of the flock knew each animal individually as well as its history.

The twenty does with young kids were used for oestrus synchronisation and AI as they were probably the only non-pregnant does in the flock. A number of severe nutritional, managerial and seasonal constraints and limitations applied, even to these 20 does, although they were in reasonable body condition and the farmer had agreed to flush feed them. The programme was to take place in the winter and the does were suckling kids of 6-8 weeks old. Handling facilities were typical of a resource poor set-up.

Semen Collection and Processing
Semen was collected by electrostimulation from two Gorno Altai rams. The ejaculates were washed and centrifuged to remove seminal plasma and then diluted using a two step glycerol method. The diluted semen was frozen in 0.5 ml straws at a concentration of 180 x 10⁶ per straw. Only ejaculates with >60% post-thaw progressive motility were used. One straw was used to inseminate one doe.

Oestrus Synchronisation and AI programme
On day 17 of the programme the owner was responsible for withdrawing the progestagen sponges (Ovachron, Millborrow’s). He also injected 300 International Units (IU) Pregnant Mare Serum (PMSG, Pregnacol) intra-muscularly at sponge removal. A single fixed time insemination was performed between 52 and 53 hours after sponge removal.

Table 1 Time of the various procedures performed during oestrus synchronisation and
artificial insemination of indigenous does

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Action</th>
<th>Distance Travelled</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Visit</td>
<td>3 July 98</td>
<td>Inspection</td>
<td>400 km</td>
</tr>
<tr>
<td>Second Visit</td>
<td>24 July 98</td>
<td>Insert Sponges</td>
<td>400 km</td>
</tr>
<tr>
<td>Day 17</td>
<td>9 August 98</td>
<td>Remove Sponges and Inject PMSG (9h00)</td>
<td>Owner</td>
</tr>
<tr>
<td>Third Visit</td>
<td>11 August 98</td>
<td>AI with frozen semen (13h00)</td>
<td>400 km</td>
</tr>
<tr>
<td>Fourth Visit</td>
<td>15 Sept 98</td>
<td>Ultrasound Examination</td>
<td>400 km</td>
</tr>
</tbody>
</table>

Transcervical intrauterine insemination of does

Does were inseminated by the transcervical intrauterine route because laparoscopic insemination was not feasible with the prevailing practical restrictions. The inseminator used a medium cow AI pistolette, in an attempt to penetrate the cervix and deposit the dose of semen intrauterine. Best exposure of the cervix was gained when the hindquarter of the does was suspended over a cross bar.

Results

Table 2 reflects the results after oestrus synchronisation and insemination of does with frozen-thawed goat semen. Five does lost their vaginal sponges; therefore, only 15 received PMSG at sponge removal. All 15 does treated with PMSG showed intense signs of oestrus; energetic mounting of flock mates and vigorous tail wagging was observed before insemination. The inseminator only penetrated the cervices of 6 (6/15) does.

Table 2  The results after oestrus synchronisation and insemination of does with frozen-thawed goat semen

<table>
<thead>
<tr>
<th>Number of does:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sponged</td>
</tr>
<tr>
<td>which lost their sponges</td>
</tr>
<tr>
<td>Showing signs of oestrus</td>
</tr>
<tr>
<td>In which the inseminator penetrated the cervix</td>
</tr>
<tr>
<td>Pregnant</td>
</tr>
<tr>
<td>Number of foetuses counted by ultrasound</td>
</tr>
</tbody>
</table>

Conclusion

This was a first attempt to manipulate the reproductive cycle of indigenous goats, under communal grazing systems, which imposed major managerial constraints for artificial breeding. The persistent presence of an assortment of males within the flock and from adjacent flocks presents two problems. Firstly, the pregnancy status of the does is unknown. Secondly, they constitute a real danger because they may mate with the synchronised does. Unfortunately managerial practices do not allow for the separation of sexes.

Although all the does treated with 300 IU PMSG showed signs of oestrus it is possible that not all
ovulated. Only a trial with controls will establish whether follicular growth is normal in does synchronised out of season and suckling young kids of 6-8 weeks old.

Penetration of the caprine cervix presented problems and the long cow AI pistolette was a clumsy instrument to use. Although the frozen goat semen was of excellent quality it was mainly deposited in the cervix (9/15). However, it is necessary to keep in mind that, generally, the success of intrauterine insemination is not due to dexterity of the inseminator but rather insemination at the right time relative to ovulation (Chemineau et al., 1991). The ease of passing a pipette through the cervix into the uterus is closely associated with the time of ovulation (Chemineau et al., 1991). Injections of oxytocin at the time of insemination dilated the cervix and resulted in an increase of cervical penetration. The percentage of does cervically penetrated was 85% and 25% for oxytocin-treated and controls, respectively. No adverse effect on fertility was reported (Garcia et al., 1994).

Further investigation on the effects of oestrus synchronisation and transcervical intrauterine insemination is necessary before this method of breeding can be made available to commercial farmers.

References

Controlled breeding for improved reproductive efficiency in goats

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Just by having a restricted breeding season at a specific time of the year, a degree of controlled breeding is being practiced. By restricting or programming the time of breeding or even selecting the animals with which are being bred, controlled breeding is being implemented. Breeding is naturally controlled to make maximum use of the seasonal sexual activity or nutrition available - with the highest kidding rates and lowest costs.

When using controlled induced breeding, certain objectives are to be fulfilled. The main reasons for artificially inducing sexual activity are: (1) to accelerate genetic progress i.e. using a superior male to cover many females; (2) to induce mating out of the natural breeding season, so that the season of kidding for example is synchronised with the time of nutrient availability; (3) a synchronised mating, kidding, weaning and marketing season is nice to have, but this will cost the producer money that may not be recovered. Factors to be kept in mind when using synchronisation agents are the cost, expected reduced fertility (when compared to natural mating) and the higher level of management required.

Natural synchronisation can be performed in two ways: By making use of a teaser male early in the breeding season and by nutritional flushing prior to breeding. With flushing, the ovulation rate of the females could also be increased.

The most common technique used to induce oestrous activity artificially and to synchronise the occurrence of oestrus is with the aid of progestagen intravaginal sponges. Different synchronisation techniques have different advantages or disadvantages. The main disadvantage of using the double prostaglandin technique (same as in cattle) is that goats are seasonal breeders and this technique is not effective outside the natural breeding season. The use of PMSG inside or outside the breeding season is essential to make the synchrony more compact and to stimulate the female, but not to induce multi-ovulations.

When implementing controlled natural mating, the most important factor to take into account is seasonal, the seasonal availability of nutrients and the seasonal sexual activity of the goats. For the best kidding rate and fecundity it is essential that the does be mated during the period of peak sexual activity, which is April and May. A factor that could help in controlled natural breeding is the male-effect where pheromones help to stimulate females into cyclic activity.

There are several factors that could influence the efficiency of oestrous synchronisation in goats. These include the dose and type of progestagen used (there is a practice to halve the intravaginal sponges - which is warranted). Some of the progestagen preparations tend to stimulate animals to show oestrus sooner with greater synchronisation. The period of progestagen administration is effective from 12 to 18 days, but there is a tendency for the longer treatment of progestagen to be more efficient. The use of PMSG is advantageous in the synchronisation technique, irrespective of the route of administration (intra-muscular or subcutaneous). The use of a double PGF injection (as in cattle) is also effective in goats, but is only effective in the breeding season. Care is to be
taken that females are not pregnant when they are subjected to this synchronisation technique.

One of the big advantages of inducing oestrus and ovulation by hormonal synchronization of goats, is the implementation of fixed time AI. Oestrous detection is superfluous and much time and labour is saved. Acceptable fertility results (especially with laparoscopy) have been attained with fresh and frozen goat semen.

To conclude, when using controlled breeding in goats, the aim is important. If the aim is to induce controlled breeding by hormones, it is going to cost the producer money, time and energy and the aim must thus be warranted. It is difficult to recover the cost of synchronisation from the reproduction management programme. It is seldom that this controlled breeding would be used on commercial animals. Controlled breeding (whether induced or natural) is a tool to improve reproduction efficiency and accelerate genetic progress of the goat herd and help to implement an efficient reproduction and nutrition management programme.
**In vitro** production of embryos for improved production

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**Introduction**
The purpose of our research is to utilise *in vitro* fertilisation to improve the genetics of indigenous goats. The ultimate goal is to increase production of sellable commodities, particularly cashmere.

*In vitro* fertilisation (IVF) is the process by which oocytes and sperm are mixed in a petri dish, allowing fertilisation to occur outside the mother's body. Similarly to the genetic advantage obtained using artificial insemination with respect to the paternal parent, IVF affords the ability to more stringently select the maternal parent. Oocytes from one valuable female can be transferred into several less valuable recipients, thus, one oocyte donor can give rise to several offspring in a single breeding season, rather than only one or two.

**General description of oocyte retrieval and IVF**
Many sperm can be obtained from a single ejaculate or from the epididymis after death. Retrieval is relatively easy and has been a major reason for the commercial success of artificial insemination in several species. On the other hand, oocytes are far fewer and more difficult to recover from ovaries. Oocyte retrieval after the donor's death, such as at the time of slaughter, can be performed by using a needle and syringe to aspirate the oocytes from follicles. Alternatively, a razor blade can be used to lightly slice the surface of the ovary, releasing oocytes. The razor blade method is more time consuming but releases more oocytes and is generally used in cases where there are one or few valuable donors. Aspiration is commonly utilised in research situations where large numbers of non-valuable slaughterhouse ovaries are used. Retrieval of oocytes from living donors is more difficult and usually involves laparoscopy to visualise the ovaries, or ultrasound imaging with a vaginal probe and needle. Ultrasound is generally performed on larger animals, such as cattle, while laparoscopy is performed on smaller animals, such as the goat. In live animals, oocytes can be retrieved up to twice per week.

Oocytes are recovered and cultured for approximately 24 hours, depending on species. This allows oocyte maturation to occur, in preparation for fertilisation. After maturation, oocytes and sperm are co-incubated overnight using either fresh or frozen semen. After co-culture, sperm are washed away and the embryos are cultured for an additional 7 days, allowing blastocyst formation to occur. Blastocysts can be frozen or transferred to an estrus-synchronised recipient.

**Caprine IVF results**
We will be starting IVF in goats next week; hence no data is available from our laboratory at the moment. However, reports from other laboratories on caprine IVF have been published.

Most work in goat IVF has been done in a research setting with oocytes from abattoir-derived ovaries. From each pair of ovaries approximately 5-18 oocytes can be recovered (Pawshe *et al.*, 1994). Sixty to seventy percent of these eggs can be fertilised, while ten to thirty percent might form blastocysts (Keskintepe *et al.*, 1994, Crozet *et al.*, 1995, Martino *et al.*, 1995, Pawshe *et al.*, 1996, Simplicio *et al.*, 1997). These results are similar to those obtained in other, better studied, ruminant species. After embryo transfer, 35-50% of the embryos transferred should be capable of
producing a pregnancy and a live kid (Keskintepe et al., 1994, Han et al., 1996). In total, one might expect 0-3 kids to be produced from a single donor, although the results from donor to donor are highly variable. One recent abstract shows a 30% survival rate of vitrified (cryopreserved) embryos, this is the first report of a substantial number of cryopreserved blastocysts surviving to kidding (n = 43, Traldi et al., 1998).

In one abstract, the recovery of oocyte from live female goats was attempted, comparing laparoscopy and ultrasound guided oocyte retrieval (Graff et al., 1995). All donors were hormonally treated to induce follicular growth. With laparoscopy, 11 oocytes per donor were obtained, while with ultrasound 4 oocytes per donor were obtained. These authors suggest that fewer adhesions were found with ultrasound, so that for long term studies it might be preferable.

**Advantages of IVF**

There are many potential benefits to using IVF to produce embryos. The most obvious is that by transporting embryos from distant locations into a local region a complete set of new genes can be introduced. These embryo transfers provide greater genetic gains over that obtained with artificial insemination, whereby only the paternal half of the genome can be introduced. Embryo transportation is also considerably easier than live animal transportation. Importantly, the chances for disease transmission are greatly reduced when compared to whole animal or semen introductions. Properly handled embryos have transmitted no known disease. Additionally, the introduced embryo will inherit appropriate antibodies from its gestational mother, thus increasing its survivability as well.

With IVF, genetic material from dead animals can be utilised. If valuable females get old or need to be put down, oocytes can be retrieved and offspring produced from them. Repeated oocyte recoveries can be performed on live donors, allowing several offspring to be produced per year from a single female. Thus, a valuable doe can contribute heavily to the next generation. In the case of expensive, imported semen, many oocytes could be fertilised using a single straw. Rather than insemination of one doe, many IVF embryos could be transferred to recipients, making economical use of the straw. In addition, IVF and embryo transfer can be performed far away from the herd of interest. Thus, in making new crossbreeds, the offspring could be tested for desirable traits in an experimental herd (such as cashmere production and disease resistance) before introducing them into a community and contaminating its gene pool.

**Disadvantages of IVF**

The drawbacks of IVF compared to other breeding methods are substantial, even when compared to artificial insemination. The primary problem is the cost. IVF requires skilled labour, a controlled laboratory environment and expensive equipment. Experiments are underway at Onderstepoort to try to simplify the equipment required, however, the labour and laboratory requirements will not be so easily dismissed. In addition, fertilisation and pregnancy rates are not as high as with natural mating or artificial insemination, leaving some recipients open. Embryos with more manipulation, such as those that have been frozen, have even lowered survivability.
Conclusion
As we have already heard, the indigenous goat in South Africa produces a small amount of fine cashmere. Individual goats have been shown to produce far more. By selecting these high producing goats and breeding them intensively, a line of indigenous goats producing a large quantity of fine quality cashmere could be established. Alternatively, an indigenous x Gorno Altai crossbreed could be tested, to determine if high amounts of fine quality cashmere could be produced. IVF could form an intrinsic part of these processes, increasing the speed of genetic gain considerably, particularly in the early generations.

References


Management of goats at pasture

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Introduction
In Australian and most Asian production systems, goats are held continuously at pasture for their productive life, and housed only to avoid environmental stress or for management operations. In these systems, native or improved pastures are the major source of feed, and the supply is seasonal according to rainfall and temperature limitations. Management of goats in these systems is largely a matter of fitting the cycle of animal growth and reproduction into an environmental context, and this involves matching animal production to the availability of feed and other resources. The resources available are pastures, animals and strategic inputs of resources (feed, drugs, technology), and the level of strategic input will depend on the socio-economic significance of improved production in the system. The development of effective goat management systems depends on an understanding of how the environment impacts on goat growth, reproduction and health. The following paper identifies some of the environmental and biological limitations to improved production of goats from tropical and sub-tropical pasture systems in Australia.

Herd management
The climate of south-east Queensland (24 - 28 degrees south) is sub-tropical with cool (7 - 14°C) dry winters (June - August) and hot (19 - 35°C) wet summers (December - February). As for South Africa, the summer solstice falls on December 21 - 22 and the winter solstice on June 21 - 22. The annual rainfall is highly variable in both amount (800 to 2000 mm/year) and distribution. Tropical pastures grow rapidly over spring and summer, but stop growing in winter due to both temperature and water limitations. At this time, temperate pastures can be grown (oats, rye-grass) as annual crops to supplement available forages, and fodder trees may be used for supplementary feeding.

The environment determines the annual cycle of management, and joining (mating) date determines the annual pattern of events. Does are joined in mid-March (bucks in for 5 weeks only), shorn and vaccinated in mid-July prior to kidding in mid - late August, kids weaned in early November at 10 - 12 weeks of age and goats culled/sold in late February. Weighing, sorting, health care and parasite control measures are carried out at these times each year, and all breeding and management records maintained as book records initially, which are then transferred to a computer data base management system.

Stocking rates for intensive management systems
The number of animals per unit area of pasture or rangeland (stocking rate) is the major determinant of animal productivity from pasture. It is important to know how production changes with stocking rate over the season of pasture growth, so that animal numbers can be manipulated to optimise the health and annual productivity of the herd. Issues such as, how does pasture type, time of year, animal status, species and production expectations affect the stocking capacity of pastures in different environments, require answers if good management practices are to be developed.

The following information has been generated from our studies of cattle, sheep and goats...
managed on tropical pastures:
- Comparative stocking rates of sheep and goats on improved tropical pastures.
- Comparative use of pastures and concentrate feeds by sheep and goats.
- Selective grazing behaviour - on improved legume-grass pastures
- on native pastures.
- The use of goats for weed control.

**Supplementary feeding for production**
The vagaries of the environment create times when feed quantity and/or quality limits the productivity of goats maintained as pasture. In these circumstances, the strategic feeding of supplements may be indicated, depending on the severity of the deficiency and on the likely economic returns to additional feeding. We have investigated the potential for improving productivity in bucks, does and their kids at all stages of the growth and reproduction cycle. The results from some of these studies are described below:

Feeding the bucks - effects on fertility and libido (see Walkden-Brown *et al.*, 1993).
Feeding the does - effects on fertility (see Restall *et al.*, 1994)
- effects on kid birth weights and follicle development
- effects on milk production and kid growth to weaning
- effects on cashmere and hair growth
Feeding the kids - effects of feeding before weaning on weaning stress
- protein and energy supplements
- supplementary feeding of goats
Fodder trees and special purpose pastures
- grazing management studies
- comparative value of different fodder trees for goats

**Intestinal parasites and their management**
The maintenance of herd health is a major component of any animal management system. In Australian goats, clostridial diseases and intestinal parasites have proved to be the most important. While routine vaccinations have effectively controlled clostridial disease, intestinal parasite control have proved to be more difficult to control. The climate of sub-tropics provides a continuously favourable environment for intestinal parasites, and frequent treatment with anthelmintics is required to control infection. In some areas, there is a high level of resistance of goats to most anthelmintics, and in some cases, even to the ivermectins. Effective control requires a broad approach, and techniques such as pasture spelling or grazing with cattle, strategic use of anthelmintics, resistant animals and use of fodder trees are being developed as management packages for the intestinal parasite control. There also appears to be evidence that goats metabolise anthelmintics differently to sheep, and that the acquisition of immunity to infection occurs over a shorter period than in sheep.

**Conclusion**
Effective management of goats at pasture requires that environmental limitations for growth and reproduction be recognised and ameliorated by appropriate strategic intervention(s).

**Evaluation of cashmere production in the Adelaide Boer goat flock**

JA Roux¹, S Herrmann², G Trethewey³ and A Braun²
Introduction
Recently a project was initiated by the Department of Agriculture and the CSIR to establish a cashmere industry in South Africa. Cashmere is produced by various goat breeds in different amounts and of varying quality. As the Boer goat is one of the largest goat breeds in South Africa as far as numbers are concerned, one of the phases of the cashmere project is to evaluate cashmere production in the Boer goat.

During the development and upgrading of the Boer goat much emphasis was placed on meat production characteristics. Breed standards actually discriminate against cashmere in the coat. The aim of this study was to evaluate the cashmere production of the experimental Boer goat flock at the Adelaide Experimental Station in the Eastern Cape province. Selection of replacement animals is done annually by the Boer Goat Breeders' Society according to breed standards, with no selection for cashmere production.

Material and methods
Data collected on the Adelaide Boer goat flock during 1996 and 1997 were used for the study. The animals were kept on pastures without any supplementary feeding. Body weights of ewes were recorded at mating. Cashmere was harvested through a combing method. The combs used were made of the base plates of electrical sheep shearsers. Each goat was comb three times at two week intervals, starting at the 15th July each year. Before combing, cashmere fibre length was determined on the shoulder, rib and hind leg. Raw cashmere production was determined after each combing. Fibre diameter was measured by means of the Optical Fibre Diameter analyser (OFDA ver. 2.07 - Baxter et al., 1992; IWTO, 1995). The resulting fibre diameter distribution, containing both fibre components, was used to calculate down fibre and guard hair diameter.

Results and discussion
From Table 1 it is evident that cashmere length on the shoulder, rib and hind legs is shorter than the ideal length of 40 mm. Average raw cashmere production of 28 g per adult ewe is low compared to other cashmere producing goats, such as Feral (Browne, 1990) and Xinjiang goats (Yerxat, 1995), which produce more than 80 g and 137 g of cashmere, respectively.

According to Russel (1990), the term cashmere describes down fibres that have an average fibre diameter of less than 18,5 Φm. The average fibre diameter of 17,8 - 17,9 Φm of adult ewes in the Adelaide Boer goat flock conforms to this description. It is important to note that fibre diameter increases with age. An increase of 1,4 Φm was recorded between the first and second fleeces of goats in this flock. This is in agreement with a study of Russel (1990), who reported an increase of 1,25 Φm between the first and second fleeces, and a 0,5 Φm increase between subsequent fleeces. This increase in fibre diameter should be kept in mind during selection of young breeding ewes for cashmere production.

Body weight, cashmere production, cashmere fibre length and fibre diameter are summarised in Table 1.
Table 1  Body weight and cashmere production characteristics of the Adelaide Boer goat flock

<table>
<thead>
<tr>
<th>Trait</th>
<th>1996</th>
<th>1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight at mating (kg)</td>
<td>65,17 ± 8,02</td>
<td>63,0 ± 8,70</td>
</tr>
<tr>
<td>Cashmere length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder (mm)</td>
<td>25,5 ± 8,1</td>
<td>22,2 ± 10,4</td>
</tr>
<tr>
<td>Rib (mm)</td>
<td>20,4 ± 8,7</td>
<td>22,1 ± 10,5</td>
</tr>
<tr>
<td>Hind leg (mm)</td>
<td>29,8 ± 7,5</td>
<td>26,2 ± 7,0</td>
</tr>
<tr>
<td>Raw cashmere production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult ewes (g)</td>
<td>28,3 ± 18,4</td>
<td>28,3 ± 16,4</td>
</tr>
<tr>
<td>Range for adult ewes (g)</td>
<td>2,7 - 122,2</td>
<td>4,8 - 87,1</td>
</tr>
<tr>
<td>Young ewes (g)</td>
<td>18,0 ± 6,6</td>
<td>20,8 ± 7,7</td>
</tr>
<tr>
<td>Range for young ewes (g)</td>
<td>7,1 - 33,0</td>
<td>7,5 - 34,1</td>
</tr>
<tr>
<td>Fibre diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult ewes (Φm)</td>
<td>17,8 ± 1,1</td>
<td>17,9 ± 1,0</td>
</tr>
<tr>
<td>Range for adult ewes (Φm)</td>
<td>15,3 - 20,6</td>
<td>16,1 - 20,6</td>
</tr>
<tr>
<td>Young ewes (Φm)</td>
<td>16,1 ± 0,7</td>
<td>15,8 ± 0,6</td>
</tr>
<tr>
<td>Range for young ewes (Φm)</td>
<td>14,4 - 17,4</td>
<td>14,8 ± 16,9</td>
</tr>
</tbody>
</table>

When harvesting cashmere with a combing method, it is important that combing should start when the goat is in the process of shedding. If combing starts too early, the cashmere would not comb out, and if combing starts too late, cashmere losses would occur because of natural combing out of the down fibres during shedding. Shedding time varies from animal to animal, and even between different parts on the same animal. The percentage of total raw cashmere harvested during the first, second and third combings are summarised in Table 2. From Table 2 it is evident that more than 50% of the total raw cashmere production are combed out during the first combing, while more than 80% was harvested during the first and second combings. It therefore seems that 15 July is a suitable date to start combing in the Adelaide Boer goat flock.
Table 2  Percentage raw combed cashmere per combing

<table>
<thead>
<tr>
<th></th>
<th>1996 %</th>
<th>1997 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st combing</td>
<td>65,7</td>
<td>53,9</td>
</tr>
<tr>
<td>2nd combing</td>
<td>26,7</td>
<td>30,8</td>
</tr>
<tr>
<td>3rd combing</td>
<td>7,6</td>
<td>15,3</td>
</tr>
</tbody>
</table>

In Table 3 the down fibre profile of ewes in the Adelaide Boer goat flock is compared to that of Chinese Liaoning goats. From these results it is evident that the down fibre profiles of the Boer goat cashmere compare favourable with those of the Chinese goats.

Table 3  Down fibre diameter profile in fleeces of female Boer and Chinese Liaoning goats (Herrmann, Unpublished)

<table>
<thead>
<tr>
<th>Diameter class</th>
<th>Percentage fibres per diameter class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SA Boer goat</td>
</tr>
<tr>
<td></td>
<td>%</td>
</tr>
<tr>
<td>&lt;10 Φm</td>
<td>3</td>
</tr>
<tr>
<td>10 - 20 Φm</td>
<td>91</td>
</tr>
<tr>
<td>20 - 30 Φm</td>
<td>6</td>
</tr>
<tr>
<td>&gt;30 Φm</td>
<td>0</td>
</tr>
</tbody>
</table>

Conclusion
From these data it is evident that the raw cashmere production per goat in the Adelaide Boer goat flock is too low and the cashmere fibre length is also too short. Fibre diameter of the cashmere produced by these goats fall within the defined range for cashmere, while the percentage fibres per diameter class compares well with Chinese cashmere. It therefore seems that with selection for increased length and production, the Boer goat could have the potential to produce good quality cashmere.

References
Implications of selection of goats for divergent production characteristics in environments subject to fluctuations in nutrient supply

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Pretoria 0002, South Africa

Although there is general agreement that the indigenous animals of Africa are well adapted, there is increasing pressure to increase the productivity of these animals. It is important to establish from the outset that one-sided genetic selection for individual performance characteristics without a corresponding improvement in environmental nutrient supply has always produced negative side effects. In communal land tenure systems where animal numbers are unrestricted, and nutritional resources are consequently depleted, there is little scope for improvement of animal productivity by genetic means. There are, however, a range of other emerging systems such as free-hold small-farmer enterprises where the nutritional supply would allow for a moderately increased degree of productivity, but where management constraints call for an animal which has inherent tolerance against internal and external parasites and related diseases. If Indigenous animals are to be used as the basis for selection for improved performance characteristics, the challenge is to produce an animal capable of higher performance, but which is still adapted to its environment. Adapted animals are those that have genetic settings for many traits which harmonise the animal with the environment: Those with settings which are too high for the environment will misdirect endogenous resources and typically exhibit problems with reproduction.

While it is relatively easy to breed an animal in which productivity is adapted to a specific and unvarying nutritional environment, but it is much harder to breed an adaptable animal which has the capacity to adjust the partitioning of endogenous resources between the various body functions in accordance with variations in nutrient supply. Most evidence indicates that genetic selection for 'increased productivity' in animals is brought about by a re-direction of nutrient partitioning between different metabolic processes, and not by an increase in the efficiency of metabolism of nutrients for individual processes. The impact of an alteration of nutrient priorities is often obscured when nutrient supply is abundant, but is manifest as a reduction in reproduction rates when nutrient supply decreases. The failure of numerous attempts to introduce so-called 'high producing' genotypes into African farming systems characterised by seasonal or periodic fluctuations in nutrient supply is evidence not only of inappropriate use of animals in which nutrient partitioning has been adapted by selection to relatively constant and high-level nutrient intakes, but more importantly, evidence that current methods of selection have resulted in a decreased ability to alter nutrient partitioning in accordance with plane of nutrition. This suggests that current selection indices have resulted in increased nutrient flux through certain defined biochemical pathways (adaptation) by decreasing the sensitivity of rate-limiting control reactions to external stimuli (adaptability).
Our current ability to select, manipulate, engineer and clone animals for increased production rates by far outstrips our knowledge of the physiological processes underlying these changes, their interactions with other metabolic processes within the body and the long-term consequences of altering these processes. Research priority should be given to characterisation of both adaptability and adaptation in indigenous genotypes and studies into the physiological consequences of genetic selection for different production characteristics.
CURRENT GOAT RESEARCH PROJECTS

Individual presentations by delegates on current goat research projects

Agricultural Research Council (ARC)

Current and proposed research and rural entrepreneurship endeavours of the goat programme of the ARC-ANPI

H Dombo (ARC)
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Traditionally livestock have been kept for sacrificial purposes and for the purpose of initiation and securing good relations, such as marriage or lease-lending agreement. Commercially goats play an important role in income generation in rural communities through the provision of meat, milk, fibre skin, manure and transport power. Many goat breeds like the Gorno Altai, and the Angora produce fibre (e.g. cashmere and more hair which are of high commercial value and when harvested can be used in a cottage style industry and can supplement the commercial factor requirements. The Nutritional Physiology and Production of goat programme of the ARC concentrates its efforts on several aspects of goat production.

Several projects are currently underway at the present moment and we are pleased to say the ARC has probably has the largest goat research programme in the country, investigating the widest range of subjects and collaborating with the most other organisations.

- Alternative feeds
  The first is the testing of alternative feed resources for goats. Available feed resources which can be used by resource poor farmers and which are underutilized and cannot be used by other livestock in rural areas has been identified

- Alternative products
  Alternative product from goats e.g. meat, milk, hair and leather products from indigenous goats are compared to that harvested from commercial goat breeds and results thus far have indicated that indigenous goat products have great value-adding potential. New technologies create awareness concerning the value-adding potential of the goat products in rural communities and also concerning the potential commercial use of goats and employment possibilities. Commercialization of the indigenous goats and their products is promoted through the design and development of small processing units.

- The ARC has sorted out several different projects that are deeply geared towards the development and improvement of the commercialization of goat products at the bases of a small and a broad scale commercialization sector in rural entrepreneurship. The utilisation of Regional Agricultural Waste Products is an alternative and renewable feed resource for goats in small scale farming operations. Research is currently focused on the ensiling potential of the various plant resources (such as bananas, citrus, avocados and papayas) and feed preservation in this manner may bridge adverse periods of feed shortage in rural small scale
farming operations in Southern Africa and this can do much to provide small scale farmers with cheap, renewable feed resources. This project aims to determine the nutritional quality and fermentation characteristics of plant waste material by in vitro and in vivo techniques.

- Awareness creation.

The use of goats in forestry management. Several methods are used in forestry plantations to control competitive weeds and other understorey vegetation and to clear areas before harvesting and planting. The use of goats is of high biological importance and it is environmentally compatible and rewarding. Such an alternative is to consider forestry weeds and vegetation as a potential ruminant feed resource which would be lost if it is burned or poisoned.

Both kid and goat meat is internationally acceptable to consumers and in certain instances may even replace mutton, lamb and beef. The need for a good quality goat products is essential when quality characteristics are compared to those of sheep meat. It is necessary to produce commercial type products from goat meat because goat meat is entirely non-commercialized in South Africa and for this reason the effects of age, breed and sex type on the manufacture, quality and acceptability of traditional African type chevon sausage is being determined. Currently the quantity, quality and potential final use of leather is being studied in collaboration with the Leather Industries Research Institute of Grahamstown.

- Cashmere Goat Production for the small holder farmer.

The project entails drawing attention to the possibility that the indigenous goats, the boer goat, the savanna and the Gorno Altai are at present an enormous untapped financial resource for both the developing and the commercial farmer. There’s currently no cashmere industry in South Africa. Nonetheless approximately 2.5 million boer goats, 20 000 savanna goat, 500 Gorn Altai and an untold number of indigenous goats in South Africa are available. Super white cashmere presently attains US$110/kg and Afghanistan brown attains US$56/kg on the world market. Hence the shortage of 4000 tons in the world market has created a ready market for these fibre.

The ARC has become the secretariat of The Cashmere Breeders Society established after the auction at Rumevite in March 1997. At the auction 23 Gorno Altai bucks and 64 Gorno Altai embryos were donated to the ARC. These bucks are also used for semen collection to be able to cross –breed the Gorno Altai with boer and indigenous goats.

**Assisted reproductive techniques**

*Embryo transfer*

Although embryo transfer (ET) has been used more frequently in sheep than in goats, the procedures that need to be employed are essentially similar. The use of embryo transfer yields advantages in expanding the populations of scarce and expensive animals at the ARC e.g. Gorno altai and the breeding of Cashmere goats ranks as one of the most promising new animal enterprises.

- Breeding of the Donor Goats

Breeding is by Artificial Insemination. In breeding donor goats, AI at predetermined time after the end the super ovulation treatment has been envisaged when ovulation is closely synchronized.
Laboratory production of goat embryos
During the past decade considerable efforts has been devoted to the development of *in vitro* fertilization (IVF) and in vitro maturation (IVM) of oocytes from the farm animals (goats) in particular. The use of ovaries collected from the animals at the abattoir as a source of oocytes for IVM-IVF for the large scale production of embryos that can be used in the development of new biotechnologies (sex determination and control, pre-selecting sex of mammalian offspring, splitting embryos and transferring genetic materials) cloning and genetic engineering. These technologies in goats would permit more rapid progress in the production of transgenic animals than would be possible in other livestock with longer generation intervals.

Synchronization of oestrus in goats.
Based on research reports on goats it appeared that synchronization of oestrus and ovulation control is possible in goats. However a great deal more research is needed with this species. Even though PGF2α has been shown to synchronize oestrus in does, the number of observations is still insufficient to draw firm conclusions.

Pregnancy diagnosis, pregnancy diagnostic techniques like non-return of oestrus, ultrasonics, real-time ultrasonic scanning and hormonal assays are resorted to.
CURRENT AND PROPOSED GOAT RESEARCH PROJECTS: 1999/2000

JG Raats
Department of Livestock and Pasture Science
University of Fort Hare

1. Animal / Plant Interaction:
   i) Feeding behaviour of free range browsers (goats)
      Objectives: Determine plant species preference of goats as affected by both season and stocking intensity.
      Methods: Plant based techniques:
               Mark branches, tufts and tillers. Measure frequency and intensity of defoliation.
               Animal based technique:
               Observe plant species selection patterns of goats.

   ii) Feed Intake of free range browsers.
       Objectives: Determine quantity and quality of DM intake (DMI) of goats as affected by both season and stocking intensity.
       Methods: OF valve and n-alkane techniques.

   iii) Nutritional Stress Indicators of free range browsers.
       Objective: Identify sensitive behavioural, physiological and performance indicators of nutritional stress of goats as affected by both season and stocking intensity.
       Methods: Behavioural indicators:
                  Time management (active feeding vs. non-feeding)
                  Succession of species selection.
       Physiological indicators:
       Blood metabolites (glucose, BHB, urea, non-EFA).
       Performance indicators:
       Milk yield and livemass change. Faecal moisture content.

   iv) Harvesting rate of available forage by free range browsers.
       Objective: Determine the harvesting rate of different plant species by goats as affected by both season and stocking intensity.
       Treatments: 50 Goats on 10 ha for a period of 40 days during June/July 1998 on

**Methods:**  OF-valve technique.

v) **Identification of bulk and selective feeders amongst free range grazers.**

**Objective:**  Identify bulk- and selective grazers.

**Treatments:**  Free range cattle on sourveld of the Eastern Cape.

Expected starting date: 1999/2000

**Methods:**  Screen faecal samples for particle size.

vi) **Saliva production of free range browsers.**

**Objective:**  Determine the rate and composition of saliva production as affected by time of day and vegetation type.

**Treatments:**  Free range goats on False Thornveld of the Eastern Cape.

Expected starting date: 1999/2000

**Methods:**  Measure saliva content of OF-extrusa samples and rate of saliva production from OF goats.
TRIAL NUMBER:  NPA 3/1/2/4/2

Title:  A comparison of four small stock breeds under extensive grazing conditions in the arid sweet bushveld

Objective
The aim of the trial is to compare Dorper sheep, Pedi sheep, Indigenous goats and Boer goats in terms of production, diet preferences, resistance to parasites and diseases. This will be measured by means of the following factors:

X  Determination of preferences for tree, shrub, forb and grass species in terms of the frequency at which each species is selected.
X  Determination of the average daily gain (ADG), pre- and post-weaning.
X  Determination of lamb/kid live mass production per ewe.
X  Determination of carcass traits (carcass mass and classification).
X  Determination of annual lambing/kidding and weaning percentage.
X  Determination of disease and mortality occurrence.

Measurements
X  Ewe mass 48 hours post partum.
X  Birth mass of lambs/kids.
X  Sex of lambs/kids.
X  Frequency of multiple births per lambing.
X  Frequency of ewes lambed/kidded per lambing/kidding season.
X  Masses of all animals, every 28 days.
X  Mortality rate.
X  Cause of each mortality.
X  CSC of tree, shrub, forb and grass species.
X  Number of bites taken of each plant species during each observation session.
X  Number of worm eggs/gram faeces of the animals, every 28 days.
Out of season breeding of milk goats – the effect of light treatment, melatonin and breed

ER du Preez
Department of Animal Health and Production, Faculty of Veterinary Science, Medical
University of Southern Africa, PO Box 243, MEDUNSA 0204, South Africa

Saanen milk goats are seasonal breeders as they originated in temperate latitudes. The indigenous goats of South Africa are not strict seasonal breeders but when crossbred with the Saanen they show more seasonal breeding activity. This seasonal nature of milk goats limits the kidding to only one period of the year which is not optimal for continuity of milk production and marketing and the kids are also born during a time of the year which is not ideal for raising kids in the area of South Africa. Out-of-season breeding is thus an important consideration to improve productivity of a goat milk concern.

The object of this study was to evaluate the affectivity of melatonin in addition to light treatment to modify the breeding season of Saanen and Crossbred milk goats and to assess the difference between breeds.

The study was done with the Milch Goat Research Project in the Department of Animal Health Production situated at the Farm Animal Production Unit of the Veterinary Faculty of the Medical University of Southern Africa (MEDUNSA).

Only goats that had kidded before were included in the trial. The same management was applied to all the goats and all were kept on the same ration throughout the trial. For the purpose of this trial all the pure Saanen goats were assigned to the Saanen group, while all the goats that had some indigenous genetic make up were assigned to the Crossbred group, which then included six does that were 50:50, 10 does that were 25:75 and six does that were 12.5: 87.5. Each of these two groups of does was randomly subdivided into two treatment groups and a small control group. The control group (Group 1) was kept in a separate closed building to ensure that these does did not get any light exposure at night.

Group 2 and 3 received light treatment for 37 days, which consisted of turning on the open shed for two hours at night (10 - 12 pm). Group 3 received melatonin implants after the light treatment. Melovine from Sanofi, France was used as subcutaneous implants behind the ear. According to previous research mating should only begin five to six weeks after implanting melatonin. In this trial the belly goat was introduced for mating five weeks after the implanting was done.
The billy goats also received light treatment plus melatonin to attain the so-called “Hot Bucks”. They were separated from the does until one was introduced for six weeks for natural mating. This separation was done to attain the “male effect”. All three groups were mixed together for the mating period. The relative good response of the control group in this trial may be ascribed to the high levels of estrous activity in the does from the treatment groups and the “female effect”.

Results:

Table 1  The number of Saanen and crossbred does assigned to each treatment group

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saanen</td>
<td>3</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Crossbred</td>
<td>6</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Total in trial</td>
<td>9</td>
<td>18</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 2  Number of does that were found pregnant and that kidded in the treatment groups

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>LD*</th>
<th>LD+MEL#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saanen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pregnant (Kidged)</td>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Not pregnant</td>
<td>1</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Total in group</td>
<td>3</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Crossbred</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pregnant (Kidged)</td>
<td>5</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Not pregnant</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total in group</td>
<td>6</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

* Long Day = Light Treatment
# Long Day & Melatonin treatment = Melatonin treatment in addition to light treatment

Table 3  Fertility of goats in trial after natural mating

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>LD</th>
<th>LD+MEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertility after natural mating</td>
<td>77.8</td>
<td>55.6</td>
<td>100</td>
</tr>
<tr>
<td>(No. kidded/goat introduced to ram)</td>
<td>(7/9)</td>
<td>(10/18)</td>
<td>(17/17)</td>
</tr>
<tr>
<td>Litter size</td>
<td>1.85</td>
<td>1.70</td>
<td>1.82</td>
</tr>
<tr>
<td>(kids per doe kidding)</td>
<td>(13/7)</td>
<td>(17/10)</td>
<td>(31/17)</td>
</tr>
<tr>
<td>Fecundity</td>
<td>1.44</td>
<td>0.94</td>
<td>1.82</td>
</tr>
<tr>
<td>(kids per doe introduced to buck)</td>
<td>(13/9)</td>
<td>(17/18)</td>
<td>(31/17)</td>
</tr>
</tbody>
</table>
### Table 4  Breed differences in fertility in the treatment groups

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>LD</th>
<th>LD+MEL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fertility after natural mating (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saanen</td>
<td>66.67</td>
<td>45.45</td>
<td>100</td>
</tr>
<tr>
<td>Saanen kidded/no. introduced to buck</td>
<td>(2/3)</td>
<td>(5/11)</td>
<td>(8/8)</td>
</tr>
<tr>
<td>Crossbred</td>
<td>83.33</td>
<td>71.43</td>
<td>100</td>
</tr>
<tr>
<td>Crossbred kidded/no. introduced to buck</td>
<td>(5/6)</td>
<td>(5/7)</td>
<td>(9/9)</td>
</tr>
<tr>
<td><strong>Litter size</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saanen</td>
<td>2.00</td>
<td>1.40</td>
<td>1.88</td>
</tr>
<tr>
<td>Saanen kids/doe kidding</td>
<td>(4/2)</td>
<td>(7/5)</td>
<td>(15/8)</td>
</tr>
<tr>
<td>Crossbred</td>
<td>1.80</td>
<td>2.00</td>
<td>1.78</td>
</tr>
<tr>
<td>Crossbred kids/doe kidding</td>
<td>(9/5)</td>
<td>(10/5)</td>
<td>(16/9)</td>
</tr>
<tr>
<td><strong>Fecundity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saanen</td>
<td>1.33</td>
<td>1.00</td>
<td>1.88</td>
</tr>
<tr>
<td>Kids/doe introduced to buck</td>
<td>(4/3)</td>
<td>(7/7)</td>
<td>(15/8)</td>
</tr>
<tr>
<td>Crossbred</td>
<td>1.50</td>
<td>1.43</td>
<td>1.78</td>
</tr>
<tr>
<td>Kids/doe introduced to buck</td>
<td>(9/6)</td>
<td>(10/7)</td>
<td>(16/9)</td>
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The only meaningful differences found in this trial was when the light treatment group was compared to the group that had additional Melatonin. There was a significant difference ($p = 0.018$) in the number of Saanen does that became pregnant and kidded and also the difference in fertility between the light treatment group and the group that had light treatment plus melatonin was highly significant ($p = 0.00289$).

The benefits derived from an out of-season-breeding, by far outweighs the costs of the Melatonin. The trial is being repeated to assess whether the repeated Melatonin treatment has any effect on conceptions and fertility.
Goat research at Medunsa

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The Milch Goat Project was established in 1987 within the Department of Animal Health and Production in the Faculty of Veterinary Science at MEDUNSA. This was made possible by grants from Janssen Pharmaceutica. In recent years S. A. Breweries have supported the programmes by supplying feed ingredients. Most running costs are covered by sales of milk and surplus animals. Current and future research projects are severely limited by financial constraints. There are many potential research projects identified which are restricted or are not possible because of lack of funding.

The main aim of the Project is to develop appropriate systems of management of dairy goats for householders and smallholder farmers.

1. General Husbandry
On-going research activities at MEDUNSA include the development of simple systems of management for milk production. These include: kid rearing; feeding and nutrition; milk hygiene; and disease control.

2. Specific Registered Research Projects
2.1 The effect of crossbreeding of Saanen goats and Indigenous goats on milk production [Research Project V3/88]
This project has assessed the productivity of Indigenous and Crossbred goats in comparison to Saanen goats.

2.2 The comparative influence of fibre concentration in complete rations on growth rate, mineral deposition and rumen function in young goats [Research Project V1/89]
This experiment was initiated to assess the importance of fibre, a key component of the diet, in complete feeds. Experimental complete feeds have been used for the goat herd since its inception. Complete feeds will have most applicability in the peri-urban context.

2.3 A comparison of the genetic resistance to heartwater of Saanen, Indigenous and Crossbred goats [Research Project V4/91]
Heartwater is a major tick-borne disease that is a severe constraint in many developing areas within South Africa and elsewhere.

2.4 The development of goat milk production by small-scale farmers [Research Project VR4/93]
Small demonstration herds of milk goats have been established by other organizations in many parts of South Africa. However, the specific problems to be solved in facilitating the establishment of viable units with smallholder farmers in developing areas requires careful on-farm research and extension. This has begun in Winterveld and in the Molopo area, but is very limited at present.

2.5 Leucaena leucocephala as a fodder source for milk goats.[Research Project VR14/93]
A major constraint to goat milk production in developing areas is the lack of suitable feed resources. *Leucaena leucocephala* is a fodder tree that has been used for goats elsewhere in the world. This experiment was intended to assess its applicability in this context at MEDUNSA.

2.6 Evaluation of the use of melatonin in addition to light treatment on the fertility of Saanen and Crossbred milk goats during and out-of-season breeding period [Research Project VR9/97]
This research is being carried out by Dr ER du Preez, using the goat herd. This is of particular value to commercial producers, who need a continuous supply of milk throughout the year, to ensure sustainable marketing. A viable commercial industry must be developed to be able to support subsistence and small-scale farmers, at least with the provision of genetic material.

2.7 A comparative study of the acquired resistance to the tick species *Amblyomma hebraeum*, *Rhipicephalus appendiculatus* and *Rhipicephalus evertsi evertsi* in goats [Research Project BP6/98]
This research project is being carried out in collaboration with the Department of Biology at MEDUNSA (Dr FC Clarke and JBP Gopal Raj). Ticks and tick borne diseases are major problems in many developing areas.

3. Associated Registered Research Projects
3.1 Evaluation of indigenous shrubs as potential feeds for small ruminant milk and meat production [Research Project V3/94]
This research project is registered in the name of Professor Boyazoglu, and will make use of the milk goat herd when sufficient quantities of potential feeds have been collected.

3.2 Histological and ultrastructural evaluation of the postnatal closure of the ductus arteriosus in Saanen and Indigenous goats [Research Project VR1/97]
This research project is registered in the name of Professor L. Ohale. The Milk Goat Project has supplied goat kids from different breeds for his research. This assessment may have relevance to the survival of goat kids.

3.3 A scanning electron microscope study of the common lice, fleas and selected mites of the domesticated animals in the rural communities of South Africa [Research Project VR4/97]
This research project is registered in the name of Professor E. D. Green. He has used lice from the Milk Goat Project, which are the only significant ectoparasites affecting the goats in the goat shed. The lice can contribute to the mortality of goat kids.

3.4 Microbiological quality of milk obtained from goats under different production systems
This project is being carried out by Dr J. Kyozaire, using the goat herd in comparison to other herds. This should identify the appropriate procedures essential for hygienic milk production by small-scale milk goat farmers.
4. New Research Projects Using the Goat Herd
A number of new research projects using the goat herd are in the planning stage, including:
* studies on the development of the digestive tract;
* studies on folic acid in goat milk.

5. Other Collaborative Research
Other collaborative research carried out in previous years has included:
* Udder health. [Collaboration with Dr D Lloyd].
* Blood cytology. [Collaboration with Professor ED Green].
* Coccidiosis. [Collaboration with Dr C Harper].
* Rotaviruses. [Collaboration with Professor AD Steele].
* Internal parasites. [Collaboration with Professor J Boomker].
* Histology of the goat digestive tract. [Collaboration with Professor E D Green].

Future research projects envisaged
Many other areas of research have been identified as the subjects of future research projects, to be implemented when funds are available:
* Alternative feed sources for milk goats.
* Coccidiosis: immunology and control.
* Systems for rearing goat kids.
* Breeding season control.
* Internal parasite resistance.
* Viral diseases.
* Breed development: heartwater resistant milk goats.
* The mechanism of heartwater resistance.
* Processing and marketing: appropriate systems.
* Interaction of nutrition and disease.
* Comparative pharmacokinetics.
* Goat milk for infant nutrition: specifically for babies allergic to cow's milk.

Extension activities
Active co-operation exists between MEDUNSA and other development agencies working with milk goats, as well as with commercial milk goat enterprises. The development of the commercial goat milk industry is essential for the sustainable development of small-holder production. Research at MEDUNSA has application in developing areas, and feedback from other projects helps determine research priorities. Promotion of the concept of goat milk production in developing areas has taken place through Farmers’ Days, short courses, direct contact with farmers, and through liaison with agricultural extension services. In addition, many requests for advice are received from individual smallholders planning to keep dairy goats. It is essential also to support the commercial development of milk goat production in South Africa as a source of genetic material and expertise that can be applied in developing areas. Advice is given on the use of goat's milk for babies with allergy problems as part of the marketing outreach. Practical application of all research is vital, in keeping with the broad aim of reducing malnutrition.
Before the concept of milk production from goats can be applied successfully on a wide scale in developing areas, many questions will need to be answered which apply specifically to the people and the areas to be helped. This will require applied research, primarily of the type carried out in Farm Systems Research and Extension (FSR-E). This will include sociological, marketing and consumer research. For example, it has been alleged that Zulu people will not drink goat milk, but practical experience by at least one small-scale farmer has shown this to be inaccurate: the adult men would not drink it, but the children were not affected by these prejudices.

Other major areas to be researched will include:

- Local disease problems. An example is the incidence of *Brucella melitensis* in northern KwaZulu-Natal.
- Feed resources, particularly roughages, throughout the year.
- Appropriate breeding programmes. For example, the question of what billy goat to use when breeding with the Crossbred goats has no simple answer, and will depend on the local people and their circumstances.
- Suitable training programmes for the development of support veterinary and agricultural extension services.
- Appropriate and effective processing methods. Fermented milk products are probably more acceptable than fresh milk, because of the incidence of cow milk allergy among people in developing areas, and because of traditional practices. How will these be developed successfully, while still ensuring adequate hygiene of the products?

An effective extension programme will have to be carefully developed in order that such problems can be overcome. The development of such programmes should also be the subject of research.
Computerised decision support for rural goat production systems.

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Project information
Computerised decision support for rural goat production systems.

Duration of project
January 1999 to November 2002

Overall aims and research objectives
* Conduct more research and surveys on the effects of environmental and social factors on the production of goats in different production systems in southern Africa, as well as the interactions with other livestock and wild animals grazing in the same areas.
* Quantify the effect of land tenure systems on animal production.
* Develop a computerised decision support system to assist extension officers and farmers in optimising goat production in rural areas of southern Africa.
* Facilitate capacity building through easy access to decision support (based on computer model), in order to improve animal production and consequently sustainability in rural areas of southern Africa.
* Form the basis for the training of three post-graduate students (M.Sc. and Ph.D.- levels).

Background and motivation
The present proposal is to develop a computerised decision support system to assist extension officers and farmers in optimising goat production in rural areas of southern Africa. According to Bembridge and Tapson (1993), the implementation of grazing schemes should be accompanied by collective improved livestock management and breeding programmes on an integrated package basis. “Unlike crop production, commercial or high technology has equal application with commercial and small-scale stock owners in communal land.” (Bembridge and Tapson, 1993).

Computerised management and decision support systems in animal production appear to be accurate and realistic methods to assess with confidence the consequences of current and alternative management strategies (Webb et al., 1997). Such models were developed for pigs (Moughan and Smith, 1984; Whittemore, 1986; Black et al., 1987; Whittemore & Morgan, 1990; Pomar et al., 1991; Black et al., 1993), poultry (Emmans, 1981; Kleyn and Gouws, 1988; Talpaz et al., 1991) and ruminants (Black, 1984; Blackburn & Cartwright, 1987; France et al., 1987; Loewer et al., 1987; Dowle et al., 1988; Gillard and Monypenny, 1988; Korver et al., 1988; Bowman et al., 1989; Di Marco and Baldwin, 1989; Oldham and Emmans, 1989; Azzam et al., 1990; Blackburn et al., 1991; Werth et al., 1991).

Many modern electronic technologies are now utilised by the industry to assist in the continuous
recording of animal performance. Examples of these include the electronic weighing of animals, devices that record milk production and composition, probes for backfat thickness measurements and electronic weather recording equipment (Black and Vickery, 1986). The industry now accepts the importance of electronic and computer technologies and therefore it is sensible to study and develop a computerised decision support system in order to improve goat production in southern Africa, without adversely affecting the environment.

Relevance to development
It is estimated that more than 80% of southern Africa consists of barren land. In terms of agriculture, herbivores are the only animals that can be kept economically in these areas. Unfortunately, livestock production currently contributes little to the cash economy in southern Africa (Webb, 1998). Goats have an important enterprise function and provide an ideal opportunity for rural development. Goats are often used for home consumption, ceremonial slaughters and lobola (to pay for a wife), but they also serve as a source of income or investment. The potential of goat farming in southern Africa is tremendous.

Goats are reported to be better adapted to harsh extensive conditions compared to either sheep or cattle (Van Niekerk and Schoeman, 1993). These browsers are more heat tolerant, can withstand dehydration and survive on deplorable low planes of nutrition i.e. coarse, fibrous feeds. They often utilise desert shrubs and coarse roughage. In addition, goats are fairly selective and tend to walk long distances in search of feed.

“The question is not whether there will continue to be a viable role for the goat. There will be. The question and the continuing challenge is to define the roles for the goat and to find the most productive ways that goats can fill these roles to improve the environment and provide food and fibre and contribute to the social well-being of people” (International Goat Association).

In recent studies (Mamabolo, 1999) the fertility and production of indigenous goats were studied extensively (seasonal, management, environmental and social factors). A research project was also recently initiated to quantify the effects of land tenure systems on animal production. Results suggest a deplorable low reproductive rate in indigenous goats, mainly due to poor management. The results suggest that inbreeding in indigenous goats is a common phenomenon (estimated from DNA-analysis and microsatelite markers), which also explains the poor reproduction efficiency. In addition, the current stocking densities often result in over-grazing and significant veld deterioration. Evidently the feasibility / sustainability of an enterprise is dependent on the interaction of many factors and it is almost impossible for an individual to predict with confidence the consequences of different production strategies on the efficiency and profitability of an enterprise.

To summarise:
* A limited amount of information is currently available on the effects of the various environmental and social factors that influence the productivity and sustainability / profitability of livestock production in the different production systems in rural areas.
* Extension officers and farmers struggle to improve rural animal production, mainly due to the number of complex factors and their interaction that may influence the system.
* It is almost impossible for an individual to predict with confidence the consequences of different production strategies on the efficiency and profitability of an enterprise.
**Expected Benefits**

* The research results, condensed in a computerised decision support system, will contribute to better management, breeding and production of livestock.
* In the medium to long run, this information will benefit the rural or small-scale farmer to ensure sustainable animal production and food security.

**Benefits of computerised management and decision support systems include (from Webb et al., 1997):**

1. Provide a better understanding of the various components and their interactions in biological systems.
2. Identification of research areas where scientific information is lacking, particularly within the growth process.
3. Provide a method to predict in a logical way the performance of animals in a given environment.
4. Predict the physiological consequences of genetic improvement or alternative inputs.
5. Predict the economic implications of alternative dietary, feeding or housing conditions and improve the management of the production system.
6. Make comparisons between actual and potential production in order to identify limitations or constraints in a production system.
7. To aid in the design and interpretation of nutrition experiments.
8. To demonstrate the principles of nutrient utilisation and animal growth in the teaching of nutrition.

**Dissemination strategy**

A computerised decision support system (interactive computer programme) will be provided to extension officers at the regional offices of the Department of Agriculture, the National Department of Agriculture, the ARC and small-scale farmers. A good working relation has already been established with community leaders and extension officers. Support from the community leaders is vital for successful implementation of the decision support system.

The programme will be demonstrated to users and a backup support system will be provided by the Animal Science departments at the University of Pretoria and University of Venda. The Computerised Decision Support System for Goats will also be propagated through the International Goat Association, particularly since various other countries have similar problems with goat production and management.
SUMMARY OF ISSUES DISCUSSED AND RESEARCH PRIORITIES IDENTIFIED

Research and Training Strategies for Goat Production Systems in South Africa

1. **Session theme:** Constraints and Opportunities to Goat production in South Africa
   1. **Topics:**
      1. A perspective on the constraints, opportunities and issues surrounding research on goat production in Southern Africa - Pierre Cronje (University of Pretoria).
      2. Constraints and opportunities for small-holder goat production systems in Asia - Barry Norton (University of Queensland).
      3. Constraints and opportunities in Australian goat production systems - Barrie Restall (University of Queensland).
      4. The farming systems approach and goat production by small-holder and communal farmers - Lawrence Tawah (University of the North).
      5. Socio-economic aspects of sustainable goat production - Roelf Coetzee (University of the North).

2. **Discussion on broad issues affecting goat production and goat production research**
   1. Lack of information on human resources and systems dynamics were identified as one of the major constraints affecting goat productivity. The following issues were identified and discussed:
      (1) Product value is a major motivator in small-scale and communal farming systems. A major constraint to delivering product value to the small farmer was lack of knowledge of existing market channels and a lack of understanding of the existing extensive informal marketing patterns. The group recommended the following actions be executed in the following order of priority:
         (1) That research be initiated to collect data on marketing dynamics, constraints and opportunities, which may require the use of specialist multi-disciplinary teams (including economists, sociologists and extension workers)
         (2) That research be initiated to identify new markets, marketing channels, secondary industries and value-added products and that research be directed towards the development of these products. Examples of novel products were discussed:
            (1) Leather
            (2) Cashmir
            (3) Processed meat products
            (4) Milk and milk products
         (3) That goats be promoted to both the small-farmer producer and the consumer as ecologically friendly, a source of additional farm income and food security and as a source
of healthy and nutritious products. Goat milk production was identified as an example of a product which could significantly decrease infant mortality rates and improve human health status.

2. **Session theme: Product Potential**

1. **Topics**

   1. Milk production from goats for households and small-scale farmers in South Africa - Ned Donkin (Medical University of South Africa - Veterinary Faculty)
   2. Meat production from goats in communal vs. commercial farming systems in the Eastern Cape region - Patrick Maseka (University of Fort Hare)
   3. The potential of leather production from goats - Mike Ginn (Leather Industries Research Institute)
   4. The meat production potential of Indigenous vs. Boer goats in extensive farming systems in the Northern Province - Isak du Plessis (Mara Research Station, Department of Agriculture)
   5. Cashmere production potential of indigenous goats - Albie Braun (Textile Technology division - CSIR)
   6. Biological constraints and opportunities for the production of meat, milk and fibre from goats - Barry Norton (University of Queensland)

2. **Discussion of issues related to meat, milk, leather and fibre production from goats**

   1. The following product-specific issues were identified and discussed:
      (1) **Milk:** The following areas requiring further research were identified:
         (1) Evaluation of the quality of goat milk in relation to human nutrition (nutrient content, contamination with pathogens, etc)
         (2) Disease resistance of milk goats, indigenous goats and their cross-breeds (resistance to ticks, tick-borne diseases and intestinal parasites).
         (3) Characterisation of optimal combination of milk breed crosses with indigenous goats for milk production in various South African environments
      (2) **Meat and leather.** The group identified a lack of information on the productive potential of indigenous and other genotypes under different farming systems with particular reference to lifetime productivity as a major constraint. Leather is considered to be a component of the productive potential of the animal. The meeting identified an initiative of the Leather Industries Research Institute as being of significant potential for developing a home leather processing industry in the communal farming systems of South Africa.
Goat fibre: Viability and marketing studies were identified as a first priority action with regard to evaluation of potential production initiatives for mohair, cashmere and goat wool. Since there are no known markets for these products, apart from mohair, it is essential that evaluation include determination of the quantity and quality of fibre production.

3. Session theme: Pasture and veld management
   1. Topics
      1. Diet selection and intake in goats - Jan Raats (University of Fort Hare)
      2. Role of goats and fire in control of bush encroachment - Jorrie Jordaan (Tawoomba Research Station, Department of Agriculture)
      3. Potential of agro-forestry shrubs and tree legumes in communal goat farming systems - Lindela Ndlovu (University of the North)
      4. Impacts of browsing on savannah woody plants in Africa - Peter Scogings (University of Fort Hare)
      5. Management of goats at pasture - Barry Norton (University of Queensland)
      6. Vegetation dynamics in the communal rangelands of the Eastern Cape - Theuns De Bruyn and Peter Scogings (University of Fort Hare)

   2. Discussion: Identification of specific issues affecting pasture utilisation and nutrition of goats: The extensive (veld) grazing environment was identified as the future focus for new research in South Africa, and issues of the range management and condition, stocking rates and management of goats within a multi-species grazing system and the strategic management of goats for optimising productivity and for weed control was discussed. The constraints noted related to ownership laws and responsibilities for animal management in communal farming systems, drought frequency and its management, overgrazing, lack of fencing and in the longer term a likelihood that these grazing systems will not be sustainable.

4. Session theme: Reproductive efficiency of goats
   1. Topics
      1. Reproductive status of goats in communal systems in South Africa - Eddie Webb (University of Pretoria)
      2. The use of frozen goat semen in AI programmes for the improvement of indigenous goats - Johan Terblanche (University of Pretoria - Veterinary faculty)
      3. Controlled breeding for improved reproductive efficiency in goats - Johan Greyling (University of the Free State)
      4. In-vitro production of embryos for improved goat production - Theresa Arlotto (University of Pretoria - Veterinary faculty)
      5. Reproduction in goats - Barrie Restall (University of Queensland)

   2. Discussion: Identification of specific issues affecting reproductive efficiency in goats. The meeting concluded that little was known of the reproductive patterns and fecundity of indigenous goats in small-scale and communal farming systems. Such information is essential for improvement of overall productivity in these
farming systems. The following areas of future research were identified as high priority:

1. Baseline studies of reproductive performance in communal systems. Because of the uncontrolled mating practised in these systems, appropriate parameters such as annual reproductive rate and lifetime production should be used.

2. Identify opportunities for the management of reproduction through the use of environmental and social cues that initiate and influence reproductive performance.

3. Characterise the responsiveness of both male and female of different genotypes to environmental cues throughout the year.

4. Enhancement and facilitation of social and environmental cues for the management of reproductive performance.

5. Long-term effects of nutritional variations on reproductive performance.

5. Session theme: Breeding plans for goats

1. Topics

1. Breeding a dual-purpose goat for communal farming systems - Joshua Roux (Cradock Experimental Station, Department of Agriculture)

2. Implications of selection of goats for divergent production characteristics in environments subject to fluctuations in nutrient supply - Pierre Cronje (University of Pretoria)

3. Genetics and breeding in goats - Barrie Restall (University of Queensland)

2. Discussion: Identification of specific issues affecting utilization and conservation of genetic resources. The meeting recognised the diversity of indigenous genotypes and the paucity of knowledge in this field and the dangers of indiscriminate crossbreeding with exotic genotypes. The following areas were identified as research priorities:

1. Characterisation of the productive potential of the indigenous genotypes with particular reference to adaptation.

2. The conservation of valuable / unique genotypes identified as a consequence of the actions referred to in (i) by the establishment of regionally based open nucleus herds.

3. Evaluation of mohair and cashmere crossbreeds.

Summary of major conclusions

The workshop recognised the considerable potential of the indigenous goat to contribute to the quality of life of communities within small-scale and communal farming systems. The single most limiting factor was identified as a lack of research on indigenous goats, which can be overcome by the following actions:

1. The establishment of a network of goat research and extension workers in South Africa to efficiently use the collective resources of the group.

2. To develop a tertiary curriculum and training courses for graduate workers and extension officers employed in the goat industry pertinent to the realisation of the potential of the indigenous goat.

3. To seek support to harness the momentum generated by this workshop in order to launch a
training course to collect, collate and disseminate existing information on goat technology which will have a significant impact on the quality of life of rural farming communities.
# LIST OF PARTICIPANTS

<table>
<thead>
<tr>
<th>Surname</th>
<th>First name</th>
<th>Title</th>
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