

Sustainable animal agriculture and crisis mitigation in livestock-dependent systems in southern Africa

Proceedings of the regional conference held at Malawi Institute of Management, Lilongwe, Malawi 30 October to 1 November 2000.

Edited by:

J.W. Banda, M.G.G. Chagunda, L.A. Kamwanja, R.K.D. Phoya and A.C.L. Safalaoh

March 2001

Bunda College of Agriculture, P.O. Box 219, Lilongwe, Malawi

USAID, P.O. Box 30045, Lilongwe, Malawi

GTZ, Private Bag 387, Lilongwe, Malawi

Table of Contents

[Abstract](#)

[Foreword](#)

[Opening address](#)

[Preface](#)

Session 1: Livestock management and improvement

[Characterisation and conservation plan of the Sudanese Kenana cattle breed](#)

[Livestock production improvement at small scale household level in a developing country set up: The fate of indigenous goat gene pools in Malawi](#)

[Characterisation of small scale cattle farming in two districts of the Free State Province of South Africa](#)

[Genetic evaluation of grade, appendix and pedigree cow classes in Holstein, Jersey and crossbred dairy breeds in Zimbabwe](#)

[Estimation of body composition in tropical sheep raised under seasonal feed supply conditions: Prediction models](#)

[Fodder yield and nutritive value of leucaena, acacia and calliandra at three cutting regimes and two locations in Malawi](#)

[Effect of draft work on production and reproduction of Malawi Zebu cows](#)

[A study of the flock dynamics, marketing, and socio-economic roles of small ruminants in crop-livestock farming systems in Malawi](#)

[Prospects of genetic improvement programmes in populations: A case of dairy production in Malawi](#)

[Relationship between annual rainfall oscillations and mohair production between 1935 and 1996](#)

[On-farm and on-station evaluation of growth and reproductive characteristics of pigeons in Malawi](#)

[Strengths and weaknesses of smallholder poultry improvement programmes in Malawi](#)

[Sheep responses to different stocking rates and seasonal variation under rangeland conditions of Lesotho](#)

[Forage responses to different stocking rates and seasonal variation under rangeland conditions of Lesotho](#)

[Roasted sorghum as an alternative energy source in pig feeding](#)

[The effect of a community-based animal health service programme on livestock mortality, offtake and husbandry applications — A field study in northern Malawi](#)

Session 2: Policy analysis, socio-economics and sustainable integrated animal health

[Socio-economic and biological issues to consider in smallholder poultry development and research in Southern Africa in the new millennium](#)

[Analysis of socio-economic factors influencing egg production in Maseru District, Lesotho](#)

[Epidemiology of parasite infestation in goats belonging to resource limited communities in eastern Namibia](#)

Session 3: Crisis mitigation in livestock dependant systems

[Crisis mitigation in livestock dependant systems: The role and limitations of current initiatives for livestock systems in South Africa](#)

[Crisis mitigation in livestock dependent systems: Concern, universal experiences and challenges in promotion of livestock production in Dedza District](#)

Session 4: Product enhancement and human resources development

[Promotion of higher education: Is there a role for the traditional agricultural university in development?](#)

[The framework for regional collaboration in animal agriculture: The SADC animal agriculture network \(SAARNET\)](#)

[The challenges of training animal scientists in the SADC: Experiences from Malawi](#)

[Capacity building for sustainable use of animal genetic resources](#)

Session 5: Short communications

[Keeping quality of cow and goat milk under different temperatures in different seasons in Malawi](#)

[Prospects for the 2000/2001 rainfall season in Malawi](#)

[The effect of variety and geographical location on the mineral content of sorghum and finger millet in Kenya and Uganda](#)

[Milk yield, physico-chemical properties and composition of milk from indigenous Malawi goats and their Saanen half-breeds](#)

Session 6: Abstracts

[Genetic diversity in indigenous cattle breeds of East Africa](#)

[Carcass composition of tethered, supplemented Tanzanian goats and prediction models for carcass weight and composition](#)

[Post-weaning performance of local Malawian pigs fed soyabean-based diets containing different levels of raw, untreated sunflower seed meal](#)

[Using carbon isotope ratios \(\$\delta^{13}\text{C}\$ \) in determining diet changes in animals: the case of the Lake Malawi bathyclarias nyassensis \(pisces: claridae\)](#)

[Characterisation of the local Zambian chicken — A case study of Chikondwa area in Chongwe](#)

[The prevalence, incidence and effects of trypanosomosis on reproductive performance of cattle in north-eastern Zimbabwe](#)

[Constraints to rural poultry production and diversity in Lilongwe and Mzuzu agricultural development divisions, Malawi](#)

[Village chicken production in Zimbabwe — Constraints and potential](#)

[Some socio-economic factors constraining farm animal production in Malawi](#)

[Use of maize and crotalaria leaves as supplements for tethered sheep and goats](#)

Abstract

These proceedings contain papers, abstracts and posters of the Regional Conference on Sustainable Animal Agriculture and Crisis Mitigation in Livestock-dependent Systems in Southern Africa that took place at Malawi Institute of Management (MIM) in Lilongwe, Malawi, from 30th October to 1st November 2000. A keynote paper opens each theme and is followed by scientific contributions, short communications, and abstracts. Posters are published as short communications and/or abstracts. These proceedings are organised as follows:

Session 1 Livestock Management and Improvement (16 papers)

Session 2 Policy Analysis, Socio-economics and Sustainable Integrated Animal Health (4 papers)

Session 3 Crisis Mitigation in Livestock-dependent Systems - Held as a mini workshop within the conference (2 papers)

Session 4 Product Enhancement and Human Resources Development (4 papers)

Session 5 Short Communications (4 papers)

Session 6 Abstracts (10 abstracts)

Foreword

The numerous constraints to animal agriculture in Southern African Development Community (SADC), including further limitations exerted by man-made and natural disasters or crises necessitated the organisation of the "Regional Conference on Sustainable Animal Agriculture and Crisis Mitigation in Livestock-dependent Systems in Southern Africa". The goal was to map out strategies that would be used by all stakeholders in animal agriculture to improve production to levels that will enhance and sustain food security and improve living standards as well as mitigate crises in the region.

Previous attempts to consolidate information have been limited by lack of such a forum to bring together scientists, farmers, processors, traders, development and extension agents, decision and policy makers and all stakeholders from the government, NGO and private sectors.

These proceedings publish papers, posters and abstracts based on research, development and review work in animal agriculture as well as crisis mitigation aspects. The proceedings review most of this work conducted not only in SADC countries, but also in other countries in order to provide lessons for livestock improvement and crisis mitigation. The proceedings also contain recommendations on strategies for present and future development in animal agriculture and crisis mitigation as well as on enhancing/strengthening of collaboration, co-operation, human resource development and exchange of information among the various stakeholders.

Some recommendations require immediate attention and institutional reform, while others require development of research and outreach projects and programmes that will assist in improvement of the animal industry and mitigation of crises. The development and implementation of such projects and programmes will depend on the understanding of the rationale to change, and willingness and co-operation of all concerned stakeholders. The recommendations are made on the presumption of good will, commitment and continued support of donors and governments.

Those interested in the detailed summaries of the conference can request special copies of the Conference Report and the report on The Mini Crisis Mitigation Workshop held during the conference.

Opening address

Professor Gearge Y. Kanyama-Phiri
Principal, Bunda College of Agriculture

It is my humble duty as Principal of Bunda College of Agriculture, University of Malawi, to present these proceedings to all participants and stakeholders with the hope that it will provide consolidated information and recommendations required in the animal agriculture sector. I would like to take this opportunity to express my sincere gratitude to the donors for their support and contribution to the conference. I hope they will continue supporting activities, projects and programmes that will emanate from the conference recommendations.

These proceedings are a result of the first ever international conference on animal agriculture. As such I would like to thank all individuals or committees involved directly or indirectly in the organisation of the conference and putting together of this document.

Preface

Domesticated livestock play a dominant role in most SADC countries through contribution to the Gross Domestic Product (GDP) and agricultural output, nutrition, income and nutrient recycling. Despite this, inadequate nutrition, animal diseases and parasites, poor performance of indigenous animal genetic resources, low production systems, adverse socio-economic and policy environment, low levels of processing, inadequately trained human resources, and weak institutional linkages, have constrained improved productivity, particularly in the smallholder crop-livestock systems. These have to be addressed in a holistic approach. Further limitations to animal agriculture has been posed by man-made and natural crises such as persistent droughts and floods, diseases and pests, food and feed shortages, and market distortions, to list a few. Current early warning systems do not address or integrate these livestock issues. Therefore there are no strategies or coping mechanisms to mitigate against such crises. There is a need to address these issues especially in the new millennium.

It is against this background that this conference was organised. It drew together 74 national, regional and international scientists, farmers, processors, traders, development and extension agents, decision and policy makers, and all stakeholders from the government, NGO and private sectors to map out strategies to improve livestock production to levels that will enhance and sustain food security and improve living standards as well as mitigate crises in Southern Africa. The objectives are to:

- review research, development, extension, policy and human resource work in animal agriculture
- identify strategies for present and future development of animal agriculture in Southern Africa
- suggest crisis indicators and coping mechanisms or contingency plans for crisis mitigation in livestock systems
- enhance/strengthen collaboration, co-operation, human resource development and exchange of information between universities, animal industries and relevant stakeholders regionally.

The conference proceedings reflect the oral paper and poster presentations at the conference held at Malawi Institute of Management, Lilongwe, Malawi from 30th October to 1st November 2000. The conference drew together over 80 national, regional and international scientists, farmers, processors, traders, development and extension agents, decision and policy makers and all stakeholders from the government, NGO and private sectors. The participants presented more than 40 papers and 18 posters that covered the following themes: livestock production management, policy analysis, socio-economics and sustainable integrated animal health, crisis mitigation in livestock dependent systems, and product enhancement and human resources development.

For the session on "Crisis Mitigation in Livestock-dependent Farming Systems", the strategies, coping mechanisms and clear quantitative bases were determined in order to cope with persistent crises in Southern Africa.

The conference was organised by Bunda College of Agriculture with funding from USAID, GTZ, SACCAR and the NORAD Project at Bunda College.

The participants of the conference were drawn from the Republic of South Africa, Lesotho, Namibia, Zimbabwe, Zambia, Tanzania, Kenya, Uganda, Ethiopia, Sudan, the United

Kingdom, Norway, Germany, New Zealand and the host country Malawi. The discussions were extended to include formation of national animal science associations.

The conference was officially opened by the Minister of Agriculture and Irrigation Development (MoAI), Honourable Leonard Mangulama, MP. The directors of the major funding agencies/donors of USAID, Mr. Kiertsak Toh and of GTZ, Dr. R. Pollvogt gave remarks.

Session 1: Livestock management and improvement

Characterisation and conservation plan of the Sudanese Kenana cattle breed

I. A. Yousif

Department of Genetics and Animal Husbandry, Faculty of Animal Production,
University of Khartoum, P.O. Box 32, Khartoum North, Sudan

[Abstract](#)

[Introduction](#)

[History of the Kenana cattle breed](#)

[Description](#)

[Population](#)

[Systems of production](#)

[Performance](#)

[Current effort for genetic improvement of Kenana](#)

[Genetic improvement and utilisation](#)

[References](#)

Abstract

The Kenana cattle breed originated from *Bos indicus* or the humped cattle. Other evidence suggests that Kenana cattle resulted from interbreeding the Nilotic Sana cattle with the short-horn Zebu during tribal migration before recorded history. The name Kenana came from the owners who are mainly nomadic and semi-nomadic tribes. The light blue-grey coat is the characteristic colour of Kenana. The calves are frequently born with brown-red coats that tend to change to permanent grey at 3–6 months of age. The horns are short and they are relatively short in females. At maturity (five years) the average body weight of males and females range from 300– 500 kg and 250–350 kg, respectively. The total population of Kenana has been estimated at 3,000,000 head which represents 12% of the whole cattle population in Sudan. The homeland of Kenana is the delta between the White Nile and the Blue Nile; however they are also found along the western and eastern banks of those rivers as far as Northern Kordofan State. This habitat could be described as semi-desert and desert scrub.

The main system of production is the range system which includes the pastoral and semi pastoral types. The nature of nomadism is relatively mild in Kenana; this is because Kenana homeland is partially extended to an irrigated area of Elgezira Scheme. The Kenana breed has been classified among the highest milk producing Northern Sudan Zebu Cattle. The

average milk production per lactation varies between 1400 and 2100 kg and the maximum production is attained at 6–7 years of age. Umbanein Research Station was established in the year 1957 with the primary objective of improving the Kenana breed for milk and beef production through a continuous selective breeding program. Even though Kenana cattle are described as relatively low production animals (milk and meat), however they are well adapted to the harsh climatic and environmental conditions.

Attempts at genetic improvements of the Kenana breed have not progressed considerably. Plans for further genetic improvement could be dependent on the establishment of a selection strategy involving a multi-nucleus herd stage to solve the problem of the unavailability of an organised record system. This will lead to the development of a well-established central nucleus herd station, where intensive selection can be practised and will ultimately result in selection of superior cows and bulls.

Introduction

Sudan is one of the largest countries in Africa and the Near East with an area of approximately one million square miles. The country possesses a large livestock wealth and ranks first in Africa in total livestock numbers. There are approximately 22.5 million head of cattle in Sudan, and about 98% of them are owned by pastorals. This large population is mainly concentrated in three major regions, namely Western Sudan – the homeland for Baggara cattle, mid-Sudan – the homeland for Kenana and Butana Breeds, and Southern Sudan where the Nilotic breed is dominant.

History of the Kenana cattle breed

The Kenana breed originated from *Bos indicus* or humped cattle. It has been suggested by Payne (1970) that the origin of Zebu breeds of cattle appeared to be Western Asia and not the Indian subcontinent. Zebu cattle were imported into Africa during recorded history through the migratory people, thus representing the ancestor of the vast majority of cattle breeds found today (Payne 1964). The migration of short-horn cattle owners (including the North-Sudan Zebu) took place along the Southern Mediterranean and southwards along the Nile into Upper Egypt and Sudan, but not across what is now the Sahara. Other evidence suggested that Kenana cattle have resulted from interbreeding the Nilotic Sanga cattle with the short-horn Zebu during tribal migration (Rouse 1970). Sanga cattle are a cross between the hamitic and the long-horn *Bos indicus*. The name Kenana came from the owners who are mainly nomadic and semi-nomadic tribes which include the Kenana, the Rufa Elhoy and the Beni Moharib. There are a number of related types of North Sudan short-horn Zebu among which Kenana synonymous to Blue Nile, Fung and Rufa'ai can be distinguished. Mason and Maule (1960) described Kenana as a sub-type of the Northern Sudan short-horn Zebu. It is a representative of the nomadic cattle of Northern Sudan.

Description

Figures 1 to 6 show animals of the Kenana breed of different sex and age. The characteristic colour of Kenana is light blue-grey, with gradation from nearly white to steel grey. Shading to nearly black is common on the head, neck, hump, hindquarters and legs. Black points are also visible on the muzzles, horns, tail tips and eyes. The individual hairs are black at the base and white (or occasionally red) at the tip. Darker coat colours and darker areas are due to the hairs having a broader black band. Calves are frequently born with brown-red coats that tend to change to permanent grey at 3–6 months of age. The hair with the red tips in calves may apply to those on the poll only or to the whole body. The head is long and coffin-shaped with a thin face. The horns are short, they seldom exceed 30–35 cm, and they are relatively shorter in males than in females. In a cross section, this horn appears oval in shape. Even though

polledness is exceptional, animals with loose horns are very common. Horns grow from the flat poll in an outward and upward direction. The hump is cervico-thoracic in position; it is large in males and tends to hang over at the rear, but is less developed in females. The dewlap is large and prominent in males. Because of the better frame and relatively good milk production, Kenana cows provide their calves with a high level of nutrition up to the weaning age. At maturity (about 5 years) the average body weights of males and females as reported in the literature, range between 300–500 kg and 250–350 kg, respectively depending on the managerial conditions (Saeed et al. 1987).



Figure 1. *A typical mature Kenana bull.*



Figure 2. *Kenana cow with loose horns.*



Figure 3. *Kenana calf less than six months old.*



Figure 4. *A typical mature Kenana cow.*



Figure 5. *Polled Kenana bull.*



Figure 6. *Kenana calf three months old.*

Population

The total population of Kenana has been estimated at 3,000,000 head, which represents about 12 percent of the whole cattle population in Sudan. The homeland of Kenana is the delta between the White Nile and Blue Nile. It is also spread along the western and eastern banks of those rivers in a triangular area bounded by the cities of Sinnar, Singa, Roseries and Kosti (Figure 7). The breed is also found in Northern Kordofan State and as far as the area of the Abbasiya in the eastern part of Nuba Mountain. The general description of this habitat is a semi-arid desert scrub with rainfall ranging between 336 and 457 mm. Under traditional management, the sizes and compositions of the herds are influenced by a number of factors

such as seasonal availability of water and feed, market prices and infectious diseases.



Figure 7. Map of Sudan showing the main breeding area of the Kenana breed (dark triangle).

Generally herds under the nomadic system tend to include a high proportion of bulls than those required for breeding purposes. It is also expected that a large sized herd will contain more bulls at different ages than those with small sizes. For breeding purposes, owners select the large sized bulls to serve the cows in a ratio of approximately 1:25.

Generally there is no specific breeding season; however, most of the cows conceive during the rainy season when pasture is rich and abundant. As a result of nomadic migration, the Kenana breed has been exposed to a degree of interbreeding with Western Sudan Zebu and probably the nilotics, in addition to the artificial crossbreeding with exotic breeds, but still it is believed that this process has not yet seriously endangered the original breed.

Systems of production

The traditional grazing system is considered to be the most common upon which more than 80% of livestock owners are dependent. The range system is the main production system; it includes the pastoral and semi-pastoral types. The pasture region in the country extends in a wide belt between the northern desert and the southern forest for a distance of 1000 miles from east to west and 500 miles from north to south. Annual rainfall varies from 10 inches in the north to 35 inches in the south. Cattle owners who are mostly nomads or semi nomads seasonally migrate with their herds and gather around the areas rich with water and grass. Milk is sold to the nearest towns to generate cash income. Seasonal cheese factories may be established by merchants in association with cattle owner settlements.

Nomadism of Kenana is less pronounced compared to Baggara cattle in Western Sudan, which pass through a very long migratory process. This is mainly related to the fact that the Kenana homeland is partially extended to an irrigated area of Elgezira scheme where a variety of crops are grown. Therefore the post harvest crop by-products provide a better chance for settlement during this period of time.

More than 80% of the milk sold to big cities and towns in Sudan is still provided by the

traditional sector. Most of the dairy farms include small or medium-sized herds (20–50 milking cows), which are mainly Kenana, and its crosses with exotics. This system of production could be defined as semi-intensive. Kenana cattle are not considered as a major source for beef in the country.

Performance

The Kenana breed has been classified among the highest milk producing Northern Sudan Zebu. According to several reports (Alim 1960; El Amin 1969; and Saeed et al. 1987), the average milk production per location varies between 1400 and 2100 kg (Table 1). The maximum production is attained at 6–7 years of age. This is fairly comparable with other important milk producing Zebu breeds in Africa. Results from Nisheisheiba Research Station showed that milk fat and solid not fat (SNF) vary with lactation season in a range of 4.2–5.4% and 8.7–9.0% respectively (unpublished data).

The Kenana bull is commonly characterised by a fairly large body size. In general, data on reproductive and productive performance of the Kenana breed under nomadism is very scanty; therefore the results, which were obtained from the research stations, are considered as the closest an approximation. The average birth and weaning (120 days) weights of Kenana at Umbanein Research Station was found to be 23.0 kg and 52.0 kg respectively (Saeed et al. 1987), whereas the dressing percentage was 55%. Traditionally Kenana is used for milk, meat and hide production. Bulls are also used for draft power in the migration season.

Under traditional management the seasonality is very marked, with more than 60% of all calving taking place in a 3-month period related to the conception in the previous rainy season. The age at first calving that was reported at different research stations ranges between 38.4 months at Gezira Farm (Alim 1960) and 50 months at Umbanein Station (Saeed et al. 1987). The age at first calving is expected to be relatively higher under the nomadic system, though it may not exceed the reported range at the research stations. The range for the number of services per conception at different seasons was reported to be 1.4–1.8 (Saeed et al. 1987). The calving interval at Umbanein Station was found to be 485 days which is longer than that reported at Gezira Farm (368–405 days). The reproductive life defined as the number of calves born per cow, is reported to be in the range of 4–5.4 calves.

Calf mortality data at Umbanien Station showed that it was highest during the neonatal period of up to one week of age. From one week to weaning at 120 days, the mortality rate is considerably lower; but again it rises after weaning. The overall mortality rate to one year was found to be 16.6% (Saeed et al. 1987). 75.6% of all animals born survived up to ten years of age.

Table 1. Performance of Kenana Cattle (location data from Kenana cattle herds).

Herd and source of data	Number	Lactation yield (kg)	Lactation Length (days)	Calving interval (days)	Annual yield (kg)
Gezira Research Farm	539	1613	224	395	1491
Khartoum University Farm (El Amin 1969)	1537	1860	294	428	1568
Um Banein Research Station (1987)	1263	1497	251	479	1141

Source
Saeed et al.
1987.

Current effort for genetic improvement of Kenana

The governmental effort to conserve and genetically improve the indigenous cattle breeds has been going on since the early 1940s, which consequently led to the establishment of a number of research centres in the areas of livestock concentration. Umbanein Research Station was established in 1957, with the primary objective of improving milk and beef production through selection within the Kenana breed. In the early 1960s, a multi-purpose research centre was established at Kuku district in Khartoum North province. It includes several animal production units, among which the A. I. centre is considered as an imminent progress in animal breeding. At the same time the research effort which was carried on at Khartoum and Gezira University farms indicated the probability of achieving some genetic progress in milk production of Kenana cattle (Alim 1962) . However, because small herd sizes and financial problems presented a genetic progress, a major goal of these research centres is to conserve small pure-bred nucleus herds of Kenana. On the other hand the introduction of foreign temperate breeds to improve the milk yield of indigenous cattle (Kenana and Butana) is considered despite the fact that there is no clearly defined national crossbreeding policy.

Genetic improvement and utilisation

The plans and suggestions for genetic improvement of the indigenous cattle breeds in many tropical countries are more or less similar. Improvement could be achieved through two parallel schemes; these are within population selection and introduction of improved exotic germplasm. For practical reasons however, much more emphasis should be given to the former scheme, whereas the latter should be implemented under certain restrictions.

The decentralised multi-nucleus herd scheme is suggested to deal with the problem of unavailable organised record systems as a result of continuous migration under nomadism. The selection criterion of individual cows for these nucleus herds could be based on direct assessment of their milk yields. It is obvious that concurrency using this procedure is questionable; however, it is useful to study the performance of Kenana. The substantial variation in milk production of the breed is mainly attributable to the wide range of environmental differences and the genetic variability within the breed. Furthermore, genetic parameters which are essential for selection planning could also be estimated during this first stage of the scheme.

In the next stage and after having established records, individuals should be selected on the basis of their own and relative information in order to develop central nucleus herds on station. This station must be well established and provided with means that are necessary for intensive selection procedures. Since the primary objective is selection for milk production, it would be worthwhile to include economical aspects of the dairy breed in the index of selection according to their appropriate weights. Due to this effort it would be expected that few but superior cows and bulls will be produced and through artificial insemination (AI) techniques the semen could be disseminated to farmers. However, because of ritualistic beliefs and traditional attitudes of the nomad's application of AI procedures in the nomadic herds may not be welcomed. This program is designed to last for as many generations as possible to maximise the genetic improvement for milk production. In addition, selection for both milk and growth rate in the Kenana breed would be feasible.

In Sudan, importation of exotic breeds was initiated between 1925 and 1927 when Short Horn cattle from the U.K and Holstein Friesian from the USA were introduced to the country. Regarding the indispensable role of the indigenous cattle for the vast majority of the nomadic tribes, any improvement programme which may jeopardise the existence of indigenous species is not at all acceptable. However it should be noted that the application of a scientifically well-planned crossing scheme under necessary restrictions should not be considered a risky process. Moreover this kind of crossing programme may be best suited in the areas where semi-intensive systems of production are prevalent; therefore relatively better

management would be provided. Even though the Kenana breed has not yet been exposed to severe and risky crossbreeding efforts, it is believed that the initiation of an early conservation scheme is strongly recommended. Among the foreign breeds imported to Sudan, Holstein Friesian and their crosses with Kenana and Butana have shown the best performance indicating they are comparatively better adaptable to the local environment (Fadl-Moula 1994).

References

- Alim K.A. 1960. Reproductive rate and milk yield of Kenana cattle in Sudan. *Journal of Agricultural Science (Cambodia)* 55:183–158.
- Alim K.A. 1962. Body reactions of Kenana cattle under natural and artificial shade in the Sudan. *Tropical Agriculture (Trinidad)* 39:13–16.
- El-Amin F. 1969. *Environmental and genetic factors influencing reproduction and milk yield of Sudanese indigenous dairy cattle*. MVSc thesis, University of Khartoum, Khartoum, Sudan.
- Fadl-El-Moula A.A. 1994. *Factors affecting reproductive and productive performance of crossbred dairy cattle in Sudan*. MSc thesis, University of Khartoum, Khartoum, Sudan.
- Mason I. L. and Maule J.P. 1960. *The indigenous livestock of eastern and southern Africa*. Tech. Comm. 14. Commonwealth Bureau of Animal Breeding and Genetics. CBA, Farnham Royal, U.K.
- Payne W.J.A. 1964. The origin of domestic cattle in Africa. *Empire J. Exp. Agric.* 32:97–113.
- Payne W.J.A. 1970. *Cattle production in the tropics*. Vol. 1: Breeds and Breeding. Longman, London, UK. .
- Rouse J.E. 1970. *World cattle: Cattle of Africa and Asia*. University of Oklahoma Press, Oklahoma City, USA, .
- Saeed A.M, Ward F.A., Light, D., Durkin, J.W. and Wisom R.T. 1987. *Characterisation of Kenana cattle at Um Banein, Sudan*. ILCA Research Report 16. Addis Ababa, Ethiopia.

Livestock production improvement at small scale household level in a developing country set up: The fate of indigenous goat gene pools in Malawi

A. J.D. Ambali,¹ J. W. Banda² and L.A. Kamwanja²

1. Molecular Biology and Ecology Research Unit Department of Biology, University of Malawi, Chancellor College, Box 280, Zomba, Malawi

2. Bunda College of Agriculture, Lilongwe, Malawi

[Abstract](#)

[Introduction](#)

[Genetic improvement of the local Malawi goat](#)

[Reflection on the MGLDP's goat improvement programme](#)

[Status of the indigenous goat gene pool in Salima district](#)

[The way forward](#)

[Acknowledgements](#)

[References](#)

Abstract

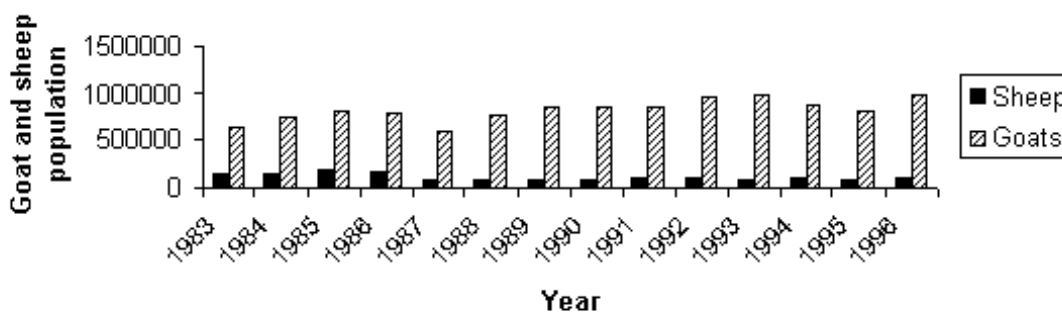
A goat breed improvement programme was initiated at Lifidzi Goat Breeding Centre in Salima District in the mid 1980s with the objective of improving meat production and animal population at the household level through crossbreeding. An exotic Boer breed was introduced from South Africa and crossbred with the local Malawi goat. Three main breeding strategies emerged in the area covered, namely stud breeder programme, buck centre programme and uncontrolled breeder mating system. While the first two programmes were controlled at the beginning, the last method was not controlled once the buck had been purchased from a stud breeder. This study was carried out to determine the genetic impacts of the programme with the aim of making recommendations for sustainable programmes that would increase production without compromising conservation of indigenous genetic resources. Between 1985 and 1998, goat populations have increased in Salima District from less than 82,210 to 149,930 due to deliberate selection for prolific indigenous females into the breeding programme. Growth rates of the hybrid goats improved and the offspring easily attained weaning weights of at least 20 kg in 12 months. The number of hybrids in the communal grazing areas visited, proliferated with more than 40% of the animals being Boer and local crosses. The improvement programme was however implemented without proper mechanisms for conserving the indigenous gene pools. In a setup where animals are subjected to communal grazing and uncontrolled mating, it has been impossible to maintain pure breeds of indigenous goats. Farmers have recently started to resent the hybrids due to low disease resistance and yet chances of re-establishing pure populations of local breeds seem to be low. The farmers and the animals have been abandoned the introduced Boers have succumbed to

diseases due to lack of veterinary services. The Malawi case therefore serves as a typical example of the genetic improvement programmes in developing countries where increased production through importation of exotic breeds is being carried out without proper planning for sustainable conservation of indigenous gene pools.

Introduction

Ruminant livestock contribute substantially to the animal protein supply of Malawi where a total ruminant population of 2,319,000 was estimated in 1998 (MoAI 1998). This comprised 618,800 cattle, 1,597,500 goats and 102,700 sheep. Of the cattle population, 95.2% is owned by small-scale rural farmers and the rest is shared by large-scale commercial operators in estates and peri-urban areas (MoAI 1998). About 97% of the herd comprise the Malawi Zebu, which is a naturalised indigenous breed in the country comprising several phenotypes with varied origin (Butterworth and McNitt 1994; Jere and Msiska 2000). A similar trend is also observed in the other two ruminant species where 98% and 95% of goats and sheep, respectively, are owned by small-scale rural farmers. The sheep and goats constitute the small ruminant livestock of the country, of which more than 90% are indigenous breeds raised by small-scale farmers at an average of six animals per household distributed in the low-lying areas (Jere and Msiska 2000).

It is observed in Figure 1 that during the period 1987 and 1996 the sheep population declined and did not reach the 1983–85 population levels. The decline in sheep population was due to high demand for mutton/lamb in the urban areas and parasite infestation (Chikagwa-Malunga, unpublished). The goat population however picked up from the 1987-drop and maintained annual population levels of more than 82,000 animals. In the early 1990s the flock growth rate was estimated at 1.8% annually, contributing about 3,700–4,400 tonnes of meat per annum which represented about 11% of the total livestock meat consumed in the country (Banda et al. 1993). Banda (1992) observed that the rural households in Malawi readily accept goat and sheep milk, only that it is not available due to low production. This paper appraises the genetic improvement efforts that have been carried out on goats in the country, with the most emphasis on the Malawi German Livestock Development Project.



Source:

MoAI (1998).

Figure 1. Goat and sheep population in Malawi, 1983–96.

Goats are usually tethered and herded during different times of the year. Tethering is practised during the rainy season when most arable land is subjected to intensive cultivation and little area is available for grazing. Tethering limits the amount of feed available to the animals and as a result they lose weight and kid birth weight also reduces. However, this does not significantly affect reproductive performance (Banda et al. 1993). Herding is practised during the dry season when crops have been harvested. The alternative system involves tethering

during the morning hours and herding in the afternoon. Those who feed their animals in communal grazing areas tend to expose their goats to an extensive system where goats browse, graze and scavenge.

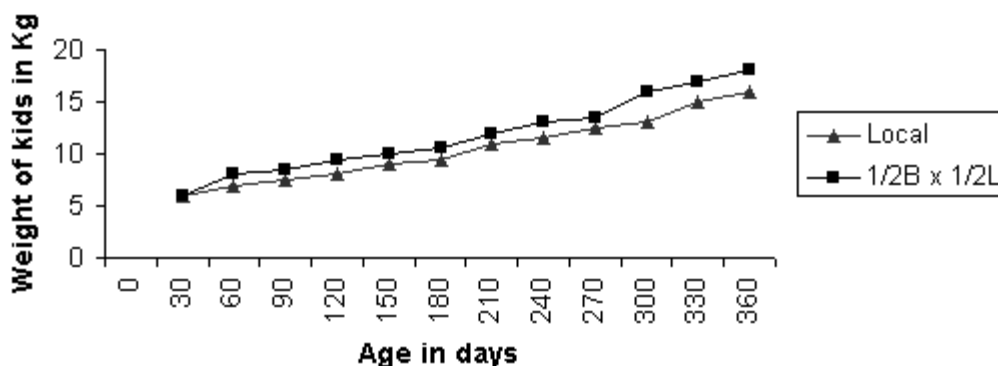
Mortality tends to be high in kids primarily due to poor management, which include overcrowding, poor nutrition, parasites and diseases. Effects of these have been discussed in Banda et al. (1993).

The local goats in Malawi are naturalised indigenous stock that originated from Asia and spread southwards from Egypt and Ethiopia to East Africa and then Malawi (Epstein 1971). There are speculations that they could also be some stock that came in from the south by the Zulu people (Banda et al. 1993). These collections have adapted to harsh climates and low management regimes over the years. Although the local goats are adapted, they generally have been described as low producers compared to exotic breeds, hence efforts have been carried out to improve their performance using genetics and improved management approaches.

Genetic improvement of the local Malawi goat

The Government of Malawi has carried out a two-phase genetic improvement strategy for goats in the country. The first was through introduction of an exotic breed, Boer goat, at Mikolongwe Veterinary Station and Bunda College of Agriculture for crossbreeding and upgrading of the indigenous goat to improve the final slaughter weights.

The F_1 hybrids grew faster than the local goat progenies (Figure 2). Average weight gains of 40g/day and 23g/day were observed in the crossbred progenies and pure local progenies, respectively. Under village conditions in Lilongwe district, Banda et al. (1993) reported results where pre-weaning body weights were higher in the local progeny than in the crossbred (L \times B) with daily weight gains of 110.0 and 90.5 g/day, respectively. Mortality was also lower in the local progenies than in the crossbred with 16.7 and 37.5% mortality, respectively. Banda (1992) argues further that overall, the biological productivity rate is higher in the local progeny than in the crosses, which probably suggests that the local gene pool was more efficient than the exotic breeds and their crosses under village conditions.



Source: Modified from Zerfas (1992).

Figure 2. Growth comparison between pure local (L) and crossed local \times Boer ($1/2L \times 1/2B$) kids.

The second genetic improvement programme was carried out from 1983 to 1993 by the Malawi Germany Livestock Development Programme (MGLDP) with the objectives of producing genetically improved local bucks and does for smallholder farmers; producing pure-

bred Boer bucks for small holder crossbreeding activities; carrying out breed evaluation trials; and packaging goat management innovations for farmers (Schmidt 1992).

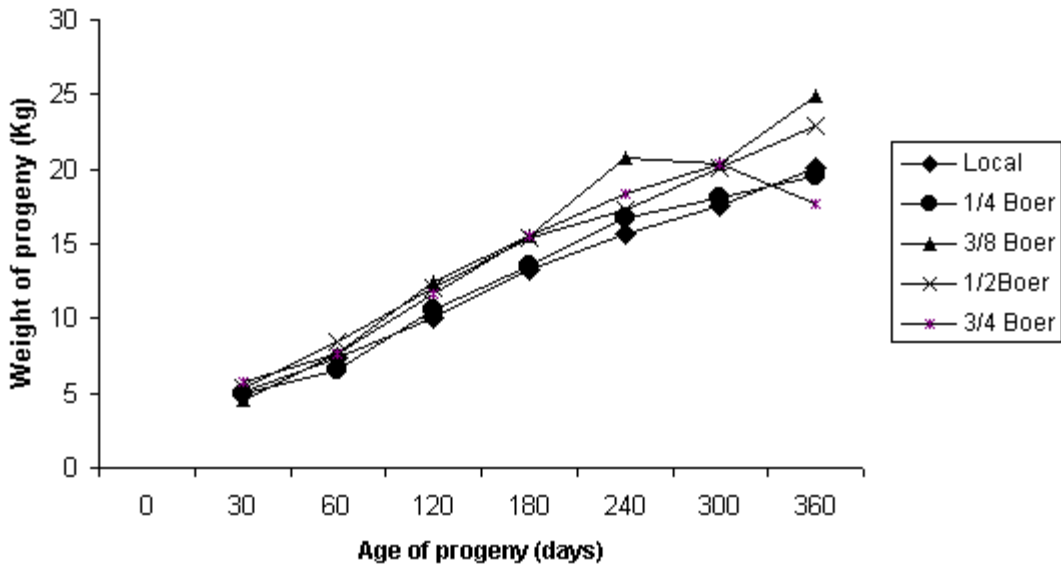
The programme was phased out in 1993 and currently there are three sets of breeding strategies in the project areas: namely the Stud Breeder Programme, the Buck Centre Programme, and the Uncontrolled Breeder Mating System. The first two programmes were controlled during the project period. The last strategy was not controlled once the buck had been purchased from a stud breeder. In the stud breeder breeding strategy, 30 farmers were provided with 10 hybrid animals (7/8B × 1/8L) comprising nine females and one male for rapid multiplication at the farmstead. The progenies from the stud breeders were sold to other farmers who wanted to cross their local goats with the hybrids. The male goats provided in the stud breeder package were supposed to be exchanged among the stud breeders after every year, hence there were 30 bucks to be exchanged among the stud breeders.

The buck centre strategy involved farmers with local goats bringing their female goats to buck centres for mating with a Boer buck. Bucks in excess of 100 were placed in the villages in Salima District while the local males were castrated. This resulted in the proliferation of hybrids in the villages.

The uncontrolled breeder mating system was the long existing system practised by the farmers themselves whereby mating was not controlled in the communal grazing areas or in the kholas. The males in this case would be local and/or hybrids in areas where the crosses were available. Male crosses bought from stud breeders mated with the local females in communal grazing areas.

Results from the improvement programme generally suggest that the hybrids performed better than local goats as summarised below.

The local goat and hybrid progeny performance over 360 days is plotted in Figure 3. The local goat progeny had the lowest weight up to 300 days. Backcrossing the progenies to Boer yielded an improvement in growth to the effect that they easily attained 20 kg in 360 days. Similar observations were made by Schmidt (1992) who reported the highest growth rates in crossed progenies than in the local goat progenies at the age of 12 months. A high weight variation was however reported in the crossed progenies with changes in environmental conditions (Figure 4), implying that the local goats were relatively more stable to adverse environmental regimes than the hybrids.



Source: Zervas (1992).

Figure 3. Weight of local and hybrid goat progenies at different ages.

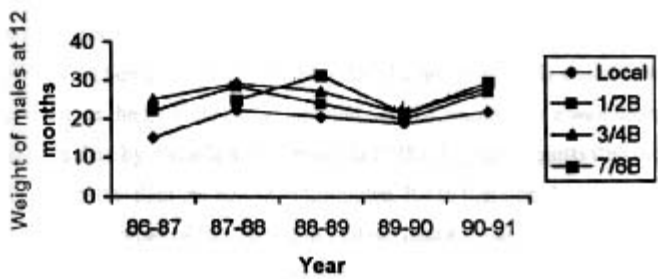
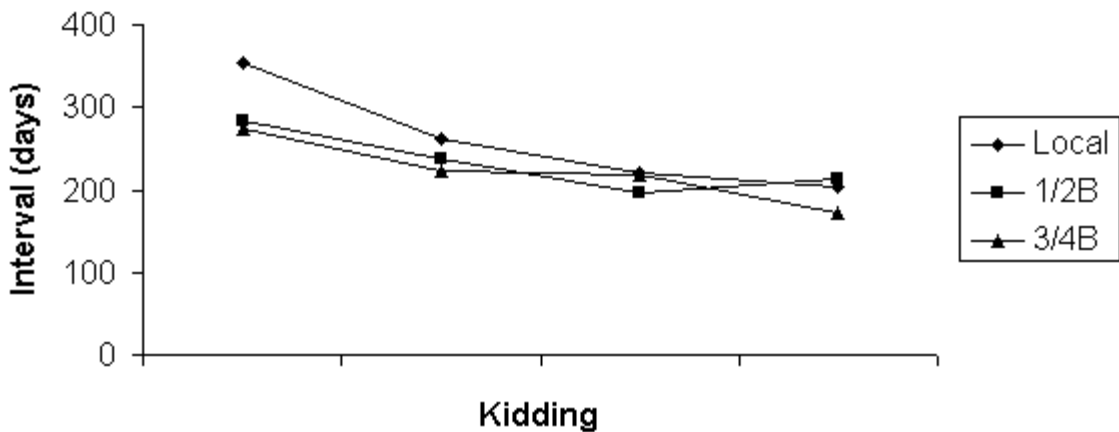


Figure 4. Weight of male local and hybrid goat progenies at 12 months of age

Parturition intervals are plotted in Figure 5. Kidding interval was lowest among the hybrid progenies than in the local goats. The decline in kidding interval with parity was however higher in the local goats than in the hybrids.



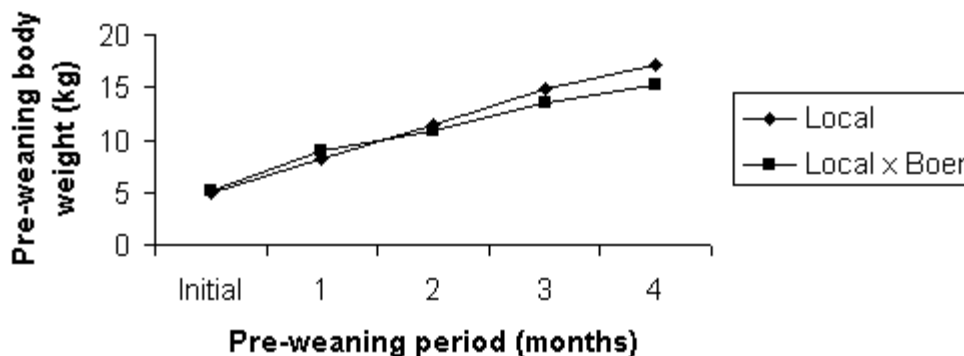
Source: Schmidt (1992).

Figure 5. Parturition interval among the various goat progenies.

Reflection on the MGLDP's goat improvement programme

The programme might have achieved its objectives whereby it demonstrated that genetic improvement through cross breeding improved the performance in goats for the traits of interest. There are however several factors in the programme which were not addressed and hence could affect the validity of the findings.

The local goat that was compared to the hybrids and the Boer in this programme is not genetically known. There are several phenotypes of goats in Salima district let alone the Malawi nation as a whole. The MGLDP did not genetically characterise the local goats though the Boer that was imported into the country was a well characterised breed. The data by Ayoade and Kamwanja (1985) in Figure 6 suggests that the local goat performed better than the hybrid in Lilongwe. It can therefore be argued that there may be several types of local goats in Malawi hence, if the various types had been identified and compared to the crosses the results could probably be different from what was obtained by the Project. A hypothesis can be made that not all local Malawi goat types were inferior in performance to the hybrids. This is yet to be addressed.



Source: Ayoade and Kamwanja (1985).

Figure 6. Pre-weaning body weight of local and hybrid progenies at household level in Lilongwe district.

If indeed there were no genetic differences between the local goats in Salima and those in Lilongwe, there might have been significant genotype x environmental interaction. The Project did not explore the genotype x environment interaction hence the hypothesis that the superiority of hybrid goats over local goat progenies throughout the country was not tested. Salima district was the only locality that did not represent the broad environmental conditions under which goats are raised in Malawi.

The local goats used in the breeding programme were not subjected to any prior selection before they were crossed with the Boer goats or when they were being compared to the hybrids. The data on parturition interval suggests that there was high variation among the local goats, which could be exploited through deliberate selection. The Boer was a highly selected breed while the local goats were not selected.

The environmental conditions under which the goats were raised within Salima were not uniform. Zervas (1992) indicates that there was a tendency among the farmers who raised hybrid goats to invest relatively more in goat enterprise than those who raised local goats. In fact the criteria for choosing farmers who raised hybrids were such that the poor farmers were

left out. Indeed even among the farmers, there were likely to have been environmental differences between them.

There was conflict of interest between farmers' goals and those of the Project. Small-scale farmers are primarily interested in numbers of goats and such traits as hardiness and twinning ability; growth rate is a secondary trait. The Project was interested in improving growth rate. Farmers' interests could have been met by first selecting for the traits among the local goats and then growth rate would be improved by either selecting among the local goats or crossbreeding with the Boer. Unfortunately this oversight has had a negative impact on the farmer acceptability of the hybrids especially now that veterinary services have been phased out. In 1995, when farmers were offered to buy the bucks that were used for buck centre breeding, they declined because the bucks were not hardy enough to survive in the local conditions; they easily succumbed to diseases and parasites.

The statistical analyses carried out were also questionable especially regarding the sample sizes. Banda et al. (1993) cautions on the conclusions that could be drawn out of the Ayoade and Kamwanja (1985) study where the local goat outperformed the local × Boer progeny due to the small sample sizes. The data obtained by the MGLDP has similar problems where there were large sample sizes for local goats but the sample sizes for the hybrids were low. Indeed Schmidt (1992) expressed similar concern. The statistical implications of small samples for experiments of this nature could be enormous.

Status of the indigenous goat gene pool in Salima district

Although the hybrids might have performed better than local goats, their poor survival under low management regimes renders them unsuitable for the small-scale farmers in Salima and probably Malawi as a whole. The uncontrolled mating in the communal grazing areas has unfortunately led to high introgression of the Boer gene pool into the salima goat population. Hybrids of other exotic breeds like Sanean and Damascus were also observed during the study. Among the areas visited, there was a proliferation of Sanean × local hybrids in the Ngozi area where a German researcher introduced the breed and abandoned it after trials.

Dispersive genetic effects observed in 13 mixed breeds of north European cattle over 40 years suggest that Nordic breeds have lost between 1–11% of their genetic variation. Although the native breeds have retained a reasonably high genetic diversity, their genes contribute less to the genetic variation of the popular production breeds than was previously the case (Kantanen et al. 1999). It is not known at present how much of the genetic diversity in the Salima is contributed by the indigenous breed types. It could probably be low.

Poor record keeping, uncontrolled mating and lack of genetic conservation protocols might have led to decreased genetic purity of the Malawi local goat. In addition these unwitting cross breeding programmes may result in outbreeding depression where the local co-adaptive gene complex breaks down after the F_1 generation. For instance in intertidal copepods (*Tigriopus californicus*), Edmund (1999) observed that first generation hybrids showed some heterosis which was not related to the geographic or genetic distance separating the parents. However, mean fitness decreased and its variance increased in subsequent generations when the F_1 hybrids mated among themselves. This hybrid breakdown problem in the later generations increased with the distance between the original parents. Genetic interpretation of these patterns suggests that both the beneficial effects of dominance and the detrimental effects of breaking up coadaptation are magnified by increasing evolutionary distance between populations. It is not known at present how genetically distant the parents (i.e. Boer, Sanean, Damascus etc.) are that were used to cross breed with the Malawi goat. This has gone unchecked for several years.

The way forward

The Malawi case therefore serves as a typical example of the genetic improvement programmes in developing countries where increased production through importation of exotic breeds is being carried out without proper planning for sustainable conservation of indigenous gene pools. The continuous loss of the indigenous gene pool in Salima district can be arrested by discouraging farmers from continuous exchange of the hybrid goats. Non-governmental organisations like World Vision International have been involved in the transfer of hybrid goats to other districts like Dowa, Mchinji and Karonga. They should also be discouraged from such practices. There is a need for genetic characterisation of the Malawi local goat so that the various types that are available, if any, can be documented, improved and conserved as such.

Genetic improvement should start with exploiting additive genetic variation through selection. The traits of importance should be those in which farmers are interested.

The local goat gene pool that was collected by the MGLDP was lost due to lack of maintenance of in situ conservation facilities after the project was phased out. It is recommended that the government and quasi-government institutions should complement farmers' efforts of conserving indigenous gene pools by establishing in situ conservation facilities for goat genetic resources and providing continued financial support for such facilities.

Acknowledgements

We are sincerely grateful to the Lake Malawi Ecology Project for providing resources for carrying out this study. Additional funding was provided by the research grants of Dr J.W. Banda and Prof L.A. Kamwanja. We thank the Salima ADD staff, especially Messrs. Nyoni, Njoka and Nkochi for providing some of the information included in the report and all the farmers we interviewed during the study.

References

- Ayoade J.A. and Kamwanja L.A. 1985. A note on the pre-weaning body weight changes and mortality in Malawi local and Malawi local \times Boer kids under village management system. Paper presented at the 5th Veterinary Association Conference, September 1985, Salima, Malawi.
- Banda J.W. 1992. Acceptability of goat's, sheep's and cow's milk in Malawi. *Journal of Consumer Studies and Home Economics* 16:129–138.
- Banda J.W., Ayoade J.A., Karua S.K. and Kamwanja L.A. 1993. The local Malawi goat. *World Animal Review* 74/75(1–2):49–57.
- Butterworth M.H. and McNitt J.I. 1994. The Malawi Zebu. *World Animal Review* 49:6–12.
- Edmund S. 1999. Heterosis and outbreeding depression in interpopulation crosses spanning a wide range of divergence. *Evolution* 53:1757–1768.
- Epstein H. 1971. *The origin of the domesticated animals of Africa*. Volume 2. African Publications, New York, USA, .
- Jere J. and Msiska H.D.C. 2000. Current status on the management and utilisation of farm animal genetic resources in Malawi. Paper presented at farm animal genetic resources workshop, Natural Resources College, Lilongwe, Malawi. March 2000.
- Kantanen J., Olsaker I., Adalsteinsson S., Sandberg K., Eythorsdottir E., Pirhonen K., and

Holm L.E. 1999. Temporal changes in genetic variation of North European cattle breeds. *Animal Genetics* 30:16–27.

MoAI (Ministry of Agriculture and Irrigation). 1998. *National Livestock Development Master Plan*. Agricultural Sector Programme Support, Livestock component, Malawi. Draft Final Report. Department of Animal Health and Industry, Lilongwe, Malawi.

Schmidt U. 1992. Goat performance at Lifidzi breeding station. Paper presented at the workshop on small ruminant activities in Malawi and the contribution of MGLDP, Lilongwe, November 1992.

Zerfas H.P. 1992. Results of MGLDPs field activities in Salima RDP. Paper presented at the workshop on small ruminant activities in Malawi and the contribution of MGLDP, Lilongwe, November 1992.

Characterisation of small scale cattle farming in two districts of the Free State Province of South Africa

L. E. Moorosi., L.M. J. Schwalbach. and J.P. C. Greyling

Department of Animal Science, University of the Orange Free State, P.O. Box 339, Bloemfontein 9300, South Africa

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Results and discussion](#)

[Conclusion](#)

[References](#)

Abstract

This study was conducted in two districts in the southern part of the Free State. A total of 510 small scale cattle farmers from Thaba Nchu (255 farmers) and Botshabelo (265 farmers) were individually interviewed and responded to a questionnaire designed to assess the farming characteristics and management practices in both areas. The most important farming characteristics and management practices as well as the productivity and the sustainability of these farming systems were evaluated and the most important production constraints were identified.

Results showed that most farmers in both areas own less than 10 head of cattle (65.8% in Thaba Nchu and 86.5.4% in Botshabelo). The total cattle herd structure in both areas reflected major imbalances, with breeding females making up the largest proportion of the total herd accounting for 60.4% and 67.1% of the total herds in Thaba Nchu and Botshabelo, respectively. The proportion of heifers and calves in both areas were very low, 10.4% and 7.7% for heifers and 26.9% and 24.2% for calves in Thaba Nchu and Botshabelo, respectively.

The proportion of bulls and oxen in the total number of animals kept in both areas showed major differences in the two areas. Thaba Nchu and Botshabelo were farmed with 2% and 8.1% bulls and 10.7% and 0.6% oxen, respectively. The bull to cow ratio was found to be extremely low in Thaba Nchu (1.46%). In contrast, Botshabelo had far more bulls than needed. However very few farmers own mature bulls (9.6% for both areas) and the use of communal bulls is a very common practice.

Most farmers keep dual-purpose (meat and milk) crossbred cattle. Brown Swiss type animals are the preferred cattle breeds in these areas, where almost all farmers milk some of their cows (94.5% and 96.6% in Thaba Nchu and Botshabelo, respectively) exclusively for home consumption.

Cattle management practices in these two areas are considered very unproductive, with low

support services available for farmers. The nutritional management is characterised by communal grazing, overstocking, and degradation of the natural resource base — the veld. Estimated calving rates are low (54% and 41% for Thaba Nchu and Botshabelo respectively), and are much lower than perceived by the respondent farmers. The estimated intercalving periods are extremely long (676 and 890 days for Thaba Nchu and Botshabelo respectively). The mean total milk production per farmer per day was recorded as 4.15 litres and 3.46 litres in Thaba Nchu and Botshabelo, respectively.

The adoption of basic disease control measures such as vaccination and dipping against external parasites by small-scale cattle farmers differed considerably between the two areas studied, the differences being due to the availability and accessibility to extension services and veterinary products. In Thaba Nchu 95.3% and 96.5% of the cattle farmers vaccinate and dip their animals, respectively, in contrast with only 5.4% and 4.2% in Botshabelo. The major production constraints identified were poor management practices and inefficient farming support services. The sustainability of these small-scale productive systems for the long term is not guaranteed under the present farming conditions.

Introduction

Small scale cattle production is extremely important for the economy of developing countries in general, and to Southern African countries in particular. Cattle farming is an important part of the African culture and a means of capital investment or wealth accumulation (Kalunda 1996). Besides its direct benefits, cattle can sustain the household by providing meat and milk. The value of cattle in providing rural transportation, draft power for cultivation, and manure for crop and fuel production are functions not to be underestimated (FAO 1997). Although small-scale cattle production (mainly for subsistence purposes) is practised in most Sub-Saharan regions, its productivity is considered to be very low and in most cases insufficient to ensure food security and adequate financial returns.

Traditional small-scale cattle production systems in South Africa have not received adequate attention regarding land rights, extension support services, access to credit and market opportunities. These constraints have however been recognised by the National Department of Agriculture (1998), that has reported poverty in the rural areas of South Africa to be associated with poor agricultural policies.

Very little is known regarding the characteristics of these small-scale farming systems. Therefore, to facilitate the policy makers to introduce appropriate policies and support services to assist these farmers and to fulfil the present government objectives, characterisation of small-scale farming systems in South Africa should be prioritised in the agricultural research programmes.

The objective of this paper was thus to characterise small scale cattle farming systems in the Thaba Nchu and Botshabelo areas, to evaluate their sustainability, and to identify some constraints limiting their productivity. This can be useful for policy makers and extension services to improve the productivity and sustainability of these farming systems.

Materials and methods

This study was conducted over a period of 20 months in two districts of Bloemfontein, namely Thaba Nchu and Botshabelo. Twenty-one of the 40 agricultural villages known as 'trusts' in Thaba Nchu were randomly selected. Botshabelo, situated 10 km from Thaba Nchu, is divided into 17 general blocks or sections of which ten were selected at random. A questionnaire with 28 questions was designed to characterise the farming systems used in these areas. During the survey 255 and 265 cattle owners were individually interviewed in Thaba Nchu and Botshabelo, respectively. This brings the total number of cattle owned by the farmers

interviewed to 2694 and 1907 in Thaba Nchu and Botshabelo, respectively.

Results and discussion

According to the results obtained during the survey, the majority of the farmers in both areas own less than 10 head of cattle, with the higher frequency distribution of 5 –10 head of cattle per farmer. Similar results were reported by Dreyer et al. (1999) in the same districts of the Free State Province. The mean herd size in Thaba Nchu was 10.8 cattle, which is significantly higher ($p < 0.01$) than the mean herd size in Botshabelo (7.2 animals per cattle farmer). The significant difference in mean herd size between the districts of Thaba Nchu and Botshabelo, and the fact that in general, the cattle herds in Thaba Nchu were larger than those in Botshabelo, may be explained by the historical and socio-economic differences experienced in the two areas. Thaba Nchu was established as an agricultural area for small-scale black farmers for a much longer period of time. Farmers in this area also have a longer tradition of cattle farming, a relatively larger grazing area, and better support services. On the other hand, Botshabelo was more recently established and developed from an illegal squatter camp for unemployed people who owned farms in areas designated for white people and others that were evicted from white farms.

The herd structure and the percentage of farmers farming with different cattle classes (Tables 1 and 2) clearly show that breeding females make up the largest group of the total herd in both areas (accounting for 60.4% and 67.1% of the total herds in Thaba Nchu and Botshabelo, respectively).

Table 1. *Distribution of herd size per cattle farmer.*

	Thaba Nchu	Botshabelo
Herd size distribution	Number of farmers (%)	Number of farmers (%)
<5	67 (26.2%)	77 (29.1%)
5–10	101 (39.6%)	152 (57.4%)
11–20	66 (25.9%)	31 (11.6%)
21–50	18 (7.1%)	5 (1.9%)
>50	3 (1.2%)	–
Mean herd size \pm SD	10.8 \pm 11.5 ^a	7.2 \pm 4.8 ^b
Total number of farmers	255	265

a, b - Rows with different superscripts differ significantly ($p < 0.01$).

Table 2. *Cattle herd structures in the Thaba Nchu and Botshabelo areas.*

	Thaba Nchu	Botshabelo
Herd Structure (distribution)	Number (%)	Number (%)
Old Cows (>10 years)	1316 (48.8%)	890 (46.7%)
Young Cows (3–10 Years)	32 (1.2%)	242 (12.7%)
Heifers (1–2 Years)	279 (10.4%)	146 (7.7%)
Calves (<1Year)	725 (26.9%)	461 (24.2%)
Young Bulls (2–5 Years)	44 (1.6%)	29 (1.5%)
Mature Bulls (>5 Years)	10 (0.4%)	126 (6.6%)
Oxen	288 (10.7%)	13 (0.6%)
Total number of animals	2694	1907

These herd sizes and structures are in agreement with those reported by most authors investigating similar small-scale farming systems in Southern Africa. Swanepoel and De Lange (1993) and Muchena et al. (1997), found herd size to be a critical factor determining herd production efficiency. Nthakheni (1993), postulated that the smaller the herd, the less the chances were of making a living out of livestock farming. Sieff (1999) reported breeding females compose 70% of the cattle herds in Tanzania, while in the Southern part of Mozambique, this group represented 54% of the total herd size (Rocha et al. 1991). In this study an extremely high percentage of farmers (99%) keep old cows (>10 years).

This clearly reflects the objectives of keeping cattle for milk production and reproduction. The same tendency was reported by Rocha et al. (1991) and Nthakheni (1993). These old cows, although less productive, still produce milk and calves, which the farmers prefer from the production system. On the other hand, productivity is not the main issue for these farmers, as cattle numbers and not necessarily the quality or productivity of the animals reflects the wealth of the traditional small-scale African farmer (Magadlala and Kadzere 1996). The proportion of young cows and heifers from the total cattle herds and the percentage of farmers with young cows and heifers in their herds in both areas studied are very low. This can limit both productive (milk and weaner calves) and reproduction (calving percentage) rates in these herds. The low percentage of calves maintained in these herds (26.9% and 24.2% in Thaba Nchu and Botshabelo, respectively), confirm the low reproductive rates of these herds. Furthermore the herd structures, particularly regarding the female breeding classes, put at risk the long-term sustainability of these cattle farming systems.

The shortage of mature bulls is clearly demonstrated by the low percentages of these animals in the Thaba Nchu (0.4%) and Botshabelo (6.6%) herds with only 2.4% and 7.2% of the farmers having mature bulls in their herds, respectively. These tendencies are also reported in Mozambique by Rocha et al. (1991) and in Tanzania by Sieff (1999), who have reported 6.1% and 3.5% bulls in the cattle herds, respectively. The fact that fewer farmers own bulls in this survey could be attributed to the communal grazing practice which allows bulls of some farmers to run together with the cows of the whole village. These bulls are usually referred to as 'communal bulls' and many farmers do not see the need of owning their own bulls, especially if the neighbours own a bull. This practice, although economically justifiable, puts an extra load on the bulls. In many cases the bull to cow ratio is not considered. This problem is aggravated by the fact that most of these communal bulls are usually not tested for fertility and venereal diseases or vaccinated against common diseases. The low number of bulls and eventual fertility problems may affect the whole herd without being detected, limiting total herd productivity.

In Thaba Nchu oxen constitute 10.7% of the cattle herd, which is much higher than the 0.6% for the herds in Botshabelo. These differences are also seen as the percentage of farmers with oxen in their herds, (42.3% in Thaba Nchu and 4.2% in Botshabelo). A high percentage of oxen in the herd structure is indicative of the use of animal traction practices such as ploughing and transportation of water and agricultural produce (Blench 1987). A possible reason for low number of oxen in the herd structure of Botshabelo may be the fact that there is very little arable land available.

The estimated conception rate (CR) and inter-calving period (ICP), based on the herd structure, number of potential breeding females and the number of calves, are set out in Table 3. According to calving rate and ICP estimations, the calving rate of 54% for Thaba Nchu and 41% for Botshabelo is much lower than that perceived by the local cattle farmers. The intercalving periods of 676 and 890 days for Thaba Nchu and Botshabelo respectively, is much longer than perceived by the farmers. These estimations do not take into consideration the mortality rates, as no records are available. However, even if these records were available,

it is unlikely that the mortality rates could account for such a high difference in the perceived and estimated ICPs and CRs. The calving rates estimated in this study are in agreement with the results of Dreyer et al. (1999), who have estimated a calving rate of 45.5% for Thaba Nchu and Botshabelo combined. The low reproductive rates in Thaba Nchu and Botshabelo can be explained by a combination of management-related factors such as poor nutrition and unbalanced herd structures.

Table 3. *Estimated calving rates and intercalving period for small-scale farmer in Thaba Nchu and Botshabelo.*

Areas	Potential breeding females	Number of calves	Estimated calving rate (%)	Estimated ICP (days)
Thaba Nchu	1384	725	54%	676 days
Botshabelo	1132	461	41%	890 days

Milk production is one of the main reasons why small-scale farmers in the Thaba Nchu and Botshabelo districts keep cattle. The high percentage of mature cows, as well as the high percentage of dual-purpose and crossbred predominantly containing dairy genes, are strong indications that as in most of the Southern African regions, milk production is a major reason for cattle farming (Dugmore et al. 1996). Milk production is exclusively for home consumption. The total daily milk production per farmer in the areas surveyed was generally low (Table 4). Farmers were unable to relate to the individual daily milk production of their animals, as no records and measurements are taken regarding milk production.

Table 4. *Mean milk production (\pm SD) for small-scale cattle farmers in Thaba Nchu and Botshabelo.*

Areas	Farmers milking cows	Farmers not milking cows	Mean total milk production/farmer/Day
Thaba Nchu	241(94.5%)	14(5.5%)	4.15 \pm 1.3 ^a
Botshabelo	256(96.6%)	9(3.4%)	3.46 \pm 2.7 ^b

ab columns with different superscripts differ significantly ($p < 0.01$).

Application of disease control measures by cattle farmers in the Thaba Nchu and Botshabelo areas as shown in Table 5, differ considerably. The poor adoption of basic disease control measures such as vaccination against diseases and dipping against external parasites in Botshabelo can be explained by lack of basic farming infrastructures such as crush pens and dipping tanks in this area. Although extension services still operate from Thaba Nchu, farmers and extension staff are most of the time faced with transport problems.

Table 5. *Average application of health control measures in both cattle herds.*

Area	Number (%) of farmers adopting	
	Vaccination	Dipping
Thaba Nchu	243(95.3%)	246(96.5%)
Botshabelo	14(5.3%)	11(4.2%)

Farmers in Thaba Nchu have enjoyed free extension programmes offered over many years by AGRICOR. Most of these farmers have realised the advantages of disease control measures and are still implementing programmes even after the government stopped these free

services. These farmers now buy their own vaccine and dipping remedies. The main reasons for low implementation levels of disease control measures are general lack of funds by most governments, and the inability to support and maintain an efficient operational extension service (Bembridge 1984; Nthakheni 1993; Tambi et al. 1999).

Farmers reported that cattle are sold whenever cash is needed. This usually happens around January every year, when school fees for their children are needed. The price is usually determined by the condition of the animal, although due to lack of a marketing infrastructure such as transport, farmers feel that they are forced to submit to prices offered by the buyer. The proportion of farmers buying cattle is very low. Only 5.9% in Thaba Nchu and 2.6% in Botshabelo were reported as buying cattle. The reason is due to lack of access to credit to buy more animals. Farmers usually depend on their existing animals to reproduce and increase their herd size.

Conclusion

The general management and farming practices adopted by small-scale cattle farmers in Thaba Nchu and Botshabelo are still done in a traditional and unproductive manner. The general farming characteristics and management practices of small-scale cattle farming activities in Thaba Nchu and Botshabelo districts of the Free State Province are characterised by communal grazing, overstocking of the veld, small and unbalanced herds, uncontrolled breeding and crossbreeding, poor reproductive performance, natural weaning, low milk production, and lack of basic disease control practices. In general, these characteristics are no different from those seen in other regions of Southern Africa. There are however some particularities in Thaba Nchu and Botshabelo, which are determined by the farming conditions and the historical background of these two farming areas. Farmers from Thaba Nchu are in general more experienced, have a better farming infrastructure, and have more access to farming support services.

The main reasons for cattle farming are milk production for home consumption and it is a means of capital savings. The low productivity and the progressive degradation of the basic resource—the veld— seriously put at risk the long-term sustainability of these farming systems.

Key words: Small Scale Cattle Farmers, Farming Characteristics, Management Practices, Sustainability

References

- Bembridge T.J. 1984. *A systems approach study of agricultural development problems in Transkei*. PhD thesis, University of Stellenbosch, South Africa.
- Blench R.M. 1987. *Social determinant of animal traction in central Nigeria*. Report submitted to Agricultural Research Unit, The World Bank, Washington, DC, and International Livestock Centre for Africa, Kaduna, Nigeria. 82 pp.
- Dugmore T.G., Oosthuizen, P.A. and Du Toit J.F., 1996. Strategies for dairy production in rural areas. *Proceedings 2nd All Africa Conference on Animal Agriculture, 1–4 April 1996*. Pretoria, South Africa.
- Dreyer K., Fourie L. J. and Kok D.J. 1999. Assessment of cattle owner's perceptions and expectations and identification of constraints on production in a peri-urban resource poor environment. Onderstepoort. *Journal of Veterinary Research* 66:95–102
- FAO (Food and Agriculture Organization of the United Nations). 1997. *Agriculture, food*

security and nutrition. Agriculture, food and nutrition for Africa. FAO, Rome, Italy, pp. 5–46.

Kalunda M. 1996. *The role of livestock in the socio-economic development of Uganda. Proceedings 2nd All Africa Conference on Animal Agriculture, 1–4 April, Pretoria, South Africa.* pp 1–5.

Magadlela M.A. and Kadzere C.T. 1996. *Dualism of cattle production in Southern Africa. Proceedings 2nd All Africa Conference on Animal Agriculture, 1–4 April 1996. Pretoria, South Africa.*

Muchena M., Presse J., Thirtle C. and Townsend R.F. 1997. Herd size and efficiency on mixed crop and livestock farms: Case studies of Chiweshe and Gokwe, Zimbabwe. *Agrekon* Vol. 36, No.1:46–64.

Nthakheni D.N. 1993. *Productivity measures and dynamics of cattle herds of small scale producer in Venda.* MSc Theses, University of Pretoria, South Africa.

Rocha A., Starkey P. and Dionision A.C. 1991. Cattle production and utilisation in small holder farming systems in Southern Mozambique. *Agricultural Systems* 37:53–75.

Sieff, D.F. 1999. The effects of wealth on livestock dynamics among the Datoga pastoralists of Tanzania. *Agricultural Systems* 59:1–25.

Swanepoel, F.J.C. and De Lange, A.O. 1993. Critical determinants for successful small scale livestock production. *Livestock Farmer Support Programme Workshop, Venda Agricultural Training Centre, 22–23 March 1993. Venda, South Africa.*

Tambi N.E., Mukhebi W.A., Maina W.O. and Solomon H.M. 1999. Profit analysis of livestock producers' demand for private veterinary services in the high potential agricultural areas of Kenya. *Agricultural Systems* 59:163–179.

Genetic evaluation of grade, appendix and pedigree cow classes in Holstein, Jersey and crossbred dairy breeds in Zimbabwe

S.M. Makuza, V. Muchenje and S. Chiyanike
Department of Animal Science, University of Zimbabwe
P.O. Box MP 167 Mount Pleasant, Harare, Zimbabwe

[Abstract](#)

[Introduction](#)

[Objectives](#)

[Materials and methods](#)

[Source of data](#)

[Data editing](#)

[The animal model](#)

[Results and discussions](#)

[Conclusions](#)

[Recommendation](#)

[Acknowledgements](#)

[References](#)

Abstract

Genetic parameters of milk yield of pedigree, appendix and grade Holstein, Jersey and crossbred cows were estimated using the Average Information Restricted Maximum Likelihood (AIREML) animal model. The objectives were to determine the best cow class, in terms of milk production, and determine whether the cow classes are different in the three major dairy breeds and whether there are any genetic differences among the three cow classes namely pedigree, appendix and grade.

The records were obtained from the Zimbabwe Dairy Services Association (ZDSA) for total lactation from 1979 to 1994. The fixed effects in the animal models were herd-year, month of calving, age at calving and parity. Random effects were residual error, permanent environmental effects of the cow and the individual animal or cow effects. The cow classes were analysed separately within each breed group because of limitations of computer memory.

Appendix cows had the highest milk yields, followed by pedigree cows, with grade cows producing the least. Heritabilities (h^2) for milk yield in Holsteins were 0.23, 0.24 and 0.23 for

pedigree, appendix and grade cows, respectively. Similar values for Jerseys pedigree, appendix and grade cow classes were 0.36, 0.36 and 0.25, respectively. Heritabilities for milk yield in crossbred cows were 0.28 and 0.33 for appendix and grade cows, respectively. Repeatabilities (r_p) were similar and averaged 0.42 for all breeds and all cow classes. Major differences among the cow classes across the breeds were observed in the additive, residual and phenotypic variances.

The variances observed suggest adequate genetic variation in the Zimbabwean dairy breeds cow classes for an effective direct selection programme. This genetically improves milk yield and its positively correlated traits.

Introduction

Zimbabwean dairy cattle can be divided into three classes, which are pedigree, appendix and grade. Registered classes include pedigree and appendix cows for which the Zimbabwe Herd Book (ZHB) will issue a certificate and confirms the breed stated on the certificate. A grade daughter mated to a registered sire will produce appendix A offspring. By continued use of registered sires, offspring of succeeding generations go from appendices A to B to C and finally to pedigree, thus there is an open herdbook on registered Holsteins, Jerseys, crossbred cows and other dairy breeds. Grades are those not included in the herdbook. The registration by ZHB is done under the appendix scheme, which is an upgrading process where non-registered or grade animals can achieve full pedigree status in three generations. However, it should be emphasised that this registration is not based on performance but on identification of pedigree and parentage. It has been reported that the pedigree has the highest milk yields, followed by the appendix and the grade cow with the least milk yields (Makuza 1988; Trigg 1989). However, Muchenje (1996) found that the appendix cows had the highest milk yields, followed by the pedigree then the grade cow class. Makuza (1995) reported heritabilities and repeatabilities for milk yield of 0.19 and 0.45 in Holsteins, 0.27 and 0.45 in Jerseys, and 0.26 and 0.40 in crossbred cows, respectively. He also reported additive standard deviations for milk yield of 488, 571 and 658 kg in Holsteins, Jerseys and crossbred cows, respectively. The corresponding phenotypic standard deviations were 1120, 1104 and 1288 kg, respectively. Reported repeatabilities for milk yield in the literature range from 0.35 to 0.60 (Mao 1984). Similarly the range of heritabilities for milk production is from 0.15 to 0.40 (Mao 1984). Banga (1992) reported a heritability estimate of 0.54 ± 0.16 for milk yield in Zimbabwean Jersey cows. This is a little bit too high possibly due to the method of estimation which was Harvey's least squares mixed models. The estimates vary due to different measurements, samples, populations, models or estimation procedures. Literature genetic parameter estimates of different breeds also differ due to differences in population structures among breeds. Small heritabilities (less than 0.10) mean that regardless of genetic evaluations and selection methods used, the genetic gain would be relatively small.

Due to the contrasting findings by the different Zimbabwean researchers on the performance of breed cow classes, there was a need to evaluate the genetic and phenotypic performance of Holstein, Jersey and crossbred cow classes. The Holstein, Jersey and crossbred cows are the three major dairy breed groups in Zimbabwe (Makuza 1995). The hypothesis tested in this study was that the pedigree class produces the highest milk yield in all the three dairy breeds of Zimbabwe.

Objectives

The objectives of the study were to:

- establish the best class of cow in three Zimbabwean dairy breeds
- determine whether there are genetic differences (heritabilities, repeatabilities and

- standard deviations) among cow classes of Holsteins, Jerseys and crossbred cows
- compare genetic estimates from pedigree, appendix and grade daughters across breeds.

Materials and methods

Source of data

Total lactation milk yield records for multiple lactations were available from 1979 to 1994 calvings of Holstein, Jersey and crossbred commercial dairy cattle (Table 3). The records were provided by the Zimbabwe Dairy Services Association (ZDSA). The field records consisted of parentage, production and reproduction data.

Data editing

To remove outliers and incorrect data, records with age at calving outside the range of 16 to 200 months were deleted. Days in milk considered ranged between 250 and 300 days with a calving interval between 300 and 600 days. Lactations 1 to 12 were evaluated. Lactations greater than 4 were combined with lactation 4 into one subclass. Milk yield was restricted between 1000 to 15000 kg per lactation. Records with cow classes incorrectly recorded apart from 1 (pedigree), 2 (grade) or 3 (appendix) were deleted. The data also had to be consistent in birth dates, calving dates, year of calving and region of the country. The records were also deleted for missing sire and dam identification or duplication or misidentification of parentage. Each sire was supposed to have at least 2 daughters for AIREML to run.

The Animal model

The animal model used in the analyses was as follows:

$$Y_{ijklmno} = : + HY_i + M_j + P_k + Age_l \\ + Animal_n + PE_{n(m)} + E_{ijklmno}$$

where:

$Y_{ijklmno}$ = response variable milk yield;

$:$ = overall mean common to all observations;

HY_i = i^{th} combined effect of herd and year of calving on milk yield;

M_j = j^{th} effect of month of calving on milk yield;

P_k = k^{th} effect of parity on milk yield;

Age_l = l^{th} effect of age at calving on milk yield;

$Animal_n$ = n^{th} individual random animal effect on milk yield;

$PE_{n(m)}$ = n^{th} random permanent environmental effect of the m^{th} animal on milk yield;

$E_{ijklmno}$ = random residual error.

The inverse of the matrix of additive genetic relationships was added to improve linkage between sires and improve the accuracy and precision of the estimates. The average information restricted maximum likelihood (AIREML) FORTRAN algorithm of Gilmour (1995) was used for analyses. Sparse matrix techniques were employed to calculate those elements of the inverse of the coefficient matrix required for the first derivatives of the likelihood. Residuals and fitted values for random effects can be used to derive additional right-hand sides for which the mixed model equations can be repeatedly solved in turn to yield an average of the observed and expected second derivatives of the likelihood function.

This Newton method, using average information, generally converges in less than 10 iterations. The Restricted Maximum Likelihood algorithm (REML), using average information, is about five times faster than a derivative-free algorithm, using the simplex method, which in turn is about three times faster than an expectation - maximisation algorithm (Johnson and Thompson 1995). The REML animal model accounts for losses in degrees of freedom of fitting fixed effects and selection bias. The cow classes were analysed separately within each breed. Each dairy breed was therefore also analysed separately. Grade and appendix Jersey cows and grade crossbred cows were analysed as single records. We could not run multiple records due to the small sample sizes resulting in a non full rank matrix meaning that it had dependencies in the factors fitted in the models. This could have resulted in convergence reaching a local rather than a global maximum.

The values reported therefore correspond to a generalised inverse approach and are therefore less reliable as they are not unique solutions to the mixed model equations.

Results and discussions

In the preliminary analyses with SAS's PROC GLM (SAS 1994) for the three cow classes and in all dairy breed groups, fixed effects of herd-year, month of calving, parity and age at calving affected milk yields ($P < 0.001$). These results are in general agreement with those reported in the literature (Makuza 1995; Muchenje 1996; Chiyanike 1997).

Table 1 shows the percentages of cow classes by breed group. The majority of cow classes are grade, which comprise 65% in Holsteins, 45% in Jerseys and 81% in crossbred cows. The proportion of pedigree cows, which are close to 100% pure-bred exotic blood, is small. They comprise 11% and 22% in Holstein and Jerseys respectively. As is expected there are no pedigree Crossbred cows.

Table 1. Percentages of cow classes by breed group.

Cow Class	Breed		
	Holstein	Jersey	Crossbred
Pedigree	11%	22%	0%
Appendix	24%	33%	19%
Grade	65%	45%	81%

The percentages of cow classes by breed group and agroecological region are given in Table 2. For Mashonaland, the distribution of cow classes by breed is similar to that of Table 1. However, for Midlands and Manicaland, the percentage of grade cows by breed group is higher than those in Table 1. This indicates that these two regions have the majority of unregistered cows in Zimbabwe. Almost 71% of Jersey cows in Matabeleland are pedigree cows. As this is the driest region of the country, this finding is rather surprising and unexpected. Again, as was expected, there are no pedigree crossbred cows in all the four milk

recording scheme regions of Zimbabwe. Herds with some of each type of cow may have represented management systems that were attempting to increase the proportion of registered cows i.e. pedigree and appendix. Grade cows in these herds would have faced lower probabilities of survival than appendix or pedigree cows or even comparable cows in all grade herds of Holstein, Jersey and Crossbred cow classes. This could be true for Mashonaland with the majority of cows for the three breed groups and shows a deviation of proportions from those of other regions (Table 2).

Table 2. Percentages of cow classes by breed and agroecological region.

Region	Cow Class	Breed		
		Holstein	Jersey	Crossbred
Matebeleland	Pedigree	6	71	–
	Appendix	22	9	3
	Grade	71	20	97
Midlands	Pedigree	2	19	–
	Appendix	13	28	2
	Grade	85	53	98
Mashonaland	Pedigree	17	10	–
	Appendix	28	40	21
	Grade	55	50	79
Manicaland	Pedigree	1	4	–
	Appendix	19	19	13
	Grade	80	77	87

Table 3 shows the raw means and standard deviations for various traits of the Holstein, Jersey and Crossbred cow classes. Milk yield, lactation number, days dry and calving intervals in all the three breed groups were highest in the appendix cows which were also the oldest with an average age at calving of 59 months compared to 54 months for grade and 50 months for pedigree. Fat percentages tended to be slightly higher in grade cows for all the three breed groups. Days in milk were similar for all cow classes in all the breeds. Grade and pedigree cows left herds at younger ages. Grade and pedigree cows averaged 2.7 lactations across breeds versus 3.0 lactations for appendix cows.

Table 3. Raw means and SD for various traits of Holstein, Jersey and Crossbred cow classes.

Class of cow	Trait	Breed					
		Holstein		Jersey		Crossbred	
		Mean	SD	Mean	SD	Mean	SD
Pedigree	Milk yield (kg)	6212	1667	3628	1198		
	Fat %	3.55	0.37	4.68	0.52		
	Days in milk	292	19	286	28		
	Age at calving (mo)	46	22	54	31		
	Calving interval (d)	251	198	263	184		

Pedigree	5971	0.23	0.40	1025	0.36 ¹	0.38	-	-	-
Appendix	9635	0.24	0.43	1040	0.36 ¹	0.38	655	0.28	0.52
grade	8658	0.23	0.42	1646	0.25	0.45	2393	0.331	0.34

¹ Run as single records and used a generalised inverse approach due to a non full rank matrix.

Standard deviations by cow class and by breed are in Table 5. In general, standard deviations (Φ_a , Φ_{pe} , Φ_e and Φ_p) were highest in Holsteins followed by Crossbreds, with Jerseys having the lowest. The same trend was reported by Makuza and McDaniel(1995).

Table 5. Additive σ_a permanent environmental (σ_{pe}) standard deviations (kg) for milk yield in cow classes of three major Zimbabwean dairy cows.

Cow Class	Breed group											
	Holstein				Jersey				Crossbred			
	σ_a	σ_{pe}	σ_e	σ_p	σ_a	σ_{pe}	σ_e	σ_p	σ_a	σ_{pe}	σ_e	σ_p
Pedigree	540	470	880	1134	408	_1	540	677	-	-	-	-
Appendix	584	518	894	1186	419	_1	554	695	404	371	530	763
Grade	503	442	794	1039	328	293	488	657	425	_1	605	739

¹ Run as single records therefore could not separate permanent environmental effects from additive effects.

Appendix cows had higher standard deviations across breed groups followed by pedigree cows. Grade cows had the lowest standard deviations.

These findings suggest that in a large population of any breed, including both registered animals and grades resulting from several generations of use of pure-bred sires, there will inevitably be some animals in the lower strata of the breed structure which are genetically superior to some in elite herds.

Even if selection programmes in elite herds are highly effective and directed to goals of commercial importance, this will occur due to genetic recombination or heterotic effects and the fact that phenotypes are imperfect indicators of genotypes.

The fact that the data analysed covered the whole country of Zimbabwe, might indicate that appendix cows have the right breed composition for general adaptation to the Zimbabwean environment. Appendix cows are referred to as appendix for at least three generations under the grading up appendix scheme. Usually the first crossbred progeny shows maximum heterosis and this will envisage maximum milk production by appendix A cows.

Our study has indicated basic genetic and phenotypic differences in field data for grade, appendix and pedigree milk production.

Conclusions

- Appendix cows outperformed pedigree and grade cows in milk production in all three breed groups.
- Genetic parameters (h^2 , r_p and variances) were highest in appendix cows in Holsteins,

Jerseys and Crossbreds. Pedigree and grade cows had similar genetic parameters in the three breed groups.

- Genetic parameters (h^2 , r_p and variances) were highest in Crossbreds followed by Jerseys.
- There is adequate genetic variation in Zimbabwean dairy breed cow classes for an effective direct selection programme for milk yield.
- Milk yield in Zimbabwe is as heritable and repeatable as in the temperate and tropical regions of the world.

Recommendation

There is a need to determine what genotype proportions of Pedigree and Grade cows achieve the maximum milk production in Zimbabwe.

Acknowledgements

We would like to thank the Zimbabwe Dairy Services Association (ZDSA) for providing the records as input to this study. We also send our gratitude to Mrs V. Choruma for typing this manuscript.

References

- Banga C. 1992. Genetic parameters for milk production traits in Jersey cattle. *Zimbabwe Journal of Agricultural Research* 30:45–48.
- Chiyanike S. 1997. *Genetic evaluation of Grade, Appendix and Pedigree Holstein cows in Zimbabwe*. BSc honours thesis, Department of Animal Science, University of Zimbabwe.
- Gilmour A. 1995. Average Information REML Manual. NSW Agriculture, Australia
- Johnson D.L. and Thompson R. 1995. Restricted maximum likelihood estimation of variance components for univariate animal models using sparse matrix techniques and average information. *Journal of Dairy Science* 78:449–456.
- Makuza S.M. 1988. *Influence of imported sires on production of dairy herds in Zimbabwe*. MSc thesis, Michigan State University, East Lansing, Michigan, USA.
- Makuza S.M. 1995. *Studies on the genetics of dairy cattle in Zimbabwe and North Carolina*. PhD dissertation, North Carolina State University, Raleigh, North Carolina, USA
- Makuza S.M. and McDaniel B.T. 1995. Genetic and phenotypic parameters for production traits in Zimbabwean dairy breeds. *Journal of the Zimbabwe Society for Animal Production* 7:151–156.
- Mao I.L. 1984. Variation in dairy cattle population: causes and consequences. *Proceedings of the National Invitational Workshop on Genetic Improvement of Dairy Cattle. Milwaukee, Wisconsin, USA* pp.25–43.
- Muchenje V. 1996. *Development of age-month adjustment factors for lactation milk yield of Zimbabwean Holstein dairy cattle*. MSc thesis, Department of Animal Science, University of Zimbabwe.
- SAS (Statistical Analysis System). User's Guide; Statistics, Version 6.10 Edition. 1994. SAS Inst., Inc., Cary, NC.

Trigg C. 1989. *Holstein, sire and cow evaluation for milk production traits in Zimbabwe*. MPhil dissertation, Department of Animal Science, University of Zimbabwe. Zimbabwe.

Estimation of body composition in tropical sheep raised under seasonal feed supply conditions: Prediction models

E. Negussie, O. J. Rottmann, F. Pirchner and J. E. O. Rege

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

Institute of Animal Breeding, Technical University of Munich, D-85350 Freising-Weihenstephan, Germany

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Management of experimental lambs](#)

[Experimental layout](#)

[Infusion of D₂O, sample collection and body measurements](#)

[Application of D₂O dilution technique](#)

[Live animal measurements](#)

[Slaughter and carcass dissection](#)

[Chemical analyses](#)

[Statistical analyses](#)

[Results and discussion](#)

[Prediction of body components from body weight measurements](#)

[Prediction of body components from BW and TBW](#)

[Prediction of body components from BW and D₂O space \(DS\)](#)

[Contributions of age and live animal measurements to the accuracy of prediction models](#)

[Acknowledgements](#)

[References](#)

Abstract

Prediction models were developed from isotope dilution space (D₂O) and live animal measurements (heart girth, height at withers, body length and tail volume measurements) to estimate chemical body components of indigenous tropical fat-tailed sheep breeds in vivo. A STEPWISE multiple regression procedure of SAS was used to assess the predictive power of

combinations of variables and models which minimise the predicted residual sum of squares. With regard to the accuracy and robustness of prediction, models containing body weight as the only predictor variable resulted in less accurate estimates of body components, especially that of body fat and energy contents. However, the use of isotope dilution space (as an index of Total Body Water) along with body weight measurements showed significant improvements in R^2 and accuracy of prediction equations. Testing the predictive ability of models containing live animal measures only, the result obtained showed that, despite a small reduction in accuracy, indices of live animal measures gave comparable estimation of body components with models containing isotope dilution space. Therefore, considering the cost of D_2O and its applicability in the field, indications are that the use of models containing indices of live animal measurements only (in various combinations) is promising for field applications, to provide longitudinal measures of change in body composition of tropical fat-tailed sheep.

Key Words: Sheep, Body Composition, D_2O Space, Prediction Equations.

Introduction

In the tropics, marked seasonality in the quantity and quality of feeds available for livestock affects greatly the growth and development of animals. Therefore, some understanding of changes in the body composition of animals is essential not only for understanding growth and development processes, but also for planning appropriate mating and feeding strategies so as to prevent adverse effects of marked seasonality in feed supply. Moreover, since faster genetic gain in the growth rate and hence improved meat production potential of livestock can be enhanced by the ability to accurately and easily measure sequential changes in body composition of animals *in vivo*, the development of accurate prediction models for use on live animals is vital. In this regard, however, there are only a few reports on indigenous African sheep breeds. Particularly for the indigenous Ethiopian fat-tailed sheep breeds, such information is lacking. The main objective of this study was, therefore, to develop prediction equations for an *in vivo* estimation of the chemical body composition of indigenous Ethiopian fat-tailed sheep breeds from D_2O dilution space and live animal measurements.

Materials and methods

Management of experimental lambs

This study was conducted at the ILRI (International Livestock Research Institute) Debre Berhan Research Station in Ethiopia. In this study, the two indigenous Ethiopian fat-tailed sheep breeds (the Menz and Horro) were used. Lambs were born from ewes which were oestrous synchronised in order to obtain contemporary groups of study lambs. All lambs were reared on their dams until weaning at 3 months of age. Except for limited supplementation made during parts of the dry season, lambs were raised entirely on natural pasture. At the station, all lambs were routinely checked for any health problems and therapeutic treatments were given to sick animals.

Experimental layout

This study included two groups of experimental lambs. The first group comprised 52 lambs (27 Menz and 25 Horro) of both sexes born in the wet season while the second group included sixty-lambs (30 Menz and 30 Horro) of both sexes born in the dry season. The whole experimental period for each group was divided into five growth phases (i.e. 1st, 2nd, 3rd, 4th, 5th phases). The division of growth phases was based on the stage of maturity of lambs with an interval of three months between each consecutive growth phase (1, 3, 6, 9 and 12 months). When lambs attain the prescribed stages of growth, randomly selected lambs of both

sexes per breed were dosed with a deuterium oxide (D_2O) solution to determine D_2O space and thereby estimate Total Body Water (TBW) from blood samples collected at equilibrium of dilution. Soon after the collection of the last blood samples, D_2O dosed lambs were slaughtered, dissected and tissue samples were collected from each of the slaughtered lambs and used for the analyses of the chemical body components and the calorific value of the body.

Infusion of D_2O , sample collection and body measurements

Application of D_2O dilution technique

Deuterium oxide (99.8%, Deutro GmbH, Germany) was injected at a rate of 0.5 gram per kilogram of body weight using disposable plastic syringes (15ml, fitted with 21 gauge, 38mm needles). During each injection, syringes were weighed full and empty to the nearest 0.01g. The actual dose of the solution injected was calculated as the difference between the weight of the full syringe before, and empty syringe after the injection. At equilibrium of dilution 10 ml of blood samples were collected from each of the D_2O dosed lambs and stored deep-frozen. The vacuum sublimation technique was used to extract D_2O containing blood water from deep-frozen samples. The concentration of D_2O in the sublimate was read at the Institut für Nutztierwissenschaften der Humboldt Universität Berlin, in Germany, using an Infrared Spectrophotometer (16 PC FT-IR attached to digital DECPc LPv 433dx PC) at a wave number 2700 cm^{-1} to 2400 cm^{-1} against water. Finally, the D_2O dilution space (kg) was calculated from the actual amount of D_2O dosed and the concentration of D_2O (g/kg) in vacuum sublimates of the collected blood samples.

Live animal measurements

Live animal measurements were taken from each experimental lamb at the end of each growth phase prior to D_2O dosing. Measurements taken included: body weight (BW), heart girth (HG), height at withers (HW) and tail volume (TV). The tail volume was estimated using the Archimedes' principle by submersion of the tail into a 10-litre cylinder completely filled with water.

Slaughter and carcass dissection

Soon after the last blood samples were collected at equilibrium of dilution, D_2O dosed lambs of both sexes per breed were slaughtered and dissected. Tissue samples were collected from each of the slaughtered lambs at all stages of slaughter and dissection processes. Collected samples were put into properly labelled plastic bags and stored deep-frozen at $-18^\circ C$ until ground for laboratory chemical analyses.

Chemical analyses

Except for blood samples, all collected tissue samples were minced, sub-sampled, freeze-dried and ground to 3 mm sieve size. Ground samples were then thoroughly mixed and duplicate samples of about 70g were taken from each component and stored deep-frozen in polyethylene bags until chemical analysis. Samples from each of the slaughtered and dissected lambs were analysed for body chemical components (moisture, ether extract, crude protein and ash) and gross energy (GE) content.

Statistical analyses

All statistical analyses were made using the Statistical Analysis System (SAS). Simple and multiple regression equations were developed to predict body components from all combinations of independent variables (D_2O space, age, BW, EBW, and various indices of live animal measurements) using the SAS REG procedures. Outlier, collinearity, and influence diagnostics were examined and models which minimise predicted residual sum of squares were selected and fitted to the data. The STEPWISE procedures of SAS (SAS 1990) were used to assess the contribution of each additional variable to the accuracy of prediction models, and variables were retained in the best models only when judged a significant predictor (after adjusting for other variables when the model contained more than one variable).

Results and discussion

Prediction of body components from body weight measurements

Prediction equations expressed in kilograms for estimating body chemical components from BW are presented in Table 1. Equations developed from the pooled data produce higher coefficients of determination (R^2) and generally smaller model standard error than any of the age groups used individually. Moreover, such calculated models resulted in higher accuracy of prediction when expressed in kilograms than as a percentage of soft tissue.

Table 1. Equations relating body chemical components (kg) and energy (Mcal) to body weight (BW, kg) and empty body weight (EBW, kg) in Menz and Horro sheep

Body Components	Breed	$a + \beta_1 BW$				$a + \beta_1 EBW$			
		a	β_1	R^2	RMSE	a	β_1	R^2	RMSE
	Horro	0.0591	0.1043	0.912	0.120	-0.0475	0.1530	0.985	0.049
Protein	Menz	0.0319	0.1056	0.929	0.105	-0.0232	0.1507	0.983	0.050
	Horro	0.0062	0.0199	0.876	0.027	-0.0055	0.0281	0.877	0.027
Ash	Menz	0.0025	0.0200	0.927	0.020	-0.0037	0.0279	0.942	0.018
	Horro	-0.0132	0.0978	0.656	0.263	-0.2110	0.1558	0.834	0.182
Fat	Menz	-0.0863	0.1005	0.791	0.188	-0.1748	0.1484	0.897	0.132
	Horro	0.1978	1.4532	0.775	2.913	-2.1787	2.2430	0.927	1.657
Energy (Mcal)	Menz	-0.6147	1.4846	0.865	2.131	-1.7177	2.1632	0.956	1.126

Table 2. Equations relating body chemical components (kg) and energy (Mcal) to body weight (BW, kg) and total body water (TBW, kg) in Horro and Menz lambs

Body Components	Model	Horro					Menz				
		a	β_1	β_2	R^2	RMSE	a	β_1	β_2	R^2	RMSE
Protein	$a + \beta_1 BW$	0.0591	0.1043	--	0.912	0.118	0.0319	0.1056	--	0.929	0.105
	$a +$	0.0451	0.3580	-0.3509	0.965	0.070	0.0604	0.3573	--	0.965	0.070

	β_1 BW + β_2 TBW								0.3515		
Ash	a + β_1 BW	0.0062	0.0199	–	0.875	0.027	0.0025	0.0200	–	0.927	0.020
	a + β_1 BW + β_2 TBW	0.0055	0.0319	-0.0166	0.875	0.001	0.0048	0.0402	– 0.0282	0.934	0.017
Fat	a + β_1 BW	- 0.0132	0.0978	–	0.656	0.263	- 0.0863	0.1005	–	0.790	0.188
	a + β_1 BW + β_2 TBW	– 0.0517	0.7951	–0.9647	0.983	0.054	– 0.0182	0.7033	– 0.8420	0.984	0.044
Energy (Mcal)	a + β_1 BW	0.1978	1.4532	--	0.775	2.913	– 0.6147	1.4846	–	0.865	2.131
	a + β_1 BW + β_2 TBW	– 0.2283	9.1703	– 10.6766	0.990	0.612	0.1592	8.3301	– 9.5619	0.929	0.564

BW, Body weight; TBW, Total body water; Coefficient of determination; RMSE, Root mean squares of error; Mcal, Mega calories; EBW, Empty bodyweight

Results presented in Table 1 shows that body protein was predicted relatively accurately from a model containing BW alone with an R^2 of 0.912 for the Horro and 0.929 for the Menz sheep, respectively. The prediction of body fat and body energy content was, however, less accurate with an R^2 of 0.656 and 0.775 in the Horro, and 0.791 and 0.865 in the Menz sheep, respectively. In this regard, Velazco et al. (1997) also working with urea dilution and dairy cows at different ages, reported more accurate predictions of body water and protein from body weight than for body fat and ash, agreeing with the results reported by Swartz et al. (1991). This is also in line with the results of the present study in that for BW and ash, greater than 90% of the variation was explained by body weight alone in contrast to 60 to 80% of the variation for body fat and energy contents. Therefore, at times when accurate information on body reserve and energy status of tropical sheep is required, body weight alone can not be a suitable index to obtain reliable estimates of these components on live animals.

Similar equations calculated with EBW in the model are also presented in Table 1. As compared to BW, the use of EBW as a predictor variable showed a significant improvement in both R^2 and root mean squares of error (RMSE) of prediction equations for all the different body components. Particularly, body fat and body energy contents were predicted more accurately from the model containing EBW rather than BW as a predictor variable. The inclusion of EBW to the model resulted in an increase of 10.6 and 17.8% and 9.1 and 15.2% in the R^2 of prediction equations for body fat and energy in the Menz and Horro sheep, respectively. Although different researchers have shown that live weight preceding slaughter is the most important variable for predicting body components, there are mixed findings with respect to its value in sheep. Kempster et al. (1982) reported that live weight at evaluation is normally the most effective predictor of carcass composition as it gives the most precise prediction when used alone and, also, the highest level of precision when scan measurements were used along with it in multiple regression equations. On the contrary, Sykes (1974) in sheep, and Johnson and Farrell (1988) in poultry, reported that body weight per se provides a

less accurate prediction of body components and especially that of body fat and energy. Thompson et al. (1977) and Scents et al. (1982) also indicated that live weight offers much less as a predictor of body composition because of the many factors affecting the rate and onset of fattening in meat animals. The results of this and other studies also showed that the use of EBW instead of BW increased the accuracy of prediction models. The main reason for this improvement may be related to the exclusion of the large variability associated with gut fill of ruminants, which normally accounts for about 13.8 to 17.3% (Devendra 1980) of the live weight in small ruminants, depending on such factors as age, diet, breed or species of animal.

Prediction of body components from BW and TBW

The close relationship between TBW and body chemical components has long been noted and its use with other variables in prediction models gives an accurate estimation of body composition in animals. But in this study, the inclusion of TBW as a predictor variable along with body weight resulted in a very little or no improvement in the R^2 and accuracy with which both body protein and ash components are predicted. On the contrary, however, the inclusion of TBW into the model resulted in a highly significant improvement of the accuracy of prediction of body fat and body energy content. When TBW was added to the model containing body weight alone, the R^2 was increased by 32.7 and 21.5% and by 19.4 and 12.5% for body fat and body energy in the Horro and Menz sheep, respectively (Table 2). Such use of TBW for routine applications is, however, limited by lack of methods for its direct measurement on live animals.

Prediction of body components from BW and D₂O space (DS)

Since, there are no direct means of quantifying TBW on live animals, its use in prediction models has been restricted to controlled scientific studies. Instead, therefore, the dilution space of hydrogen isotopes has been used for an in vivo estimation to provide an index of TBW in prediction models for accurate estimation of body composition in pigs (Houseman et al, 1973; Shields et al. 1983; Farrel and Cornelius 1984), sheep (Searie 1970b; Donnelly and Freer 1974) and cattle (Crabtree et al. 1974; Chigaru and Topps 1981). Thus accurate estimation of TBW from DS in sheep (Wright and Russel 1984 ;Rozeboom et al. 1994) and the relative ease of obtaining BW measurements has led to the use of multiple regression equations with these variables as best predictors of the main body chemical components (Panaretto 1963; Keenan et al. 1969; Searie 1970a) in live animals.

In this study the predictive power of DS (as an index of TBW) when used along with BW in prediction models was investigated (Table 3). The results show that in both breeds the addition of DS to the model containing BW had no significant effect on the accuracy of prediction of body protein and ash components. This may be due to the fact that compared to BW, DS is not a particularly good predictor of body protein and ash and hence its contribution in multiple regression equations with live weight is not significant. The most significant improvement due to the addition of DS to the model containing BW was, however, observed in the prediction of body fat and energy contents in both breeds. In the Horro sheep, the R^2 was increased from 65.5 to 87.3% and from 77.5% to 91.6% with corresponding reduction of the RMSE from 0.263 to 0.161 and from 2.913 to 1.799 for fat and body energy contents, respectively (Table 3).

These results are in general agreement with literature findings. Numerous experiments with young growing animals have shown that body fat can be predicted precisely from live weight and either tritiated water or deuterium oxide space (Panaretto 1963; Donnelly and Freer 1974; Trigg 1974; Searie 1970a, b; Robelin 1977). Working with three different isotopic methods on sheep and with tritium and D₂O concurrently, Trigg et al. (1978) and Johnson and Farrell

(1988) also reported that multiple regression equations including either deuterium or tritium space with live weight predicted body fat content with significantly greater precision than live weight alone.

Table 3. Models for estimation of body chemical components (kg) and energy (Mcal) from BW (kg) and DS (kg) in Horro and Menz lambs

Body Components	Model	Horro					Menz				
		A	β_1	β_2	R ²	RMSE	A	β_1	β_2	R ²	RMSE
Protein	a + β_1 BW	0.0591	0.1043	–	0.912	0.120	0.0319	0.1056	–	0.929	0.105
	a + β_1 BW + β_2 DS	0.0998	0.2921	–0.2555	0.945	0.094	0.0546	0.1592	–0.0745	0.934	0.102
Ash	a + β_1 BW	0.0062	0.0199	–	0.875	0.027	0.0025	0.0200	–	0.927	0.020
	a + β_1 BW + β_2 DS	–	–	–	–	–	0.0042	0.0240	–0.0055	0.928	0.020
Fat	a + β_1 BW	–0.132	0.0978	–	0.656	0.263	–0.0863	0.1005	–	0.790	0.188
	a + β_1 BW + β_2 DS	0.1029	0.6339	–0.7297	0.873	0.161	–0.0186	0.2601	–0.2221	0.835	0.168
Energy (Mcal)	a + β_1 BW	0.1975	1.4532	–	0.775	2.913	–0.6147	1.4846	–	0.865	2.131
	a + β_1 BW + β_2 DS	1.4749	7.3469	–8.0230	0.916	1.799	0.1244	3.2264	–2.4253	0.891	1.926

Table 4. Models for estimation of body chemical components (kg) and energy (Mcal) from BW, DS and age in Menz lambs

Body Components	Model	Constants				R ²	RMSE
		A	β_1	β_2	β_3		
	a + β_1 BW	0.0319	0.1056	–	–	0.929	0.104
	a + β_1 BW + β_2 DS	0.0546	0.1592	–0.0745	–	0.934	0.100
Protein	a + β_1 BW + β_2 DS + β_3 T	0.0268	0.1701	–0.0760	–0.0104	0.938	0.100

	$a + \beta_1 BW$	0.0025	0.0200	–	–	0.927	0.044
	$a + \beta_1 BW + \beta_2 DS$	–0.0001	0.0209	–0.0010	–	0.928	0.031
Ash	$a + \beta_1 BW + \beta_2 DS + \beta_3 T$	0.0014	0.0250	–0.0056	–0.0010	0.929	0.031
	$a + \beta_1 BW$	–0.0863	0.1005	–	–	0.790	0.187
	$a + \beta_1 BW + \beta_2 DS$	–0.0186	0.2601	–0.2221	–	0.835	0.167
Fat	$a + \beta_1 BW + \beta_2 DS + \beta_3 T$	–0.0796	0.2839	–0.2254	–0.0227	0.852	0.158
	$a + \beta_1 BW$	–0.6147	1.4846	–	–	0.865	2.130
	$a + \beta_1 BW + \beta_2 DS$	0.1244	3.2264	–2.4253	–	0.891	1.926
Energy (Mcal)	$a + \beta_1 BW + \beta_2 DS + \beta_3 T$	–0.5817	3.5022	–2.4633	–0.2635	0.903	1.834

BW, Body weight; DS, D₂O space; T, Age; R², Coefficient of determination; RMSE, Root mean squares of error; Mcal, Mega calories.

On the contrary, however, working with 40 mature ewes in late pregnancy, Lodge and Heaney (1973) found no increase in accuracy from inclusion of D₂O space in prediction models agreeing with the results reported by Velazco et al. (1997) for dairy cows.

Contributions of age and live animal measurements to the accuracy of prediction models

The inadequacies of published equations support the suggestion of Seebeck (1968) that live weight and dilution spaces (D₂O space or TOH space) alone are insufficient to specify body composition of animals in vivo. In most cases, however, it is also not clear what additional predictors, measurable on the live animal, could be usefully added to them to increase the accuracy and robustness of prediction equations. It might be expected that an index of skeletal development would merit inclusion, as this would differentiate between a fat young animal and a thin adult of the same live weight. Age is one such index and equations calculated for the prediction of body components from BW, DS and age in various combinations are presented in Table 4. The result shows that except for a very little increase in the accuracy of prediction of body fat and energy contents, the inclusion of age as an additional variable to the model containing BW and DS did not result in significant improvements of the accuracy with which the other body components are predicted. But Hofmeyer et al. (1971) and Benjamin et al. (1993) found that body components as well as body energy contents are predicted more accurately from multiple regression equations that included body weight and age as predictor variables in addition to isotope dilution space. On the contrary, however, Viljoen and Coetzee (1988) and Gizaw and Abegaz (1995) reported that the addition of age as an additional independent variable to live mass in the prediction of body components did not show any significant improvement. In general, in this study the fact that body weight and D₂O space are associated with a considerably greater proportion of the variability in body constituents than in age (when both are used in the same model) might

explain the reason why age did not have a significant effect, and accounts for only 0.3 to 0.5% of the total variability.

The contribution of each of the different live animal measures to the predictive power of a model containing BW and DS are presented in Table 5a and 5b. The result in general shows that the addition of indices of live animal measures (HW, BL, HG and TV) to the model containing BW and DS resulted in very little improvement of the accuracy of prediction. For both breeds, the increase in the R^2 and the reduction in RMSE ranged from 0.5 to 4.5% and from 0.05 to 0.50 for body fat and energy content, respectively. This is, however, contrary to the results of Seebeck (1968) and Donnelly and Freer (1974) who have strongly suggested that indices of skeletal size are of great value in prediction of body composition in domestic animals. Literature reports regarding the added advantage of including such measurements in prediction models are also conflicting. Wright and Russel (1984) working on mature cows used indices of skeletal size in addition to BW and DS and found no significant advantage in accuracy of predictions, especially for body protein, which is in line with the results of the present study. The reason for this lack of significant contribution of indices of live animal measurements (when used along with DS) in this and other studies, may be due to the fact that variation within breeds in live animal measurements is too small to allow it to improve upon the level of prediction given by live weight and D_2O space alone. However, in situations where meaningful live weight measurements cannot be obtained such as in gestation, etc., indices of live animal measures could still be used to improve upon the accuracy of prediction of body components.

Table 5. Accuracy of prediction models for estimation of body components (kg) and energy (Mcal) from various indices of body composition, including BW, DS, T and linear body measurements (TV, BL, HG and HW) in Horro and Menz lambs

HORRO			MENZ		
Models and independent variables	R^2	RMSE	Models and independent variables	R^2	RMSE
Protein			Protein		
$a + \beta_1 BW$	0.898	0.118	$a + \beta_1 BW$	0.909	0.118
$a + \beta_1 BW + \beta_2 DS$	0.930	0.100	$a + \beta_1 BW + \beta_2 T$	0.947	0.089
$a + \beta_1 BW + \beta_2 DS + \beta_3 HW$	0.944	0.089	$a + \beta_1 BW + \beta_2 T + \beta_3 DS$	0.949	0.089
$a + \beta_1 BW + \beta_2 DS + \beta_3 HW + \beta_4 HG$	0.961	0.077	$a + \beta_1 BW + \beta_2 T + \beta_3 DS + \beta_4 TV$	0.951	0.089
			$a + \beta_1 BW + \beta_2 T + \beta_3 DS + \beta_4 TV + \beta_5 HW$	0.956	0.083
			$a + \beta_1 BW + \beta_2 T + \beta_3 DS + \beta_4 TV + \beta_5 HW + \beta_6 BL$	0.958	0.083
Ash			Ash		
$a + \beta_1 BW$	0.965	0.044	$a + \beta_1 BW$	0.975	0.031
$a + \beta_1 BW + \beta_2 HW$	0.970	0.031	$a + \beta_1 BW + \beta_2 T$	0.983	0.001
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG$	0.976	0.001	$a + \beta_1 BW + \beta_2 T + \beta_3 DS$		
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG + \beta_4 TV$	0.980	0.001			
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG + \beta_4 TV + \beta_5 T$	0.982	0.001			

Table 5b Continued			Fat		
Fat					
$a + \beta_1 BW$	0.437	0.296	$a + \beta_1 BW$	0.695	0.230
$a + \beta_1 BW + \beta_2 DS$	0.800	0.178	$a + \beta_1 BW + \beta_2 DS$	0.791	0.194
$a + \beta_1 BW + \beta_2 DS + \beta_3 TV$	0.820	0.176	$a + \beta_1 BW + \beta_2 DS + \beta_3 T$	0.833	0.176
$a + \beta_1 BW + \beta_2 DS + \beta_3 TV + \beta_4 T$	0.836	0.170			
Energy (Mcal)			Energy (Mcal)		
$a + \beta_1 BW$	0.639	3.212	$a + \beta_1 BW$	0.805	2.559
$a + \beta_1 BW + \beta_2 DS$	0.863	2.026	$a + \beta_1 BW + \beta_2 DS$	0.880	2.039
$a + \beta_1 BW + \beta_2 DS + \beta_3 HW$	0.878	1.962	$a + \beta_1 BW + \beta_2 DS + \beta_3 T$	0.904	1.857
$a + \beta_1 BW + \beta_2 DS + \beta_3 HW + \beta_4 BL$	0.890	1.915	$a + \beta_1 BW + \beta_2 DS + \beta_3 T + \beta_4 TV$	0.906	1.873
$a + \beta_1 BW + \beta_2 DS + \beta_3 HW + \beta_4 BL + \beta_5 TV$	0.895	1.919	$a + \beta_1 BW + \beta_2 DS + \beta_3 T + \beta_4 TV + \beta_5 HW$	0.918	1.778
$a + \beta_1 BW + \beta_2 DS + \beta_3 HW + \beta_4 BL + \beta_5 TV + \beta_6 T$	0.901	1.920			

DS, D₂O space (kg); BW, Body weight (kg); T, Age (months); TV, Tail volume; BL, Body length; HG, Heart girth, HW, Height at withers; R², coefficient of determination;

RMSE, Root mean squares of error, Mcal, Mega calories.

Table 6a. Accuracy of prediction models for estimation of body components (kg) and energy (Mcal) from the body weight (BW) and various indices of live animal measurements (TV, BL, HG and HW) in Horro and Menz lambs

HORRO			MENZ		
Models and independent variables	R ²	RMSE	Models and independent variables	R ²	RMSE
Protein			Protein		
$a + \beta_1 BW$	0.898	0.118	$a + \beta_1 BW$	0.909	0.118
$a + \beta_1 BW + \beta_2 HW$	0.907	0.114	$a + \beta_1 BW + \beta_2 T$	0.947	0.089
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG$	0.931	0.100	$a + \beta_1 BW + \beta_2 T + \beta_3 TV$	0.949	0.089
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG + \beta_4 T$	0.935	0.100	$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HW$	0.955	0.083
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG + \beta_4 T + \beta_5 TV$	0.938	0.100	$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HW + \beta_5 BL$	0.957	0.083
			$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HW + \beta_5 BL + \beta_6 HG$	0.959	0.083
Ash			Ash		
$a + \beta_1 BW$	0.965	0.031	$a + \beta_1 BW$	0.975	0.031

$a + \beta_1 BW + \beta_2 HW$	0.970	0.031	$a + \beta_1 BW + \beta_2 T$	0.983	0.001
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG$	0.976	0.031			
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG + \beta_4 TV$	0.980	0.001			
$a + \beta_1 BW + \beta_2 HW + \beta_3 HG + \beta_4 T + \beta_5 T$	0.982	0.001			
Fat			Fat		
$a + \beta_1 BW$	0.437	0.296	$a + \beta_1 BW$	0.695	0.230
$a + \beta_1 BW + \beta_2 TV$	0.493	0.288	$a + \beta_1 BW + \beta_2 T$	0.791	0.194
$a + \beta_1 BW + \beta_2 TV + \beta_3 T$	0.600	0.262	$a + \beta_1 BW + \beta_2 T + \beta_3 TV$	0.797	0.194
$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 BL$	0.622	0.260	$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HG$	0.824	0.184
$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 BL + \beta_5 HW$	0.637	0.264	$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HG + \beta_5 BL$	0.828	0.184
			$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HG + \beta_5 BL + \beta_6 HW$	0.833	0.187
Energy (Mcal)			Energy (Mcal)		
$a + \beta_1 BW$	0.639	3.212	$a + \beta_1 BW$	0.805	2.559
$a + \beta_1 BW + \beta_2 TV$	0.676	3.119	$a + \beta_1 BW + \beta_2 T$	0.880	2.039
$a + \beta_1 BW + \beta_2 TV + \beta_3 T$	0.739	2.872	$a + \beta_1 BW + \beta_2 T + \beta_3 TV$	0.886	2.029
$a + \beta_1 BW + \beta_2 T + \beta_3 T + \beta_4 BL$	0.746	2.909	$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HG$	0.903	1.900
$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 BL + \beta_5 HW$	0.760	2.911	$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HG + \beta_5 BL$	0.906	1.904
$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HG + \beta_5 HW + \beta_6 HG$	0.768	2.952	$a + \beta_1 BW + \beta_2 T + \beta_3 TV + \beta_4 HG + \beta_5 BL + \beta_6 HW$	0.911	1.893

BW, Body weight (kg); T, Age (months); TV, Tail volume; BL, Body length; HG, Heart girth; HW, Height at withers; R^2 , Coefficient of determination; RMSE, Root mean squares of error; Mcal, Mega calories.

Considering the cost, technical and/or analytical difficulty and the ease with which measurements of the different predictors are obtained under field applications, the predictive power of models containing live animal measures only was tested (Table 6). The result showed that except for a slightly reduced accuracy of prediction of body fat and energy contents, the use of indices of live animal measures alone in prediction models gave estimates of body components which are comparable to estimates from models containing isotope dilution space. Therefore, the general indications are that in view of the economics of D_2O and its applicability, the use of properly measured body indices alone in prediction models will have great promise for field applications involving tropical fat-tailed sheep breeds.

Acknowledgements

The authors would like to thank the German Academic Exchange Services (DAAD) and the International Livestock Research Institute (ILRI) for technically, materially and financially

supporting this study as part of the PhD research project of the principal author.

References

- Benjamin R. W., Koenig, R. and Becker, K. 1993. Body composition of young sheep and goats determined by the tritium dilution technique. *Journal of Agricultural Science, (Cambodia)* 121: 399–408.
- Chigaru P. R. N. and Topps, J. H. 1981. The composition of body weight changes in underfed lactating beef cows. *Animal Production* 32:95.
- Crabtree R. M., Houseman R. A. and Kay M. 1974. The estimation of body composition in beef cattle by deuterium oxide dilution. *Proceedings of the Nutrition Society* 33, 74A–75A (abs).
- Devendra C. 1980. Goat production in the Asian region: current status, available genetic resources and potential prospects. *International Goat and Sheep Research* 1: 55–78.
- Donnelly J. R. and Freer M. 1974. Prediction of body composition in live sheep. *Australian Journal of Agricultural Research* 25: 825–834.
- Farrel C. L. and Cornelius S. G. 1984. Estimation of body composition of pigs. *Journal of Animal Science* 58: 903.
- Gizaw S. and Abegaz S. 1995. Changes in carcass characteristics of Horro rams with increasing age and body weight under different feeding regimes. In: "*Proceedings of the 7th Annual Conference of the Ethiopian Society of Animal Production (ESAP) on "Livestock production and the environment-implications for sustainable livestock production and the environment - implications for sustainable livelihoods"*". 27–29 April, 1995. Addis Ababa, Ethiopia . pp. 233–239.
- Hofmeyr H. S., Oliver I., Kroon F. E., and VanRensburg W. J. J. 1971. Mededeling oor verwantskappe tussen tritiumruimte en liggaamsamestelling by 3 skaaprasse. *South African Journal of Animal Science* 1: 13.
- Houseman R. A., McDonald I., and Peenie K. 1973. The measurement of total body water in living pigs by deuterium oxide dilution and its relation to body composition. *British Journal of Nutrition* 30: 149–156.
- Johnson R. J. and Farrel D. J. 1988. The prediction of body composition in poultry by estimation in vivo of total body water with tritiated water and deuterium oxide. *British Journal of Nutrition* 59: 109–124.
- Keenan D. M., McManus W. R., and Freer M. 1969. Changes in the body composition and efficiency of mature sheep during loss and regain of live-weight. *Journal of Agricultural Science, (Cambodia)* 72: 505–508.
- Kempster A. J., Cuthbertson A. and Harrington G. 1982. *Carcass evaluation in livestock breeding, production and marketing*. Granada, London.
- Lodge G. A., and Heaney D. P. 1973. Energy cost of pregnancy in single and twin bearing ewes. *Canadian Journal of Animal Science* 53: 479–489.
- Panaretto B. A. 1963. Body composition in vivo. III. The composition of living ruminants and its relation to the tritiated water spaces. *Australian Journal of Agricultural Research* 14: 944.
- Robelin, J. 1977. In vivo prediction of lamb body composition using heavy water space.

Annales de Biologie Animale, Biochimie, Biophysique 17: 95–105.

Rozeboom D. W., Pettigrew J. E., Moser R. L., Cornelius S. G. and Kandelgy S. M. E. 1994. In vivo estimation of body composition of mature gilts using live weight, back fat thickness and deuterium oxide. *Journal of Animal Science* 72: 355–366.

SAS (Statistical Analysis System). 1990. SAS Institute Inc., Cary. North Carolina.

Searie T. W. 1970a. Body composition in lambs and young sheep and its prediction in vivo from tritiated water space and body weight. *Journal of Agricultural Science (Cambodia)*. 74: 357–362.

Searie T. W. 1970b. Prediction of body composition of sheep from tritiated water space and body weight: Tests of published equations. *Journal of Agricultural Science (Cambodia)*. 75: 497–500.

Seebeck R. M. 1968. Developmental studies of body composition. *Animal Breeding*. Abstract 36: 167–181.

Scents A. E., Walters L. E. and Whiteman J. B. 1982. Performance and carcass characteristics of ram lambs slaughtered at different weights. *Journal of Animal Science* 55: 1360.

Shields, R. G., Jr., Mahan, D. C., and Graham, P. L. (1983). Efficiency of deuterium oxide to estimate body composition of growing swine. *Journal of Animal Science* 57: 66.

Swartz L. A., Heinrichs A. J., Varga G. A. and Muller L. D. 1991. Effects of varying dietary undegradable protein on dry matter intake, growth and carcass composition of Holstein calves. *Journal of Dairy Science* 74: 3884.

Sykes A. R. 1974. The prediction of body composition of hill sheep from body weight, red cell volume and tritiated water space. *Journal of Agricultural Science (Cambodia)* 269–275.

Thompson J. M., Pattie W. A. and Butterfield R. M. 1977. An evaluation of the "Sancogram" as an ultrasonic aid in assessing carcass composition of live sheep. *Australian Journal of Experimental Agriculture and Animal Husbandry* 17: 251.

Trigg T. E. 1974. *Body composition of ruminants in relation to plane of nutrition and production*. PhD thesis, University of Aberdeen. Scotland.

Trigg T. E., Domingo E. A. and Topps J. H. 1978. A comparison of three different isotopic methods for measuring body components of sheep. *Journal of Science Fd. Agric.* 29: 1007–1016.

Velazco J., Morrill J. L., Kropf D. H., Brandt R. T. Jr., Harmon D. L., Preston R. L., and Clarenburg R. 1997. The urea dilution for estimating of carcass composition of Holstein steers at 3, 6, 9, and 12 months of age. *Journal of Animal Science* 75: 139–147.

Viljoen J. and Coetzee S. E. 1988. The in vivo prediction of body composition in Boer goat does by means of the tritiated water space technique. *South African Journal of Animal Science* 18: 63–67.

Wright I. A. and Russel A. J. F. 1984. Estimation in vivo of the chemical composition of the bodies of mature cows. *Animal Production* 38: 33–44.

Fodder yield and nutritive value of leucaena, acaecia and calliandra at three cutting regimes and two locations in Malawi

G.Y. Kanyama Phiri, H.D.C. Msiska, B.H. Dzowela,
W.M.M. Ngwira, M.J. Njewa and L.L. Kalanje

[Introduction](#)

[Materials and methods](#)

[Location of the study](#)

[Experimental design and treatments](#)

[Data collection](#)

[Chemical analysis](#)

[Data analysis](#)

[Results and discussion](#)

[Fodder matter yields at Bunda](#)

[Nutritive value](#)

[Fodder yields of accessions at Bvumbwe \(1998/99 season\)](#)

[Conclusion](#)

[References](#)

Introduction

Multipurpose trees and shrubs (MPTS) constitute a rich and critical source of supplementary fodder and protein in the diet of ruminants especially during the dry season (Chen Halim and Chin 1992; Devendra 1992). In Malawi, leucaena (*leucaena leucocephala* (ham) de wit) has been naturalised and is widely adapted in many parts of the country (Savory and Thomas 1971; Savery and Breen 1979). It used to rank high among the tree legumes used as fodder for protein supplementation in beef and dairy diets. However, continued use of this multipurpose tree legume has been threatened by the leucaena psyllid pest called *Iteteropsylla cubana* which is capable of massively defoliating and killing the tree (Austin et al. 1997; Bray, Palmer and Ibrahim 1997; Mugundi and Nair 1997). At the University of Hawaii, Beldt and Nampopeth (1992) have researched on psyllid resistant varieties. Their results have shown variety K636 to be resistant to the psyllid pest.

The psyllid problem has also forced researchers to explore other alternative species of leucaena as well as species other than *leucaena leucocephala* which would be suitable candidates for supplementary feeding. *Leucaena tricendra*, *leucaena esculinta*, *leucaena dwersifolia* and *leucaena pallida* have demonstrated remarkable ability to resist psyllid damage

(Bray and Woodrope 1998; Dzowela 1994; Kavachi and Shirima 1997; Akyeampong 1998).

Fodder species have also been evaluated for adaptability; for instance, calliandra (*Calliandra calothyrsus* (Meiss) L. and acacia (*Acacia angustissima* (Mill) Kuutze have been shown to be suitably adapted to the tropics (Chamberlain 1998; Akyeampong 1998; Lesueur et al. 1996 and Paterson et al. 1996) Lesueur reported that *Calliandra calothyrsus* was successfully introduced in the highlands of Burundi, Kenya and Rwanda.

Multipurpose tree species have also been evaluated for dry matter yields and results have revealed remarkable variations. Bray et al. (1997) reported lower dry matter yields from *Leucaena leucouphala* than from *Calliandra calothyrsus*, *Acacia angustissima*, *Gliricidia selsium*, *Leucaena dillensifolia* and *Leucaena pollida*. This disparity in dry matter yield between *Leucaena leucocephala* and the other species was also related to the psyllid attack on *Leucaena leucocephala*.

Acacia angustissima is believed to have originated from Belize on the Caribbean Coast. It is resistant to the psyllid pest and produces large quantities of leaf biomass which is rich in protein. Its leaves also form a rich source of mulch and litter for soil moisture conservation and nutrient cycling (Dzowela 1994). *Calliandra calothyrsus* is yet another multipurpose tree which originated in Central America and is a rich source of protein. In a comparative performance trial Akyeampong (1998) reported higher leaf production (4.5 tonnes per hectare) from *Calliandra calothyrsus* than from *Leucaena pallida* (1.2 tonnes per hectare). Wood biomass yields were 5.0 and 1.1 tonnes per hectare, respectively.

Mkgundi, Kettler and Nair (1997) reported higher nitrogen and carbon contents in *Calliandra calothyrsus* foliage than in *Cordia africana* and *Grevillea rubusta*. Fresh foliage of *Calliandra calothyrsus* was reported to be more digestible than the dried foliage (Paterson 1996). The digestibility of dried foliage was 40% while that of fresh foliage was 60%. Apparently, the low digestibility of dried foliage was attributed to high values of condensed tannins. This suggests that digestibility of some species may depend on the form in which they are presented.

Acacia angustissima has been shown to respond well to cutting by producing leafier and more digestible material, but it tends to defoliate its leaves under infrequent cutting especially during the dry season (Dzowela 1994). Under frequent cutting, its leaves contain larger amounts of nitrogen than those of *Sesbania sesban* (L.) Merr, *Cajanus Cajan*, *Gliricidia sepium*, *Calliandra calothyrsus* and *Flemingia macrophyne*, (Dzowela 1994). *Calliandra calothyrsus* coppices well following cutting (Tomaneng 1990).

Dry matter yield can also vary with cutting time and variety of the multipurpose tree species. In Malawi, Savery and Breen (1979) reported higher dry matter and nitrogen content from *Leucaena leucocephala* C.V. Cumingham than from either CV Peru or CV Hawaiian giant CK8. Frequent cutting has been reported to produce a high proportion of shorter and thinner branches which are relatively high in crude protein and palatability. The only problem is high concentrations of numosine at the tips of branches especially the new growth (Adeneye 1991). This could bring about variations in the nutritive value of leaf and stem fractions (Karachi 1998).

The overall objective of this study was to determine the yield and nutritive value of *Leucaena*, *Acacia* and *Calliandra* fodder at three cutting heights and two locations in Malawi. Specifically the study sought to evaluate the effect of cutting height on:

- growth rate of the leucaena, acacia and calliandra species and accessions
- leafy and woody biomass yields of leucaena, acacia, and calliandra species and accessions
- crude protein Neutral and acid detergent fibre contents of leucaena, acacia and

calliandra species and accessions

- leaf to stem ratio of leucaena, acacia and calliandra species and accessions

Materials and methods

Location of the study

The study was conducted at Bunda College of Agriculture (1158 m above sea level, 14°18` S, 33° 76' E with 1100mm average annual rainfall) and Bvumbwe Agricultural Research Station (1350 m above sea level, 15° 55' S, 350 ° 05' E with an annual rainfall averaging 1100 mm). The study spanned a period of two years.

Experimental design and treatments

There were a total of 8 accessions of multipurpose trees (MPTS) of which four were leucaena species, namely, *Leucaena esculenta* (OFI 52/87) *Leucaena tricandra* (OFI 37/94) and *Leucaena diversifolia* (OFI 135/98), three accessions of *Acacia angustissima* (OFI 68/92, OFI 65/92 and OFI 70/93), and one accession of *Calliandra calothyrsus* (OFI 12/91). Seedlings of these accessions were sown in the nursery and raised as bare - rooted seedlings. These seedlings were transplanted in rows 18 m long, 0.5 m apart. Each row was spaced 1.5 m apart. The trees were then allowed to establish for twelve months. Thereafter, cutting height treatments of 0.25, 0.50 and 0.75m were imposed on the plants within the next plot of 9 m long, discarding 4.5m from either side of the row.

The eight accessions and three cutting height treatments served as main plots and sub-plots, respectively. Thus, the treatments were factorially combined in a split plot design with four replicates per treatment combination.

Data collection

The growth of trees was monitored at monthly intervals within the net plot. The trees were filled after every four months. The filled trees were hand stripped of the leafy biomass which was weighed fresh. A sub sample of the leafy biomass was weighed fresh then oven dried and weighed to determine dry matter yield per hectare. Fifteen centimetre sections were cut from all base, tip and middle sections of the stems. These were weighed fresh and oven dried at 105°C for 48 hours. The remainder of the stems from the net plot were weighed fresh and oven dry weight was determined by extrapolation.

Chemical analysis

Leafy biomass samples were oven dried at 70°C and ground to pass through a 1 mm sieve and analysed for nitrogen using a Kjeldahl digestion method (Anderson and Ingram 1989). Neutral and Acid were determined using the procedure as described by Goering and Van Soest (1970).

Data analysis

All data were subjected to analysis of variance by General Linear Models (GLM) procedures using a Statistical Analysis System (SAS) package. Significant differences among the treatment means were separated by fishers Least Significant Difference (LSD).

Results and discussion

Multipurpose tree growth performance at Bunda (Table 1) indicates that *Leucaena tricandra* and *Acacia angustissima* (OFI 68/92) exhibited the fastest growth rate followed by *Leucaena esculenta* and *Acacia angustissima* (OFI 70/93). Lower growth rates were observed in *Calliandra calothyrsus* and *Leucaena diversifolia*.

Table 1. Growth rate of leucaena, acacia calliandra species and accessions at three cutting heights at Bunda College

Species	Accession	Growth rate			(cm/day)	Mean
<i>Leucaena</i> <i>Esculanta</i>	OF1 52/87	1.89	1.42	1.93	1.95	
<i>Leucaena</i> <i>Tricandra</i>	OF1 53/88	2.48	2.45	1.40	2.11	
<i>Leucaena</i> <i>Pallida</i>	OF1 137/94	1.27	1.50	1.82	1.53	
<i>Leucaena</i> <i>Dullrsifolia</i>	OF1 135/98	1.32	1.01	1.66	1.33	
<i>Acacia</i> <i>Angustissima</i>	OF1 68/92	1.87	2.68	1.92	2.16	
<i>Acacia</i> <i>Angustissima</i>	OF1 65/92	1.77	1.47	1.29	1.51	
<i>Acacia</i> <i>angustissima</i>	OF1 70/93	1.78	1.88	1.81	1.82	
<i>Calliandra</i> <i>calothyrsus</i>	OF1 12/91	1.77	1.29	0.80	1.29	

Growth rates of *Leucaena pallida* and *Acacia angustissima* (OFI 65/92) were intermediate. Growth rates of the multipurpose trees during the dry season (Table 2) followed a similar pattern except that in most cases the dry season growth rate was one third of that in the wet season, apparently a reflection of declining moisture content normally experienced during the dry season. Nevertheless, if selection was based on growth rate performance, then *Leucaena tricandra* and *Acacia angustissima* (OFI 68/94) would be primary candidates for further agronomic and nutritive evaluation.

Table 2. Growth rate of leucaena, acacia and Calliandra species and accessions at three cutting heights at Bunda (Dry season)

Species	Accession	Growth rate (cm/day)			Mean
<i>Leucaena</i> <i>esculanta</i>	OF1 52/87	0.66	0.60	0.49	0.58
<i>Leucaena</i> <i>tricandra</i>	OF1 53.88	1.04	0.74	0.89	0.89
<i>Leucaena</i> <i>pallida</i>	OF1 137/94	0.49	0.82	0.61	0.64
<i>Leucaena</i>					

<i>paliideia</i>	OF1 135/98	0.57	0.57	0.58	0.57
<i>Acacia</i>					
<i>angustissima</i>	OF1 68/92	0.42	1.15	0.62	0.73
<i>Acacia</i>					
<i>angustissima</i>	OF1 65/92	0.80	0.75	0.62	0.72
<i>Acacia angustissima</i>	OF1 70/93	0.92	0.83	0.95	0.90
<i>Calliandra callothyrsus</i>	OF1 12/91	0.44	0.45	0.23	0.37

The results presented in Table 3 suggest that a low cutting height of 0.25m stimulated branching in *Leucaena pallida* (92 primary branches per plant) and *Acacia angustissima* (OFI 70/93;86 primary branches per plant) when averaged across the cutting regimes. However, it was observed that *Acacia angustissima* accessions OFI 65/92 and 70/93 exhibited branching performance. Two lessons could be drawn from this table. First, branching behaviour could be species specific. Secondly, branching could be dependent on height of cutting. From these results it is arguable that the *Acacia angustissima* accessions OFI 65/92 and OFI 70/93 have the potential for higher dry matter yields assuming that dry matter production is positively correlated to the number of primary branches per tree. A cutting height of 0.25m appeared to be the most suitable cutting height in so far as branching was concerned and could therefore be adopted as a suitable cutting height.

Table 3. Number of primary branches per plant for leucaena, acacia and calliandra species and accessions at three cutting heights at Bunda

Species	0.25cm	0.50cm	0.75cm	Mean
<i>Leucaena esculanta</i> OF1 52/87	52 ^c	64 ^{bc}	69 ^b	67
<i>Leucaena tricandra</i> OF1 53.88	85 ^a	74 ^b	61 ^{bc}	73
<i>Leucaena pallida</i> OF1 137/94	92 ^a	73 ^b	57 ^c	74
<i>Leucaena paliideia</i> OF1 135/98	82 ^{ab}	78 ^b	66 ^b	75
<i>Acacia angustissima</i> OF1 68/92	54 ^c	68 ^b	82 ^{ab}	68
<i>Acacia angustissima</i> OF1 65/92	78 ^b	79 ^b	80 ^{ab}	79
<i>Acacia angustissima</i> OF1 70/93	86 ^a	81 ^{ab}	71 ^b	79
<i>Calliandra callothyrsus</i> OF1 12/91	67 ^b	81 ^{ab}	59 ^c	69
Mean				72
LSD 0.05				58.91
cv %				41.97

^{abc}Means in rows or columns bearing the same superscripts are not significantly different

Fodder matter yields at Bunda

Leaf biomass yields were highest for *Leucaena esculenta* (2139 kg ha⁻¹) *Leucaena tricandra* and *Leucaena pallida* (2020 kg ha⁻¹) when they were both at 0.75m (Table 4).

Table 4. Fodder yield of leucaena, acacia and calliandra species and accessions at three

cutting heights at Bunda during the 1998/99 season.

Species	Cutting height (cm)	Leaf yield (kg/ha-1)	Stem yield (kg/ha-1)	Total yield (kg/ha-1)	Leaf:stem ratio
<i>Leucaena</i>	0.25	1793	3001	4794	0.60
<i>esculenta</i>	0.50	1180	2387	3567	0.49
(OF1 52/87)	0.75	2139	2066	4205	1.04
<i>Leucaena</i>	0.25	1293	2509	3802	0.52
<i>tricandra</i>	0.50	1833	1833	3666	1.00
(OF1 53/88)	0.75	1322	2530	3852	0.52
<i>Leucaena</i>	0.25	1255	2462	3717	0.51
<i>pallida</i>	0.50	1480	2688	4168	0.55
(OF1 137/94)	0.75	2020	2382	4407	0.85
<i>Leucaena</i>	0.25	1011	2218	3229	0.46
<i>diversifolia</i>	0.50	1974	2215	4189	0.89
(OF1 135/98)	0.75	1540	2747	4287	0.56
<i>Acacia</i>	0.25	1074	2273	3347	0.47
<i>angustissima</i>	0.50	1709	2916	4625	0.59
(OF1 68/92)	0.75	1700	2908	4608	0.58
<i>Acacia</i>	0.25	1159	2377	3526	0.49
<i>angustissima</i>	0.50	1467	2649	4096	0.55
(OF1 65/92)	0.75	1270	2478	3748	0.51
<i>Acacia</i>	0.25	1205	2414	3619	0.50
<i>angustissima</i>	0.50	1531	2739	4270	0.56
(OF1 70/93)	0.75	1679	2886	4565	0.58
<i>Calliandra</i>	0.25	1554	2751	4305	0.56
<i>callothyrsus</i>	0.50	1287	2495	3782	0.52
(OF1 12/91)	0.75	1293	2472	3765	0.52

At this height of cutting, their leaf to stem ratios were 1.04 and 0.89, respectively. Highest dry matter yields of stems were recorded in *Leucaena esculenta* (OFI 52/87) and *Acacia angustissima* (OFI 68/92). When cut at 0.25m, leucaena and esculenta produced 3001 kg ha⁻¹. When cut at 0.5 and 0.75m, stem biomass yields for *Acacia angustissima* (OFI 68/92) were 2916 and 2908kg ha⁻¹, respectively. The same accessions gave the highest total yields. From these results it could be argued that *Leucaena esculenta* and *Acacia angustissima* OFI 68/92) are the best candidates for fodder and fuel wood, both of which are required by small holder farmers.

Nutritive value

Nutritive value of the 8 accessions were generally comparable. Table 5 shows phosphorous content was higher in *Acacia angustissima* (OFI 70/93) (0.5% P) *Calliandra calothyrsus* (0.5% P) than the rest which averaged 0.4% P. Crude Protein contents for *Leucaena diversifolia* (21.3 cp) *Acacia angustissima* (OFI 65/92; 21.3%) and *Acacia angustissima* (OFI 68/92; 20.6%cp) were significantly higher than those of *Leucaena tricandra* (18.1% cp) and *calliandra calothyrsus* (19.4% cp). There was insufficient evidence to indicate that neutral and acid detergent fibre contents were significantly different. This suggests that the digestibilities of these multipurpose trees are similar.

Table 5. Nutritive value of leucaena, acacia and calliandra species and accessions at Bunda (average cutting heights)

Species	%N	%P	%CP	%NDF	%ADF
<i>Leucaena esculanta</i> (OF1 52/87)	3.3	0.4	20.6	36.8	20.2
<i>Leucaena tricandra</i> (OF1 53/88)	2.9	0.4	18.1	36.8	19.1
<i>Leucaena pallida</i> (OF1 137/94)	3.2	0.4	20.0	37.8	20.6
<i>Leucaena diversifolia</i> (OF1 135/98)	3.4	0.5	21.3	36.9	20.5
<i>Acacia angustissima</i> (OF1 68/92)	3.3	0.3	20.6	34.5	21.1
<i>Acacia angustissima</i> (OF1 65/92)	3.4	0.4	21.3	31.3	21.2
<i>Acacia angustissima</i> (OF1 70/93)	3.2	0.5	20.0	35.8	21.1
<i>Calliandra calothyrsus</i> (OF1 12/91)	3.2	0.5	19.4	35.1	20.3
Mean	-	-	20.2	35.6	20.5
SE±Mean	-	-	0.44	0.51	0.28
cv	-	-	16.44	11.80	13.96

Fodder yields of accessions at Bvumbwe (1998/99 season)

At Bvumbwe Agricultural Research Station, highest dry matter yields were obtained when the trees were cut at 0.75m. Table 6 shows for instance, *Acacia angustissima* accessions OFI 68/92, OFI 65/92 and OFI 70/93 were 2391, 2742 and 3442 kg ha^{-1} , respectively. Except for *Acacia angustissima* (OFI 68/92) the accessions with the highest dry matter yields did not necessarily have the highest leaf to stem ratio. It would appear, however, that the ecology of Bvumbwe Agricultural Research Station favoured *Acacia angustissima* in terms of dry matter yields. A similar trend occurred in the 1999/2000 growing season (Table 7).

Table 6. Fodder yield of leucaena, acacia and calliandra species and accessions at three cutting heights at Bvumbwe during the 1998/99 season

Species	Cutting height (cm)	Leaf yield (kg ha^{-1})	Stem yield (kg ha^{-1})	Total yield (kg ha^{-1})	Leaf:stem ratio
Leucaena	0.25	432	2160	2992	0.36
collinsii	0.50	603	1921	2524	0.36
(OF1 51/88)	0.75	904	2208	3112	0.42
Leucaena	0.25	1193	2520	3713	0.47
tricandra	0.50	1198	1904	3102	0.58
(OF1 53/88)	0.75	1503	2313	3816	0.67
Leucaena	0.25	957	2380	3337	0.41
pallida	0.50	735	1560	2295	0.46
(OF1 137/94)	0.75	1337	2412	3749	0.55
Acacia	0.25	1675	2408		0.71
angustissima	0.50	2289	4366	4083	0.52
(OF1 68/92)	0.75	2391	3335	6655	0.73
Acacia	0.25	1516	2525	5726	0.60
angustissima	0.50	2119	3500	4041	0.64
(OF1 65/92)	0.75	2741	4687	5691	0.58
Acacia	0.25	2992	5028	7428	0.50
angustissima	0.50	2985	4734	8020	0.60
(OF1 70/93)	0.75	3442	5690	7219	0.64
Calliandra	0.25	1137	1663	9132	0.69
callothyrsus	0.50	1228	1649	2800	0.72
(OF1 12/91)	0.75	944	1628	2877	0.60
				2512	
Mean (overall)	1739	3029	4692	0.59	
SE \pm (interaction)	307	490	771	0.08	
cv (%)	32	29	30	24	

Table 7. Fodder yield of leucaena, acacia and calliandra species and accessions at three heights at during the 1999/2000 season.

Species	Cutting height (cm)	Leaf yield (kg ha^{-1})	Stem yield (kg ha^{-1})	Total yield (kg ha^{-1})	Leaf:stem ratio
Leucaena	0.25	1414	3073	4487	0.50

collinsii	0.50	1959	4526	6485	0.41
(OF1 51/88)	0.75	1985	3827	5012	0.51
Leucaena	0.25	2874	4746	7621	0.60
tricandra	0.50	1748	3239	4987	0.59
(OF1 53/88)	0.75	4098	5803	9880	0.70
Leucaena	0.25	2338	5135	7472	0.45
pallida	0.50	3397	6655	10,051	0.50
(OF1 137/94)	0.75	3805	6979	10,783	0.49
Acacia	0.25	3591	6530	10,121	0.58
angustissima	0.50	4632	7351	11,983	0.65
(OF1 68/92)	0.75	4442	7273	11,715	0.64
Acacia	0.25	4486	7870	12,356	0.58
angustissima	0.50	5268	8989	14,257	0.63
(OF1 65/92)	0.75	6131	10,190	16,321	0.60
Acacia	0.25	4837	11,343	15,864	0.54
angustissima	0.50	7796	11,315	20,736	0.58
(OF1 70/93)	0.75	7587	10,589	18,176	0.68
Calliandra	0.25	2642	4551	7093	0.61
callothyrsus	0.50	2978	4104	7081	0.77
(OF1 12/91)	0.75	3075	4735	7810	0.71
Overall mean	4160	7114	11,338	0.63	
SE± (interaction)	972	1743	2617	0.07	
CV (%)	50	53	50	23	

Conclusion

Under the conditions of this study, it can be concluded that growth, yield and quality of fodder from leucaena, acacia and calliandra are influenced by cutting regimes and location growth rate and number of plots per tree were highest at a cutting height of 0.25m. On the contrary, dry matter yields were highest at a cutting height of 0.75 m regardless of location. Based on location, *Acacia angustissima* accessions gave the highest fodder yields at Bvumbwe. On the other hand, the new introduction of leucaena species appeared to give higher yields than the acacia and calliandra accessions.

Finally it is concluded that the 8 accessions offer an attractive alternative to leucaena leucocephala. Further studies should screen leucaena leucocephala against these 8 accessions to confirm the results.

References

- Adeneye J.A. 1991. Mimosine content in various fractions of *Leucaena leucocephala* grown in Western Nigeria. *Journal of Animal Science and Technology* 33: 349–353.
- Akyeampong E. 1998. Comparative performance of *Leucaena pallida* and *Calliandra calothyrsus* on an acid soil in a sub humid environment in Burundi. *International Tree Crops Journal* 9(3): 227–232.
- Anderson J.M. and Ingram J.S.L. 1993. *Tropical Soil Biology and Fertility: A Handbook of Methods*. Second Edition CAB International. Wallingford, U.K.
- Bray R.A.F. and Woodroffe T.D. 1998. Resistance of some *Leucaena* species to the *Leucaena* psyllid. *Tropical grasslands* 22(1):1–10.
- Chamberlain J.R. 1998. Isozymic variation in *Calliandra calothyrsus*: Its implications for species delineation and conservation. *American Journal of Botany* 85(1): 37–47.
- Chen C.P., Halim R.A. and Chin F.Y. 1992. Fodder trees and fodder shrubs in range and farming systems of the Asian and Pacific Region: Legume trees and other fodder trees as protein sources for livestock. *Animal Production and Health* 102:11–22.
- Devendra C. 1992. Fodder trees and fodder shrubs in range and farming systems in Tropical Humid Africa: Nutritional potential of fodder trees and shrubs as protein sources in ruminant nutrition. *Animal Production and Health* 102:95–108.
- Dzowela B.H. 1994. *Acacia angustissima*: A Central American Tree that is going places. *Agroforestry Today* 6(3):13–14.
- Goering H.K. and Van Soest P.J. 1970. *Forage and Fiber analysis*. United States Department of Agriculture (USDA) Agriculture Handbook No. 379. USDA, Washington DC, USA.
- Karachi M. 1998. Variation in the nutrition value of leaf and stem fractions of nineteen *Leucaena* lines. *Animal Feed Science and Technology* 70(3): 304–314.
- Karachi M. and Shirima D.S. 1997. Agronomic evaluation of eleven *Leucaena* lines at Tambi, Tabora, Western Tanzania. *Agroforestry Systems* 35(2): 155–165.
- Kettler J.S. 1997. Fallow enrichment of traditional slash/mulch system in Southern Costa Rica. Comparisons of biomass production and crop yields. *Agroforestry Systems* 35: 165–176.
- Lesueur D., Tassin J., Evilorae M.P., Sarrailh J.M. and Peltier R. 1996. Improving *Calliandra* growth. *Agroforestry Today*. 8(3): 12–13.
- Savory R. and Breen D.A. 1979. Production of *Leucaena leucocephala* in Malawi. UNDP/FE/MW/75/020. Working Paper numbers 15–22.
- Savory R and Thomas D. 1977. *Pasture Handbook for Malawi*. Bunda College of Agriculture, Lilongwe, Malawi.
- Paterson R.T., Kariuki I.W. and Roothaert R.L. 1996. *Calliandra* for cows in Kenya. *Agroforestry Today* 8(4): 20–21.
- Tomaneng A.A. 1990. *Calliandra calothyrsus*: Observation on coppicing characteristics. *Agroforestry Today* 2(2):15.
- Van Den Beldt R.J. and Napompeth B. 1992. *Leucaena* psyllid comes to Africa. *Agroforestry Today* 4(4): 11–12.

Effect of draft work on production and reproduction of Malawi Zebu cows

S.K. Chikagwa-Malunga, W.F. Kumwenda and F.K. Nyondo
Chitedze Agric, Res. Station, P. O. Box 158, Lilongwe

[Abstract](#)

[Introduction](#)

[Objectives](#)

[Materials and methods](#)

[Results and discussion](#)

[Work performance](#)

[Cow weight changes](#)

[Calf weight development and milk yield](#)

[Reproductive performance](#)

[Conclusion](#)

[References](#)

Abstract

A study was carried out to evaluate the effect of draft on the performance of Malawi Zebu cows in order to supplement work oxen, which are in short supply. A total of 24 cows were randomly allocated to one of the following three treatments: a control group in which cows were not exposed to any type of work, a light work group where cows pulled a cart loaded with 300kg weight, or a cultivated light soils (sandy soils) and heavy work group where cows pulled a cart loaded with 600kg weight or cultivated heavy soils (clay soils). Work had no effect ($P>0.05$) on the milk yield of cows. Similarly there were no significant differences ($P>0.05$) on birth weight and weaning weight of their calves. The results indicate that Malawi Zebu cows can be used for draft work and calf growth provided the animals are adequately supplemented. Farmers are encouraged to use cows as a multipurpose animal for cow meat, milk and traction/draft power.

Introduction

The Agriculture Policy of the Malawi Government is to increase smallholder production of both food and cash crops through improved yields. In trying to achieve this, the government is encouraging and assisting smallholder farmers to adopt improved farm technologies including farm mechanisation in the form of animal draft power. Mechanising cropping operations using draft animals reduces timeliness of operations thereby reducing bottlenecks at peak periods of labour during land preparation, weeding and harvesting.

Animal traction fits into the existing smallholder-farming system and allows mixed cropping. The proportion of farmers using draft animal power (DAP) is only 13% (Moald 1990) and the estimated total population draft animals is 6,971 (Kumwenda and Kunkwezu 1987). A shortage of work animals (steers) limits the use of draft animals by smallholder farmers who are willing to have work animals. This constraint is partly due to competition between use of steers for draft and beef production. Therefore, use of Malawi Zebu cows is now encouraged in order to increase the number of draft animals, to allow more steers to be sold to other farmers for fattening thereby increasing meat supplies for human consumption as well as production of calves and milk, thus, making cows efficient utilisers of scarce feed resources.

Cows are 10 –15% lighter than males (Reh and Horst 1985) but females may be able to perform the same work as males especially if they work in sandy soils. Use of cows as draft animals would enhance the changing of pairs of work animals and result in healthier animals being used. Farmers with more animals may hire them out to farmers with few or no animals and this will increase the income obtained from the farmer's surplus animals.

Work on draught animal power (DAP) has been carried out for five years in order to support a viable introduction and development of a multipurpose draft option for the smallholder farmers in Malawi. From the little information available, it appears that the extent to which cows could be used for draught largely depends on the provision of adequate supplementary feed supplies, proper especially during the dry season. Studies on the effect of work on fertility and productivity of cows suggest that draft use may reduce consumption rate and milk yield if poor quality or insufficient feed is provided (Jabbar, 1993; Agyemang et al., 1983). However, data from the International Livestock Centre for Africa (ILCA) shows no significant differences in terms of productive and reproductive performance between draft and non draft cows which were both fed adequately (Agyemang et al. 1983). The provision of adequate feed in the dry season can be a problem since during this period both the quality and quantity of feed is very low. Availability of concentrates is sometimes a problem and their costs may hinder their use as supplementary feed for draft animals by most of the smallholder farmers. In such cases, feed stuffs, which are locally available, for example, tree fodder mixed with crop residues, can be important sources of feed for working animals.

The work by Chamdimba (1991) shows that Malawi Zebu cows can be used for draft work and that such a practice would impose minimal adverse effect on milk production and calf rearing. However, the effect of work on the fertility of Malawi Zebu cows was not studied in detail. Many factors were also omitted from the study such as differences in field conditions, like soil condition and temperature. It is also not known how much energy was expended by cows in specific groups.

Although Reh and Horst (1985) and Agyemang et al. (1983) indicated that cows could be used for draft without any adverse effect on fertility and milk production, especially if the requirement for draft is light and for short periods, the minimum work for draft cows is still not clear. Malawi Zebu cows traditionally are utilised over long periods of the day, as they are used to travelling long distances to provide transport for smallholder farmers. Therefore, there is a need to come up with the minimum work for draft cows as well as feed packages for recommendations to smallholder farmers.

Draft cows may be used during early or late pregnancy and this may lead to abortions or stillbirth even with minimum use at these times. Agyemang, et al. (1983) did not observe this probably because cows worked for 3 hours per day only. It is therefore important that further investigations should be carried out to determine when the cow should be worked depending on the condition of the animal.

Objectives

- To evaluate the potential of Malawi Zebu cows for draft work in order to supplement work oxen, which are currently in short supply.
- To evaluate the effect of work on body weight changes, fertility and milk production of Malawi Zebu cows.
- To investigate factors affecting work output of cows as draft animals.
- To investigate the effect of supplementary feeding on live weight and work output of Malawi Zebu cows.

Materials and methods

This research which was initiated by Bunda College and continued by Chitedze Research Station was carried out at Mbawa experimental station for five years. The experiment involved a total number of 24 cows, which were randomly allocated to three treatments comprising of 8 animals each. Treatment I involved a control group in which cows were not exposed to any type of work. In treatment II (light work group), cows pulled a cart loaded with 300kg weight or cultivated light soils (sandy soils). Treatment III was the heavy work group and cows pulled a cart loaded with 600kg weight or cultivated heavy soils (clay soils). Each pair of cows was worked three times a week for three hours per day. The cows were working throughout the year alternating between pulling a load, ploughing or ridging. The route for carting was fixed at a stretch of 11km.

Milking was done everyday in the morning and daily milk yields were recorded. Cows were weighed once a month and calves were weighed at birth and at two week intervals up to weaning (7 months). All data were analysed using statistics version 3.0 Analytical Package Programme. Data, which was subjected to analysis of variance (ANOVA), included plough, ridge and cart rate, body weights, deaths and weaning weights, milk yields and conception rate.

Results and discussion

Work performance

The effect of each treatment on working area, time and speed are presented in Table 1. Treatment had no effect on working area, time and speed as the differences between the two treatment groups were small ($P>0.05$). However, cows working on heavy soil tend to cultivate a bigger area than cows on light soils.

The results on working time are consistent from 1990 to 1994 although the results reported by Jere and Zimba (1994) were somewhat lower than those reported by Chamdimba (1991) which ranged between 0.19 and 0.20 ha per day. One of the causes would have been the level of supplementation, which was generally reduced to maize bran only i.e. 1.3kg per animal per day while Chamdimba fed 5kg Rhodes grass per animal per day in addition to maize bran. In this study the cows had a much lower work rate than that of Malawi Zebu oxen. Several factors might have influenced the speed of work of these cows and these include weather, soil condition and depth of ploughing. Hot days and very wet soils, especially for the heavy clay soils, reduced work speed greatly. Thus, animals slowed down in their work in hot weather conditions because they got tired easily. Dry soil conditions, especially in clay loam soils, increased the draft power requirement and hence lowered working rates. Ploughing operations had higher draft requirements than ridging. However, cows developed adequate power for ploughing provided they were adequately supplemented for work. In all operations the heavy work group had a higher draft power output than the light weight group (Table 1) indicating that the performance of the heavy weight group was better than that of the light weight work group.

Table 1. Performance of cows in light and heavy work

Operation	Year	Light work	Heavy work
Ridging area (ha)	1991–93	1.03 ± 0.06	1.28 ± 0.08
	1993–94	0.09 ± 0.06	0.12 ± 0.12
	Mean	0.56	0.70
Ridging time (hr.)	1991–93	2.22 ± 0.06	2.27 ± 0.06
	1993–94	2.55 ± 0.44	2.10 ± 0.32
	Mean	2.39	2.19
Ridging speed	1991–93	0.46 ± 0.43	0.56 ± 0.59
	1993–94	0.03 ± 0.03	0.05 ± 0.04
	Mean	0.25	0.31
Ploughing area (ha)	1991–93	0.82 ± 0.02	0.93 ± 0.03
	1993–94	0.05 ± 0.07	0.05 ± 0.05
	Mean	0.44	0.49
Ploughing time (hr.)	1991–93	2.26 ± 0.03	2.23 ± 0.03
	1993–94	2.29 ± 0.40	2.21 ± 0.34
	Mean	2.28	2.22
Ploughing speed (ha/hr)	1991–93	0.36 ± 0.38	0.42 ± 0.21
	1993–94	0.02 ± 0.02	0.02 ± 0.02
	Mean	0.19	0.22
Carting distance (km)	1991–93	10.4 ± 0.28	10.4 ± 0.10
	1993–94	8.68 ± 2.26	8.07 ± 2.14
	Mean	9.54	9.24
Carting time (hr)	1991–93	2.8 ± 5.10	3.0 ± 0.01
	1993–94	3.05 ± 0.06	2.98 ± 0.26
	Mean	2.93	2.99
Carting speed (km/hr)	1991–93	3.7 ± 0.01	3.5 ± 0.03
	1993–94	2.87 ± 0.73	2.77 ± 0.61
	Mean	3.29	3.14

Cow weight changes

Table 2 shows the average live weight changes of cows for each treatment group from March 1991 to March 1994. There were no differences in live weights among the three treatment groups ($P>0.05$). In general, all cows in the different treatment groups lost weight between 1991 and 1992 but gained weight in 1993 although the difference in live weight changes were not significant. These results indicate that work did not have an adverse effect on live weight of the cows. This was probably due to adequate supplementation. However, Chamdimba (1991) observed that the period of calving (September–October and November–December) had an effect on cow live weight. September–October calvers had a higher weight loss due to slightly heavier birth weights of their calves (18.25kg) and the weight loss thereafter was an effect of the deteriorating feed quality and quantity towards the end of dry season. Those that calved in November–December experienced a lower weight loss as an immediate effect of calving due to slightly lower birth weights of their calves (17.11kg). These late calvers did not experience a long period of weight loss after calving as quantity and quality of feed improved within 3 to 6 months after calving, providing sufficient nutrients for cow and calf growth as well

as for increasing milk production. It is also important to observe that in some years (1993–94) cows that were not exposed to any work were the lightest, although this was not significant there may have been additional factors affecting the weight of these cows apart from draft work.

Table 2. Average live weight of cows for light and heavy work

Year	Control	Light work	Heavy work	Mean
1991	293.5 ± 6.1	283.3 ± 8.6	298.0 ± 8.0	291.6 ± 7.28
1992	283.3 ± 3.44	264.7 ± 3.44	273.6 ± 5.4	273.8 ± 2.05
1993	286.8 ± 87.0	304.7 ± 35.2	297.5 ± 85.6	296.6 ± 85.65
1994	271.1 ± 105.3	310.7 ± 32.9	298.0 ± 19.13	293.0 ± 66.54

Calf weight development and milk yield

Birth weights, weaning weights and average milk yields for 1991, 1992 and 1993 are indicated in Table 3. Birth weights between the treatment groups were not significantly different ($P>0.05$). Similarly, there were no differences in weaning weights and 200-day adjusted weaning weights although the heavy work group calves were heaviest followed by the non-working group and then the light work for 1991, 1993 and 1994.

Table 3. Productive performance and milk yield of cows for each treatment group

Year	Parameter	Control	Light work	Heavy work
1991	Birth wt (kg)	16.75 ± 1.55	17.88 ± 2.55	18.41 ± 0.69
	Calf ADG (g)	343.5 ± 52.7	292.6 ± 57.8	361.3 ± 48.4
	Milk yield (kg/d)	1.780 ± 0.38	1.433 ± 0.28	1.682 ± 0.55
1992	Birth wt (kg)	16.7 ± 2.51	17.4 ± 5.77	18.2 ± 2.07
	Weaning wt(kg)	77.2 ± 32.55	74.4 ± 31.57	89.2 ± 11.07
	200 days(kg)	72.3 ± 29.77	67.1 ± 28.33	83.5 ± 7.11
	Milk yield(kg/d)	1.5 ± 0.55	1.2 ± 0.42	1.4 ± 0.46
1993	Birth wt (kg)	14.9 ± 3.42	15.4 ± 6.53	15.7 ± 11.71
	Weaning wt (kg)	64.8	62.9	72.2
	200 day wt (kg)	63.2 ± 19.96	59.6 ± 26.56	71.1 ± 46.74
	Milk yield kg/d	1.61 ± 0.97	1.92 ± 0.66	1.94 ± 0.74

Chamdimba (1991) observed that the average daily gain (ADG) was highest for the calves in the heavy work group followed by those in the non-working group while the light work group had the lowest ADG. He also observed that calves that were born in November/December were slightly lighter in birth weight than those born in September/October (Table 4). Because of poor pasture conditions, their dams went through immediately before they calved and there was a limited supply of nutrients for the growing foetus. The severity of poor feeding increased as the dry season progressed. For these early calvers, grass was insufficient during the time that calf growth was totally dependent on milk supplied by the dam. Therefore, September/October calves delayed rumen development because they could not consume the feed, which had high crude fibre (CF).

On the other hand, calves born in November/December showed an overall faster growth than those born in September/October because of improved pasture conditions with the rains, which started soon after they were born. Work of the dam had a significant disadvantage on growth of their calves only in the light work group.

Milk yield was not different between the treatment groups. Thus, work did not have an effect on milk production in cows kept under the proper feeding management. This is in agreement with the results of Zerbini (1993). The period of calving had an influence on milk yield (Chamdimba 1991). The milk yield of animals that calved in September/October rose for a short time and then declined abruptly with inadequate feed availability until week 10, when it rose again. The rise in milk yield from the 10th week onwards took place after the first rains had started when pasture was plentiful. Those that calved in November/December were able to increase their milk yield (Table 4) consistently, as pasture became available before the body reserves were depleted. Malawi Zebu mean daily milk yield was 1.63 litres for the non-working group; 1.52 litres for the light work group and 1.67 litres for the heavy work group from 1991 to 1993. Malawi Zebu can produce an average daily milk yield of 1.591 with a mean lactation of 261 days in its first lactation (Kasowanjete 1981). The national average is estimated at 1.7 litres/day; (range 2.21–1.2 litres) (Bunda College of Agriculture and Chitedze Research Station 1988).

Table 4. Effect of period of calving on birth weight, milk yield and calf average daily gain

Parameter	Period of calving	
	September/October	November/December
Birth weight (kg)	18.25 ± 2 .02	17.11 ± 1.17
Milk yield (kg /day)	1.484 ± 269	1.716 ± 0.491
Calf ADG (g)	351 ± 60	346.8 ± 60.1

Reproductive performance

Cows were served every year between December and March, and the same bull was used in all the three treatment groups. The effect of work on conception rate is shown in Table 5. Conception rates were 100% in 1990 and 1992 in all the three treatment groups indicating that work did not have any adverse effect on conception in those years. No negative effect of work was observed on the calving performance of the working cows. None aborted, gave stillbirths or showed any sign of difficulty in calving. Conception rates varied from year to year in all the three treatments. It is also important to note that in 1991, no animal conceived for the light work group. This was probably because the Malawi Zebu cow is a low producer with a long calving interval, which can go beyond 12 months. The period of calving had an effect on cow body weight development. September/October calvers did not only experience a higher weight loss at the time of calving but that weight thereafter continued to decrease until about December, when the animals started to regain weight. Those calving in November/December did not lose weight due to calving but were able to regain weight shortly after calving.

Table 5. Effect of work on conception rates

Year	Control	Light work	Heavy work
1990	100 (8)	100 (8)	100 (8)
1991	12.5 (1)	0 (0)	0 (0)
1992	100 (8)	100 (8)	100 (8)
1993	50 (4)	62.5 (5)	12.5 (1)
1994	62.5 (5)	75.0 (6)	62.5 (5)

Figures in brackets indicate number of animals, which conceived.

Conclusion

The results of this 5-year on-station study indicate that Malawi Zebu cows can be used for draft work and calf growth. Cows can do heavy work without significant negative effect on other productive performance, like milk production for calf rearing and for subsistence consumption. Work did not disadvantage the general performance of their calves when compared to non-working counterparts. However, effects of work on fertility is still not clear as conception rates tended to fluctuate as the years progressed in all the treatment groups, including the non-working cows.

In addition, work rate achieved by the treatment animals was much lower than that reported in the literature. Therefore, further investigations should be carried in these areas so as to substantiate the current findings especially on conception rate and work output of Malawi Zebu cows before they are recommended for smallholder use. Future studies should also look at parameters like feed intake of the animals, amount of energy expended when working, amount of time spent working, soil condition and ambient temperature. It is therefore recommended that future research on draft animals should be carried out by the Farm Machinery Commodity with the Livestock Commodity playing a supporting role.

References

- Agyemang K., Asteatke A., Anderson F.M. and Youlbeab W. M. 1983. *Early indicating of effects of work on reproduction and reproductive performance of dairy cows in the Ethiopian highlands*. ILCA (Mimeograph).
- Bunda College of Agriculture and Chitedze Research Station. 1988. *Beef/dairy production systems in Malawi*, Annual Technical Report. Lilongwe, Malawi.
- Chamdimba E.A.T. 1991. *The effect of draft work on some productive characteristics of the Malawi Zebu (Bos indicus) heifers and their calves*. MSc thesis, Bunda College of Agriculture, University of Malawi. Malawi.
- Jabbar M.A. 1993. Research on cow traction in Africa; some lessons to be learned. *World Animal Review/Revue Mondiale de Zootechnie* 74/75: 1–2.
- Jere A.J. and Zimba A.W.C. 1994. *Effect of draft work on some production characteristics of Malawi Zebu cows*. Technical Report. Chitedze Research Station, Lilongwe, Malawi.
- Kasowanjete M.B.B. 1981. Breeds of cattle and breeding programmes in Malawi. *Presented at the FAO/SIDA workshop on breeding and feeding of cattle for milk production. December 1981. Lilongwe, Malawi*.
- Kumwenda W. and Kunkwezu E. 1987. *Research on use of draft animal power and mechanisation in Malawi: Proceedings of a workshop on animal tracking and agricultural mechanisation research in SADC countries. Maputo, Mozambique, 8–12 August 1987. Unpublished data*.
- MoALD (Ministry of Agriculture and Livestock Development). 1990. A guide to agriculture production in Malawi (1989–1990). Ministry of Agriculture and Livestock Development, Malawi.
- Reh I. and Horst P. 1985. Beef production from draft cows in small-scale farming systems. *Quarterly Journal of International Agriculture*. Vol. 24 no. 1:38–47.
- Zerbini E. 1993. Cow tracking - What about milk and calves? Newsletter 10 (1). ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

A study of the flock dynamics, marketing, and socio-economic roles of small ruminants in crop–livestock farming systems in Malawi

J. W. Banda, S. C. F. Chapa, A. K. Nyasulu, W. Muyaya and C. S. Mataya
Bunda College of Agriculture, Lilongwe, Malawi

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Results and discussion](#)

[Productive and reproductive coefficients](#)

[Marketing](#)

[Socio-economic contribution](#)

[Conclusions](#)

[References](#)

Abstract

The study was aimed at establishing the flock dynamics, supply patterns and the socio-economic importance of small ruminants, especially goats, to household income and food security. The performance of 337 goats from 43 households owning goats was monitored for some productive and reproductive parameters. Questionnaire surveys of the producers and sellers (stock agents and or middlemen) were conducted in four locations covering a total of 722 records of sellers and 651 buyers between January 1996 and January 1998. Data collected included supply of goats and sheep, characteristics of animals, prices and forms sold, constraints in buying and selling goats and sheep, and suggestions for future improvements.

The average flock size was 8. The annual parturition rate was 83% with a prolificacy of 1.3 kids per female per year. Overall mortality rate was 34% with a risk of 28.8%. Mortality rate was higher in rearing males (42%) than in breeding stock (15%) or suckling stock (27%) showing that rearing kids are at high risk of dying before 12 months of age. The overall offtake rate was 21% with a risk of 19%. It increased from young to old stock, and was highest in rearing and breeding stock.

Of the total goat supplied, producers themselves sold 44.8% while middlemen sold 55.2% ($P < 0.01$). For sheep, only 28.1% were supplied by the producers while middlemen supplied 71.9%. Middlemen supplied more animals to the markets irrespective of season. Their animals were heavier and they obtained significantly ($P < 0.001$) more cash for their animals. The profit margins were 29–39% for producers and 33–58% for middlemen ($P < 0.05$). The margins for

sheep were 24% for producers and 35–44% for the middlemen. As the age of the animals increased, the live weights, and selling and buying prices increased ($P < 0.05$). However, profit margins significantly decreased after animals attained a third pair of permanent incisors. The results show how much the middlemen contribute to the offtake and income of the farmers.

The proportion of profit goats produced was 77.4% of the capital invested, which is greater than 46–52% interest charged by the lending commercial banks in Malawi. The contribution of small ruminants to total gross returns of the farms was 30.3%.

It is suggested that mortality, especially of rearing stock, and offtake of females should be reduced in order to sustain goat numbers and make goat production profitable and sustainable. Improvements in the marketing of goats could be achieved through improved farm productivity and social as well as physical marketing facilities.

Introduction

The goat, sheep and cattle populations in Malawi are 1,600,000, 100,000 and 600,000, respectively (NLDMP 1998). Most of these animals are kept by smallholder farmers who own less than 1 to 1.5 ha of land. For survival, these farmers practice integrated farming based on crop/livestock production. The small pieces of land have encouraged many households to keep small ruminants as opposed to cattle. This has led to an increase in the goat population from 800,000 in 1990 (NLDMP 1998) to 1,600,000 in 1998 and a decrease in cattle population from about 1 million in 1990 to 600,000 in 1998. However, the productive and reproductive coefficients that contribute to the changes in goat populations have not systematically been determined.

The small land holdings make it difficult for the households to produce enough food for the family members to last the whole year. Consequently, there are regularly recurring periods every year when the staple food (maize) runs out from September (World Bank 1995). This period coincides with the time of greatest workloads in crop fields. During such times, selling of goats to earn cash to purchase food is one of the major strategies farmers take to make their households survive. Due to these sales, the contribution to the socio-economic and cultural objectives of the rural community is quite large, but is quantitatively unknown.

Despite the recognised contributions of goats to smallholder farms, such roles and contributions have not fully been studied and quantified. The knowledge of the system in which goats interact with other farm enterprises is essential for identifying opportunities to shape the future of small ruminant production in Malawi.

The objective of this study was, therefore, to characterise and quantify some of the productive and reproductive coefficients and the marketing and socio-economic roles of small ruminants with a view to influencing policy formulation that may lead to economically sustainable production in crop/livestock systems.

Materials and methods

Data were collected during implementation of the EU- Science and Technology in Development Programme 3 (EU-STD3) Research Project on small ruminant production. The study was carried out in four locations of Mitundu, Nanjiri, Kamphata and Nkhoma in Central Malawi (crop/livestock production area). Tobacco and maize are the major crops grown and goat production is one of the major livestock activities households are engaged in. Very few households keep sheep.

The methodology included initially a cross-sectional baseline socio-economic household survey. The household survey was carried out to provide information on the family size and

age structure, household activities other than livestock production, land use, intra-household division of labour, as well as ownership patterns and production goals. It included livestock production systems and constraints in general. This survey covered 100 households in all four locations and 43 flocks (households) were selected randomly based on the outcome of the 100 farms covered for the monitoring phase as well as during the marketing surveys.

The monitoring phase involved monitoring flocks of goats that were tagged for identification. All animal related production parameters regarding events such as births, deaths, sales, purchases, slaughters, gifts and thefts, as well as factors influencing these events, were recorded on structured forms by trained enumerators, who visited each household once or twice a month over 12 months. Weights and ages of all the goats were recorded during the visits. From the data collected, parturition rates, offtake rates, mortality rates, survival abilities and their associated risks including those due to sales and slaughters were derived. Incidence and risk rates were calculated for all classes of animals covered.

At the same time that monitoring of the flocks took place, the relative profitability and income contribution of the goats were studied on 40 out of the 43 farms. Simple budgeting and gross margins analyses were used at household level and the results were then pooled over 40 households.

Detailed marketing studies were conducted between January 1996 and January 1998. Structured questionnaires were used in both phases covering four major markets of Mitundu, Nanjiri, Kamphata and Nkhoma where monitoring studies were conducted. The interviews included sellers (producers/middlemen) and buyers (consumers). Information on sellers included their background profile, supply of goats/sheep and the characteristics of animals supplied, prices and forms sold, constraints in selling animals or buying animals and what the government should do to assist them. Information on buyers (consumers) included their background profile, demand consumption patterns, expenditures on the various foods, meat and market preferences, and problems faced in buying goat/sheep meat.

All data were analysed using SPSS/PC+ software by generating frequencies and other descriptive statistical parameters. Where appropriate cross tabulations were conducted. One-way analysis of variance was carried out where appropriate.

Results and discussion

Productive and reproductive coefficients

The average flock size was 8 (range: 2–21). Over 56% of the flocks had less than 8 goats per flock. Breeding and rearing females (before first parturition) comprised 82% of the flocks. This implies that farmers are conscious of keeping only those animals which are productive for increasing the herd. The flock size reported here is similar to that reported by Rischkowsky and Steinbach (1997) and Banda et al. (1998) for other parts of Central Malawi. The annual parturition rate was 82.6 with a prolificacy of 1.3 kids/parturition. This rate is lower than that obtained by Banda (1992) of 1.47 for local goats. Rischkowsky and Steinbach (1997) obtained even higher values of 2.0 for local Malawi goats.

Table 1. Some productive and reproductive coefficients of the flocks studied

Number of flocks	43
Total number of parturitions	200
Number of first parturitions	29
Annual parturition rate (%)	82.6
Number of kids born per parturition	1.3

First parturition before 18 months of age (%)	79
First parturitions between 18 and 24 months (%)	21
Males surviving to 6 months of age (%)	88.2
Females surviving to 6 months of age (%)	88.2

Table 2 shows some productive and reproductive parameters by class of goats in the villages studied. The large proportion of the flocks was composed of breeding females. This shows that farmers are consciously keeping the females for breeding. The number of breeding and rearing males was kept to a minimum because most of these animals are sold before they reach 18 months. The highest offtake risk of about 88% was observed in males above the age of rearing.

Table 2. Some productive and reproductive parameters by class of goats in Central Malawi.

	No. anim.	Flock	Mortality	Offtake	Theft
	in flock	structure*	(%)	(%)	Lost(%)
Suckl. Stock(0-6mo)	92	27.3	27	27	0
Rear. males(6-18mo)	17	5.0	42	25	0
Breed. males(>18mo)	2	0.6	–	3	0
Rear.fem.6-1st Kidd)	87	25.8	–	20	3
Breed.fem.(>1st Kidd)	139	41.4	–	43	6
Rear.+Breed fem.	226	67.1	15	24	9
Total	337				

* Add to more than 100% due to the combination of animal classes.

The overall mortality rate was 34.0% with a risk of 28.8%. The mortality rate was highest for rearing males, followed by suckling stock. These values are higher than those reported by Rischkowsky and Steinbach (1997), although the methodology of calculation was different. Mortality rates were higher in rearing males (42%) than in either suckling stock (27%) or rearing plus breeding stock (15%), particularly starting from June, soon after harvest. The trend was also similar for suckling stock.

The overall offtake rate was calculated to be 21.1% with an offtake risk of 19.0%. The offtake rate increased from young stock to old stock. The risks of offtake were highest in rearing and breeding stock. The major reasons for the offtake were mainly the need for cash, if the animals were sold or slaughtered for ceremonies and family consumption.

Marketing

Male animals were mostly sold and this agrees with results of Kusina, Dzudar, Chikura and Sibanda (2000) in Zimbabwe. Since most males were sold, the season of sale was monitored. It was observed that most sales took place from September to March during the study period. Normally, most slaughters and sales of goats take place from September to March each year (Figure 1). During this period yearly food shortages recur in households. Hence as a family survival measure, selling of goats or slaughter are the main ways for obtaining cash for food, which runs out by September (World Bank 1995). It is also the period when slaughters are most predominant due to hunger, and when the social and ritual dances take place. It is common to see goats being slaughtered.

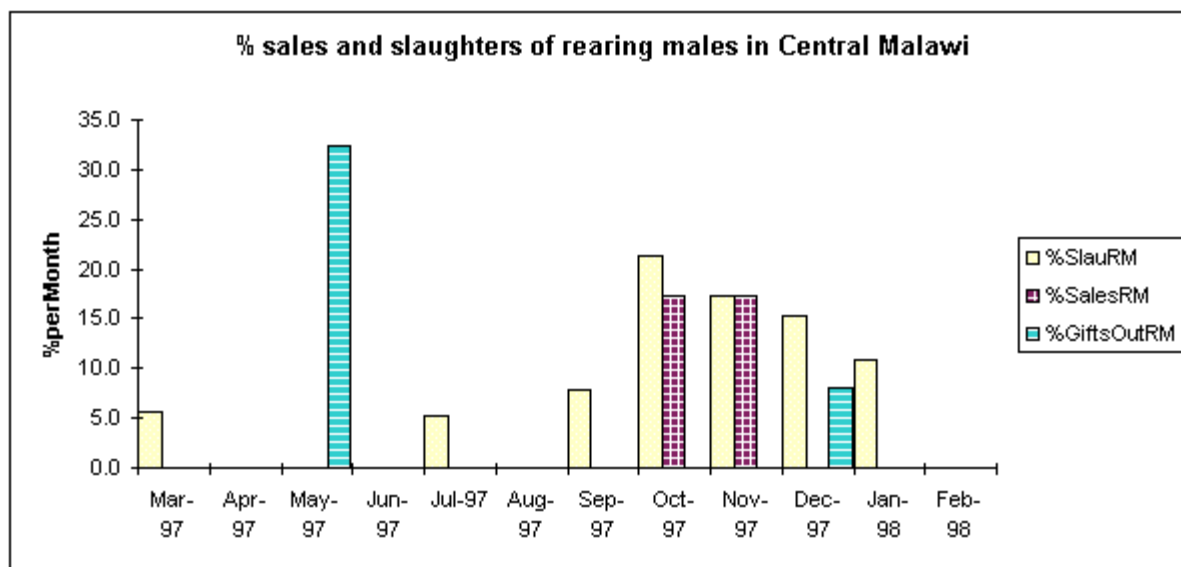


Figure 1: Percent of sales and slaughters of rearing males in Central Malawi.

Of the goats sold at all farms, 47% of the goats were sold directly at the market or to other farmers by the producers themselves while 53% were sold by the middlemen who purchased the goats from the farmers. The prices of goats sold by the producers and those purchased and sold by the middlemen were recorded. The summaries are shown in Table

Table 3. The average sale prices and marketing margins of goats by the producer in 1997/98 (US\$1=MK 26.00)

	Producer/own	Middleman	Sign
% of total sold	45	55.2	**
Av. weight buying (kg)	22.8 ± 7.0	23.9 ± 6.0	NS
Av. buying price (MK)	256 ± 68	285 ± 9	NS
Av. selling price (MK)	298 ± 107	377 ± 142	***
Av. Margin (MK)	72 ± 87	92 ± 83	***
% Margins	29 ± 31	33 ± 28	*
Av. sell price dead (MK)	356 ± 160	449 ± 148	
% final margin	39 ± 51	58 ± 82	NS

NS = Not significant; * = P<0.05; ** = P<0.01; *** = P<0.001

Producers make 29–39% profit margins while middlemen make 33–58%. The contribution of small ruminants to the producer (owner) and even to the middleman is quite immense. The producers who also sell their own animals walk an average of 8 km only while middlemen walk an average of 12 km. There were no significant differences in distance sellers moved with regard to sheep marketing. Irrespective of type of supplier, the mode of transport was predominantly either on foot (40.2%) or on bicycle (57.1%). The differences in profit margins

and goat/sheep selling prices could be attributable to the distances moved, and not to mode of transport. The observations in the present study are not in agreement with the results reported by Lovelace, Vaz, Mikuka, Simukoko and Chitambo (1997) of 38% for farmer, 32% for stock agent and only 16% by market trader. The low prices obtained by small ruminant producers in the villages suggest that farmers have less bargaining power than the middleman who took 33–58% of the final price as profit for transportation, market fee, market storage and for the labour (time).

Table 4. The average sale prices and marketing margins of sheep by the producer in 1997/98 (US\$1=MK 26.00)

	Producer	Middleman	Sign
% of total sold	28.1	71.9	**
Av. weight buying (kg)	22 ± 6.5	24 ± 6.2	NS
Av. buying price (mk)	281 ± 70	279 ± 95	NS
Av. selling price (mk)	300 ± 133	377 ± 146	NS
Av. Margin (mk)	57 ± 81	98 ± 72	NS
% Margins	24 ± 36	35 ± 22	NS
Av. sell price dead (mk)	664 ± 122	495 ± 117	NS
% final margin	–	44 ± 22	–

NS = Not significant; ** = P<0.01

The market prices and marketing margins for sheep are higher than for goats due to the long distance covered in sheep movements (over 26 km) compared to goat movements (10 km), but also due to the scarcity of sheep compared to demand for sheep. Sheep in Malawi could therefore be considered as a luxury if purchased by Malawians. More effort in multiplication of sheep and investment in marketing infrastructure could lower marketing costs of sheep to that closer to goats.

Table 5. Characteristics and prices of goats marketed related to age of the animals

Age by dentition (pairs)						
	0	1	2	3	4	Broken teeth
Average Number Sold	1.0	1.3	1.4	1.4	1.6	1.0
Liveweight (kg)	14.4 ^a	17.5 ^b	22.3 ^c	24.3 ^{cd}	26.6 ^d	28.4 ^e
Buying price	198 ^a	219 ^b	304 ^c	291 ^c	313 ^{cd}	315 ^d
Selling price	212 ^a	300 ^b	370 ^c	320 ^b	367 ^c	402 ^d
% Margin	15.0 ^a	64.6 ^c	46.5 ^b	23.9 ^a	20.0 ^a	40.6 ^b
Price of dressed goats	296	345	461	363	446	245
% Final Margin	–	32.0	48.4	31.2	31.5	36.1

There are clear differences (P<0.01) in prices related to age and weight of the animals. As age advanced, live weights and hence buying and selling prices significantly increased. This trend was also reported by Lovelace et al. (1997). However, the margins obtained decreased significantly after the animals reached 3 pairs of teeth. A similar trend was observed in sheep. It is therefore important that farmers be advised to sell goats when they have reached this

stage. The best option for farmers to get the best price is to sell at the right age and weight which could be achieved through improved nutrition. This will improve the income and relative profitability of the enterprise. This is particularly important in this mixed crop/livestock system of Central Malawi where only a few goats (1–4) may be culled or selected for marketing.

At the other end of the chain, buyers of meat or goats for consumption (consumers) were interviewed on the problems they face in buying goats or goat meat. Table 5 indicates the high prices of meats, poor handling or poor hygiene during slaughter and selling (with no refrigerators) and non-availability of goat/sheep (especially sheep) meat, ranked in this order, irrespective of the type of consumer. The high cost of goat meat discourages consumers from purchasing them in large amounts.

Table 6. Problems with buying goats, sheep and their meat

	Rural		Urban		Total	
	No	%	No	%	No	%
Meat not available	27	19.7	3	2.2	30	21.9
Prices very high	33	24.1	11	8.0	44	32.1
Long distance to market	8	5.8	1	0.7	9	6.6
No standard/cheating	4	2.9	0	0.0	4	2.9
Handling/hygiene poor	30	21.9	4	2.9	34	24.8
Others	10	7.3	6	4.3	16	11.7
Total	112	81.8	25	18.2	137	100.0

Socio-economic contribution

Results on the profitability of the goat enterprises as well as their income contribution to the rural households are presented in Table 6.

Table 7. Simple budget for goat production enterprise in the 40 villages in central Malawi

Variables	Total value (MK)
A. Revenue	2425.00
B Operating costs	115.98
C: Fixed cost value	322.90
D: Interest on capital invested (opp. cost)	49.00
E: Total cost of enterprise (B+C+D)	487.88
F: Net profit of enterprise (A-E)	1937.12
G: Net profit per animal	387.42
H: Percentage return on capital	77.4

On average, the small ruminant production enterprise earned a household a total net profit of MK1937.12 (US\$49.18) for an average flock of 5 per family. An animal, therefore, made a net profit of MK387.42 (US\$9.68). The proportion of this is 77.4% of the capital invested which is greater than 46–52% interest charged by the lending commercial banks in Malawi. This very high contribution is due to very low inputs injected into small ruminant production compared to the output. Panin (1997) found similar results. This suggests that small ruminants are profitable under this system of management.

Table 8. Summary of income analysis in the in Lilongwe, Central Malawi

Income source	Total income (MK)	% Contribution
A:Net crop income	925.45	11.6
B:Net livestock income	5800.00	
C:Net income: small ruminants	2450.00	30.3
D:Net income: cattle	2850.00	35.6
E:Net income: others livestock	500.00	6.2
F:Net farm income	5775.00	
G:Off farm income	1310.00	16.4
H:Total net household income	8010.45	100.00

The average net household income was MK8010.00 (US\$200). About 30% of this was from small ruminants. Compared to crops which contributed 11.6% to the total net farm income, livestock contributed 72%. Cattle alone accounted for 35.6%. Although the households were predominantly goat owners, the contribution of small ruminants surpassed that of crop production by 17%. This provides ample evidence for the farmers to reallocate resources to small ruminants. The conclusions may, however, vary depending on the farm enterprise combination.

Therefore, more technologies and development initiatives should be implemented in order to reduce poverty and contribute to nutritional and incomes of the rural households through goat production. These results could be used for decision making on resource allocation by farmers themselves, policy makers and other institutions involved in small ruminant production.

Conclusions

The study revealed that the Malawi goats in the villages are more prolific, but have a high mortality rate in rearing stages of males (42%) and that 27% of the suckling stock risk dying before 12 months of age. The offtake rate was 21% with a risk of 19%. It increased from young to old stock, and was highest in rearing and breeding stock. These observations are very high and pose a problem in sustaining flock numbers and making the enterprise competitive in the crop-livestock farming systems. It is suggested that in order to sustain goat numbers and make goat production profitable and sustainable, mortality, especially of rearing stock and offtake of females should be reduced. In addition, improvements in management should be made to avoid the factors which cause mortality and reduced survival of the goats.

For the marketing system to be sustainable and benefit all the producers, middlemen and consumers, the producer has to make goats available that are in good condition and age as well as weight. This calls for improved productivity at the farm level by increasing the reproduction/breeding and nutrition, management and disease control. This will automatically reduce meat prices. Middlemen and sellers themselves must endeavour to maintain high handling and hygienic standards, if consumers are to be satisfied. The sellers and/or middlemen could form groups and contribute to a revolving fund from sales to improve the marketing facilities, other than waiting for funds from the government.

References

Banda J.W. 1992. *Genotypic and seasonal influences on milk yield and milk composition of sheep and goats in Malawi*. PhD thesis, Justus-Liebig-University of Giessen, Germany.

Banda J.W., Mtukuso A.P. and Jere J.A. 1998. Small ruminants in smallholder crop/livestock systems in Malawi Identification and prioritisation of constraints. *UNISWA Research Journal of Agriculture, Science and Technology*. 2(1): 180–183.

Kusina N.T., Dzudar L., Chikura S. and Sibanda S. 2000. Goat marketing systems in a crop-livestock farming system in Wedza Communal Area and consumer preferences for goat meat in some areas in eastern Zimbabwe. *FVSc/DGIC/ITM Workshop on Health, Production and Management of Small Ruminants*. 14–16 August, 2000, Harare, Zimbabwe.

Lovelace C.E.A., Vaz Y., Mukuka J., Simukoko H. and Chitambo H. 1997. *The marketing chain for goats from farms in the Zambezi Valley in Zambia*. Technical Report, EU-STD3 Project/Zambia, Lusaka, Zambia.

NLDMP (National Livestock Development Master Plan). 1998. Customary land livestock census. National Livestock Development Master Plan. Department of Animal Health and Industry (DAHI), Ministry of Agriculture and Irrigation (MoAI), Lilongwe, Malawi.

Panin A. 1997. Profitability and household income contribution of small ruminants to small-scale farmers in Botswana. *Small Ruminant Research* 25: 9–15.

Rischkowsky B. and Steinbach J. 1997. Goat's milk for smallholders in Malawi - A way of improving the nutrition of the rural population. *Animal Research and Development* 46: 55–62.

World Bank. 1995. *Malawi Food Security Report*. Report No. 8151 - MAI, 27 June, 1995.

Prospects of genetic improvement programmes in small populations: A case of dairy production in Malawi

Mizeck G. G.Chagunda^{1, 2}, Clemens B. A. Wollny² and Erich W. Bruns¹

Department of Animal Science, Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe, Malawi Institute of Animal Breeding and Genetics, Georg-August-University of Göttingen, Germany.

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Results and discussion](#)

[Productive and reproductive coefficients](#)

[Marketing](#)

[Socio-economic contribution](#)

[Conclusions](#)

[References](#)

Abstract

Genetic improvement is inherently a long-term process in which the progress in the future is built upon improvement in the past (Gibson and Wilton 1998). To this end, setting up of well-defined breeding goals, organising a well co-ordinated recording system, defining elaborate breeding strategies, and establishing selection programmes for improving economically important variables including adaptation traits, are a prerequisite. Genetic evaluation of breeding strategies to generate information that could be utilised in making breeding decisions is essential. It is important to set up systems of getting reliable data on the phenotypic and economic performance of the breeds, improving infrastructure and technical assistance, developing and installing selection programmes for raising productivity, and optimising production systems.

Lack of adequately defined breeding objectives and insufficient description of the animal populations as regards to their phenotypic and genetic performance ability in production, reproduction and adaptation, are some of the constraints in livestock development in Malawi. Although some on-station performance testing has been carried out in the past, they have been limited and discontinuous due to organisational and financial problems. Regular performance recording under field conditions is rare, but essential for improving and preserving local populations, which is a main component in the crop-livestock production systems.

Since Nicholas and Smith's paper (1983) on nucleus herds, the idea has been intensely

discussed and reviewed by different authors. To date it is known that nucleus schemes, more so those supported by multiple ovulation and embryo transfer (MOET), can lead to 10 to 20 % extra annual gain (Lohuis 1998). However, different versions of nucleus schemes need to be adjusted and modified in order to adapt to prevailing farming conditions and production systems. The main aspects of recording structure, sampling of farms and family groups, and performance of small animal populations, with respect to biometrical problems are discussed. The major benefits and optional parameters of nucleus scheme are reviewed. An open dispersed nucleus scheme is proposed for the Malawian dairy production system.

(Key words: genetic improvement, dairy, small populations)

Introduction

Genetic improvement is inherently a long-term process in which the progress in the future is built upon improvement in the past (Gibson and Wilton 1998). To this end, setting up of well-defined breeding goals, organising a well co-ordinated recording system, defining elaborate breeding strategies, and establishing selection programmes for improving economically important variables including adaptation traits, are a prerequisite. Genetic evaluation of breeding strategies to generate information that could be utilised in making breeding decisions is essential. It is important to set up systems of getting reliable data on the phenotypic and economic performance of the breeds, improving infrastructure and technical assistance, developing and installing selection programmes for raising productivity, and optimising production systems.

Currently, milk production in Malawi is performed on smallholder farms on the one hand, and large scale dairy farms on the other. Among others, the major differentiating features are the holding size, the genotype of cattle raised, and the level of management. Recent information (Malawi Government 1997) indicates that there are about 3600 smallholder farmers who use over 6000 Holstein Friesian x Malawi Zebu cows, and about 1700 smallholder farmers who use an unknown number of Malawi Zebu cattle for commercial milk production in the peri-urban setting. Although the smallholder farms play an important role in milk production in Malawi, genetic evaluation studies are currently difficult if not impossible to carry out because of the unavailability of systematically kept records (Chagunda 1996). In addition to the smallholder farmers, there are 15 private large scale dairy farms accounting for about 2200 milking cows. The predominant genotype on the large scale dairy farms is the Holstein Friesian although some of these farms also have Aryshire and Jersey cattle.

The total milk production from both the large scale and the smallholder sub-sectors is estimated to be 34 million kg per year (Banda and Mwenifumbo 1998). Using the figures of total milk available on the Malawi market and the country's human population of about 10.5 million, Banda and Mwenifumbo (1998) estimated the average milk consumption of 3.2 kg per capita. Official estimates from FAO (1994) put Malawi's per capita consumption at 6.9 kg. Both these estimates indicate low milk consumption in Malawi. The average milk consumption for Africa is 15 kg per capita. This pronounces the need for improving milk production and the consequent milk consumption in Malawi. This paper reviews some aspects of recording structure, sampling of farms and family groups, and performance of small animal populations, with respect to biometrical problems. The major benefits and optional parameters of nucleus schemes are highlighted and prospects of applying some are discussed and reviewed.

Constraints in genetic improvement programmes

Genetic improvement in the dairy sector in Malawi is hampered by several constraints. Among them are the following:

1. Lack of adequately defined breeding objectives and insufficient description of the animal

populations as regards to their phenotypic and genetic performance ability in production, reproduction and adaptation, are some of the constraints in livestock development in Malawi (Wollny 1995).

2. Although some on-station performance testing has been carried out in the past, they have been limited and discontinuous due to organisational and financial problems. Regular performance recording under field conditions is rare, but essential for improving and preserving local populations, which are a main component in the crop-livestock production systems.
3. The existence of genotype by environment interaction on some large-scale dairy farms in Malawi with respect to Canadian imported semen highlights an important feature to be considered in assessing the genetic merit of Holstein Friesian cows in Malawi (Chagunda 2000). The estimate of genetic correlation for milk yield of Holstein Friesian cows in Malawi and Canada was low and the sires ranked significantly different, suggesting a substantial genotype by environment interaction.
4. Small livestock population sizes, small herd sizes and unreliable animal identification (Wollny 1995). Although some pedigree records go up to the grandparent generation, survey records indicate that there is a substantial number of animals with missing records on parent or grandparent identification (Chagunda 2000). This limits the estimation of the additive genetic variance, a component used in determining heritability.

Towards a national selection and breeding programme

So far it is clear that environmental factors of nutrition and management play an important role in milk production in Malawi (Mwale et al. 1999, Chagunda 2000). These factors are normally masked within the herd and year of calving (Schmidt and Van Vleck 1974). The high milk production potential of Holstein Friesian cows may not have been fully expressed due to the environmental factors. This indicates that considerable improvement could be achieved by improving the production environment. The same applies to the relatively long calving intervals, which were observed in the study. A need is therefore apparent to identify the most effective management and breeding practices to circumvent the environmental constraints on genetic expression of Holstein Friesians in Malawi.

Since importation of foreign genetic material involves the use of foreign exchange which is extremely scarce, and the existence of genotype by environment interaction slows down the rate of genetic progress (Mpofu et al. 1993a), there is a need therefore to revise the breeding strategy to find the most suitable bulls for the production system in Malawi.

As Smith (1988) pointed out, if genotype-environment interactions are important across countries, then an independent domestic genetic improvement programme would be needed and would be justified. He, however, cautioned that what developing countries should avoid is the unnecessary duplication of expensive breeding efforts being carried out in other countries from which they could benefit at little cost.

For the smallholder and communal sector in southern African countries, Wollny (1995) suggested an open nucleus scheme approach. This approach could be adapted for the large-scale dairy farms. However, the more appropriate breeding programme for the large scale dairy farms would be the dispersed open nucleus scheme as represented in Figure 1. By definition, in a dispersed open nucleus scheme, the animals are not physically located in one place and there is allowance of inflow of foreign germplasm into the system (Lohuis 1998). As compared to the centralised closed nucleus scheme, the dispersed open nucleus scheme has, on the one hand, the following advantages:

- a. There is less threat from high inbreeding levels since the nucleus has no size limitations and the scheme is still open to some percentage of foreign germplasm.

- b. The nuclear environment automatically reflects the production environment hence a very reduced (if any) rate of within-country genotype by environment interaction.
- c. There is increased farmer participation since more farmers have a direct impact on the breeding programme.
- d. Farmers still own and control top germplasm.
- e. There is less demand for additional investment since there is high utilisation of the existing infrastructure.

On the other hand the centralised closed nucleus scheme has the following advantages:

- a. There is more flexibility and options such as collection ore more trait information, protection of best cows and heifers, and development of ground-parent lines.
- b. There is more accurate female rankings in that bias is reduced and also the best females compete head to head.
- c. Technologies like artificial insemination embryo transfer, and in vitro fertilisation are more effectively used.

Setting up a nucleus breeding scheme in Malawi would mean all the effective breeding and selection activities would be confined within the nucleus scheme, which would be the source of male stock in the system. These also proposes some restructuring and adjustment of some of the current functions of the National Artificial Insemination Scheme and also ensure that the major constraints that retard the efficiency in the delivery of the artificial insemination services in Malawi (Chagunda et. al. 1998) are alleviated.

On the other hand, the effective population size should be large enough to sustain continued genetic improvement over many generations (Smith 1988). An effective population of 72 per generation would ensure a sustainable programme. Nucleus stocks would be open continuously to the introduction of higher genetic merit from any source to increase genetic variation and reduce inbreeding levels. Currently, the strategy in the large scale farms is based on 100% continuous semen importation. In the nucleus scheme a lower percentage of imported semen is proposed. In a simulation study, Mpofu et al. (1993b) evaluated breeding strategies for commercial dairy cattle in Zimbabwe from a genetic and also an economic viewpoint. In that study, the authors compared local programmes based on progeny testing in a closed population, progeny testing combined with semen importation to sire 30% of the cows, progeny testing with foreign sires as sires of bulls, and a closed nucleus scheme using embryo transfer started from elite imported cows. Further strategies, which were evaluated, were based on continuous importation of semen for 30, 50, or 100% of the cows and semen from elite foreign bulls used on elite local cows and, finally, bulls from elite imported embryos. The results of their study showed that continual semen importation for 30% of the population was better in the initial period than using progeny testing schemes initially. Since the rate of imports depends on the immigration rate and the initial difference in the genetic mean between the exporting and the importing populations, need is there to determine the actual level of importation suitable for the Malawian production system.

The optimal family size in a half-sib analysis can be calculated as, $n = 4/h^2$. If heritability (h^2) for milk yield is assumed to be 0.25 the optimal number of half-sibs (progeny) per sire should be 16. Assuming progeny of 20 sires are available then the standard error of the estimated heritability will be $(32 h^2 / T)^{1/2}$ whereby T is the total number of cows recorded, in this case being 320. This gives the standard error of the heritability estimate of 0.16. This indicates that with half-sib analysis, the accuracy of the heritability estimate improves with the increase in number of the half-sibs groups assuming the same number of sires. With the current situation

where there is no united recording system and sourcing of sires in Malawi, this number can only increase if a nucleus breeding scheme would be in place. This is because nucleus breeding encourages utilisation of the same elite bulls and also proper record keeping.

Phenotypic herd comparison is a sound management tool for identifying sub-optimal management procedures. The number of animals per farm that would warrant such a comparison is calculated as follows: $n = k (c/d)^2$ where, k = constant depending on the significance level and the probability of detecting the difference (@ 20); c = coefficient of variation (%); d = important difference between the group means to be detected (% of the mean). Table 1 gives an example of such a calculation with known parameters from a previous study on a Holstein Friesian herd in Malawi (Chagunda 1996).

Table 1 Estimates of number of animals required for Holstein Friesian herd average comparison in Malawi

Number of flocks	43
Total number of parturitions	200
Number of first parturitions	29
Annual parturition rate (%)	82.6
Number of kids born per parturition	1.3
First parturition before 18 months of age (%)	79
First parturitions between 18 and 24 months (%)	21
Males surviving to 6 months of age (%)	88.2
Females surviving to 6 months of age (%)	88.2

* Add to more than 100% due to the combination of animal classes.

If the between-herds difference for milk yield is to be detected and declared significant at 5% then up to 659 cows per farm are necessary. For age at first calving and calving interval, 104 and 356 cows are required, respectively. The combination of production and reproductive traits like calving interval by applying the basic principles of selection index (Hazel 1943) would need, therefore, to be supported and applied in the nucleus programme (Chagunda et al. 1998).

This programme would only function well with the full participation of the dairy farmers (both large-scale and smallholder) and all institutions involved in dairy production. This would help pool efforts, existing facilities and technical know-how together for the effective and efficient establishment of the programme.

Conclusion

Setting up of well-defined national breeding goals, organising a well co-ordinated recording system in the large scale dairy and some smallholder farms, defining more elaborate breeding strategies, and the application of a properly constructed selection index are a prerequisite to dairy improvement in Malawi. It is important to set up systems of getting reliable data on the phenotypic and economic performance of the breeds, improving infrastructure and technical assistance, developing and installing selection programmes for raising productivity, and optimising production systems.

References

Banda J. W. and Mwenifumbo C. 1998. *Dairy production and marketing*. Working Paper.

National Livestock Development Master Plan. Ministry of Agriculture and Irrigation. Lilongwe, Malawi.

Chagunda M. G. G. 1996. Evaluation of the Malawian artificial insemination program for small and large scale dairy farms. MSc thesis, University of Malawi, Zomba, Malawi.

Chagunda M. G. G., Wollny C. B. A., Bruns E. and Kamwanja L. A. 1998. Evaluation of the artificial insemination program for small scale dairy farms in Malawi.

Chagunda M. G. G. 2000. *Genetic evaluation of Holstein Friesian cattle on large scale dairy farms in Malawi*. PhD thesis, Institute of Animal Breeding and Genetics, Georg-August-University of Göttingen, Germany. Cuvilier Press, Göttingen. 114 pp.

FAO (Food and Agriculture Organization of the United Nations). 1994. Yearly Handbook, Rome, Italy. 235 pp.

Gibson J. P. and Wilton J. W. 1998. Defining Multiple-Trait Objectives for Sustainable Genetic Improvement. *Journal of Animal Science* 76: 2303–2307.

Hazel L. N. 1943. The genetic basis for constructing selection indices. *Genetics* 28: 476 – 490.

Lohuis M. 1998. Establishment and use of nucleus herd schemes for genetic improvement in dairy cattle. Paper presented at Congress CAAB/CETA Convention, Saint-Hyacinthe, Quebec, August 30–September 2, 1998. Available at: <http://www.aps.uoguelph.ca/lohuisim/CAAB/CAAB.html>. Accessed Dec. 2, 1999.

Malawi Government. 1997. Annual Livestock Census. Department of Animal Health and Industry, Ministry of Agriculture and Livestock Development. Lilongwe, Malawi.

Mpofu N., Smith C. and Burnside E.B. 1993a. Breeding Strategies for genetic improvement of dairy cattle in Zimbabwe. 1 Genetic evaluation. *Journal of Dairy Science Handbook* 76: 1163–1172.

Mpofu N., Smith C., Van Vuuren W. and Burnside E. B. 1993b. Breeding Strategies for genetic improvement of dairy cattle in Zimbabwe. 2 Economic evaluation. *Journal of Dairy Science Handbook* 76:1173–1181.

Mwale S.E., Wollny C., Banda J.W., Chagunda M.G.G. and Bruns E. 1999. Evaluation of Malawi Zebu and its crosses on smallholder dairy farms in Mzuzu, Northern Malawi. Paper presented at Tropentag 99, Humboldt University of Berlin, 14–15 October, 1999.

Nicholas F.W. and Smith C. 1983. Increased rates of genetic change in dairy cattle by embryo transfer and splitting. *Animal Production* 36: 341–353.

Schmidt G. H. and Van Vleck L.D. 1974. *Principles of Dairy Science*. W. H. Freeman and Company. San Francisco, California, USA. 288 pp.

Smith C. 1988. Genetic improvement of livestock using nucleus breeding units. *World Animal Review* 65: 2–10.

Wollny C. 1995.

Breed improvement and future breeding strategies in livestock in Southern Africa. *Proceedings of the International Symposium of Animal Production through Breeding and Genetics*. Dzama, K., Ngurume F.N., and Bhebhe, E. (Ed), Harare, Zimbabwe, 10th – 11th May 1995, University of Zimbabwe, Harare, Zimbabwe. pp 61–70.

Wollny C. B. A., Namwaza A. G, Makamba T. S. W. and Küttner K. 1998. Zum Stand der Rinderzucht in Malawi. *Archiv für Tierzucht. Dummerstorf* 41(1/2):33–44.

Relationship between annual rainfall oscillations and mohair production between 1935 and 1996

Ng'ambi, J.W. and L. Khit_ane

National University of Lesotho, P.O. Roma 180, Lesotho

[Abstract](#)

[Introduction](#)

[Methodology](#)

[Site](#)

[Data collection](#)

[Data analysis](#)

[Results](#)

[Discussion](#)

[Conclusion](#)

[References](#)

Abstract

Angora goats in Lesotho depend mainly on communal rangeland pastures which depend on rainfall for their growth. The main objectives of this study were to determine trends in annual rainfall oscillations and mohair production, and calculate the relationship between annual rainfall oscillations and mohair production in Lesotho between 1935 and 1996.

An exponential regression equation of the form $\text{Ln}Y = \text{Ln}A + bx$ was used to estimate trends. Between 1935 and 1965 Angora goat numbers, mohair production and mohair yield per goat increased at annual rates of 1.1, 1.9 and 1.1%, respectively ($P < 0.01$). During years of independence (1966 to 1996) annual goat numbers remained largely stagnant at around one million animals ($P > 0.05$). However, Mohair yield per goat declined at an annual rate of 1.2% to around 0.85kg in 1996 ($P < 0.01$). Similarly, mohair production declined at an annual rate of 1.2% to 970,000kg in 1996 ($P < 0.01$).

A long-term (1935 to 1996) annual rainfall mean of 700mm was calculated for Lesotho. There were recurrent wet years (rainfall above long-term mean) and dry years (rainfall below long-term mean). However, no clear alternate rainfall oscillations of wet and dry years were observed. It was thus difficult to predict years of drought (rainfall below long-term mean) from alternate annual rainfall oscillations. A positive but non-significant ($P > 0.05$) relationship ($r=0.261$) between annual mohair yield per goat (kg) and rainfall (mm) was observed, possibly indicating that there were other major factors that affected mohair yield per goat.

Keywords: Rainfall oscillations; mohair production trends; relationships.

Introduction

The agricultural sector is the largest single sector in the economy of Lesotho. It contributes to income and employment for more than 85% of the population (Eckert and Nobe 1982; Bureau of Statistics 1987). In 1990, agriculture contributed 23.9% of the Gross National Product. Seventy five percent of this contribution came from the livestock sector (Phororo, Kidman and Ponzoni 1993).

Angora goats have played an important role in the economy of Lesotho for a long time. They provide an important source of cash income through the sale of their mohair, their meat or the animals themselves. In the food system, Angora goats provide meat which is a high quality protein food for Basotho people (Phororo 1979; Lawry 1986; Hunter 1987). Mohair sales contribute between 14 and 20% of the total income generated by the livestock sector in Lesotho (Hunter 1987). In 1990, more than R12 million was realised from mohair sales (Phororo, Kidman and Ponzoni 1993). However, most studies indicate that annual mohair production, mohair yield per goat and Angora goat numbers have declined or remained low and stagnant over the past 30 years (Uys 1977; Wyeth et al. 1983; Hunter 1987; Belete et al. 1994). These studies listed poor nutrition as being the most important cause of low annual mohair production, mohair yield per goat and Angora goat numbers.

Communal rangelands play an important role in the livestock production system in Lesotho (Phororo 1979). Thus, Angora goats depend mainly on natural pastures in these rangelands for their nutritional requirements. These natural pastures, in turn, depend on rainfall for their growth. Reduced amounts of rainfall or droughts have a negative effect on pasture growth, resulting in less food for the animals and hence low mohair yield per goat (Hunter 1987). Thus, each time there is drought, farmers in Lesotho are caught unaware and hence lose a lot in terms of a decline in annual mohair yield per animal and deaths of animals. Knowledge of rainfall oscillations and the relationship between rainfall and mohair production in Lesotho would help farmers prepare themselves for drought years. However, such information has not been generated in Lesotho.

The objectives of this study were:

- To determine trends in production and interactions between annual Angora goat numbers, mohair production and mohair yield per goat in Lesotho between 1935 and 1996.
- To determine the annual rainfall oscillations in Lesotho between 1935 and 1996 and estimate their possible impact on mohair production.

Methodology

Site

The study was carried out in Lesotho. Lesotho is a semi-temperate country with cold winter and warm summer months. The temperature may range from -20 to 15.9 °C in winter and from 24 to 32 °C in summer. The average annual rainfall is between 600 and 1775 mm, with most of the rain falling in summer (Bureau of Statistics 1987). Owing to its mountainous character, much of Lesotho is well suited for Angora goat and sheep production (Hunter 1987).

Data collection

Secondary data on annual rainfall, Angora goat numbers, mohair production and mohair yield per goat in Lesotho were used in this study. Major sources of this data were government

reports, annual statistical bulletins, published research articles and books. The data collected covered the period between 1935 and 1996. However, trends in the above factors were calculated for the colonial period (1935 to 1965) and years of independence (1966 to 1996). These are distinct periods in terms of government policies, management practices and livestock production systems (Hunter 1987).

Data analysis

An exponential regression equation of the form $\text{Ln}Y = \text{Ln}A + bx$ was used to estimate trends in annual Angora goat numbers, mohair production and mohair yield per goat in Lesotho (Steel and Torrie 1960). In this equation 'LnA' is the intercept, 'b' is the slope and 'x' is the time indexed to 1, 2, up to 31. Correlation analysis was used to estimate the relationships (r) between the above production parameters.

Mean annual rainfall in Lesotho between 1935 and 1996 was calculated. Annual rainfall data was then calculated as deviations above or below the 62-year mean. This data was plotted to observe variations above and below the long-term mean. A ten-year weighted moving average was used as a simple smoothing and generalising device (Dyer and Tyson 1977; Eckert and Nobe 1982). Patterns of wet (annual rainfall above long-term mean) and dry (annual rainfall below long-term mean) years were observed.

Results

Between 1935 and 1965 Angora goat population in Lesotho increased ($P < 0.01$) from 501,000 to 1,018,000 at an annual rate of 1% (Table 1). Mohair production and mohair yield per goat increased at annual rates of 1.9 and 1.1%, respectively ($P < 0.01$). There was some significant ($P < 0.01$) indication that during that period, growth in mohair production depended on annual growth in both Angora goat numbers and mohair yield per goat (Table 2).

During years of independence (1966 to 1996) annual goat numbers remained, largely, stagnant ($P > 0.05$) (Table 3). However, during this period mohair yield per goat declined at an annual rate of 1.2% to a value of around 0.85kg ($P < 0.01$). The end result was a decline in mohair production at an annual rate of 1.2% to 970,000kg in 1996 ($P < 0.05$). There was some relationship between the decline in annual mohair production and the decline in both annual goat numbers ($r = 0.658$) and mohair yield per goat ($r = 0.453$) (Table 4).

Figure 1 presents a graphical display of the annual rainfall results. Annual rainfall is shown as deviation above or below the 62-year mean of 700 (± 113) mm. The data show that there were dry (rainfall below long-term mean) and wet (rainfall above long-term mean) years. However, no clear alternate oscillations of wet and dry years were observed. A positive but non-significant ($P > 0.05$) relationship between annual rainfall and annual mohair yield per goat was observed (Table 5).

Table 1. Regression model for annual Angora goat numbers, mohair production and mohair yield per goat in Lesotho between 1935 and 1965

Variable	Parameter, $Y = Ae^{bx}$	Growth rates (%)
Angora goat numbers (' 000)	A = 588	
	b = 0.010	1.0
	r = 0.619	
	P = 0.000	
Mohair production (' 000kg)	A = 427	
	b = 0.019	1.9

	$r = 0.614$	
	$P = 0.000$	
Mohair yield/goat (kg)	$A = 0.662$	
	$b = 0.011$	1.1
	$r = 0.525$	
	$P = 0.002$	

r = Correlation co-efficient

P = Probability value

A = Intercept

b = Slope or growth rate

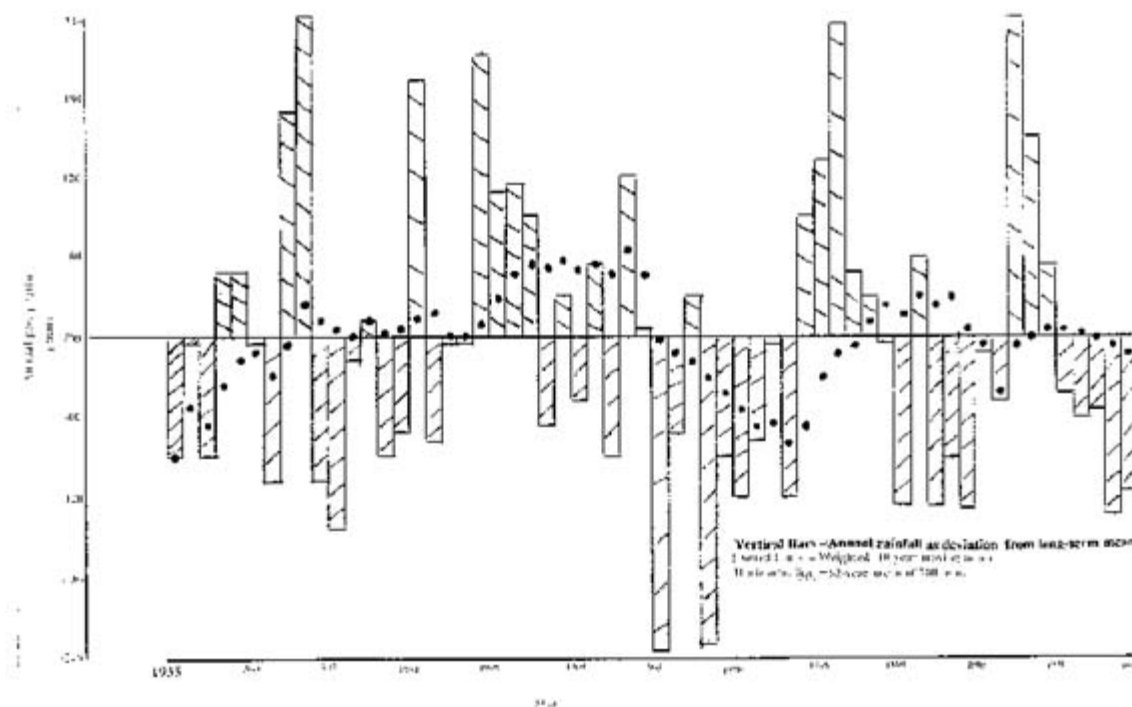


Figure 1. Annual rainfall deviations from long-term mean of 700 mm in Lesotho between 1935 and 1996.

Table 2. Relationship between annual Angora goat numbers and mohair production and between annual mohair yield per goat and mohair production in Lesotho between 1935 and 1965

Variables	Relationship
Annual goat number and mohair production	$r = 0.732$
	$p = 0.01$
Annual mohair yield/goat and mohair production	$r = 0.695$
	$p = 0.01$

r = Correlation co-efficient

P = Probability value

Table 3. Regression model for annual Angora goat numbers, mohair production and mohair yield per goat in Lesotho between 1966 and 1996.

Variable	Parameter, $Y = Ae^{bx}$	Growth rates (%)
Angora goat numbers (' 000)	A = 950	
	b = 0.005	-0.5
	r = 0.257	
	P = 0.163	
Mohair production (' 000kg)	A = 836	
	b = -0.012	-1.2
	r = 0.394	
	P = 0.030	
Mohair yield/goat (kg)	A = 1.089	
	b = -0.012	-1.2
	r = 0.498	
	P = 0.004	

r = Correlation co-efficient

P = Probability value

A = Intercept

b = Slope or growth rate

Table 4. Relationship between annual Angora goat numbers and mohair production and between annual mohair yield per goat and mohair production in Lesotho between 1966 and 1996

Variables	Relationship
Annual goat number and mohair production	r = 0.658
	p = 0.01
Annual mohair yield per goat and mohair production	r = 0.453
	p = 0.05

r = Correlation co-efficient

P = Probability value

Table 5. Relationship between annual mohair yield per goat (kg) and annual rainfall (mm) in Lesotho for the period 1935 to 1996

Variables	Relationship
Annual mohair yield and annual rainfall	r = 0.261
	p = 0.381

r = Correlation co-efficient

P = Probability value

Discussion

Annual mohair production can be influenced by the number of goats shorn and mohair yield per goat (Drummond 1985; Hunter 1987). Between 1935 and 1965 annual goat numbers and mohair yield per goat increased. The overall result was that there was an increase in annual mohair production. Thus, annual mohair production depended on growth in both goat numbers and mohair yield per goat. The growth in goat numbers may have been possible during that

time because the communal rangelands were still able to sustain more animals (Hunter 1987). However, the increase in goat numbers and other livestock species resulted in overstocking and degradation of the communal rangelands (Phororo 1979; Hunter 1987). This, in turn, led to the communal rangelands being unable to sustain good levels of livestock production (Hunter 1987). Thus, between 1966 and 1996 annual goat numbers remained largely stagnant at around one million ($P > 0.05$) while mohair yield per goat declined at an annual rate of 1.2% ($P < 0.05$). Indeed, it could be argued that the future prospects for increasing mohair production in Lesotho may depend, mainly, on increasing the annual mohair yield per goat rather than on increasing goat numbers. Unfortunately, annual mohair yield per goat has been declining over the past 30 years. The present low annual mohair yield mean of about 0.85kg per goat may be compared with a mean annual yield of about 4.0kg mohair per goat in South Africa (South African Wool and Mohair Board 1992). Thus, improvements of around 370% are possible.

The major factors limiting mohair yield per goat in Lesotho have been identified as poor nutrition, poor management practices, too many old goats and poor genetic mohair production potential among the goat population (Uys 1977; Wyeth et al. 1983). Previous Lesotho governments responded to the problems of low mohair yield per goat with a variety of policies and remedial programmes (Uys 1977; Wyeth et al. 1983; Hunter 1987). These included compulsory rotational grazing in the communal rangelands, exchange of old goats with young ones imported from South Africa, introduction of grazing fees, routine dosing and dipping against parasites, formation of associations, etc. However, it seems that past policies and remedial programmes did not have a positive impact on annual growth of mohair yield per goat during the 1966 to 1996 period. It is therefore suggested that in future, attention should be placed on increasing mohair production through improvements of mohair yield per goat. Initially, an attempt should be made to quantify the major factors that limit growth in mohair yield per goat. Then, policies and programmes putting more emphasis on those factors having higher limiting effects can be instituted.

In the present study recorded data show that there were wet years (rainfall above long-term mean) and dry years (rainfall below long-term mean). However, there were no clear alternate 10-year oscillations of wet and dry periods as suggested by Eckert and Nobe (1982). In that study, which involved data from lowland districts of Lesotho, there was some pattern of alternate 10-year periods of below or above long-term average annual rainfall. However, even in that study, there were a number of deviant years within wet or dry spells.

It is also clear from the present study that drought (annual rainfall below long-term mean) was a recurrent feature in Lesotho during the period under study. This is similar to the findings of Eckert and Nobe (1982). There is, thus, a need for Angora goat farmers in Lesotho to have resources and knowledge so that they can prepare for droughts and adjust their management strategies accordingly. Droughts should be seen and treated as part of the whole livestock production industry and not as something which takes the country by surprise every now and then. The aim should be to minimise the impact of droughts on livestock production. This will ensure the industry's sustainability.

Angora goats in Lesotho depend mainly on natural pastures for their nutritional requirements. These natural pastures depend on rainfall for their moisture requirements and hence their dry matter production (Phororo 1979; De Waal 1994). However, the relationship between annual rainfall and annual mohair yield per goat in Lesotho was very poor. Such poor relationships may indicate that there are other major factors determining annual mohair yield per goat (Hutchings and Stewart 1953; Eckert and Nobe 1982; De Waal 1994). These include the rainfall distribution within the year and any intervention by the farmers in terms of feed supplementation to the animals (Eckert and Nobe 1982; De Waal 1994).

Conclusion

The communal rangelands of Lesotho are not able to sustain the present Angora goat numbers, mohair yield per goat and mohair production. It is recommended that in future, emphasis should be on increasing mohair production through improvement of mohair yield per goat.

A long-term annual rainfall mean of 700mm was calculated. There were annual rainfall oscillations of wet (rainfall above long-term mean) and dry (rainfall below long-term mean) years between 1935 and 1996. Drought (annual rainfall below long-term mean) was a recurrent feature. It is, thus, important for Angora goat farmers to always have necessary resources and management skills for drought preparedness. However, the magnitude and extent of the impacts of such climatic changes on dry matter production of natural pastures and hence mohair production were not predictable.

References

- Belete A., Ng'ambi J.W., Makoanyane M.P. and Morojele E.M. 1994. Growth trends of wool and mohair production and export in Lesotho since independence in 1966. *University of Swaziland Journal of Agriculture* 3:86–93.
- Bureau of Statistics. 1987. *Statistical Yearbook*. Bureau of Statistics, Maseru, Lesotho.
- De Waal H.O. 1994. The effects of long-term variation in rainfall and dry matter production of veld on the financial position of a beef weaner enterprise. *South African Journal of Animal Science* 24:113–118.
- Drummond S.B. 1985. *Angora goats the northern way*. Stoney Lonestone Farm, Michigan, USA.
- Dyer T.G.T. and Tyson P.D. 1977. Estimating above and below normal rainfall periods over South Africa, 1972–2000. *Journal of American Meteorology* 16:5–11.
- Eckert J.B. and Nobe K.C. 1982. *Toward the year 2000: Strategies for Lesotho's agriculture*. Research Report No.10. Ministry of Agriculture, Maseru, Lesotho.
- Hunter J.P. 1987. *The economics of wool and mohair production and marketing in Lesotho*. Institute of Southern African Studies Research Report No.16, Roma, Lesotho.
- Hutchings S.S. and Stewart G. 1953. *Increasing forage yields and sheep production on intermountain winter ranges*. U.S. Department of Agriculture Circular, U.S.
- Lawry S.W. 1986. *Livestock and range management in Sehlabathebe: A study of commercial resources management*. A Research Report, Ministry of Agriculture, Maseru, Lesotho.
- Phororo D.R. 1979. *Livestock Farming in Lesotho and Pasture Utilisation and Suggested National Policy*. Ministry of Agriculture and Co-operatives and Marketing, Maseru, Lesotho.
- Phororo D.R., Kidman P.R. and Ponzoni R.W. 1993. *Developing strategic plan for the wool and mohair industry in Lesotho*. UNDP/FAO Technical Mission Report. Maseru, Lesotho.
- South African Wool and Mohair Board 1992. *Statistical Analysis of Mohair Clip*. South African Wool and Mohair Board, Port Elizabeth, South Africa.
- Steel R.G. and Torrie J.H. 1960. *Principles and Procedures of Statistics*. McGraw-Hill Book Company, Washington D.C., USA.

Uys D.S. 1977. *The Lesotho Mohair Industry: History and Evaluation 1970 and Five More Years*. South African Wool and Mohair Board, Port Elizabeth, South Africa.

Wyeth P.W., Moletsane N. and Motsamai M. 1983. *Trends in mohair sales, and reflections concerning economic incentives for mohair producers*. A Research Report. Ministry of Agriculture, Maseru, Lesotho.

On farm and on station evaluation of growth and reproductive characteristics of pigeons in Malawi

T.N. Gondwe, F.C. Chilera, R.K.D. Phoya and J.B. Jonazi

Department of Animal Science, Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe, Malawi

[Abstract](#)

[Introduction](#)

[Methodology](#)

[Results and discussion](#)

[On-farm production characteristics](#)

[On-station production characteristics](#)

[Reproduction characteristics in pigeons](#)

[Conclusion](#)

[Acknowledgement](#)

[References](#)

Abstract

A field study was conducted to evaluate diversity and production performance of pigeons in Lilongwe and Mzimba Districts of Lilongwe and Mzuzu Agricultural Development Divisions, respectively. The districts are in two distinct agro-ecological zones. On-farm results initiated an on-station study at Bunda College of Agriculture to evaluate growth and reproductive characteristics of pigeons using the village production system. Sixty young pigeons were collected in pairs from rural areas of Lilongwe and Mzimba districts and these formed an initial stock for evaluation. These were housed in traditional pigeon type houses and released in the morning for roaming around. Minimal supplementation with maize grits was provided in the morning and afternoon, while water was provided in clay pots for ad libitum consumption.

The on-station study showed that pigeons had fast growth rates during the first 10 weeks of age. Live weights reached 0.3 kg at 15 weeks of age, and thereafter, live weights stabilised or declined. Sexual dimorphism was not clearly distinct in live weights. These results confirmed field study observations in which highest live weights were attained when pigeons were squabs (0.33 kg at less than 10 weeks) and they became lighter afterwards. Most people in rural areas traditionally consume squabs, leaving adults for breeding. Both field and on-station findings showed no significant differences in live weights due to location or origin of pigeons. The on-farm study showed that pigeons are prolific, producing a pair of squabs almost every month. In the villages, farmers reported that pigeons took 13 weeks to start laying but the on-station study observed that pigeons started laying after 30 weeks of age.

Pigeon growth and reproductive characteristics have been studied and the results support the potential of integrating pigeons in other poultry production in order to diversify and improve food security among rural farmers in Malawi, hence sustaining human livelihood.

Key words: Pigeons, diversity, integration, and potential

Introduction

Pigeon production has remained neglected in Malawi but has the potential to be promoted or integrated with other poultry species in the rural areas. This neglect is basically due to the fact that chickens are the only poultry species that have received considerable attention in Malawi (GoM 1998). Pigeons are however, widely owned and ranked second to chickens in prevalence in the villages (Gondwe et al. 1999). Pigeons are mainly kept for consumption with minimal care. Their existence and diversity show the potential to contribute meat to human diets. Promoting their production would be a means of contributing animal protein to the diets of the majority of the Malawi human population that stay in rural areas. This would directly contribute to increased food security for people who are below the poverty line. Such efforts could not be attained without due attention to their production, health and reproduction. There is a need to maintain and improve the diversity in pigeons as the species form part of the rural poultry integrated production system. In the absence of relevant information in Malawi, the productive and reproductive performance and potential for pigeons remains unknown. This calls for the need to study their characteristics and determine technical parameters pertaining to traits of importance. Studies were therefore initiated to determine the production and reproduction performance of different phenotypes of pigeons that exist in Malawi. Some of the results are presented in this paper.

Methodology

A field study was conducted as part of a survey on biodiversity in poultry in the rural areas of Lilongwe and Mzimba Districts of Lilongwe and Mzuzu Agricultural Development Divisions (ADD), respectively, in 1998. The two districts are in two distinct agro-ecological zones of Malawi with different ethnic tribes. Different types of pigeons were observed and weighed in the morning, with an age determined from estimates by the farmer. Most reproductive characteristics were recorded from farmers' observations. All data were recorded on formatted sheets by enumerators. Kitchen scales were used to determine weights of pigeons.

On-station studies were initiated after compiling the on-farm results and these studies took place at Bunda College of Agriculture, Students' Livestock Farm. Sixty young pigeons were purchased in pairs from the villages of Lilongwe and Mzimba as initial stock. These were kept in specially constructed traditional pigeon type houses (kholas). Pigeons were released during the day for scavenging with chickens and ducks. Minimal supplementation in the form of maize grits was provided in the morning and afternoon, just like what was observed in the villages. Water was provided in special clay pots placed on a raised pole.

Initial live weights and physical characteristics were collected on the arrival of pigeons. They were then weighed fortnightly using a kitchen scale. Pigeons were individually identified using numbered wing bands, hence individual data recording was possible.

Quantitative data collected were analysed for means and their standard deviations in Statistical Analysis System (SAS 1994).

Results and discussion

On-farm production characteristics

Table 1 shows flock sizes and mean live weights of adult pigeons (over 20 weeks old) determined in Lilongwe and Mzimba. There were equal numbers of male and female pigeons in the flocks. This was basically due to the fact that pigeons are hatched in pairs and these grow and reproduce. Flock sizes were higher in Lilongwe Agricultural Development Division (ADD) than in Mzuzu ADD. Mature live weights showed the potential for growth performance in pigeons. There were no significant differences in weights between sexes or between ADDs. Within the species though, variations was large, indicated by the large standard deviations. The components of within species variation could however not be split during this study, but show the potential for improving the species.

Table 1. Mean live weights of pigeons determined in villages by sex (means (g) and standard deviation)

Parameter	Sex	n	Lilongwe ADD		Mzuzu ADD		
			Mean	SD	n	Mean	SD
Flock size per household	Female		15.6	9.1		11.0	8.5
	Male		15.3	9.2		11.2	8.8
Live weights	Female	195	290	100	335	310	200
	Male	183	330	100	336	310	100

Figure 1 shows the trend in growth of pigeons in the two ADDs by age group. There was no specific pattern of growth in pigeons. Young pigeons (< 10 weeks old) and growers were heavier than old ones. Farmers indicated that they consume squabs (young pigeons) and leave old ones for breeding. Probably farmers take advantage of the large size of squabs which are more tender to consume.

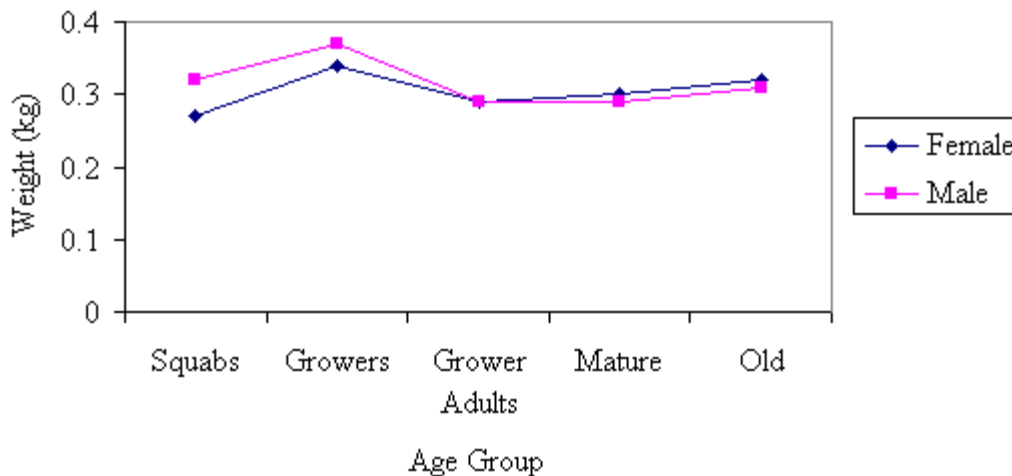


Figure 1.

Live weight trend of pigeons by age group.

Note:- Age range in weeks are: squabs (<10), growers (11–20), grower adults (21– 30), mature (31–52) and old (>52).

On-station production characteristics

The on-station initial results showed that pigeons grow fast during their first 10 weeks of life. Most pigeons reached 0.3 kg live weights by week 15 with males weighing significantly ($p < 0.05$) more than females (Table 2). This is unlike the findings observed on-farm where sexual dimorphism was not significant.

Table 2. Live weights and weight gain for pigeons raised on station at Bunda (means in g and standard deviation) by sex and origin.

Parameter	Sex	Lilongwe			Mzimba		
		n	Mean	SD	n	Mean	SD
Initial weight (4.0 weeks)	Female	6	219.2 ^b	24.0	21	261.9 ^b	34.1
	Male	7	246.4 ^a	44.8	21	286.9 ^a	24.5
Weight at 15 weeks	Female	6	287.5 ^b	20.9	17	283.8 ^b	27.9
	Male	5	310.0 ^a	28.5	20	305.0 ^a	23.8
Live weight gain	Female	6	68.3	23.2	17	23.5	36.9
	Male	5	56.0	62.1	20	18.8	26.8

^{a,b} Means between sex within a column with different superscripts differ significantly ($P < 0.05$)

Weight gains at 15 weeks were significantly ($P < 0.05$) different between pigeons of Lilongwe and Mzimba. Pigeons from Lilongwe had significantly ($P < 0.05$) higher gains than the ones from Mzimba. The trend in sex was, however, similar between pigeons from the two areas. Initial live weights (from day old to 4 weeks) were not taken in these birds. The lower weight gains in pigeons from Mzimba may imply that adult weight is reached at earlier age than those from Lilongwe. More data that is being collected will verify the findings.

The trend in growth pattern on-station (Figure 2) follows that observed on-farm in Lilongwe and Mzuzu ADDs (Figure 1). The two figures show that large weights were attained during the grower stage (between 5 and 10 weeks of age) in pigeons. Thereafter, live weights stabilised or declined. This probably supports the fact that farmers consume squabs. It can be determined therefore that pigeons should be

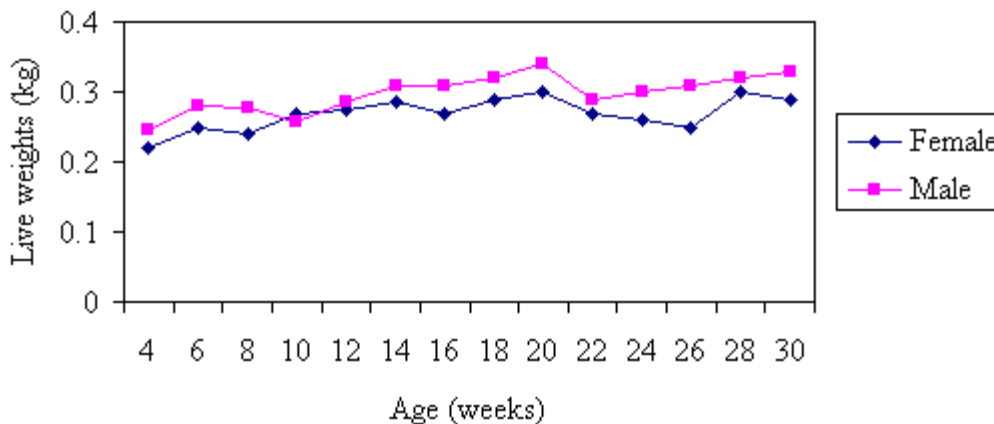


Figure 2. Growth trend in pigeons raised on - station at Bunda.

consumed at the ages of 5 to 10 weeks to take advantage of large weights (more meat). With this, adult pigeons will be left for breeding. Raising pigeons in integration with chickens could best complement each other in terms of supplying meat at different times. Chickens reach table size at 22 weeks of age (Gondwe et al. 2000), while faster returns are obtained from pigeons.

Reproduction characteristics in pigeons

Table 3 shows some estimated reproduction traits in pigeons obtained on-farm in Lilongwe and Mzimba. Farmers reported that pigeons start laying eggs within three months. Two eggs were laid per clutch that usually hatched. This observation suggests that pigeons are a highly inbred species. Pigeons were noted to be prolific, producing a pair of pigeons almost every month. The estimated values obtained on-farm did not agree with those determined on-station. Pigeons took 30 weeks to start laying on-station. More will be verified during subsequent studies as on-farm data is still inadequate to analyse reproduction.

Table 3. Means and standard deviations for reproduction traits in pigeons, on-farm

Trait	Lilongwe			Mzimba		
	n	Mean	SD	n	Mean	SD
Age to point of lay (weeks)	56	11.9	4.9	83	13.0	5.0
Number of eggs per clutch	58	2.0	0.0	87	2.0	0.0
Number of clutches per year	56	11.7	4.7	87	8.6	3.2

n = number of respondents

Conclusion

Results are still inconclusive but have generated initial information needed for further research in pigeons. There is potential in promoting pigeons to be raised in integration with other poultry species in rural areas.

Acknowledgement

Malawi - Norway NORAD project and USAID / MEMP are acknowledged for financial support to the studies in indigenous poultry at Bunda College of Agriculture.

References

- GoM (Government of Malawi). 1998. *National Livestock Development Master Plan*, Final Report. Department of Animal Health and Industry. Ministry of Agriculture and Irrigation, Lilongwe, Malawi.
- Gondwe T.N.P., Ambali A.D.J., Chilera F.C., Lwesya H. and Wollny C. 1999. Rural poultry biodiversity in Lilongwe and Mzuzu Agricultural Development Divisions, Malawi. *Malawi Journal of Science and Technology* 5: 17–25.
- Gondwe, T.N.P., Chilera, F.C., Ambali, A.D.J., Lwesya, H. and Wollny, C. and Phoya, R.K.D. (2000). Characteristics and potentials of rural poultry in Lilongwe and Mzuzu Agricultural Development Divisions (ADD), Malawi. Paper presented at the 6th University Research Conference held at Boadzulu Holiday Resort, Mangochi from 21st to 24th February, 2000
- SAS (1994). Statistical Analysis System. Users' Manual. Version 6.0 Release 6.12.
- SAS Institute, Inc., Cary, NC, USA.

Strengths and weaknesses of smallholder poultry improvement programmes in Malawi

A. C. L. Safalaoh

Department of Animal Science, University of Malawi, Bunda College of Agriculture, P. O. Box 219, Lilongwe, Malawi.

Email: AndyS@chirunga.sdnpp.org.mw

[Abstract](#)

[Introduction](#)

[The smallholder commercial poultry project](#)

[The smallholder poultry improvement programme](#)

[Program operations](#)

[Choice of breed for improvement](#)

[Marketing and distribution of birds](#)

[Support services](#)

[Project risks](#)

[Impact of the SPIP](#)

[Program evaluation](#)

[Suggestions for improvement](#)

[The Malawi smallholder poultry model](#)

[Project components](#)

[Current project status](#)

[Conclusion](#)

[References](#)

Abstract

This paper gives a review of three poultry improvement programmes in Malawi viz.: the Smallholder Commercial Poultry Project (SCPP), the Smallholder Poultry Improvement Programme (SPIP), and the Malawi Smallholder Poultry Model Project (MSPMP). The SCPP was aimed at promoting commercial egg and broiler production in peri-urban areas. The project provided farmers with a ready market for their products. Due to management and funding problems, the project has since gone into oblivion. On the other hand, the SPIP was aimed at improving egg and meat production of indigenous chickens through crossbreeding

using the Black Australorp. The programme is hampered by a myriad of problems such as ill-defined programme objectives and implementation strategies, inadequate availability of improved stock, lack of appropriate poultry husbandry skills, lack of cheap quality feed, prevalence of diseases and lack of programme evaluation. The MSPM Project is aimed at enhancing employment opportunities and income generating activities of smallholder farmers through poultry production or related activities. With proper planning, monitoring, evaluation and modification, the MSPM Project has the potential to be used as a viable and relevant poultry production model in Malawi. This paper focuses on the activities of the three poultry programmes in terms of their strengths, weaknesses and makes suggestions for improvement.

Introduction

Poultry are the most widely kept class of livestock in Malawi in both rural and peri-urban areas (Safalaoh 1992; MOAI 1999). The majority of poultry kept are chickens followed by doves, ducks, and guinea fowls (Haule and Jere 2000; Safalaoh 1997). The trend in commercial poultry production has been unsteady due to an unreliable supply of feed, an inadequate supply of day old chicks and the prevalence of diseases. The MOAI (1999) indicated that Malawi had a poultry population of about 8.6 million free-range chickens, 1.6 million broiler chickens and about 0.2 million layers kept under intensive production. Realising the importance of poultry production, the Malawi Government has embarked on a number of poultry improvement programmes geared at improving productivity of subsistence and smallholder commercial poultry production. This paper discusses the Smallholder Commercial Poultry Project (SCPP), the Malawi Smallholder Poultry Improvement programme (SPIP), and the Malawi Smallholder Poultry Model Project (MSPMP).

The smallholder commercial poultry project

The Smallholder Commercial Poultry Project (SCPP) was implemented in the early 80s as a pilot project to promote commercial poultry production among small-scale farmers in Malawi. Under this scheme, farmers were provided with a starter pack that comprised day-old chicks, feed, drugs and equipment (cages, feeders, drinkers) on loan. Farmers were required to sell their products (eggs and broiler meat) using the government-owned Blantyre, Lilongwe and Mzuzu Egg Marketing Centres. Farmers therefore had a ready market for their products. Due to lack of funds, poor management and poor loan recovery mechanisms, the project was closed. Sadly, there is no documentation regarding what caused the failure of the project and no efforts have been made to evaluate the project. It is paradoxical to find that most egg producers in Malawi have problems marketing their eggs yet the now defunct SCPP provided farmers with a ready market for their products. There is a seemingly urgent need to revisit the whole poultry products marketing system so that an appropriate market structure can be established. Formation of poultry farmer co-operatives and/or clubs should be explored and the Poultry Industry Association of Malawi should take a leading role in this regard.

The smallholder poultry improvement programme

The SPIP started in the 1950s. The main objective of the programme is to improve productivity of indigenous chickens (IC) in terms of egg and meat production through crossbreeding with the Black Australorp (BA). Safalaoh et al. (1996) reported that IC attained 8-week and 20-week live weights of only 615 g and 2100 g, respectively. The need to improve the productivity of IC cannot be overemphasised. Studies carried out in Malawi (Safalaoh et al 1996; Mjojo 1983) have shown that crossbreeding the IC with the BA bird can improve 8-week bird weight and feed efficiency by 16 and 6%, respectively.

Program operations

Choice of breed for improvement

The Black Australorp (BA) was chosen as the exotic breed for crossing with the IC. The BA was chosen based on its dual-purpose nature and its ability to adapt well to tropical environments such as Malawi. On the other hand, no concerted efforts were made to identify and rigorously select an IC type that would optimally combine with the BA in order to produce an ideal crossbreed for the selected egg and meat production traits. For instance, the naked IC has been reported to have a higher meat yield than the dwarf village chicken (Safalaoh 1997).

Apart from the egg and meat production, other traits such as feed conversion, productive life, fecundity, quality of eggs (fertilisation and hatchability), growth rate, feed conversion, carcass yield and quality could have also been evaluated. Once identified, these IC genotypes would then be conserved so that they do not become extinct.

Marketing and distribution of birds

Until recently BA birds were sold to farmers at 6 weeks of age at a cost of MK80.00 (MK80.00 = ~US\$1.00). This was a deliberate decision made to relieve rural smallholder farmers of important and critical early life operations such as brooding, feeding and vaccinations. In order to increase access of birds to smallholder farmers of lower income levels, farmers can now purchase either day-old chicks or fertilised eggs at K15.00 and K5.00, respectively. Farmers place the purchased fertilised eggs under broody IC hen for natural incubation. Some smallholder farmers under the GTZ-supported Integrated Food Security Programme (IFSP) in Mulanje, Southern Malawi, are already practising this method which is referred to as the BA Multiplier Programme (Safalaoh 1998).

When birds are ready for sale, farmers are informed through radio advertisements or announcements made using public speaker vehicles that go around the villages. However, due to funding problems, such promotional activities are sporadic and done on an ad hoc basis. In order to decentralise production and distribution of the BA birds, the SPIP established breeding and multiplication centres at Mikolongwe, Bwemba and Choma in the southern, central and northern regions respectively.

While birds were initially delivered to each of the distribution centres (in the villages) using government transport, farmers are now required to provide their own transport for purchase and delivery of birds to their homesteads. This arrangement has resulted in many farmers not buying the birds due to lack of transport. Consequently, not all birds produced at the multiplication and breeding centres are sold at six weeks of age as planned. The price of MK80.00 per bird has also proved to be prohibitive for the majority of rural farmers (the target clientele of the programme) most of who live below the poverty line. These factors limit further growth in demand of BA birds. Failure to sell birds on time has also been costly for the SPIP. Keeping birds for longer than six weeks results in increased production costs for feed, disease control and water bills among others. A case has been reported where Bwemba Multiplication and Breeding Centre had about 5,206 nine-week-old birds that were consuming 650 kg per day costing the project US\$112.94 (Saini, personal communication). With proper planning such unnecessary costs and expenses could be easily avoided.

Support services

Provision of services such as vaccines and extension services were an integral part of the SPIP during inception. However, in an attempt to promote self-reliance and programme sustainability, farmers are now required to purchase their own drugs and vaccines. Not many farmers can afford to purchase these vaccines and drugs. Disease prevention is therefore an

exception under smallholder conditions. This has resulted in the prevalence of outbreaks of diseases such as New Castle Disease (Christiansen 1986). Adequate and reliable extension services are mainly constrained by a low extension worker to farmer ratio.

Project risks

The SPIP has two major risks. The first is the abrupt change birds face when they are moved from breeding centres to the villages. The change from an intensive deep litter system of management to a free range system is in itself stressful in terms of feeding (nutrition), housing and general bird welfare. Under such conditions, the performance of the BA birds is heavily compromised, as the birds may need some time to adjust. Secondly, the birds are exposed to an environment where outbreaks of diseases such as New Castle Disease come in horrendous and epidemic proportions.

Impact of the SPIP

The Impact of the SPIP leaves a lot to be desired. Safalaoh (1998) reported that only 5.3% of the rural population in Mulanje keep BA birds while approximately 97.3% keep indigenous chickens. Gondwe (1994) has reported similar observations. Low availability of BA birds has been attributed to erratic and biased distribution, high mortality rates, unaffordable bird prices and lack of good quality feed (Safalaoh 1992, Gondwe 1994). There is virtually no evidence of planned breeding programmes in the rural areas of Malawi. The breeding strategy used is indiscriminate where chickens themselves are responsible for selection, mating, incubation and brooding. Under such circumstances, no clear crossbreeding programme can be implemented with any hope of success.

Another often-overlooked fact is that most farmers in the rural areas prefer to keep hens to cockerels. However, BA hens tend not to sit on their eggs (Safalaoh 1992) hence no eggs are hatched. For crossbreeding purposes, the male BA cocks should therefore be introduced in order to cross with local hens, which naturally sit on their eggs. Beneficial effects of crossbreeding the BA with the IC include improved weight gain and improved feed efficiency (Safalaoh et al 1996).

Program evaluation

Albeit being in existence for more than 40 years, the SPIP has never been evaluated. Programme evaluation is important for beneficiary impact assessment and modification of the programme, where necessary, in order to achieve the desired goals/objectives. Additionally, timely programme evaluation would identify strengths and weaknesses that would be used to draw up recommendations that would be used to strengthen the SPIP.

Suggestions for improvement

Several options exist for improving the SPIP. Accessibility to BA birds can be improved by encouraging farmers to purchase fertilised eggs to be incubated using IC hens. However, farmers need to have proper poultry feeding, general management and disease control skills so that bird survival can be improved. Vaccination campaigns of diseases such as New Castle Disease should be strengthened and drugs for all-important diseases made available at affordable rates through reasonable cost recovery mechanisms to ensure sustainability. Mechanisms for reducing the price of six-week old birds should also be sought so that a larger proportion of the target clientele can afford to buy the birds. Finally, there is an urgent need for the Malawi Government to evaluate the programme so that the SPIP can be put on the right course.

The Malawi smallholder poultry model

Poultry production at the smallholder level is generally characterised by low productivity (Safalaoh 1997). However, the importance of poultry as a source of income to rural landless and economically marginalized households in Malawi has recently received tremendous recognition by both government and non-governmental organisations. With appropriate improvements to the existing poultry production systems it is envisaged that small-scale farmers in the rural areas of Malawi can greatly benefit from keeping poultry. In view of this, the Government of Malawi, through the DANIDA Agricultural Sector Programme Support Phase II (DASPS II) - Livestock Component, initiated the Malawi Smallholder Poultry Model (MSPM) Project. This project is an adaptation of the Bangladesh Poultry Model. This project is aimed at development of a poultry production model to enhance employment opportunities and income generating activities of smallholder farmers in Malawi (Haule and Jere 2000).

It is envisaged that development of the MSPM would invariably work as a poverty reduction strategy thereby improving the economic status of the poorest of the poor households with priority given to female-headed households. A Participatory Rural Appraisal was conducted before commencement of the project in order to generate information regarding perceptions and constraints of smallholder farming communities in relation to livestock production with emphasis on poultry. The project is being implemented in two sites of Lilongwe West Rural Development Project and Kasungu Rural Development Project.

Project components

The MSPM is designed as an integrated system that provides all the prerequisite inputs/supplies and services that are required to maintain and sustain a viable semi-scavenging poultry production system. The model is designed to synchronise all related poultry activities hence their interdependency. The poultry model has the following components:

The Poultry Worker: The poultry worker is responsible for provision of services such as vaccination of birds and training farmers in managerial skills.

The Feed seller: The function of the feed seller is to supply feed to chicken growers.

The Chicken rearer: The function of the chick rearer is to raise birds up to eight weeks of age for sale to the key rearer.

The Key rearer: This is the main target of the model. The key rearer keeps local broody hens and exotic ones. In Malawi, the Hyline is being used for production of table eggs.

Pullet rearer: The pullet rearer raises birds up to 18 weeks of age for sale to the Model breeders.

Model Breeders: These are supposed to maintain breeding stock for production of chicks for use by chick and key rearers.

Egg seller: These collect and sell eggs from the key rearers.

Mini hatcherers: These hatch day old chicks which are distributed to chick and key rearers.

Current project status

Mini hatcherers: In the initial stages of the MSPM Project, the use of mini hatcherers has been temporarily removed. This has been done due to lack of appropriate incubation equipment for

use at the smallholder level. The use of rice husk incubators is currently being tested at Chitedze Agricultural Research Station. Considering the fact that rice husks are not readily available in the pilot project sites, there is a need to look for alternative materials that could be used as incubation materials instead of rice husks. In the absence of incubators, fertilised eggs are purchased from commercial hatcheries and sold to farmers. The farmers then place these eggs on broody IC hens for natural incubation. However, one of the problems with this approach is that there is no assurance that all the eggs bought from the hatcheries are fertile. Another apparent problem with regard to sustainability is that the project buys the fertilised eggs on behalf of the farmers. It is important that farmers themselves should be involved in the procurement of these eggs so that they should get used to the process, thereby simultaneously promoting an element of project ownership.

Egg sellers: The main purpose for keeping hens is the egg. As such, the expectation of most farmers is that they will produce and sell the eggs themselves. However, the MSPM is designed in such a way that the eggs should be sold by a farmer other than the producer - key rearer. Preliminary observations have shown that the key rearer would rather sell the eggs himself and not through the egg seller. The need to thoroughly analyse and evaluate various components of the MSPM becomes apparent. For instance, could the key rearer and egg seller components be combined? The views and feelings of the farmers should be part and parcel of the model before any success is anticipated.

Model breeders: Currently, farmers are using hatched eggs from commercial breeders. Use of commercial hatcheries as a source of fertilised eggs may not be sustainable. The project should establish its own breeding stock so that farmers and mini hatcherers can easily access the fertilised eggs. Initial indications are that the Hyline breed is performing well under village conditions using the semi scavenging system of production. The performance of the Hyline breed should be studied thoroughly before it can be recommended for use at the village level in Malawi. There is also a need to assess how crossbreeds from the local chickens with the BA or other exotic breeds can perform under conditions as stipulated in the MSPM.

The Feed seller: Feed is a very important component of the MSPM as it is one of the major constraints to poultry production in Malawi (Safalaoh 1992). Currently, farmers are using feed purchased from commercial millers. This feed is generally expensive and in the absence of a sound economic base, the sustainability of such an approach is questionable. Another flaw of the approach is that the project is responsible for the purchase and delivery of feed to the farmers. There is a need to evaluate the project in these early stages to assess if the farmers, without project intervention, can effectively manage and sustain the project. It might be prudent to consider teaching feed sellers how to mix their own feed on the farm. This would ensure that feed is always available on the farm. The farmers should also be taught to grow crops such as soybeans that form a large proportion of poultry feeds.

It is therefore of paramount importance that the MSPM Project should be accorded all the financial and technical support so that it can accomplish its laid out objectives. There is a need for an ongoing monitoring and evaluation system so that timely project modifications can be made and implemented in order to suit prevailing conditions and farmers' aspirations.

Conclusion

Poultry production is, and will continue to be, an integral part of life in Malawi. For any poultry improvement programme to succeed, there is a need to take into consideration the prevailing situation of the farmers and their aspirations and ambitions. Proper planning and constant monitoring and evaluation are prerequisites. There is a need to review the Smallholder Commercial Poultry Project concept in line with the newly introduced Malawi Smallholder Poultry Model. The failures associated with the SPP may be applied to the MSPM and appropriate corrective steps taken accordingly. Revival of egg marketing centres would

provide farmers with a ready market for their products. Components of the MSPM should be thoroughly examined in terms of their applicability and suitability at the local level. More importantly, the Malawi Government should always evaluate its projects before embarking on new ones. Under normal situations, it would have been expected that the Smallholder Commercial Poultry Project and Smallholder Poultry Improvement Programme could have been evaluated before commencement of the Malawi Smallholder Poultry Model Project.

References

- Christiansen N.H. 1986. Disease and mortality in poultry in the Shire Highlands of Southern Malawi. *World's Poultry Science Journal* 42:243–247.
- Gondwe T.N. 1994. *Prevalence of black Australorp chickens in extension planning areas 11 and 12 of Lilongwe ADD*. BSc thesis Project Report, Bunda College of Agriculture, University of Malawi, Lilongwe, Malawi.
- Haule A.P. and J. Jere 2000. *Report on Participatory Situation Analysis of Livestock Production Smallholder Farmers in Lilongwe West and Kasungu Rural Development Project*. Department of Animal Health and Industry. DASPS II - Livestock Component.
- MOAI (Ministry of Agriculture and Irrigation). 1999. *Final Report, National Livestock Development Master Plan*. Department of Animal Health and Industry.
- Mjojo D.P.K. 1983. *Comparison of Reproductive and Productive Performance of Black Australorp and Local Chickens*, Degree Projects, Bunda College of Agriculture, University of Malawi.
- Safalaoh A.C. L. 1992. *A Review of Poultry Production in Malawi: Constraints and Possible Solutions*. 3:15–22. Malawi National Commission for UNESCO. Malawi.
- Safalaoh A., Kadigi H. J. S. and Phoya R. K. 1996. Growth performance of the Malawi local chicken, the Black Australorp Chicken and their crosses at twenty weeks of age. *Uniswa Res. Journal of Agriculture Science & Technology* 1(1): 61–66
- Safalaoh A.C.L. 1997. Characteristics of indigenous chickens of Malawi. *AGRI* 22: 61–69.
- Safalaoh A.C.L. 1998. *Poultry Survey Consultancy Report*. GTZ Integrated Food Security Programme (IFSP), Mulanje, Malawi.

Sheep responses to different stocking rates and seasonal variation under rangeland conditions of Lesotho

L. M. Mpiti- Shakhane¹, G. Y. Kanyama- Phiri¹, J. W. Banda¹ and W. O. Odenya²

¹ Bunda College of Agriculture, Lilongwe, Malawi

² National University of Lesotho, Roma, Lesotho.

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Experimental design](#)

[Ewe handling and management](#)

[Data analysis](#)

[Results and discussion](#)

[Live weights of Merino ewes](#)

[Fleece production and quality](#)

[Birth weight, growth rate and mortality of lambs](#)

[Conclusion](#)

[Acknowledgements](#)

[References](#)

Abstract

A study was conducted at Lekubane Rangeland Research Station in Lesotho to determine sheep responses to stocking rates over a one-year period. The experimental design consisted of three stocking rates namely, light (3.5 ewes ha⁻¹ year⁻¹), moderate (5.6 ewes ha⁻¹ year⁻¹) and heavy (14 ewes ha⁻¹ year⁻¹) in a Completely Randomised Block Design (CRBD) with three replicates per treatment. Data collected from ewes included live weights, grease fleece weight, fibre diameter and crimp frequency. Data collected from lambs included birth weight, weekly weights, mortality and weaning weights. Weight changes of both ewes and lambs were calculated.

Ewes in the heavy stocking rate had significantly ($p < 0.05$) lower final liveweights (36.0 kg) than ewes in the moderate (39.0 kg) and light (40.0 kg) stocking rates. Heavy stocking rate had significantly ($p < 0.05$) lower fleece weight (2.2 ± 0.1 kg) than moderate and light stocking rates (2.8 ± 0.1 kg and 2.9 ± 0.02 kg, respectively). Ewes in the stocking rates of 3.5, 5.6 and 14 ewes ha⁻¹ year⁻¹ had fibre diameters of 23.3 ± 0.8 μm , 24.5 ± 0.7 μm and 23.1 ± 0.8 μm ,

respectively; staple lengths of 66.4 ± 1.1 mm, 74.9 ± 1.0 mm and 57.7 ± 1.1 mm, respectively and crimp frequencies (25mm) of 9.89 ± 0.6 , 11.13 ± 0.6 and 12.4 ± 0.6 , respectively.

Birth weights of lambs in the light-stocking rate were significantly ($p < 0.05$) higher (3.24 ± 0.1 kg) than in the heavy stocking rate (2.82 ± 0.2 kg). The birth weights of lambs in the moderate stocking rate (5.6 ewes ha^{-1}) did not differ significantly (3.06 ± 0.3 kg) from those in the heavy (14 ewes ha^{-1}) or in the light stocking rates (5.6 ewes ha^{-1}). The lambs in the heavy and moderate stocking rates had significantly ($p < 0.05$) higher mortality (64% and 58%) than those in the light stocking rate (40%). There were no significant differences in the average weight gain per lamb between moderate and light stocking rates. However, the heavy stocking rate registered a significantly lower (0.059 Kg) average weight gain than the moderate (0.088 Kg) or lighter (0.069 Kg) stocking rates. The weaning weights for light, moderate and heavy stocking rates, were 10.4 kg, 13.3 kg and 9.0 kg, respectively. The average weight gain per hectare increased significantly ($p < 0.05$) from 20.2 kg through 41.4 kg to 69.4 kg for light, moderate and heavy stocking rate, respectively.

Under the conditions of this study, it is concluded that the heavy stocking rate significantly reduced ewe and lamb performances.

Introduction

The livestock industry in Lesotho has long been a vital component of the economic and social structure of the country. Basotho (people of Lesotho) have long invested in cattle and have extracted many valuable products from them including meat, milk, manure and draft power. Basotho rapidly adopted Angora goats and Merino sheep, which generate cash income through sales of wool and mohair as main exports for the country. Of the total income generated by the livestock sector (75%), wool and mohair sales contribute between 14 and 20% (Hunter 1987; Phororo, Ponzoni and Kidman 1993). Cattle, sheep and goats have also become important in ceremonies and social obligations.

While there is evidence to suggest that livestock remains one of the best investments available to individual Basotho, there is a cause for concern about the future of the livestock industry. There is a low-marketed offtake of livestock and livestock products in Lesotho. Angora goat population and mohair production per goat have been declining at annual rates of 0.5% and 1.8%, respectively (Bureau of Statistics 1999). The Merino sheep population and wool production have also been declining at annual rates of 0.2% and 1.5%, respectively (Bureau of Statistics 1999). This progressive decline over the years is indicative of the reduced capacity of rangelands in Lesotho to sustain livestock productivity (Buzzard 1995). It is obvious that at the current stocking rates and range conditions of Lesotho, there will be a continuous low-marketed offtake of both animals and animal products. Further, with an increase in annual population growth of 2.6% and an increase in demand per capita for livestock products, communal rangelands of Lesotho should receive careful management to ensure their functional and sustainable productivity and thus improve production of livestock grazing on these rangelands.

The purpose of the study was to establish an appropriate stocking rate, which would lead to an increase in sheep productivity whilst ensuring conservation of forage resources.

Specifically this study was designed to:

- Determine liveweight changes of Merino ewes under different stocking rates;
- Determine wool production (grease fleece weight) and wool quality (fibre diameter, staple length and crimp frequency) of Merino ewes under different stocking rates;
- Determine birth weights and mortality of lambs under different stocking rates;
- Monitor growth rate of lambs from birth to weaning.

Materials and methods

A study was conducted at Lekubane Rangelands Research Station in Lesotho from February 1999 to February 2000. The study area was located at 29.5° South Latitude and 27.9° East Longitude. The elevation ranges from 2275 m above sea level at substation headquarters to 2618 m above sea level at the highest mountain peak. The area is characterised by extremely low and high temperatures ranging from -20°C in winter to 32°C in summer. Mean annual precipitation ranges from 800 mm to 1000 mm (Bureau of Statistics 1999). Soils are deep dark brown mollisols, moderately coarse textured and fairly well drained. The station has two slopes: the east and west facing slopes. The west facing slopes of the station are dominated by *Themeda triandra* and *Aristida bipartita* and the east facing slopes are dominated by *Festuca caprina* and *Aristida bipartita*. The station has been fenced and stocked at a moderate rate of 5.6 ewes ha^{-1} on a year round basis. The condition of the camps is estimated to be good while most of the surrounding rangeland outside the station is estimated to be in poor condition based on rainfall distribution (Figure 1).

Experimental design

The study area had a total of 11.25 hectares of rangeland pasture. This rangeland pasture was subdivided by barbed wire fencing into nine paddocks. Three paddocks of 2.00 hectares were stocked at 3.5 Merino ewes $\text{ha}^{-1} \text{ year}^{-1}$ while three paddocks of 1.25 hectares were stocked at 5.6 Merino ewes $\text{ha}^{-1} \text{ year}^{-1}$ and the remaining three paddocks of 0.5 hectares were stocked at 14 Merino ewes $\text{ha}^{-1} \text{ year}^{-1}$, representing light, moderate and heavy stocking rates, respectively. Sixty-three Merino ewes were involved in the study and were divided into nine groups of equivalent weight. These groups of ewes were randomly allocated to each paddock. The study was conducted over four seasons, namely, autumn (February to April), winter (May to July), spring (August to October) and summer (November to January).

The experimental design consisted of three stocking rates laid out in a Randomised Complete Block Design (RCBD) with three replicates per treatment. The "moderate" stocking rate (5.6 merino ewes $\text{ha}^{-1} \text{ year}^{-1}$) was arrived at using the Standard Animal Unit (one mature cow of equivalent weight of 450 kg with a daily dry matter intake requirement of 12 kg) (Tainton 1981).

Ewe handling and management

Before the initiation of the trials, all ewes were ear-tagged with plastic tags for ease of identification. Thereafter, the ewes were de-wormed monthly against internal parasites, using Valbazine at the rate of 2.5 ml/ 10 kg live weight. Each ewe was sprayed with chlorofenvinfos every two months against external parasites such as lice and fleas. The ewes were taken to pasture every morning at 0830 hours and were allowed to graze in their respective paddocks for 8 hours during the day and then were penned at night. The animals were allowed free access to coarse salt and water.

Grease fleece for each ewe was weighed during the shearing season in October. Fleece samples were then taken to Lesotho Products and Marketing Services (LPMS) to be graded by staple length, fibre diameter and crimp frequency.

Mating of ewes was done between May 5th and June 7th 1999. Lambing was from late October to late November 1999. Lambs were weighed immediately after birth. Thereafter, lambs were weighed weekly to monitor their growth rates up to weaning at 12 weeks of age. Mortality of lambs was also recorded from birth to weaning. It was assumed that the liveweight

gain from birth to twelve weeks of age was linear and constant. Thus average daily gain (ADG) was calculated by deducting the birth weight from the weaning weight, divided by the number of days to weaning as follows:

$$\text{ADG} = \frac{\text{Weaning weight} - \text{birth weight}}{\text{Number of days to weaning}}$$

Data analysis

Data on dam live weights, fleece production and quality, and lamb performance were subjected to Analysis of Variance by the General Linear Model (GLM) Procedure using Statistical Analysis Computer Package (SAS Institute 1994). The means were separated and compared using the Least Square Means Procedure.

The model used for analysis of stocking rate effect on liveweight changes, grease fleece weight, fibre diameter, staple length and crimp frequency of Merino ewes, birth weight, daily weight gain and weaning weight of Merino lambs was:

$$Y_{ij} = \mu + R_i + S_j + b(W_i) + E_{ij}$$

Where

Y_{ij} = liveweight changes, grease fleece weight, fleece diameter, staple length, crimp frequency of Merino ewes, birth weight, average weight gains and weaning weight of Merino lambs

μ = Overall mean

$R_i = i^{\text{th}}$ effect of the replicate where $i = 1, \dots, 3$

$S_j = j^{\text{th}}$ effect of the stocking rate where $j = 1, \dots, 3$

b = Partial linear effect of initial live weight on animal performance

W_i = Initial live weight (a covariate of subsequent animal performance)

E_{ij} = Error component

The percentage mortality of lambs from birth to weaning age was calculated and compared for different treatments using the Chi-Square (χ^2) test.

Results and discussion

Live weights of Merino ewes

The live weights of Merino ewes at the beginning and at the end of the study are shown in Table 1. There were no significant differences in the average live weights of Merino ewes attributed to the stocking rate at the beginning of the study. This was expected since at the initiation of the study, the ewes were allocated to stocking rate based on equivalent weights. However, there were clear indications that these live weights followed seasonal trends. There was a consistent pattern of weight loss as the season advanced from autumn to winter. This declining trend occurred across all the stocking rates. The reduction may be ascribed to reduced forage intake and diet quality caused by the little or lack of rainfall (Figure 1) and very low temperature (-20°C) during winter months, which resulted in little or no growth of vegetation. The weight loss observed during spring might also be attributed to lambing, which coincided with harvesting of fleece. This was more pronounced in the heavy stocking rate than in the light and medium stocking rates.

Table 1: Least square means of live weights (kg \pm se) of Merino ewes in response to different stocking rates

AVERAGE LIVEWEIGHTS			
Stocking rate Ewes ha ⁻¹	Start weight kg ewe ⁻¹	Final weight kg ewe ⁻¹	^a Adj. R ²
	Mean ± se	mean ± se	
3.5	35.8 4.8	40.0 ^a 4.11	0.93
5.6	36.1 5.0	39.0 ^a 3.75	0.89
14	34.7 4.9	36.0 ^b 4.10	0.93

^{a, b} Means in a column with different superscripts are significantly different ($p < 0.05$)
 se = Standard error
^aAdj. R² : Adjusted R²

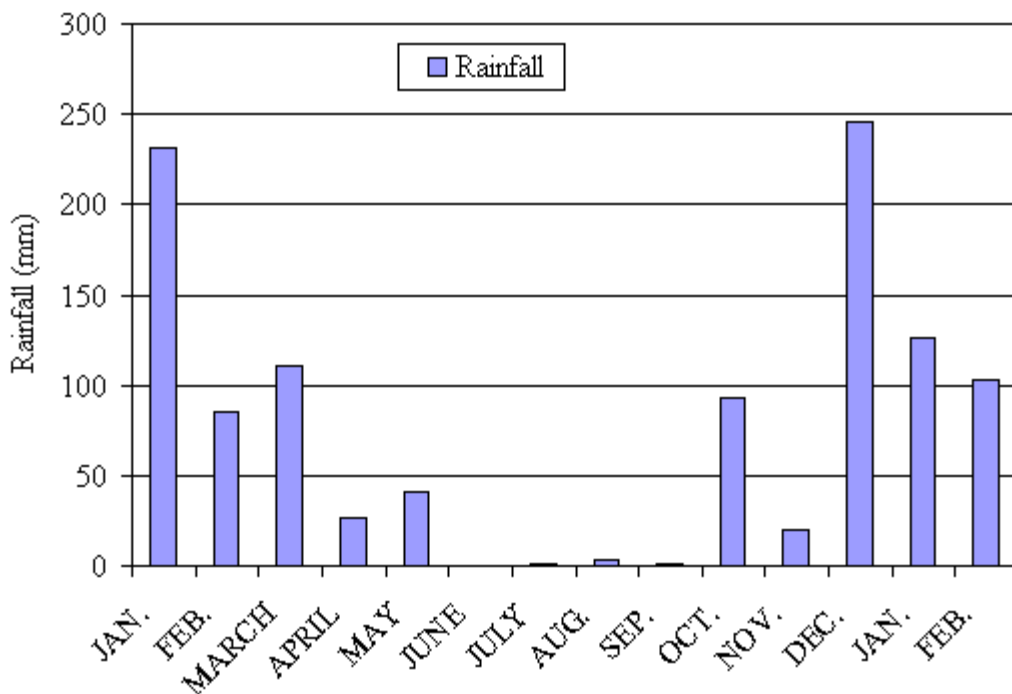


Figure 1: Rainfall distribution in Lekubane Rangeland Research Station during January 1999 to February 2000

Final live weights were significantly lower ($p < 0.05$) in the heavy stocking rate treatment than in the light and moderate stocking rates (Table 1). These observations are similar to results obtained by Nolan (1972) and Sharrow, Krueger and Thetford (1991) who applied similar stocking intensities. Nolan (1972) observed a decrease of 8.8 kg mean peak live weight ewe⁻¹, if stocking rate was increased from 10 to 20 ewes per ha⁻¹. This compares well with this study, in which a decrease of live weight of 4 kg ewe⁻¹ was observed, if stocking rate increased from 3.5 to 14 ewes ha⁻¹.

Fleece production and quality

Least square means for wool production and quality of Merino ewes in response to stocking rate are presented in Table 2. The average fleece weight per sheep ranged between 2.2 and 2.9 kg. This is in agreement with the results of Ngambi and Belete (1994) who reported the performance to be between 2.4 and 3.5 kg in Lesotho. Their work, however, never considered differences in stocking rates.

Table 2: Least square means of wool production and quality of Merino ewes in response to different stocking rates

Rate	Fleece production		Fleece quality		
	Grease weight (kg ewe ⁻¹)	Diameter (µm) (kg ha ⁻¹)	Length (mm)	Crimp (25mm) **	
Ewe ha ⁻¹	mean ± se	Mean ± se	mean ± se	mean ± se	mean ± se
3.5	2.9 ^a 0.02	10.2 ^a 0.03	23.3 0.8	66.4 ^b 1.1	9.9 0.6
5.6	2.8 ^a 0.1	15.7 ^b 0.1	24.5 0.7	74.0 ^a 1.0	11.1 0.6
14	2.2 ^b 0.1	30.8 ^c 0.1	23.1 0.8	57.7 ^c 1.1	12.2 0.6

a, b, c Means in a column with different superscripts are significantly different (p<0.05)

** (p<0.001)

se = standard error

Stocking rate had significant effects on fleece production (Table 2). The light and medium stocking rates had significantly (p<0.05) higher grease fleece weight per ewe than the heavy stocking rate. These results are supported by the work of White and McConchie (1976) and Langlands et al. (1984), which indicated that wool production per sheep was reduced when ewes were stocked at the high rate. Stocking rates of 3.5, 5.6 and 14 ewes ha⁻¹ produced 10.2, 15.7 and 30.8 kg of wool ha⁻¹, respectively.

Fleece lengths differed significantly across the stocking rates. Ewes on the heavy stocking rate had significantly (p<0.05) shorter fleece length than those on the light and moderate stocking rates. Similar observations were made by White and McConchie (1976) and Langlands et al. (1984) who reported that increased stocking rate resulted in a decline in staple length and fibre diameter and an increase in staple crimp frequency (waviness of the fleece). However, fibre diameter and staple crimp frequency found in this study did not differ significantly across the stocking rates. This could be explained by the fact that the stocking rates used in this study were not significantly reliable to show the effects on fleece quality.

Birth weight, growth rate and mortality of lambs

Birth weight, daily weight gains, mortality and weaning weights of Merino lambs are shown in Table 3. The birth weight of lambs in the light stocking rate was significantly (p<0.05) higher than the birth weight of lambs in the heavy stocking rate. On the other hand, birth weight of lambs in the moderate stocking rate was not significantly different from the birth weight in either heavy or light stocking rate. It was however, observed that the lambs in the heavy and moderate stocking rates registered significantly (p<0.05) higher mortality than those in the light stocking rate. These results are comparable to previous reports, which indicated that lamb birth weight decreased as stocking rate increased (Nolan 1972).

Table 3: Least square means of birth weights, growth rate and mortality of lambs response to different stocking rates

-1					2
----	--	--	--	--	---

Ewe ha	Birth weight (kg)	Weight gains kg lamb ⁻¹	Weaning kg ha ⁻¹	Mortality(%) weight (kg)	(x = 7.20) (p < 0.05)
	mean ± se	mean ± se	mean ± se	mean ± se	
3.5	3.24 ^a 0.1	0.069 ^a 0.003	20.2 ^c 0.004	10.4 ^b 0.1	40
5.6	3.06 ^{a b} 0.3	0.088 ^a 0.001	41.4 ^b 0.002	13.3 ^a 0.1	58
14	2.82 ^b 0.2	0.059 ^b 0.004	69.4 ^a 0.01	9.0 ^b 0.2	64

a, b, c Means in a column with different superscripts are significantly different (p<0.05)

X² = Chi- square

Stocking rate had no significant effect on daily weight gains of lambs. There was however, a tendency for daily weights to decrease as stocking rate increased. A similar tendency was observed by Sharrow et al. (1991).

Lamb production per hectare significantly (p<0.05) increased with increasing stocking rate (Table 3 and Figure 2). This increase occurred in spite of the declines in the birth weights, weight gains per lamb and percentage lamb crop. Similar results have been reported by Timberlake (1994), MacLeod and McIntyre (1997), McCollum III, Gillen, Karges and Hodges (1999) who noted that increasing the stocking rate from 14 to 20 ewe ha⁻¹ reduced average birth weight and average weight gain per lamb, but increased average weight gains per hectare. The medium stocking rate had significantly higher weaning weight than the light and heavy stocking rates. These results are in agreement with the report of Sharrow et al. (1991), which indicated that average weaning weight of lambs during the study was significantly (p<0.05) higher at 7.4 ewes ha⁻¹ than at the 12.4 ewe ha⁻¹ stocking rate.

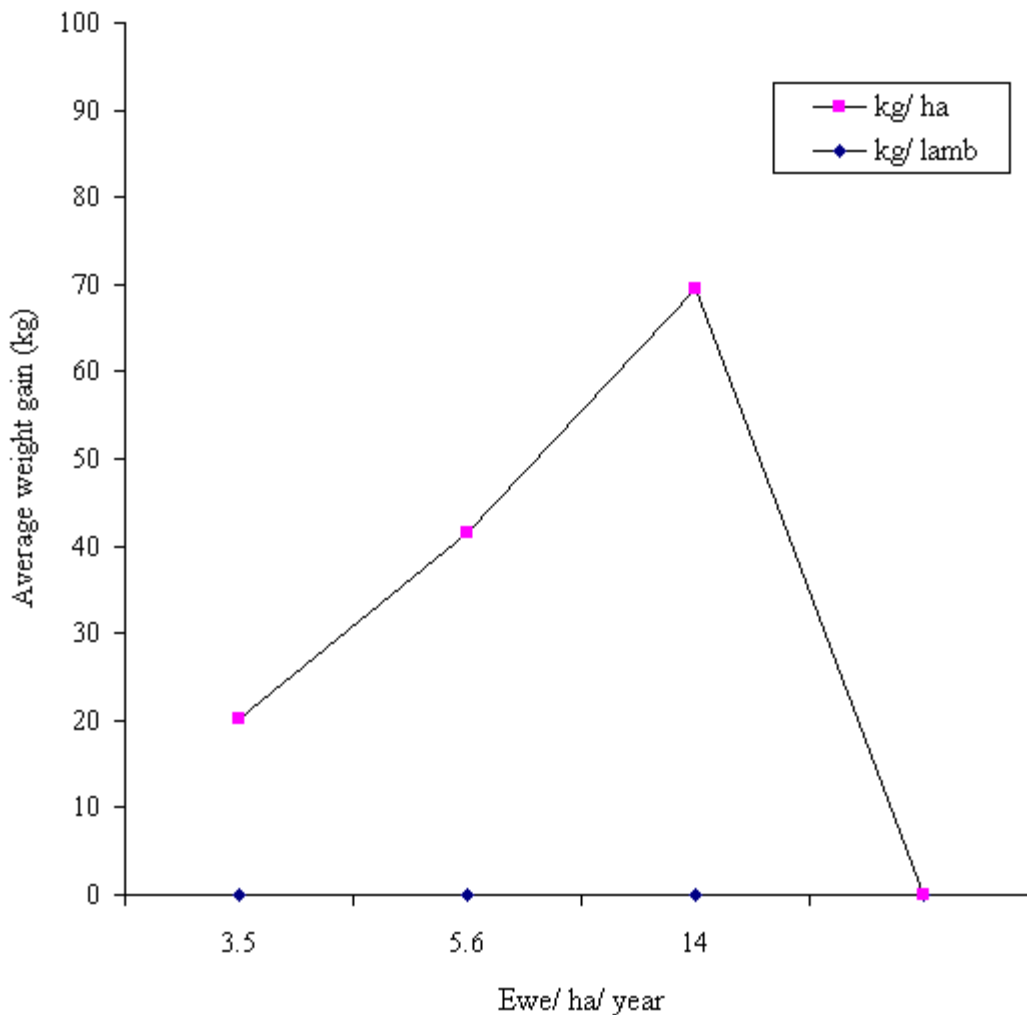


Figure 2: Weight gains of Merino lambs in response to stocking rate

Conclusion

The results of this study indicated that the heavy stocking rate significantly ($p < 0.05$) reduced the birth weight of lambs. The study further demonstrated that the lambs in the heavy and moderate stocking rates had significantly ($p < 0.05$) higher mortality than their counterparts in the light-stocking rate. While the lamb production per hectare significantly increased with increasing stocking rate, the average daily gain per lamb remained similar across the stocking rates. It can therefore, be concluded that the "moderate" (optimum) stocking rate required in this study to confirm linearity between gain per lamb and stocking rate was not achieved.

Since the results of this one-year study were inconclusive, it is recommended that, the study should be repeated. The moderate stocking rate of $5.6 \text{ ewes ha}^{-1} \text{ year}^{-1}$ currently used at the research station should be adjusted upwards until optimal stocking rates that will permit efficient forage utilisation and sheep productivity are realised. It is further recommended that in the new study, the stocking rate of $5.6 \text{ ewes ha}^{-1} \text{ year}^{-1}$ should be included as a control.

Acknowledgements

The authors would like to acknowledge Deutsche Gesellschaft fuer Technische

Zusammenarbeit (GTZ) for funding the study and the National University of Lesotho for providing field and laboratory facilities.

This study would not have materialised without the assistance of the Research Division, Conservation Division, Livestock and Range Division. The Research Division assisted with workers to fence the study site, transport to the research site on weekly basis, and the study site and herdsmen. The Conservation Division surveyed the research site and came up with the map demarcating the paddocks. The Livestock and Range Division provided transport during the collection of vegetation data and provided research technicians who assisted in the data collection and identification of grass species.

The smallholder farmer is gratefully acknowledged for providing Merino ewes used in this study. The Lesotho Products and Marketing Services is equally acknowledged for grading of fleece samples.

References

- Bureau of Statistics. 1999. *Annual Wool Statistical Bulletin*. Bureau of Statistics, Maseru, Lesotho.
- Buzzard R.F. 1995. *An introduction to ecological monitoring*. Lesotho community natural resource management project. Range Management Division. pp121–142.
- Hunter J.P. 1987. *The economics of wool and mohair production and marketing in Lesotho*. ISAS Research No. 16, Roma, Lesotho. pp 15–56.
- Langlands J. P., Donald G. E. and Paull D.R. 1984. Effects of different stocking intensities in early life on the productivity of merino ewes grazed as adults at two stocking rates. *Australian Journal of Experimental Agricultural and Animal Husbandry*. CSIRO Division of Animal Production, Pastoral Research Laboratory, Armidale, NSW 2350, Australia. 24: 124, 34–36.
- MacLeod N. D. and McIntyre S. 1997. Stocking rate impacts on the production and economic performance of steers grazing black speargrass pastures. *Rangeland Journal* 19 (2): 174–89.
- McCollum III, F. T., Gillen, R. L. Karges, B.R. and Hodges, K. M. 1999. Stocker cattle response to grazing management in tall grass prairie. *Journal of Range Management* 52:1–7.
- Ngambi J. W. and Belete A. 1994. Mohair production trends in Lesotho between 1935 and 1990. *An International Workshop on Research and Development of Small Ruminants held in 1994 in Southern Africa, Zimbabwe*. pp 1–7.
- Nolan T. 1972. Fat lamb production in the west of Ireland. 2. Effects of stocking rates on Lamb growth rate and on production of lamb carcass meat and wool per hectare. *Irish Journal of Agricultural Research* 11:47–55.
- Phororo D.R., Ponzoin R.W., Kidman P.R. 1993. *Developing a strategic plan for the wool and mohair industry in Lesotho*. UNDP/FAO. Technical Mission Report, Maseru, Lesotho. pp 1–5
- SAS (Statistical Analysis System). 1994. User Guide: Statistics, version 6. 10th Edition. 1994. SAS Institute, Inc., Cary, NC. USA.
- Sharrow S. H., Krueger W. C. and Thetford F.O. 1991. Forage standing crop and animal diets under rotational and continuous grazing. *Journal of Range Management* 36: 447– 450.
- Tainton N. M. 1981. *Veld and pasture management in South Africa: Grazing management*. Shuter and Shooter, Pietermaritzburg in association with University of Natural Press,

Pietermaritzburg, Republic of South Africa. pp 322–354.

Timberlake J. R. 1994. An analysis of a stocking rate trial at Chobela, Southern Mozambique. *African Journal of Range and Forage Science*. 11:51–53

White D. H. and McConchie B. J. 1976. Effect of stocking rate on fleece measurements and their relationships in merino sheep. *Australian Journal of Agricultural Research*. S. S. Cameron Lab., Department of Agriculture, Victoria, Werribee, Australia. 27: 163–174.

Forage responses to different stocking rates and seasonal variation under rangeland conditions of Lesotho

*L. M. Mpiti- Shakhane*¹, *G. Y. Kanyama- Phiri*², *W. O. Odenya*¹ and *J. W. Banda*²

¹ National University of Lesotho, Department of Animal Science, P. O. Box 180, Lesotho.

²Bunda College of Agriculture, Lilongwe, P. O. Box 219, Malawi.

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Experimental design](#)

[Measurement of vegetation composition, biomass production and forage quality](#)

[Data analysis](#)

[Results and discussions](#)

[Establishment of botanical composition](#)

[Biomass production](#)

[Crude protein content](#)

[Conclusion](#)

[Acknowledgements](#)

[References](#)

Abstract

A study was conducted at Lekubane Rangeland Research Station in Lesotho to determine forage responses to stocking rates and season over a one-year period. The experimental design consisted of three stocking rates namely, light (3.5 ewes ha⁻¹ year⁻¹), moderate (5.6 ewes ha⁻¹ year⁻¹) and heavy (14 ewes ha⁻¹ year⁻¹) and four seasons (autumn, winter, spring and summer) combined factorially in a Completely Randomised Block Design (CRBD) with three replicates per treatment. Data collected included biomass production, botanical composition and crude protein content.

Total biomass production of forages at the end of the study was significantly ($p < 0.05$) lower (3191 kg ha⁻¹) in the heavy stocking rate than in the moderate (3821 kg ha⁻¹) and light (3834 kg ha⁻¹) stocking rates. Seasonal variation significantly ($p < 0.05$) altered crude protein (CP) content of the grass species as evidenced by a decline in crude protein from 5.6 % CP in summer and 7.8 % CP in autumn to 4.2 % CP in winter and 4.3 % CP in spring.

The results of this study suggest that an appropriate stocking rate that would lead to an

increase in sheep productivity while ensuring conservation of forage resources was not achieved. Under the conditions of this study, it would be concluded that season exerted greater impact on sward productivity than stocking rate.

Introduction

Lesotho is a small mountainous country covering an area of 30,555 km². Its population of 1.7 million is growing at an annual rate of 2.6% (Bureau of Statistics 1999). Owing to its mountainous character, 75 percent of the land is non-arable, subject to physical limitations such as low and erratic precipitation, poor soils, rough topography and cold temperatures making it unsuitable for cultivation, and is therefore best put to use as a rangeland.

Based on carrying capacity estimates reported by the Range Management Division (RMD 1988), the rangelands were estimated to be overstocked by about 45 percent, an increase of 15 percent from ten years earlier. This has led to a severe reduction of available forage despite the fact that rangelands of Lesotho have grass with a high regeneration capacity. The current estimation of rangeland carrying capacity indicates that stocking rates in the country are exceeded by 75 percent (RMD 1998), an increase of 30% since 1988.

It is obvious that at the current stocking rates and range conditions of Lesotho, there will be continuous low-marketed offtake of both animals and animal products. Further, with the increase in annual population growth of 2.6% and an increase in per capita demand for livestock products, communal rangelands of Lesotho should receive careful management to ensure their functional and sustainable productivity and thus improve production of livestock grazing on these rangelands. The purpose of the study was to establish an appropriate stocking rate, which would lead to an increase in sheep productivity whilst ensuring conservation of forage resources at Lekubane Rangeland Research station in Lesotho.

The purpose of this study was to:

- establish botanical composition under different stocking rates.
- determine biomass production of species under different stocking rates.
- determine quality of species (crude protein) under different stocking rates.

Materials and methods

A study was conducted at Lekubane Rangelands Research Station in Lesotho from February 1999 to February 2000. It is a mountainous area located at 29.5° South Latitude and 27.9° East Longitude. The elevation ranges from 2275 m at substation headquarters to 2618 m at the highest mountain peak. The area is characterised by extremely low and high temperatures ranging from -20°C in winter to 32°C in summer. Mean annual precipitation ranges from 800 mm to 1000 mm (Bureau of Statistics 1999). Soils are deep dark brown mollisols, moderately coarse textured and fairly well drained. The station has two slopes; the east and west facing slopes. The west facing slopes of the station are dominated by *Themeda triandra* and *Aristida bipartita* and the east facing slopes are dominated by *Festuca caprina* and *Aristida bipartita*. The station has been fenced and stocked at a "moderate" rate of 5.6 sheep ha⁻¹ on a year round basis. The condition of the camps is estimated to be good while most of the surrounding rangeland outside the station is estimated to be in poor condition based on rainfall distribution (Figure 1).

Experimental design

The study area had a total of 11.25 hectares of rangeland pasture. This rangeland pasture was subdivided by barbed wire fencing into nine paddocks. Three paddocks of 2.0 hectares

were stocked at 3.5 Merino ewes ha⁻¹ year⁻¹, while three paddocks of 1.25 hectares were stocked at 5.6 Merino ewes ha⁻¹ year⁻¹, and the remaining three paddocks of 0.5 hectares were stocked at 14 Merino ewes ha⁻¹ year⁻¹, representing light, moderate and heavy stocking rates, respectively. Sixty-three Merino ewes were involved in the study and were divided into nine groups of equivalent weight. These groups of ewes were randomly allocated to each paddock. The study was conducted over four seasons, namely, autumn (February to April), winter (May to July), spring (August to October) and summer (November to January).

The three stocking rates and four seasons were combined factorially in a Randomised Complete Block Design (RCBD) with three replicates per treatment. The "moderate" stocking rate (5.6 merino ewes ha⁻¹ year⁻¹) was arrived at using the Standard Animal Unit (one mature cow of equivalent weight of 450 kg and a daily dry matter intake requirement of 12 kg (Tainton 1981).

Measurement of vegetation composition, biomass production and forage quality

The Metric Belt Transect (Schmutz et al. 1982) was used for measurement of vegetation composition and biomass production (Figure 1).

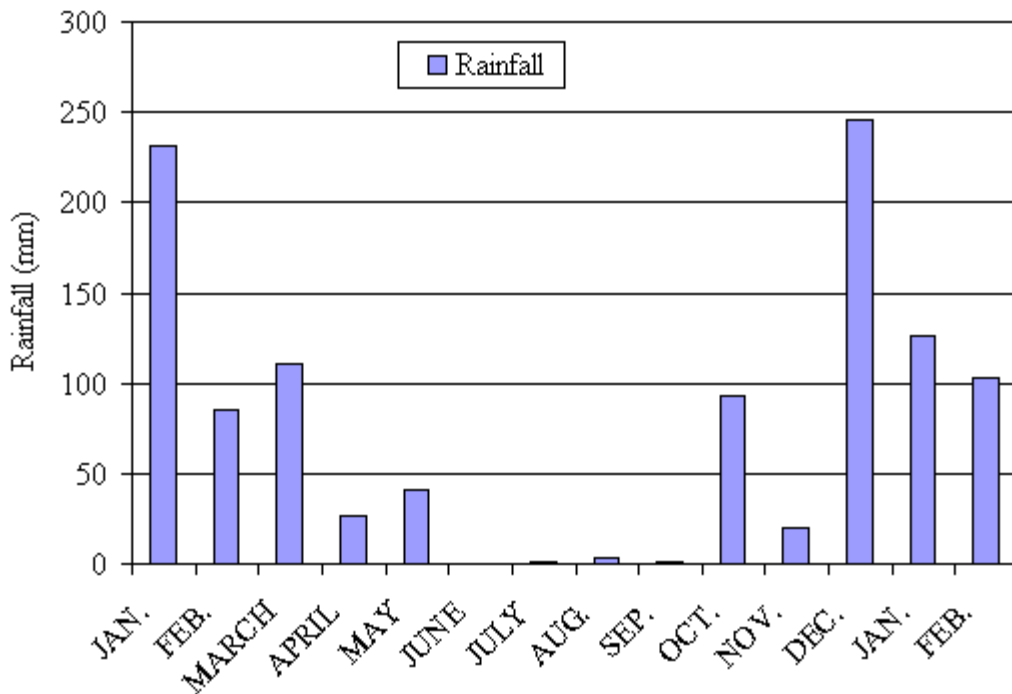


Figure 1. Rainfall distribution in Lekubane Rangeland Research Station during January 1999 to February 2000

Crude protein was analysed using spectrophotometric method (Weatherburn 1987). Data were collected during the first month of every season. Thus, for the autumn, winter, spring and summer, data were collected in February, May, August and November, respectively.

Data analysis

Data were subjected to Analysis of Variance by the General Linear Model (GLM) Procedure using a Statistical Analysis Computer Package (SAS Institute 1994). The means were separated and compared using the Least Square Means Procedure.

The model used for the analysis of the effect of stocking rate and season on botanical composition, biomass production and crude protein was:

$$Y_{ijk} = \mu + R_i + S_j + (R*S)_{ij} + T_k + (S*T)_{jk} + (R*T)_{ik} + E_{ijk}$$

where

Y_{ijk} = Observation for botanical composition, biomass production, and crude protein

μ = Overall mean

R_i = i^{th} effect of the replicate where $i = 1, \dots, 3$

S_j = j^{th} effect of the stocking rate where $j = 1, \dots, 3$

$(R*S)_{ij}$ = ij^{th} interaction effect between replicate and stocking rate (Error a)

T_k = k^{th} effect of season where $k = 1, \dots, 4$

$(S*T)_{jk}$ = jk^{th} interaction effect between stocking rate and season

$(R*T)_{ik}$ = ik^{th} interaction effect between replicate and season

E_{ijk} = Error component (Error b)

Results and discussions

Establishment of botanical composition

Table 1 presents least square means for botanical composition of grass species in response to stocking rate. At least nine species of grasses and forbs were identified in the area. This shows some biodiversity within the 11.25 ha study area. This biodiversity should serve as an impetus for sustainability (efficient resource use) especially in Lesotho rangelands where weather patterns are common.

Table 1. Least square means of botanical composition (% \pm standard error) of grass species in response to stocking rate

Species	3.5 ewes ha ⁻¹ mean \pm se	5.6 ewes ha ⁻¹ mean \pm se	14 ewes ha ⁻¹ mean \pm se	Ecological status
Andropogon appendiculatus	16.6 ^a 1.8	11.4 ^b 1.8	10.9 ^b 1.8	Decreaser
Themeda triandra	18.3 1.9	21.7 1.9	23.1 1.9	Decreaser
Aristida bipartita	19.9 ^{ab} 1.4	22.6 ^a 1.4	18.2 ^b 1.4	Increaser
Festuca caprina	6.5 1.3	5.5 1.3	5.3 1.3	Variable
Elionurus muticus	7.5 1.7	9.3 1.7	8.4 1.7	Increaser
Eragrostis capensis	6.0 ^b 1.0	7.2 ^b 1.0	11.2 ^a 1.0	Variable
Eragrostis chloromelas	10.0 1.7	10.1 1.7	6.7 1.7	Increaser
Harpochloa falx	2.4 0.4	2.1 0.4	2.4 0.4	Increaser
Heteropogon contortus	2.5 ^b 1.9	8.3 ^a 1.9	4.8 ^{ab} 1.9	Variable

Other species	1.9 ^a 0.3	1.0 ^b 0.3	2.9 ^b 0.3	–
Forbs	2.4 ^b 0.5	2.5 ^b 0.5	4.6 ^a 0.5	–
Total	100.0	100.0	100.0	

a, b Means in a row with different superscripts are significantly different ($p < 0.05$)
se = standard error

Andropogon appendiculatus significantly decreased as stocking rate increased. The light-stocking rate had significantly ($P < 0.05$) higher composition of this species than the moderate and heavy stocking rates. This was expected because this species is a Decreaser. It is palatable and has a high grazing value. It is, therefore, more preferred by the animals than the other species categories and decreases under continued grazing (Tainton 1981). Normally one would have expected *Themeda triandra* to decrease with increased stocking rate. On the contrary, the composition of *Themeda triandra* was not significantly reduced by increased stocking rate. This anomaly could be explained by the differential heights of the species. Sheep generally prefer short grasses and forbs to tall grasses. In this study, *Themeda triandra* was taller than *Andropogon appendiculatus* hence the preference over the latter. Botanical composition of *Aristida bipartita* was significantly ($p < 0.05$) higher in the moderate than in the heavy stocked pasture. However, the botanical composition of this species in the light stocked pasture was not significantly different from that in the moderate or heavy stocked pasture. *Aristida bipartita* is an Increaser, extremely unpalatable and is consequently of little grazing value. The high composition of this species is an indication that the study site was previously under poor grazing management and incorrect fire management (Tainton 1981). The composition of *Eragrostis capensis* was significantly ($P < 0.001$) higher in the heavy stocking rate than in the light and medium stocking rates. The composition of *Heteropogon contortus* increased significantly ($p < 0.05$) as stocking rate was increased from 3.5 to 5.6 ewes ha⁻¹ although it was not significantly different from the composition in the heavy stocking rate. The ecological status of *Eragrostis capensis* and *Heteropogon contortus* was variable, and therefore the composition of these two species tended to vary under different stocking rates. Botanical composition of *Festuca caprina*, *Elionurus muticus*, *Eragrostis chloromelas*, *Harpochloa falx* and other species (*Merxmullera disticha*, *Eragrostis racemosa*, *Pennisetum spicatum*, *Trachypogon specatus*, *Eragrostis gummiflua*, *Tristachya leucothrix*, *Poa annua* and *Cymbopogon excavatus*) remained similar across the stocking rates. Forbs were significantly higher ($p < 0.05$) in the heavy stocking rate than in the light and moderate stocking rates. Sharrow, Krueger and Thetford (1991); Hassan and Krueger (1980); Du Toit and Aucamp (1985); Van Oudtshoorn et al. (1992) reported that continuous grazing allows livestock a considerable amount of dietary selectivity. This selectivity, while allowing animals to choose a high quality diet, often results in over-utilisation of the most preferred plants allowing less preferred plants to become rank. The lack of response by the vegetation in terms of changes in botanical composition to stocking rate in this study, could be an indication of selectivity under-utilisation of the pasture. Further, most botanical changes take place between 2 to 10 years (Jones et al. 1995).

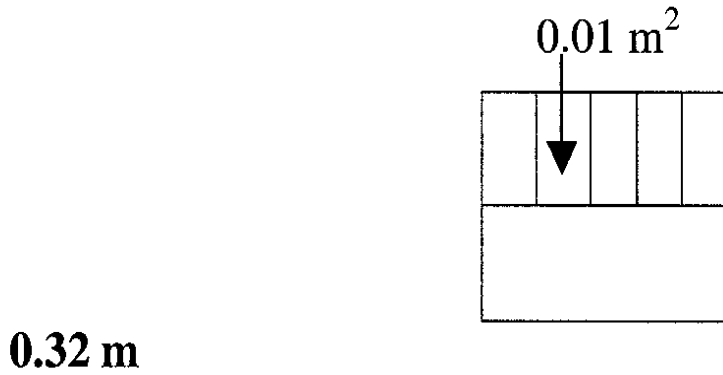


Figure 2. Tenth-metre- square quadrant for measuring vegetation along a Metric Belt Transect

Biomass production

The standing biomass production of individual grass species in the enclosure plots is presented in Figure 3. This figure indicates that generally, all species registered greater biomass in 2000 than in 1999 with the highest biomass production recorded for *Themeda triandra* and *Eragrostis gummiflua*. This may be attributable to residual plant material experienced in 2000 from 1999. The lowest production was recorded for *Poa annua* in 1999. This is probably because the species is a poor competitor in mixed pastures (Van Oudtshoorn et al. 1992).

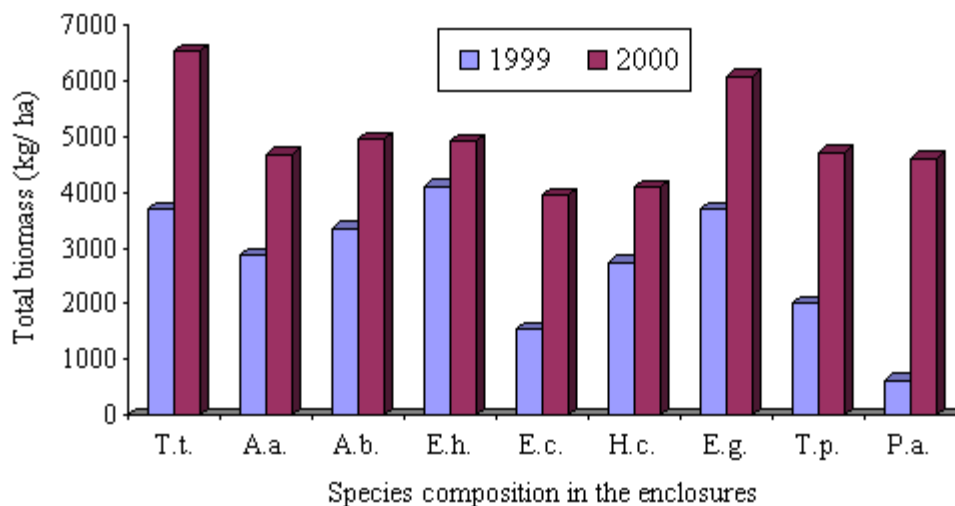


Figure 3. Standing biomass of individual grass species in the enclosure plots during 1999 and 2000.

Key:

T.t = *Themeda triandra*

A.a = *Andropogon appendiculatus*
A.b = *Aristida bipartita*
E.h = *Eragrostis chloromelas*
E.c = *Eragrostis capensis*
E.g = *Eragrostis gummiflua*
H.c = *Heteropogon contortus*
T.p = *Trachypogon spicatus*
P.a = *Poa annua*

The total biomass production of grass species in the enclosures was significantly ($p < 0.001$) higher than that in the grazed plots (Table 2). When averaged across the species, the total biomass production of forage at the end of the grazing trial was significantly ($p < 0.05$) lowered by the heavy stocking rate (Figure 4).

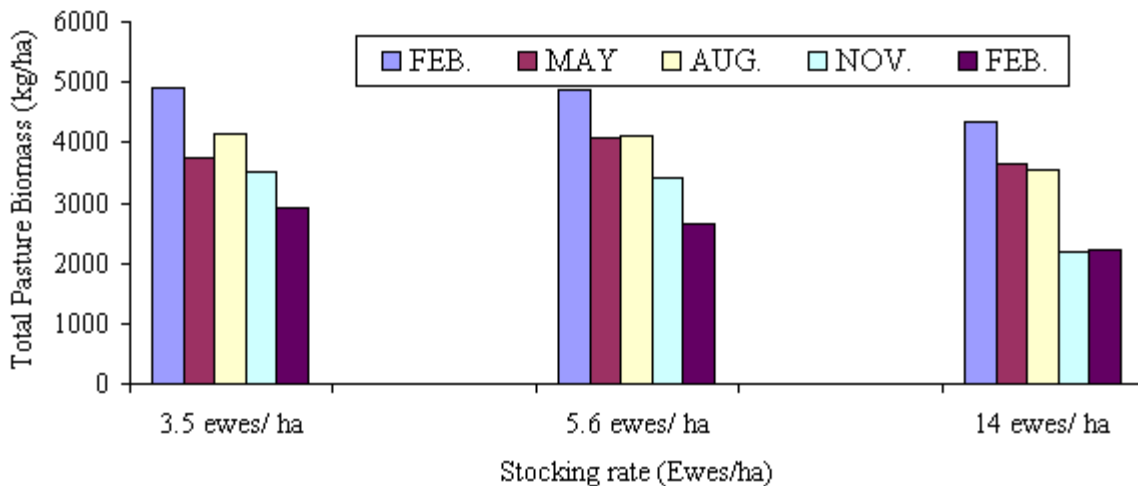


Figure 4. Total pasture biomass in response to stocking rate and seasonal variation

Thus the biomass production in the heavy stocking rate was 643 kg ha^{-1} lower than that in the light stocking rate and 630 kg ha^{-1} lower than that in the moderate stocking rate. The lowered herbage production could be due to reduced plant vigour. There were significant ($p < 0.05$) differences in the forage produced per ewe per grazing season between stocking rates of 3.5, 5.6 and 14 ewes ha^{-1} (1,917, 1,274 and 456 kg of forage produced per ewe per grazing season, respectively).

Table 2. Least square means of biomass production (kg ha^{-1}) in the enclosure plots and under different stocking rates over a period of one year

Stocking rate	Month					Total 2000
	February 1999	May 1999	August 1999	November 1999	February 1999	
Ewe ha^{-1}						
Enclosure						
3.5	4918	3731	4136	3479	2905	4292 ^a
5.6	4865	4074	4108	3422	2638	3834 ^b
14	4349	3656	3548	2219	2181	b

						3821
						3191 ^c

a, b, c Means with different superscripts are significantly different ($p < 0.05$)

These observations are supported by the work of Nolan (1972) in Ireland who applied stocking intensities of 10, 15 and 20 ewe ha⁻¹ (1,079, 726 and 464 kg of forage produced per ewe per grazing season, respectively) to a mixed pasture of perennial rye grass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.). Further, Hassan and Krueger (1980) concluded that stocking density should be based on at least 650 kg forage per ewe (9.9 ewe ha⁻¹) if forage is to remain vigorous. It is therefore clear that in this study the moderate stocking rate should be between 5.6 and 14 ewes ha⁻¹. Cook (1970) reported that herbage production on most ranges could be substantially increased by switching from heavy to moderate or light grazing intensities particularly for grassland ranges. Du Toit and Aucamp (1985) observed light grazing to be an economically effective means of improving shortgrass prairie ranges. This suggests that there is an optimum stocking rate, which should be recognised if maximum pasture productivity is to be sustained. This optimum stocking rate is the best compromise for the welfare of both plants and the animals.

When averaged across the stocking rate treatments and the species, it was found that a 44% utilisation level could maintain both the animal performance and vegetation performance over a one-year period of study. This was comparable with the study of Vallentine (1990) who found that a 32% utilisation level gave a high rate of recovery for deteriorated black gram ranges. Similarly, Martin and Cable (1994) found that an average utilisation level of 40% maintained the perennial grasses over a 10-year period of study.

Crude protein content

Table 3 shows the crude protein (CP) content (%) of individual grass species in the enclosures and under three different stocking rates. Crude protein content of individual grass species in the enclosure plots recovered after one year was relatively higher than that from the grazed plots. The low crude protein content of the species in the grazed plots could be attributed to the effects of grazing which include loss of vigour through depletion of nutrients and carbohydrate reserves. Generally, crude protein content of grass species did not differ across the stocking rate. This could be attributed to the fact that the rangeland was under-stocked and the vegetation was under-grazed, consequently the protein content remained similar in all stocking rate treatments.

Table 3. Least square means of Crude protein content (% \pm se) of individual grass species in response to stocking rate effect

Species	3.5 ewes ha ⁻¹ mean \pm se	5.6 ewes ha ⁻¹ mean \pm se	14 ewes ha ⁻¹ mean \pm se	Enclosure mean \pm se
<i>Andropogon appendiculatus</i>	8.3 ^{bc} 0.5	9.3 ^b 0.5	7.6 ^c 0.5	12.6 ^a 0.4
<i>Themeda triandra</i>	7.8 ^b 0.5	7.3 ^b 0.5	7.4 ^b 0.5	11.5 ^a 1.5
<i>Aristida bipartita</i>	8.1 ^b 0.4	7.4 ^{bc} 0.4	6.6 ^c 0.4	10.3 ^a 0.9
<i>Festuca caprina</i>	6.5 ^a 1.0	6.4 ^a 1.0	4.7 ^a 1.0	-
<i>Elionurus muticus</i>	4.6 ^{ab} 0.8	6.5 ^a 0.8	4.5 ^b 0.8	-
<i>Eragrostis capensis</i>	7.0 ^b 0.5	5.6 ^c 0.5	5.8 ^c 0.5	10.4 ^a 1.0
	b	b	b	a

<i>Eragrostis chloromelas</i>	7.3	0.8	6.8	0.8	7.3	0.8	13.8	1.7
<i>Harpochloa falx</i>	5.7 ^a	0.7	5.6 ^a	0.7	5.0 ^a	0.7	-	
<i>Heteropogon contortus</i>	4.2 ^b	1.0	4.2 ^b	1.0	5.6 ^b	1.0	10.9 ^a	1.1
Other species	2.0 ^b	0.2	1.6 ^b	0.2	1.0 ^c	0.2	15.1 ^a	1.7

a, b, c Means in a row with different superscripts are significantly different ($p < 0.05$)
se = standard error

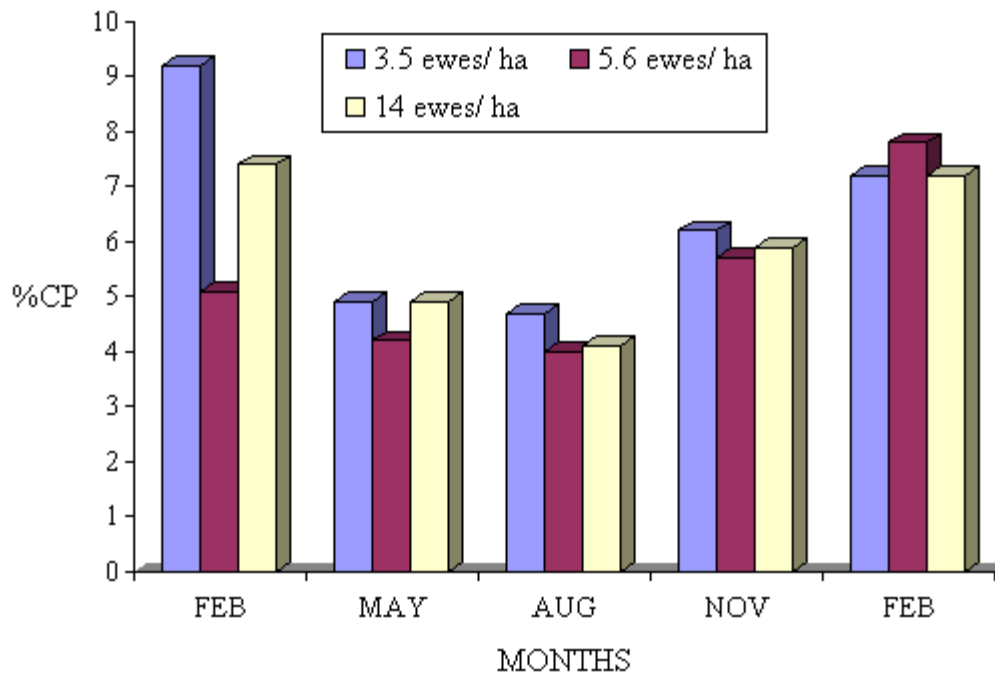
Table 4 shows the crude protein content of individual grass species in response to seasonal variation.

Table 4. Least square means of crude protein content (% \pm se) of individual grass species in response to seasonal variation

Season Species	February Mean \pm se	May mean \pm se	August mean \pm se	November Mean \pm se	February mean \pm se
Andropogon appendiculatus.	10.6 ^a 0.6	6.9 ^b 0.6	5.1 ^c 0.6	8.3 ^b 0.6	11.1 ^a 0.6
Themeda triandra	9.4 ^a 0.6	5.6 ^b 0.6	5.1 ^b 0.6	7.9 ^a 0.6	9.7 ^a 0.6
Aristida bipartita	9.2 ^a 0.5	5.2 ^b 0.5	5.0 ^b 0.5	8.1 ^a 0.5	9.3 ^a 0.5
Festuca caprina	8.5 ^a 1.2	5.0 ^{ab} 1.2	4.3 ^b 1.2	6.4 ^{ab} 1.2	5.0 ^{ab} 1.2
Elionurus muticus	5.8 ^{ab} 1.	3.5 ^b 1.0	3.9 ^{ab} 1.0	6.2 ^{ab} 1.0	6.6 ^a 1.0
Eragrostis capensis	9.0 ^a 0.6	4.6 ^b 0.6	5.3 ^b 0.6	3.4 ^b 0.6	8.4 ^a 0.6
Eragrostis chloromelas	10.0 ^a 1.7	5.8 ^b 1.1	5.6 ^b 1.1	6.9 ^b 1.1	7.3 ^{ab} 1.1
Harpochloa falx	8.3 ^a 0.9	2.9 ^c 0.9	5.0 ^{bc} 0.9	3.6 ^c 0.9	7.5 ^{ab} 0.9
Heteropogon contortus	5.8 ^b 1.3	1.5 ^c 1.3	2.4 ^{bc} 1.3	3.5 ^{bc} 1.3	10.2 ^a 1.3
Other species	1.8 ^a 0.2	1.3 ^{abc} 0.2	0.8 ^c 0.2	1.7 ^{ab} 0.2	1.8 ^a 0.2
Average	7.8	4.2	4.3	5.6	7.7

a, b, c Means in a row with different superscripts are significantly different

The table shows that season had a highly significant ($p < 0.001$) effect on the crude protein of species regardless of the stocking rate. There was a consistent decrease in crude protein content as the season advanced from autumn through spring. Thereafter, there was a pickup as the season advanced from spring to summer and from summer to autumn (Figures 5, 6a, 6b and 6c).



Figure

5. Crude protein content (%) of grass species under different stocking rates

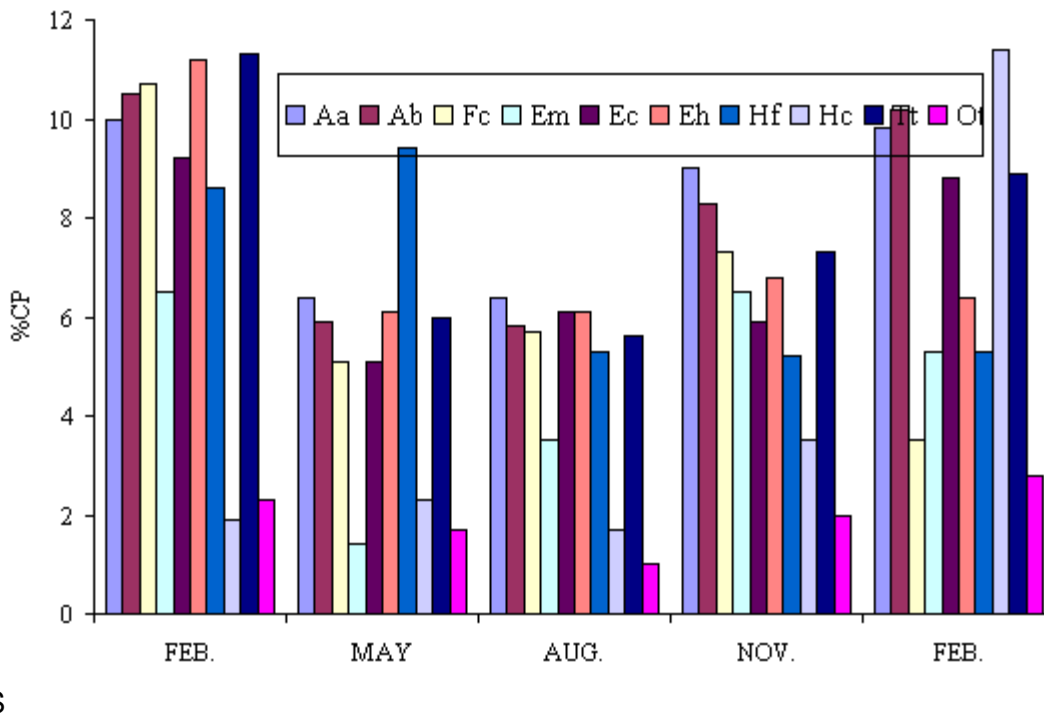


Figure 6a. Crude protein content (%) of individual grass species under stocking rate of 3.5 Ewes ha⁻¹

Key:

A.a = *Andropogon appendiculatus*

A.b = *Aristita bipartita*

F.c = *Festuca caprina*

E.m = *Elionurus muticus*

E.c = *Eragrostis chloromelas*

H.f = *Harpochloa falx*

H.c = *Heteropogon contortus*

T.t = *Themeda triandra*

Ot = Other species

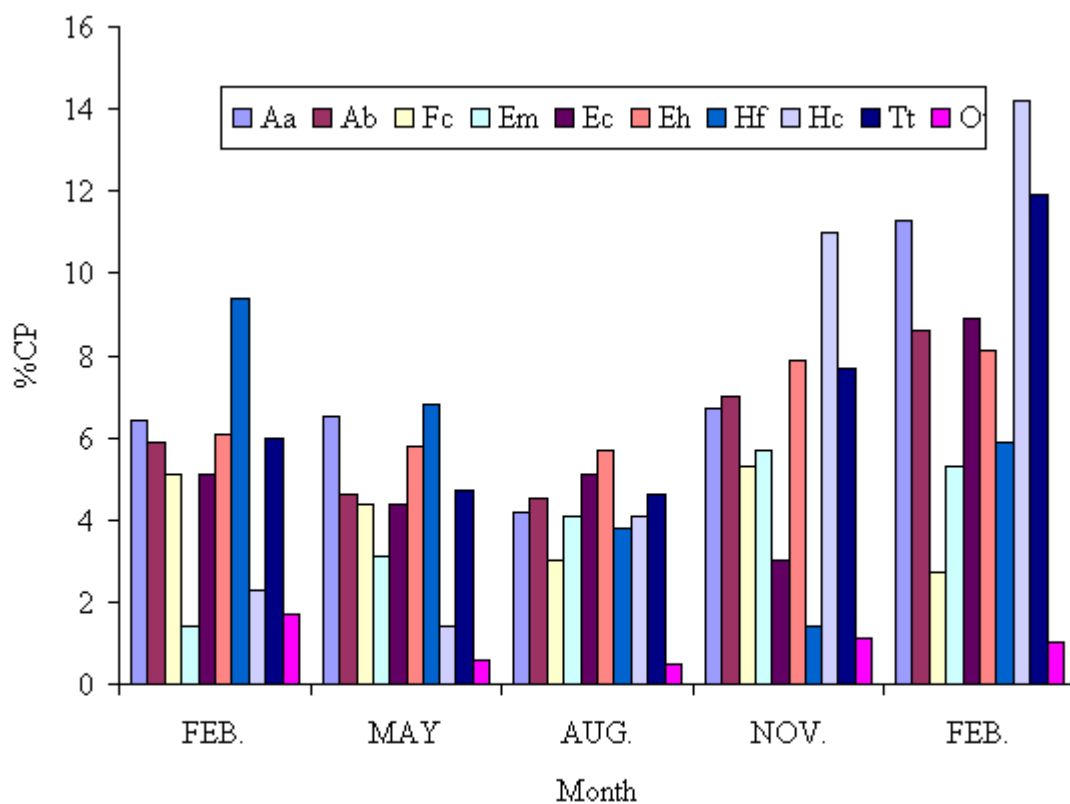


Figure 6b. Crude protein content (%) of individual grass species under stocking rate of 5.6 Ewes ha⁻¹

Key:

A.a = *Andropogon appendiculatus*

A.b = *Aristita bipartita*

F.c = *Festuca caprina*

E.m = *Elionurus muticus*

E.c = *Eragrostis chloromelas*

H.f = *Harpochloa falx*

H.c = *Heteropogon contortus*

T.t = *Themeda triandra*

Ot=Other species

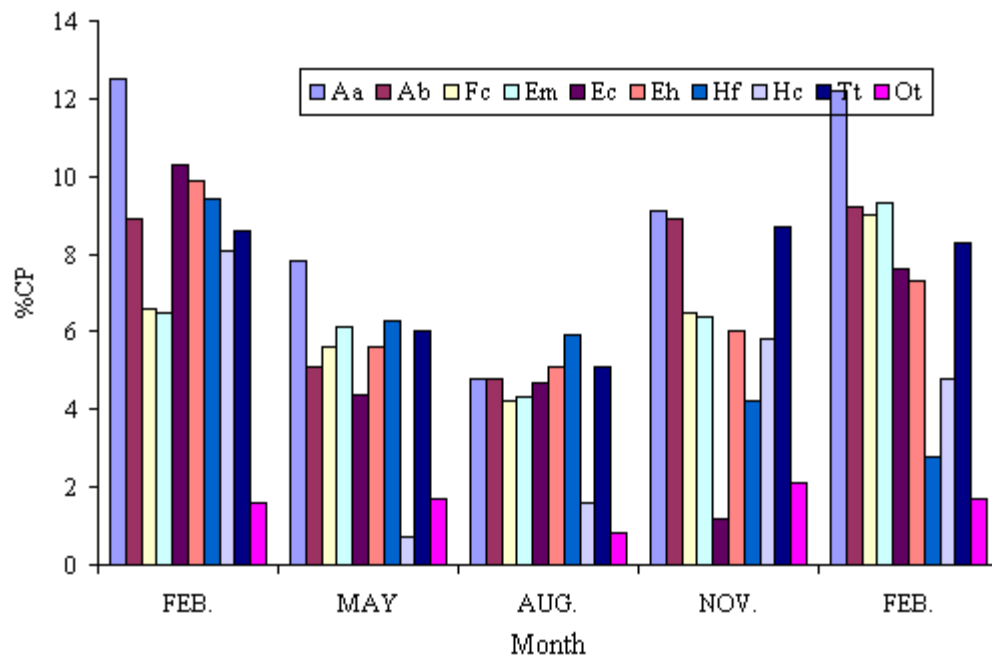


Figure 6c. Crude protein content (%) of individual grass species under stocking rate of 14 Ewes ha⁻¹

Key:

A.a = *Andropogon appendiculatus*

A.b = *Aristita bipartita*

F.c = *Festuca caprina*

E.m = *Elionurus muticus*

E.c = *Eragrostis chloromelas*

H.f = *Harpochloa falx*

H.c = *Heteropogon contortus*

T.t = *Themeda triandra*

Ot = Other species

This significant decline in crude protein in winter and spring could be attributed to the extremely low temperatures (-20°C) experienced in winter and relatively little or no precipitation from May to September. In agreement with the present study, Stoddart and Smith

(1975), Tainton (1981), Heady (1982) and Limbach (1985) reported that forage quality declines with grass maturation and translocation of nutrients to reserve pools. Stocking rate becomes manifest during late winter (Black 1978; Ash and Stafford 1996). Similarly, Tainton (1981) reported that the changes in crude protein and crude fibre are consistent with rainfall causing a flush of growth and so increasing the proportion of young leaf and twigs high in protein and low in fibre.

Table 4. Least square means of crude protein content (% \pm se) of individual grass species in response to seasonal variation

Season Species	February Mean \pm se	May mean \pm se	August mean \pm se	November Mean \pm se	February mean \pm se
Andropogon appendiculatus.	10.6 ^a 0.6	6.9 ^b 0.6	5.1 ^c 0.6	8.3 ^b 0.6	11.1 ^a 0.6
Themeda triandra	9.4 ^a 0.6	5.6 ^b 0.6	5.1 ^b 0.6	7.9 ^a 0.6	9.7 ^a 0.6
Aristida bipartita	9.2 ^a 0.5	5.2 ^b 0.5	5.0 ^b 0.5	8.1 ^a 0.5	9.3 ^a 0.5
Festuca caprina	8.5 ^a 1.2	5.0 ^{ab} 1.2	4.3 ^b 1.2	6.4 ^{ab} 1.2	5.0 ^{ab} 1.2
Elionurus muticus	5.8 ^{ab} 1.	3.5 ^b 1.0	3.9 ^{ab} 1.0	6.2 ^{ab} 1.0	6.6 ^a 1.0
Eragrostis capensis	9.0 ^a 0.6	4.6 ^b 0.6	5.3 ^b 0.6	3.4 ^b 0.6	8.4 ^a 0.6
Eragrostis chloromelas	10.0 ^a 1.7	5.8 ^b 1.1	5.6 ^b 1.1	6.9 ^b 1.1	7.3 ^{ab} 1.1
Harpochloa falx	8.3 ^a 0.9	2.9 ^c 0.9	5.0 ^{bc} 0.9	3.6 ^c 0.9	7.5 ^{ab} 0.9
Heteropogon contortus	5.8 ^b 1.3	1.5 ^c 1.3	2.4 ^{bc} 1.3	3.5 ^{bc} 1.3	10.2 ^a 1.3
Other species	1.8 ^a 0.2	1.3 ^{abc} 0.2	0.8 ^c 0.2	1.7 ^{ab} 0.2	1.8 ^a 0.2
Average	7.8	4.2	4.3	5.6	7.7

a, b, c Means in a row with different superscripts are significantly different ($p < 0.05$)

Conclusion

The study demonstrated that botanical composition of individual grass species was not significantly affected by the stocking rate. Thus, it is possible that productive native pastures dominated by perennial grasses can be maintained at these stocking rates without damaging the range.

The study has clearly demonstrated that biomass production decreased significantly ($p < 0.05$) with increased stocking rate, with lower biomass being observed under heavy stocking rates than under moderate and light stocking rates. This could be attributed to the effects of grazing, which include reduced plant vigour resulting from depletion of carbohydrate reserves and reduction of photosynthetic tissue.

The stocking rates (3.5 ewes ha⁻¹ to 14 ewes ha⁻¹) applied in this study could not show significant effects in the nutritive value of grass species. Seasonal variation, however, exerted great impact in the crude protein of grass species, which significantly ($p < 0.05$) declined in the winter and spring than in the summer and autumn.

Under rangeland conditions of the one-year study, it would therefore appear that an appropriate stocking rate that would lead to an increase in ewe productivity while ensuring conservation of forage resources was not obtained. The implication could be that the stocking rate of 5.6 ewes ha⁻¹ year⁻¹ currently practised in Lekubane Rangelands Research Station in Lesotho is not optimal and could not elicit significant effect in forage utilisation.

Since the results of this one-year study were inconclusive, it is recommended that the study should be repeated. The "moderate" stocking rate of 5.6 ewes ha⁻¹ year⁻¹ currently used at the research station should be adjusted upwards until optimal stocking rates that permit efficient forage utilisation are realised. It is further recommended that in the new study, the stocking rate of 5.6 ewes ha⁻¹ year⁻¹ should be included as a control.

Acknowledgements

The authors would like to acknowledge Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) for funding the study and the National University of Lesotho for providing field and laboratory facilities.

A study such as this would not have materialised without the assistance of the Research Division, Conservation Division, the Department of Livestock Services, and Range Management Division. The Research Division assisted with workers to fence the study site, transport to the research site on weekly basis, the study site and herdsmen. The Conservation Division surveyed the research site and came up with the map demarcating the paddocks. The Department of Livestock Services, Range Management Division provided transport during the collection of vegetation data and provided research technicians who assisted in the data collection and identification of grass species.

The smallholder farmer is gratefully acknowledged for providing Merino ewes used in this study.

References

- Ash A.J. and Stafford D.M. 1996. Evaluating stocking rate impacts in rangelands. Animals don't practice what we preach. CSIRO Division of Wildlife and ecology, Alice Spring NT 0871. *Range Journal* 18 : 216–43.
- Black W. J. M. 1978. Winter grazing of pasture by sheep. 1. Some effects of sheep stocking density on performance of pasture including sward recovery, botanical composition and animal performance assessments, *Irish Journal of Agricultural Research* 14: 275–281.
- Bureau of Statistics. 1999. *Annual wool statistical bulletin*. Bureau of Statistics, Maseru, Lesotho. pp1–21.
- Cook W.C. 1970. Energy budget of range and range livestock, Colorado State University, Colorado, USA. Expt. Sta. Bull. TB. 109.
- Du Toit P. F. and Aucamp A. J. 1985. Effect of continuous grazing in the Dohne sourveld on species composition and basal cover. *J. Grassl. Soc. South Africa* 2 : 41– 45.
- Hassan B. and Krueger W. C. 1980. The impact of grazing pressure and season of grazing on carbohydrate reserves of perennial ryegrass. *Journal of Range Management* 33: 200–210.
- Heady H.F. 1982. *Rangeland wildlife management in the tropics*. Longman Group Limited. USA pp 5–24.
- Jones R. M., Jones R. J. and McDonald C. K. 1995. Some advantages of long - term grazing trials, with particular references to changes in botanical composition. *Australian Journal of Experimental Agriculture* 35: 1029–1038.
- Limbach, W.E. 1985. *Introduction to range management* . Report to the farm policy committee of Lesotho Agricultural College. Maseru, Lesotho. pp 25–50.

Martin S. C. and Cable D. R. 1994. Influence of stocking rate on forage production. *Journal of Range Management* 35: 174–176.

Nolan T. 1972. Fat lamb production in the west of Ireland. 2. Effects of stocking rates on Lamb growth rate and on production of lamb carcass meat and wool per hectare. *Irish Journal of Agricultural Research* 11:47–55.

Range Management Division. 1988. *Lesotho National Rangeland Inventory*. Ministry of Agriculture and Marketing. Maseru, Lesotho. pp 2–45.

Range Management Division. 1998. *Lesotho National Rangeland Inventory*. Ministry of Agriculture and Marketing. Maseru, Lesotho. p 33–35.

SAS (Statistical Analysis System). 1994. User Guide: Statistics, version 6. 10th Edition.. SAS Institute, Inc., Cary, NC. USA.

Sharrow, S. H., Krueger, W. C. and Thetford, F.O. 1991. Forage standing crop and animal diets under rotational and continuous grazing. *Journal of Range Management* 36: 447– 450.

Schmutz, E. M., Reese M. E., Freeman, B. N., Weaver, L. C. 1982. Metric belt transect system for measuring basal plant cover, composition and production of plants. *Rangelands* 4: 162–164.

Stoddart L.A. and Smith A.D. 1975. *Range management*. McGraw - Hill, New York. pp. 33–79.

Tainton N. M. 1981. *Veld and Pasture Management in South Africa*. Shuter and Shooter, University of Natal Press. Pietermaritzburg, South Africa. pp 325– 334.

Vallentine J. F. 1990. *Grazing Management*. Academic Press Inc. N. Y. pp. 553–560.

Van Oudtshoorn F.P., Trollope W.S.W., Scotney D.M. and Mcphee P. J. 1992. *Guide to grasses of South Africa*. National Book Printers, Capetown ,South Africa. pp. 257– 278.

Weatherburn N. W. 1987. Phenol- hypochloride reaction for the determination of ammonia. *Analytical Chemistry* 23: 971–979.

Roasted sorghum as an alternative energy source in pig feeding

*O. Mwale*¹, *R.K.D. Phoya*², *T. Mujahid*², *J.P. Mtimuni*²

¹Ministry of Agriculture, Food and Fisheries, P.O. Box 21916, Kitwe, Zambia

²Bunda College of Agriculture, University of Malawi

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Determination of tannins](#)

[Rapid tannin analysis: semi-quantitative method](#)

[Follin-Ciocalteu assay technique](#)

[Laboratory analysis on feed ingredients](#)

[Feed formulation](#)

[Housing and management of animals](#)

[The feeding trial](#)

[Phase I \(starter period\)](#)

[Phase II \(grower period\)](#)

[Data collection](#)

[Kleiber ratio](#)

[Statistical analysis](#)

[Results](#)

[Tannin analysis](#)

[Starter phase performance](#)

[Starter phase performance \(ADG\)](#)

[Effect of initial weight on overall performance](#)

[Effect of starter ration on overall performance](#)

[Overall performance over the 18 week period](#)

[Time taken to reach target weight](#)

[Effect of sex on the overall performance](#)

[Cost of production of the pigs](#)

[Discussion](#)

[Tannin analysis](#)

[Roasting as a method of reducing tannin content](#)

[Starter phase performance](#)

[Overall performance over the 18 week period](#)

[Average daily gain and the Kleiber ratio](#)

[Time taken to reach maturity](#)

[Cost of production of the pigs](#)

[References](#)

Abstract

Eight sorghum varieties (Masotongo, Kapile, Kalombo, Kawaladzuwa, Shabala, Misinde, Pilira 1 and Pilira 2) were analysed to establish their tannin status and subsequently the higher tannin variety was used to replace maize diets in a growth trial with pigs.

Tannin (proanthocyanidin) concentrations were determined using the Folin-Ciocalteu assay technique with Catechin as the standard. The tannin concentrations were as follows: Misindi (1.193mg/ml), Kapile (0.396mg/ml), Kalombo (0.062mg/ml), Kwaladzuwa (0.284mg/ml), Shabalala (0.535mg/ml), Masotongo (0.640mg/ml), Pilira-1 (0.469mg/ml) and Pilira-2 (0.448mg/ml). The variety Misinde was tested to be higher in tannins ranging from 0.29–0.99% catechin equivalents compared to 0.10–0.25% for the rest, and hence was used in feeding trials. Roasting Misinde on a charcoal flame reduced its tannin level to 0.10–0.25% catechin equivalents representing a 37% decrease.

The performance of Large-White and local Malawian pigs fed on maize based- diet (Ration1), raw-sorghum based diet (Ration 2), 50% maize and 50% roasted sorghum- based diet (Ration 3) and 100% roasted sorghum-based diet (Ration 4) as a major energy source was investigated. Average daily gains (ADG) and the Kleiber ratio were determined during the starter phase. For Large-Whites fed on Ration 1, 2, 3 and 4 ADG in kg were not significantly different at 0.443, 0.525, 0.453 and 0.491 and Kleiber ratios 0.483, 0.582, 0.491 and 0.535, respectively. For local Malawian pigs also fed on the above diet in the same order, the ADG in kg were 0.192, 0.344, 0.126 and 0.359 and the Kleiber ratios were 0.349, 0.525, 0.466 and 0.497, respectively, significantly lower for Ration 1. In the grower phase, the ADG (in kg) for Large-Whites on Rations 1 and 2 were significantly higher ($P < 0.05$) at 0.431 and 0.459 compared to 0.364 and 0.379 for those on Rations 3 and 4. In the grower period the Large-Whites had Kleiber ratios of 0.361, 0.374, 0.355 and 0.349 while local pigs were at 0.267, 0.327, 0.283 and 0.306 for Rations 1, 2, 3 and 4 respectively.

The target weight was 55kg for Large-Whites and 45kg for local Malawian pigs. Sorghum-based rations, both starter and grower, were cheaper to compound. Although roasting of the sorghum (variety Misinde) reduces tannin levels, it increases costs of the ration and does not contribute to any significant difference in growth performance. It is therefore concluded that low tannin sorghum can replace maize as a major source of energy without affecting the

average daily gain or carcass characteristics of Large-Whites or local pigs.

Key words: Low-tannin sorghum diet, Large-Whites and local pigs, growth performance

Introduction

With an increasing human population, especially in the Southern African Developing Countries (SADC), the meat requirements have to be increasingly met from diverse forms of production, which would also contribute towards food security, poverty alleviation and income generation. The greatest constraint to livestock production in non-ruminants is the cost of feedstuff. Hence, efforts should be concentrated on using often unconventional feeds as alternate sources of energy and proteins. In spite of its favoured statistics, maize production alone does not meet the consumption levels of the Malawian population. Ironically, the same is also utilised in livestock feed formulations— a scenario which exerts pressure and competition between human population and livestock industry. Sorghum, on the other hand, a drought tolerant crop, is mostly grown in the low rainfall areas of the Lower Shire as a staple food. Brown sorghum varieties with a higher tannin content are not likely to be consumed by human beings because of an unpleasant astringent taste. The land pressure resulting from an increasing human population also calls for production systems that are not only intensive and less demanding on space, but also give quick returns. Hence, pigs qualify when compared to other smaller stock, because of their fecundity and growth potential. This research therefore was aimed at reducing the dependence on maize as an energy source in intensive pig production systems by suggesting the use of a treated high tannin sorghum variety as an alternative.

The objectives of the study were to:

- investigate the effect of replacing maize with a roasted high tannin (RHTS) variety and raw high tannin sorghum (UHTS) on the performance of both local Malawian pigs and Large-White breeds with respect to bodyweight changes, feed utilisation, efficiency, average daily gain (ADG), and time taken to reach the targeted marketing weight of 55 kg for the Large-whites and 45 kg for the local pigs
- compare the cost of raising piglets up to marketing weight based on rations of RHTS, UHTS, maize and their mixtures as energy sources.

Materials and methods

Eight varieties of sorghum were obtained from Chikwawa district in the Lower Shire Valley of Southern Malawi, an area that is 400 metres above sea-level, and receives an annual rainfall of 400–800 mm. Apparently, the low rainfall pattern has prompted the production of sorghum and millet, which are relatively more drought resistant than maize and many other cereals. The varieties collected were Kapile, Shabalala, Masoton'go, Kalombo, Misinde, Kawaladzuwa, Pilira 1 and Pilira 2 of which the last two are newly introduced hybrids while the others are local varieties.

All eight varieties were subjected to tannin analysis using two methods which included the colorimetric Folin-Ciocalteu assay and a semi-quantitative rapid analysis technique.

Misinde was identified as the variety with the highest tannin content. Subsequently, this variety was purchased in bulk for the experiment. Maize grain was obtained from the Field Research Section of the Crop Science Department at Bunda College of Agriculture while soyabeans were bought from farmers in surrounding villages.

Determination of tannins

Rapid tannin analysis: semi-quantitative method

The method is as presented in the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) Technical Manual (1977). The rationale in this tannin analysis method is that it provides a rapid and convenient visual estimation of the quantity of polyphenols in sorghum grain, without the use of instrumentation and with the minimum of glassware. This is a subjective method based on the reduction of ferric ions to ferrous ions by tannins and other polyphenols, followed by the formation of a coloured ferricyanide-ferrous complex commonly known as Prussian Blue (Price and Butler 1977). The intensity of the colour formed enables the tannin content to be determined using a set of standards as reference.

Follin-Ciocalteu assay technique

This method gives a more accurate measure of tannin content. Readings for absorbance as estimates of tannin concentration were taken off a spectrophotometer and the tannin concentration was calculated.

After identifying Misinde as the variety high in tannins, a sample was roasted on a charcoal flame in a large tray and later analysed for tannins using the two methods outlined. While it was not possible to measure the temperature of the fire, the roasting was done on a flame hot enough not to cause charring of the sorghum grain. Once the fire was prepared, soyabeans were first roasted so that the intensity of the heat subsided.

Laboratory analysis on feed ingredients

Samples of each ingredient were taken and ground to pass through a 1 mm sieve at the small animal unit and analysis was done in the Animal Nutrition Research Laboratory. Results are given in Table 1.

Table 1. Chemical composition of the major ingredients utilised in the rations

Ingredient	Dry Matter (%)	Ash (%)	Crude Protein (%)	Ether Extract (%)	Gross Energy (kcal/kg)
Maize	9.02	1.5	8.8	3.9	4436
Sorghum	91.3	1.6	8.9	3.0	3865
Soyabeans	90.6	4.5	36.1	26.3	6172
Maize bran	90.2	3.9	11.8	8.6	4698

Kcal/kg = kilo calories per kilogram

The following proximate analysis was done:

- Crude Protein (CP) which was determined by the macro Kjeldal procedure (AOAC 1984)
- Dry Matter (DM) was determined in an oven (AOAC 1984)
- Ether Extract (EE) was determined using the Soxhlet apparatus (AOAC 1984)
- Gross Energy (GE) was done by use of adiabatic bomb calorimeter (Goering and Van Soest 1970)
- Total ash was determined by burning the samples in a muffle furnace (AOAC 1984).

Feed formulation

Rations were formulated using a linear programming computer package BLP88 (1987) to meet the nutritional requirements of the pigs at each stage of growth. Inclusion levels of both

sorghum and maize in the rations compounded are shown in Table 2. There were four (4) starter and grower rations prepared with maize and sorghum as the varying ingredients as shown in Tables 3 and 4, respectively.

Table 2. Inclusion levels of maize and sorghum as major energy sources in the rations**

Treatments	Starter	Grower
Ration 1	100% maize	100% maize
Ration 2	100% raw sorghum	100% raw sorghum
Ration 3	50% maize and 50%roasted sorghum	50% maize and 50% roasted sorghum
Ration4	100% roasted sorghum	100% roasted sorghum

Ration 1 =Maize based ration

Ration 2= Raw sorghum-based ration

Ration 3 = 50% maize and 50% roasted sorghum

Ration 4 = Roasted sorghum based

**All other ingredients were the same for the rations

Table 3: Composition of starter experimental diets (%)

Ration 1	Ration 2	Ration 3	Ration 4	
Ingredient				
Maize	54.52	–	27.26	–
Sorghum	–	56.00	27.26	56.00
Maize bran	15.00	15.00	15.00	15.00
Soyabeans	22.92	21.40	22.90	21.40
Fishmeal	4.00	4.00	4.00	4.00
Salt	0.50	0.50	0.50	0.50
Monocalcium Phosphate	0.51	0.50	0.50	0.50
Pig Vitamin Premix	0.30	0.30	0.30	0.30
Dolomitic lime	1.25	1.30	1.30	1.30
DL-Methionine	0.50	0.50	0.50	0.50
Lysine	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
*Cost/kg	MK9.58	MK9.25	MK9.44	MK9.25

*Based on prices of May 1998

Table 4: Composition of grower experimental diets (%)

	Ration 1	Ration 2	Ration 3	Ration 4
Ingredient				
Maize	63.00	–	31.50	–
Sorghum	–	63.80	31.50	63.80
Maize bran	19.38	18.48	19.38	18.48
Soyabeans	10.80	10.90	10.80	10.90
Fishmeal	4.00	4.00	4.00	4.00
Salt	0.50	0.50	0.50	0.50

Monocalcium Phosphate	0.35	0.35	0.35	0.35
Pig vitamin premix	0.30	0.30	0.30	0.30
Dolomitic lime	1.07	1.07	1.07	1.07
DL-Methionine	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00
*Cost/kg	MK8.15	MK7.84	MK7.99	MK7.84

*Based on prices of May 1998

Housing and management of animals

A total of 64 piglets were raised from the breeding stock available at the Bunda College of Agriculture. There were 32 piglets of the Large-White breed and an equal number of the local Malawian breed whose average age was 15 weeks \pm 3 days for the former and 14 weeks \pm 4 days for the latter. At weaning, all the piglets were given Dectomax, a long-acting injectable, broad-spectrum paraciticide solution which is recommended for pigs, cattle and sheep. This was injected at the recommended rate of 300ug/kg or 1ml/33kg body weight. This particular drug is effective against round worms and lungworms. It is also very effective against sarcoptic mange mites and lice on pigs.

Pig husbandry practices such as tooth clipping, tail docking and male castration were carried out. The animals were randomly allocated to a total of 16 pens, each with 4 piglets of the same breed in it. A completely randomised block design was used. The breeds were used as blocks. The initial average weight (taken when introducing grower ration) was 10.9 kg for the Large-Whites and 6.2 kg for the local pigs.

The feeding trial

Initial weights of the piglets were taken immediately before they were put through their respective treatments and before feed was offered. The first phase of the feeding trial was the Starter period and the second was the Grower period.

Phase I (starter period)

The piglets were given the starter rations as shown in Table 3 and this was fed until the animals had attained an average weight of 25kg/pen for the Large-Whites and 20kg/pen for the local pigs before changing to grower diets. The duration of the starter period was 4 weeks for the Large-Whites and 6 weeks for the local Malawian pigs. All treatments were formulated in such a way that they were isonitrogenous and isocaloric. For each breed, there were two pens (each with 4 pigs) for each ration. Over a period of one week they were given 1 kg of feed per animal per day which was reduced on each subsequent day depending on the incidence of feed refusals the previous day. This was then changed to 2kg per day per animal in the grower period when the animals were weighing on average, 30 kg/pen for the Large-Whites and 25kg/pen for the locals. The meals were given daily in two equal portions depending on the number of animals in each pen, at 08.00 hrs and at 15.00 hrs.

Phase II (grower period)

The composition of the grower rations was as shown in Table 4. The animals were weighed weekly until they reached the targeted weights of 45 kg for the local Malawian pigs and 55 kg for the Large-Whites.

Data collection

Parameters of interest were Average Daily Gain (ADG), the time taken to reach maturity and the Kleiber ratio for growth performance. Feed utilisation efficiency would not be determined directly due to the absence of individual feeding pens for the pigs. Instead, the Kleiber ratio was used to approximate feed conversion efficiency.

Kleiber ratio

The Kleiber ratio was devised by Max Kleiber and is related to the feed conversion ratio as measured in phase-D tests done with cattle (Bergh 1992). Phase-D tests are performed in group-fed animals where individual feed consumption cannot be determined. The Kleiber ratio is calculated as follows:

Kleiber ratio = Average daily gain/Metabolic weight

where metabolic weight is taken as the final mass of the animal during the period of observation to the power of 0.75.

This was calculated at the end of the starter period for each of the breeds, and also at the end of the experiment.

Statistical analysis

Initial, weekly and final weights of the pigs were recorded. Feed consumption was calculated from the feed offered and feed refused data. Weight gain was determined from the liveweight records.

Data collected was analysed using Statistical Analysis System (SAS 1989). The performance parameters were Average Daily Gain, Time taken to maturity and the Kleiber ratio as an estimator of feed conversion efficiency.

Results

Tannin analysis

The results of the tannin analysis expressed as Catechin concentration using the Folin-Ciocalteu method are shown in Table 5. The variety Misinde was found to have the highest tannin level at 1.193mg/ml which after roasting dropped to a lower tannin level of 0.752mg/ml, representing a 37% drop in the tannin level. The classification of the different sorghum varieties by the rapid analysis method also showed that Misinde was in a higher tannin group compared to the other varieties as given in Table 6.

Table 5. Tannin content of sorghum varieties by Folin-Ciocalteu method

Sorghum variety	Absorbance (nanometers)	Catechin Concentration (mgm ⁻¹)
Kapile	0.060	0.396
Masotong'o	0.097	0.640
Kalombo	0.062	0.409
Misinde	0.293	1.193
Kawaladzuwa	0.043	0.284

Pilira 1	0.071	0.469
Pilira 2	0.068	0.448
Misinde (roasted)	0.114	0.752
Shabalala	0.081	0.535

Figures are means of four readings taken at wavelength of 675 nanometers

Table 6. Tannin content: semi-quantitative method

Sorghum variety	Sample colour	Range of catechin	Tannin level equivalents (CE)%
Kapile	light green	0.10–0.25	low
Masoton'go	light green	"	low
Kalombo	light green	"	low
Misinde	blue-green	0.29–0.99	intermediate
Kawaladzuwa	light green	0.10–0.25	low
Pilira 1	light green	"	low
Pilira 2	light green	"	low
Misinde (roasted)	light green	"	low
Shabalala	light green	0.10–0.25	low

Classification adapted from Price and Butler (1977)

Starter phase performance

The parameters of interest were the Average Daily Gain (ADG) and Kleiber ratio (Klb1) at the end of the starter period.

Starter phase performance (ADG)

The comparison of average daily gain (ADG) and Kleiber ratio as affected by ration for the Large-White pigs is presented in Table 7. There was no significant difference in performance among the four treatments administered. A graphical comparison of the different levels of daily gain for the Large-Whites on the different rations is given in Figure 1.

Table 7. Effect of starter rations on performance of Large-White and local pigs

		Large-white pigs		Local pigs	
		lsm	sem	lsm	sem
	ADG	0.443	0.041	0.192 ^{ab}	0.065
Ration 1					
	Klb1	0.483	0.044	0.349 ^b	0.048
	ADG	0.525	0.040	0.344 ^a	0.065
Ration 2					
	Klb1	0.582	0.044	0.525 ^a	0.044
	ADG	0.453	0.040	0.126 ^{ab}	0.079
Ration 3					
	Klb1	0.491	0.046	0.466 ^a	0.062
				a	

	ADG	0.491	0.040	0.359	0.070
Ration 4					
	Klbi	0.535	0.045	0.497 ^a	0.070

r² values ADG = 0.59, Klbi = 0.71

abc=lsmeans for each parameter per breed with the same superscript do not differ significantly (P<0.05)

ADG = Average daily gain (kg/day), Klbi= Kleiber ratio

Ration 1 = maize-based ration

Ration2 = raw sorghum-based ration

Ration3 = 50% maize and 50% roasted sorghum

Ration4 = roasted sorghum-based ration

lsm = least square means, sem = standard error mean

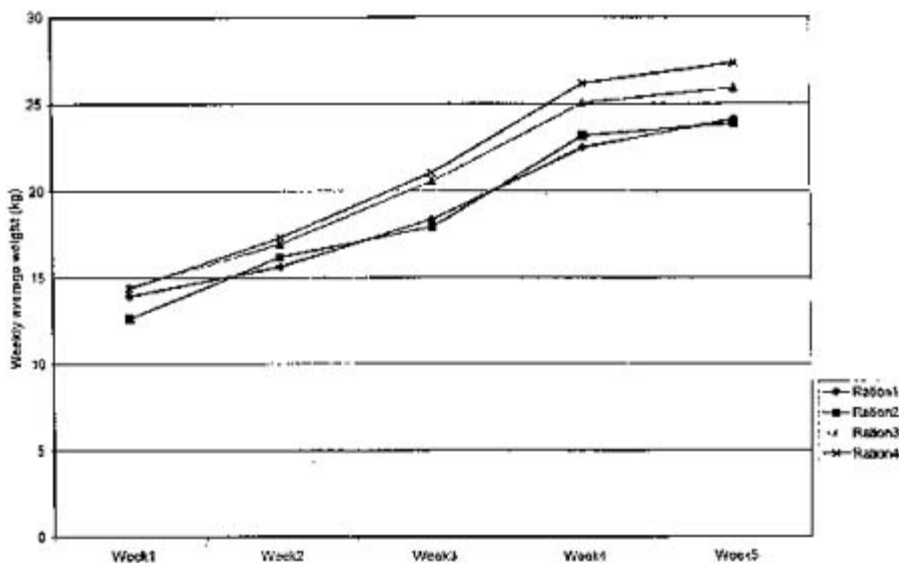


Figure 1. Performance of the Large-White pigs in the starter phase.

For the local Malawian pigs on similar diets, the average daily gains were not significantly different for the pigs fed Ration1, Ration 2 and Ration 4. The rate of gain for the pigs on Ration 4 was, however, significantly different (P<0.05) from that recorded for Ration3. Table 7 gives a summary of the effects of different rations on the performance of the local Malawian pigs regarding ADG and the Kleiber ratio. A graphical comparison of the different levels of daily gain for the rations is given in Figure 2.

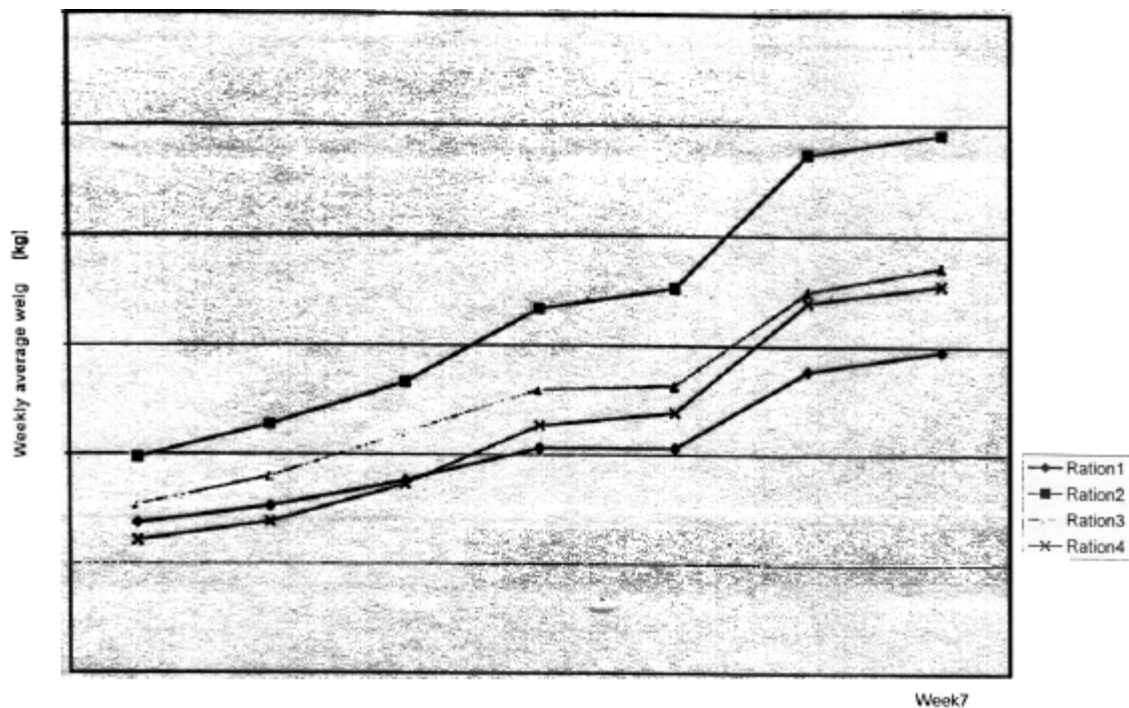


Figure 2. Performance of the Local Malawian Pigs in the starter phase

The Large-White pigs performed at significantly higher rates than the Malawian pigs. It should be mentioned that eight out of thirty two local Malawian pigs died in the course of the experiment, which was attributed to their poor health status due to early weaning.

Effect of initial weight on overall performance

The initial weights of the experimental animals were divided into three weight ranges which were 3–7.5 kg (Inwt1), 8–12.5 kg (Inwt2) and 13–19 kg (Inwt3). The overall effect of the initial weight on the performance of the pigs in general, was such that the heavier pigs gained at a significantly higher ($P < 0.05$) rate of 0.641 kg/day compared to 0.464 kg/day for the pigs in the weight range labelled Inwt2, and 0.273 kg/day for the lighter (Inwt1) pigs. The Kleiber ratio was also larger for the pigs in the heavier weight range (Inwt3) at 0.768 as opposed to 0.371 (Inwt2) and 0.320 (Inwt1). This represented an estimated better feed utilisation efficiency for the heavier pigs than for their lighter contemporaries. Summarised results of the overall effect of initial weight are shown in Table 8.

Table 8. Effect of initial weight on the general performance of both Large-white and local Malawian pigs in the starter period

	Inwt1		Inwt2		Inwt3	
	lsm	sem	lsm	sem	lsm	sem
ADG	0.273 ^a	0.087	0.464 ^b	0.089	0.641 ^c	0.092
Kibl	0.320 ^a	0.099	0.571 ^b	0.107	0.768 ^c	0.111

a,b,c lsm means having different superscripts in a row differ significantly ($P < 0.05$)

ADG = average daily gain (kg/day), Kib l = Kleiber ratio

sem = standard error mean, lsm = least square mean

Inwt 1 = initial weight range 3.5--7.5kg

Inwt 2 = initial weight range 8--12.5kg

Inwt 3 = initial weight range 13 -19kg

Effect of starter ration on overall performance

The analysis of performance of the rations in general was also conducted. There was no significant difference in both the ADG and Kleiber ratio for all the rations administered. A summary of the results is presented in Table 9.

Table 9. Effect of starter ration on the general performance of both large-white and local Malawian pigs.

	Ration 1		Ration2		Ration 3		Ration4		r ²
	lsm	sem	lsm	sem	lsm	sem	lsm	sem	
ADG	0.324	0.034	0.416	0.038	0.395	0.048	0.400	0.037	0.89
Klbi	0.454	0.042	0.565	0.046	0.537	0.059	0.547	0.044	0.83

ADG = average daily gain (kg/day), Klbi = Kleiber ratio

lsm = least square mean, sem = standard error mean

Ration 1 = maize based ration

Ration 2 = Raw sorghum-based ration

Ration 3 = 50% maize and 50% roasted sorghum-based ration

Ration 4 = Roasted sorghum-based ration

Overall performance over the 18-week period

The overall performance of the Large-White pigs and local Malawian pigs as indicated by the average daily gain (ADG), Kleiber ratio (KR) and the time taken to maturity (Tmat) for each treatment is given in Table 10. While the ADG for the Large-White pigs on Ration 2 was not significantly different from the pigs on Ration1, it was significantly different ($P < 0.05$) from those on Ration 3 and Ration 4, respectively. There was no significant difference in ADG for the local pigs in all the rations fed. The comparisons of growth for the Large-Whites and for the local pigs on different treatments are given in Figures 4 and 5 respectively.

When a comparison of ADG between the two breeds on similar rations was made, it was found that there were significant differences ($P < 0.05$) in daily gain with the Large-Whites performing better than the local pigs. A summary of the results is presented in Table 10.

Table 10: Overall performance of the experimental pigs by treatment as indicated by Average daily gain (ADG) kg/day, Kleiber ratio (KR) and time taken to reach target weight (Tmat) in weeks

Treatment	Ration 1		Ration 2		Ration 3		Ration 4		r ²
	lsm	sem	lsm	sem	lsm	sem	lsm	sem	
ADG	0.431 ^{ab}	0.029	0.459 ^a	0.029	0.364 ^b	0.031	0.372 ^b	0.031	0.61
	(0.250)	(0.030)	(0.389)	(0.029)	(0.316)	(0.030)	(0.335)	(0.032)	
KR	0.361 ^{ac}	0.015	0.374 ^a	0.015	0.355 ^{be}	0.015	0.349 ^e	0.015	0.47
	(0.267)	(0.016)	(0.327)	(0.015)	(0.283)	(0.019)	(0.306)	(0.017)	
Tmat	15.31	0.564	13.81	0.559	14.71	0.749	15.25	0.632	0.76
	(13.83)	(0.874)	(14.12)	(0.549)	(11.39)	(0.892)	(13.71)	(0.726)	

Figures in parentheses represent the performance of the local Malawian pigs

^{a,b,e} lsm means within the same row with the same superscript do not differ significantly ($P < 0.05$)

lsm = least square means, sem = standard error means

Ration 1 = maize-based ration

Ration 2 = raw sorghum-based ration

Ration 3 = 50% maize and 50% roasted sorghum-based ration

Ration 4 = roasted-sorghum based ration

Time taken to reach target weight

The results as shown in Table 10 indicate that there was no significant difference in the number of weeks taken from the start of the fattening trial to attainment of the targeted weight for both the Large-Whites (50-55 kg) and the local Malawian pigs (40-45 kg) in all the treatments.

Table 11. Overall performance of the experimental pigs for ADG, KR and Tmat as determined by sex

	ADG		KR		Tmat	
	lsm	sem	lsm	sem	lsm	sem
female	0.386	0.0117	0.343	0.0077	14.74	0.319
male	0.350	0.0113	0.312	0.0079	13.29	0.349

Lsmeans in a column do not differ significantly ($P < 0.05$)

ADG Average daily gain (kg/day)

KR Kleiber ratio

Tmat Time taken to reach target weight (weeks)

Effect of sex on the overall performance

The effect of sex on the ADG, Kleiber ratio and time taken to reach maturity are presented in Table 11. There was no significant difference in the growth rate of the female pigs in general at 0.368kg/day compared to 0.350kg/day for the males.

Cost of production of the pigs

The cost of production of the pigs was mostly centred on feeding. Tables 12 and 13 indicate the average cost of feeding both the Large-Whites and the local Malawian pigs with each of the four rations. Ration 1 was the most expensive followed by Ration 3. The costs of Ration 2 and Ration 4 were the same.

Table 12. Feeding costs in the starter period.

	Ration 1	Ration 2	Ration 3	Ration 4
No. of Pigs ^a	8(7)*	8 (6)*	8 (5)*	8 (7)*
Mean consumption per day (kg)	1.0 (0.56)	1.0 (0.57)	1.0 (0.57)	1.0 (0.53)
Length of starter period (days) ^a	28 (42)	28(42)	28(42)	28(42)
Mean total Consumption (kg) [']	224 (164.6)	224(143.6)	224 (113.4)	224(155.8)
Cost/kg (MK)	9.58	9.25	9.44**	9.25**
Average cost of	2,145.92	2,072.00	2,114.56	2,072.00

starter feed (MK) ^a	(1,576.88)	(1,328.30)	(1,070.50)	(1,441.15)
Net cost of starter rations (MK)	3,722.80	3,400.30	3,185.06	3,513.15
Live-weight gain (kg/day)	0.443 (0.192)	0.525 (0.344)	0.453 (0.126)	0.491 (0.359)
Feed cost per live-weight gain (MK) ^a	9.58 (5.37)	9.25 (5.27)	9.44 (5.38)	9.25 (4.90)

^a figures in parentheses are for local Malawian pigs

*note the fewer local pigs on the treatments to explain lower feed cost per live-weight gain

**The cost of Rations 3 and 4 excludes the actual cost of roasting the sorghum, estimated at MK200.00 for the starter ration

Ration 1 = maize-based ration

Ration 2 = raw sorghum-based ration

Ration 3 = 50% maize and 50% roasted sorghum-based ration

Ration 4 = roasted sorghum-based ration

Table 13: Feeding costs in the grower period

	Ration 1	Ration 2	Ration3	Ration 4
No of pigs ^a	8 (7)*	8 (6)*	8 (5)*	8 (7)*
Mean consumption per day (kg) ^a	2.5 (2)	2.5 (2)	2.5 (2)	2.5 (2)
Mean length of grower period (days) ^a	70.9(74.9)	66.5 (52.5)	70.9 (56)	69.13 (63)
Mean total consumption (kg) ^a	1,418 (1,049.9)	1,330 (630)	1,418 (560)	1,383 (882)
Cost/kg (MK)	8.15	7.84	7.99**	7.84***
Mean cost of grower ration (MK) ^a	11,556.70 (8,556.69)	10,427.20 (4,939.20)	11,329.82 (4,474.22)	10,842.72 (6,914.88)
Net cost of grower ration (MK)	20,113.39	15,366.40	15,804.22	17,757.60
Live-weight gain (kg/day) ^a	0.461 (0.297)	0.487 (0.316)	0.476 (0.336)	0.404 (0.287)
Feed cost per live-weight gain(MK) ^a	20.38 (16.32)	19.61 (15.67)	19.99(1 5.99)	19.61 (16.32) (15.67)

^a Figures in parentheses are for the local Malawian pigs

* note the fewer local pigs on the treatments to explain the lower feed cost per live-weight gain

**The cost of Rations 3 and 4 excludes the actual cost of roasting the sorghum, estimated at MK200.00 for the grower ration

Ration 1 = maize-based ration

Ration 2 = raw sorghum-based ration

Ration 3 = 50% maize and 50% roasted sorghum-based ration

Ration 4 = roasted sorghum-based ration

The grand cost of feed for both the starter and grower rations compounded was MK82,862.92

Discussion

Tannin analysis

The analysis for tannins of the eight sorghum varieties showed that the red and brown coated varieties were high in tannin levels. The two methods of analysis consistently showed that variety Misinde (a predominantly red/brown sorghum variety) was of the highest tannin as shown in Tables 5 and 6. The high tannin in the red-coated Misinde is consistent with the findings of Boren and Waniska (1992), who reported that a dark seed coat is indicative of higher tannin content with the lighter colours indicating lower tannin levels. It has been reported that tannins give sorghum a resistance to birds, insect and fungal depredation (Harris and Burns 1973).

The classification of sorghum in the rapid tannin analysis method suggested by Price and Butler (1977) leaves the variety Msinde in the intermediate level (0.26–0.99% catechin equivalents), while the rest of the varieties are in the low tannin group with a range of 0.10–0.25% catechin equivalents. Banda-Nyirenda and Vohra, (1990) classified some sorghum varieties as low in tannin content at 0.001% catechin equivalents to high at 1.15% catechin equivalents, while Ibrahim et al., (1988) had some varieties ranging from the lowest at 0.00%CE to the highest at 2.00%CE.

There are other factors which affect tannin levels in sorghum or indeed any other crops such as location of growth (McMillian et al. 1972; Guiragossian et al. 1978), stage of growth and the part of the plant being tested. Although Misinde showed an intermediate tannin level when grown in the Lower Shire valley, it could probably be of higher tannin content (>1.00% catechin equivalents), or lower when cultivated in other regions of Malawi.

Roasting as a method of reducing tannin content

The sorghum variety Misinde that was identified as being higher in tannin content was subjected to roasting on a charcoal flame, and analysis was done before and after roasting as shown in Tables 5 and 6. Analysis of tannins employing the Folin-Ciocalteu method of tannin showed the concentration dropping from 1.193mg/ml to a significantly lower 0.752mg/ml indicating a 37% depression. A similar observation was made when the semi-quantitative method of tannin classification (Price and Butler 1977) was employed where the pre-roasted Msinde at 0.26–0.99%CE (intermediate) was reduced to 0.10–0.25%CE (low tannin level) after being roasted.

Roasting reduces the tannin levels in high tannin sorghum varieties, Bangu (1992). Deshpande et al. (1984) cited by Huisman et al. (1990) reported that tannins can be reduced upon heat treatment.

Starter phase performance

There were no significant differences in the average daily gain (ADG) for the Large- White pigs fed different rations. The data agrees with the findings of Jernigan et al. (1988) who observed that there were no significant differences in weight gain when pigs were fed rations based on maize-soyabean, roasted sorghum-soyabean and raw sorghum-soyabean mixtures. While digestibility was improved due to roasting, the conclusion was that there was no corresponding improvement in average daily gain (ADG) which meant that roasting as a treatment was almost unnecessary.

The ADG among the local Malawian pigs showed that there were no significant differences for pigs fed raw sorghum-based ration (Ration 2) and roasted sorghum-based ration (Ration 4). However, there were significant differences ($P < 0.05$) in ADG when compared to the pigs fed Ration 3 and Ration 1 which were lower. Differences among treatments were mostly circumstantial in that most of the Malawian pigs were obtained for the experiment at a time when they were highly malnourished, small and weak resulting from early weaning. It has been stated that weaning weight is positively related to post weaning growth (King et al. 1997), which means that the lower weaning weights of local pigs when compared to exotic pigs jeopardises their growth soon after weaning.

The mortality figures of eight out of thirty two local pigs for minor incidences of scouring could be attributed to the assertion above. Simoongwe (1998), suggested that the practice of weaning the local Malawian pigs below 5kg live-weight was a risk to their survival.

The breed differences in performance during the starter period were significantly different with the Large-White pigs showing better daily gains compared to the local pigs. The difference in gain between the two breeds could also have been genetic. The ADG for the Large-Whites (in kg/day) were 0.431, 0.459, 0.364 and 0.372 for the pigs fed Ration 1, Ration 2, Ration 3 and Ration 4, respectively. The local pigs fed similar rations gained at 0.280, 0.389, 0.316 and 0.335 kg/day. It has been stated that exotic pig breeds have a higher feed conversion efficiency which results in a better growth rate and bigger litters than the African indigenous pigs. Haley, d'Agaro and Ellis, (1992) reported a feed conversion efficiency of 2.7 for Large-White pigs compared to 5.3 for the local Malawian pigs (Mapemba 1996). In another report, Simoongwe (1998), observed significant differences ($P < 0.05$) when a comparison of the exotic and the local Malawian pigs fed on a soyabean based ration was made. The Large-Whites gained at 373g/day compared to 310g/day for the local pigs.

The Kleiber ratio for the Large-White pigs followed a similar pattern to the live-weight gain where there was no significant difference in performance among all the treatments. The fact that the results at this stage were not significant might be due to the small number of experimental animals. Figure 2 illustrates the differences in performance of the local Malawian pigs fed different rations in the starter period. The pigs fed the raw sorghum-based ration (Ration 1) were growing at a faster rate than the other pigs. The explanation for this would be that raw sorghum generally has a higher protein level than maize. Therefore, heat treatment (roasting in this case) may have affected the protein content by denaturation since there was no strict control of the temperature at which the sorghum grain was roasted, hence the seemingly lower growth rate exhibited by the pigs fed roasted sorghum-based ration (Ration 4). The better performance of the pigs fed Ration 2 compared to those fed the maize-based ration (Ration 1), 50%maize and 50%roasted sorghum (Ration 3), and Ration 4 is because of the higher protein level in raw sorghum than in maize, and also the loss in value of the roasted sorghum grain.

This suggestion agrees with Yu et al. (1996) who reported that heat treatment decreases proteolysis. The differences in performance among the diets are graphically presented in Figures 1 and 2 for the Large-White and local pigs, respectively. Another explanation would be that heat treatment also reduced the levels of lysine in sorghum. Lysine and Methionine are already known to be the most limiting amino acids in cereals such as sorghum and maize (McDonald et al. 1994) and therefore, roasting further serves to decrease their availability.

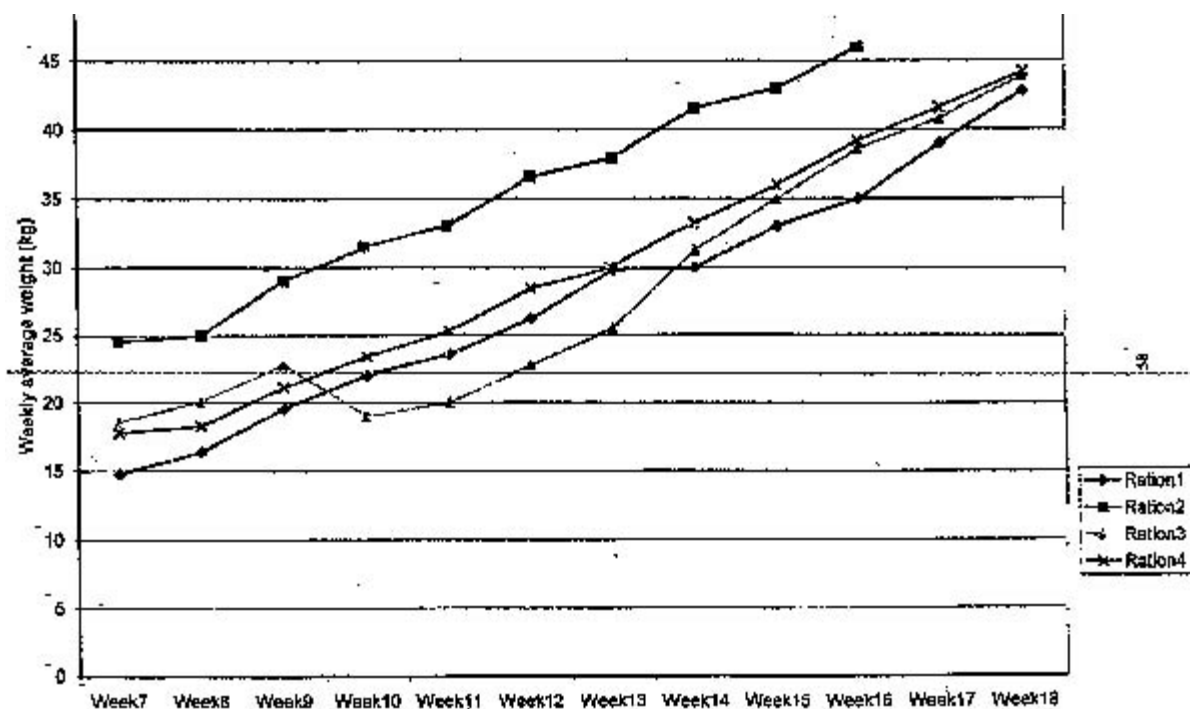


Figure 3. Performance of the Local Malawian pigs in the grower phase.

The results in this growth trial as shown in Tables 7 and 10 indicate a superior performance in daily gain and the Kleiber ratio for raw sorghum-based rations. This means that the relatively higher tannin levels in raw red-coated sorghum (Misinde) were not at levels high enough to cause nutritional problems in the pigs, hence the apparent better performance. The classification of sorghum according to tannin content using the protocol by Price and Butler (1977) indicates that for a sorghum cultivar to be classified high in tannin, it must have a range of Catechin Equivalents (CE) higher than 1%. The variety Misinde fell short of this and was instead classified as intermediate (0.26–0.99 % CE), although much higher than the other varieties which were in the low tannin group with a range of 0.10–0.25% CE.

The initial weight had a significant influence on the performance of both the Large- White and local Malawian pigs. The heavier pigs in both breeds had a better average weight gain compared to the lighter pigs as given in Table 8.

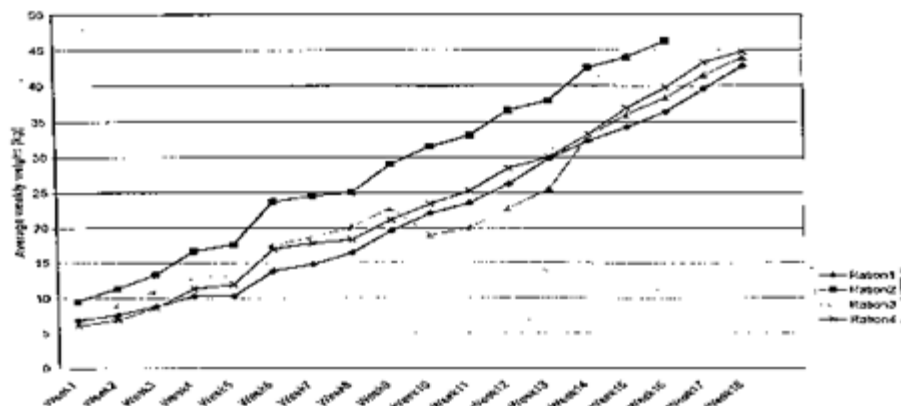


Figure 4. Growth of the Local Malawian pigs on their different rations

Overall performance over the 18 week period

Average daily gain and the Kleiber ratio

The data revealed that over the 18-week growth trial, the average daily gain of the Large-White pigs fed maize-based (Ration 1) and the raw sorghum-based (Ration 2) rations was not significantly different. The pigs fed Ration 1 did not differ significantly from those on the 50% maize, 50% roasted sorghum (Ration 3) and roasted sorghum (Ration 4) rations, while the pigs on Ration 2 had an average daily gain that was significantly higher ($P < 0.05$) than for the pigs fed either Ration 4 or Ration 3. The daily gain for the local Malawian pigs was not significantly different for all the rations, although Figure 4 indicates a slightly better performance for the local pigs fed raw sorghum-based ration (Ration 2). The differences appear to have been not significant mostly because of the relatively small number of local pigs involved in the trial due to higher mortality.

However, the earlier explanation concerning the relatively higher growth rate for the local Malawian pigs fed Ration 2 in the starter period is still valid in the grower period. Raw sorghum is reported to be higher in protein than even maize. Roasting of sorghum just assisted in denaturing some of the amino acids which would otherwise have been available for uptake by the pigs. The picture portrayed in Figures 2 and 4 is proof enough of the assertion that the performance of the pigs on the Ration 2 was superior to the rest of the treatments.

The Kleiber ratio for the Large-Whites indicates that the pigs fed Ration 2 (0.374) were more efficient feed converters together with the pigs on Ration 1. The pigs on Ration 3 had a Kleiber ratio of 0.355 which was significantly different ($P < 0.05$) from 0.361 for the pigs on Ration 1 and 0.349 for those on Ration 4. The observation agrees with the assertion made earlier about the average daily gains of the pigs on Ration 2. The results of a better feed conversion efficiency (as estimated by the Kleiber ratio) are evident in the average daily gain. The Kleiber ratio for the local pigs also followed a similar pattern as for the ADG.

Time taken to reach maturity

There was no significant difference in the time taken to attain the targeted maturity of 55kg among the Large-Whites for all treatments. Similarly, there was no significant difference in the time taken to reach the targeted weight of 45kg among the local Malawian pig breeds fed the different rations. The Large-Whites attained the target weight at 15.31 weeks (Ration 1), 13.81 weeks (Ration 2), 14.71 weeks (Ration 3) and 15.25 weeks (Ration 4). These were not significantly different from 13.83 weeks, 14.12 weeks, 11.39 weeks and 13.71 weeks for the local pigs fed Ration 1, Ration 2, Ration 3 and Ration 4, respectively when breed comparison was carried out. The result is interesting in that the targeted weights were different at 55kg for the Large-Whites and 45kg for the local pigs. However, the different growth rates account for the uniformity observed in the time taken to reach target weight. The inability of the local pigs to reach maturity earlier, given their lighter targeted weight is testimony of their slow growth rate. Some of the factors of major importance for commercial meat production are the weight at which the animal produces a carcass of the desired conformation, required degree of fatness and the efficiency of feed utilisation necessary to obtain these objectives (Payne 1990). Growth rate is important in this particular aspect because it determines the amount of time that the animal is kept. Mapemba (1996) suggested that the longer the animal was kept, the greater the proportion of feed that was utilised for maintenance, rather than for production and the result was a slow annual turnover rate per unit land or housing space. Commercially therefore, local Malawian pigs may not be so desirable until such a point that selection will have been done to come up with strains with a better feed conversion efficiency and improved growth rate which will also reduce the time it takes to attain mature weight given well balanced feed.

Apart from breed differences in the time taken to reach mature weight, the uniformity within

breed also indicates that the tannins in the ration based on raw high-tannin sorghum (Ration 2) did not affect the ultimate performance of the pigs. Probably the tannin level in variety Misinde (a red coated sorghum cultivar) was not high enough (perhaps towards the lower end of the range 0.29–0.99% CE) to cause growth problems in both the local and Large-White pig breeds.

The time taken to reach maturity was not significantly different as revealed by the data in Table 11. The notion that the average daily gain differences by sex were not significant is further seen in the time taken to reach maturity, although there is a contradiction with established fact that female pigs tend to grow faster than male castrates, as suggested by (Whittemore 1987).

The effect of sex on the overall performance of the experimental pigs was such that there was no significant difference between the females and the male pigs gaining at 0.386kg/day and 0.350kg /day, respectively. It should be noted that the males used in this experiment were castrated. Female pigs have been reported to have better growth rates than the male castrates (Whittemore 1987).

Cost of production of the pigs

Feed was evidently the most demanding input on the budget. The cost of raising an average pig per day on the starter ration shows that those fed Ration I (maize-based ration) were more expensive to feed than the rest. The data on feed cost per live- weight gain was not statistically analysed, but a price comparison did show differences. The feeds based on raw sorghum and roasted sorghum were the least expensive in both the starter diets at MK925.35/100kg bag compared to MK958.11 (maize-based ration) and MK944.32 (50% maize and 50% roasted sorghum-based ration). In the grower period, the raw sorghum and roasted sorghum based rations were cheapest at MK784.31 compared to MK815.19 and MK799.44 for the maize-based ration (Ration I) and Ration 2, respectively. The cost of roasting can be estimated at MK200.00 for each growth phase which raises the cost of ration 4 to about MK1,125.35/100kg bag and Ration 3 to MK144.32/100kg bag in the starter phase. In this experiment, the cost of charcoal at MK200.00 is merely an estimate to emphasise the fact that roasting is an added cost to the production of a roasted sorghum-based ration. Since soyabeans also require roasting, and the sorghum was only roasted after soyabeans to take advantage of the lower temperatures of the charcoal, the cost related to roasting can almost be ignored, unless where soyabeans or indeed another ingredient requiring roasting is not part of the ration.

References

AOAC (Association of Official Analytical Chemists). 1994. *Official Methods of Analysis*, 4th Edition, 1111, North Nineteenth Street, Suit 210, Arlington, Virginia, 22209, USA.

Banda-Nyirenda D.B.G. and Vohra P. 1990. Nutritional improvement of tannin containing sorghums (*Sorghum bicolor*) by sodium bicarbonate. *Cereal chemistry* 67: 533–537.

Bangu, N.T.A. 1992. Traditional technologies in small grain processing: roasting and malting-The Tanzanian experience, pp57–59. In: *Utilisation of sorghum and millets*. Gomez M.I., House L.R., Rooney L.W and Dendy D.A.V. (eds). Patancheru A.P. 502 324, India: International Crop Research Institute for the Semi-Arid Tropics (ICRISAT).

Bergh, L. 1992. *The Kleiber ratio as a measure of feed conversion efficiency in phase -D tests*. National beef cattle and progeny testing scheme (1980–1992 results) Livestock Improvement Scheme, Irene, Pretoria, Republic of South Africa.

- Boren B and Waniska R.D. 1992. Sorghum seed colour as an indicator of tannin content. *Journal of Applied Poultry Research* 1:117–121.
- BLP88. 1987. Linear Programming with Bounded Variables, User Manual, Eastern Software Products.
- Goering H.K and Van Soest P.J. 1970. *Forage Fibre Analysis. (Apparatus, Reagents, Procedures and some Applications)*. Agricultural Handbook N° 379, Agricultural Research Service, United States Department of Agriculture.
- Guiragossian V., Chibber B.A.K., Van Scoyoc S., Jambunathan R. Mertz E.T. and Axtell J.D. 1978. Characteristics of proteins from normal, high-lysine and high tannin sorghums. *Journal of Agricultural Food Chemistry* 26:219–223.
- Haley C.S., d'Agaro E. and Ellis M. 1992. Genetic components of growth and ultrasonic fat depth traits in Meishan and large-white pigs and their reciprocal crosses. *Animal Production* 54:105–115.
- Harris H.B. and Burns R.E. 1973. Relationships between tannin content of sorghum and pre-harvest moulding. *Agronomy Journal* 65: 957–959.
- Huisman J., Van der Poel A.F.B., Vestergem M.W.A. and Weerden E.J. 1990. Anti-nutritional factors in pig nutrition. *World Review of Animal Production* 25 (2): 78–82.
- Ibrahim S., Fisher C., El-Alaily H., Soliman H. and Anular A. 1988. Improvement of the nutritional quality of Egyptian and Sudanese Sorghum grains by the addition of phosphates. *British Poultry Science* 29: 721–728.
- ICRISAT (International Crop Research Institute for the Semi-Arid Tropics.). 1977. *Technical Manual 2, Laboratory Procedures for Quality Evaluation of Sorghum and Millet*. Patancheru 802–324, Andra Pradesh, India.
- Jernigan J.S., Combs W.R., Walker G.E. and White C.E. (1988) Effect of roasting grain sorghum on the performance and digestibility of nutrients in pigs. *Nutrition Reports International* 38: 79–89.
- King R.H., Mullan B.P., Dunshea F.R. and Dove H. 1997. The influence of piglet body weight on milk production of sows. *Livestock Production Science* 47: 169–174.
- Mapemba J.P. 1996. *Evaluation of the potential performance of the Malawian indigenous pigs*. MSc thesis, Faculty of Agriculture, University of Malawi.
- McDonald P., Edwards R.A. and Greenhalgh J.D.H. 1994. *Animal Nutrition*. 4th edition. (Longman).
- McMillian W.W., Wiseman B.R., Burns R.E., Harris H.B. and Greene G.L. 1972. Bird resistance in diverse germplasm of sorghum. *Agronomy Journal* 64: 821–822.
- Payne W.J.A. 1990. *An Introduction to Animal Husbandry in the Tropics*. Longman, Harlow, UK. 4th edition. 881 pp.
- Price M.L. and Butler L.G. 1977. A critical evaluation of the vanillin reactions as an assay of tannins in sorghum grain. *Journal of Agricultural and Food Chemistry* 63(3): 201–207.
- SAS (Statistical Analysis Systems). 1989. SAS/STAT User's Guide, SAS Institute Inc., Cary N.C.

Simoongwe V. 1998. *The performance of large-white and local Malawian pigs fed rations based on soyabeans (Glycine Max), cow-peas (Vigna unguiculata) or pigeon peas (Cajanus cajan)*. MSc thesis, Faculty of Agriculture, University of Malawi. Malawi.

Whittemore C.T. 1987. *Elements of pig science*. Longman Scientific and Technical, Essex, UK.

Yu. F., McNabb W.C., Barry T.N. and Moughan P.J. 1996. Effect of heat treatment upon the chemical composition of cotton-seed meal and upon the reactivity of cottonseed condensed tannins. *Journal of the Science of Food and Agriculture* 72: 263–272.

The effect of a community based animal health service programme on livestock mortality, offtake and husbandry applications — A field study in northern Malawi

*K. Hüttner*¹; *K.Leidl*²; *D.U.Pfeiffer*³; *F.B.D.Jere*² and *D.Kasambara*²

¹ EpiCentre, Massey University, PB 11-222 Palmerston North, New Zealand

² Basic Animal Health Service Project/GTZ, P.O.Box 611 Mzuzu, Malawi

³ The Royal Veterinary College, London, UK

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Farm-selection](#)

[Interviews](#)

[Follow-ups](#)

[Ecological zones and climate](#)

[Calculation of rates](#)

[Offtake rates](#)

[Mortality rates](#)

[Approach to data analysis](#)

[Results](#)

[Farm locations](#)

[Herd size](#)

[Cattle movements in and out of herds](#)

[Livestock offtake](#)

[Mean monthly cattle offtake](#)

[Period-specific cattle offtake](#)

[Mean monthly offtake for small ruminants](#)

[Period-specific offtake rates for small ruminants](#)

[Livestock mortality](#)

[Calf mortality](#)

[Cattle mortality](#)

[Mortality in small ruminants](#)

[Adult chicken mortality](#)

[Livestock husbandry applications](#)

[Seasonal pattern of selected husbandry measures](#)

[Farmer's perception about the observation period](#)

[Discussion and conclusions](#)

[Acknowledgement](#)

[References](#)

Abstract

Livestock dynamics, offtake, mortality and husbandry measures of 96 randomly selected users of a community-based animal health (BAHS) program were compared with 96 matched part-users and 96 non-users, respectively. More than 5000 farm visits were conducted between July 1997 and February 1999, of which 3724 visits were used for this evaluation.

Univariate and multivariable analyses were performed to compare farm characteristics and livestock performance among the three user categories. The results showed that users of the program owned larger herds of ruminants and more chickens compared to part-users and non-users. For non-users, mean monthly mortality in calves (3.2 %), sheep and goats (2.8 %) and chickens (4.4 %) were twice as high compared to user farms (1.4 %, 1.3 % and 2.0 %). All livestock species monitored in this study showed a decline in numbers during the 14 month period of evaluation. There were large movements of cattle into and out of kraals. These were animals that were managed but not owned by respective farmers. Offtake rates varied considerably between different species and at different periods. The adjusted annual cattle offtakes between December 1997 and November 1998 on average were 10.5 % (users), 9.5 % (part-users) and 7.8 % (non-users). Users of the BAHS-program applied various livestock husbandry and management measures more often than either of the other groups.

During concluding interviews in January and February 1999, BAHS-users felt significantly more positive about the previous year in terms of livestock health and production compared to part- and non-users. Overall, the results indicated a positive effect of the community-based animal health service program in northern Malawi on animal health and productivity.

Introduction

Traditional livestock production systems in developing countries have recently been the focus of considerable research. (Tuah and Ya Nyamma 1985; Rodgers and Homewood 1986; De Jode et al. 1992; Uza 1997; Kudi et al. 1998). Some researchers have investigated the effects of community-based animal health or management interventions on livestock production in these environments (Meemark 1988; Ngategize 1989; Jemal et al. 1995; Schreuder et al. 1996; Sulistiyo et al. 1998; Jones et al. 1998).

The Basic Animal Health Service (BAHS) Project in northern Malawi was launched in the late 1980's to provide a regional service to livestock owners. Self-help, demand-driven strategies and consequent cost-recovery are essential components of the program. At present, BAHS

operates within an area of 27,000 km². The focal point of BAHS is part-privatisation of field veterinary services through a Drug Revolving Fund and deployment of trained farmers, appointed by their community as village keymen (KM). These trainees are supplied with a paramedical kit (drug box), which allows them to treat village livestock and provide general advice on health and husbandry in their home area. Supervision of KM is done through veterinary assistants (VA), who are also provided with a drug-box (Leidl et al. 1995). The BAHS-Project places much of its effort into extension, which includes participatory techniques and specific messages in form of pictorials. Improvement of existing management techniques in livestock production has been given priority. BAHS-users currently pay an annual membership-fee equivalent to about US\$ 0.3. They are organised in village livestock-groups. The organisational set up of the BAHS-Project has been discussed in detail by Jere (2000). All non-members of BAHS, who call the KM or VA for treatments, are defined as part-users. They pay a fee equivalent to about US\$ 0.2 per prescription in addition to the price of the drugs. The range of drugs offered through BAHS, and the annual treatment pattern of VA and KM were described by Hüttner et al. (2000a).

At present, there are about 200 drug-box holders operating in Karonga and Mzuzu Agricultural Development Divisions (ADD), with the latter being the study area (Figure 1), involving 42 KM and 84 VA. Demand for BAHS by livestock farmers is strongest for cattle followed by small ruminants and chickens. The study therefore concentrated on these species.

This article was part of a series of studies that lead to a comprehensive impact assessment including an economic analysis of the BAHS-Project (Hüttner 2000). The objective of this article was to compare livestock offtake, mortality and husbandry applications between users, part- and non-users of the BAHS-program. It may contribute towards a critical review of the effects of such programmes for small holder farmers in developing countries.

Materials and methods

Farm-selection

Eleven KM and 21 VA were randomly selected from the 126 drug-box holders that operated within Mzuzu ADD as of June 1997. A minimum BAHS-involvement of 12 months was required for eligibility. At each of those 32 locations, three BAHS-users were selected randomly from the list of paid members. Another 3 part-users and 3 non-users of BAHS were selected in each area as matched cases, emphasis being given on similar livestock ownership to the BAHS-users. The selection was based on the knowledge of the respective KM and VA at those locations with the final decision being made together with the BAHS-team comprising of two veterinarians and three veterinary field supervisors.

Interviews

An initial questionnaire was conducted at all 288 farms in order to describe the social background, farm characteristics, livestock ownership and self-evaluation of farmers (Hüttner et al. 2000b). Interviews were conducted between July 1997 and October 1997 by the BAHS-team. In addition, a concluding interview was conducted at the end of the study period in January and February 1999. The final herd inventory, current prices for livestock, and summary remarks of farmers were recorded.

Follow-ups

Follow-ups commenced after the initial questionnaire in July 1997 and finished in December 1998. Respective KM and VA serving the communities in selected areas conducted them. Farms were visited at 4-week intervals and all changes in livestock numbers and husbandry

methods were recorded on a prepared farm-monitoring sheet. Animal units were defined as following: adult cattle ≥ 12 months, adult chicken ≥ 8 weeks, adult sheep and goats ≥ 4 months of age.

During the monitoring period the BAHS-team had to intervene only on a few occasions. For instance, there were difficulties during the beginning of this exercise, mainly with KM who were not used to handling the relatively complex farm sheets. In some locations accessibility became an issue during the rainy season. We also had to handle expectations by a number of farmers, whereby some kind of regular bonus was anticipated in return for being involved in this exercise. A total of 5003 visits were conducted of which 3724 were used for the evaluation. This reduction became necessary because complete records of all 288 farms were obtained for the period between November 1997 and December 1998 only.

Ecological zones and climate

A diverse physical environment comprising three ecological zones characterises the study area. The lakeshores have warm to high temperatures, are 450–600 m in elevation and have a mean annual rainfall of 1,500 to 1,750 mm. The Central African Plain is 800 to 1,300 m in elevation, has mild to warm temperatures and a mean annual rainfall of 1,000 to 1,500 mm. The highlands are 1,300–2,600 m in elevation, have mild to cool temperatures and a mean annual rainfall varying from 1,000 to 2,000 mm. Two major seasons determine farming in the northern region. The dry season lasts from end of April to the end of October, with July/August making up the cooler part of it. With the onset of the rains during November, temperatures climb and it remains hot and humid until about February (Wanda 1994).

Calculation of rates

Offtake rates

Offtake rates were based on monthly totals of animals, which were sold, slaughtered or used for ceremonial purposes versus the respective number of animals kept during the same months. The denominator for 12- and 14-months offtakes was made up by the average herd-size. Offtake records were only determined for ruminants but not for chickens.

Mortality rates

Calculation of mortality rates was based on monthly totals of animals that died versus the respective number of animals kept during the same months

Approach to data analysis

Data were stored using Microsoft ACCESS 2000 (Microsoft Corporation, Redmond, USA). GPS receivers were used to determine the precise locations of KM-houses and VA-stations within the study area. Maps were produced using the geographical information system software ARCVIEW for Windows version 3.1 (ESRI Inc., Redlands, USA). The effect of user-status, visit number (month) and VA/KM-status as explanatory variables on mortality in calves, small ruminants and chickens was examined using a generalised estimated equations (GEE) model suitable for analysis of longitudinal data. GEE allows the mean of a population parameter to depend on a linear predictor through a non-linear link function and allows the response probability distribution to be any member of a range of different distributions (Zeger and Liang 1986). Mortality as the dependent variable was expressed as a binomial variable (events/trials). Farm visits, where the population at risk for a particular livestock species was zero, were excluded from the analysis. The first category of the categorical explanatory

variables was used as the reference category as outlined in Tables 3, 4 and 5. The statistical analyses were performed using NCSS 2000 (NCSS Statistical Software, Kaysville, Utah, USA) and PROC GENMOD in SAS for Windows version 8.0 (SAS Institute, Cary, NC, USA).

Results

Farm locations

Figure 1 shows the location of farms included in the study.

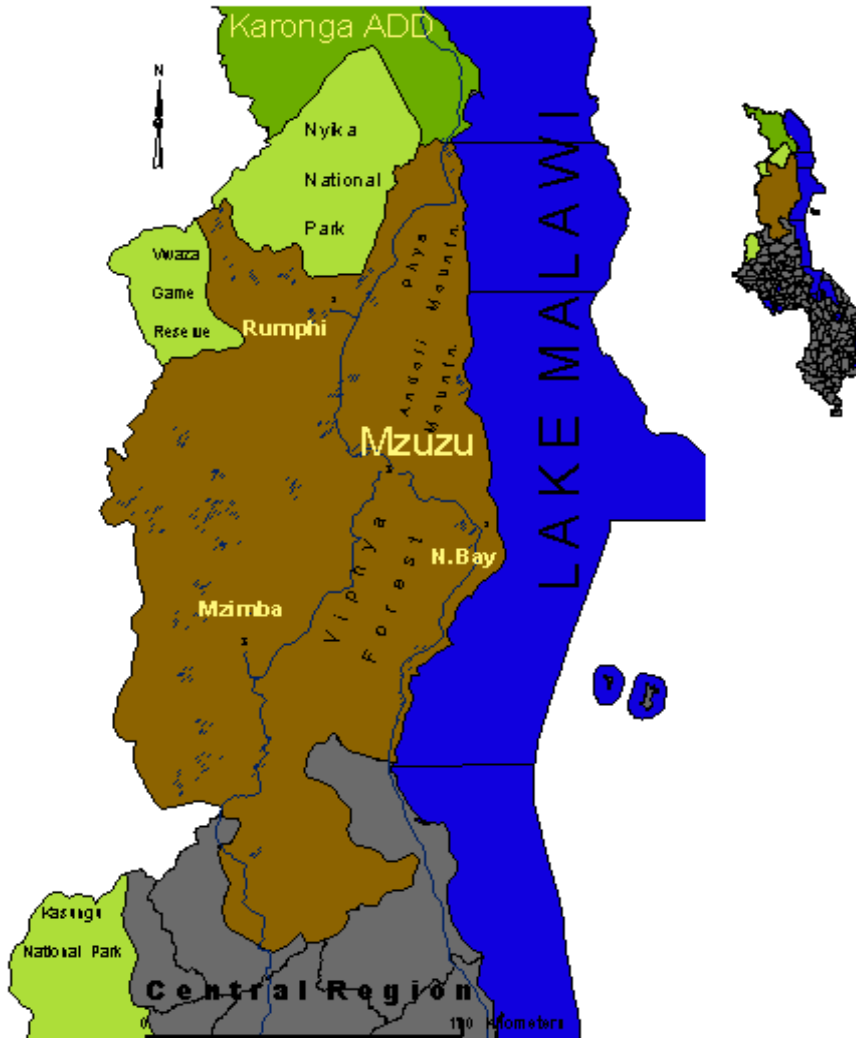


Figure 1: Location of study farms within Mzuzu ADD (n=288)

Herd size

The average cattle herd-size of BAHS-users of 16.2 (SD 9.5) was higher compared with part- (13.8, SD 9.0) and non-users (11.5, SD 8.2) (Kruskal-Wallis test; Chi-square 183.6, df 2, $p = .000$). BAHS-users also kept larger herds of sheep and goats (mean 10.2, SD .37) compared with part- (8.4, SD .57) and non-users (9.6, SD .99) (Kruskal-Wallis test; Chi-square 26.4, df 2, $p = .000$). Similarly, BAHS-users maintained larger chicken flocks (22.2, SD 1.9) followed by part-users (19.1, SD 2.0) and non-users (16.9, SD 1.8) (Kruskal-Wallis test; Chi-square 48.4, df 2, $p = .000$). Overall, there was a decline for all livestock species under investigation during the study period, which is illustrated in Figures 2, 3 and 4. The average cattle population

across farmer-groups decreased by 10 % during the 14 month observation period. This trend was more evident among non-users (13 %) and part-users (9 %) than BAHS-users (6 %).

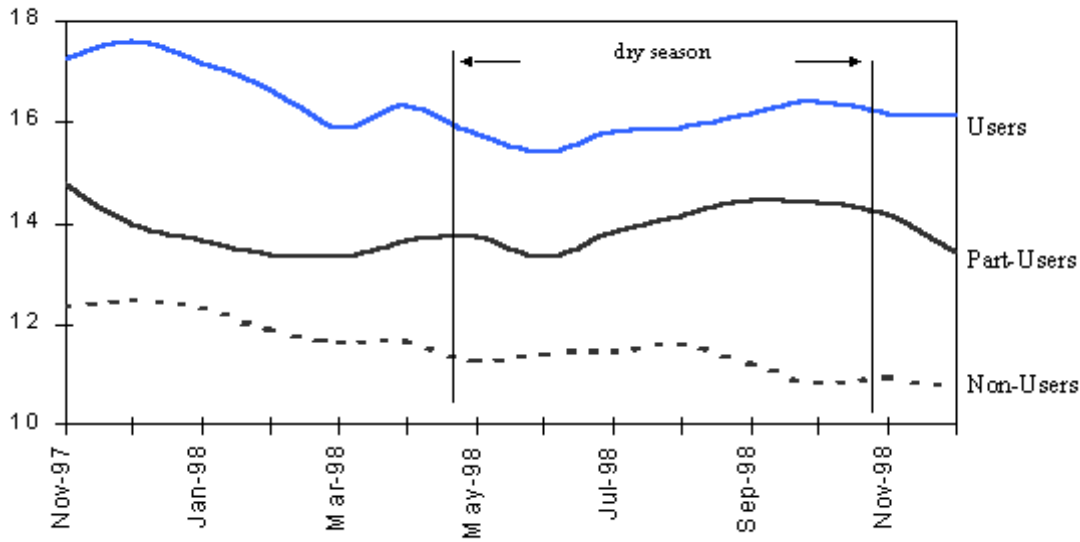
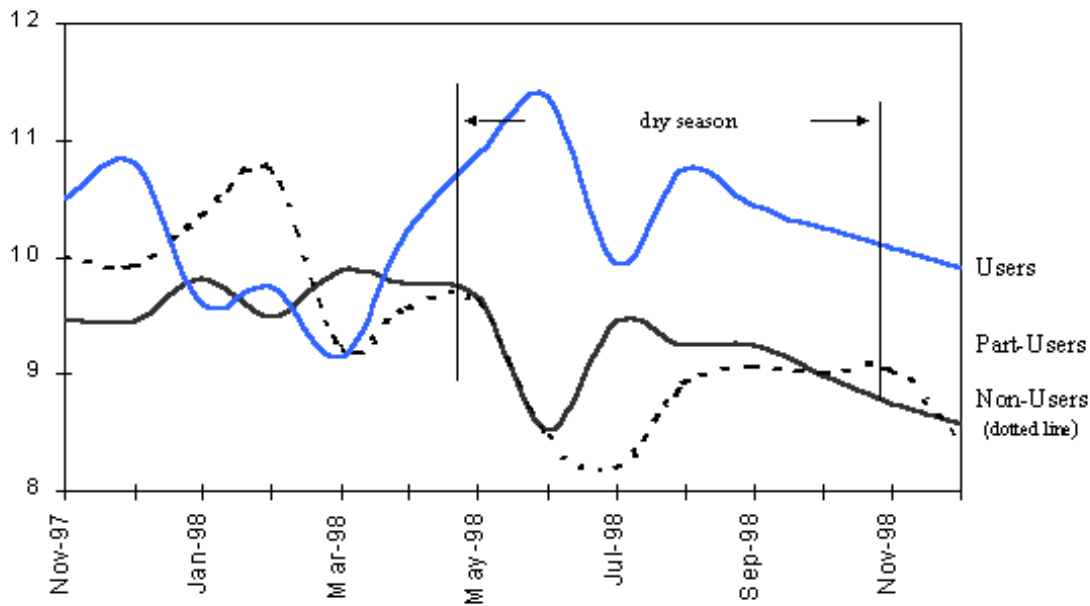


Figure 2: Mean cattle herd-sizes between 11/97 and 12/98 stratified by farmer-status (n=276)

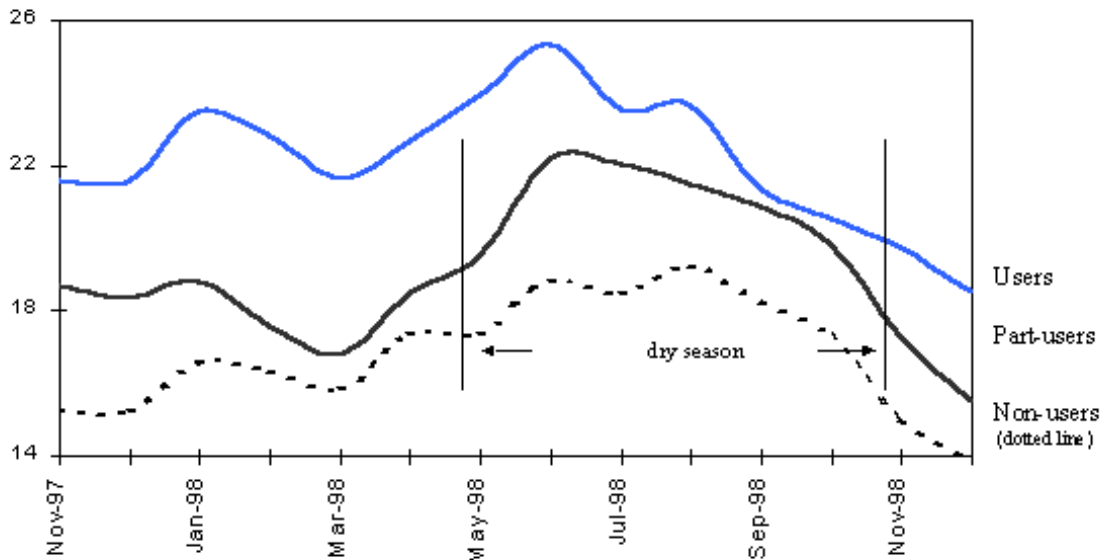
The respective decline in small ruminants was 16 % of the opening stock, 25 % for non-users, 19 % for part-users and 4 % for users (Figure 3).



Figure

3: Mean herd-sizes of small ruminants between 11/97 and 12/98 stratified by farmer-status (n=213)

Chicken flock sizes also decreased by 13%, 9 % for non-users, 17 % for part-users and 14 % for users (Figure 4).

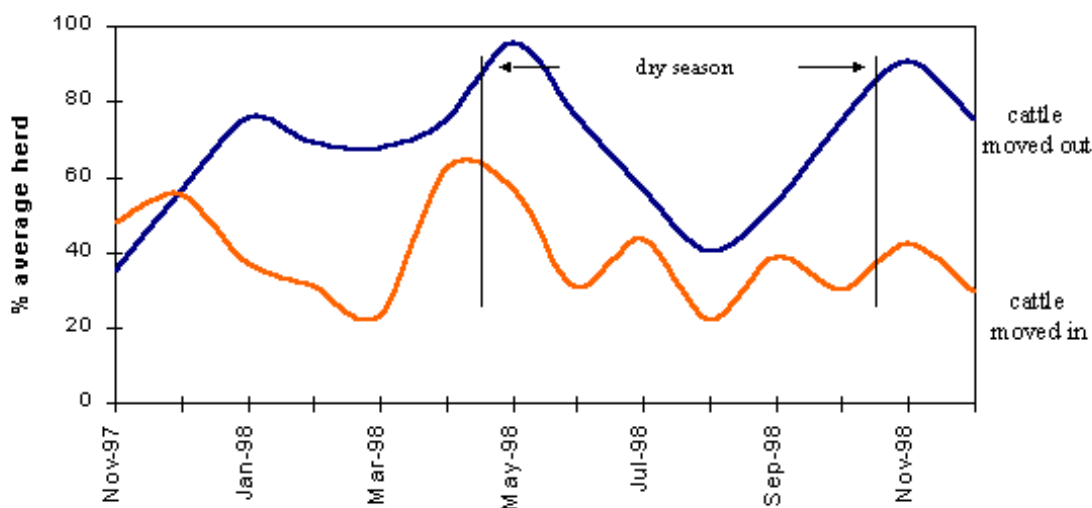


Figure

4: Mean flock-size of village chickens between 11/97 and 12/98 stratified by farmer-status (n=288)

Cattle movements in and out of herds

Large numbers of cattle were "brought in" or "moved away" from cattle kraals. These are animals, which were kept but not owned by the respective study-farmers. In addition, animals such as oxen or bulls are commonly hired out and returned later. Our monthly records allowed distinguishing between cattle that were slaughtered, sold or bartered as true offtakes and those moved. Figure 5 shows the percentage of cattle moved into or out of the kraal summarised across farmer-groups, because the temporal patterns were very similar. The calculation is based on monthly totals of cattle moved, against the annual average herd-sizes.



Figure

5: Monthly percentage of cattle moved out of and into the kraal between 11'97 and 12'98 for reasons other than offtakes or ceremonial purposes (n=276)

There were no significant differences (Kruskal-Wallis test; Chi-square 2.2, df 2, p= .33) between farmer-groups. There were two peaks in May and November 1998 (almost coincident for both curves).

The average relative percentage of cattle moved out was 67.5 % (SD 23.4) compared to 39.4 % (SD 13.7) of cattle moved into kraals. Users on average moved the largest proportion of cattle out of their kraals (73.5 %, SD 17.2), followed by non- (68 %, SD 23.4) and part-users (60.4 %, SD 19.1). The percentage of cattle moved into kraals was 44.1 % (SD 25.3) for users, 37.2 % (SD 16.5) for part- and 37.0 % (SD 13.7) for non-users. The respective out/in ratios were 1.7, 1.6 and 1.9. These ratios were used to calculate adjusted cattle offtake rates. Out/in ratios also differed according to ecological zone. They were highest in the highlands (2.6), followed by the lakeshore (2.2) and the plains (1.4).

Livestock offtake

Mean monthly cattle offtake

The mean monthly offtake rate between November 1997 and December 1998 was 1.74 % for BAHS-users (SD 0.64), 1.67 % for part-users (SD 1.1) and 1.62 % for non-users (SD 1.0), which is not significantly different (Kruskal-Wallis test; Chi-square 2.5, df 2, p= .28). Overall there was a common offtake pattern across all three groups. One peak occurred in January followed by larger peaks around May and again between September and November. Low monthly offtake rates occurred before the onset of the rains in October/November and between July and August.

Period-specific cattle offtake

Cattle offtake rates for periods of 12 and 14 months per farmer-group and ecological zone between November 1997 and December 1998 are shown in Table 1. Adjusted offtakes rates are calculated under the assumption of equal proportions of cattle being "moved in and out" of kraals for reasons other than offtakes. Average herd-sizes, therefore, have been multiplied with out/in-ratios as explained earlier.

BAHS-users had the highest 12- and 14-months (adjusted and non-adjusted) offtake rates followed by part- and non-users throughout all periods. There were fairly large variations within the groups during different underlying periods. No significant differences were found between groups. Looking at ecological zones (not adjusted for cattle movements) shows that Lakeshore-farmers had the highest offtakes and farmers in the plains sold or slaughtered the lowest number of cattle off their herds, which is significantly different for all periods under investigation. Applying adjusted rates change this sequence, whereby farmers in the plains had the highest offtake followed by those at the lakeshores and the highlands, which is independent of farm-status and remains significantly different.

Table 1: Adjusted and non-adjusted cattle offtake rates for different time-periods according to farm-status and ecological zone calculated as total offtakes against average herd-size (n=276)

	non-adjusted offtake rates no consideration for in/out ratios		adjusted offtake rates including ratios as specified below	
	annual offtake rates(SD)	14 months offtake rates (SD)	annual offtake rates (SD)	14 months offtake rates (SD)
status/ zone	12'97–11'98 n=3192	11'97–12'98 n=3719	11'97–12'98 n=3719	12'97–11'98 n=3192
non-users	14.6 (15.1)	17.1 (16.8)	7.69 (7.93)	9.0 (8.9) ratio = 1.9
part-users	15.2 (16.7)	17.3 (18.2)	9.50 (10.47)	10.8 (11.4) ratio = 1.6
users	18.0	20.5	10.5	12.1 (11.8)

	(18.9)	(20.0)	(11.13)	ratio = 1.7
p-value and χ^2 statistics	0.47 (1.54, df 2)	0.37 (1.96, df 2)	0.45 (1.51, df 2)	0.32 (2.11, df 2)
Highlands	18.2 (17.0)	20.9 (19.9)	6.98 (6.54)	8.0 (7.7) ratio = 2.6
Lakeshore	20.5 (20.8)	22.9 (21.5)	9.29 (9.46)	9.5 (9.0) ratio = 2.2
Plains	11.7 (15.6)	13.8 (16.2)	9.51 (11.13)	11.0 (11.5) ratio = 1.4
p-value and χ^2 statistics	.022 (7.61, df 2)	.023 (7.56, df 2)	.019 (7.84, df 2)	.021 (7.93, df 2)

Mean monthly offtake for small ruminants

Farmers sold or slaughtered sheep and goats more frequently compared to cattle. Users and part-users followed a fairly similar pattern with peaks around January, June and November, while non-users showed recurrent peaks more frequently. Non-users on average had a monthly offtake rate of 5.4 % (SD 3.0) followed by part-users with 4.4 % (SD 3.3) and BAHS-users with 4.3 % (SD 2.8), which is not significantly different (Kruskal-Wallis test; Chi-square 1.32, df 2, $p = .52$). Offtakes typically were low during February/March and again during August/September.

Period-specific offtake rates for small ruminants

Period-specific offtake rates for sheep and goats between November 1997 and December 1998 are shown in Table 2. Non-users maintained the largest offtake rates throughout the specified period, followed by either users or part-users. The annual offtake was generally high amongst study-farms ranging between 31 % and almost 45 % of the annual average herd-size. No significant differences were found between groups. There were no indications of large movements of sheep and goats due to reasons other than offtakes unlike the data for cattle. Thus, no adjusted offtakes were calculated.

Table 2: Offtake rates of sheep and goats for different time-periods according to farm-status and ecological zone calculated as total offtakes against average herd-size (n=213)

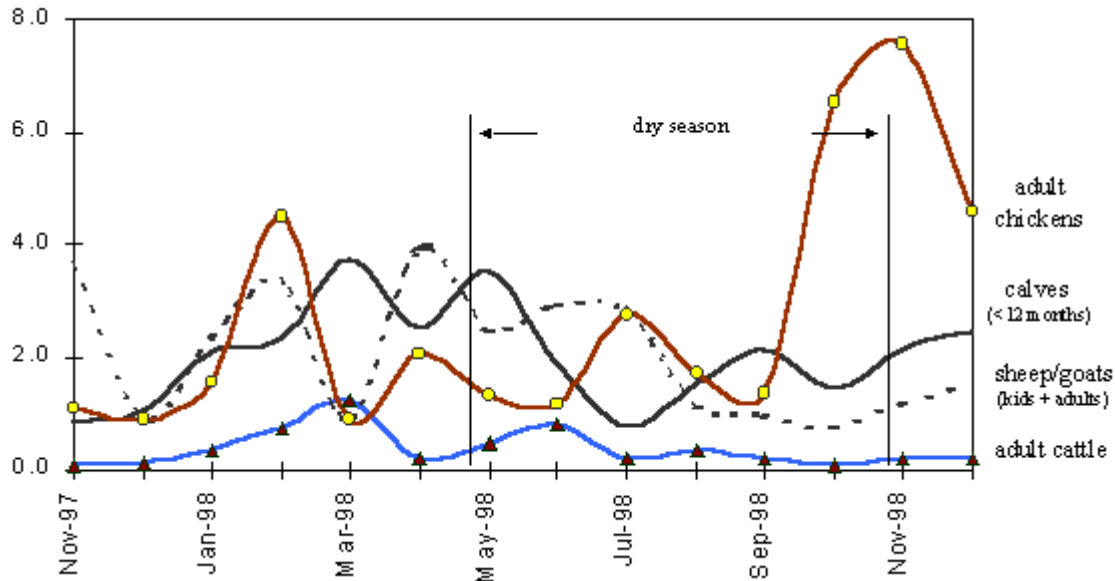
Status/zone	Annual offtake rates(SD) 12'97–11'98	14 months offtake rates 11'97–12'98
Non-users	44.3(38.9)	52.2(44.5)
Part-users	37.1(37.3)	40.6(37.0)
Users	36.4(33.0)	42.9(38.6)
p-value (χ^2 statistics)	0.47(1.50).df 2)	0.39(1.86.df 2)
Highlands	36.6(36.3)	42.9(40.4)
Lakeshores	57.4(47.8)	58.7(48.8)
Plains	37.6(33.7)	44.0(38.3)
p-value(χ^2 and statistics)	0.10(4.48.df 2)	0.33(2.22.df 2)

Comparing offtake rates according to ecological zones shows that farmers at the lakeshores had the highest rates followed by farmers in the plains and in the highlands. There were no

significant differences between zones.

Livestock mortality

The monthly pattern of mortality in calves, adult cattle, small ruminants (kids plus adults combined) and adult chickens is shown in Figure 6. The lowest monthly mortality of all species occurred towards the end of the dry season around September/October 1998.



Figure

6: Mean monthly mortality rates for calves, adult cattle, sheep and goats (including kids) and adult chickens between 11/97–12/98

Calf mortality

Non-users on average had a mean monthly calf (< 12 months of age) mortality rate of 3.2 % (SD 1.9) followed by part-users (1.5 %, SD 1.1) and BAHS-users (1.4 %, SD 0.9), which is not significantly different in the univariate analysis (Kruskal-Wallis test; Chi-square 2.31, df 2, $p = .31$). Fifty percent of BAHS-users (47/94) did not experience any calf mortality. Similarly, 45 % (41/91) of part-users and 43 % (39/91) of non-users did not lose any calf. The results of multivariable analysis of calf mortality using a GEE model are presented in Table 3.

Table 3: Final generalised estimating equation model looking at the effects of user-status, visit number and KM/VA-status on calf mortality between Nov. 1997 and Dec. 1998 (n=264)

Parameter	Level	Estimate	Standard error	OR	Z	P
Intercept	–	–5.3737	–	–	–	–
Visit	1(Nov. 97)	–	–	1	–	–
	2 (Dec. 97)	0.8457	.6238	2.330	1.36	.111
	3 (Jan. 98)	1.3578	.6110	3.888	2.22	.001
	4 (Feb. 98)	1.7909	.5779	5.995	3.10	.000
	5 (Mar. 98)	1.6391	.6001	5.151	2.73	.001
	6 (Apr. 98)	1.6868	.6037	5.413	2.80	.000
	7 (May 98)	1.8398	.5791	6.295	3.18	.000
	8 (June 98)	1.7393	.5969	5.693	2.91	.000

	9 (Jul 98)	1.3171	.5728	3.733	2.30	.010
	10 (Aug.98)	1.0530	.6086	2.866	1.73	.045
	11 (Sep.98)	1.3689	.5887	3.931	2.33	.007
	12 (Oct. 98)	1.0875	.6637	2.967	1.64	.037
	13 (Nov.98)	0.9728	.6637	2.645	1.47	.067
	14 (Dec.98)	1.0851	.5777	2.960	1.88	.040
Userstatus	user	–	–	1	–	–
	Part-user	0.2651	.2095	1.304	1.27	.1001
	Non-user	0.3802	.2121	1.463	1.79	.0218

Visit number (month) had a significant effect on calf mortality. Calves being monitored at the first (November 1997) compared to the following visits had higher odds of death for all but the second (December), and the 13th (November 1998) visit. The respective odds ratios varied between 1.6 (October 1998) and 3.2 (May 1998). In addition, user status was significantly associated with calf mortality. Non-users had a 1.8 higher odds of experiencing calf mortality compared to users of BAHS.

Cattle mortality

Part-users on average had a mean monthly adult cattle mortality rate of 0.44 % (SD 0.77) followed by non-users (0.39 %, SD 0.53) and BAHS-users (0.30 %, SD 0.16), which is not significantly different (Kruskal-Wallis test; Chi-square 2.4, df 2, p= .91). Relatively higher adult cattle fatalities occurred between February and June (calving season commences in May).

Mortality in small ruminants

Mortality in small ruminants was assessed for kids and adults combined. Animals were not tagged, which made it difficult to accurately distinguish between young and mature animals especially at 4–7 months of age. Non-users had the highest mean monthly mortality rate in sheep and goats of 2.8 % (SD 2.2) followed by part-users with 2.1 % (SD 1.8) and BAHS-users with 1.3 % (SD 0.8), which is not significantly different (Kruskal-Wallis test; Chi-square 3.0, df 2, p= .22). A peak occurred during the rains between November and May and there was a general decline towards the end of the dry season in October. The final GEE model for mortality in sheep and goats is presented in Table 4.

Table 4: Final generalised estimating equation model looking at the effects of user-status, visit number and KM/VA-status on small ruminant mortality (kids + adults combined) between Nov. 1997 and Dec. 1998 (n=212)

Parameter	level	estimate	standard error	OR	Z	P
Intercept	–	–4.4489				
Visit	1 (Nov.'97)	-	-	1	-	-
	2 (Dec.'97)	–0.8676	.4247	0.420	–2.04	.011
	3 (Jan.'98)	-0.2052	.4368	0.814	–0.47	.482
	4 (Feb.'98)	0.1159	.4180	1.123	0.28	.601
	5 (Mar.'98)	0.1168	.5096	1.124	0.23	.584
	6 (Apr.'98)	0.6096	.4460	1.840	1.37	.007
	7 (May'98)	0.8441	.4561	2.326	1.85	.000
	8 (Jun.'98)	0.6071	.4079	1.835	1.49	.007
	9 (Jul.'98)	0.5760	.4561	1.779	1.26	.013
	10 (Aug.'98)	–0.4500	.4833	0.638	-0.93	.141

	11 (Sep.'98)	-0.1546	.4821	0.857	-0.32	.615
	12 (Oct.'98)	-0.4588	.4941	0.632	-0.93	.155
	13 (Nov.'98)	-0.3817	.4977	0.683	-0.77	.235
	14 (Dec.'98)	-0.4734	.5254	0.623	-0.90	.129
Zone	Plains	-	-	1	-	-
	Highlands	0.4771	.2115	1.611	2.26	.000
	Lakeshore	0.2228	.4547	1.250	0.49	.369

The animals had a significantly higher probability of death between the sixth and ninth visits (cool dry) compared to the first visit in November 1997. The respective odds ratios varied between 1.4 and 1.9 whereas the odds of death were about half during the time of the second visit (December 1997) compared to the first visit. Ecological zones also had a significant effect on small ruminant mortality. The odds of death for animals kept in the highlands were 2.3 compared to those kept in the plains.

Adult chicken mortality

Non-users showed the highest monthly adult chicken mortality rate with 4.4 % and the largest variation (SD 7.7), followed by BAHS-users with 2.6 % (SD 2.2) and part-users with 2.0 % (SD 1.8), which is not significantly different (Kruskal-Wallis test; Chi-square 2.0, df 2, $p = .98$). The highest mortality occurred between September and December 1998. The final GEE model in table 5 shows a significant association between adult chicken mortality and visit number.

Table 5: Final generalised estimating equation model looking at the effects of user-status, visit number and KM/VA-status on adult chicken mortality between Nov. 1997 and Dec. 1998 (n=283)

Parameter	level	estimate	standard error	OR	Z	P
Intercept	-	-4.2642	-	-	-	-
Visit	1 (Nov.'97)	-	-	1	-	-
	2 (Dec.'97)	-0.6523	.5048	0.521	-1.29	.019
	3 (Jan.'98)	0.0943	.4510	1.099	0.21	.636
	4 (Feb.'98)	0.3121	.4501	1.366	0.69	.116
	5 (Mar.'98)	0.0829	.4768	1.086	0.17	.670
	6 (Apr.'98)	0.1488	.4285	1.160	0.35	.474
	7 (May'98)	-0.5998	.4693	0.549	-1.28	.030
	8 (Jun.'98)	0.0849	.4799	1.089	0.18	.654
	9 (Jul.'98)	0.4381	.4506	1.550	0.97	.028
	10 (Aug.'98)	-0.6998	.5487	0.497	-1.28	.008
	11 (Sep.'98)	-1.2260	.5359	0.293	-2.29	.000
	12 (Oct.'98)	0.3001	.4767	1.350	0.63	.139
	13 (Nov.'98)	-0.1829	.4505	0.833	-0.41	.451
	14 (Dec.'98)	0.7459	.5162	2.108	1.45	.000

The odds of death for these animals was lower at the second, seventh, tenth and eleventh visit compared to the first visit and varied between 0.29 and 0.55. A higher odds of death was 2.1 for the last- and 1.6 for the ninth compared to the first visit.

Livestock husbandry applications

Table 6 shows the results of chi-squared cross-tabulation of the frequencies of selected husbandry measures, which were applied by the farmers.

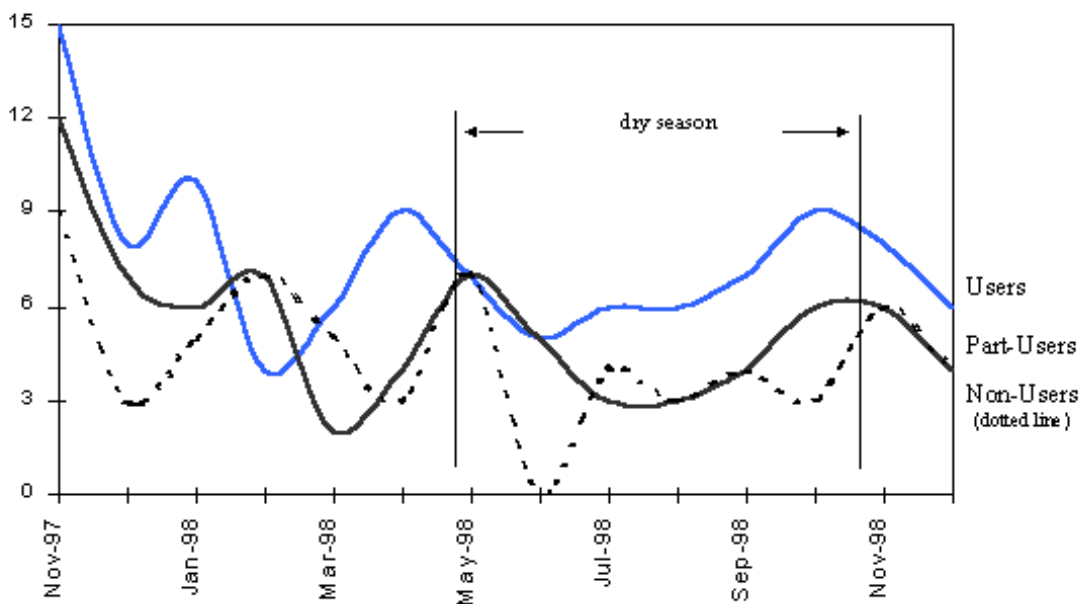
Table 6. Cross-tabulation of frequency of use of selected husbandry measures between 11'97 and 12'98 stratified by farm status (n=276)

Measure	Percent yes			p-value (χ^2 statistics)
	non-users n=92	part-users n=90	BAHS-users n=94	
Cattle kraal repaired?	42.7	52.1	58.3	.09 (χ^2 4.75, df 2)
New cattle kraal built?	27.1	24.0	26.0	.88 (χ^2 .25, df 2)
Calf house repaired?	5.2	6.3	17.7	.005(χ^2 10.5, df 2)
New calf shed constructed?	14.6	15.6	22.9	.26 (χ^2 2.72, df 2)
Chicken house repaired?	24.0	20.8	25.0	.77 (χ^2 .50, df 2)
New chicken house built?	13.5	16.7	21.9	.03 (χ^2 2.37, df 2)
Sheep/goats shed repaired?	27.1	27.1	35.4	.34(χ^2 2.12, df 2)
New sheep/goat shed built?	13.5	20.8	21.9	.27(χ^2 2.59, df 2)
Cattle manure applied?	86.5	84.4	87.5	.82(χ^2 .41, df 2)
Chickens manure applied?	67.7	64.6	64.6	.87 (χ^2 6.28, df 2)
Sheep/goat manure applied?	56.3	62.5	58.3	.67 (χ^2 .80, df 2)
Drinkers for chickens in use?	75.0	76.0	83.3	.31 (χ^2 2.32, df 2)
Nests provided for hens?	78.1	79.2	79.2	.98 (χ^2 .04, df 2)

Most of the husbandry measures are not significantly different between farmer-groups but their frequencies clearly indicate a higher adoption of improved husbandry by BAHS-users for almost all selected measures.

Seasonal pattern of selected husbandry measures

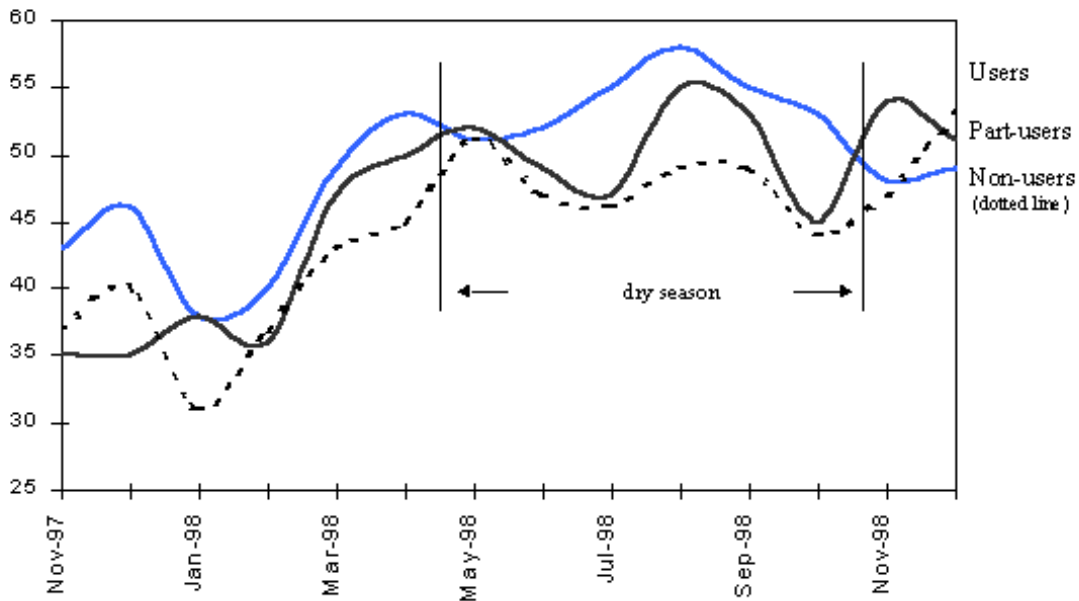
Figure 7 presents the total number of monthly cattle-kraal repairs. The traditional cattle kraal is a basic stake enclosure that makes regular maintenance of the wooden structures necessary.



Figure

7: Temporal pattern of cattle-kraal-repairs as monthly totals between 11'97 and 12'98 stratified by farm-status (n=276)

Most repair work happened around the onset and during the wet season with a peak during November for all farmer-groups.

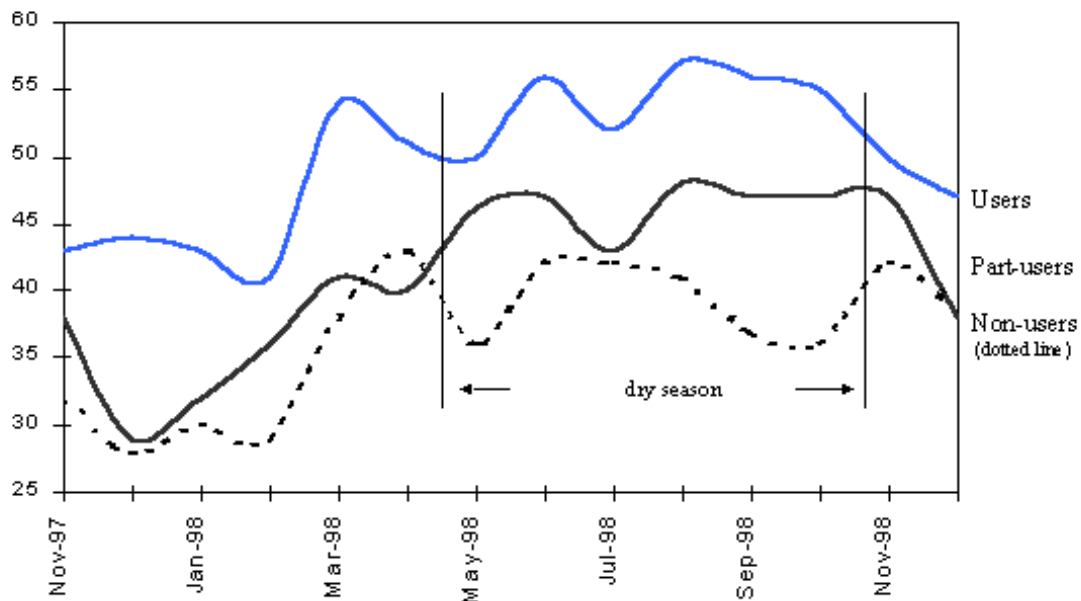


Figure

8: Temporal pattern of nest provision for brooding hens as monthly totals between 11'97 and 12'98 stratified by farm-status (n=288)

Figure 8 shows the frequency of nest-provision for brooding hens in villages. The proportion of farmers providing nests was comparably high. Forty-four non-users (SD 6.1), 46 part-users (SD 7.2) and 49 BAHS-users (SD 5.8) on average applied this measure. It means that about half of all selected farmers monitored their brooding hens regularly. All curves show a similar shape over time with a decline during January and the highest levels between May and September 1998, except for non-users, who had the highest level during the last visit.

Figure 9 shows the monthly number of farms providing drinkers to their flocks stratified by farm-status. There were on average 37 non-users (SD 5.2), 41 part-users (SD 6.1) and 50 BAHS-users (SD 5.5) ensuring that chicken flocks had access to proper drinkers during respective months.



Figure

9: Temporal distribution of total number of drinker-provision for chicken-flocks as monthly totals between 11'97 and 12'98 stratified by farm-status (n=288)

The graph shows that during the peak of the rains (December to February) drinkers were less frequently used, which applied to all farmer-groups.

Farmer's perception about the observation period

Table 7: Farmers judgement about their livestock production during the study period in comparison with previous years (n=288), (χ^2 167.6, df 6, p = .000)

Status	bad	normal	better
non-users	42	26	28
part-users	38	27	31
BAHS-user	31	17	48

As part of the concluding visits in January/February 1990, farmers were asked about their perception towards the past 14 months in terms of livestock health and production. BAHS-users had a significantly more positive view compared to part-and non-users Table 7.

Discussion and conclusions

All livestock species monitored during this study showed an overall decline in total numbers. However, chicken flock-sizes as a rule show large variations within the traditional farming system in Malawi (Ahlers 1999) and developing countries in general (Ajuyah 1999; Kitalyi 1999; Mallia 1999). For this reason, the current level of decline is not likely to lead to major concerns about the chicken population in the study area. Nonetheless, losses in village chickens are largely reducible by applying better management practices and also through improved uptake of vaccine against Newcastle Disease (Ahlers et al. 1999).

The issue of a shrinking ruminant-population particularly in cattle, however, has a different background compared to chickens. Cattle herds are traditionally held very stable. Moreover, the natural conditions in the study area, including pasture availability still allow an extension of cattle herds, which is different in the central and more so in the southern region of Malawi. In addition, the exceptional population growth in Malawi has led to a strong demand for livestock

and livestock products, which is currently only met by rising imports from neighbouring countries (The World Bank Group 1999). A Danish appraisal mission noted a decline in national cattle numbers, which commenced during the late eighties (Malawi Report 1999). This decline has apparently accelerated since 1992. Possible reasons cited in the same report included the repatriation of almost 1 million refugees (including their livestock) to Mozambique, and also an alarming rate of cattle thefts during the nineties. Whole herds were (and still are) stolen and moved across borders. The latter, however, was not an issue on our study farms. The Danish report mentioned stagnant productivity under traditional livestock management as another contributing factor for a decline in the national livestock population.

Our results show, that annual cattle offtakes (adjusted and non-adjusted) are comparably high for all user-groups (Table 1). Ngategize (1989) estimated the annual offtake of smallholder cattle farmers in northern Tanzania at 5 %. Perry et al. (1984) studied traditionally managed cattle herds in Zambia and found a mean offtake of 10 %. Rodgers and Homewood (1986) investigated cattle herds in north-western areas in Tanzania and reported a mean annual offtake of 8 %. The authors, however, provided no indication on whether movements of cattle in and out of the pen for reasons other than offtake were of relevance despite the fact that the traditional cattle farming system is very similar within the region. During the course of on-farm visits a farmer's response to a missing cattle beast such as "has been given away" had to be carefully verified in order to be able to distinguish whether this very animal was consumed, hired out or was simply returned to its owner. It is likely that the issue of cattle movements in and out of kraals for reasons other than offtakes explains the decline in cattle numbers on one hand and the seemingly high offtake rates on the other. A possible explanation of much larger removals than returns of cattle is likely to be the strong demand for livestock and livestock products and/or higher requirements for cash by people that own these animals. The largest relative percentage of animals is moved during May and around November. During May, maize as the main staple food is harvested and dried. Grazing of animals on communal land is less restrictive in terms of potential crop damage. We know, for instance, that people at the lakeshores return large numbers of cattle from uninhabited mountainous bush areas during May because of the latter. During this time loans are also commonly repaid in either cash or alternatives such as agricultural products. April/May also marks the beginning of the main calving season. During November, which is the planting season, demand for cash and loans is very strong, mainly because of the need for fertiliser and seeds. Controlled grazing becomes essential during this time. These are factors, which possibly had an impact on cattle movements and offtakes. They might have led to a bias towards the actual cattle herd-size of the kraal-owners during the observation period. It would be important for future BAHS-expansion to assess whether kraal-owners direct the same degree of attention to animals other than their own. It also remains to be investigated why there are such large differences between adjusted and non-adjusted offtake rates according to ecological zone.

Our results suggest that BAHS-users not only had the highest cattle offtakes but also managed more stable cattle herd-dynamics as compared to either of the other groups. Lower mortality in young and adult stock by BAHS-users is highly likely to have contributed to that. Data retrieved earlier from the initial questionnaire defined BAHS-users as farmers that were already better educated and better motivated and that owned significantly more livestock compared to part- and non-users (Hüttner et al. 2000b). Ownership of more livestock, therefore, is certainly a driving force for a strong interest in the BAHS-program.

The end of the dry season in October/November corresponds with low livestock mortality overall. This is because tick born diseases but also helminthiasis in livestock as the main health constraints in the region are of greater importance during the rains because of the biological cycle of the parasites. Therefore, visit number, equivalent to months and thus an expression of season is significantly associated with mortality for all species under investigation. Calf mortality is highest between March and May. The calving season commences in April/May and

earlier findings (Wanda 1994) showed that 30 % of all new-born calves died within the first four weeks of life, confirming the seasonal pattern of death in young calves (Norman et al. 1997). For small ruminants, mortality during the cooler months between April and June are significantly higher compared to November, which is irrespective of the BAHS-user status. Helminthiasis, particularly infections caused by *Haemonchus spp.*, and respiratory diseases are also management constraints and are major contributors to death in sheep and goats in Malawi (Edelsten 1992). In addition, ecological zone was significantly associated with small ruminant mortality. Sheep and goats kept in the highlands have higher odds of death than those kept in the plains or at the lakeshores. It is possible that religion attributes to the degree of attention to these animals, with predominantly Islamic influence at the lakeshores.

Our mean monthly mortality rates in adult chickens between 2 % and 4.4 % are well below of what Ahlers (1999) found on study farms within Mzuzu ADD. Her mean monthly mortality rate came to 9.2 % in hens and 9.9 % in cocks. It is likely that the different study design with the explicit focus on village chicken flocks involving daily visits has led to more realistic results. This was one of the reasons why we did not attempt to evaluate chick mortality (because this figure changes daily). The seasonal pattern of adult chicken mortality as shown in Figure 6 matches those identified by Ahlers (1999).

Results of the initial questionnaire already provided some indication as to the disparities of husbandry measures applied by study-farmers (Hüttner et al. 2000b). These findings are complemented by the outcome of the current longitudinal study results.

BAHS-users apply better husbandry and management practices more frequently than either of the other two groups (Table 6). Repair of calf-pens or complete overhaul of chicken-houses occurred significantly more frequently amongst BAHS-users than in either of the other groups. Farmers of all groups, though in varying proportions, clearly followed a seasonal calendar while being engaged in all sorts of management activities.

Addressing the issue of improved husbandry, however, may not just be based on intensified extension efforts and education. In the context of the AIDS epidemic in Sub-Saharan Africa, lack of labour becomes increasingly important in these production systems (Anon. 1999). In addition, natural building materials are already difficult to obtain in certain parts within the Project-area, because forests and natural bush are rapidly disappearing due to deforestation and land degradation. This all has to be considered when further planning is undertaken.

Despite these constraints, the results of our study show the benefits, which can be obtained by utilising BAHS. The findings complement results of a benefit/cost analysis that was conducted by Hüttner (2000). Losses in young and adult stock can be reduced and increased cattle offtake in conjunction with more stable cattle herds appears likely as a result of BAHS usage. This is supported by the assessments made by study-farmers at the end of the observation period, whereby significantly more BAHS-users were satisfied with health and productivity of their livestock compared to part- and non-users. However, our study farms represent households with larger livestock numbers and thus better income compared with the general population. Involvement of the majority of livestock holders in the project area is one of the goals to be achieved by the BAHS-Project. It is therefore crucial to address the special needs of the majority of poorer families that own chickens, ducks or rabbits only.

Acknowledgement

This longitudinal study was a major effort for all parties involved. We wish to thank in particular all keymen and veterinary assistants as well as their supervisors for their commitment. We also greatly appreciate the patience and support our farmers have shown during the course of follow-up visits.

References

- Ahlers C. 1999. *Characteristics and constraints of the traditional poultry keeping system in northern Malawi*. Unpublished Doctorate thesis, Free University Berlin, Germany. 175 pp.
- Ahlers C., Hüttner K., Pfeiffer D.U. 1999. Comparison between a live and an inactivated vaccine against Newcastle Disease in village chickens. A field study in northern Malawi. *Tropical Animal Health & Production* 31, 3, pp. 167–174.
- Ajuyah A. O. 1999. Rural family poultry production in the South Pacific Region. *The First INFPD/FAO Electronic Conference on Family Poultry*
[Http://www.Fao.Org/Waicent/Faoinfo/Agricult/Agap/Agap/Lps/Fampo/Leadpap4.Htm](http://www.Fao.Org/Waicent/Faoinfo/Agricult/Agap/Agap/Lps/Fampo/Leadpap4.Htm)
- Anon. 1999. Aids in Africa, <http://www.unaids.org/highband/fact/saepap98.html> Globale Aids-Situation: http://www.rki.de/INFEKT/AIDS_STD/GLOBAL/GLB_SEL.HTM
- De Jode A., Reynolds L. and Matthewman R. W. 1992. Cattle production systems in the derived savannah and southern guinea savannah regions of Oyo State, Southern Nigeria. *Tropical Animal Health & Production* 24, 90–96
- Edelsten, R.M., 1992. Health and husbandry of sheep and goats in Malawi. *Proceedings of a Workshop on Small Ruminants Activities in Malawi. 5th – 8th October 1992, Capital Hotel, Lilongwe, Malawi*, pp. 149–155
- Hüttner K., Leidl K., Jere F.B.D. and Pfeiffer D.U., 2000a. Characteristics and Performance of Village Animal Health Workers and Veterinary Assistants in northern Malawi. *Journal of the South African Veterinary Association*. published in 9/2000.
- Hüttner K., Leidl K., Pfeiffer D.U., Jere F.B.D. and Kasambara, D. 2000b. Farm and personal characteristics of the clientele of a community-based Animal Health Service Program in northern Malawi. *Tropical Animal Health & Production*, to be published in 3/2001.
- Hüttner K. 2000. *Impact Assessment of a community based animal health service program in northern Malawi*. MSc thesis, Massey University, Palmerston North, New Zealand, 117 pp.
http://epicentre.massey.ac.nz/documents/Thesis/Klim_Thesis.PDF
- Jemal A., Justic D. and Hugh-Jones M.E. 1995. The estimated long-term impact of Tsetse control on the size of the population of cattle in the Didessa Valley, Western Ethiopia. *Veterinary Research Communication* 19: 479–485
- Jere F.B.D. 2000. Set up and implementation of FIAH's drug revolving fund. In: Hüttner K., Leidl K. and Jere F.B.D. (Eds.). Primary Animal Health Activities - Topic Day. Proceedings of an International Seminar, 15th–17th Mzuzu, Malawi. Basic Animal Health Project, Mzuzu, Malawi. p 15–17. http://epicentre.massey.ac.nz/Documents/PDF/KLIM_ProceedingsII.pdf
- Jones B.A., Deemer B., Leyland T.J., Mogga W. and Sterm E. 1998. Community-based animal health services in Southern Sudan; The experience and future. In: *Proceedings of the 9th International Conference of the Association of Institutions of Tropical Veterinary Medicine (AITVM), 14–18 September 1998, Harare, Zimbabwe* (in press)
- Kitalyi A.J. 1999. *Family poultry management systems in Africa*. The First INFPD/FAO Electronic Conference on Family Poultry, FAO, Rome, Italy.
[Http://www.Fao.Org/Waicent/Faoinfo/Agricult/Agap/Agap/Lps/Fampo/Leadpap3.Htm](http://www.Fao.Org/Waicent/Faoinfo/Agricult/Agap/Agap/Lps/Fampo/Leadpap3.Htm)
- Kudi A.C., Umoh J.U., Eduvie L.O. and Gefu J. 1998. Relative survival of calves in 16 traditionally managed herds in Bauchi, Nigeria. *Preventive Veterinary Medicine* 36: 307–312.

Leidl K., Jere F.B.D., Wanda G., Hüttner K. and Stange M. 1995. Establishment of a basic animal health service program in northern Malawi - dimensions of activities through field work prior to implementation. Proceeding of the 8th International Conference of Institutions of Tropical Veterinary Medicine, 25–29 September 1995, page 113

Malawi Report. 1999. Malawi National Livestock Development Masterplan. Final Report, Lilongwe, Malawi, 114 pp

Meemark N. 1988. *The development and evaluation of a village-based parasite control program for swamp buffalo and cattle in northeast Thailand*. Unpublished MSc Thesis, Massey University. Palmerston North, New Zealand. 169 pp

Mallia J.G. 1999. Observations on family poultry units in parts of Central America and sustainable development opportunities. The First INFPD/FAO Electronic Conference on Family Poultry. [Http://www.Fao.Org/Waicent/Faoinfo/Agricult/Agap/Agap/Lps/Fampo/Freeco13.Htm](http://www.Fao.Org/Waicent/Faoinfo/Agricult/Agap/Agap/Lps/Fampo/Freeco13.Htm)

Ngategize P.K. 1989. Economic evaluation of improved management for Zebu cattle in northern Tanzania. *Agricultural Systems* 31 : 305–314

Norman N., Claes L., Soldan N., Banda M.. 1997. Observations on undipped Malawi Zebu cattle. In: Zimmermann, W., Pfeiffer, D.U., Zessin, K.H. (Eds.): *Primary Animal Health Care Activities in Southern Africa, Proceedings of an International Seminar held in Mzuzu, Malawi, February 26 to March 8 1996*, pp. 90–107

Perry B. D., Mwanaumo B.; Schels H. F., Eicher E. and Zaman M. R., 1984. A study of health and productivity of traditionally managed cattle in Zambia. *Preventive Veterinary Medicine* 2: 633–653.

Rodgers W. A. and Homewood K. M. 1986. Cattle dynamics in a pastoral community in Ngorongoro, Tanzania, during the 1982–83 drought. *Agricultural Systems* 22: 33–51.

Schreuder B.E.C., Noorman N., Halimi M. and Wassink G. 1996. Livestock mortality in Afghanistan in districts with and without a veterinary program. *Tropical Animal Health & Production* 28:129–136.

Sulistiyo U., Wahyuni D. and Leksmono C.S. 1998. Village Animal Health Workers in Minahasa District North Sulawesi, Indonesia. In: *Proceedings of the 9th International Conference of the Association of Institutions of Tropical Veterinary Medicine (AITVM), 14–18 September 1998, Harare, Zimbabwe* (in press).

The World Bank Group, 1999. Country at-a-glance, website, http://www.worldbank.org/data/countrydata/aag/mwi_aag.pdf

Tuah K. and Yaa Nyamaa D. 1985. Preliminary studies on the performance and productivity indices of N'dama and West African Shorthorn cattle in Ghana. *Tropical Animal Health & Production*, 17: 114-120.

Uza D.V. 1997. The productivity of Muturu cattle (*Bos brachyceros*) under ranching conditions in the Southern Guinea Savanna of Benu State, Nigeria. *Outlook on Agriculture* 26:19–23

Wanda G.W. 1994. *Health constraints of calves and young stock in Mzuzu Agricultural Development Division*. MSc thesis, University of Reading, Reading, UK.102 pp.

Zeger S.L. and Liang K.Y. 1986. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 42: 121–30

Session 2: Policy analysis, socio-economics and sustainable integrated animal health

Socio-economic and biological issues to consider in smallholder poultry development and research in Southern Africa in the new millennium

V. Muchenje^{1}, M. M. Manzini¹, S. Sibanda² and S. M. Makuza²*

Correspondence to: ^{1*} Zimbabwe Open University, Bulawayo Region, P. O. Box 3550 Bulawayo, Zimbabwe, Tel: 263-9-68663 / Fax 263-9-70790, e-mail: vmuchenje@hotmail.com

² University of Zimbabwe, Department of Animal Science, P. O. Box MP 167, Mt. Pleasant, Harare, Zimbabwe

[Abstract](#)

[Introduction](#)

[Importance and uses of poultry](#)

[Poultry productivity in the smallholder farming sector](#)

[Non-adoption of poultry production technology by farmers](#)

[Possible changes to improve productivity of indigenous flocks](#)

[Feed resources and requirements](#)

[Breeding in extensive production systems](#)

[Markets](#)

[Other issues to consider in smallholder poultry research and development](#)

[Conservation of genetic resources in poultry](#)

[Computer simulation modelling in farming systems and scientific research](#)

[Conceptual structure](#)

[Model building and validation](#)

[The future](#)

[References](#)

Abstract

Poultry provide major opportunities for increased protein production and incomes for smallholder farmers because of the following factors: small generation interval, the high rate of

productivity, the ease with which poultry products can be supplied to different areas, the ease with which poultry products can be sold due to their relatively low economic values, minimal association of poultry with religious taboos, and the complementary role poultry play in relation to other crop-livestock activities. Despite the potential of poultry production to attain rapid growth, constraints such as diseases, pests, predators, poor housing, poor nutrition, lack of knowledge about poultry production, lack of genetic improvement in commercially important traits in indigenous breeds, lack of capital and poor accessibility to markets can negatively affect poultry production in the smallholder farming sector. To boost income generation and nutrition for the smallholder farmers and their families these constraints should be addressed by carrying out on-farm research involving farmers, especially women who normally carry out the day to day activities of the poultry sub-system. Since smallholder farming systems are bio-economically complex involving several kinds of resources and input/output flows, it would not be advisable to study poultry production only without considering other crop-livestock components of the farming system. Farming systems research (FSR) has emphasised traditional cropping systems, with little attention to livestock sub-systems, let alone poultry. The reason could be that the economic importance of poultry is not adequately appreciated by researchers and decision-makers because poultry products in the smallholder farming sector only passes through non-formal marketing channels. For the smallholder farmers to adopt new technologies meant to improve poultry production, the technologies should be compatible with local socio-cultural, political, economic and institutional conditions. This can only be done by carrying out more holistic FSR which go beyond biological production in crop and livestock sub-systems to include utilisation, marketing outputs and off-farm activities. Research methods should be more participatory than extractive.

This paper therefore highlights smallholder poultry research, development and production potential, constraints and challenges for the Southern African poultry researchers in the new millennium. The term 'smallholder farmers' refers to farmers in communal, resettlement and small-scale commercial areas.

Introduction

Although poultry may be of low economic value in smallholder farming systems, it is an important source of protein in both rural and urban areas. Due to recurrent droughts in Southern Africa and decreasing grazing land, which tend to result in the reduction of the national cattle herds, poultry has the potential to become a major source of protein and a ready source of income in the smallholder farming sector. In Zimbabwe demand for day-old chicks increased from 10 million in 1988 to 24 million, while that of eggs increased from 11.5 million to 20 million in 1995 (Government of Zimbabwe 1995). While the 1963 to 1975 period saw an annual growth rate of livestock production in developing countries of 2.4 %, the annual growth rate for poultry production was much higher at 6.5 % (Hrabovszky 1981).

In most developing countries poultry production systems vary from being extensive to intensive. In Zimbabwe there are the large-scale poultry production and smallholder poultry production systems. Large scale poultry production units are characterised by huge capital investments, intensive management, mechanisation and specialisation. The smallholder poultry sector can be intensive characterised by exotic breeds of broilers and layers, semi-intensive or extensive dominated by indigenous poultry breeds that are not specifically classified. The indigenous poultry breeds in Zimbabwe are estimated to be between 15 and 30 million (Lambrou 1993). Although they are characterised by low production, indigenous birds are tolerant to diseases and are adapted to poor nutrition. The free-range poultry production system can best be described as a low input-low output system where the birds are rarely given any extra feed besides what they get from the surroundings. This system represents a part of a balanced farming system where little or no inputs are involved. The indigenous birds are also an important reservoir of genomes that may be used in the future to improve hybrid

birds.

Of the 36 million day-old chicks produced annually in Zimbabwe, 50 % are purchased by the smallholder producers (Government of Zimbabwe 1995), but little information is available on what happens in this sector. This can be attributed to lack of support and development of rural poultry production by the government and development agencies. Some of the constraints to poultry production are diseases, pests, predators, poor housing, poor nutrition, and lack of genetic improvement in commercially important traits in indigenous breeds; lack of capital and poor accessibility to markets (Faranisi 1995; Tadelle 1996; Government of Zimbabwe 1995; Muchenje and Sibanda 1997). Improved management of these birds through, for example, supplementing indigenous birds with energy, protein and calcium can increase poultry productivity in extensive systems (Tadelle 1996).

Despite the constraints listed above, there are several factors that make expansion of poultry production in the smallholder farming sector attractive. Poultry meat and egg production enterprises grow very rapidly, not only because of the biological, physical and economic potential, but also because well-run poultry enterprises provide high levels of protein output per unit of feed (Hrabovszky 1981). Unlike pigs, poultry are associated with few religious or social taboos. Supply of poultry products in poor countries is technically possible because the birds easily adapt to most areas of the world, have a low economic value, have a small generation interval and a high rate of productivity (Smith 1990). Meat from poultry can be produced within eight weeks and eggs within 18 weeks of the first chick being hatched. In addition, poultry play an important complementary role to other crop-livestock activities. Poultry production is a dynamic sub-sector within livestock production systems and improvements in management and technology in smallholder poultry production systems will ultimately improve household income and nutrition. This can be achieved through participatory research in smallholder poultry production. Such research activities would result in poultry production models clearly describing the input-output relations in, for example, extensive poultry production systems and interrelationships between poultry production and other crop-livestock sub-systems.

Importance and uses of poultry

Poultry are an important source of ready income and protein in rural areas. Rural poultry also integrate very well and in a sustainable way into other farming activities (Tadelle 1996). Furthermore, rural poultry play important cultural and social roles in rural communities. The main objectives of rural poultry are producing eggs for hatching, sale and home consumption, and birds for sale, healing ceremonies, traditional offerings, replacement, home consumption and for gifts to visitors and relatives (Mutisi and Kusina 1996; Tadelle 1996; Muchenje and Sibanda 1997). Money from the sale of the birds is used to buy immediate household requirements such as food, dairy feeds and to pay school fees, among other purposes. By eating leftovers from the kitchen and insects such as cockroaches, birds perform a valuable sanitary function in villages. Poultry manure can be used as field manure or as feed supplement for ruminants.

Poultry can be kept for socio-cultural or financial purposes. Under such circumstances introducing management changes such as regular watering and feeding, cleaning the fowl-runs and taking care of the young chicks can be complex. When designing programmes to expand poultry production it is important to consider issues related to gender and labour-sharing within households. Some studies have shown that poultry keeping in most developing countries is the responsibility of women (Tadelle 1996; Muchenje and Sibanda 1997). Understanding the roles of each household member is important in sustainable poultry production.

Poultry productivity in the smallholder farming sector

Free-range poultry production levels are generally low and most flock sizes average 10 to 20 birds; two to three clutches per year, with an average of 10 to 15 eggs per clutch. The average annual egg production is between 30 and 60 small sized eggs (Smith 1990; Tadelles 1996; Muchenje and Sibanda 1997). The low production levels can also be attributed to high chick mortality levels (Tadelles 1996), diseases, pests, predation, poor housing and poor management (Muchenje and Sibanda 1997). According to Tadelles (1996), chick mortality, which may be over 60 % between hatching and end of brooding, represents a major loss in scavenging village chicken production systems. This may be due to a combination of poor housing, competition for the same feed resource base with stronger and more vigorous members of the flock, low protein and energy of available feed, the low hatching weight of chicks, predation and diseases.

In addition to keeping indigenous chickens, some farmers in rural areas of Zimbabwe rear broilers and layers. In most cases, broilers are reared and targeted for the December, April and August public holidays when the market is lucrative. The average broiler flock size in Zimbabwe is 25 birds, although some farmers can buy as many as 100 chicks at a time (Muchenje and Sibanda 1997). It is important to study the different production systems in the smallholder sector to have an insight into the problems and come up with programmes to alleviate such problems.

Besides chicken production, other poultry species such as turkey, pigeons and ducks are kept in the smallholder sector. These are mainly for family consumption. The average turkey flock size in Nharira-Lancashire and Sanyati Smallholder Farming Areas of Zimbabwe was 2–5 birds, and most farmers were interested in expanding their flocks (Muchenje and Sibanda 1997). In the same areas pigeon flock sizes ranged from 2 to 52 birds. Little research work has been conducted on the production systems of these minor poultry species in most developing countries (Faure et al. 1996; Kusina and Muchenje 1997).

Non-adoption of poultry production technology by farmers

Despite considerable research and extension efforts in agricultural systems, smallholder farmers continue to shun most available technologies, particularly those that relate to livestock. This may be attributed to inappropriate research methodology, lack of inter-disciplinarity within research teams, and weak farmer-research-extension interaction (Francis and Mutisi 1997). Some of the factors resulting in slow progress in smallholder farmers adopting new technologies in poultry production are highlighted in Table 1.

Table 1. Comparison of characteristics of smallholder crop and poultry production systems.

Factor	Crops	Poultry	Implication for on-farm poultry research
Mobility	Stationary	Mobile	Difficult to measure and control non-experimental variables. High chances of missing data.
Life cycle synchronisation	All units synchronised	Units seldom synchronised	Difficult to find comparable units.
Multiple units	Only grain or tuber and residue	Many:- meat, manure, cultural	Difficult to measure and value treatment effect
Non-market inputs or outputs	Few	Many	Difficult to value input/output
PRODUCER ATTITUDES	Impersonal	Personal taboos	Difficult to cull or impose treatments or production "deemed" harmful to animals

Observation units	Many	Few	Large statistical variability:- experimental design should allow for loss of experimental unit
Variability of observations	Lower	HIGHER	Experimental design should allow for loss of experimental unit

Adapted from: Francis and Mutisi (1997).

Farmers are worried to expose their animals to risk through research or trial of new technologies. Therefore farmers usually prefer that their weakest and/or oldest animals be used in trials, hoping that they would be improved (Francis and Mutisi 1997). This results in researchers having difficulties in coming up with proper experimental designs. Furthermore, there is no synchrony in the life cycles of the birds, making it difficult to obtain enough birds which meet the specific criteria demanded by researchers, for example the same breed, laying stage, sex and age. The implication on on-farm poultry research is that usually there are insufficient replications. Management of poultry by farmers varies considerably. This is mainly due to different physical and biological site characteristics, and different socio-economic conditions among farms. Such variations result in wide statistical variability, most on-farm trials being associated with large coefficients of variation and hence difficulties in interpreting results, and no statistically significant differences between treatments when such effects may exist. Incidences of missing data may be high since farmers may fail to avail their birds when measurements are taken. The complex nature of smallholder farm production systems makes it difficult to account for all the possible interactions and environmental effects. There is therefore a need to explore alternative methods of evaluating such trials. Analyses such as nested designs and incomplete block designs need to be considered in such circumstances.

Multiple non-cash outputs of poultry, such as manure, traditional purposes, home consumption and status compound the difficulty in analysing poultry enterprises. Since poultry products consumed by the farming family only passes through non-formal marketing channels, researchers and decision-makers do not adequately appreciate the economic importance of such products. Researchers also usually regard the years when crop failure is experienced as unrepresentative and often stop data collection. This results in recording of peak cash output from poultry being missed. This calls for supplementing conventional economic analyses with the farmers' own assessment of the importance of poultry outputs in any research and development effort. Predetermined agendas and duplication of on-station methodologies should be avoided. The search for quantifiable data should be done without ignoring farmers' on-farm trial results based on their experience over the years. On-farm research should be participatory rather than being extractive.

While both biological and socio-economic aspects of smallholder farm production are important, there is lack of inter-disciplinarity in most on-farm research activities. Research teams should be fully integrated and inter-disciplinary involving both biological and social scientists (Hanyani-Mlambo 1997; Francis and Mutisi 1997). Studies should address the integrated nature of livestock and crop production subsystems and off-farm activities. There is also a need to link research and extension activities.

In most on-farm studies there is a weak farmer-research-extension interaction. Participation of resource-poor farmers is low yet technological recommendations tend to be general. Extensionists should also participate in research as opposed to only assisting in transferring technology from researchers to farmers (Francis and Mutisi 1997). There should be joint planning and review meetings, workshops and conferences between researchers, extensionists and farmers. Consideration of farmers' knowledge/technology and language use are pivotal in adopting any new technologies. Researchers should therefore view farmers as consultants, collaborators or colleagues. Participatory research should be introduced/improved in agricultural colleges' and universities' syllabi. Holistic farming systems research (FSR) that

go beyond biological production in crop and livestock subsystems to include utilisation and marketing of outputs, and off-farm activities are needed.

Some impressive advances have already been realised through utilisation of the FSR approach. The International Livestock Research Institute (ILRI) has been applying the FSR approach mainly on pastoral systems (Hanyani-Mlambo 1997). In Zimbabwe the FSR Unit in the Department of Research and Specialist Services (DR and SS) has carried out research using the FSR approach in Chivi and Mangwende Communal Areas. The Faculty of Agriculture, University of Zimbabwe has been using the same approach in studying crop-livestock farming systems in several smallholder farming areas in Zimbabwe.

Possible changes to improve productivity of indigenous flocks

According to Smith (1990), the low input-output levels are economically efficient, since with the low output from the individual birds, the inputs are low or virtually non-existent. Small management changes, such as regular watering, night enclosures, discouraging hens from getting broody, vaccination against common diseases, small energy and protein supplements and caging chicks can bring about significant improvements in the productivity of indigenous birds (Tadelle 1996). Smith (1990) estimated that under scavenging conditions the reproductive cycle consists of a 10-day laying phase, a 21-day incubation phase and finally a 56-day brooding period. This implies a theoretical maximum number of 4.2 clutches per hen each year, although in reality the number is 2–3 (Mutisi and Kusina 1996; Muchenje and Sibanda 1997). In the Eastern hills of Nepal, indigenous birds kept under semi-extensive management conditions produced 125 eggs in 11 clutches per annum, compared to 3–4 clutches per annum produced under normal scavenging systems (Smith 1990). By improving existing management, it is possible to increase indigenous poultry production in the smallholder sector. Benefits from genetic improvement can only accrue if existing management is improved.

Feed resources and requirements

The feed resource base for rural poultry production is scavenging, and consists of household waste, anything edible found in the environment and small amounts of grain supplements. It is not constant. The portion that comes as a grain supplement and from the environment varies with activities such as land preparation and sowing, harvesting, grain availability in the household and season and the life cycles of insects and other invertebrates. According to Tadelle (1996), protein supply may be critical, particularly during the drier months, whereas energy supply may be critical during the rainy season. In the absence of an event that diminishes the flock biomass, such as diseases, the village flock will normally be at the maximum biomass that can be supported by the available feed resource base. Any additions to the flock that increase the biomass result in increased survival pressure and selection against the weakest members of the flock. The feed resource base is usually deficient in protein, energy and probably calcium for layer birds.

Determination of the nutritional status of indigenous birds and an assessment of changes in their diets throughout the year can be done by analysing crop contents and doing carcass measurements. After slaughtering the birds, materials in the crop are combined, mixed and physically identified (Feltwell and Fox 1978). Seeds, insects, worms and plant materials are separated, weighed, and recorded, and the proportion of each calculated. The collected crop contents can also be analysed for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), and ash according to AOAC (1985), for calcium (Ca) by atomic absorption spectrophotometer, and for Phosphorus (P). The metabolisable energy (ME) levels of the contents can also be determined by an indirect method, using the following equation (Wiseman 1987):

True ME (Kcal/kgDM) = 3951 + 54.4EE-88.7CF-40.8Ash.

Different parts of the carcass can be separated and measured. Carcass weight, gastro-intestinal tract (GIT), proventriculus, crop, gizzard, liver, ovary and oviduct weights can also be measured. Lengths of parts of the body such as the GIT, caecum and circumference of the upper leg (thigh) can also be measured. Carcass weight can be taken after the offal comprising feathers, lower leg, heart, crop, pancreas, lungs, head and digestive and urogenital tracts have been removed. Then the carcass dressing percentage can be calculated.

The possibility of increasing free-range poultry production through energy and protein supplementation, and improved housing also needs to be investigated. For the benefit of those smallholder farmers who keep broilers and layers, the need to consider home grown feeds as substitutes is not overemphasised. This is against a background of ever escalating feed costs.

Breeding in extensive production systems

Practically all village producers breed and rear indigenous day-old-chicks for themselves in order to maintain or increase the number of their flocks (Smith 1990; Lambrou 1993; Mutisi and Kusina 1996; Tadelle 1996; Kusina and Muchenje 1997; Muchenje 1997). The breeding of indigenous birds is not controlled because of the mixing of different flocks. The breeding season for village birds varies according to the condition of the bird, the natural availability of feed and the weather. According to Lambrou (1993) and Kusina and Muchenje (1997), the breeding season for village birds in Zimbabwe is from September to April. A strategic supplementary feeding during the breeding season will improve the indigenous bird condition at breeding, the breeding efficiency and will increase egg production, fertility and hatchability. There is also a need to come up with a more effective and economic ratio of males to females in indigenous birds. Is the 1: 15 ratio generally recommended in Zimbabwe (Lambrou 1993) the most economic and effective?

Markets

Ways in which farmers can improve their image and offer a competitive and consistently quality product on a regular basis to their customers need to be explored. Furthermore, aspects such as transport, market accessibility, marketing channels and organisation need to be addressed if farmers are to benefit from research. In rural areas poultry products are usually sold locally. Densely populated areas such as growth points, service centres, boarding schools and other government institutions are important markets for poultry products.

In Zimbabwe broilers are usually sold when they are at least six weeks old, although some farmers keep the birds for more than twelve weeks, depending on season and demand. Where people are into broiler production, indigenous birds are rarely sold and cost less than broilers. However, in areas where broiler production is not common, indigenous birds are usually sold. Usually, there is no defined selling age for the indigenous birds. They are sold depending on supply and family financial demands, for example, when school fees are needed. In a survey carried out in Nharira-Lancashire Smallholder Farming Area of Zimbabwe (Muchenje and Sibanda 1997), layers were reported to start producing eggs at between 24 to 28 weeks and the eggs were being sold at the same price, irrespective of their size. The market for broilers and eggs in all areas was said to be favourable during holidays such as Christmas and Easter. The market for the less common poultry species, such as turkeys, pigeons and ducks, is normally not clearly defined.

Other issues to consider in smallholder poultry research and development

Conservation of genetic resources in poultry

Conservation of domestic animal diversity (CDAD) encompasses characterisation, identification, monitoring and utilisation to ensure management for best short term use and longer term ready availability (Moyo 1995). There is a need to conserve "adaptive" traits as opposed to "commercial" traits. The conserved genetic resources will be future sources of unique genes and will be useful when environmental concerns necessitate change in production systems. Indigenous birds in most African countries are not adequately characterised to understand the existing diversity to facilitate development of rational utilisation and conservation strategies. Biotechnology techniques such as gene mapping could be used to characterise indigenous birds. It should, however, be noted that several Southern African countries face a lack of infrastructure for breeding purposes and have relatively small defined populations (Wollny 1995a; Wollny 1995b). There is a need to consider characterisation of indigenous poultry breeds if genetic conservation for economic, scientific, cultural and social, development and sustainability (Wollny 1995b) is to succeed.

Computer simulation modelling in farming systems and scientific research

Computer simulation models are useful tools, which can be used in studying farming systems. They can be used to describe the behaviour of business, economic, social, biological, physical or chemical systems over periods of time. The tremendous revolution in computer technology has resulted in growth in simulation modelling and this has eased the integration of agricultural sciences.

Computer simulation models mimic real life situations. They can be used to make the same decisions that would be made if it were feasible to experiment with the system itself. Since a system is a collection of entities acting and interacting together towards accomplishment of a logical end, computer simulation models can play an important role in systems analysis. A model for semi-scavenging poultry rearing has been developed in Bangladesh and has been applied with considerable success to the benefit of rural, poor women (Rahman et al., undated). The model included the indigenous breed (desi) and its crosses with exotic breeds. Some of the traits, which were considered in the model, were age of first egg, eggs/hen/year, mortality rate, and mortality due to predator.

A computer simulation model requires formalisation of current knowledge in the form of equations, solutions of the equations and interpretation of the results. Models have been used in studying metabolism. They integrate a variety of nutrient inputs for their outputs as products, heat or other metabolic consequences and satisfy an objective of intake models - that of integrating a wide variety of factors known to influence intake. The interaction between physical and metabolic pathways affecting feed intake have therefore been successfully integrated by modelling.

A bio-economic model developed in Brazil has been used to help in identifying priority areas for applied research, to explore various combinations of herd potential and level of feeding, the behaviour of different herd sizes, and the potential returns from specific technical innovations (Brockington et al. 1983). Another model was developed to assess the risks and returns from establishing improved pasture in an extensive beef breeding enterprise, for use by farmers and extensionists (Beck et al. 1982).

Conceptual structure

The main components of the input-output system of free-range poultry production systems and poultry-other-crop-livestock systems can be incorporated into the models. Concepts and

quantitative values from literature and field studies can be used to develop the models. Quantitative data may be used to describe the relationships and define default values, and the qualitative data can help in coming up with reasonable assumptions for the model.

Model building and validation

The discipline of mathematics, which provides appropriate structure with which to represent the biological and socio-economic concepts, can be used to interrelate the component parts. The processes within the systems are normally represented by sets of equations. Laws of probability guard stochastic models. They involve use of random variables, for example, inheritance. This means that a spread of results can be obtained from the same initial values and parameter values. Deterministic models give definitive predictions, without any probability distribution. An independent variable causes consistent changes in the dependent variable. Deterministic models can therefore be used for determination of nutritional requirements of free range chickens, and egg output for both free range chickens and intensively produced layers. They can also be used to predict the flock biomass of birds the scavenging feed resource base can support. Stochastic models can be used for calculating aspects such as chick mortality rates. Mathematical models can also be used to simulate the behaviour of the poultry-other-crop-livestock systems free-range poultry production systems. Models that predict the effect of flock size on scavenging feed resource base, weights of chickens, mortality; output for sale/consumption and flock composition may be incorporated.

The effects of changes in fixed parameters on model performance need to be examined. This is done to test the correctness of the internal workings of the system and the model assumptions. Statistical comparison of observed values from an independent data set and model predictions can be done using regression/correlation and the χ^2 -test for goodness of fit. The model must be able to simulate reality if it is going to be useful. Aspects such as inputs and outputs need to be recorded in the field. Such field results are tested against model predictions using regression/correlation and the χ^2 -test for goodness of fit. Recommendations, as regards the use of the model and the possibility of redesigning it, can then be made.

The future

Poultry are an important component of farming systems in smallholder farming areas. Research efforts in poultry should be targeted at aspects ranging from feeding, breeding, disease control and husbandry to obtain a better understanding of poultry production systems in relation to other crop-livestock systems and the changes in socio-economic conditions in smallholder set-ups. Biological factors are not the only factors considered by farmers when adopting technologies to suit their local farming circumstances. Instead, socio-economic factors are also important to the farmer and, therefore, should not be ignored. Both objectively measured variables and subjectively measured variables should be studied to produce more meaningful research results.

Detailed studies of most of the issues raised above would contribute to improved poultry production and contribute towards improving family income and nutrition. Qualitative data can be gathered in a once off/single visit. Reliability of such data depends on the ability of farmers to recall past events. Smallholder farmers do not usually keep farm records! More reliable data are obtained through monitoring studies and discussions with farmers. All the different aspects of poultry covered in this paper should be incorporated into a model together, rather than individually, in order to identify combinations that optimise smallholder poultry production and improve smallholder household's income and nutrition.

References

- Association of Official Analytical Chemists (AOAC). 1985. *Official Methods of Analysis*. 12th ed. Washington, D.C., 957p.
- Beck A. C., Harrison L., and Johnson J. H. 1982. Using simulation to assess the risks and returns from pasture improvement for beef production in agriculturally underdeveloped regions. *Agricultural Systems* 8: 55–71.
- Brockington N. R., Gonzalez C. A., Veil J. M., Vera, R. R., Texeira N. M., and Assi A. G. 1983. A bio-economic modelling project for small production systems in south-east Brasil. *Agricultural Systems* 12: 37–60.
- Faranisi A. T. 1995. Poultry Breeding in Zimbabwe. In *Proceedings of the International Symposium on Livestock Production through Animal Breeding and Genetics, 10 to 11 May, 1995*, (Eds.) Dzama, K., Ngwerume, F. and Bhebhe, E., Sheraton Harare, Zimbabwe.
- Faure J. M., Melin J. M. and Mantovani C. 1996. Welfare of guinea fowl and game birds. *Proceedings, Fourth European Symposium on Poultry Welfare*. Published by Universities Federation for Animal welfare. (Eds.) Savory, C. J. and Hughes, B. O. London, UK.
- Feltwell R. and Fox S. 1978. *Practical Poultry Feeding*, Faber and Faber Limited, Great Britain.
- Francis J. and Mutisi C. 1997. Review of Smallholder Crop-Livestock Research in Zimbabwe: Lessons for the future. *Proceedings of the Workshop on Crop-livestock farming systems research methodologies training, 1–12 December 1997*, (Ed.) Sibanda, S, Faculty of Agriculture, University of Zimbabwe, Harare.
- Government of Zimbabwe. 1995. *Zimbabwe's Agricultural Policy Framework 1995–2020*. Ministry of Agriculture, Harare, Zimbabwe.
- Hanyani-Mlambo B. T. 1997. Technical Issues to consider: Socio-Economic Aspects. *Proceedings of the Workshop on Crop-livestock farming systems research methodologies training, 1–12 December 1997*, (Ed.) Sibanda, S., Faculty of Agriculture, University of Zimbabwe, Harare.
- Hrabovszky J. P. 1981. Livestock Development: Toward 2000 with special reference to developing countries. *World Animal Review*, 40:2–16.
- Kusina J. and Muchenje V. 1997. *Micro-Project Feasibility Study in Small Animal Breeding in Angwa-Neshangwe-Gonono, Guruve, Zimbabwe*. CIRAD-IFRA Report. Unpublished.
- Lambrou L. 1993. Indigenous Poultry in Zimbabwe. *Farming World*, 19 (3): 11–12.
- Ministry of Agriculture, Food and Fisheries (MAFF). 1985. *Small-scale guinea-fowl production*, London. UK.
- Moyo S. 1995. Conservation strategies for endangered livestock species. *Proceedings of the international symposium on livestock production through animal breeding and genetics, 10 to 11 May, 1995*, (Eds.) Dzama, K., Ngwerume, F. N. and Bhebhe, E, Sheraton Hotel, Harare, Zimbabwe.
- Muchenje V. 1997. Potential for Improved Poultry Production in the Smallholder Sector. *Paper presented at a Workshop on Commercial Smallholder Goat and Poultry Production, 15 October 1997*, Mukamba, Wedza, Zimbabwe.
- Muchenje V. and Sibanda S. 1997. *Informal Survey Report on Poultry Production Systems in Nharira-Lancashire and Sanyati Farming Areas. Zimbabwe*. Unpublished.

Mutisi C. and Kusina N. T. 1996. *Draft Report-Role of livestock in Sanyati Communal Area*. Zimbabwe. Unpublished.

Rahman M., Sorensen P., Jensen H.A., Dolberg F. (undated). *Exotic hens under semi-scavenging conditions in Bangladesh*. Bangladesh. Unpublished.

Smith J. A. 1990. *Poultry*. Centre for Tropical Veterinary Medicine. University of Edinburgh.

Tadelle D. 1996. *Studies on village poultry production systems in the Central Highlands of Ethiopia*. MSc Thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Wiseman J. 1987. *Feeding of Non-ruminant Livestock*. Butterworth and Co Ltd. pp 9–15.

Wollny C.B.A. 1995a. Breed improvement and future breeding strategies for livestock in Southern Africa. *Proceedings of the international symposium on livestock production through animal breeding and genetics, 10 to 11 May, 1995*, (Eds.) Dzama, K., Ngwerume, F.N. and Bhebhe, E, Sheraton Hotel, Harare, Zimbabwe.

Wollny C.B.A. 1995b. Conserving the biodiversity of Southern African livestock resources. *Keynote address presented at the Annual Symposium of Developing Areas Branch of the South African Society of Animal Science (SAGAS)*, 6 to 19 October 1995, Loskopdam, Groblersdal, Republic of South Africa.

Analysis of socio-economic factors influencing egg production in Maseru District. Lesotho

F.O.C. Nwonwu

Department of Agricultural Economics and Rural Sociology
National University of Lesotho, Lesotho

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Surveys](#)

[Sample selection](#)

[Data](#)

[Analytical models](#)

[Test of hypotheses](#)

[Cobb Douglas production function](#)

[Results and discussion](#)

[Status of egg production in Lesotho](#)

[Age and marital status of farmers](#)

[Number of birds](#)

[Technology in use](#)

[Regression results](#)

[Linear models](#)

[The Cobb Douglas production models](#)

[Elasticities](#)

[Correlation](#)

[Conclusion](#)

[Recommendations](#)

[References](#)

Abstract

This study investigated the socio-economic factors that affect egg production in Maseru District, Lesotho. The nature of the egg production function was analysed and the degree of responsiveness of output to changes in capital, technology, number of birds, and type of feed as decision variables was estimated. A sample of 45 poultry farmers was selected and interviewed. Both a linear and a Cobb-Douglas production function were used to predict egg output and to determine output elasticity with respect to the independent variables. In the Cobb Douglas function, the natural logarithm of egg output was regressed on the natural logarithms of capital, technology, number of birds, and type of feed. Results show that the average age of farmers is 45 years; the industry comprises of small-scale operators with an average of 230 birds per farmer; an average investment capital of R.2000 per enterprise; and an annual output of 6000 eggs per farmer. Of the four independent variables used as predictors, two of them namely number of birds and type of feed are statistically significant in predicting egg production at the 1% level while technology is significant at the 10% level with an adjusted R^2 value of 0.99. The elasticity of egg output with respect to the number of birds (ϵ_b) is unity showing that output of eggs would change by as much as the percentage change in the number of birds. Egg output elasticity with respect to capital (ϵ_k), technology (ϵ_t), and type of feed (ϵ_f) stand at 0.69, 0.06, and 0.09, respectively. It is concluded that with such a high responsiveness of output to changes in capital, egg production in Maseru District would be significantly increased if sufficient capital were injected into the industry.

Key Words - Egg production, Maseru, Cobb-Douglas, elasticity, natural logarithms

Introduction

The inception of large-scale egg production in Lesotho is as recent as 1971 when the Department of Agriculture introduced commercial poultry farming through its poultry improvement scheme. Prior to that date, in the 1950s and 1960s, egg production in the country was limited to non-commercial small-scale production by subsistence farmers who stocked indigenous or range scavenging breeds of birds (GOL 1986a). Commercial egg producers are still very few in the country and their stocks range between 1500 to 20,000 birds (GOL 1988). The small-scale operators with laying stocks of 50 to 300 birds are fast growing to expand the poultry industry in the country (Mafoso 1999). With the formation of the Lesotho Poultry Association and the passage of two important laws: the Agricultural Marketing Act of 1967 and the Agricultural Marketing (Egg Control) Regulations of 1969, the commercial egg industry began to take on the outlines of its present day structure (GOL 1986a).

It is estimated that there are currently about 300,000 egg producing layers in the poultry industry in the country (Anon 1999). Pullets are mainly imported from South Africa. The demand for pullets by the small-scale farmers is met purely through domestic supply by the Lesotho Government Poultry Production plant, which has a total capacity of 75, 000 pullets (Anon 1999). The fast growth in the industry is predicated on the high potentials in meeting the social and economic development objectives of increased employment, higher and equitable distribution of income, and improved nutritional standards at lower cost. The investment opportunity and the dominant role, which the industry offers women, are seen as an added advantage.

Recent surveys reveal that Maseru District is the highest producer and consumer of poultry products in the country. Hence, a study of the industry situation in Maseru, which is also the capital city of Lesotho, can be extrapolated to represent the industry situation in the country.

The marketing system for eggs is a factor, which poses a major setback to the development of the poultry industry in Lesotho. This is because the Lesotho Agricultural Marketing Regulations Act of 1975 established a single marketing Regulation (GOL 1991). The Act stipulates a single

marketing channel for eggs in the country. It also empowered the Lesotho Poultry Co-operative Society to be the sole buyer and seller of eggs in the country. The poultry farmers opposed this policy and demanded that they be allowed to operate a competitive market structure. Their desire was further heightened by the failure of the co-operative society to pay farmers promptly for commodities already supplied. The incentive to increase egg production became so successful that excess supplies between the months of August through December became a major problem of the poultry industry. The districts of Leribe, Berea and Maseru have experienced this over supply at both producer and wholesale levels and large quantities of eggs have spoiled as a result of the glut in the market (GOL 1986b).

Livestock farming is of both cultural and economic importance to Basotho people. Animals are kept as symbols of wealth, for payment of bride price, to provide meat during celebrations such as funerals, and for sale to earn income. Poultry production appears very conducive to the Lesotho socio-economic and biophysical characteristics. As a small country and with pastoralism as the main occupation of the people the land is over stocked and overgrazed. Large ruminants such as cattle, horses and donkeys on the one part, and small ones such as sheep and goats on the other, exert much pressure on the available land. The disproportionate demand for grazing land vis-à-vis the available land, causes even fragile areas to be grazed with serious threat to the environment. A diversion from land demanding agricultural enterprises to less land- oriented investment such as poultry keeping is considered the way to save the environment, diversify the investment portfolio, and guarantee employment and better income distribution in the country. Projected demand for eggs beyond the year 2000 shows that demand will outstrip the supply. The excess demand is caused by the increasing desire of Lesotho like other developing countries, to improve the nutritional status of her people. Eggs and poultry meat are easy and affordable options for fulfilling this need.

This study analyses the social and economic factors that affect poultry production in Maseru District in Lesotho. The extent to which the identified factors affect poultry production are investigated. The degree of responsiveness of egg output to changes in the factors included in the model are quantified and the policy implications interpreted. It is hoped that the study will shed more light into strategies to adopt to reduce the over-dependency on South Africa for meeting the deficit in egg supply in the country. Recommendations are made on how to improve on the performance of the poultry industry to increase the supply of eggs and enhance the nutritional status of the people.

Materials and Methods

Surveys

An initial survey was carried out nation-wide to scrutinise the size and distribution of poultry farmers and the geographical and spatial spread in the country. This survey identified Maseru District as the major producer and consumer of eggs in the country. The district was then selected for study based on the strength of the survey findings. The district was stratified into north, east and west for purposes of this study. A preliminary survey was conducted to determine the geographical spread and concentration of poultry farmers within the different strata. The preliminary survey was also used to pretest the questionnaire to validate its comprehensiveness. Maseru North, which has similar socio-economic and cultural characteristics as the East and West was used to pretest the questionnaire. The final survey conducted in Maseru East and West involved house to house visit to farmers and interview sessions during which discussions were held and specific questions were also posed to farmers. Data from responses to the questions were collected with the help of structured questionnaires.

Sample selection

A multi-stage sampling method was applied in the selection of farmers. The farmers were first identified in clusters of residential areas within the urban and peri-urban locations within the chosen clusters. The sampling frame was then defined as the clusters of hamlets and settlements contained in Maseru East and West from where samples were finally chosen. In the first stage, a judgement or purposive sampling method was used to select clusters. The basis of the selection is to ensure that farmers that face different scales of operation, technology, infrastructure facilities and social amenities have equal and likely chance of being selected. The diversities considered in the sample selection include population of clusters, accessibility to social infrastructure such as power supply, access roads, potable water, historical and cultural considerations and demonstrable interest in poultry production.

Within the selected clusters, a simple random sampling method (SRS) was used to select the sample of farmers. Samples proportionate to the sizes of clusters were selected. A total of 45 farmers, which cut across the geographical spread and diversity in resource endowment, socio-cultural characteristics and scale of operation were selected from the district.

Data

Primary data was collected in the field from field observations during the preliminary surveys and during interview sessions in the main survey. Data collection was done with the help of a structured questionnaire and through note taking during the interviews. Secondary data was collected from the Bureau of Statistics annual publications; Annual Reports and Marketing Bulletins of the Ministry of Agriculture; the Central Bank Annual Reports; and publications of the Marketing Division of the Ministry of Industries.

Types of data collected and used in the analysis include number of laying birds; type of technology in use (deep litter and battery cage); types and cost of feeds; sources and costs of point of lay (POL) birds; sources of heat energy (paraffin, gas, electricity, solar). Others are, scale of operation and equipment in use; breeds of bird; management technique (whether farmer buys day-old chicks or POL birds); price of day old chicks; output of egg; price per unit of eggs; age; and marital status of farmer.

Analytical models

Two production function models, a linear and a curvilinear function were adopted in the analysis of the data. The linear and curvilinear functions were used to estimate decision parameters and to determine which of the two groups of models best predicts egg output given the prevailing production characteristics in the industry. In the linear equation, egg output was assumed to be dependent on number of birds, type of feed, capital, technology, age, and marital status of farmer. These variables were introduced in stepwise manner into the model one after another. The decision rule is to choose the combination of variables or the single variable that has the highest adjusted coefficient of determination (R^2_{adj}). The underlying assumption is that the introduction of more variables into the model will reduce the standard error of estimate and therefore improve the value of R^2_{adj} . For each model introduced, the value of the R^2_{adj} is observed and the model with the highest R^2_{adj} is chosen as the best predictor for egg production. The functional form of the linear model is first assumed to be a simple relation in which output of eggs depends only on one of the variables say the number of birds. This is represented functionally as follows:

$$Q = f(N, \epsilon) \quad (1)$$

The multiple form of the relationship assumes that output of eggs is dependent on all the

independent variables as shown in Equation 2.

$$Q = f(N, F, K, T, M, A, \epsilon) \quad (2)$$

Where:

N = number of birds

F = type of feed

K = capital

T = technology

M = marital status of farmers

A = age of farmer

ϵ = stochastic factor or error term due to variables not included in the model.

The prediction equations for the simple form of the model is expressed generally in the form shown in Equations 3.

$$Y = \beta_0 + \beta_1 X_1 + \epsilon \quad (3)$$

The prediction equation for the multiple form of the model is shown in Equation 4.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \epsilon \quad (4)$$

Test of Hypotheses

The single and multiple regression models are used to test different hypotheses based on a *priori* assumptions. The single regression analysis tests the null hypothesis H_0 against an alternative one H_1 , both of which state as follows:

$$H_0: \beta_1 = 0$$

$$H_1: \beta_1 \neq 0$$

The null hypothesis states that the mean for number of birds is zero. In other words, it states that the number of birds which a farmer has does not significantly contribute to the amount of eggs produced in the farm. The alternative hypothesis states that the number of birds in the farm has an effect on the amount of eggs produced.

The multiple regression model tests a null hypothesis H_0 against an alternative hypothesis H_1 both of which state as follows:

$$H_0: \beta_i's = 0$$

$$H_1: \beta_i's \neq 0$$

$$(i = 1, 2, \dots, 6)$$

The null hypothesis for the multiple model states that none of the six independent variables has effect on the output of eggs. The alternative hypothesis states that at least one of the factors contributes to output of eggs.

Cobb Douglas production function

The Cobb Douglas Production Function is a typical case of a production function that is homogeneous of the degree one (Henderson and Quandt 1980). In other words, if we vary the inputs by some amount, the output will vary by the same amount as the input. Since it is believed that most production functions are curvilinear, the single independent variable

relationship is expressed as in Equation 5.

$$Q = AX^\alpha \quad (5)$$

$(0 < \alpha < 1)$

In this multiple variable non-linear model, the marital status and age of farmer were dropped and the output of eggs was then estimated with the number of birds, capital, technology and type of feed. The price of eggs was also not included in this estimation because a constant wholesale price for eggs was assumed in the analysis.

The multiple equation states that output of egg is determined by four factors represented by X_1 , X_2 , X_3 and X_4 as shown in Equation 6.

$$Q = AX_1^\alpha X_2^\beta X_3^\delta X_4^\psi \quad (6)$$

$(\alpha + \beta + \delta + \psi = 1)$

The estimation of the parameters α , β , δ , ψ is done by transforming the curvilinear function to a linear one. This is done by taking the natural logs of the variables and regressing the natural log of output Q on the natural logs of the constant A and those of the variables X_1 , X_2 , X_3 , and X_4 . The coefficients α , β , δ , and ψ of the independent variables X_1 , X_2 , X_3 , and X_4 represent the elasticities of egg output with respect to the independent variables.

The linear form of Equation 6 following the transformation is expressed as in Equation 7.

$$\ln Q = \ln A + \alpha \ln X_1 + \beta \ln X_2 + \delta \ln X_3 + \psi \ln X_4 \quad (7)$$

Results and discussion

Status of egg production in Lesotho

Maseru District is the largest producer of eggs among the 10 districts in Lesotho. The district alone accounts for 34 per cent of the total egg production in the country (see Figure 1). The other districts are Berea, Leribe, Botha-Bothe, Mafeteng and Mochale's-Hoek, Qacha's Nek, Mokhotlong Thaba-Tseka and Quathing. The high percentage share of Maseru in egg production and in the poultry industry at large stresses the importance of the district in the industry and the relevance of this study. The district also occupies a dominant position in the consumption of eggs and poultry meat relative to other districts in the country.

Age and marital status of farmers

Results show that the age of farmers ranges between 28 to 60 years with an average age of 45 years. This result agrees with the findings of GOL (1987) which indicated that 70 per cent of egg producers in Lesotho are over 40 years of age. The age class distribution for the sample of 45 farmers is shown in Figure 2. With an age class interval of 10 years, the figure shows a normal distribution with majority or 17 farmers falling within middle age group of 41–50 years. The number of farmers who fall within the younger age bracket of 31–40 and those that fall within the older age group of 51–60 are equal at 14. Only one farmer falls below the age of 30 years and there is no farmer above 60 years of age. It is shown that the majority of the farmers or 89 per cent are married or have been married with 30 of them married and 10 widowed. Only 5 farmers or a mere 11 per cent are single.

Number of birds

The study shows that egg production in Maseru District is predominantly on a small-scale as demonstrated by the number of birds per farmer. Results show that the number of birds per farmer ranges from as little as 25 birds to a maximum of 1300 birds with a mean of 230 birds. The size distribution of farms with respect to the number of birds is shown in Figure 3. The figure shows that majority of the farmers, equivalent to about 44 per cent of the total, have less than or equal to 100 birds. Only one farmer has more than 1000 layers in the industry. Considering that commercial poultry farming attracts as many as tens of thousands of birds per farmer, this result clearly shows the small-scale and subsistence nature of egg production in Maseru District. As already noted, the country depends on South Africa for meeting the deficit in the supply of eggs at the moment.

Technology in use

About half of the farmers or 22 of them, representing 49 per cent of the sample, use the battery cage system of production while the remaining 23 or 51 per cent use the deep litter system. According to the farmers, the deep litter system is much cheaper to set up as it requires relatively much less initial capital outlay. However, the system has its drawbacks which include much greater disposition of birds to disease and pest attacks; it is labour intensive to manage especially in feeding, egg collection, and cleaning of the floor and changing of the litter. Productivity is relatively lower partly because of the pest and disease menace but also due to the vices of birds especially with pecking one another.

The battery cage apart from its relatively high initial capital demand, better reduces all the disadvantages associated with the deep litter such as high incidence of diseases, pecking, and dirtiness. It also minimises labour demand and supervision time. It achieves relatively higher productivity per unit of resource committed into production. The system also minimises the wastage of inputs such as feeds and water through contamination and trampling which is common with the deep litter system.

Paraffin is the principal source of energy for heating with 28 or 62 per cent of the farmers reporting its use. Electricity is second to paraffin with 15 farmers or 33 per cent of the sample farmers reporting the use of this device for heating. Only one farmer reported using gas for heating the poultry house. Heating is a major contributor to cost of production considering that Lesotho goes through some severe four months of winter every year. Paraffin is relatively cheap, hence the majority of the farmers opt for its use. However, it has the disadvantage of being relatively less effective in heat supply compared to electricity or gas. It also has the disadvantage of being highly inflammable with relatively higher chances of causing fire outbreaks especially in the deep litter system. Electricity is reported to be far more effective for heating but more costly to use.

Two breeds of bird namely the Lohmann and Hyline Brown are commonly kept by farmers. The two breeds were selected after some initial countrywide screening of breeds for egg productivity, egg size, shell quality, interior quality, liveability and thriftiness in feed consumption. Four types of feed are commonly used by farmers in the egg production industry in the district. They are the Makhulo, Nelko, Epol and Moreson. Of the four, the most widely used is the Makhulo with about 56 per cent of the farmers reporting its use. The least used is the Nelko with only 9 per cent of the farmers reporting its use.

Regression results

Linear models

The results obtained with the single and multiple linear models are presented in Table 1.

Table 1. Estimated Parameters for Different Models Used in Predicting Egg Output with Assumption of Linear Relationship

Single regression	R ²	R ² _{adj}	Significance (F)	Coefficient (β)	Significance (t)
<i>Independent variable</i>	0.772	0.776	0.000***		
Capital			Constant	-7.272	
			Capital	3.296	0.000***
Multiple regression 1	0.992	0.991	0.000***		
<i>Independent Variables</i>			Constant	153.597	0.821NS
Age, marital status,			Age	-15.762	0.228NS
Number of birds			Number of birds	29.227	0.000***
			Marital status	-4.005	0.979NS
Multiple regression 2	0.992	0.992	0.000***		
<i>Independent Variables</i>			Constant	-1032.803	0.237NS
			Age	-4.615	0.734NS
Age, marital status			Number of birds	28.88	0.000***
Number of birds			Marital status	127.719	0.429NS
Type of feed			Type of feed	224.518	0.043**

NS = not significant at 10%; ** = significant at 5%; *** = significant at 1%

The results show that capital is a major limiting factor and contributor to egg production. The importance of capital is illustrated from the single regression equation, which has capital as the explanatory variable. It illustrates that of all the variables assumed *a priori* to affect egg production in Maseru District, capital is the single significant factor in the prediction of egg output.

In the three-variable multiple regression equation, only the number of birds among the three variables shows a highly significant effect on egg production at the 1% level. The age and marital status of farmer show no statistical significance. However, the highly significant F-ratio and the high value of R²_{adj} indicate some goodness of fit. The significance of the F-ratio demonstrates that all the variables included in the model contribute significantly to the prediction of egg output. The four-variable model further demonstrates the utility of the multiple regression approach to statistical analysis. The model shows further improvement of the R²_{adj} from 0.991 in the three-variable model to 0.992 as a result of the addition of the variable type of feed. Overall, the multiple regression model improved the quality of the prediction as demonstrated by its improvement of the R²_{adj} from 0.766 in the single regression model to 0.992 in the four-variable model. This result contradicts the view of Hair (1967) who reported that single regression models are better than multiple regression models in prediction. It is further noted that there is no model that used all the six independent variables chosen *a priori* to predict output of eggs.

The Cobb Douglas production models

Results obtained with the curvilinear functions are shown in Table 2

Table 2. Estimated Parameters for Different Models Used in Predicting Egg Output with Assumption of Curvilinear Relationship

Single regression	R ²	R ² _{adj}	Significance (F)	Coefficient (β)	Significance (t)
<i>Independent Variable</i>	0.987	0.986	0.000***		
Natural Log of Number of Birds			<i>Constant</i>	2.937	0.000***
			<i>Number of birds</i>	1.058	0.000***
Multiple Regression 1	0.990	0.989	0.000***		
<i>Independent Variables</i>			Constant	2.977	0.000***
Natural Logs of Number of Birds, Type of Feed			<i>Number of birds</i>	1.041	0.000***
			<i>Type of feed</i>	0.09	0.001***
Multiple Regression 2	0.806	0.797	0.000***		
<i>Independent Variables</i>			Constant	3.484	0.000***
Natural logs of Capital and Technology			Capital	0.690	0.000***
			Technology	0.06	0.77NS
Multiple Regression 3	0.991	0.990	0.000***		
<i>Independent Variables</i>			Constant	2.874	0.000***
Natural logs of Capital			Capital	0.019	0.491NS
Number of Birds			Number of birds	1.03	0.000***
Technology			Technology	0.088	0.071*
Type of Feed			Type of Feed	0.09	0.003***

The curvilinear form generated four possible equations. They include a single regression equation with the number of birds as the only independent variable. The other three comprise of two models with two of the four independent variables alternating in their inclusion while one model has all four independent variables included as shown in Table 2.

In all four models, the number of birds has proved to be highly and statistically significant at the 1% level in predicting the output of eggs in the poultry industry. Type of feed also shows high statistical significance at the 1% level in the prediction of output of eggs. While technology is not significant in the two-variable model it is fairly significant at the 10% level in the four-variable model. Capital shows high statistical significance in the two-variable model and no statistical significance in the four-variable model.

All four models show goodness of fit as demonstrated by highly significant F-ratios at the 1% level. The R² and R²_{adj} values for the models are very high and further support the fact that the variables included in the models contribute significantly to the prediction of output of eggs. Only the model with capital and technology has relatively low R² and R²_{adj} values of 0.806 and 0.797 respectively. This result shows that in relative terms, the two-variable model with capital and technology are less accurate or efficient than number of birds and type of feed in predicting output of eggs in Maseru District. From the stepwise regression analysis, it was seen that when the number of birds and type of feed were introduced in the model, technology and capital were the variables rejected from entering the model.

Since the battery cage and deep litter systems of egg production depict technology in this analysis, the result demonstrates that the use of either method in egg production does not significantly affect the amount of eggs produced in Maseru District. This result is supported by the findings of the Planning Division of the Ministry of Agriculture, Co-operatives and Marketing, which reported that the operating cost of a 600-bird battery cage unit is basically the same as that of a 600-layer deep litter unit (GOL 1987).

That capital shows no statistical significance in the four-variable model portrays the dominance of small-scale producers in the poultry industry in Maseru District. With holdings of as little as 25 birds, an average of 230 birds per farmer, and only one farmer having over 1000 birds, egg production in the district is far from being capital intensive.

Since the four variables have shown statistical significance in both the single and multiple regression models, we then reject the two null hypotheses and accept their corresponding alternative hypotheses. We therefore conclude that at least one of the variables in the models contributes significantly to the prediction of output of eggs in Maseru District.

Elasticities

In the Cobb Douglas production function, the coefficients of the variables represent the powers of the curvilinear equation as shown in Equation 6. The elasticities with respect to the independent variables in the models for the four models analysed are shown in Table 3.

Table 3. Elasticities for the Independent Variables in the Curvilinear Models

Coefficients	Model 1	Model 2	Model 3	Model 4
α	$\epsilon_b = 1.058$	$\epsilon_b = 1.041$	$\epsilon_k = 0.69$	$\epsilon_k = 0.69$
β		$\epsilon_f = 0.09$	$\epsilon_t = 0.06$	$\epsilon_b = 1.041$
δ				$\epsilon_t = 0.06$
ψ				$\epsilon_f = 0.09$

α , β , δ , and ψ represent the powers of the first, second, third and fourth variables respectively in the Cobb Douglas models.

ϵ_b = elasticity for number of birds

ϵ_k = elasticity for capital

ϵ_f = elasticity for type of feed

ϵ_t = elasticity for type of technology

The results show that in all four models, the number of birds has unitary elasticity. This indicates that egg production will increase by as much as the number of birds is increased. In other words, a hundred percent increase in the number of birds will increase the output of eggs by hundred percent. Put differently, the production function exhibits constant returns to scale with respect to number of birds. Capital shows a high positive elasticity with respect to egg output of 0.69. This is an indication that capital is a limiting factor that can substantially boost egg production if it is sufficiently injected into the industry. Type of feed and technology have positive but small values of elasticity, which signify that a percentage change in them will increase the output of eggs by less than proportionate amount. In other words, output of eggs is highly inelastic to changes in the technology and type of feed.

Correlation

The correlation matrix for the dependent and independent variables is presented in Table 4. The matrix shows that egg output is highly and positively correlated with capital and number of birds so is capital with number of birds. The correlation coefficients of the latter two are also highly significant at the 1% level. Technology is negatively but significantly correlated with egg output, capital and number of birds.

Table 4. Correlation Matrix of the Dependent and Independent Variables

	Egg output	Capital	No.of birds	Technology	Type of feed	
Egg output	1.00					
Capital	0.898***	1.00				
No. of birds	0.993***	0.894***	1.00			
Technology	-0.318**	-0.333**	-0.349***	1.00		
Type of feed	0.335**	0.359***	0.285**	-0.047NS	1.00	

NS implies not significant at the 10% level

* implies significant at 10% level

** implies significant at 5% level

*** implies significant at 1% level

Conclusion

This study has shown that the output of eggs in the poultry industry in Maseru District is not affected by the marital status and the age of the farmer. The major factors that influence egg output are found to be, the number of birds, capital, technology in use (deep litter or battery cage), and the type of feed used. These factors proved highly and statistically significant at the 1% level in predicting output of eggs. The models containing these factors as single or multiple variables show goodness of fit with high R^2 and R^2_{adj} values.

Farm sizes are generally small with one farm having as little as 25 birds and only one farm has over 1000 birds with an average farm size of 230 birds. Egg output has unitary elasticity with number of birds; it is highly elastic to changes in capital; and highly inelastic to changes in technology and type of feed. It is concluded that given the elastic nature of egg output to changes in capital, the output of eggs in Maseru District can be boosted by introducing sufficient capital in the poultry industry.

Recommendations

In the light of the findings of this study, the following recommendations are made:

- Efforts should be made to provide capital to poultry farmers to boost egg production, as capital is a seriously limiting factor in egg production in the country.
- Farmers should invest more in the relatively cheaper deep litter system than the more capital-intensive battery cage technology since there is no statistical significance in their contribution to egg production in the district.

References

Anon. 1999. Poultry production section policy objectives and programmes. Livestock

Department, Ministry of Agriculture, Maseru.

GOL. 1986a. *The commercial egg industry of Lesotho*. 1986. Ministry of Agriculture and Marketing, Agricultural Marketing Section, Maseru, Lesotho. 31 pp.

GOL. 1986b. Current Thinking of the District Poultry Officers About Issues Relating to the Poultry Industry. *Proceedings of the First Seminar on Egg and Broiler Production and Marketing Situation* in Lesotho. Lesotho Agricultural College. Ministry of Agriculture and Marketing, Maseru, Lesotho. 10 pp.

GOL. 1987. *Lesotho Egg Study*. Planning Division, Ministry of Agriculture, Co-operatives and Marketing, Maseru, Lesotho. 38 pp.

GOL. 1988. *Poultry Marketing Bulletin*, Ministry of Agriculture, Livestock Department, Maseru, Lesotho..

GOL. 1991. *Poultry Marketing Bulletin*, Ministry of Agriculture, Livestock Department, Maseru, Lesotho.

Hair M.W. 1967. *Use of regression equations for projecting trends in demand for paper and board*. Forest Research Report No. 18. US Forest Service, Washington, USA. 178 pp.

Henderson James M. and Richard E Quandt 1980. *Microeconomic Theory. A Mathematical Approach*. Third Edition, McGraw-Hill Book Company, International Edition 420 pp.

Mafoso L. 1999. *Economic analysis of factors influencing egg production in Maseru Urban*. Dissertation submitted in partial fulfilment for the award of Bachelor of Science in Agriculture. National University of Lesotho, Roma, Lesotho

Epidemiology of parasite infestation in goats belonging to resource limited communities in eastern Namibia

F.F. Kumba¹, M. Undi¹, H. Katjivena², G. Kauta², A. Hengua², and F. Tjiteere²

¹Department of Animal Science, Faculty of Agriculture and Natural Resources, University of Namibia, Private Bag 13301, Windhoek, Namibia.

²Directorate of Research and Training, Ministry of Agriculture, Water and Rural Development, Private Bag 1437, Otjiwarongo, Namibia.

E-mail: fkumba@mail.unam.na

[Abstract](#)

[Introduction](#)

[Material and methods](#)

[Results and discussion](#)

[Constraints to goat production.](#)

[Epidemiology of parasitic diseases](#)

[Coprological analysis](#)

[Conclusions](#)

[Acknowledgement](#)

[References](#)

Abstract

The epidemiology of parasitic diseases in farm animals with special emphasis on indigenous goats was undertaken in the communal farming areas of eastern Namibia. Monitoring surveys, dialogue workshops, farmers' interviews and coprological analysis were the approaches adopted in the investigation. Findings indicated that environmental conditions on the communal farms were most favourable for the survival of free-living forms of intestinal parasites during the summer and autumn months and most adverse during spring and early summer. Conditions favourable to parasites existed within goat and sheep kraals all year round due to poor management of these structures. Heavy faecal-egg-counts (FEC) were observed in goats during all seasons of the year but to a lesser degree during the drier periods. Major intestinal parasites found in goats were the strongyles and strongyloides. Increased mortality, attributed by most farmers to famine, was observed among goats in spring and early summer seasons of feed shortages. The heavy burden of gastrointestinal parasites seems to augment the effect of famine by decreasing the natural ability of indigenous goats to survive periods of reduced feed in-take and other stressful conditions. Based on the findings, a rational management measure recommended by the study was to establish, at the end of winter, a strategic de-worming programme covering all small ruminants in the communal grazing area. This strategy, accompanied by preventive management measures such as the

relocation of kraals and the prevention of access to contaminated water points, would appear a cost-effective intervention to eliminate the negative effect of gastrointestinal parasitism during the critical seasons of famine.

Introduction

Indigenous Namibian goats are known to be hardy, highly resistant to endemic diseases and prosper relatively well under the harsh environment (Thawana and Visser 1999). Being mostly a semi-arid country, Namibia's climate is generally characterised by frequent droughts that give rise to serious livestock feed shortages especially in the east. This combination of factors partly explains why most resource limited communities in the communal grazing area in the east of the country have, in recent years, tended to reduce cattle numbers, traditionally the preferred domestic species, in favour of goat production. Census figures of the Directorate of Veterinary Services (1997) show that over 70% of Namibia's goat population of 1.8 million animals are raised by small farming households in the communal areas. In a recent study, Kumba et al. (1999) found that about 95% of households in the eastern communal area owned goats, 90% owned cattle and 59% owned sheep. Communal farming areas in Namibia account for 41% of the country's agricultural land and provides a means of livelihood for 47.9% of the country's 1.5 million inhabitants (Ministry of Agriculture Water and Rural Development 1995; Putz 1996; Rothauge et al. 1999). Commercial farms cover 44% and are owned by 0.3% of the population. Overstocking, droughts and bush encroachment have caused severe strains on communal pastures resulting in feed shortages during certain seasons of the year (Moyo et al. 1996). Farmers have noticed an increased mortality rate, especially among goats, in these seasons. Katjivena et al. (1998) reported heavy FEC of parasites in all goats examined in the eastern communal farms. An attempt by these workers to reduce the parasitic burden in this species, by the administration of anthelmintic remedies, proved unsuccessful. High FEC were quickly re-established in the treated animals. It was not clear if high FEC appearing in the treated animals was a result of rapid re-infestation by new colonies of parasites or if this was due to some hypobiotic forms unaffected by the treatment. The likelihood of rapid re-infestation seems plausible since poor control measures appear to promote high infective doses of gastrointestinal parasites in the grazing environment of communal farms. De-worming can eliminate the premune status of farm animals and render them more prone to rapid re-infestation if the environment remains contaminated (Radostits et al. 1994). Therefore, it became important to investigate the epidemiology of intestinal worms in goats and other farm animals in order to provide a rational basis for strategic planning of cost-effective de-worming and other preventive management measures.

Material and methods

Preliminary dialogue workshops (Ison and Ampt 1992; Mariner and Van't Klooster 1994) were undertaken with farmers in 15 villages all over the communal area in order to establish the role of parasitic diseases within the perspective of major livestock constraints.

A standard questionnaire was designed and tested (Thrusfield 1995a;1995b) before being used to collect information about the evolution of local environmental, management and animal health factors that influence infestation rates of livestock by intestinal parasites and the onset of clinical manifestations they cause through the year. Forty-five farming households in 18 villages participated in the investigation. Villages were pre-selected and participating households were randomly chosen. Factors investigated included the following (Radostits et al. 1994):

- Factors related to the micro-climate of the environment: temperatures and rainfall.
- Factors related to pasture management and micro-climate of the environment: stocking densities; duration spent by animals on same pastures; changes in the length and bulk

of pastures; distribution of vegetation on the grazing pastures; extent of water lodging on pastures; presence of known parasite vectors; methods of watering animals; and the practice of zero-grazing.

- Factors related to the kraal: general hygiene in kraals; state of faecal accumulation in kraals; kraaling different species of animals; kraaling young animals.
- Factors related to the general nutrition and health of animals: scoring body condition of animals; variations in pasture availability; morbidity and mortality rates.
- Timing seasonal movements of livestock on the communal grazing lands.

The above parameters were later monitored by direct monthly observation over a period lasting one year in order to determine changes in the environment, and management and health conditions of the animals that promote the survival of free-living forms of intestinal parasites and predispose animals to infestation and disease. This investigation was undertaken to validate findings obtained in the dialogue workshops.

Coprolological analysis was undertaken during all the months of the year to identify the main endemic parasitic species in goats and periods of heavy parasitic burden. Six farms located in different parts of the communal area were identified for this study. Owners of the selected farms never de-wormed their animals. Ten goats in each farm were selected and marked. About 10g of faeces was obtained intra-rectally from the selected goat. Faecal samples collected on each farm were pooled in plastic bags, stored in cold boxes on ice and dispatched to the laboratory for FEC and parasite egg identification. The lapse of time between faecal sample collection and laboratory examination was 1 - 5 days. The floatation McMaster technique was applied for faecal examination (Reinecke 1983). Species identification was done by microscopic observation of eggs for specific morphological features. Rainfall and temperature records were obtained from the local meteorological department.

Results and discussion

Constraints to goat production

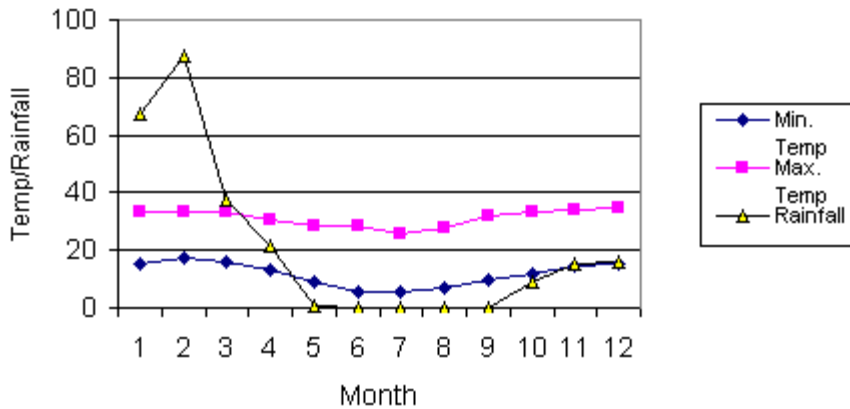
Preliminary dialogue workshops indicated that the main livestock constraint in the eastern communal areas of Namibia was the scarcity of pasture due to drought. Livestock diseases were also incriminated, but farmers did not seem to perceive disease as an important constraint comparable to famine. This is probably because, in Namibia, the existence of a veterinary cordon fence, which isolates major disease endemic areas in the north of the country, has, for many years, provided an effective control barrier against major epizootics. The effect of less dramatic disease conditions, such as parasitosis, appears largely masked by the predominant role played by famine. Losses in production, caused by parasites in livestock farms, are usually manifested by non-specific signs that the unsuspecting farmers cannot easily link to these etiological agents of disease (Radostits et al. 1994). Kumba et al., (1999) observed that animals from this communal area did not compete favourably in the local market with those from the neighbouring commercial farms even when pasture conditions were good.

Epidemiology of parasitic diseases

Findings related to the epidemiology of parasitic diseases showed the following: Rainfall (Figure 1) was confined to the months of summer and early autumn (January, February and March) as previously reported (Du Pisani 1999). During this period, the study found that open ground water points accessible to livestock abound in the grazing areas in ponds, streams, marshes, dug-outs, ditches and dams. Environmental temperature was quite warm (Figure 1). However, some rays do not easily reach the soil surface in many places during summer and autumn because of significant increases in the height and bulk of the vegetation cover. The above findings show that conditions in summer and autumn are very favourable for the

survival of free-living forms of gastrointestinal worms. Goats and other domestic livestock are most likely to be infected during this period. In spring, on the other hand, environmental conditions were largely unfavourable for free-living forms of parasites. Open water points had dried-up, vegetation cover was sparse, temperatures were high and the sun's rays were very intense.

Figure 1. Mean Monthly Rainfall(1983-87) & Temp (1986-99) Omaruru

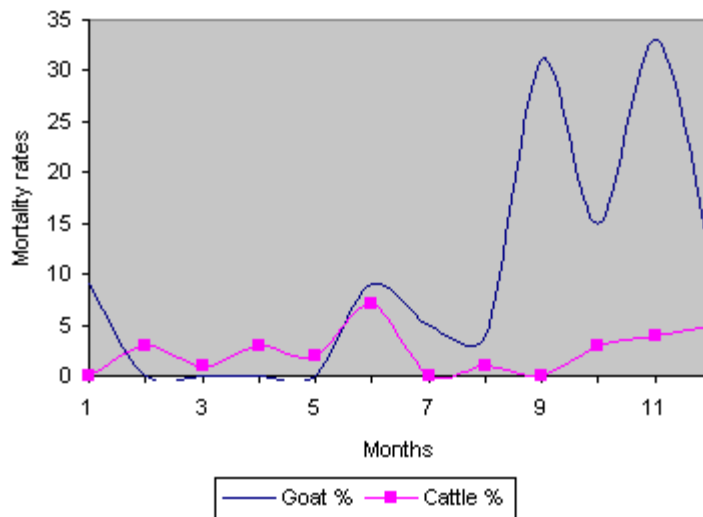


It was also observed that all farm animals tended to spend much of the summer and autumn near villages. The consequent increase in faecal contamination in summer pastures close to villages appears to enhance the build up of infective doses of parasites in the environment. The study, however, showed that farm animals are in good nutritional condition during this period probably because grazing is plentiful. This explains why most animals did not show clinical conditions during this season. Well-fed animals are more resistant to the negative effect of parasitosis than debilitated malnourished animals (Radostits et al. 1994).

At the beginning of winter, summer pastures close to villages were mostly run down. Cattle were seen to graze on the more distant pastures which were rested since they were not utilised during summer and would consequently be expected to remain much less contaminated. Goats and sheep still remained in the contaminated environment close to villages for fear of jackals and other predators. Furthermore, unlike cattle, which spent the nights on the veld, small ruminants returned to spend nights in kraals. Kraals were rarely moved and never cleaned. Consequently, faecal accumulation in goat and sheep kraals was often seen to reach enormous proportions. Although different livestock species were kraaled separately, young animals often shared the same kraals with adults. During the day, when adult animals were released into the veld, kids and lambs were retained and usually confined and fed in kraals. These management practices increased considerably the likelihood for small ruminants, especially the young animals, to become heavily infested by gastrointestinal parasites.

Heavy parasitic infestation is probably an important contributing factor that explains why goats tend to succumb more easily than cattle to the effect of reduced feed intake experienced during spring and early summer (Figure 2). It was observed that goat mortality was nearly nil during the summer and autumn months when grazing is abundant (Figure 2). This is a further indication that when nutritional levels are good, indigenous goats are more resistant to endemic pathogenic agents and adverse environmental conditions than cattle.

Figure 2. Goats & Cattle Mortality



Information collected from the farmers during the interviews showed that increased livestock mortality was mostly experienced in spring and early summer than at any other time of the year. This is the season when grazing is most scarce, especially for small ruminants. Most animals exhibited poor nutritional conditions during this season. It appears that intestinal parasites that seem to infect animals mainly in summer and autumn, later play a big role in increased mortality rates experienced among small ruminants during the feed gap period in spring and early summer. However, environmental conditions observed in grazing pastures, during this time of the year, were invariably unfavourable for free-living forms of intestinal worms. Temperatures were very high (Figure1), humidity was low and vegetation cover was generally absent or minimal- conditions which are generally lethal for these parasitic stages. However, it would appear that continuous utilisation of the same pasture facilities by infected small ruminants all year round ensures that these remain contaminated at all times.

The institution of a strategic de-worming programme for all small ruminants at the end of winter or the beginning of spring would have a dual advantage. On one hand, this would eliminate the important role played by gastrointestinal parasites in increasing livestock mortality during the seasons of famine (spring and early summer). On the other hand, the continuous contamination of pastures by carrier animals would be eliminated and the natural sterilisation of the pasture environment by harsh weather conditions would be permitted.

Coprological analysis

Coprological analysis showed high counts of nematode eggs during all the seasons of the year in all the villages under study (Table 1). However, FEC appearing in summer and autumn were much higher than at other times of the year. FEC dropped considerably during the drier periods (winter and spring). The reasons for this phenomenon could not be immediately established. Some authors observed increased periparturient output of nematode eggs in infested pregnant ewes (Nuvor et al. 1997). The number of adult *Haemonchus contortus* worms in sheep was seen to diminish significantly during the dry season (Mukaratirwa et al. 1997). It is possible that parasite egg output is influenced by changes that affect the physiological state of the host animal. It has been established that during adverse environmental conditions, gastrointestinal helminth parasites tend to develop hypobiotic forms, a largely sexually inactive mechanism to ensure that progeny worms will survive (Urquart et al. 1996; Mukaratirwa et al. 1997).

Table 1. Parasite egg counts in six selected villages in eastern Namibia

Month	Okatuhoro	Okanjopo.	Omatupa	Oruvize	Otjimat	Otjiyere
Jan	xx	xxxxxxxxxxxxxxxx xxxxx	x o	xxxxxxx oooo	xxxxxxxxxxxxxxxx x oo	xx
Feb	xxxxxxxxxxxxxxxx ooooooo	Xxxxxxxxxxxxxxxxx Xxxxxxxxxxxxxxxxx Xx m	Xxxxxxxxxxxxxxxxx Xx o	Xxxxxxxxxxxxxxxxx Xxxxxxxxxxxxxxxxx Xx oooooooo	Xxxxxxxxxxxxxxxxx Xxxxxxxxxxxxx o	Xxxxxxx
Mar	xxxxxxxxxxxxxxxx oooooooooooo	Xxxxxxxxxxxxxxxxx Xxxxxxxxxxxxxxxxx Xxxxxxxxx o m	Xxxxxxxxxxxxxxxxx Xx	Xxxxxxxxxxxxxxxxx Xxxx	Xxxxxxxxxxxxxxxxx Xxxxxxxxxxxxxxxxx Xxxxxxxxxxxxxxxxx Xxxxxxxxxxxxx o	Xxxxxxxxxxxxxxxxx Xxxx oooooooooooooooooooo o
Apr	xxxxxxxxx o	Xxxxxxxxxxxxxxxxx Ooooooooooooooooo Ooooooooooooooooo Ooooooooooooo m	Xxx o	Xxxxxxxxxxxxxxxxx Xxxx ooooooo	Xxxxxx O	x
May	xxxxxxx	Xxxx T	xxxxxxxxxxxxx	xxxxxxxxxxx	Xxx oo	Xx
Jun	xxx	xxxxxxxxxxxxx	X o	xxxxxxxxxxxxx o	Xxx oo	xxxxxxx
Jul						
Aug	X	xx	xxxxxxxxxxxxx	Xx ooooo	xxxxxxxxxxx	xx
Sep		x	Xxxx o	Xxxx o	Xxxxxxx o	xx
Oct	xxxxxxx	Xxx o	Xxxxxxxxxxx o	xxxxxxxxxxx	Xxxxxxxxxxx o	xxxxxxxxxxxxx
Nov	xxxx oooooooooooooooo	Xxxxxxxxx o	Xxxxxxxxxxxxxx Xx Ooooooo	Xxxxxxxxxxxxxx Xxxxxxxxxxxxxx Xxxxxx Ooooooooooooooooo Ooooooooooooooooo Ooooooooooooooooo oooooooooooo	xxxxxxx	x
Dec	x	xxxxx	Xxxxxxxxxxxxxx Xxxxxxxxx Oooo	Xxxxxxxxxxxxxx oooooooooooo	Xxxxxxxxxxxxxx Xxxxx oo	xxxxxxxxxxxxx

Key:

X = 100 strongyle eggs counted

O = 100 strongyloide eggs counted
m = presence of *Monezia* eggs
T = presence of *Toxocara* eggs

The predominant species of worms seen in this study were the strongyles and the strongyloides. Faecal culture is recommended to establish the exact species of the endemic parasites. More serious pathogenic species like *Haemonchus contortus* might well have been present as it is difficult to distinguish between most of these eggs under the microscope. Few ascaris eggs of the *Toxocara* species were seen on one farm during the summer and autumn months and eggs of the cestode, *Moniezia*, were also encountered in animals on the same farm. The above observation shows how the epidemiology of gastrointestinal parasitism can vary in farms within the same geographical location depending on differences in management and micro-climatic factors. This is why it is not always correct to prescribe blanket control protocols across farms even within the same district before carrying out epidemiological investigations on each of them. No trematode eggs were reported in the study. The habitat in the east of Namibia is unfavourable for the molluscan intermediate hosts of these parasites.

Conclusions

Heavy losses among indigenous goats raised on communal farms in the east of Namibia have been observed during seasons of feed shortages: spring and early summer. Although these animals are naturally resistant to famine, heavy infestation by gastrointestinal parasites appears to augment the effect of famine in causing these losses. Heavy parasitic burden seems to eliminate the natural tolerance of indigenous goats to famine. This study showed that factors that predispose animals to parasitic infestation in these communal farms included access to contaminated water, absence of appropriate hygienic measures in kraals, and the inability to prevent pasture contamination during periods detrimental to free-living forms of intestinal worms. The months of spring and early summer were found to be the most unfavourable period for the free-living forms of intestinal worms, but also the time when small ruminants are most vulnerable to the effects of parasitosis. The main intestinal parasites of goats seen in the area were the strongyles and strongyloides. As a rational control measure, it is recommended that an affordable, but potent anthelmintic drug against both adult and hypobiotic forms of strongyles and strongyloides be identified and used by all communal farmers in strategic de-worming interventions in small ruminants to be undertaken yearly at the end of winter or beginning of spring. This would appear a cost-effective intervention to reduce the negative influence of parasitosis in animals during the feed gap period and to eliminate continuous contamination of pastures. The intervention would be accompanied by the relocation of kraals and access to faeces accumulated in the old kraals prevented by burning or fencing them off. In addition, draining or fencing off contaminated water points within the farms would prevent access of animals to these sources of infestation.

Acknowledgement

This study was funded by the University of Namibia Research and Publications Committee and the Ministry of Agriculture, Water and Rural Development. Coprological analysis was carried out by Dr. R. Hillbert at the Regional Veterinary Laboratory in Grootfontein. Special words of appreciation go to the communal farmers of Okakarara district for their co-operation.

References

Du Pisani A.L. 1999. The Idiosyncrasies of Namibian Rainfall. Proceedings: 8th Congress of the Agricultural Scientific Society of Namibia, Ehoru Lodge, 2nd – 4th November. Namibia. pp 9–14.

- Ison R.L. and Ampt P.R. 1992. Rapid rural appraisal: A participatory problem formulation method relevant to Australian agriculture. *Agricultural Systems* 38: 363–386.
- Katjivena H., Kauta G., and Hengua A. 1998. The effects of de-worming of goats with both registered and traditional remedies to improve production and reproduction in eastern communal areas (Okakarara, Okamatopati, and Epikro). In: *Proceedings of the second national annual agricultural research reporting conference, Neudamm Agricultural College, Windhoek, 8th–10th September*. pp 135.
- Kumba F.F., Undi M., Katjivena H., Kauta G., Hengua A. and Tjiteere F. 1999. Taping indigenous knowledge to time strategic de-worming treatment of livestock on communal grazing lands in the east of Namibia. *Review of Southern Africa Studies: The special issue on sustainable agriculture in Southern Africa*, vol. 4, Number 2.
- Mariner J.C. and Van't Klooster G.G.M. 1994. Community-based approaches to veterinary privatization in pastoral systems. *Paper presented at the Pan Africa rinderpest campaign conference on privatization, 21st November*. Nairobi, Kenya. pp 1 –15.
- Ministry of Agriculture, Water and Rural Development, 1995. *National Agricultural Policy*. White paper presented to parliament. MAWRD, Windhoek, Namibia.
- Moyo S., O'keete, P. and Sill M. 1996. *The Southern African environment: Profiles of the SADC countries*, Chapter 6: Namibia. Earthscan publications, London, UK.
- Mukaratirwa S., Hove T., and Kyvsgaard N. 1997. An abattoir study of seasonal fluctuations of adults and larval stages of haemonchus contortus in sheep in Zimbabwe. *Bulletin of Animal Health and Production in Africa* 45: 165–168.
- Nuvor S.V., Assoku R.K.G. and Agyei A.D. 1997. Peri-parturient rise in faecal nematode egg counts in Djallonkex Nungua Blackhead crosses in the forest zone of Ghana. *Bulletin of Animal Health and Production in Africa* 45: 169–171.
- Putz J. 1996. *The agricultural sector. Business guide to Namibia*. An investment center publication. Ministry of Trade and Industry, Windhoek, Namibia. pp 29–32.
- Radostits O.M., Blood D.C. and Gay C.C. 1994. Diseases caused by helminth parasites. In: *Veterinary Medicine: a textbook of diseases of cattle, sheep, pigs, goats and horses, 8th edition*. London, Balliere Tindall. Pp 1223–1230.
- Reinecke R.K. 1983. Diagnosis of helminthes in the live animal. In: *Veterinary helminthology*. Butterworths Durban/Pretoria pp 66–69.
- Rothauge A., Abate A.L., Kavenji G. and Ngbikembua M.L. 1999. What goats eat in the highland savanna of Namibia in summer. In: *Proceedings 8th congress of the Agricultural Scientific Society of Namibia, Ehoru lodge, Windhoek, 2nd– 4th, Namibia*. November, 1999. pp 66–69.
- Thawana S.B., and Visser W.H. 1999. *Indigenous goats: communal farmers' wealth*. Spotlight on Agriculture N^o 26. Ministry of Agriculture Water and Rural Development, Windhoek, Namibia.
- Thrusfield M. 1995a. *Surveys in Veterinary epidemiology*. Blackwell science Ltd., Osney Mead, Oxford pp 178–198.
- Thrusfield, M. 1995b. The ecology of diseases. In: *Veterinary epidemiology*. Blackwell Scientific Publication, UK. Pp 9 Ltd., Osney Mead, Oxford.

Urquart G.M., Armour J., Duncan J.L. Dunn A.M., and Jennings F.W. 1996. Veterinary helminthology. In: *Veterinary parasitology*, second edition, Oxford: Blackwell Science.

Session 3: Crisis mitigation in livestock dependant systems

Crisis mitigation in livestock dependant systems: The role and limitations of current initiatives for livestock systems in South Africa

Sahr. H. B . Lebbie

International Livestock Research Institute (ILRI)
P. O. Box 30709, Nairobi, Kenya

[Abstract](#)

[Introduction](#)

[The SADC initiatives for drought crisis mitigation](#)

[The early warning systems \(EWS\)](#)

[The challenges for addressing livestock issues](#)

[Conclusions and recommendations](#)

[Acknowledgement](#)

[References](#)

Abstract

Livestock are central to the livelihoods of livestock-dependent systems in Africa, particularly pastoralists and agro-pastoralists. Over the years, however, climatic extremes in this sub-region have impacted the agricultural production systems including livestock-dependent systems and hence the livestock owners. In recognition of this problem, the SADC member states have elaborated a Sub-Regional Action Programme (SRAP) to Combat Desertification in Southern Africa under the umbrella of the SADC Environment and Land Management Sector. In addition, the sub-region has, with the assistance of collaborating partners, established early warning systems (EWS) to assist farmers anticipate and prepare for climatic extremes such as drought. This paper discusses these initiatives focusing on their role and limitations to serve the livestock sector and suggests opportunities to enhance their effectiveness to support and improve the management of livestock and drought.

Keywords: livestock; climatic extremes; drought; early warning systems; ESA

Introduction

Livestock are central to the livelihoods of the livestock-dependent production systems in Southern Africa, accounting for about 25% of the total agricultural output of the member states. In particular, livestock are central to the well-being of the pastoralists and the agro-pastoralists.

Climatic extremes are a critical phenomenon in the pastoral and agro-pastoral communities largely because of the extreme dependence of these communities on the natural environment for their livelihoods and the welfare of their animals. In most parts of the arid and semi-arid areas of southern Africa, a common feature is unreliable rainfall and periodic droughts. This climatic phenomenon is known to impact biodiversity, human health, the productivity of the systems and hence the well-being of the livestock owners (Ford 1971; Lewis 1975; Hussein 1976; Swift 1976; Horowitz and Little 1987). For the Southern African Development Community (SADC) region, drought can no longer be regarded as a catastrophe but rather accepted as a recurrent feature of the environment. (Pereira 1968)

This and other climatic phenomena have been recognised as crucial to the development of the sub-region at the highest political levels. In direct response to this concern, the SADC member states have elaborated a Sub-Regional Action Programme (SRAP) to implement the UN Convention to Combat Desertification under the umbrella of the SADC Environment and Land Management Sector. At the same time, a network of early warning systems (EWS) has been established in the sub-region addressing regional as well as national perspectives.

In order to contribute to these efforts, the SADC Regional Animal Agriculture Research Network (SAARNet) has also started an initiative to undertake studies on "Crisis Mitigation in Livestock-Dependent Systems" to understand the risks associated with climatic variability and to provide policy options, technologies and knowledge products that will make the livestock sector more resilient in times of drought and thus promote food security, poverty alleviation and sustainable natural resource conservation.

The SADC initiatives for drought crisis mitigation

The SADC Sub-Regional Programme to Combat Desertification (SADC-SRAP): Following the SADC Council of Ministers approval of the "SADC Policy and Strategy for Environment and Sustainable Development - Towards equity-led growth and Sustainable Development in Southern Africa", in August 1996, the Council established the distinct Policy and Strategy Co-ordination Unit called the SADC Environment and Land Management Sector (SADC-ELMS) under the SADC Committee of Ministers of Environment.

The overall aim of SADC-ELMS is "to achieve sustainable utilisation of the natural resources and effective protection of the environment" (SADC 2000). To achieve this overall goal, SADC-ELMS will co-ordinate activities at the level of three programmes, namely the Land Management Programme, the Environment Management Programme and the Information Management Programme.

Within this framework, the SADC Council of Minister approved and adopted a *Sub-Regional Action Plan (SRAP)* in August 1997 to combat desertification in Southern Africa as the key operational instrument for implementing the United Nations Convention to Combat Desertification (UNCCD) in the sub-region. One of the priority programme areas identified and agreed upon to be implemented by SRAP is the "Strengthening of Early Warning Systems".

SADC-ELMS is evolving and has already undertaken an assessment of institutions in SADC countries that could assist it in leading the co-ordination and implementation of activities in the SRAP priority programme areas. Thus far the Desert Research Foundation of Namibia (DRFN) has been selected and approved by Council as the Lead Institution for SRAP's Capacity Building and Institutional Strengthening priority programme area. DRFN will, among other things, establish a network of institutions to build capacity to combat desertification and mitigate the effects of drought as well as provide leadership in the various aspect of research on desertification and drought.

The early warning systems (EWS)

A number of EWS have been established in SADC over the past decade or so, with focus on the communities that are extremely vulnerable to climatic variability. Following is a brief review and evaluation of the most successful EWS in SA so far, highlighting their strengths and weaknesses.

The major objective of most EWS is to rapidly provide decision makers with timely and accurate information to quickly take informed decisions on food security and environmental management planning (Walker 1989; Wakesa 1997; Agastiva 1997). Largely, these EWS essentially collect, process, analyse and disseminate observational data on a number of interrelated variables and depend very little on predictive models.

The Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS): This is a Food and Agriculture Organisation of the United Nations (FAO) funded project. The overall objectives of the project are to strengthen EWSs for food security in east Africa by establishing satellite remote sensing capabilities in the sub-region and preparing and distributing monthly early warning information to users in the SADC member countries and is based in Harare. It uses satellite data from NOAA HRPT, Meteosat Artemis and Meteosat PDUS to generate and produce timely information on the status of agricultural and environmental resources to assist national and regional institutions concerned with food security and environmental monitoring. The information bulletins are distributed as both GIS-based maps and reports. End-users surveys have shown a general satisfaction with the quality of its products and considerable enthusiasm for EWSs to continue operation in the region.

Famine Early Warning Systems (FEWS): These are two parallel regional initiatives operated and financed by the USAID Africa Bureau in both the Inter-governmental Authority for Development (IGAD) countries of eastern Africa and the SADC countries of southern Africa. They report on price status of food commodities as well as assess weather and growing season status. In addition they provide information on crop production outlooks. Based on these the systems provide quantitative estimates of food aid requirements as well as confirmed emergency food aid and pledges. They do not provide animal production estimates. They distribute their products electronically and by post, targeting national and sub-national level agencies and policy makers.

Drought Monitoring Centres (DMCs): These are jointly operated by the United Nations Development Programme (UNDP) and the World Meteorological Organisation (WMO) with one based in Harare covering southern Africa and the other based in Nairobi covering eastern Africa. These generate quantitative data on the status of the weather and growing season on a monthly basis using monthly and seasonal rainfall forecast information produced by the Climate Prediction Centre (CPC) in Washington D.C., USA along with satellite-based Normalized Difference Vegetation Index (NDVI) and locally collected agro-meteorological data. They produce monthly bulletins which are distributed in hard copy only to national-level technicians through courier and normal mail for informing the relevant policy makers.

The challenges for addressing livestock issues

SADC-ELMS and EWS provide many opportunities for a holistic approach to mitigating the effects of drought in the region. However, a number of constraints need to be addressed to enhance the value of these initiatives:

- With the exception of a few, the climate predictions or crisis indicators provided by most EWS are point forecasts and therefore are of limited value for livestock impact forecasts and long-range climate forecasts. The short-notice nature of these systems could

largely account for intervention failures, especially among the resource poor stakeholders, who are usually ill prepared to effectively mobilise the necessary resources to adequately respond to crisis situations.

- Information produced by most EWS tends to be oriented to short-range action time scales, drawing largely on locally available data (observational data) and very little use of data external to the region (satellite information). The systems are thus oriented to adverse shocks and hence demand ex-poste rather than ex-ante responses to shocks. They promote coping strategies oriented to relief operations and handouts rather than mitigation.
- There is a general inability to provide reliable and complete information. The satellite technologies currently used by the EWS are relatively new and therefore not well understood and appreciated by ground technical staff. Equally true is that the involvement of different players employing different methodologies to gather the same data creates problems for the harmonisation of data to produce integrated and accurate information and knowledge products for use in decision-making.
- Most EWS do not provide the required information rapidly and on time to enable end-users to make quick decisions to ameliorate prospective risks and exploit emerging opportunities. This is largely due to their use of courier and normal mails rather than electronic mail for the dissemination of the information they generate.

Conclusions and recommendations

There is an urgent need to improve and strengthen the existing mechanisms for rapid and timely provision of reliable and relevant information for quick decision making. The relevant institutions in the region must therefore build capacity for use of electronic mail for information dissemination both for those that require the primary data to generate early information and those change agents that need to inform the communities to be affected.

There is also an urgent need to enhance the value of the existing EWS by increasing the capacity for extended range climate forecasting and livestock impact forecasting. This can be achieved by the use of emerging inter-seasonal and inter-annual climate forecasting capabilities. There also exist well-established models of animal diseases and growth, range ecology (for example at ILRI) and crop growth, that could be linked to climate forecasts to establish climate-driven forecasts for fodder, animal disease epidemiology and animal growth.

For decades now, development resources have been increasingly used up by relief operations necessitated by unsatisfactory anticipation and/or mitigation of drought. Enhancing the capacity of EWS to mitigate crises, but more importantly to cue opportunistic development interventions will break the cycle of dependence on external relief and the diversion of development or aid resources toward development. Increasing the capacity of EWS for long-range climatic forecasting will enhance the ability of the end-users of their forecast information to make timely decision to take advantage of emerging opportunities and or ameliorate prospective crises rather than depend largely on coping strategies.

As satellite technology is new, there is a need to train (in-service) the ground technical staff to make them more effective in data collection, processing and interpretation. This will improve the accuracy and quality of the forecast information.

EWS must ensure that the countries they serve, build the capacity for quick response to risks shocks as well as opportunities presented by the forecast information. The current lack of harmonisation and co-ordination of the activities of the EWS is counterproductive. Currently different EWS use different data sets to produce climatic predictions, thus tending to differ in the quality and accuracy of these predictors. In Kenya national EWS, for example, several institutions are involved in collecting the same data but using different methods thus putting in question the reliability of the results.

There is a need to bring satellite technology to those countries that do not have their own receiving facilities by the RCSSMR supplying satellite data to those countries.

The human and economic value of the forecast information must be estimated to rationalise the investment into EWS in the region. This will require regular end-user valuation of the information provided by the EWS and the level to which the use of the information has impacted food security.

Acknowledgement

I wish to acknowledge the Conference Organising Committee for inviting me, and to SACCAR for sponsoring my participation.

References

- Agatsiva J.L. 1997. Experiences, operational mechanisms and lessons from Early Warning and Environmental Remote Sensing for Eastern Africa Sub-Region, paper presented to July 1997 ASARECA workshop in Nanyuki, Kenya.
- Ford J. 1971. *The role of trypanosomiases in African ecology*. Oxford, Clarendon Press. UK.
- Horowitz M.M. and Little P.D. 1987. African pastoralism and poverty: some implications for drought and famine. In: Glantz, M.H. *Drought and hunger in Africa: denying famine a future*, Cambridge, Cambridge University Press.
- Hussein A.M. (ed) 1976. *Rehabilitation: drought and famine in Ethiopia*. African Environment Special Report 2, London, International African Institute.
- Lewis I.M. (ed) 1975. *Abrar: the Somali drought*. London, International African Institute. UK.
- Pereira H. C. 1968. Land use and misuse. In: M. O. Collins (ed). *Proceedings of Symposium on Drought and Development*, First Rhodesian Science Congress, Bulawayo, 16–20 May, 1967. pp 9–12.
- SADC (Southern African Development Community). 2000. SADC programme for environment and sustainable development: Implementing the UN Convention to Combat Desertification. *An Information Note for the SADC Annual Consultative Conference, Mbabane, Swaziland, 9–24 February 2000* (Unpublished), SADC Environment and Land Management Sector (ELMS).
- Swift J. 1976. Desertification and man in the Sahel. In: O'Keefe P., and Wisner B. (eds) *Land use and development*. African Environment Special Report 5, London, International African Institute, pp 171.
- Walker P. 1989. *Famine early warning systems: victims and destitution*, London Earthscan Publications. England.
- Wekesa E. M. N. 1997. Experiences and lessons from the drought preparedness interventions and recovery programme in the arid lands of Kenya. A paper presented during the International Livestock Research Institute's Seminar on "Crisis Mitigation in Livestock Production Systems in the Horn of Africa", held at the Muro Lodge, Nyanyuki, Kenya, 6– 11 July, 1997.

Crisis mitigation in livestock dependent systems: Concern, universal experiences and challenges in promotion of livestock production in Dedza District

Richard Mwanza and Jacob Mapemba
Food Security & Sustainable Livelihoods Programme
Concern Universal P.O. Box 217, Dedza, Malawi

[Introduction](#)

[Crisis indicators](#)

[Inadequate extension and training on livestock management:](#)

[Scarcity of feeds due to seasonality of forages and high cost of concentrates:](#)

[High incidences of diseases and parasites:](#)

[Theft and predation:](#)

[Lack of cash to buy livestock drugs](#)

[Insufficient land for grazing:](#)

[Uncontrolled livestock breeding:](#)

[Poor livestock marketing](#)

[The impact of the crisis on the bio-diversity and farmers](#)

[Coping mechanisms deployed by farmers](#)

[Concern Universal experiences in mitigating the livestock crisis](#)

[Reducing diseases and parasites:](#)

[Development of community based livestock breeding centres](#)

[Cross breeding](#)

[Livestock credit scheme](#)

[Improved livestock extension](#)

[Local feed formulation and stocking](#)

[Livestock marketing](#)

[Local capacity building](#)

[Challenges in mitigating the livestock crisis](#)

[Sustainability](#)

[People centred livestock mitigation programme](#)

[Empowerment of livestock farmers](#)

[Participatory livestock development](#)

[Capacity building of livestock farmers and communities](#)

[Institutional development](#)

[Learning process oriented](#)

[Forging linkages and alliances](#)

[Policy issues](#)

[Conclusion](#)

[References](#)

[ANNEX: Concern Universal livestock strategies](#)

Introduction

The importance of livestock in sustaining the livelihoods of the rural communities cannot be overemphasised. Despite its low contribution to the GDP (7%) and agricultural production (12%), it is a very important sector in improving the food and livelihood security status of the smallholder households in rural Malawi. In Dedza District, recent surveys by Concern Universal have indicated that 64% of the households keep livestock. And 37.8 % of households keeping livestock view livestock as the asset with the highest value. The Concern Universal Commissioned Survey by James Banda (1999) revealed that households benefit from livestock as follows (in order of priority):

- Source of income
- Source of food
- Risk aversion
- Source of manure
- Social activities (funeral and wedding ceremonies)
- Payment of court cases
- Transport

The same surveys by Concern Universal in the District have revealed that the livestock sector in the District is in a crisis situation. This paper, therefore, outlines some of the crisis indicators, coping mechanisms deployed by farmers and the impact of the crisis on the biodiversity and farmers. The paper also shares experiences and challenges of Concern Universal in mitigating the crisis.

Crisis indicators

The Concern Universal Commissioned Surveys {Small Scale Dairy Production conducted by Banda (1999), Factors Affecting Rabbit Production by Mapemba (1999a) and Constraints to Livestock Production by Mapemba (1999b)} reveal several crisis indicators in livestock production which are discussed below.

Inadequate extension and training on livestock management

There is increasing evidence that there is very little contact between front line staff and livestock farmers, there are limited extension packages developed and disseminated to livestock farmers and there is inadequate training of farmers in livestock management. In Dedza District, 69.8 % of the households keeping livestock do not get any advice on livestock management. In a survey on Small Scale Dairy Production commissioned by Concern Universal and conducted by James Banda revealed that 89 % of the households keeping goats have never been visited by a Veterinary Assistant. In another Concern Universal survey on constraints to adoption of agricultural technologies by Jacob Mapemba, 88.1 % of the households keeping livestock indicated that they have never been visited by a Veterinary Assistant. In a survey by Jacob Mapemba on Factors Affecting Rabbit Production, 42.3 % of the households keeping rabbits did not seek any advice from front line agricultural staff because they did not know the staff responsible for livestock production. Forty-seven percent of the households who sought advice said they did not receive any advice and 69.2 % of households did not receive any training on rabbit management.

This state of affairs is evidenced by poor livestock housing, feeding, health, breeding practices, and the fact that livestock are not multiplying in most of the villages.

Scarcity of feeds due to seasonality of forages and high cost of concentrates

This results in low quality of feed. The Concern Universal Survey on Factors Affecting Rabbit Production indicated that farmers feed their rabbits with cabbages, maize bran, potato vines, bidens pilosa and some other natural green plants/vegetables of which most are scarce during dry season. Production of pasture crops and storage of these crops for use in the dry season is an idea on the shelf in the University and Research Institutions and is foreign to most farmers. Development organisations promoting livestock production in Malawi are still far from moving the ideas from the University and research institutions shelves to the farmers' fields.

High incidences of diseases and parasites

In a Concern Universal Survey on Factors Affecting Rabbit Production, 48.8 % of the households indicated diseases and parasites as the major cause of deaths in rabbits (Mapemba 1999a). Although diseases appear to be a major cause of mortality, most households could not indicate the type of disease. A few households, however, mentioned running noses and discharges from the eyes (Pasteurellosis) and Coccidiosis as being the type of disease causing death in rabbits. This further justifies the inadequate training and extension given to farmers. Red ants and fleas were mentioned as major parasites affecting rabbit production. This survey revealed that 78 % of households have never given any kind of treatment to sick rabbits either due to unavailability of drugs or lack of cash to buy drugs and only 25% of the households vaccinate their chicken against New Castle Disease.

The survey on small-scale dairy production by James Banda in Dedza District revealed that 53.4 % of the households keeping goats lose their goats during the rainy season due to worms, diarrhoea and skin diseases. The government introduced the Drug bank System whereby the communities themselves buy drugs and Veterinary Assistants administer the drugs to the animals. This system, however, is limited by the following factors:

- Free range system that favours outbreaks of African Swine Fever and New Castle
- diseases
- High costs of veterinary drugs
- Scarcity of drugs

Theft and predation

There are increasing high cases of theft and predation of livestock in the communities. The Concern Universal commissioned surveys in Dedza District have revealed that 61 % of the households keeping livestock lose their stock through theft and 69 % of the livestock farmers lose their stock through predation. This is evidenced by the reduced number of large scale livestock such as cattle. Theft and predation is aggravated by the following factors:

- Free range system of keeping livestock
- Poor housing structures
- Weak leadership at community level to police the livestock security
- Poor marketing systems
- Open slaughter of livestock

Lack of cash to buy livestock drugs

Most farmers do not view livestock farming as a business and instead they depend on other sources of income to feed their livestock and buy drugs for their livestock. The cash crop enterprise is also crumbling and this makes the situation even more difficult for farmers to forge ahead with livestock keeping. It is only when farmers take livestock keeping seriously as a business that farmers can realise adequate income to maintain their livestock.

Insufficient land for grazing

Farmers are experiencing further reductions in land as more and more marginal land is put into crop cultivation. Most farmers in Malawi keep livestock as a hobby and as a secondary means of livelihood. This being the case the first value for land is crop production and not livestock keeping. Animals are therefore left to graze on very marginal lands and dambos/wetlands.

Uncontrolled livestock breeding

The system of rearing livestock in a free-range system contributes to uncontrolled breeding. The Concern Universal Commissioned Survey conducted by James Banda revealed that 47 % of the households keeping goats in Dedza District use bucks from other households during free range grazing.

Poor livestock marketing

There is very high evidence of limited organised markets in livestock and wide prevalence of open and uncontrolled markets for livestock and livestock products.

The impact of the crisis on the bio-diversity and farmers

The major impact of this crisis on bio-diversity is a declining trend in livestock production and population and increasing food and livelihood insecurity of the rural households. Eighty-five percent of the households in Dedza district are food insecure from October to March every year according to Participatory Rural Appraisal Reports by Concern Universal. During the same period, 36.3 % of the children under-five are malnourished according to Concern Universal Nutrition Assessment Surveys. In order to maintain the status quo in sustaining their livelihoods, rural communities resort to other means of getting income.

A Concern Universal recently Commissioned Baseline Survey by Gasheke Simons (1998/99) has revealed that 11 % of the total households get their income from livestock. Other sources,

according to the same survey, include crop production (53.4%), natural resources (20.6%), wage employment (7.4%), asset sales (0.01%), land rentals (0.28) and gifts and remittances (1.52%).

Coping mechanisms deployed by farmers

Farmers deploy several coping mechanisms in livestock production including:

- Feeding animals with inferior feed
- Not keeping livestock at all
- Using inferior breeding stock
- Not vaccinating livestock and not giving drugs to sick livestock
- Using traditional drugs
- Increased open slaughter of livestock
- Killing diseased animals and selling meat of these animals
- Overgrazing

Concern Universal experiences in mitigating the livestock crisis

Concern Universal, recognising the importance of livestock in sustaining the food and livelihood security of the rural households and recognising the current crisis in livestock production, developed a three-year (May 1999 to April 2002) livestock development strategy for Dedza District. This strategy was developed in liaison with key stakeholders in the livestock industry in Malawi.

The following are the key strategic areas to be addressed during this period (see annex for details):

- Strategies for monogastric livestock improvement on smallholder farms.
- Strategies for small ruminant improvement in smallholder farms.
- Strategies for large ruminant improvement on small holder farms.

In order to implement the livestock development strategy, Concern Universal increased its budget on livestock in Dedza District and is currently supporting the following initiatives:

Reducing diseases and parasites

This is being done through mobilising farmers to contribute money towards the costs of New Castle Vaccine and training of farmers on livestock management.

Development of community based livestock breeding centres

The task is being done in liaison with Land O Lakes and Bunda College of Agriculture. The idea is to make available improved livestock breeds in the local communities to meet farmers' demand in livestock production. This will eventually reduce the problem of scarcity for breeding stock and hence increase the number of farmers keeping livestock and also increase the number and species of livestock being kept by farmers. The centres would also supply the breeding stock beyond the impact area.

Cross breeding

The idea is to improve the genetic potential of livestock breeds. The CU programme is supporting cross breeding of local goats with boar goats, land race/large white pigs with local pigs, and Black Australorp chickens with local chickens.

Livestock credit scheme

CU is supporting farmers with livestock for multiplication through an in kind livestock credit scheme - pass a livestock scheme. The project has since July 1999 supported over 800 livestock farmers with various types of small-scale livestock including pigs, goats, rabbits and chicken. The programme budget allows for an increase in this number to more than four times in a year but due to a scarcity of breeding stock, the majority of farmers are not being supported.

Improved livestock extension

CU is supporting the development of extension materials for good livestock housing, feeding and disease control. The development of farmer led extension and research in livestock production is also supported. Farmer field schools in livestock production have been developed in the impact area and are being supported by CU. Village resource centres as learning centres and means of disseminating information have been developed by farmers themselves and are being used by both farmers and extension staff. These allow farmers to share their experiences and lessons in livestock production. The project is supporting farmer to farmer learning through farmer exchange visits.

Local feed formulation and stocking

CU is also supporting farmers in processing locally produced feed for their animals including feed formulation.. The CU Food Security and Sustainable Livelihoods Programme also integrates the practice of agro-forestry into livestock production with the aim of increasing livestock feed availability.

Livestock marketing

CU is supporting the development of livestock clubs and associations to improve marketing of livestock and livestock products. These associations will also give farmers a voice in issues affecting their livestock marketing.

Local capacity building

CU is strengthening community capacity in managing livestock development issues. The development and training of livestock committees is the key focus in this process. This also reduces theft of livestock in the communities.

Challenges in mitigating the livestock crisis

In order to mitigate the crisis in the livestock industry, the following challenges need to be addressed among many others:

Sustainability

There is a need to put in place a livestock mitigation programme that meets the needs of the present without compromising the ability of future generations to meet their own food and livelihood security needs. The programme should take sustainability as a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet farmers needs and aspirations in livestock production. The basic understanding is that the programme can be sustainable if it is farmer/people centred.

The philosophy is to put in place a livestock mitigation programme that that will be viable and continuously revolving from generation to generation.

People centred livestock mitigation programme

The livestock mitigation programme that focuses on the needs and cultural practices of the livestock farmers is what is desired. This entails a programme that recognises the farmer's systems of production and builds on it for future development. The principle focus is to develop a livestock mitigation programme approach that is accepted by rural people.

Empowerment of livestock farmers

The challenge is to develop a livestock mitigation programme that will focus on the creation of awareness and stress solidarity and mutual responsibility within local communities and groups of farmers. Thus the programme should be concerned with individuals gaining strength, confidence and vision to work for positive changes in their livestock crisis situation. This is a measure of people's capacity to bring about change in the livestock industry.

The thinking is that livestock farmers must be able to have a critical understanding of their own livestock production situation and they must organise themselves to undertake their livestock development. The idea is to build confidence in them in undertaking their livestock development process with a united vision.

Participatory livestock development

The challenge is to work with a practice and approach which ensures that those who bear the risks and costs of livestock development retain authority in its inception, planning, implementation and evaluation. Empowerment will be demonstrated by the quality of farmers' participation in the decisions and processes affecting their livestock production. The philosophy is that farmers will determine the nature and extent of participation in the livestock industry that they themselves require. Livestock mitigation will have little effect or may not even reach its most important objectives, unless farmers participate. Participation will enhance the efficiency, effectiveness and sustainability of the livestock development process. The use of participatory methods such as Participatory Rural Appraisal, Participatory Learning And Action, Learning For Transformation, Theatre for Development need to be encouraged in the mitigation process.

Capacity building of livestock farmers and communities

Farmers have their own ability to work and the skills and knowledge with which to produce. Communities have social/organisational capacities such as leadership and decision-making systems, and clan/family loyalties. They also have attitudinal/motivational capacities and shared beliefs.

Institutional development

A livestock mitigation programme that supports farmers' capacity to create appropriate structures through which to participate effectively in the decisions that affect their livestock industry need to be considered. Institutional strengthening is a key factor in partnership and self-reliance. The improvement in livestock development requires competent institutions to turn labour, land, capacity and technology into on-going improvements in farmers' lives. The philosophy is that strong organisations at all social levels are critical for the cost-effective transformation of rights into outputs; on-going participation of stakeholders; the mobilisation and regulation of local resources; the resolution and management of conflicts; effective control

in the division of benefits; the monitoring, evaluation and validation of externally suggested change; and the transformation of livestock policies into practice.

A programme that supports local institutions that promote the rights of the farmers in a way that is accountable to them needs to be the main focus. The basic idea is that insufficient and weak institutions are a critical bottleneck to sustainable and more equitable livestock development in Southern Africa.

Learning process oriented

The livestock mitigation programme should be able to learn from its own successes and errors in development. It should be able to embrace the error, not to externalise it. The challenge is to create and sustain mechanisms for learning and sharing lessons. International workshops like these are good and need to continue. There is however more need to have these workshops at all levels - local community, district, regional and national levels. More farmers should be allowed to participate in such workshops in future than at present.

There is a need to integrate farmer-led research and participatory research in the process of learning.

Forging linkages and alliances

The challenge in all this work of mitigating the crisis is to forge linkages and alliances with key stakeholders in livestock production.

Policy issues

While the government is creating a conducive policy environment in livestock development, there is a need to further examine some of the policies and practically implement such policies. Livestock marketing and slaughter of livestock are very critical issues to address in Malawi.

Conclusion

The importance of livestock in sustaining the livelihoods of rural communities need not be overemphasised. The livestock industry is however in a crisis situation as evidenced by the following indicators: in-adequate extension and training, lack of feeds, high incidences of diseases and parasites, theft and predators, lack of cash to buy livestock drugs, insufficient land for grazing, uncontrolled livestock breeding, and poor livestock marketing.

The major impact of this crisis on bio-diversity is a declining trend in livestock production and population and increasing food and livelihood insecurity of the rural households. In order to maintain the status quo in sustaining their livelihoods, rural communities resort to other means of getting income.

Concern Universal, recognising the importance of livestock in sustaining the food and livelihood security of the rural households, and recognising the current crisis in livestock production, developed a three - year (May 1999 to April 2002) livestock development strategy for Dedza District. This strategy was developed in liaison with key stakeholders in the livestock industry in Malawi.

In order to implement the livestock development strategy, Concern Universal is currently supporting the following initiatives: reducing diseases and parasites, development of community based livestock breeding centres, cross breeding, livestock credit scheme, improved livestock extension, local feed formulation and stocking, livestock marketing, local

capacity building.

In order to mitigate the crisis in the livestock industry, the following challenges need to be addressed among many others: sustainability, people centred livestock mitigation programme, empowerment of livestock farmers, participatory livestock development, capacity building of livestock farmers and communities, institutional development, learning process oriented, forging linkages and alliances and policy issues.

References

Banda J.W. 2000. *Small Scale Dairy Production In Dedza District: A Survey commissioned by Concern Universal in Dedza West*. Dedza, Malawi. polycopy

Banda J.W. 1999. *Livestock production in Malawi: Constraints and Options for Improvement in Productivity of Small Ruminants*. Dedza, Malawi. polycopy

Gasheke S. 2000. *Baseline Survey of Household Income, Assets and Farm Production, Dedza Sustainable Livelihood Project*, Concern Universal. Dedza, Malawi. polycopy

Mapemba J. 1999a. Factors Affecting Rabbit Production and Impact On Smallholder farmers: A Commissioned Concern Universal Case Study of Rabbit Beneficiaries. Concern Universal, Dedza, Malawi. polycopy

Mapemba J. 1999b. Constraints To Livestock Production In Dedza District: A Concern Universal Commissioned Case Study in Dedza West. Concern Universal, Dedza, Malawi. polycopy

ANNEX: Concern Universal livestock strategies

Table 1: Strategies for monogastric livestock improvement on smallholder farms

POULTRY
Diseases and parasites:
1. <u>New castle disease/ worms</u>
<ul style="list-style-type: none">• Vaccination - Farmers should be in groups so that vaccination can be carried out easily. Farmers should be made aware of the services.• Use of Ethno veterinary medicine should be encouraged e.g. Chitedze Roots and Dema.
2. <u>Fleas and mites</u>
<ul style="list-style-type: none">• Regular cleaning of the khola.• Disinfection of the khola.• Paraffin application on affected body parts of livestock.• Assessment of the existing drug supply system and its effectiveness.
3. <u>Poor housing</u>
<ul style="list-style-type: none">• Promote standard low cost and strong khola.
4. <u>Poor feeding</u>
<ul style="list-style-type: none">• Supplementation with madeya.• Provide clean water in troughs.• Release livestock to feed in the morning in the case of a free-range system.
5. <u>Lack of extension service</u>

- Strengthen extension in poultry through provision of training to field assistants in poultry production techniques.
- Veterinary assistants should be trained in poultry production and extension.
- Develop poultry extension packages.
- Encourage farmer participation in the poultry improvement programme.

6. Low genetic potential

- Promote selection within breed
- Promotion of cross breeding of strains that are prolific.

7. Theft and predation

- Promote good and strong housing.
- Facilitate the formation of strong livestock development committees.
- Use of ownership certificates
- Confine the movement of brooding hens.

COMMERCIAL POULTRY

1. Poor quality/ high cost and scarcity of feed

- Encourage farmers to use available or alternative materials for feed formulation.
- Train farmers / frontline staff in feed formulation.
- Promote bulk purchasing of essential/ expensive ingredients.
- Promote formation of clubs/ association.

2. Source of day old chicks

- Encourage the establishment of local hatcheries where-by farmers can come up with business plans for hatcheries for funding.

3. Incidence of diseases (NCD, Gumboro and Coccidiosis) and parasites

- Follow vaccination programme.
- Drugs should be accessible to farmers.

4. Poor management

- Proper advice on - feeding
 - housing
 - Vaccination
 - Cleaning and disinfection of kholas

General comments on poultry

- There is a need to promote other species of poultry like guinea fowl, ducks, pigeons, turkeys.
- Research in other poultry species should be encouraged.

PIGS

1. Diseases (ASF) and parasites (mites, worms, fleas) could be controlled through:

- Confinement of pigs
- De worming
- Pig cleaning and disinfection.

2. Poor management

- Confinement
- Promote good housing
- Promote on farm feed formulation

- Promote extension and research

RABBITS

1. Diseases

- Promote good housing
- Use of drugs
- Regular cleaning of houses

2. Feeding

- Proper feeding programme.
- Promote supplementation of concentrates.

3. Poor housing

- Promote good housing.

4. Lack of extension services

- Strengthen extension in rabbit production
- Train front line staff and farmers in rabbit production techniques.

5. Marketing

- Promote consumer awareness and preparation of rabbit meat.

Table 2: Strategies for small ruminants improvement on smallholder farms.

STRATEGIES FOR IMPROVING SMALL RUMINANT PRODUCTION

1. Diseases and Parasites

- Design extension messages on proper feeding and housing and prevention, control of diseases and parasites.
- Promote use of ethno veterinary drugs e.g. T. Vogelli (Jerejere).
- Encourage and strengthen the use of drug boxes at dip tanks.
- Improve accessibility of drugs to farmers.
- Conduct a diagnostic survey on prevalence of diseases and parasites and their causes to establish an annual trend.
- Document the required/ essential drugs.

2. Theft

- Form and strengthen livestock development committees to assist in security during sales and purchases of Livestock.
- Facilitate exchange visits to successful livestock development committees.
- Encourage construction of secure houses.

3. Grazing and feeding

- Encourage herding and appropriate tethering.
- Encourage integration of Agro-forestry with livestock production.
- Encourage the establishment of fodder banks/ pastures.
- Encourage conservation and utilisation of crop residues.
- Liaise with research Institutes on available alternatives on feed technologies.

4. Destructive behaviour/ and labour

- See feeding above (No.3).
- Awareness meetings on the behaviour of the small ruminant vs. husbandry practices
- Use of live fences e.g. sisal.

5. Lack of technical knowledge and poor management

- Conduct training for frontline staff and farmers on livestock management.
- Produce and disseminate extension messages.
- Organise field tours to successful livestock projects.

6. Housing

- Training of farmers/ staff on proper construction of recommended low cost housing.
- Organise field tours to organisations and farmers with recommended housing.

7. Lack of improved breeds

- Encourage within breed selection among the local small ruminants.
- Train farmers/ staff on selection within breed.
- Liaise with organisations with improved breeds on supply and multiplication.
- Initiate and support stud breeders and multiplier farmers.

8. Research and extension

- Conduct a situational analysis on existing small ruminant systems.
- Identify research needs.
- Assess and evaluate livestock technologies and identify research gaps.
- Facilitate formation of livestock farmers groups for transmission of extension messages.
- Strengthen research and farmer linkages through demonstrations, meetings, field days etc.

9. Marketing systems

- Encourage formation of associations.
- Establish linkages with marketing organisations.

10. Input supply

- Drugs (see solution 1).
- Group formation for credit.

Table 3:Strategies for large ruminant improvement on smallholder farms

BEEF

- Form very strong livestock committees. They should sensitise people to stop slaughtering young animals which are future stock.
- Practice village level selection and multiplication within the available stock.
- Evaluation and monitoring of production costs.
- Encourage farmers to participate in price negotiation through organisation of auction.
- Community leaders should participate in curbing theft e.g. Chikwawa livestock committees and Lilongwe west RDP- Khongoni.
- Sensitise the farmers on the benefits of raising beef animals through meetings.
- Encourage strategic de-worming and vaccination of beef animals against ECF.
- Improve nutritional status through good feeding.
- Improve on kraals through extension.
- Introduce tick control measures through application of acaricides, tick grease, T. Vogelli, Mpanjovu.
- Staff and farmer training
- Develop extension leaflets, manuals to strengthen research, extension and farmer linkages.
- Conduct PRA on beef production.
- Encourage farmers to buy drugs in bulk.
- Isolate good examples of indigenous medicines for research.
- Conduct awareness meetings on utilisation of fodder, legumes and crop residues.
- Conduct on farm Demonstration on the above.

Introduce Brahman and high grade bulls.

DAIRY

- Village level selection and multiplication of dairy breeds.
- Introduce other types of breeds e.g. Jersey , Gurnesy, Ayreshire, Sahiwal.
- Proper feeding in relation to breeding.
- Improve management in feeding: demonstration in feed conservation, legume utilisation, agro-forestry (with close supervision).
- Housing- demonstration and extension materials.
- Disease control strategies- vaccination, dipping and tick control.
- Calf rearing: train farmers. Develop extension packages, on farm demonstrations.
- Train farmers in feed formulation.
- Encourage farmers to buy premixes in bulk.
- Strengthen research extension and farmer linkages.
- Evaluation and monitoring of production costs.
- Form co-operatives to negotiate prices.
- Conduct farmer training at village level.
- Increase GoM and NGO initial support i.e. Training and financing.
- Train farmers in AI and heat detection.
- Train more breeders.

The presentations by different experts resulted in a wide range of discussion through the working groups. Table 5 below gives a summary of the constraints limiting livestock production in Dedza District and the possible solutions to the constraints.

Table 4: Constraints and solutions to improving livestock production

	Problems	Solutions
Monogastrics	<ul style="list-style-type: none"> • Husbandry and management • Diseases and parasites • Low genetic base • lack of extension services • lack of participatory programme 	<ul style="list-style-type: none"> • Exploration into alternative feed resources • Promotion of on-farm feed formulation • Training in on-farm feed formulation and mixing • Bulk acquisition of some ingredients
Dairy production	<ul style="list-style-type: none"> • Shortage of dairy cows to potential farmers • Poor grade of existing dairy cows • Shortage/unavailability of fodder for sale • High feed prices from commercial factories • Low milk prices • Lack of incentives to extension staff • High farmer to staff ratio (200 farmers) due to big areas being covered • Erratic training programmes • Difficult financing terms (to beginner) 	<ul style="list-style-type: none"> • Encourage production of small dairies • Encourage rural processing • Introducing bulls and AI • Training of farmers in AI • Marketing/potential all animals have to be TB tested and if free of TB the milk can be consumed. • Select stud breeders to produce cows for other farmers

Livestock (in general)

- High cost of feed
- Diseases and parasites
- Low prices of products
- Lack of link between research and extension
- Government policy on marketing
- Lack of good genetic base for improvement
- Lack of extension packages for certain species of livestock
- Limited contact between livestock farmers and extension workers
- Theft
- Encourage on-farm compounding of feed.
- Improvement on housing, management and nutrition.
- Encourage formation of associations which could negotiate for better prices.
- Strengthen research - extension-farmer linkages through a participatory approach.
- Support and strengthen already existing rural marketing systems.

Session 4: Product enhancement and human resources development

Promotion of higher education: Is there a role for the traditional agricultural university in development?

Clemens B A Wollny

SACCAR-GTZ Project, Bunda College of Agriculture, P.O. Box 219, Lilongwe, Malawi

[Abstract](#)

[Introduction](#)

[Situation analyses](#)

[The potential of the agricultural and natural science universities](#)

[The role of information technology and distance learning](#)

[Conclusions](#)

[References](#)

Abstract

This paper analyses the status of higher education in Southern African Development Community (SADC) with a focus on agricultural universities and recommends innovative strategies and actions. The central role of higher education for development has been recently re-emphasised at various international conferences and in reports. Institutions of higher education should serve as a 'gate to global knowledge' - the key factor for development. Knowledge becomes the critical factor in the process of globalisation. The level of higher education has an immediate impact on economic competitiveness and democratic development of the society. The efficiency and effectiveness of universities are still insufficient to meet the national and regional demand for adequately trained personnel in SADC. In agriculture, the backbone of economy in SADC countries, and in the livestock sub-sector the situation is alarming. Land degradation, food insecurity and erosion of plant and animal genetic resources are some of the major challenges to be faced. Universities, therefore, should become innovators and key players in the sustainable development of the region. Agricultural universities have the tools and experiences to provide leadership in the following areas:

- Education sector - through training of teachers in agriculture and managing, reform of the educational sector through revision of curricula, and development of relevant outreach and distance learning programmes
- Poverty reduction strategy - through providing access to and transferring knowledge on technical, economical and political methodologies relevant to rural development and food production. This requires an integration of the institution itself into development programmes within and across the agricultural sector.

- Utilisation and conservation of plant and animal genetic resources - through development of strategies, concepts and action programmes. Collaboration with the CGIAR system would ensure state-of-the-art application of methodologies.

At present, eight universities host regional postgraduate programmes in agriculture for SADC and they have the experiences and tools to develop interdisciplinary training and research programmes of variable duration, to create regional technology transfer centres and to improve networking within and between regions and build formal linkages (South-South). Effective quality control of training and research programmes and regular curriculum reviews, however, are considered critical. The professional implementation and reporting of projects is essential to build up a good reputation. Cross-sectoral development programmes financed by the international donor community offer opportunities to agricultural universities to integrate their knowledge and capacity. The development of outreach and information technology based distance learning programmes could improve the efficiency of institutions. In conclusion, the institutions of higher education in agriculture should become more active and should play a leadership role in the acquisition and implementation of programmes which are relevant to the national and regional development objectives.

Introduction

The central role of higher education for development has been recently re-emphasised at various international conferences and in reports (UNESCO 2000; WORLD BANK 2000). Institutions of higher education should serve as a 'gate to global knowledge' - the key factor for development. Knowledge becomes the critical factor in the process of globalisation. The level of higher education has an immediate impact on economic competitiveness and democratic development of the society (Benell 1999). The availability of high quality agricultural and natural resources management experts with skills in policy development, and a strong technical background and management skills is essential to achieve progress in SADC countries, where the agricultural sector still dominates the standard of living of the majority of the population. The major social, political and economic forces that are influencing the development process within and across the agricultural sector are still poorly understood. Graduate and post-graduate training is therefore critically important in improving the knowledge base and to cope with the influx of new information and technologies from outside the region. The design and implementation of adequate agricultural policies, the development of entrepreneurship, the development of the private sector in several SADC countries, the empowerment of traditional communities, and the co-ordination of donor-financed activities are professional challenges that require highly trained and skilled personnel. This paper analyses the status of higher education in SADC with a focus on agricultural universities and recommends innovative strategies. In this paper the understanding of an '**agricultural university**' may include a faculty of natural science or even veterinary medicine.

Situation analyses

Table 1 presents indicators of higher education in SADC. Major progress has been made in primary and secondary gross enrolment of students over the last thirty years. Higher education, which includes college and university based studies, has become significant but it is still well below world average for SADC. The actual numbers of students and the number of students per 100,000 inhabitants show clearly low minute availability of trained professionals compared to the world average, not to mention western countries. Furthermore, such quantitative figures should be carefully interpreted, as they do not imply a standardised level of quality, as most university lectures in SADC know from their own experience. There might be flagship universities or programmes or colleges, which produce poorly qualified students for a number of reasons. The lowest figures of tertiary students are found for Mozambique, Tanzania, Malawi and Angola. From the latter the 71 students per 100,000 inhabitants

corresponds to the year 1990, indicating the instability in the country. The proportion of science based students, which include students in natural sciences, engineering and agriculture but excludes students of the medical sciences, ranges from 4 to 46 % for actually enrolled students. In most countries this may indicate the capacity of the existing universities rather than the need or the original interest of the student. Many systems are still inflexible and the undergraduate student may not be in a position to choose freely his or her field of study (World Bank 2000). Presumably a considerable number of students pursue their post-graduate training outside of SADC but statistics are not available for any of the countries of the SADC region. It is understandable that expenditures of 15 (South Africa) to more than 20 % (Malawi, Zambia) of the public currently spending money on higher education as a percentage of total public current spending on education in 1995 leaves little room for an increase of the budget for universities and colleges. The relative extraordinary high costs of one tertiary student become even more impressive when expressed as expenditure per student as a percent of GNP per capita. It ranges from 59 (South Africa) to 979 % (Malawi) for SADC countries, where data are available (World Bank 2000). Compared with the world average of 26 % of high-income countries, it is obvious, that national efforts are tremendous just to train one professional. The economic figures do not encourage donors to invest in university education as a priority giving the burning issues of food security and the HIV/AIDS problem. On the other hand, it must be argued that the agricultural sector remains the economic backbone of the region and land degradation, erosion of plant and animal genetic resources, food insecurity are major prevailing challenges in SADC. The efficiency and effectiveness of universities appears to be still insufficient to meet the national and regional demand for adequately trained professionals. The supply of computers and the access to the Internet (Table 2) demonstrates the wide range within and between the region and the rest of the world. The widely used Human Development Index (HDI) does not indicate the extreme gaps in information and communication technology (Table 2).

As early as 1988 the situation prompted the German Government to support through its implementing technical co-operation agency GTZ (Deutsche Gesellschaft fuer Technische Zusammenarbeit) post-graduate training in agriculture in SADC. The overall goal of the project is to improve postgraduate training in agriculture in SADC and to contribute through capacity building to improvement of food security.

The immediate project purpose is to establish competitive MSc programmes in agriculture relevant to SADC. The project aims follow:

- To establish effective management of the MSc programmes, and to provide well trained and motivated staff
- To offer adequately structured courses with relevant content
- To implement departmental research strategies
- To improve the quality and facilities of teaching and research
- To strengthen regional and international networking.

The Southern African Centre for Co-operation in Agricultural Research and Training (SACCAR) in Gaborone is the executing agency. The German contribution targets agricultural faculties of the universities of Malawi, Tanzania, Zambia and Zimbabwe. The support package strengthens post-graduate capacity through provision of regional MSc scholarships, expatriate assistance, supply of equipment, network support, link programmes and regional and overseas PhD scholarships. Starting from almost non-existent capacity, the currently offered annual intake capacity of about ten postgraduate students per faculty is impressive but still low compared to the situation outside of SADC. In marked contrast, academic institutions in agriculture offering courses for tropical and developing countries in Europe have a large and growing post-graduate capacity and compete on the international market. Looking at several institutions the income might be of higher priority than the relevance or the needs of the programmes. Courses range from short-term residential to long-term distance learning courses

covering all kind of subjects, options and degrees. Due to the high costs and the recognised need to train the student on relevant topics within the region the number of donor-sponsored participants from SADC is not increasing and in some disciplines it is even sharply decreasing (Benell 1999). SADC based universities should realise that they compete with universities in the region and internationally for the best students and international recognition. The need to adjust and to change to being more competitive is obvious.

The potential of the agricultural and natural science universities

Agricultural and natural science universities have the potential to provide more and better training utilising their tools and experiences. The SACCAR directory of agricultural and veterinary medicine faculties lists the various institutions in the region (SACCAR 199?). The challenge is to play a more active role and aim to gain leadership in the field of expertise. This sounds far from reality under the given situation of many faculties where most undergraduate students cannot even afford a textbook and only "those students, who regurgitate a credible portion of their notes from memory achieve exam success" (World Bank 2000). Independent and flexible thinking and learning by problem solving is often not the standard in undergraduate and even post-graduate classes of today. It is obvious that the improvement in the quality of teaching and research among other things deserve high priority and must go hand in hand with additional engagement. There is an urgent need to expand the role of the universities if they wish to play a significant role in the development of their country and the region in the future. Today's traditional universities have the potential to contribute to innovation and sustainable development in the region at a much higher level of impact. Agricultural universities, for example, could achieve impact through pursuing various strategic options such as the following:

- In the education sector through training of teachers and managers in agriculture, reform of the educational sector through revision of curricula and development of relevant outreach and distance learning programmes.
- Focus on poverty reduction programmes through providing access to and transferring knowledge on technical, economic and political methodologies relevant to rural development and food production. This requires an integration of the institution itself into development programmes within and across the agricultural sector.
- Utilisation and conservation of plant and animal genetic resources through development of concepts, management and action programmes. Collaboration with the CGIAR system would ensure state-of-the-art application of methodologies.

At present, eight universities host regional postgraduate programmes in agriculture for SADC and they have the experiences and tools to develop interdisciplinary training and research programmes of variable duration, to create regional technology transfer centres and to improve networking within and between regions and build formal linkages (South-South). Effective quality control of training and research programmes and regular curriculum reviews, however, is considered as critical to sustainability.

At the regional level universities may submit proposals for regional training programmes to SACCAR, which need to fulfil the following criteria (SACCAR 1993):

- Relevance and importance of the subject to SADC region
- The host institution must be able and willing to host and support the programme
- The host institution must have adequate staff and facilities and should be a recognised leader in their field
- A record of performance in training and research must be available and continuously updated
- The host institution should be in a position to attract financial and political support at

various levels

Such criteria are presently under review. It has been recognised that the quality aspect must be more emphasised and a quality assurance system needs to be installed. A standardised accreditation system for the host universities and reporting system needs to be introduced as well.

The professional implementation and reporting of projects is essential to build up a good reputation towards the scientific community and also towards sponsors. Cross-sectoral development programmes financed by the international donor community offer opportunities to agricultural universities to integrate their knowledge and capacity. For example, the key elements of German technical and financial co-operation, which are not particular different from other international donors, are poverty reduction, equal opportunity, conservation of natural resources and crisis prevention. It is obvious that agricultural universities could be more involved in planning and execution of development projects and programmes. The intensified interaction with the prevailing problems would have a positive effect on the relevance of teaching and research for both staff and students. In addition, the institutional ability to develop outreach programmes based on on-farm research could become attractive to stakeholders.

The role of information technology and distance learning

With proper support, adequate teaching material and effective networking a student can most likely learn better at home than under crowded college conditions. The provision of higher education will be affected by the on-going revolution of the information and communication technology sector. It may happen, that conventional campus-based universities will soon become outdated and obsolete. Overseas institutions can offer a great choice of interesting and cost efficient courses and local universities may become simply agents of franchised programmes or even left out if they resist change. Currently, the University of South Africa offers distance education programmes and is one of the world's largest providers of distance learning courses. In addition, private institutions offer numerous courses in different subjects. The University of Zimbabwe is developing a distance-learning programme in agricultural sciences. To the author's knowledge, no other university of the region offers a distance-learning programme in agriculture or natural sciences at the undergraduate level. There is considerable scope to replace the currently time and capacity consuming, inefficient undergraduate teaching through IT based interactive technologies. The standard of teaching needs to be improved in terms of quality and quantity (World Bank 2000). Learning courses for distance programmes are easier to validate - they are simply 'on file'. An update is no problem from a technical point of view. However, the initial investment is high and the reliability of the technology remains to be tested. A more efficient undergraduate programme may result in improvement of research-based post-graduate programmes, which require the student's presence on campus and in the field.

As a pilot project the Animal Science Department of the University of Malawi and the International Livestock Research Institute (ILRI) are presently developing, with the support of the SACCAR-GTZ project, a virtual library on CD-ROM on animal genetic resources and related fields. This library contains a search function and serves as a tool for researchers, trainers, managers, and policy makers and for under-graduate and postgraduate training. At a later stage it will be available through the Internet and will have links to other web pages. It provides opportunities for self-learning but students still need guidance and supervision. The Swedish University of Agriculture initiated a training resources project on animal breeding, which is currently under development by ILRI (Mpofu et al. 2000).

Conclusions

The institutions of higher education in agriculture should become more active and should play a leadership role in the acquisition and implementation of programmes, which are relevant to the national and regional development objectives. The colleges and universities should leave their 'institutional ivory tower' and get actively involved in, for example, the education sector, the national poverty reduction programmes and the management and utilisation of indigenous genetic resources. The development of attractive training materials produced on CD could be a first step to disseminate knowledge in a cost-efficient way. There is considerable scope for IT based distance-learning programmes for undergraduate courses. The improvement in the efficiency and efficacy of the existing higher education system could be significant through the use of modern communication technology. The use of IT based training resources, the expanding market for distance learning programmes and, finally, the virtual university developments, have the potential to provide knowledge to all and offer opportunities for lifelong learning.

References

Bennell P. (1999) Strengthening post-graduate training capacity in development policy analysis and management in Sub-Saharan Africa. Institute of Development Studies, University of Sussex, Report prepared for the Department for International Development (DFID), UK.

Mpofu et al., 2000 i.e. Paper presented at the same conference.

SACCAR (Southern African Centre for Co-operation in Agricultural Research and Training). 1993. *Procedures and criteria for the selection of SADC regional training programmes and host institutions*. SACCAR, Gaborone, Botswana

SACCAR (Southern African Centre for Co-operation in Agricultural Research and Training). 1997. *Directory of agricultural and veterinary medicine faculties in SADC*. SACCAR, Gaborone, Botswana

UNESCO .2000. *World education report 2000*. The right to education: Towards education for all throughout life. UNESCO Publishing, Paris, France.

World Bank. 2000. Higher education in developing countries. Peril and Promise. The Task Force on Higher Education and Society (Ed.). World Bank. Washington D.C., USA.

The framework for regional collaboration in animal agriculture: The SADC animal agriculture network (SAARNET)

Sahr. H. B . Lebbie

International Livestock Research Institute (ILRI)

P. O. Box 30709, Nairobi, Kenya

[Abstract](#)

[Introduction](#)

[The SADC animal agriculture research network \(S - AARNET\)](#)

[The evolution](#)

[Vision](#)

[Mission](#)

[Objectives](#)

[The institutional framework of the network](#)

[Regional dimension of the network](#)

[Structure of the network](#)

[Stakeholders](#)

[Governance](#)

[Office and technical committees](#)

[THE S-AARNET livestock research and development strategy](#)

[Problems to be addressed](#)

[Strategy formulation](#)

[Guiding principles](#)

[Species and commodity output](#)

[Agro-ecological zones and production systems](#)

[Research and research related priorities](#)

[Nature of research](#)

[The beneficiaries](#)

[Considerations driving the research and development agenda](#)

[Research priorities formulation process](#)

Research agenda goal and objectives

Goal

Objective

The research agenda and related activities

Genetic improvement, conservation and utilisation

Research activities

Expected products

Nutrition and feed resources development

Research activities

Expected products

Sustainable integrated animal health management

Research activities

Expected products

Natural resource management

Research activities

Expected products

Systems, policy and socio-economic analysis

Research activities

Expected products

Crisis mitigation in livestock dependent systems

Research activities

Expected products

Human resource development (capacity building)

Facilitating training for MSc and PhD in the following areas of specialisation

Short courses/workshops through collaboration with ILRI and other relevant organisations in the following areas

Training of trainers

Mode of operation and implementation

Development and approval of research and research related activities

Management of activities

Collaborators

[Monitoring and evaluation](#)

[Guidelines and format for developing project proposals](#)

[Guidelines](#)

[Format](#)

[Conclusion](#)

[References](#)

Abstract

SACCAR's strategy emphasises that dynamic, productive and responsive agricultural research systems are essential to realising the food security potential of the Southern African Development Community (SADC) region and the continuous development of technologies for different sectors of agriculture will depend on a co-ordinated effort by countries of the SADC region. It is against this backdrop that SACCAR has adopted networking as a strategy to achieve strong co-ordination and collaboration among SADC member states for regional development and advancement in agriculture. The SADC Animal Agriculture Research Network (SAARNET) was therefore formed in 1997 as a joint effort between SACCAR and International Livestock Research Institute (ILRI) to provide the framework for regional co-ordination and collaboration in animal agriculture. SAARNET as a regional network aims at promoting partnerships between different stakeholders (institutes, governments, donors, farmers and research disciplines) to solve common problems. Partnerships will be strengthened between stakeholders through participatory approaches (workshops, seminars, field days and training sessions) to plan and prioritise activities, and share information, technology, and materials. The organisation and operation of a collaborative research network such as SAARNET is very challenging though rewarding. It is therefore critical that the institutional framework and activities of the research network are clearly related to the needs and goals of all its stakeholders, including the farmer. Also crucial to the success of the network are simple but efficient mechanisms for co-ordination, information dissemination, monitoring and evaluation, and impact assessment. Above all, a network needs sustainable funding to be able to implement its programmes and ensure the effective participation of the stakeholders, particularly the National Agricultural Research Institutions (NARIs). This paper elaborates SAARNETS strategy to achieve this daunting task.

Keywords: SADC, SACCAR, Regional collaboration, Animal agriculture, SAARNET

Introduction

The central problem facing SADC member states today, like many other regions of the developing world, is providing sustainable food security for a human population that is increasing by almost 3% annually while protecting the environment at the same time. In confronting this daunting task, SADC member states agreed to work together and created the Food, Agriculture and Natural Resources Sector to address this challenge, with the Botswana Government responsible for the co-ordination of agricultural research and training (Natural Resources, Fisheries and Forestry were added later).

To fulfil its mandate, the Botswana Government established SACCAR in 1984 to co-ordinate regional research and training activities. SACCAR adopted networking as a mechanism for accomplishing its regional mandate for research in collaboration with its partners, mainly the IARCs. Up to 1996, the ILRI supported collaborative research networks, AFRNET, CARNET

and SRNET, worked within SADC, but largely on a bilateral basis. There were no direct links between these networks and SACCAR, except through reciprocal representations at meetings at institutional levels.

A number of developments have begged for the revolutionisation of this *modus operandi*. The 1990s saw a strong focus on regional associations by the World Bank and other major donors as providing the best opportunity for reinvigorating and strengthening collaboration in agricultural research compared to the traditional bilateral initiatives. An external review of the NARS- ILRI collaborative research networks (AFRNET, CARNET and SRNET) by major donors (USAID, GTZ, IDRC and ODA) in 1994 recommended that the commodity networks be transformed from their predominant disciplinary and pan-African operational strategy into a multidisciplinary livestock network with regional focus. Following the review and analysis of its 1995 priorities and long-term strategy, the Board of SACCAR and the major stakeholders recognised in 1997, the need to give livestock research, especially animal production research, a higher profile in future regional activities compared to the past. This review also underscored the need to adopt networking as the mode of operation in the implementation of all regional initiatives. Another important development worth noting is the gradual but consistent reduced funding of international and national agricultural research, especially livestock research, due to several reasons including misconceptions about the impact of livestock on the environment and human health as well as economic stress in the developed world.

It is against this backdrop that SACCAR, in consultation with its major stakeholders (including ILRI), decided to do a fundamental restructuring of its livestock sector, including the creation of a livestock research network known as the SADC Animal Agriculture Research Network (S-AARNET), to ensure a balanced development towards the achievement of sustainable food security in the region. The proposed network strategy and programmes that follow provide the platform for the implementation of the SADC-SACCAR livestock research and development strategy.

To ensure food security and stimulate development, the region must increase the productivity of agriculture, including animal agriculture through science - based technologies and inputs. This can be achieved largely through the establishment of regionally co-ordinated research systems that are strong and sustainable. This proposition was underscored in SACCAR's Regional Research Priorities for Crop and Livestock Production document (SACCAR 1997), which indicates strongly that "Dynamic, productive and responsive agricultural research systems are essential to realising the potential of the SADC region. The continuous development of technologies for different sectors of the farming community will depend on a co-ordinated effort by countries of the SADC region"

The new paradigm in networking, that is, the regional approach, is thus very consistent with this regional strategy.

The SADC animal agriculture research network (S-AARNET)

The evolution

ILRI (then ILCA), like SACCAR, adopted networking as a mechanism for capacity building for research in the National Agricultural Systems (NARS) in sub-Saharan Africa. This led to the establishment of three pan-African livestock commodity networks between 1989 and 1990: AFRNET, CARNET and SRNET.

In 1994, an external review of the NARS- ILRI collaborative research networks (AFRNET,

CARNET and SRNET), by major donors (USAID, GTZ, IDRC and ODA) recommended that the commodity networks be transformed from their predominant disciplinary and pan-African operational strategy into a multidisciplinary livestock network with regional focus. In the same year, the Special Programme for African Agricultural Research (SPAAR), the donor community, NARS and IARC's decided to work through regional organisations including ASARECA, CORAF and SACCAR, to reinvigorate and strengthen collaboration in agricultural research in sub-Saharan Africa. These developments were seen as a driving force for change in the operations and structure of the existing networks as well as providing new opportunities for technology generation and transfer to fuel sustainable increases in market oriented livestock production in the sub-region.

In March 1996, a meeting of the Steering Committees (composed of elected NARS scientists) of the three pan-African collaborative commodity research networks endorsed the recommendation to reorganise the ILRI supported networks into a multidisciplinary regional livestock network. This network was to be affiliated to the sub-regional research organisations (ASARECA, SACCAR and CORAF) in order to make them more relevant to regional animal agriculture research needs and priorities.

In September 1996, the recommendation to reorganise ILRI-supported collaborative research networks was approved by the SACCAR Board of Directors (CD).

In April 1997, at a joint SACCAR-ILRI workshop, the representatives of SADC member states formally launched the SADC Animal Agriculture Research Network and suggested its institutional framework and mode of operation. The stakeholders also reviewed the revised SACCAR Livestock Research Priorities (SACCAR 1997) and a proposal on "*Collaborative Research for Livestock Development in Southern Africa*" from which they developed the networks priorities for regional research in animal agriculture. The same year, the SACCAR Board endorsed the recommendations and approved the establishment of a Regional Steering Committee (RSC) comprising of two nominated eminent scientists from SADC regions, representatives of each SADC member state, ILRI, SACCAR, the SADC Livestock Sector Co-ordinating Unit and the donor community to serve as a governing body of the regional network. A SADC Secretariat representative could have a seat on the Committee as an observer to advise on regional policy issues.

Vision

The vision of SAARNET is to enhance food security and the well-being of present and future generations in the SADC region through sustainable increase in the productivity of the animal agriculture systems.

Mission

The mission of SAARNET is to co-ordinate and promote regional integration of animal agriculture related research, training and information exchange activities to promote a sustainable increase in livestock productivity.

Objectives

- provide leadership in animal agriculture research in the region
- develop and deliver research products that enhance the welfare of the people, particularly the rural poor
- build and sustain regional capacity, partnerships and alliances for effective regional research, training and information dissemination
- assist in setting priorities and mobilising resources for implementing the regional animal

agriculture research and related activities.

The institutional framework of the network

Regional dimension of the network

As a regional network, S-AARNET will cater for the needs, interests and expectations of the relevant stakeholders in all SADC member states. These stakeholders include scientists in the NARS, NGOs, farmers and other public and private sector organisations.

This broad based participatory approach will ensure the creation of a critical mass of regional expertise that will surpass the individual capacities of member states to tackle the numerous and variable constraints to the improvement of the productivity of animal agriculture systems.

The network will provide opportunities for a collaborative approach to research with each partner contributing according to its comparative advantages. Another benefit of the collaborative approach is that it provides opportunities for multi-site and multi-location trials of which results could be extrapolated and applied broadly.

Structure of the network

The organisational structure of S-AARNET is aimed at providing opportunities for full participation and involvement of all stakeholders interested in research and development of animal agriculture from both the public and private sectors.

Stakeholders

S-AARNET is open to all individuals, institutions and organisations with an interest in animal agriculture research and development in the SADC member countries. Members are expected to actively participate in S-AARNET activities as well as assist SACCAR and the Regional Steering Committee (RSC) in promoting the interest of the network at all times.

Governance

S-AARNET programmes and activities will be articulated and managed at various levels, namely, the SACCAR Technical Advisory Committee (TCART), the Regional Network Steering Committee, the National Network Committees, the Co-ordination Office and Technical Committee.

Office and technical committees

The SACCAR Technical Advisory Committee on Agricultural Research and Training (TCART) defines regional research policy guidelines and approves regional research priorities and programmes for technology development and transfer. The TCART will, through the SACCAR Secretariat and ILRI, assist the network in mobilising the required resources for the implementation of its programs.

The Regional Steering Committee (RSC) is composed of representatives of each SADC member state, ILRI, SACCAR, the SADC Livestock Sector Co-ordination Unit and donors, two nominated eminent regional scientists and the Network Co-ordinator who will act as Secretary to the RSC. A SADC Secretariat representative will have an observer status.

The RSC ensures that the network policies are followed and implemented. As an advisory committee, the major responsibilities of the RSC are:

- identification of the regional research and development priorities to be submitted to SACCAR TCART for approval through the statutory SADC channels;
- advising SACCAR on programmes and projects to be supported by the region
- assisting in the development of research programmes in relation to SACCAR regional priorities
- peer review and selection of research proposals for funding
- monitoring, evaluation and publicising network activities
- facilitating impact assessment by individual NARS
- assisting in capacity building in the NARS
- participating in the recruitment and evaluation of the Co-ordinator
- fostering linkages within their respective countries and with the network
- facilitating linkages with other organisations implementing similar projects
- creating public awareness.

The National Network Committees (NNC): In the spirit of encouraging the full participation and involvement of all stakeholders as well as addressing their needs, interests and expectations, each participating country will be encouraged to put in place a National Network Committee. The membership of the Committee should include NARS scientists, farmers' representatives, interested private entrepreneurs, and NGOs and regional and international organisations operating in the country. The major responsibility of the committee will be to articulate constraints to livestock production at the national level, identify research priorities and link with the RSC to develop programmes to be implemented within the framework of S-AARNET.

The national committee will also facilitate the validation and transfer at the national level of S-AARNET developed technologies and information.

For each country, the country representative to the RSC will serve as the link between the National Network Committee and the RSC.

The Co-ordination Office: The Co-ordination Office will be in ILRI or SACCAR. The implementing agents and the functions of the network co-ordinator include:

- the day to day management of the network activities under the operational directives of the RSC
- monitoring and co-ordinating the implementation of the network research programme in member countries
- assisting and whenever necessary guiding national scientists in the implementation of their protocols as well as assisting them or organising assistance in the analysis and interpretation of experimental data emanating from their research
- organising and facilitating the running of identified training courses for national scientists and other partners
- organising thematic workshops and seminars and editing their proceedings
- assembling and disseminating to participating scientists and other partners database and literature searches relevant to the network research programmes
- preparing an annual programme of work as well as annual reports for consideration and approval by the RSC and SACCAR TCART
- linking participating NARS scientists with ILRI scientists whenever necessary
- maintaining close contacts with donors through ILRI and SACCAR Secretariat
- acting as Secretary to the Steering Committee meetings
- in collaboration with the Chairman, represent the network at the relevant SACCAR meetings and other forums and establish functional linkages with the ASARECA and CORAF Animal Agriculture Research Networks as well as with other relevant networks and institutions operating in the region.

Technical Committees: The RSC will identify within the region and in ILRI, key experts to

serve as members of Technical Committees (TC) in the following areas of expertise: (i) animal breeding and genetics, (ii) forage agronomy and animal nutrition, (iii) socio-economy and policy analysis, (iv) systems and natural resources management, and (v) animal health. Each Technical Committee will include a minimum of three experts and will assist the RSC to review proposals and technical reports submitted by collaborating scientists.

THE S-AARNET livestock research and development strategy

Problems to be addressed

Without improved agricultural productivity, the SADC countries will not meet future demands for food security. The major opportunities for increasing livestock productivity lie in the better integration of crop and livestock production in smallholder systems and large-scale livestock enterprises as well as improvement of range management for large-scale beef production.

The most serious constraints to improved livestock productivity in the major ecological zones of the region (humid, sub-humid and semi-arid) are: inadequate nutrition, low animal productivity, animal diseases, lack of information reaching the farmers on potential innovations, and specific agro-ecological constraints. Livestock production is also adversely affected in a number of countries by inappropriate socio-economic and policy environments such as price control, lack of credit and market information, monopolistic behaviour, excessive regulations and control of livestock movements or inadequate infrastructure that limit producers' access to inputs and appropriate technologies. These result in severe setbacks in the development of the sector, as there is no incentive for the promotion of livestock production and the marketing of livestock and livestock products at national and regional levels. Furthermore, livestock marketing is often constrained by zoonotic and epizootic diseases such as brucellosis, anthrax, Rift Valley Fever, rinderpest, foot and mouth disease etc., which result in animals or livestock products being banned for export or local/regional consumption.

In relation to pastoral systems, some countries have developed contingency plans for emergency responses to disasters but the operations of the existing Early Warning Systems (EWS) do not address the interests of livestock systems. The frequency, quality and timeliness of information provided are still insufficient to constitute proper tools for disaster management at national or regional levels. Again findings from vulnerability studies are rarely pieced together to form a regional picture that could lead to the formulation of comprehensive strategies for disaster management and contingency plans (prevention, preparedness, early warning, mitigation, public education and training, impact assessment and need assessment, relief and rehabilitation).

From the institutional perspective, existing post-graduate education is not preparing scientists adequately for research on integrated crop-livestock systems and many scientists are working in isolation, not able to keep abreast of new techniques and methodologies. Extension services are not efficient enough in promoting the adoption of modern techniques by farmers. There are also weak links between research, extension services and farmers. The infrastructure available for livestock research and development is also usually not fully utilised for lack of operating funds or relatively minor capital items.

In order to overcome the above problems, NARS must adopt strategies to mobilise human and capital resources for implementing research projects, as well as provide continuing education opportunities to restore and strengthen their research capacity for improved technology generation and transfer to producers.

Strategy formulation

This network strategic plan is consistent with the revised SACCAR regional priorities and strategies for achieving food security in the SADC region through increases in agricultural production, efficient and sustainable utilisation and conservation of the natural resources, and increased economic growth. The plan is also in line with the recommendations made by representatives of SADC member states at the workshop that launched the network and formulated its research agenda in April 1997. Formulating a livestock research strategy to anticipate and address the needs of the region is a task with multi-dimensions. These include guiding principles and considerations for species, commodity outputs, agro-ecological zones, farming systems, research and research related priorities, the focus and nature of research, equity, poverty, the environment, sustainability and potential impact. This strategic plan is built on these elements.

Guiding principles

The success and impact of the activities to be undertaken by the network will depend largely on the extent to which these activities are focused and relevant to the livestock research and development strategy of the SADC region. Therefore the choice of activities to be undertaken by this network will be guided largely by the following criteria:

- The activity must be regional in character and consistent with SADC-SACCAR strategy and priorities. The first objective is the generation of new knowledge and products, while the others include training, information dissemination and partnerships.
- The activity must be one for which the network has a comparative advantage.
- The activity must be research or research related.
- The activity must take cognisance of global and regional concerns on food security, poverty reduction, environmental protection, gender sensitivity and sustainability.
- The activity must be demand-led, and target SACCAR-SADC priorities.
- The activity must be multidisciplinary and multi-institutional in character.
- The activity must have potential for regional impact.

Species and commodity output

The strategy targets five livestock species including cattle (beef and dairy), poultry, goats, sheep and pigs and nine commodity outputs (meat, milk, eggs, fibre, hides, skins, pelts, manure and traction). In the long term, however, with recurrent droughts and increased potential for increased commercialisation of cattle and the intensification of small-holder mixed crop-livestock systems, equines (especially donkeys) are likely to assume an important role in providing draft power in the small-holder production systems.

Agro-ecological zones and production systems

For the purpose of addressing research priorities, the region is broadly divided into three agro-ecological zones, namely, the semi-arid, the sub-humid and humid zones. Emphasis will be placed on mixed crop-livestock systems in the semi-arid and sub-humid agro-ecological zones for all species and intensive commercial production of pigs and poultry across all the zones. Some arid zone and pastoral systems have potential for increasing production and offtake, but the opportunity to enhance these will be to focus on natural resource management and drought mitigation.

Research and research related priorities

The research and research-related priority domains identified include animal genetic improvement (including the characterisation, conservation and utilisation of animal genetic resources, and the evaluation and exploitation of resistance/tolerance to diseases and

parasitism); improving feed supply and nutrition (with emphasis on locally available forages, crop residues and agro-industrial by-products); integrated animal health management (including epidemiology, vaccine development, disease control and animal health delivery systems); natural resource management in crop-livestock systems (including systems analysis and impact assessment, range land ecology studies, monitoring of land-use systems and their impact on the environment); policy and socio-economic analysis on issues relating to animal agricultural development; and strengthening regional research capacity.

Nature of research

The network research activities will focus on applied and adaptive research in the development and management of the production systems, the conservation and management of resources, and selected commodity development and improvement. However, the network will undertake basic and strategic research activities needed to support its applied and adaptive research activities in collaboration with partners including International Agricultural Research Centres (IARC's), Advanced Research Institutions (ARI's) and the private sector. The complex nature of animal agriculture demands a holistic approach to research, hence the research activities will emphasise a farming systems approach with opportunities to ensure the full participation of the relevant stakeholders, including farmers.

The Beneficiaries

The majority of the key players in livestock dependent production systems are resource poor, especially women and children. The primary concern of the strategy is therefore the generation of knowledge and products that will enhance the welfare of the resource poor.

The immediate beneficiaries will be the NARIs and their scientists as well as the collaborating research and development institutions including the NGOs, the extension services and the regional/international centres.

In the medium term it will be the farmers participating in the implementation of the network strategy programmes.

In the long-term the main beneficiaries will be farmers and the national economies through economic growth at household and national levels.

Considerations driving the research and development agenda

The logical consideration in developing a broad based regional livestock research and development agenda is to look at the development needs of the sector and the factors driving those needs.

A number of major trends are known to be affecting the livestock sector and determining the needs of the sector and therefore merit consideration. These are, *inter alia*:

- almost all of the ruminant meat and milk as well as most of the pig meat production will, for the foreseeable future, continue in the smallholder systems
- however, most of the increase in production will come from the intensification of livestock production in these smallholder-mixed farming systems, in which there will be a greater interdependence of livestock and crop sub-systems
- and as intensification increases, research must increasingly recognise the need for ecosystem management
- also with intensification of agriculture, the productivity of smallholder production systems will largely depend on increased use of inputs such as traction, manure and fertilisers
- with increase in urbanisation, changes in consumer preferences could lead to

- specialisation and in some cases, a shift to industrial scale production as in the case of pig and poultry production
- resource management issues are perceived as the major challenges in some pastoral systems with potential for increasing production and offtake
- new science-based technologies have potential to significantly enhance animal agriculture productivity
- strengthening human and institutional capacities will create greater capacity for research and development in the region.

Research priorities formulation process

The research agenda largely addresses the revised SACCAR priorities and strategy. The agenda also draws on several other sources of information including a number of studies, workshops and regional sector reviews that have identified opportunities for increased and sustainable livestock productivity deriving from the application of research-based technologies. These include among others:

- November 26–27 1986: SACCAR workshop on smallholder dairy, small ruminants, pig, poultry and rabbit production in the SADC countries, Maseru, Lesotho.
- July–August 1988: ILCA-commissioned feasibility study on ILCA/SACCAR livestock research collaborative activities in SADC countries.
- March 1989: SACCAR/Rockefeller Foundation/CGIAR Task Force on African Consultations.
- July 1992: ILCA workshop on the future of livestock industries in East and Southern Africa, Kadoma, Zimbabwe.
- November 1992: World Bank/SPAAR/SACCAR Task Force Report on Agricultural Research in Southern Africa: A Framework for Action.
- 1995: Consultancy report on the long-term strategy for regional research priorities on food, agriculture and natural resources in the Southern Africa Development Community (SADC) (Vol. 3. Livestock Sector).
- January 1997: Consultancy reports on the "regional research priorities for crop and livestock production.

February 17–21, 1997: FAO/SADC/UNDP workshop to discuss "a basic strategy for the development of farm animal genetic resources in SADC countries, Gaborone, Botswana.

- March 10–14, 1997: SACCAR major stakeholders meeting to discuss and review consultants' recommended strategies for crops, farm animals, natural resources management and human resource development in Southern Africa, Gaborone, Botswana.
- April 21–25, 1997: SACCAR/ILRI workshop on "The Regionalisation and Reorganisation of ILRI - NARS Collaborative Research Networks (Cranes), Gaborone, Botswana.
- The current SACCAR strategy for agricultural research and training in SADC.

Research agenda goal and objectives

Goal

The main goal of the research agenda is to enhance and sustain food security and improve the living standards of the people of Southern Africa through sustainable increases in the productivity of the animal agricultural production systems, especially in the smallholder systems.

Objective

The specific objective of the research agenda is to achieve sustainable improvement in animal agriculture productivity in the SADC region in order to decrease importation of livestock products and generate employment and income in the smallholder farming systems.

The research agenda and related activities

Genetic improvement, conservation and utilisation

The objectives of the genetic research are to: identify indigenous farm animal genetic resources with exceptional productive and adaptive characteristics to serve as a basis for sustainable farm animal production improvement; develop breeding strategies and feasible *in-situ* and *ex-situ* conservation methods for sustainable utilisation and conservation of identified genotypes; build a regional database on animal genetic resources and contribute information to the geo-referenced database developed by ILRI, the FAO and other organisations on farm animal genetic resources and the systems in which they exist. These activities will be linked and complementary to the FAO Global Programme for the Management of Animal Genetic Resources, the on-going FAO/SADC initiative on Farm Animal Genetic Resources and the ILRI Pan-African initiative on the characterisation of animal genetic resources.

Research activities

- Characterisation (phenotypic and genotypic) of the animal genetic resources and the systems in which they exist.
- Breed improvement and conservation.
- Development and utilisation of disease resistant breeds/strains.

Expected products

- Animal genetic resources and their systems characterised.
- Genetic relationships of known breeds established for better conservation and utilisation.
- Breeding and management strategies developed.
- Regional database on animal genetic resources established.

Nutrition and feed resources development

The objectives of the feed resources research activities are to identify and characterise available feed resources in the region; introduce and evaluate forage germplasm (grasses, MTPs etc.); and develop appropriate feeding packages based on crop residues, forages and agricultural and industrial by-products, especially for intensive production systems.

Research activities

- Introduction, evaluation and conservation of forage germplasm.
- Feed improvement (forages, crop residues and agro-industrial by-products).
- Feeding and management options for intensive management systems.
- Research to exploit indigenous knowledge.

Expected products

- Adapted forages established.
- Technologies for incorporating forages into smallholder systems developed.
- Suitable feed resources identified for supplementary feeding.
- Database on available and suitable feed resources.

Sustainable integrated animal health management

The aims of the animal health research are to develop cost effective and affordable integrated disease and parasite control regimes tailored for different farming systems and to maximise productivity by reducing the impact of target diseases.

Research activities

- Epidemiology and disease control.
- Development of vaccines and diagnostic tools.
- Disease resistance/tolerance studies for the development and promotion of disease-resistant/tolerant domesticated animals.
- Ethnoveterinary research to exploit indigenous knowledge.
- Drug efficacy and resistance studies to develop improved drug use regimes.
- Economics of diseases and their control measures.

Expected products

- Community-based integrated disease management and control strategies.
- Economic impact of target diseases.
- Vaccines for target diseases.

Natural resource management

The objective of this research domain is to improve the efficiency of use and conservation of the natural resources that support the crop- livestock systems.

Research activities

- Rangeland ecology and management (technical and socio-economic).
- Soil-plant-Animal Relationships.
- Monitoring of land-use systems and their impact on the environment.
- Research to exploited indigenous knowledge.

Expected products

- Better understanding of the interaction of livestock and environment.
- Methodologies for on-farm R&D.
- Strategies for rangeland management.

Systems, policy and socio-economic analysis

The objective of this research area is to promote better formulation of regional policies for informed decision-making.

Research activities

- Analysis of the socio-economic and policy constraints related to land tenure and land-use, marketing (including post-harvest technology), inter-regional trade, privatisation, and delivery of veterinary and other animal agricultural services.
- Economic, social and environmental impact assessment of farm animal production programmes and interventions.
- Identification and recommendation of policy options that are supportive of sustainable

farm animal production.

Expected products

- Knowledge and understanding of the technical, social and economic factors affecting animal agriculture.
- Policy options for informed decisions.

Crisis mitigation in livestock dependent systems

The objective of this work is to make livestock-dependent systems more resilient in times of crisis, especially drought.

Research activities

- Identification of the major environmental and socio-economic indicators of crisis incidents.
- Identification and evaluation of existing and potential coping mechanism and contingency plans.
- Assessment of the impact of crisis on bio-diversity and the farmers.

Expected products

- Major crisis indicators identified.
- Coping mechanisms and contingency plans developed.

Human resource development (capacity building)

The objective of this activity is to strengthen NARS capacity to carry out livestock research through training and the provision of technical and specialised information, especially within the framework of regional research projects. The tasks/activities identified are:

Facilitating training for MSc and PhD in the following areas of specialisation

- Forage science.
- Animal breeding/genetics.
- Biotechnology/molecular biology.
- Livestock economics.
- Natural Resources Management/Environmental Services.
- Social anthropology with emphasis on livestock
- Animal health economics.
- Animal Health.

Short courses/workshops through collaboration with ILRI and other relevant organisations in the following areas:

- Project proposal development
- On-farm research (surveys and monitoring methodologies including livestock breeds and diseases).
- Participatory Research methods including gender analysis.
- Statistical techniques and tools for livestock data management
- Dairy processing technologies.
- Recent advances in animal nutrition research techniques

- Improvement of agricultural information management and delivery systems (Communication).
- Diagnostic methodologies for target diseases.
- Reporting and presentation of research results.
- Impact assessment.

Training of trainers

Efforts will be made to identify, from among the participants in the various training courses/workshops, potential trainers for additional preparation to enable them assume responsibility for regional or national training.

Mode of operation and implementation

The regional collaborative research programme will be developed and implemented within the framework of several collaborative research programmes:

Development and approval of research and research related activities

A team of experts will be drawn from member states to identify and prioritise researchable issues for each research theme identified. This is to bring focus to regional research as well as avoid duplication of efforts

NARS scientists in SADC member states and their collaborating partners will develop operational research proposals addressing one or more topics of the regional collaborative research priorities identified by the regional team of experts following the guidelines and format defined by the S-AARNET RSC (see page 18).

The proposals will be reviewed by appropriate technical committees based on set criteria (including scientific merit, potential impact and regional relevance). The RSC will decide on the award of the competitive research grants to successful proposals. The Co-ordinator will provide the feedback to the participating scientists.

The successful proposals will be implemented by the investigating teams in their respective NARS institutions with the technical backstopping of the S-AARNET Co-ordinator, the members of the RSC and identified experts from within the region.

Management of activities

The programmes will be managed daily by the S-AARNET Co-ordinator under the guidance of the RSC with administrative support from ILRI and SACCAR. The Co-ordinator and the RSC chairperson will be responsible for reporting on programme activities to SACCAR and ILRI. Network programme funds will be kept in-trust by ILRI but the allocation of operational project funds and their disbursement will be decided by the RSC. ILRI will be responsible for the financial accounting to SACCAR and the donors.

Collaborators

The potential collaborators include scientists in ILRI and other regional and international research centres operating in the region (CIAT, CIMMYT, ICRAF, ICRISAT, IFPRI, IITA *inter alia*) as well as scientists from Advanced Research Institutions (ARI's) including Universities in Europe and the USA.

The scientific community will work in close collaboration with other stakeholders in the public and private sectors including farmers, relevant NGOs, entrepreneurs, extension services, government and international agencies *inter alia*.

Whenever appropriate, linkages will be established with other SADC networks and projects to avoid duplication and ensure complementarities.

Monitoring and evaluation

Overall, the achievements and successes of S-AARNET activities will be assessed in terms of its objectives as set out earlier.

Specifically, the impact of network activities will be measured in terms of research products and their direct or potential effect on the target groups, the extent and quality of human resources development and the level of information exchange (including the number of publications). Other measurable indicators at various levels (short, medium and long term) will be indicated in the logical framework developed for operational projects.

Members of the RSC will assist the Co-ordinator in monitoring the network's activities in their respective countries as well as at the regional level whenever requested by the Co-ordinator. The RSC will review all progress reports submitted by collaborating scientists. Such progress reports will follow a given format including statements on the objectives of study, work done, achievements, constraints and budget. Attached to this report should be the future work plan and the budget.

The progress of S-AARNET programmes will be reviewed annually by the Steering Committee. In addition, there will be mid-term and end-of-projects external evaluation as well as mid-term and end-of-projects workshops to discuss and share the results.

Guidelines and format for developing project proposals

Guidelines

Guidelines for project proposals follow:

- The study must address researchable areas indicated in the regional collaborative research agenda.
- Applicants should be employees of national agricultural research institutions, universities, relevant NGOs and private sector from SADC member's states.
- All proposals to the RSC should be channelled through the designated national representative to the network RSC.
- Proposals will be evaluated based mainly on scientific merit, potential impact and regional relevance.
- Multidisciplinary and trans-boundary institutional project proposals will have added advantage for funding.

Format

The proposal should follow the following format:

- Title.
- Theme: refers to the identified regional themes.
- Principal investigator(s).
- Collaborators/ partners: other scientists, extension officers, NGOs, farmers.
- Site(s).

- Starting date and ending date.
- Background and justification: description of the region; production system; problems to be addressed; current knowledge on the topic (brief review of the literature relating to key elements of the intended research).
- Objectives :
 - Overall
 - Specific objectives
- Expected output: the proposal is expected to generate products including technologies and new information. Milestones for the expected products must be indicated.
- Beneficiaries.
- Material and methods: should be clearly indicated including experimental design, taking into consideration each of the objectives of the study. Methods should be clear on what data/information will be collected, and how and when the data will be collected.
- Workplan: clearly indicate the different phases of the study. It should be an annual work plan indicating details of the activities to be carried out.
- Logical framework.
- Budget: the structure of the budget should indicate, per year, the budget requested from the network as well as the host institution's contribution by component. A summary of that budget will indicate the following components:
 - Personnel
 - Equipment
 - Operational cost
 - Human resources development: training and information
 - Overheads (not more than 10% of total operational funds requested).
 - Budget notes: These should justify the funds requested by indicating how estimates were derived

Conclusion

A strategic plan is a statement of intent with a time frame. This network strategic plan is for the next 5 years. But this is also a document to guide the stakeholders in running the network. It is there not cast in stone. It will be reviewed as and when the majority of the stakeholders feel that circumstances warrant a review.

For more information, please contact the co-ordinator at this address:

Prof. S. H. B. Lebbie

Regional Co-ordinator

SADC Animal Agriculture Research Network (SAARNET)

International Livestock Research Institute (ILRI)

P. O. Box 30709, Nairobi, Kenya

Phone : 254-2-630743 Ext. 3402

Fax : 254-2-632013 or 631499

E-Mail : s.lebbie@cgiar.org

web site: <http://www.cgiar.org/ilri/>

References

SACCAR (The Southern African Centre for Co-operation in Agricultural Research and Training) 1997. Regional Research Priorities for Crop and Livestock Production. African Centre for Cooperation in Agricultural and Natural Resources Research and Training, Gaborone, Botswana. January, 1997. pp 119.

The challenges of training animal scientists in the SADC: Experiences from Malawi

P. Mumba, J.W. Banda and C.B.A.Wollny.
University of Malawi, Bunda College of Agriculture
P.O. Box 219, Lilongwe, Malawi

[Abstract](#)

[Introduction](#)

[Method of assessment](#)

[Results](#)

[Needs of BSc \(agriculture\) holders in Malawi](#)

[Needs of final year BSc \(agriculture\) students in Malawi](#)

[Needs of \(supply to\) employers in Malawi](#)

[Discussion](#)

[Conclusion](#)

[References](#)

Abstract

The Animal Science Department at Bunda College has been running a regional postgraduate degree program at the Masters level for eight years. The candidates have been both local and international from the Southern African Development Community (SADC) region. So far, twenty-one local and fifteen internationals have graduated from the program. While the employment distribution of the graduates in Malawi has varied, the results have shown that eleven graduates are in positions not directly involved with livestock. Apart from the University, which has six of those graduates, the Ministry of Agriculture has only two graduates who are directly involved with livestock projects. However, for the internationals, nine graduates are in the Ministry of Agriculture, four in the University and only two in the other fields. This then gives an opportunity for Bunda College to train more animal scientists. However, the results of a survey carried out in Malawi and partially in Zimbabwe, have shown that the majority of the potential candidates would want to be trained outside Africa. The college should entice as many qualified applicants as possible. The challenge to the University of Malawi is to have a curriculum that addresses the needs, values and objectives of the SADC countries. However, this may not be possible and so the alternative is to reduce knowledge transfer in favour of "key competencies". Sustainability in terms of funding is another challenge to the University. The regional MSc program has to-date been funded by GTZ which is now phasing out. The question now is "What's next?" The University has to find other sponsors in order to sustain the program as regional. In addition, the government's priority is geared mostly toward crops and little effort is put on livestock. The College must sustain the program against the government's low priority in the livestock industry and the desire of candidates to go and study

abroad.

Introduction

Bunda College is one of the five constituent colleges of the University of Malawi and was opened at its present 2000 hectare site in 1967. The college has the following seven departments: Crop Science (CS), Animal Science (AS), Agricultural Engineering (AE), Rural Development (RD), Home Economics and Human Nutrition (HE/HN), Aquaculture (AQ) and Language and Development Communications (LDC). Before 1987, the College had been mounting postgraduate programs on an *ad hoc* basis only. After that year, the Animal Science Department started a full time postgraduate program at the Masters level. This program became regional, under the sponsorship of the German Technical Service (GTZ) in 1989. Later, the other departments notably, CS and RD started their Masters programs as well. The MSc program in Animal Science has been running for eight years now, with 2000 as the ninth year of operation. The program was interrupted for two years between 1990 and 1992 due to accommodation problems. The regional MSc program offers up to ten scholarships per year, 50% of who should be from the host country. In the Animal Science Department, it was observed in 1997, that only 42.2% of the total number of students (based on a theoretical total of 90) had enrolled over nine years, of whom 22.2% were Malawians (out of the required 50%) and 20% were foreign students (out of the required 50%). The figure had increased to 49% in 1999, of whom 22.7% were Malawians (an increase of only 0.5%) and 26% were from the region. In the 1998 academic year, the complete intake consisted of only regional students.

Up to 1999, the Animal Science Department at Bunda College has enrolled 61 students at Masters level, (36% Malawian and 64% International students). Of the total enrolled, eleven students either dropped or were deceased. A total of 36 students have successfully completed and defended their research work. However, not all the candidates who graduated have entered the Animal Science field. The needs of the potential candidates and those of a particular country may vary considerably. These and other factors may pose as a challenge to the training of animal science specialists in the SADC.

This paper examines the challenges of training animal scientists, with respect to the needs and supply, based on the employment type of the previous graduates and the results of a survey that was carried out in Malawi and Zimbabwe in 1997.

Method of assessment

A database of the employment record of the MSc graduates in animal science from Bunda College was compiled and used as such. Three questionnaires were formulated. One set was for BSc (agriculture) holders and was administered to a total of seventy three people with only a BSc in agriculture (those working in various government or private sectors). A second set was for final year BSc (agriculture students and was administered to a total of seventy students at Bunda College of agriculture and some animal science students at the University of Zimbabwe. A third set of questionnaires was administered to twenty BSc (agriculture) employers in Malawi. The data were all analysed by SPSS computer programs by generating frequencies.

Results

1. Distribution of Bunda College Animal Science MSc graduates in various fields in the SADC region: The distribution, in various fields, of the twenty-one Malawians who have so far graduated with a Masters degree in Animal Science is shown in Table 1. Almost half of the graduates have gone into fields other than agriculture. The "other fields" are NGOs, companies or jobs outside Malawi, which may or may not involve animal science or related

projects. People in these areas are therefore, not working full time as animal scientists. Only 3 candidates joined the Ministry of Agriculture, of whom, one is at Principal Secretary level and is not involved in fieldwork. The other two are directly involved in animal science work. Although six graduates joined the University, only three are in Animal Science. This means that over eight years, only five Malawian candidates trained at Bunda College are directly involved with animal sciences. It is interesting to note that over the same period, fifteen international students defended in the same program (Table 2). Nine of these are in the Ministry of Agriculture, involved with livestock, four are in the University/College and two are in the "other fields".

Table 1. Bunda College Malawian Animal Science MSc graduates in the various fields.

Year defended	Place of work				Total
	Ministry of Agriculture	University	Other ⁴	Deceased	
1989	1 ¹	1 ²	0	1	3
1991	0	0	2	0	2
1996	1	1	1	0	3
1997	1	2	5	0	8
1998	0	2 ³	1	0	3
1999	0	0	2	0	2
Total	3(2)	6	11	1	21

¹ Principal Secretary. ²Joined Agricultural economics department. ³ One joined Aquaculture Department and one is at Polytechnic. ⁴ These are NGOs, companies or jobs outside the country

Table 2: Bunda College International Animal Science MSc graduates in the various fields.

Year defended	Place of work				Total
	Min. of Agriculture	University	Other	Deceased	
1991	3	1	0	0	4
1996	2	1	0	0	3
1997	1	0	0	0	1
1998	1	1	1	0	3
1999	2	2	0	0	4
Total	9	4	2	0	15

Needs of BSc (agriculture) holders in Malawi

Of the respondents covered during the recent survey, 56.2% were from the government, 28.8% from parastatals and 15.1% were from the private sector. A few answers relevant to the study are presented in Figures 1–3.

Most respondents (61.1%) obtained a pass degree while 38.8% got a credit but none with a distinction. This may not be surprising as most distinction materials are usually reabsorbed into the university system. Figure 1 shows the fields in which the various respondents are working. It can be seen that 19.2% are working in crops (of which 12.3% are in government and 6.8% are in parastatals), 15.1% in Agricultural Economics, 20.5% in Extension, 6.8% in Animal Science field (of which 2.7% are in government and an equal number in parastatals and 1.4% in private sector) and 4.1% in Agricultural Engineering. However, the majority (31.5%) are in other fields, such as Banking. Of all the respondents, only 41.1% had come across the

SACCAR-GTZ scholarship advertisement. Of those that had seen the advertisement, the majority (51.3%) were interested in Agricultural Economics (Figure 2), 30.8% were interested in Crop Sciences and 7.7% were interested in Agricultural Engineering. A relatively small percentage (10.3%) was interested in Animal Sciences (of which, 5.1% were from government and 2.6% each from parastatals and private sectors). The small number of respondents interested in Animal Sciences may be related to the small number of people working in that field as shown by Figure 1.

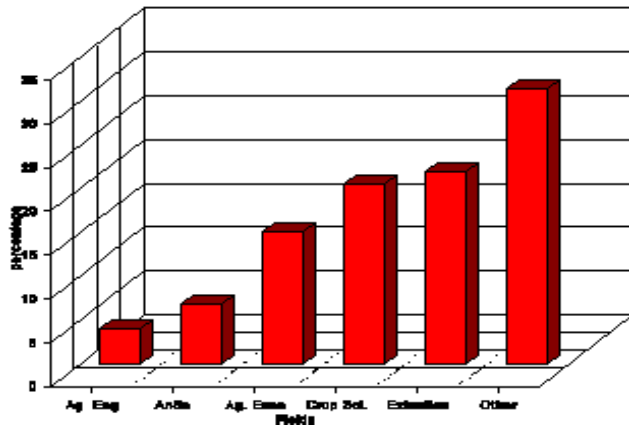


Figure 1: Respondents field of work

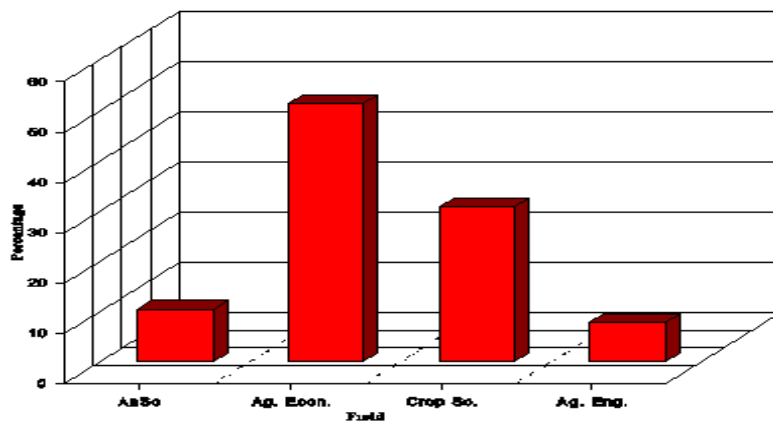


Figure 2: Field of interest in the SACCAR-GTZ advertisement by the respondents.

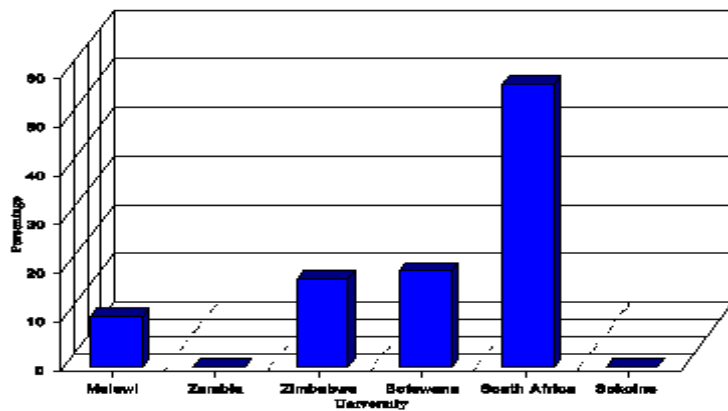


Figure 3: Choice of the Universities in the SADC by the respondents.

The proportion of respondents who have ever applied to the SACCAR-GTZ regional MSc scholarship was only 22.5% while only 8.4% have ever applied for MSc in Animal Sciences at the University of Malawi. The latter fits well with Figures 1-3. While most respondents (95.3%) were aware of the existence of the Regional MSc program in Animal Science, many (35.6%)

have not applied to the program because they are not Animal Scientists while 20.3% said they had financial problems and another 14.1% would prefer to study outside Malawi. A small number of respondents (6.3%) said that they were satisfied with their present condition. Most notable was the choice of Universities, in the SADC (Figure 3) the respondents would prefer to go attend. Most respondents would prefer to attend any South African University (57.9%), or University of Botswana (19.6%) or University of Zimbabwe (17.9%) but only a small number, 10.3%, would prefer to attend the University of Malawi.

Needs of final year BSc (agriculture) students in Malawi

While only 26% of the students preferred work, a good number (33%) indicated they would prefer further training. Although the choice for work was high, most of the students (57%) said that they had no concrete prospect for work. A more important observation was that 97% of the students indicated an interest in further training to the PhD level. Figure 4 shows that 32% of the students preferred to study in Europe and 53% in USA. A similar survey carried out in Zimbabwe showed that a larger proportion of the Zimbabwean students (17%) would prefer to study in Africa compared to only 3% of their Malawian counterparts.

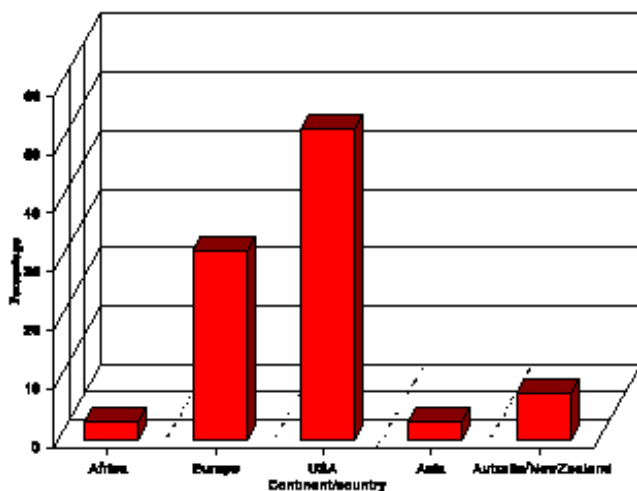


Figure 4: Choice of continent/country of study by the students

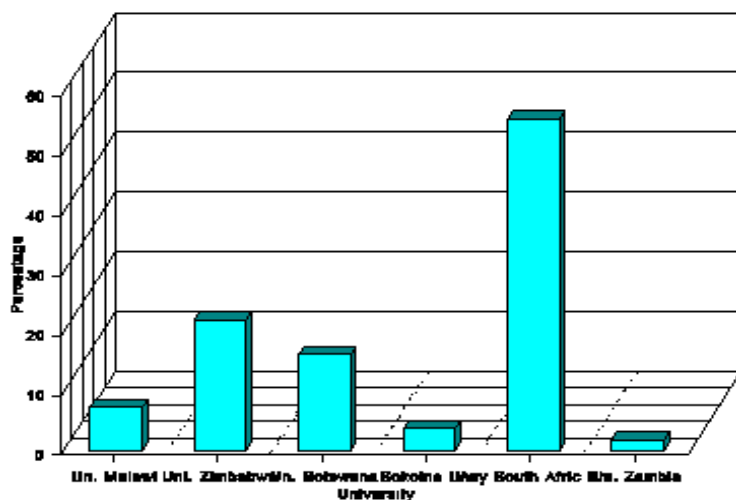


Figure 5: Choice of a SADC University by the students

Figure 5 presents a more interesting scenario on the choices of universities in Southern Africa. Most students would prefer to study in a South African university (56%), University of Zimbabwe (22%) and to some extent University of Botswana (16%) and few (7%) would want to go to the University of Malawi. A similar survey carried out in Zimbabwe showed that the

majority (50%) would prefer to go to their own university, followed by any South African university (42%) and none would want to go to the University of Malawi. Finally, a bigger percentage of the students (55%) said that they had not come across the SACCAR-GTZ regional scholarship advertisement. This was rather surprising since the advertisements are posted on the notice boards all the time. However, of the students who have come across the advertisements, 36% said they were interested in agricultural economics, 25% in animal science, 19% in crop science and 14% in agricultural engineering. For further training, there were an almost equal number of candidates who said they would pursue agricultural economics (21%), animal science (19%) and agricultural engineering (16%).

Needs of (supply to) employers in Malawi

The employers were from the government (50%), parastatals (34.6%) and the private sector (15.5%). The proportion of employees in these sectors was 8.1% in the animal science field of which, 1.6% have a BSc (agriculture) only degree. A larger proportion (30%) of the employees were in the crops field. It was noted that 92.3% of the employers offered "on the job" training to BSc (agriculture) graduates from the University of Malawi. This agrees with the BSc (agriculture) holders' rating of the relevance (i.e. how practical) of the Bunda's BSc program mentioned earlier.

The class of professionals preferred by the employers were BSc holders (42.3%) followed by MSc (38.5%) and then PhD holders (11.5%). The preference for MSc is quite high, and for this, 28.6% of the employers said they were willing to offer a full scholarship for MSc studies of their staff while 19% said they would offer only a partial (50%) scholarship. The others (52.4%) would not offer any. Although 57.9% of the employers have heard of the SACCAR-GTZ regional MSc program in animal sciences, only 15% have sent their staff to the program. The reasons given were mostly financial and that the animal science program did not meet their requirements. It seems possible therefore, that the high preference for MSc holders is in other fields and not animal science.

Discussion

Tables 1 and 2 indicate that the Animal Science Department has trained a number of Animal Scientists at the Masters level. Unfortunately for Malawi, most of them are not in the animal science field. Since the Government has now launched the livestock policy through Malawi Agricultural Sector Improvement Program (MASIP), this should be an opportunity for the Department to train even more specialists on the assumption that the graduates will work in that field. This is a challenge to the Department in that it has the chance to convince the government of the lack of work force in the animal science field. Most international Animal Science graduates from Bunda College have found jobs in the livestock field. The need for more such specialists in the SADC countries gives an opportunity to get more candidates to be trained. On the other hand, there is competition with the other universities like the University of Zimbabwe which may attract more candidates.

However, data from the potential candidates, i.e., the needs of the BSc Holders and the undergraduates show that there are two problem areas: the marketing of the MSc program is not vigorous enough and the image of the College/University is not good. It is encouraging to note that many respondents were aware of the regional MSc program in Animal Science.

Currently, advertisements for the regional programs are carried out in local daily newspapers and also by SACCAR in their newsletters. They are also sent to all relevant government ministries and organisations for information to their staff. Recently, advertisements have also been sent to SADC countries national newspapers to be covered in those papers. Despite all this effort, there are still not enough qualified Malawian applicants. This is not surprising since

most students who go out into the field are those that have obtained a pass degree at the undergraduate level. With a credit pass or better as a requirement for the Masters degree, the Department will continue to face the problem of getting more applicants. This problem is also compounded by the desire of most Malawians to go and study abroad and not within Malawi. This has also been observed by other researchers and they have suggested that this is due to the declining quality and relevance of higher education in most African Universities (Fernandez 1998; Matos 1998; World Bank 1997). The BSc holders' views of the relevance of the Bunda (BSc) programs as they relate to their work is in agreement with this. Most respondents (32%) said the programs are 60-100% practical, 41% said the programs are 50-59% practical and 28% said the programs are 1-49% practical. The figure 28% is significant enough and suggests that aspects that are more practical should be introduced into the curricula. This means that the college should reduce knowledge transfer to students in favour of more "key competencies". It is of interest to note that in a recent survey on the factors affecting the performance and quality of the students (Mumba 2000) it was observed that the students appreciated the quality of education at Bunda College. It must be recognised that postgraduate training overseas does not usually provide opportunities to work on African problems (Abegaz 1994). In this regard, the College must convince as many potential candidates as possible in the SADC, to pursue their postgraduate degree at the University of Malawi. Therefore, the College faces the challenge to come up with the curricula that is in consonance with, and respond to the needs, values, priorities and objectives of the different SADC countries. However, Aina (1998) has pointed out that because of the unequal economic and political relations between nations, the needs and priorities of different countries are bound to be different. This is where "key competencies" are more important than just knowledge transfer. The sustainability of the program also depends on continued funding. So far, the major sponsor of the regional program has been the German Technical Service (GTZ) which is now phasing out. If funding is not available, then getting the required mass of trained personnel in the Animal Sciences will present a great challenge.

The image issue is probably a more serious one. Reading through the comments of the BSc(agriculture) holders, several issues were raised such as: (a) MSc programs at Bunda College take too long (more than two years), (b) there is more theory in the curricula than in practical aspects which should be reversed and (c) the scholarship package not enough.

If the programs take too long, who would be at fault? Obviously, it is either the students or the faculty. Since students are supervised by faculty, the problem may then be with the faculty. If the faculty are not very strict with the regulations or they pamper the students to the extent that the latter relax, delays may be inevitable. For example, take thesis examinations: "*What is the dead line for submission of theses?*", "*How long should an external examiner keep a thesis?*", and "*Under what conditions is extension of scholarship permitted?*". Step by step analysis of these questions may reveal why the MSc programs at Bunda take too long and who may be at fault. The faculty must look into the analysis of these questions more closely to avoid unnecessarily long programs as claimed by the respondents. This is a real challenge to the faculty in order to improve its image. Although the Animal Science Department has greatly improved graduating its students within 2 years, the general perception of potential candidates on the prolonged graduation periods remains the same. On the other hand, the students themselves may deliberately prolong their research work so that they can look for employment. Experience has shown that once these students are employed, they do their research slowly. The college faces the need for internal quality control.

For the past five years, the government's support for tertiary education has been steadily declining. Although this is also true of many African countries (World Bank 1994), the situation in Malawi seems to be getting out of hand. The current government policy is "poverty alleviation", but it seems that this poverty alleviation policy is only geared toward crops and not animal production. This can be seen from the number of people working in crops field as

compared to those in the livestock field (Figure 1). The main problem it seems is that the government has put a low priority on livestock and no policy on livestock existed until recently. Whether this will be implemented soon or not is a matter of speculation. If the Government sees need to improve the nutritional status of its people, then there must be clear national policies on both crops and animals since both are necessary. The University must take the lead in livestock research, which deals with problems at the societal level and they must convince the policy makers that this is important for the good health of the people. Unless this done, fewer and fewer people will be in the Animal Science field and in the long run, nobody will have any vested interest in Animal Sciences. As one employer put it, "It can only be hoped that the Agriculture Sector Investment Plan which the Ministry of Agriculture and Irrigation has developed, will include a strong component on livestock development". However, such livestock development calls for the participation of the private sector as well. In order to encourage primary producers, the University, the government, parastatals and private sectors must come together with a good policy on livestock. In this way, more people can be trained in animal sciences.

Conclusion

The paper has highlighted the challenges to the training of Animal Scientists in Malawi with regard to the needs and supply. Although the college has trained several Animal Scientists at the postgraduate level, many of those are not directly working in this field. The few animal scientists in the country is an opportunity for the college to train more people in the area. However, the desire of the potential candidates to be trained overseas, has a competitive effect which is a challenge to the institution. The University should reinforce research at the grassroots level to address societal problems. However, unless the Government reconsiders its priorities to include livestock, few graduates will actually work in this field. This will kill the livestock industry. On the other hand, the University is faced with the problem of funding in both teaching and research. In the past, the major source of funding was GTZ, which is now phasing out. The College must sustain the program against the government's low priority in animal sciences, dwindling funding and the desire of candidates to study abroad.

References

- Abegaz B.M. 1994. Universities in Africa: Challenges and Opportunities of International Cooperation, p171–205. *Reader for Conference on "Challenges and Perspectives of Universities in Africa, 1998"*. Compiled by Bergs R. and Gmelin W. GTZ, DAAD, DSE.
- Aina T.A. 1994. Quality and Relevance: African Universities in the 21st Century, p15–50. *Reader for Conference on "Challenges and Perspectives of Universities in Africa, 1998"*. Compiled by Bergs R. and Gmelin W. GTZ, DAAD, DSE.
- Fernandez L.1998. Universities between commitment to local needs and international aspirations: The South African Experience, In: '*Challenges and Perspectives of Universities in Africa*. p25–31. GTZ Education report No. 82.
- Matos N. 1998. Challenges and Perspectives of Universities in Africa. In: *Challenges and Perspectives of Universities in Africa*. pp8-18. GTZ Education report No. 82.
- Mumba P. 2000. *Factors affecting the performance and quality of the students at the University of Malawi, Bunda College of Agriculture*. A report Submitted to The Deutsche Gesellschaft Fur Technische Zusammenarbeit (GZT). 13 pp.
- World Bank, 1994. *Higher Education: The lessons of Experience*. The World Bank, Washington D.C., USA.105 pp.

World Bank 1997. Revitalising Universities in Africa: Strategy and Guidelines, p51–83. Reader for *Conference on Challenges and Perspectives of Universities in Africa, 1998*. Compiled by Bergs R. and Gmelin W. GTZ, DAAD, DSE.

Capacity building for sustainable use of animal genetic resources¹

Ntombizakhe Mpofo, Habib Ibrahim, Michael Smalley and Edward Rege

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

Email: ILRI-Ethiopia@cgiar.org

[Abstract](#)

[Introduction](#)

[Needs assessment activities](#)

[Animal genetic resources for sustainable agriculture](#)

[The project's main activities](#)

[Training courses](#)

[Training resources](#)

[Partnerships](#)

[Expected outcomes and project evaluation](#)

[Expected outputs](#)

[Project evaluation](#)

[References](#)

Abstract

Africa has a challenge to meet the rising food demands that will come about due to increased population size and urbanisation. Such challenges can be tackled in many ways that include improving livestock production and this entails making improvements in feeding and disease control, using appropriate genotypes and genetic improvement of livestock. Research and training are some of the major requirements to realisation of improvements in livestock production. Sub-Saharan Africa has a number of colleges and universities and research stations that do postgraduate training and research in animal breeding and genetics. It is important that training and research at these institutions is relevant to Africa's needs so as to produce scientists that will become trainers or take up leadership in research and development in animal breeding including sustainable use of animal genetic resources. The International Livestock Research Institute (ILRI) and the Swedish University of Agricultural Sciences (SLU) have initiated a capacity building project. This project aims to address training of researchers in animal genetic resources by introducing a new model of capacity building which targets qualified lecturers and researchers working in sub-Saharan African universities and research stations with a specific focus on making graduate training in sub-Saharan Africa more relevant to the region. The paper describes the project in terms of identified needs and expectations of stakeholders, the capacity building model developed to address these needs

and the activities that are to be undertaken to meet the project outcomes. The project activities include a training of trainers course, building partnerships and developing computer-based training resources for use by university lecturers and national scientists. The proposed project evaluation procedures are also presented.

Introduction

The increased demand for livestock products has been putting pressure on African livestock owners to increase production. Steps taken to increase production included identifying and using high-producing genotypes. Unfortunately for Africa, little attention was paid to improving the genetic potential of local breeds for increased production. Instead, a view was taken that increased production would be best realised by importing foreign high-producing breeds and using them in purebreeding and crossbreeding systems. The introduction of these foreign breeds was made easy by advances in biotechnology, particularly advances in artificial insemination. This crossbreeding and/or replacement of indigenous breeds with foreign germplasm is one of the most serious threats to indigenous populations. In addition, the system is also not sustainable, as most foreign breeds are generally not adapted to African production conditions. With the expected further increase in demand for meat and milk in developing countries between now and 2020 (Delgado et al. 1999), there is even a greater need to develop and promote sustainable ways of livestock production. This will place significant new demands on national capacities for research and development in developing countries.

Even though research training is introduced at the undergraduate (BSc) level in most universities, it is at postgraduate level (MSc and PhD) that most of the research training is done. The number of national scientists for livestock research and development continues to be a cause of concern (Wilson et al. 1995). In 1986, there were fewer than 1000 livestock researchers in the national agricultural research institutes in African countries with a BSc training or above, and just over 300 with PhD degrees. Whilst most universities in Africa now have courses in the agricultural sciences, considerably fewer provide post-graduate training (Pardey et al. 1997). Africa has, therefore, relied on sending its people overseas for postgraduate training. However, postgraduate courses are increasing in universities in sub-Saharan Africa. Scientists trained at these universities are absorbed (as staff) by local universities and local research and development institutes.

The pace of scientific progress is increasing and this continues to affect both what can be achieved by agricultural research and how it is to be achieved. New tools and approaches in both molecular and quantitative genetics are supporting radical changes to what can be achieved through animal genetics. These techniques can be applied in characterising indigenous animal genetic resources and that information can promote their use in sustainable breeding programmes. There is a need, therefore, to provide national scientists with the skills and knowledge to allow these techniques to be used (FAO 1997). Another concern has been that scientists are often locked in their disciplines and are poorly prepared for systems research addressing the many components of sustainable animal breeding programmes structured to meet the needs of farmers (FAO 1991). The situation, in some cases, is made worse by the fact that most materials used in training are disciplinarily based and do not encourage thinking and planning at the systems level. In addition, most of these materials use examples and case studies from unrelated environments making them irrelevant thus often confusing the concept or principle being presented. There is, therefore, a need for capacity building on sustainable use of animal genetic resources to; help scientists build on their knowledge on current techniques in animal breeding, to ensure that scientists address the issues of sustainability in animal breeding, and to emphasise the use of relevant training materials.

The approach that has been taken by ILRI and other organisations in capacity building for research has been to hold short-term courses for the scientists. The scientists would then go back to their research stations and use the new techniques. A new model of capacity building has been adopted by the ILRI/SLU project. It stems from the realisation that most of Africa's researchers are now being trained at local universities. This model introduces three concepts. Firstly, it is based on the assumption that training of researchers and university lecturers who teach at postgraduate level has an amplified impact than training researchers alone. This is because lecturers, besides carrying out research themselves, also train postgraduate students (future researchers) who will then use the skills learnt from the lecturers in their own research. The benefits of capacity building using this model, therefore reach more researchers. Secondly, the model encourages the use of relevant resources for training of Africa's research scientists. Such resources can be made available at universities in Africa and overseas universities that train African students. Thirdly, the model calls for developing partnerships with universities and NARS. The project is demand driven as it caters for the needs of partners who also contribute to the output. This paper describes the ILRI-SLU capacity building project that employs this new model of capacity building.

Needs assessment activities

The project carried out need-assessment activities to determine the number of universities in sub-Saharan Africa that teach animal breeding and genetics at the postgraduate level, the content of the courses taught, human resources and facilities available for running the courses, constraints faced by universities when delivering the courses and the link between universities and research institutes carrying out research in animal breeding and genetics. Questionnaires were sent to fifty-three universities in sub-Saharan Africa by mail. An ILRI/SLU team followed up by visiting six countries in Eastern and Southern Africa.

Only 23 out of 53 universities responded to the questionnaire and of these only 17 offered postgraduate training in animal breeding and genetics. The countries visited were Kenya, Tanzania, Uganda, Lesotho, South Africa and Zimbabwe. The findings of these two activities were:

- The number of staff with postgraduate qualifications was impressive with 74 percent having PhDs and the rest MSc degrees. In addition, each university produces an average of six postgraduate students per year. The starting point for the project would, therefore, not be to give basic postgraduate training in animal breeding and genetics but to offer a course, which would allow participants to update their skills. Most lecturers had received little or no training in teaching methods or university teaching. The postgraduate classes are generally small, an average of six per year, but the same lecturers teach very large classes at the undergraduate level. Therefore, lecturers need to be taught teaching methods for both small and large groups.
- The postgraduate degree programmes vary a lot in terms of the actual courses offered and the course content. The courses include statistics/biometry, computer courses, biochemistry, physiology, production, genetics (basic, population, quantitative, molecular), and research methodologies. However, little or no time is spent on conservation of animal genetic resources. Most universities said they needed strengthening in statistics, basic and molecular genetics, animal genetic resources (characterisation, conservation, utilisation and management) and sustainable breeding programmes.
- Modern textbooks are often lacking. In addition, books and journals used are those published in Europe or North America. These resources provide useful information on principles and concepts of animal breeding and genetics. However, they are often lacking in examples relevant to sub-Saharan Africa.
- Universities had access to computers although the access was rather limited for some -

- in numbers and quality of computers. Various statistical software were available.
- The availability of molecular genetics laboratory facilities varied - some universities had none yet some had more than one laboratory in one campus, e.g. one in a faculty of agriculture and the other in a faculty of science or veterinary medicine.
 - Most universities do not generate data that can be used in animal breeding and as such rely on data collected by research institutes or organisations running livestock recording schemes. There is, therefore, a need to promote good links between research, extension and universities. The need for collaboration is realised and is practised in some countries.
 - Collaboration between universities is limited and is mainly through external examiners. There is limited exchange of teachers and students between universities. Increased contact between institutions and countries would reduce the isolation of staff at some universities. The project should therefore promote collaboration.
 - Funding support is limited resulting in poor facilities and resources for research and teaching, heavy teaching loads and high staff turnover.

A workshop, with participants from universities and research institutes in sub-Saharan Africa, ILRI, SLU, Cornell University and the African Development Bank, was organised to discuss the findings given above and to plan project activities. The workshop recommended that training courses for lecturers and researchers to update them on recent techniques and methodologies and topical issues in animal genetic resources should be held. The production of training resources to supplement available books and journals was also recommended. The main emphasis of these resources would be case studies that are relevant to sub-Saharan Africa and written using information collected by research organisations and extension agencies, universities and international organisations. Teachers need teaching and learning resources that are relevant to their country or the country of origin of their students, and which provide them with the tools to strengthen their teaching by using material that their students can relate to their present experience and future responsibilities. The participants identified the following modules on which the training course and training resources would be based:

Animal genetic resources for sustainable agriculture

- Improving our knowledge of tropical indigenous animal genetic resources.
- How to make breeding programmes in tropical farming systems sustainable?
- Quantitative methods to improve the understanding and utilisation of animal genetic resources.
- Teaching methods and communication.

They also developed the contents of these modules. A third recommendation was the building of partnerships; among the sub-Saharan universities, universities and research organisations within the same country, and ILRI and SLU with the universities and research institutes. The workshop participants agreed to act as a reference group for the project. This reference group would assist in identifying course participants, identifying scientists who would write the case studies, and evaluating the training resources. More than one course will be held and participants for each course will be drawn from a number of countries thus allowing links between countries. Course participants will also be asked to evaluate the courses and training resources.

The project's main activities

Based on the concerns and issues identified by the project through the needs-assessment activities, ILRI and SLU, together with partners from universities and research institutes in sub-Saharan Africa, embarked on the project "Capacity Building for Sustainable Use of Animal Genetic Resources in Developing Countries". The project planned three main activities:

training teachers and researchers on animal genetic resources via a series of courses, building training resources, and developing partnerships.

Training courses

The training courses for sub-Saharan Africa will be based on the modules agreed on at the planning workshop. They will cover topics on: (a) techniques in animal breeding and genetics and their use in characterisation and conservation of African animal genetic resources, (b) the importance of indigenous breeds, sustainable breeding programs and the utilisation of indigenous breeds in such programs, and (c) teaching and supervision of university students. Participants will get a chance to search available databases including those that are being developed by the project, use livestock recording and statistical packages, and computer software used in teaching some animal breeding and genetics principles. They will also evaluate the training resources produced by the project.

Criteria for selection of course participants were developed at the workshop. The ideal would be to have two participants per country, one from a research institute and another from a university. The participants should be people who are likely to work in research or teaching for a minimum of five years after the course. It was also agreed that a maximum of 25 participants per course would be ideal, making it necessary to hold more than one course in Africa. The first of these courses was to be a three-week course to be held in November-December 2000 in Addis Ababa, Ethiopia. Sixteen participants would come from East and South African countries. Facilitators for the first course would be from SLU and ILRI.

Training resources

This project will develop training resources to be used by university teachers responsible for teaching animal breeding and genetics to postgraduate students from sub-Saharan Africa. The teachers may be in the universities of sub-Saharan Africa, or wherever young professional from Africa are taught, including the international degree programmes of North America, Europe and Australia.

The term training resources has different meanings for different users. It is often used in reference to lists of courses and/or materials on the Internet. This project adopts a more specific definition of the term training resources, namely: an interactive electronic knowledge and information package that provides, in an integrated manner, resources for teachers and trainers on specific subject areas. Because university faculty know the facts and principles of their subject material, the resources are not an attempt to write an electronic textbook. The resources being developed are not an attempt to promulgate a fixed and "ideal" curriculum. Where a university is in the process of developing a new curriculum, the project's training resources will offer a structure and content that may be helpful. In most situations, however, we envisage university faculty using the resources to extract and adapt material that will strengthen existing lectures and practicals, and to provide insights and resources for the development of new lectures and practicals within existing courses.

The animal genetic training resource CDROM is based on five modules identified at the workshop. Figure 1 shows a general structure of a training resource. For each module, an introduction that summarises a set of basic knowledge, principles and concepts was written. We refer to this material as the "core knowledge". It should be emphasised that the introductions are a summary - albeit a comprehensive summary - and not an exhaustive treatment of the subject. The information in the introductions is structured to help engage the attention and interest of users - both faculty and students.

All the other resources complement the core knowledge in the modules. The opportunity to link information in a web based product means that these other resources are woven into the core

knowledge, but they can also be accessed directly. The other resources include case studies, information on distribution of breeds mentioned in the module introductions and maps, images and video clips, problem solving exercises, bibliographies and full text documents, databases, glossaries and dictionaries, research methodologies and software.

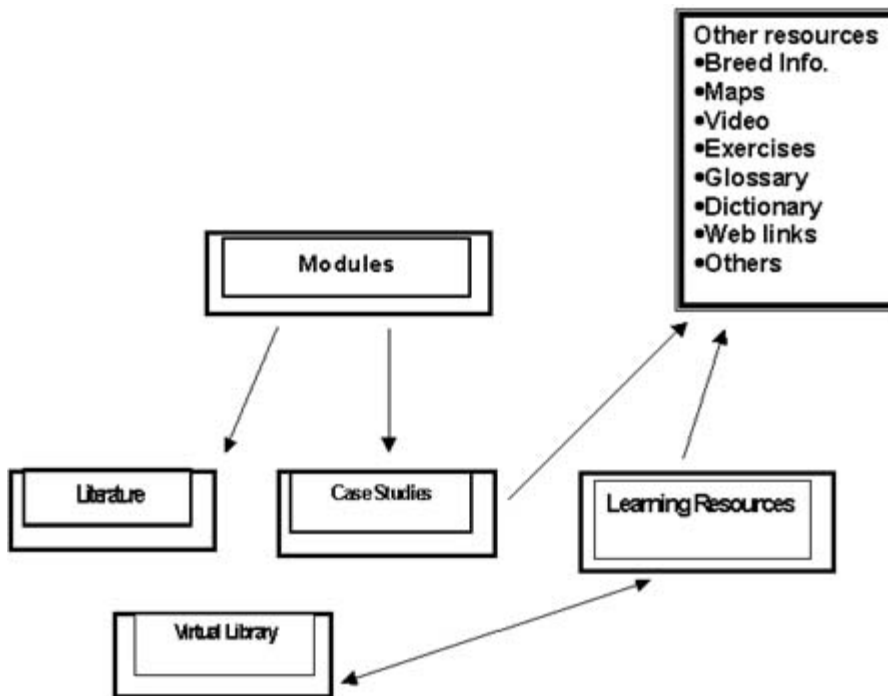


Figure 1: The general structure of training resource.

The case studies from sub-Saharan Africa will form the most important set of resources in the training resource. Because they are linked to a particular fact, concept or principle in a module, they provide users with information that helps to bring reality into what otherwise may be purely theoretical and factual presentation, concept or principle. Each case study will be a complete study and story and each is based on a practical situation. Case studies will present examples where investigations worked and where they did not, and examine why some were successful and others were not. Where appropriate, each case study will:

- improve the understanding of a key fact, principle or concept
- achieve that understanding by using practical information relevant to the country or region of the users, or the people they are training
- identify gaps in knowledge
- provide guidance on possible research methodologies to address gaps in knowledge.

The case studies will be written by ILRI and SLU staff and scientists working for universities and research institutes in sub-Saharan Africa. Up to date about 20 case studies have been written.

The resources are designed to be downloaded by teachers. The teachers can use the resources as they are or adapt them to be used in their own course work. All the resources comply with established pedagogic principles and aim to create learning environments. At the same time, the resources are flexible enough for the teachers to use information to suit their own situation.

Partnerships

ILRI developed and maintains a collaborative network of animal genetic resources scientists in

sub-Saharan Africa. This project was planned to be demand-driven hence made extensive use of existing networks. The project team formed partnerships with research institutes and universities in sub-Saharan Africa for planning and implementation of the project activities. The course and training resources are produced in partnerships with colleagues from universities and research institutes. Based on agreed work plans all partners will contribute to the content, design and functionality, and testing of the animal genetics training resource and the course structure.

The primary beneficiaries are university lecturers and research scientists in sub-Saharan Africa and those teaching international agricultural programmes in universities in developed countries. As a result of using the training resources, these people will have an impact on present and future policy makers, socio-economists and agricultural researchers. Animal breeding/genetic scientists will have access to better materials to strengthen the practical relevance of their teaching, research and policy making. Secondary beneficiaries include researchers and development agents in sub-Saharan Africa. This target audience will have a greater and more relevant understanding of key areas of animal genetic resources in their own countries. Faculty in developed countries who teach international agricultural courses to graduate students from sub-Saharan Africa will also benefit from the training resource. The final and ultimate beneficiaries are the smallholder crop-livestock farmers in developing countries who will receive new technologies that have an impact on productivity, household and national economic development and do so in ways that are environmentally sustainable.

Expected outcomes and project evaluation

Expected outputs

This project will facilitate the introduction of recent techniques/advances in animal genetics and breeding into the graduate curricula of African universities. In addition, by introducing university teachers to teaching aids and methods, it will help improve graduate supervision and effectiveness of teaching of these subjects, not only at the graduate level, but also at the undergraduate level. Indeed, this project could serve as a model through which effective teaching is disseminated throughout entire university systems.

Training resources (both electronic and print) is possibly one of the most significant potential outputs of this project. As has been alluded to, the resources will aim at providing technical material which those involved in graduate training can use to make animal breeding and genetics more interesting to students and relevant in the African context. These resources will include case studies and numerical examples, illustrated with images, video clips, etc. and supported by relevant bibliographic information. Moreover, because these resources will be in electronic form, their continued future updating will be relatively easy. Such updating could involve inclusion of links to independently developed, and continuously updated, Internet sites. Not only will provision of these resources to university teachers ensure that the courses are relevant and that teachers and students are exposed to recent technologies, it will also improve access (by both teachers and students) to the information they need for their research.

To the extent that postgraduate training provides the next generation of teachers, researchers and policy makers, this project will, through a substantial multiplier effect, ensure that capacity for animal genetic resources research and development is improved in Africa, and that the level of public awareness on sustainable use of animal genetic resources and related issues is tremendously enhanced.

Project evaluation

The Delivery Pathway will be initially through individuals who participate in the training courses. Two such courses are planned for Africa: one for Eastern and Southern and another for West and Central Africa. This will be sufficient to cover the majority of universities in sub-Saharan Africa which offer postgraduate training in animal breeding and genetics.

On return to their respective universities, course participants are expected to share the information gained from the course with colleagues. Initially, this information will be technical notes in print form. Recipients will be requested to make this material available to all those involved in animal breeding/genetics training at the graduate level in their countries. Contacts for additional information and/or comments will be provided, as will a website address from where detailed information on the training resources could be obtained (at a later stage, the entire product will be made available on the Internet).

The evaluation of electronic training resources will be continuous. The first step was to develop a demonstration CDROM which was evaluated during the planning workshop. The Beta version of the CDROM will be tested by the participants of the training courses and by the reference group. Feedback from testing the beta version will be used to improve the application and version I will be released at the end of 2001 for wider testing by universities in sub-Saharan Africa.

Evaluation of the impact of the whole project will involve an assessment of users' opinion. Users will include the following categories: those who will have attended the course; those who will have attended the course and subsequently used the training resources (electronic or print) in their teaching/research; those who will have used the training resources in their teaching/research but without having attended the course; those who will have neither attended the course nor used the training resources in their teaching/research; and graduate students who may have been taught or been supervised by individuals in these categories. The assessment to be conducted starting two years after the first course, will consist of two activities: implementation of a comprehensive mail survey (using a questionnaire) to a selected sample of individuals representative of all the above categories; and a workshop with participants representing these categories. The mail survey and workshop will serve as mechanisms to assess the value and impact of the project and how the course and training resources may be improved. The information from both sources will be collected in a way that allows for sound quantitative analysis. However, the workshop will also provide an opportunity to discuss emerging issues more exhaustively.

During the implementation of the project, a comprehensive list of animal breeders/geneticists in sub-Saharan Africa (in universities and research institutes) will be compiled. This will be used as the basis for the sampling described above. At the same time, this list will facilitate a realistic assessment of the coverage ("adoption rate") and impact of the project.

References

Delgado C., Rosegrant M., Steinfeld H., Ehui S. and Courbois C. 1999. *Livestock to 2020: The next food revolution*. The International Food Policy Research Institute (IFPRI), Food and Agriculture Organisation of the United Nations and the International Livestock Research Institute. 72 pp.

FAO (Food and Agricultural Organization of the United Nations). 1991. The role of universities in national agricultural research systems of developing countries: An overview. In: *Expert Consultation on the Role of Universities in National Agricultural Research Systems*.

FAO (Food and Agricultural Organization of the United Nations). 1997. *Issues and opportunities for agricultural education and training in the 1990s and beyond*. 87 pp.

Pardey P., Roseboom J. and Bientema N.M. 1997. Investments in African agricultural research. *World Development* 25 (3): 409– 423.

Wilson T.R., Ehui S. and Mack S. 1995. Livestock development strategies for low income countries. *Proceedings of the Joint FAO/ILRI Roundtable on Livestock Development Strategies for Low Income Countries. International Livestock Research Institute. Addis Ababa, Ethiopia. 27 February to 02 March 1995.*

Session 5: Short communications

Keeping quality of cow and goat milk under different temperatures in different seasons in Malawi

P. Mumba, J.W. Banda and S.B. Msowoya

University of Malawi, Bunda College of Agriculture, P.O. Box 219, Lilongwe, Malawi.

E-mail: ansccof@sdpn.org.mw

[Introduction](#)

[Objectives](#)

[Materials and methods](#)

[Results and discussion](#)

[Conclusion](#)

Introduction

Malawi is in the tropics and the temperatures range from 10 °C in the cold season which lasts 2–3 months to 30 °C in the hot season, which lasts up to 9 months. Milk is produced by the smallholder farmers and to some extent, the large scale farmers. Smallholder farmers take their milk to the milk bulking places from where the processing companies buy and take it to the plants. With the prevailing high temperatures, the length of time it takes for the milk to be transported from the farmer to the plant is important in connection with the keeping quality of the milk. Determination of the minimum time the milk can stay outside the plant is therefore, important both to the farmer and the processing company for maximum profit. Since most peasant farmers do not own refrigerators, such information would be to their advantage.

Objectives

The objective of this work was, therefore, to determine and compare the keeping quality of milk from cows and goats under the prevailing temperatures and seasons.

Materials and methods

The milk from each species was divided into two portions. One portion was heated to 65 °C for 30 minutes and allowed to cool under refrigeration temperature. The raw milk portion was put in different volumetric flasks covered with rubber stoppers and exposed to temperature ranges of 5–7 °C (using a refrigerator), 12–15 °C (using a charcoal cooler), 35–37 °C (using a water bath) and to room temperature (18–20 °C (cool dry season) or 22–25 °C (hot dry season)) in two seasons (cool dry season and hot dry season). Equal amounts of heated milk were put in different volumetric flasks and exposed to the same ranges of temperature. The Resazurin test was used to determine the keeping quality.

Results and discussion

The overall average keeping quality of milk (hours) by animal species, season, processing and temperature are shown in Table 1. There were significant differences ($P < 0.05$) in the keeping quality of cow (46.0 ± 1.02 hours) and goat milk (35.5 ± 1.02 hours). Milk in the cool dry season kept longer ($P < 0.05$) than in the hot dry season. Heated milk also stayed longer than unheated milk. The milk kept in the charcoal cooler stayed longer ($P < 0.05$) than that kept at room temperature in the cool dry season but there was no difference ($P > 0.05$) with that kept at room temperature in the hot dry season.

Irrespective of the process (heated or not) goat milk under temperature ranges of 5–7 °C, 12–15 °C, 18–20 °C and 35–37 °C kept good on average, for 88 ± 2.0 , 30 ± 2.0 , 36 ± 2.0 and 10 ± 2.0 hours in the cool dry season while in the hot dry season the averages were $76, \pm 2.0$, 24 ± 2.0 , 14 ± 2.0 and 6 ± 2.0 hours, respectively (Table 2). Cow milk exposed to the same temperature ranges kept good for 112 ± 2.0 , 36 ± 2.0 , 40 ± 2.0 and 10 ± 2.0 hours in the cool dry season and 105 ± 2.0 , 34 ± 2.0 , 22 ± 2.0 and 8 ± 2.0 hours respectively, in the hot dry season. For each animal species and in each season, the values were significantly different from each other ($P < 0.05$).

Table 1: Keeping quality of milk (hours) separated by type of milk test.

Main Class	Number of observations	LS Means(Hours)
Sub-class		
Overall Species	384	40.75
Cow	192	46.0 ^a
Goat	192	35.5 ^b
Season		
Cool dry	192	45.3 ^a
Hot dry	192	36.2 ^b
Processing		
Heated	192	51.8 ^a
Unheated	192	29.7 ^b
Temperature (°C)		
5– 7	76	97.0 ^a
12–15	77	35.3 ^b
18– 20	77	32.5 ^b
22–25	77	28.0 ^c
35– 37	77	11.0 ^d

Means within variable groups with different superscripts differ significantly ($P < 0.05$).

Table 2: The keeping quality of cow and goat milk (hours) at different temperatures and seasons

Season	Animal species	Temperature
		5–7 °C 12–15 °C 18–20 °C 35–37 °C

1	Goat	88± 2.0 ^a 36 ±2.0 ^a 30±2.0 ^a 10 ±2.0 ^a
	Cow	112 ±2.0 ^b 40±2.0 ^b 36±2.0 ^b 10±2.0 ^a
2	Goat	76±2.0 ^a 24 ±2.0 ^a 14 ±2.0 ^{*a} 6±2.0 ^a
	Cow	105±2.0 ^b 34±2.0 ^b 22 ±2.0 ^{*b} 8 ±2.0 ^a
* Room temperature of 22-25 °C		
Means with the same letter in a column and at each season are not significantly different at P = 0.001		

Regardless of temperature, heated cow and goat milk stayed without spoiling for up to 62±2.03 hours and 49 ± 2.03 hours respectively, in the cool dry season while unheated samples stayed for 37±2.03 hours and 33 ± 2.03 hours respectively, in the same season. Each set of values within a season, varied significantly from each other (P<0.001). In the hot dry season, heated cow and goat milk kept good for up to 56 ± 2.03 hours and 40 ± 2.03 hours, respectively, while the unheated samples kept for only 29 ± 2.03 hours and 20 ± 2.03 hours respectively

Conclusion

The average temperatures in Malawi range from 10 °C in the cold dry season to about 35 °C in the hot dry season. The results therefore suggest that in cool dry season small holder farmers should keep their goat and cow milk for not more than 30 hours and 36 hours, respectively, if kept at room temperature. However, if the charcoal cooler is available, then the farmer can keep his milk for a little longer time. The charcoal cooler is relatively easy to build and smallholder farmers should be encouraged to have one. This may help reduce loss of their milk and maximise their profit. In the hot dry season, goat and cow milk should only be stored at room temperature for up to 14 hours and 22 hours, respectively. If left too long in the heat, both types of milk may be spoiled within 6–8 hours. The charcoal cooler may also greatly prolong the keeping quality of the milk during this season. However, for a longer shelf life, milking should also be done in a clean environment to reduce contamination and early spoilage. Special hygienic care should be taken to reduce contamination of goat milk during milking.

Prospects for the 2000/2001 rainfall season in Malawi

Press Release Meteorological Department
Ministry of Transport and Public Works

The La Nina phenomenon in the equatorial Pacific Ocean, which dominated the past two rainfall seasons, 1998/99 and 1999/2000, is observed to have died down. Sea surface temperatures in the same area are currently near average and are projected to remain around normal during the next six months, implying that the ocean-atmosphere interaction will be normal (no El Nino and no La Nina). Hence, the 2000/2001-rainfall season in Malawi, which falls within these six months, will not be affected by either El Nino or La Nina implying a normal season. Typical normal seasons in recent years include 1989/90, 1978/79, 1960/61 and 1959/60. However, of these seasons, 1989/90 is the only season that precedes two strong consecutive La Nina episodes.

Analysis of these four normal seasons in Malawi indicate the following:

- The onset of the main rains was normal, relatively uniform across the country and occurred during the second ten days of November.
- The season progressed normally with the usual mid season dry spells.
- The cessation of the rains was normal; towards the end of March over the southern half of Malawi stretching into April over the northern half.
- The seasonal rainfall totals were normal in most areas.

Additional national analyses utilising other indicators have also been done to describe the prospects of Malawi's 2000/2001 rainfall as detailed below:

- Inland surface heating over the country, which precedes the onset of the rainfall season, was delayed up to August. However, from September to-date warming has been observed. Normally, a continued warming trend often leads to favourable onset of the rains.
- The Inter-Tropical Convergence Zone (ITCZ), which is the main rain bearing system over Malawi, is currently close to its normal position around the equator, slowly progressing southwards.
- Current atmospheric wind and pressure patterns favour the normal onset of rainfall over the country. Pre-season rains, locally known as chizimalupsya, are being experienced in some parts of the country.
- During a normal season tropical cyclones develop over the Indian Ocean, which have either adverse or favourable effects on Malawi rainfall depending on their position in the Mozambican channel.

Based on the above analyses, the forecast for the 2000/2001 rainfall season in Malawi is: normal rainfall across the country during the period October to March. However, pockets of dry areas associated with a normal rainfall season should be expected.

The above forecast has been produced with additional inputs from Southern African Climate Outlook Forum (SARCOF) that met in Gaborone, Botswana in September 2000 and other international climate forecasting institutions.

The effect of variety and geographical location on the mineral content of sorghum and finger millet in Kenya and Uganda

Winchester M.D Mvula¹ and A. O. Makokha²

¹University of Malawi, Bunda College of Agriculture, Box 219, Lilongwe, Malawi

²Jomo Kenyatta University of Agriculture and Technology, Box 62000, Nairobi, Kenya

[Abstract](#)

[Introduction](#)

[Materials and methods](#)

[Results and discussion](#)

[Conclusions and recommendations](#)

[Acknowledgement](#)

[References](#)

Abstract

Sorghum *S.bicolor* and finger millet eleusine coracan grain are widely consumed in East Africa. There are very many varieties of these grains and these grains differ widely in their physical and chemical composition. This study determined the influence of variety and geographical location on the mineral content of six varieties of sorghum grains grown within three different geographical locations and two similar varieties of finger millet grown within two different locations. The minerals were determined using an atomic absorption spectrophotometer. In the sorghum grain the iron, calcium, zinc, magnesium and manganese content ranged from 8.7 – 15.3, 3.3 – 6.7, 4.2 – 6.8, 15.5-- 16.2 and 2.9 – 4.3 mg/100g, respectively. In finger millet grain the iron, calcium, zinc, magnesium, and manganese content ranged from 10.3 – 14.2, 60.7-- 85.6, 5 – 5.9, 16.5 – 34.3 and 19.2-- 24.1 mg/100 g respectively. There were significant differences due to location in iron content of all finger millet varieties. However, the differences in mineral content for sorghum grain did not correlate for either variety or geographical location.

Introduction

Sorghum and finger millet grains are grown in semi areas of the tropics and sub- tropics. Many types of sorghum grown traditionally are photosensitive. Between 1930 and 1950, local sorghums were first collected in Kenya, Uganda and Tanzania in East Africa. The crop was considered to be of no importance there until about 1975 (Doggett 1988). Finger millet and sorghum are widely consumed in East, Central and Southern Africa. Sorghum and finger millet are used in the form of "ugali", "uji" or porridge and also traditional beer. Finger millet and sorghum are important sources of carbohydrate, protein and minerals. However, there are major variations in chemical and physical composition. In addition, there are major variations in mineral content among sorghum and finger millet grain world-wide. There is little

information on this variation in mineral content within East Africa. The objective of this study therefore is to determine total minerals in sorghum and finger millet grain grown in different locations within Kenya and Uganda and also to investigate the effect of variety and geographical locations on the mineral content of sorghum and finger millet grain grown in Kenya and Uganda.

Materials and methods

Finger millet and sorghum were collected from Serere in Uganda, Katumani in West Kenya, and Alupe in East Kenya. A pair of similar varieties was obtained from two different geographical locals. Six varieties of sorghum were from three different geographical locations and two varieties of finger millet from two different geographical locations. Moisture was determined by placing samples in an oven at 105°C for three hours and crude ash was determined by heating the samples in a muffle furnace at 550°C for 18 hours. Minerals were analysed by using an atomic absorption spectrophotometer (AAS; procedures are outlined by Lick et al. 1979; Khetarpaul and Chauhan 1990).

Results and discussion

Table 1. Mineral content in sorghum and finger millet grain (mg/100gm).

Variety	DM	Zinc	Mn	Fe	Ca	mg
KARI Mtama 1 Alupe Sorghum	92.2	4.6	3.3	10.1	6.1	15.8
KARI Mtama 1 Katumani Sorghum	94.9	4.2	2.9	8.7	4.9	15.5
Seredo Alupe Sorghum	90.2	5.7	4.3	10.2	3.8	16.2
Seredo Katumani Sorghum	91.2	5.3	4.0	9.2	4.0	15.8
IS 9646 Katumani Sorghum	91.7	4.8	3.4	9.1	5.2	15.8
IS 9646 Alupe Sorghum	92.1	6.8	4.2	15.3	3.2	15.6
Pes Serere Finger millet	91.8	5.0	24.1	14.2	85.8	34.3
Pes Alupe Finger millet	89.1	5.9	19.2	10.3	60.7	16.5

Dry matter (DM) is more than 90% in all cases, therefore within acceptable moisture in all cases.

In this study, there was no significant difference in iron content among sorghum varieties (mean 10.4 ± 2.3). In addition, there was no significant difference in iron among geographical locations except between IS9646 Alupe and Katumani, where there is a difference at the 5% level. (compared the means using the analysis of variance). For finger millet, Pes Serere had significantly higher iron than Pes Alupe. Therefore, there was no significant difference due to geographical location. All the iron content figures are within the range from earlier work (Doggett 1988).

KMI has significantly higher Calcium (Ca) than Serere and IS9646. There was no significant difference between IS 9646 and Seredo in Ca content. Finger millet has significantly higher Ca content than sorghum grain. Regarding geographical location, IS 9646 grown in Alupe has significantly higher calcium than that grown in Katumani. In addition, finger millet, Pes Serere, grown in Serere has significantly higher Ca content than the one grown in Alupe. KM1 grown in either Alupe or Katumani and Seredo grown in the same two locations did not show significant differences in Ca content.

Agricultural management of sorghum and finger millet grain at the three research stations is similar. No fertilisers were added.

Table 2a: Differences in mineral content among Sorghum grain

Mineral	Variety	Location
Iron	NS	SD
Calcium	SD	SD
Zinc	NS	NS
Magnesium	NS	NS
Manganese	SD	NS

SD: Significant difference at 5% level

NS: No significant differences.

Table 2b: Differences in mineral content in finger millet due to geographical locations

Iron	SD
Calcium	SD
Zinc	SD
Magnesium	SD
Manganese	SD

Conclusions and recommendations

This study shows that there was no consistent effect of variety or geographical location on the mineral content of sorghum and finger millet. More work on mineral determination needs to be done with sorghum and finger millet at more geographical locations.

Acknowledgement

Thanks to the Japanese International Corporation Agency (JICA) for providing the financial assistance and Jomo Kenyatta University of Agriculture and Technology

for providing the facilities.

References

Lick et al., 1979; Khetapaul and Chauhan, 1990, AOAC, 1984

Milk yield, physico-chemical properties and composition of milk from indigenous Malawi goats and their Saanen half-breeds

P.P. Mumba, Banda J.W., Nyoni C.C. and Kaliwo G.

University of Malawi, Bunda College of Agriculture, P.O. Box 219, Lilongwe, Malawi

E-mail: Ansconf@sdpn.org.mw

[Objectives](#)

[Materials and methods](#)

[Results and discussion](#)

[Conclusion](#)

[References](#)

Objectives

The objective of this work was to compare the milk yields, some physico-chemical properties and the chemical composition of milk from the indigenous Malawi goats and their Saanen half-breeds.

Materials and methods

The physico-chemical properties determined were pH and specific gravity. The constituents analysed were total solids, fat, crude protein (N x 6.38), lactose, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K) and chloride (Cl).

Results and discussion

The mean yields, pH and specific gravity from both local and crossbred goats are given in Table 1. The crossbred goats produced significantly higher milk yields ($p < 0.01$) than the local Malawi goat. This means that crossing the Malawi local goat with the Saanens would improve milk production by almost 300%. Both the specific gravity and the pH were not significantly different in the local and crossbred goats ($p > 0.01$). It has been reported that the specific gravity of milk is a function of the fat content and the total solids in the sample. In this experiment, both the fat and the total solids contents in the two breeds (Table 2) were not significantly different and nor was the specific gravity. The pH values of the milk from both breeds were slightly lower than the range of values (6.3–6.7) reported by other researchers.

Table 1. Milk yields (Kg), pH, and specific gravity of milk from indigenous Malawi (LL) and half-bred Saanen (SL) goats during an eight-week period

Breed	Milk yield		pH		Specific gravity	
	Mean	Sd	Mean	Sd	Mean	Sd
LL	a	4.79	5.196	0.02	1.033	0.01

	37.1					
SL	102.0 ^b	11.21	5.618	0.03	1.046	0.01

Means with different letters in a column are significantly different ($p < 0.01$)

The concentration of the milk components of the locals and their Saanen crosses are given in Table 2. The fat content of the local goat milk ($6.72 \pm 0.25\%$) was not significantly different from that of the crosses ($6.08 \pm 0.08\%$). The values obtained were in the range of values reported for the African dwarf goat (Jenness 1980). However, these values were higher than those obtained elsewhere. Peacock (1996) reported that tropical goats have fat contents ranging from 3–6%. The goats used by Braunsdorf (1966) and Dozet (1973) were of different breeds and this could account for the observed differences.

Table 2: Average milk composition of the indigenous Malawi goat (LL) and half-bred Saanen goats (SL)

Component	Breed			
	LL		SL	
	Mean	Sd	Mean	Sd
Fat (%)	6.7	0.25	6.1	0.08
Crude protein (%)	5.2	0.29	4.4	0.20
Lactose (%)	4.7 ^b	0.22	5.3 ^a	0.25
Ca (mg/l)	74.4 ^b	4.29	134.3 ^a	12.51
Mg (mg/l)	58.0 ^b	4.44	98.6	10.88
Na (mg/l)	55.9 ^b	5.19	129.7 ^a	16.58
K (mg/l)	82.7 ^b	11.0	132.9 ^a	17.36
Cl (mg/100ml)	92.1	0.54	132.9 ^a	0.26
Total solids (% w/w)	13.8	0.72	13.5	0.42

Means with different letters in a row are significantly different ($p < 0.01$)

The protein contents were also not significantly different in the local and cross-bred goats. Again, the variations from other goat milks can be accounted for by the different genetic constitutions. The lactose content in the local goat milk ($4.7 \pm 0.22\%$) was significantly lower ($p < 0.01$) than that of the crossbred goats ($5.3 \pm 0.25\%$). The observed values were higher than those reported for other breeds such as the pure Saanens, but were closer to the values of dwarf goats, which produce higher lactose than the other breeds.

The content of all determined minerals of the crossbred goats were in general higher ($p < 0.01$) than those of the local goat. All minerals in the local goat milk were much lower than the values reported by other researchers. Most notable was the chloride content which was lower in both the local and crossbred goats as compared to literature values. For example, French (1970) reported that the chloride content is in the range of 157.8–181.1 mg/ml.

The total dissolved solids were not significantly different ($p > 0.01$) in the local goat milk and in the crossbred goats but were in the range of values reported by other researchers. Banda (1992), who used the local Malawi goats and their Boer crosses, observed much higher total solids values than in the current studies.

Conclusion

Milk yield from crossbred goats was higher than that from the indigenous Malawi goats. This means that the indigenous Malawi goat can be improved by crossing it with the exotic dairy goat. There were no significant differences in fat, crude protein and total solids contents in milk from indigenous and from the crosses. However, there were differences in the contents of lactose and the trace elements, which were higher in the milk from crosses than in the indigenous breed. The high levels of nutrients in the goat milk are indicative of the potential to improve the diets of the rural Malawians.

References

- Banda J.W. 1992. *Genotypic and seasonal influence on milk yield and milk consumption of sheep and goats in Malawi*. PhD thesis, University of Giessen. Germany.
- Braunsdorf K. 1966. A report on an investigation of goat's milk. *Dairy Science Abstract*. 28:1337.
- Dozet N. 1973. Composition and nutritional value of goat's milk and goat's milk Products. *Dairy Science Abstract* 35:3147
- French M.H. 1970. *Observation on the goat*. FAO Agricultural Series No. 80. Food and Agricultural Organisation (FAO). FAO, Rome, Italy. 299 pp.
- Jeness R. 1980. Composition and Characteristics of goat milk: Review. *Journal of Dairy Science* 63:1605–1629.

Session 6: Abstracts

Genetic diversity in indigenous cattle breeds of East Africa

P. S. Gwakisa

Faculty of Veterinary Medicine, Sokoine University of Agriculture, Box 3019, Morogoro, Tanzania, Correspondence: Email - gwakisa@suanet.ac.tz

Abstract

The cattle of East Africa are generally adapted to the environment in which they occur with resistance to many parasites and to extremes of climate. These cattle are however, characterised with low productivity. When the more productive European breeds are introduced to Africa, they succumb to the local conditions. Treating these latter cattle is expensive and negates many of the advantages due to their introduction. The options to breeders are either to improve the local breeds via crossbreeding to the European cattle or to improve the local breeds by selection. Improvement of African breeds requires their preliminary characterisation, in which regard, evaluation of the level of genetic divergence among them is particularly important. By knowing the level of divergence between local breeds, appropriate choices can be made for selection, improvement and conservation of genetic material. We have used two molecular genetic techniques to compare the extent of genetic diversity among East African local *Bos indicus* breeds and compared these to a distant West African N'dama breed and improved *Bos indicus* breeds in Australia. Polymorphisms were generated by PCR analysis of random amplified polymorphic DNA (RAPD) and a variety of microsatellite markers. Similarity indices and genetic distances indicated different extents of divergence between the East African Zebu. Inclusion of distant West African N'dama and Australian *Bos indicus* breeds in the genetic comparisons, enabled a clearer indication of the hierarchy of genetic relationships between the East African breeds. The significance and implications of this genetic diversity are discussed in the context of the merits carried by these breeds.

Keywords: Genetic diversity, Cattle, DNA markers, RAPD, Microsatellites

Carcass composition of tethered, supplemented Tanzanian goats and prediction models for carcass weight and composition

Mtenga, L.A., Kakengi, A.M.V., Kimambo, A.E. and Mgheni, D.M.
Department of Animal Science and Production, Box 3004, Morogoro, Tanzania

Abstract

A study was conducted to evaluate the effect of supplementing two strains of tethered small East African goats on growth rate, killing out characteristics, carcass composition and development of prediction equations for carcass weight using linear body weights. Sixteen male goats of 9 to 12 months of age were used. Animals were sorted by their weight and strain and then randomly allocated to two treatments. The treatments were tethering with or without supplementation. All animals were tethered for 8 hours for a period of 84 days. Animals were slaughtered and carcass killing out percentage and composition were determined. Pooled prediction equations for carcass weight and composition were developed.

Supplementation significantly ($P < 0.05$) influenced the empty body weight and carcass weight when expressed as a percentage of slaughter weight. Treatment effect was observed also for the edible non carcass components such as gastro intestinal tract, pluck, kidney and gut fat where it was higher for supplemented than unsupplemented goats albeit the differences were merely numerical ($P < 0.05$). Heart girth was an independent variable that could predict the carcass weight of the goats better ($P < 0.01$, $r = 0.78$). Of the three independent variables - slaughter, carcass and empty body weight, - carcass weight was the best fit model for prediction of lean ($P < 0.001$, $r = 0.87$) and bone ($P < 0.01$, $r = 0.71$) whereas empty body weight was a better predictor of fat ($P < 0.05$, $r = 0.32$) in carcass tissues. It was generally concluded that tethering and supplementation could be a better grazing management for improvement of local goat meat production in areas under scarcity of land. It was further concluded that the developed carcass weight and composition models could be of use to farmers as tools that can determine the time and price for disposing their goats.

Post-weaning performance of local Malawian pigs fed soyabean-based diets containing different levels of raw, untreated sunflower seed meal

R. K. D. Phoya, Y. N. Vibetti and J. B. Jonazi

Abstract

The effects of feeding soyabean-based diets containing different levels of raw, unextracted sunflower seed meal on the post-weaning performance of local Malawian pigs were investigated. The treatments were 0 (T₁), 10 (T₂), 20 (T₃) and 30% (T₄) sunflower seed meal - containing starter diets formulated to provide 3320 Kcal digestible energy/kg and 22% crude protein for a period of 42 days. Then the pigs were changed to grower diets formulated to provide 3040 Kcal digestible energy/kg and 18% crude protein such that animals initially on 0, 10, 20, 30% sunflower seed meal diets were put on 0, 20, 30 and 40% sunflower respectively and only removed from the trail in the week they approached 45 kg.

Average daily gain (ADG) and the Kleiber ratio were determined during the starter period. There were no significant ($P > 0.05$) differences in ADG between treatments 1, 2 and 3, but treatment 4 was significantly different from treatment 2 at the 5% level. There were also no significant differences in the Kleiber ratio between T₁, T₂, and T₃, but T₄ was significantly different from T₁ and T₂ at 5%. ADG values in kg were 0.38, 0.40, 0.36 and 0.33; and for the Kleiber ratio, the values: 0.034, 0.035, 0.034 and 0.032, for treatments T₁, T₂, T₃ and T₄ respectively.

During the grower period, the average daily gain values in kg were 0.43, 0.47, 0.45 and 0.40, and for the Kleiber ration, the values were 0.031, 0.032, 0.032 and 0.030, and for treatments T₁, T₂, T₃ and T₄ respectively. There were no significant ($P > 0.05$) differences in the response variables between the treatments during the growing period.

Piglets on higher sunflower seed meal-containing starter diets (T₃ and T₄) showed reduced performance compared with their contemporaries on lower sunflower seed meal, although this difference became non-significant ($P > 0.05$) during the growing phase when the pigs were maintained on consistently higher sunflower seed meal diets. There were no significant differences in the carcass characteristics between the treatments. It is suggested that in local pigs, sunflower seed meal can be included up to 20 and 30% in starter and grower diets respectively, without reducing average daily gain or increasing the backfat thickness in the carcass.

Using carbon isotope ratios ($\delta^{13}\text{C}$) in determining diet changes in animals: The case of the Lake Malawi bathyclariias nyassensis (pisces: claridae)

E. Kaunda¹ and T. Hecht²

¹ Dept of Aquaculture and Fisheries Science, University of Malawi, Bunda College of Agriculture: email: ekaunda@yahoo.com

² Dept of Ichthyology and Fisheries Science, Rhodes University, Grahamstown, RSA

Abstract

The isotopic composition of the body of an animal reflects the isotopic composition of its diet, although the animal is on average enriched in $\delta^{13}\text{C}$ by about 1 % relative to the diet. We examined isotopic composition of different size groups of *Bathyclariias nyassensis* ranging from 37 to 73 cm total length (TL) and of its principal prey items (fish and zooplankton). The $\delta^{13}\text{C}$ values showed ontogenetic dietary shifts from "light" or more negative (approximately – 21 %) in small fish to "heavy" or "less negative" (–19.5 %) in medium size fish and to light or more negative (–20.7 %) in large fish. The dietary ontogenetic changes were supported by two other independent methods: morphology and gut content analysis.

Morphologically, filtering area was determined on 18 fish of varying sizes, and the area changed when fish reached approximately 50 cm TL suggesting changes in fish food habits and/or diet. Detailed gut analysis showed changes in diet from piscivory to predominantly zooplanktivory at the same fish size (50 cm TL).

These results indicate that while limits of accuracy of using $\delta^{13}\text{C}$ generally restrict its application to situations in which diet is derived from sources with relatively large differences in their $\delta^{13}\text{C}$ values, such as terrestrial Vs aquatic organisms or C_3 Vs C_4 plants, the method can be relied upon when other methods are available to validate the findings.

Characterisation of the local Zambian chicken — A case study of Chikondwa area in Chongwe

Malwa-Mushota, N.M; Mfitlodze, M.W.;
Wollny, C.B.A; Gondwe, T.N; Banda-Nyirenda, D

Abstract

A study was conducted to characterise the local Zambian chicken in the Chikondwa area of Chongwe district from February to July, 2000. A preliminary study involved using a questionnaire administered to 78 households to determine demography of the farmers and evaluate village chicken production, health, management and their importance in households. Each household had an average of 6.29 ± 3.22 persons, the majority being women. The level of education of most of these was not beyond primary school. Most farmers (50 %) kept 1 to 10 chickens, and a few (37.7%) kept between 11 and 20. More men (48%) claimed ownership of the chickens than women in the household (41%). The majority (65.4%) of the farmers acquired chickens from within the same village, 10.3% from the neighbouring village and only 5.1% from the market. The local chickens were kept mainly for consumption and as a source of income for the rural people. Chickens were kept on free range with occasional supplementation of maize grains and kitchen refuse. They were housed only at night in kitchen houses (51.3%), traditional poultry houses (9%), battery cages (2.6%) and trees (32.1%). The majority (97%) of the villagers did not give any health care to their chickens. The birds reached table weight at 4.16 months and age at sexual maturity was attained at 5.72 months. Egg production reduced in the wet season (January to March). The study confirmed that village chickens are the most common species of livestock kept by the rural Zambian. There were variations in both colour and types of these chickens, which include types like the frizzle, naked neck, dwarf and the spotted.

Key words: Zambian local chicken, management, and variation

The prevalence, incidence and effects of trypanosomosis on reproductive performance of cattle in north-eastern Zimbabwe

N.T. Kusina,^{1a} P. Muzavazi² and P. den Bossche³

¹Department of Animal Science, University of Zimbabwe, Harare, Zimbabwe

²Faculty of Veterinary Studies, University of Zimbabwe, Harare, Zimbabwe

³Regional Tsetse and Trypanosomosis Control Programme (RTTCP), PO Box A560, Avondale, Harare, Zimbabwe

Abstract

A study was conducted in three adjacent zones stretching for a distance of approximately 60 km from the Mozambican border into Zimbabwe to investigate the prevalence and incidence of trypanosomosis in cattle. The second objective was to determine the effects of the trypanosome challenge on reproductive performance of the cattle. Each zone was 20km wide. The area had been previously cleared of tsetse fly and any re-invasion was controlled by an eight-kilometre wide odour-baited insecticide treated target barrier. The trypanosome challenge was evaluated using serological and parasitological analysis of blood samples taken from sentinel herds of approximately 60 adult Mashona cows in each zone. Blood samples were collected at monthly intervals from March to August 1999. Results showed that the incidence of trypanosomosis was low with an average of 3% of the cattle infected. The level of infection decreased with increasing distance from the Mozambican border and infection was higher during the rainy season than the dry season. Trypanosome infection significantly ($P < 0.05$) reduced the packed cell volume. However, the reproductive performance of the cattle herds was not affected ($P > 0.05$) by the trypanosome challenge. In addition, abortion and mortality were similar among the cows in the three zones. It is therefore concluded that the current level of trypanosome challenge did not affect reproduction and productivity of cattle reared in the 60km zone close to Mozambique. These results suggest that the target barrier that was erected was effective in controlling tsetse fly from re-invading the area.

Key words: Tsetse fly, trypanosomosis, cattle, reproductive performance

Constraints to rural poultry production and diversity in Lilongwe and Mzuzu agricultural development divisions, Malawi

T.N.P. Gondwe¹, F.C. Chilera¹ and A.J.D. Ambal²

¹Department of Animal Science, Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe.

²Biology Department, Chancellor College, University of Malawi, P.O. Box 280, Zomba.

Abstract

Rural poultry constitute over 80% of total poultry population in Malawi. Smallholder farmers keep a diversity of species on free-range system. Chickens (mainly indigenous breed) comprise 83%, pigeons 14%, ducks 2% with a small proportion of turkeys, geese and guinea fowl. Productivity of rural poultry is generally low. In a study to evaluate biodiversity in rural poultry, specific and general constraints were observed from a random sample of 323 farmers who kept one form of poultry in Lilongwe (170) and Mzimba (153) Districts of Lilongwe and Mzuzu Agricultural Development Divisions, respectively. Some of the constraints were of threat to phenotypic and genetic diversity that exists in rural poultry. The study mainly concentrated on chickens, ducks and pigeons whose constraints are discussed in the paper.

Health constraints comprised of high prevalence of diseases and parasites (more in chickens and ducks than in pigeons), predators and bad weather conditions. Bad weather was associated with poor housing structures. Traditional houses (kholas) were used for all species in Mzimba while in Lilongwe, traditional houses were used for ducks and pigeons. Chickens were housed in human dwelling units for fear of theft that was more in chickens than in ducks and pigeons. These traditional houses were however, not protecting birds from night predators, rain and cold weather conditions. There was minimal care taken in chicken houses and duck and pigeon houses were not attended to. Human dwelling units in Lilongwe were small and with poor ventilation, creating possible chances of disease transmission.

There was haphazard breeding in rural poultry and farmers did not keep records. Most farmers exchanged their breed stock among themselves within the villages. Less than 40% of breed stock was acquired from outside the villages. The breeding structure and the exchange of breed stock are possible causes of inbreeding and genetic drift, considering the small populations that exist in the villages.

There was poor health and extension services for poultry, which was non-existent for ducks and pigeons. Duck production and consumption was also affected by cultural and religious taboos, and the preference of farmers of chickens to ducks. These also affected the diversity of species among flocks. Rural poultry production is mainly for subsistence, and hence was under the responsibility of women in households who were unfortunately more illiterate (average of standard 3) than men (average of standard 5). The husbandry care for poultry was therefore very minimal.

The study identified constraints in rural poultry relating to housing, diseases, management and socio-cultural values. These constraints affected production and species diversity in rural poultry. There is therefore a need to develop species-specific and general interventions to improve rural poultry production and sustain genetic diversity.

Key words: constraints, production, diversity, and rural poultry

Village chicken production in Zimbabwe — Constraints and potential

*J. Kusina*¹

Department of Animal Science, University of Zimbabwe,
P O Box MP167, Mt. Pleasant, Harare, Zimbabwe
E- mail address: Kusina@ansci.uz.zw

Abstract

Poultry production is widespread in Zimbabwe, comprising large-scale, small-scale commercial and extensive poultry production units. Large-scale systems are characterised by huge investments, intensive management and a high degree of mechanisation and specialisation. These systems, because of the nature of the inputs required, are confined to a few wealthy companies or individuals. Small-scale systems are found in both peri-urban and communal areas. Exotic or improved breeds are used in commercial poultry production systems. Extensive systems are found mainly in the communal areas, with almost every household owning some chickens. These systems are dominated by poultry breeds that are not classified into specific breeds, but are possibly crosses of imported and indigenous breeds or indigenous breeds depending on the area and mainly scavenge for their daily nutrient requirements. In Zimbabwe, village chickens are estimated to be between 15 and 30 million. The estimate is based on about one million communal farmers, with an average of 20 birds/flock. Village chicken production has withstood the test of time and is often described as a low input-low output production system. This makes it a very sustainable system for the resource poor, communal area farmers. Needless to say, because of this attitude, very little attention has been paid to this industry in terms of research and development, training and marketing, resulting in the lack of information on the status of poultry production in the communal areas. This lack of attention has led to many constraints in terms of improving productivity of village chickens, not only in Zimbabwe, but also in other African and developing countries. Despite the lack of attention and constraints, there is potential to increase village poultry production. Village chickens or indigenous chickens (where they still exist), are an important reservoir of germplasm that may be used in the future to improve hybrid birds to better adapt to the environments where they are kept. Village chickens are also relatively cheap to purchase, feed and house. In addition, they are an ideal source of high quality protein (both meat and eggs), income and manure fertiliser for economically disadvantage people, the majority of whom live in the rural areas of Zimbabwe and Africa. The constraints and potential to improving village and small-scale chicken production will be reviewed in this paper.

Key words: village poultry, production, constraints, protein, income

Some socio-economic factors constraining farm animal production in Malawi

J.P.Simpson

University of Malawi, Bunda College of Agriculture, PO Box 219, Lilongwe, Malawi

Abstract

By international standards, there is a fundamental lack of interest in stockmanship in Malawi. Livestock, specifically cattle, has been traditionally viewed as wealth-on-the-hoof, a security fund, with culling and marketing as alien concepts. Since time immemorial, land was owned communally, not individually. Additionally, heavy and rapidly increasing demographic pressures have created a land shortage. Matrilineal descent patterns have militated against the development of breeding herds and flocks. A bewildering array of virulent diseases has caused enormous livestock losses and official efforts to control or contain these ravages were largely undone by non-compliance. Consequently, both the colonial administration and the newly independent republic were confirmed in their views that `corn' and not `horn' was the way forward for national prosperity. Finally, a lack of interest in measuring and recording, so essential for successful livestock development, remains one of the differences between the First and Third Worlds.

Use of maize and crotalaria leaves as supplements for tethered sheep and goats

S.K Chikagwa-Malunga¹, J.A Jere¹ and J.W Banda²

¹Chitedze Agricultural Research Station, Lilongwe, Malawi.

²Bunda College of Agriculture, P.O. Box 219, Lilongwe, Malawi.

Abstract

Two experiments were conducted to evaluate the effect of supplementation on the performance of local versus Dorper x local tethered sheep (average 33.0 kg wt) with lambs (average 11.37 kg wt) in Experiment 1, and local versus Boer x local goats (average 25.8 kg wt) with kids (average 6.07 kg wt) in Experiment 2 at Chitedze Agricultural Research Station. In both experiments, a mixture of maize leaves and crotalaria (3:1, 500 g/animal/day) was compared with maize leaves (500 g/animal/day) or no supplementation. Feed intake, live weight change, mortality and milk intake were used to evaluate dam and offspring performance. Maize leaves + crotalaria leaves (MC) had a higher N content than maize leaves (M) alone. There was a significant difference ($P < 0.05$) between supplementation and no supplementation. In Experiment 1, sheep (dams and lambs) supplemented with MC gained more ($P < 0.05$) weight per day compared with those that received M only. However, there was no significant difference ($P > 0.05$) between the two breeds of sheep in terms of live weight change. However, mortality of sheep due to worm infestation was influenced by breed. In Experiment 2, dams given MC gained weight. The performance of kids was not affected ($P > 0.05$) by supplementation, but by body condition and mothering ability of the dams. Breed had an effect ($P < 0.05$) on the performance of both dams and kids in terms of liveweight change and mortality. Boer crosses were more affected nutritionally than their local counterparts. Defoliation of maize leaves did not affect maize grain yield in the field. It is concluded that supplementation significantly improved the performance of tethered sheep and goats, and the use of MC as a supplement was superior to M alone. Although breed had an effect on liveweight change of lambs and goats, and mortality of sheep and goats, it had no effect on the liveweight change of ewes.