Small Ruminant Research and Development in Africa

Proceedings of the Third
Biennial Conference of the African
Small Ruminant Research Network
UICC, Kampala, Uganda
5–9 December 1994

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July 1996

International Livestock Research Institute (ILRI)
P.O. Box 30709
Nairobi, Kenya

ISBN 92–9146–011–7

Correct citation Lebbie S H B and Kagwini E 1996 *Small Ruminant Research and Development in Africa Proceedings of the Third Biennial Conference of the African Small Ruminant Research Network UICC Kampala, Uganda, 5–9 December 1994* ILRI (International Livestock Research Institute) Nairobi, Kenya 326 pp

Abstract

This volume contains papers and abstracts of the Third Biennial Conference of the African Small Ruminant Research Network In addition to the keynote address, there are nine papers on Genetic Resources Enhancement and Utilisation, seven papers on Production Systems, Policy and Economics, six papers on Management and Health, 12 papers on Feeding and Feeding Systems and 10 papers on Performance and Reproduction Six poster abstracts covering the above topics add to the volume

Keywords

/Sheep//goats//small ruminant production systems//productivity//economics//policy//weaning practices/ /agropastoral//pastoral//production constraints//feeds//feed resources//feeding systems//digestibility/ /nutrition//supplementation//diet//reproduction//reproductive wastage//performance evaluation//health/ /peste des petits ruminants//infectious diseases//vaccines//breeds//breeding systems//breed improvement/ /Africa/

Résumé

Le present volume rassemble les exposes et les resumes des articles presentés a la troisieme Conférence biennale du Reseau de recherche sur les petits ruminants Outre le discours liminaire, il contient un total de 44 communications dont neuf sur l'amelioration et l'utilisation des ressources genetiques, sept sur les systemes de production l'economie et les politiques six sur la gestion et la sante, 12 sur l'alimentation et les systemes d'alimentation et 10 sur les performances et la reproduction A quoi il convient d'ajouter six series d'affiches presentees a cette conference sur l ensemble des sujets enumeres ci-dessus

Mots clés

/Ovins//caprins//systemes de production des petits ruminants//productivite//economie//politiques/ /modes de sevrage//agropastoral//pastoral//obstacles a la production//aliments du betail//ressources alimentaires//systemes d'alimentation//disgestibilite//nutrition//complementation//ration//reproduction/ /pertes en reproduction//evaluation des performances//sante//peste des petits ruminants//maladies infectieuses//vaccins//races//systemes d'elevage//amelioration genetique//Afrique/

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Preface

Limited access to information and limited opportunity for interaction among scientists working in the same area of interest are two of the major constraints to small ruminant development in the developing world, and in particular, Africa

It is against this background that the African Small Ruminant Research Network (SRNET) has made the promotion and improvement of information exchange on small ruminant research and development one of its major priorities in addition to collaborative research and training The network has set out to achieve this goal through the organisation and sponsoring of a biennial scientific conference, amongst other channels This provides a forum for small ruminant scientists in Africa and elsewhere, developers, policy makers and farmers to meet, exchange ideas and establish partnerships The forum also provides opportunity for small ruminant research priority setting

This proceedings reflects the oral and poster presentation at the Network's Third Biennial Conference held in Kampala, Uganda, from 5 to 9 December 1994 Some 110 participants, representing 32 African countries, five European countries and various international and regional organisations (ILCA, OAU/IBAR and FAO) were present Five scientific sessions were held, at which 44 oral and six poster presentations were made and discussed The sessions focused on production systems, economics and policy, performance and reproduction, health and reproductive wastage, feeds and feeding systems and genetic resources and breeding for both oral and poster presentations

The Network is grateful to the European Economic Community (EEC) and ILCA for their continuous promotion and support of the activities of the Network including the holding of the Third Biennial Conference and the publication of the proceedings A lot of thanks go to the ILCA Nairobi support office for the usual superb logistical support

Special thanks go to the Ugandan Government for its support in holding the conference, and in particular to the Ministry of Agriculture, Animal Production and Fisheries and the National Small Ruminant Co-ordination Committee for co-hosting the conference The Network also appreciates the kind willingness of Her Excellency, Dr Specioza Kazibwe, Vice President of the Government of Uganda, to be the guest speaker My final thanks and gratitude go to all those who made the publication of this proceedings possible, particularly Ms Anne Nyamu, for English editing, and Mr Sourou Adoutan, for French editing, and the staff of the Publications Section of the International Livestock Research Institute, Addis Ababa

S H Lebbie

SRNET Co-ordinator

Keynote address

Small ruminants: Goats and sheep in Uganda

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Introduction

There are about 400 million goats in the world, with Africa accounting for 67% In East Africa, Kenya has a goat population of 6 4 million Tanzania 4 3 million and Uganda 3 9 million The trends in Ugandan small ruminant population dynamics can be seen in Table 1 One method of increasing the number of goats and sheep is to select for twinning traits within a population The twinning rate of East African goats is 30% and triplets occur at the frequency of 2% Goats have a unique feeding characteristic of browsing which accounts for 60% while the grazing preference is only 40%

Table 1 *Sheep and goats census in Uganda 1935–94*

Year	Sheep	Goats
1935	1 062 139	2 335 033
1945	995 321	2 143 533
1950	1 065 822	2 324 232
1955	1 093 247	2 513 732
1960	865 000	2 592 000
1965	790 933	1 997 713
1970	827 444	1 801 311
1975	700 000	2 000 000
1980	1 000 000	2 100 000
1985	700 000	2 500 000
1990	570 000	3 700 000
1994	1 100 000	3 900 000

Goats and sheep make an important contribution to the subsistence subsector of the economy of Uganda and indeed of many countries in Africa Over one million goats and sheep are slaughtered and consumed annually for meat The skins contribute substantially to foreign exchange earnings as well as permitting import substitution for use in the local tannery and leather craft industry of Uganda Locally the skins are used extensively in traditional technoculture They are used notably in the making of mats, covering handles of tools (knives dancing costumes ropes drums and shields) and covering ornamental articles Footwear strings and specific musical instruments are also made from skins

Exotic goats of the Toggenburg and Anglo-Nubian breeds were imported to Uganda for cross breeding with local goats with a view to enhancing milk yield and meat production in the offspring In the early 1960s exotic wool sheep were introduced into Uganda and were bred on Government farms with the objective of assessing their ability to survive reproduce and produce wool and meat in Uganda's climatic, technical and management environment

It was planned that wool sheep production could be integrated with beef cattle ranching where tick-borne diseases were controlled Sheep prefer shorter pastures than cattle and they would therefore follow cattle in rotation management system within fenced paddocks

Exotic sheep goats and their crosses with indigenous stock are more susceptible to helminth infection than the local breeds Therefore every care should be taken to institute an effective regime of preventive measures comprising adequate rotational systems of grazing coupled with strategic prophylactic cover and all reinforced by regular chemotherapeutic preventive treatments

It has to be emphasised that meat production from small ruminants is very important in Africa This is so because these animals are more suitable for family consumption of 5–10 people than cattle owing to their comparatively small carcases (10–15 kg)

Furthermore there is lack of regular beef supplies outside the main cash-crop harvesting season Absence of networks of rural electrification virtually prevents exploitation of refrigeration technology and hence limits preservation and storage capacity of the perishable meat surplus Indeed, there is a positive correlation between slaughtering and consumption of beef and the availability of cash in rural areas during the main crop (coffee and cotton harvest) sales

Before the second world war, goats were kept in almost every household in the rural areas At that time children 8–15 years of age contributed the main source of household labour for herding the flocks of goats During the last 50 years schooling has deprived rural parents of their source of cheap and convenient labour for herding small ruminants Goats exhibit great activity in their search for feeds through browsing grazing and eating household residues They are relatively more difficult to herd than sheep which tend to fit in well in a system of joint herding with cattle

In extensive areas of northern and north-eastern Uganda there was a potential of rearing large flocks 200–300 goats using one herdsman particularly if trained sheep dogs were introduced and the husbandry internalised in the farming community

Breeds of goats

In Uganda there are three distinct breeds of goat reared for meat production

The commonest type is the smallest of the three and can be described as the Small East African (SEA) Its mature live weight is 20–25 kg It occurs extensively in northern and eastern short savannah ecological areas and the drier areas of Buganda in the northern parts of Luwero and Mukono districts (Buruli, Bulemezi and Bugerere)

The second type is described as the Mubende goat This is a large animal of 30–35 kg live weight It is renowned for its popular skin on the international market The skin is called "Kampala skin" in trade circles This breed is concentrated in the Mubende District

The third type falls in between the first two in live weight 25–30 kg Its typical ecological niche is in Kabale, Kisoro and Rukungiri in Kigezi District It is referred to as the Kigezi goat

The colour of the three types above ranges between pure white to pure black and includes all shades between those two colours

The incidence of twinning is rather low estimated at 30% Milk yields are sufficient to satisfactorily raise one kid In case of twins there is often poor initial growth which points to an inadequate supply of milk

Strategy for improvement

As with other basically meat producing species of livestock and poultry increases in meat production from goats can be based on the basic principles and practices of animal breeding These are exemplified by selection and cross-breeding methods

In an exercise of this nature it is useful to use genetic resources which have been improved but are indigenous to the African continent Such an animal is typified by the Boer goat

The Boer goat, as the name implies, was selected from indigenous goats and bred over many generations by the Boers of South Africa with the aim of improving meat production The mature female weighs about 60–75 kg live weight and the mature male weighs about 90-100 kg live weight The goat has a cream white body with a reddish-brown head

The twinning rate is 50% and the rate for triplets is 6% The breed has a high milk yield and adapts well to semi arid conditions Its carcass dressing percentage is relatively high and its skin has excellent quality for leather manufacture

In 1971 Boer goats were imported into Kenya and were used for cross-breeding with the typical East African goat similar to the one described for Uganda A comparison was made between the performance of the East African goat breed and the Boer X East African F_1 cross Tables 2 and 3 summarise the results

Table 2 *Live weight (kg) according to age of the Small East African goat and its F_1 cross with the Boer goat*

Age group	Boer x Small East African (F_1)	Small East African	Difference
Birth	2 06±0 4	2 3±0 5	0 3
42 days	8 3±1 5	6 9±1 3	1 3
150 days	19 7±2 5	14 9±2 7	4 8
180 days	21 8±2 8	16 2±2 9	5 6
275 days	28 2±2 8	20 2±2 3	8 0
365 days	34 3±2 4	20 0±3 1	12 3

Table 3 *Average daily gain (g) from birth to weaning and from weaning to 1 year old*

Period	Breed		
	Boer x small East African (F_1)	Small East African	Difference
Birth to weaning (6 weeks)	114±16	84±18	30
Weaning to 365 days	64±10	32±10	32

The performance of the native Small East African kids was fully comparable with Mubende kids studied by Sacker and Trail (1966) The crossbreds weighed more and grew faster than the SEA goats at all ages This superior weight performance improved with age

In March 1993 the Faculty of Veterinary Medicine, Makerere University imported 35 female and 5 male Boer goats from the Northern Cape Province of South Africa Preliminary research results on the Boer goats Small East Africa goats and crosses between the two breeds are shown on the following extracts compiled at Buyana Faculty Farm in Mpigi District of central Uganda

Introducing the South African Boer goat into Uganda

Statement of objectives The experiment aims to improve the productivity of the Small East African goat as far as meat production is concerned in the context of How Boer goats will be best put to use A detailed study of the reproduction growth and meat production performance of the Boer goats will be carried out Disease factors that limit production will also be studied

Introduction

The total goat population of Uganda stands today at some 3 9 million head These goats are basically of one main type — the Small East African goat It is small, compact, hardy and specially adapted to humid environments Mature weights are about 25 to 30 kg The importance of goats in Uganda is based on meat and skins Some of the major reasons for promoting goat production in Uganda include

- The human population is growing steadily creating a significant and increasing demand for goat meat in Uganda and in the Arab world
- The capital investment for the farmer is relatively low, the reproductive turnover is high and managing the goats is not labour intensive
- The genetic potential of the local goats can be improved by selection and cross-breeding If this is combined with improved feeding and health, overall production gains could be considerable
- In ranching areas goats can become very useful animals in bush clearing and they can be used as pasture improvers

Materials and methods

Thirty-five ewes and five rams of Boer goats were imported from Northern Cape Province of South Africa on 18 March 1993 The female goats were bred in March and April Thirty Small East African goats were bought in June 1993 from Kisozi Ranch for the purpose of cross-breeding with Boer goat rams in August 1993 The goats were kept under intensive system of management Animals graze in the day and are housed overnight

Preliminary results

The birth weight of the crossbred kids was superior to the Small East African kids Unfortunately, there was no correlation between the birth weight and the daily gain

Boer goats were more prolific than the SEA goats considering their relatively higher twining rate (Table 4) The SEA indicate an interesting sex ratio of the young

Table 4 *The reproductive performance of the Boer goat and the Small East African goat*

	Goat breed	
Parameters	Boer goat	Small East African goat
No of does that kidded	29	25
Type of kidding (%)		
Single	37 9	64 0
Twin	62 1	36 0
Kid sex (%)		
Male	66 7	50 0
Female	33 3	50 0

From Table 5 it could be deduced that the Boer goat kids gained most weight followed by the crossbreds and then the SEA goat kids in descending order Irrespective of type of birth and breed of goat, male kids gained more than female kids As expected also, single kids gained faster than twin kids irrespective of breed of goat and sex of kid

Discussion

When assessing the results one has to take into consideration

- the number of goats sampled for the different groups is statistically low
- all goats lambed for the first time
- the results of Boer goats are influenced by adaptation to the new environmental conditions

Nevertheless, the results are promising enough for the experiment to continue It seems that the South African Boer goats adapted well to the environmental conditions of the Buyana Stock Farm

The reproductive performance of Boer goats with 62 1% of twin births is higher than that of the Small East African goat with 36% of does kidding twins

The mortality rate of Boer goat kids was about 11% All kids which died were one of a set of twins The main causes of mortality were digestion disturbances and mismothering of twin kids within the first few days of life The mortality rate of Small East African goat lambs was also 11% with the same causes of mortality

Very little attention with regard to feeding is paid to the young stock They live on their mother s milk and begin to nibble at vegetation from a few days of age The main problem likely to be encountered is the presence of worms which can cause serious economic losses Severe worm infestation (Trichostrongyle Moniezia) were observed in the young stock and treated successfully with a dose of Wormicid Plus

Female goats get an extra feeding of approximately 150 g Calf Early Weaner Pellets per day The recorded daily average gain of Boer goat lambs aged 30 days corresponds with the results recorded in South Africa

Table 5 shows that the expected hybrid vigour appears when crossing Boer goats and Small East African goats The first cross progeny are superior to the Small East African goat in the daily average gain and mean masses of lambs aged 30 days

There is no doubt that cross-breeding will become an important and very popular method in commercial meat goat production The first results show that the

Table 5 *Daily average gain (g/day) of lambs aged 30 days*

	Boer goats	Small goats	East African	Crossbreed	goats	
Kid sex	Single	Twins	Single	Twins	Single	Twins
Male	236	160	145	73	156	100
Female	218	159	147	46	160	98

general excellence of the F_1 generation will consequently increase the goat breeder s return

Sheep

In the annual report of 1961 the Director of Veterinary Services and Animal Industry reported research results on the crosses of indigenous sheep with the exotic Dorset Horn breed as follows

> *A study was initiated in 1959 to compare the Ankole Fat tailed sheep with its Dorset Horn breed cross Data collected to date would indicate that lambing percentages are maintained and there is a marked improvement in weight gains Birth weights were heavily in favour of the crossbreds and at 18 months the latter were double the weight of the pure Ankole sheep However as so frequently happens in Africa, the net productive gain after mortality was considered rather reversed the picture Mortality from all causes for the 3 year period of the trial up to 6 months of age was 17 6% in the case of pure Ankole sheep and 24 1% for the crossbreds*

During 1959, 68 4% of the crossbred sheep died and in 1960 68 2% died The figure for 1961 was 22 1% It should be noted however that the bulk of the mortality in 1959 and 1960 was due to a toxaemic jaundice of unknown origin Sheep of about 10 months of age were mainly affected and while some pure Ankole sheep were involved the disease occurred almost entirely in crossbreds There was very little evidence of the disease in 1961, hence the lower mortality rate of 22 1% This is but further evidence of the vital role played by disease factors in the upgrading and management programmes in Africa This study was to be continued and extended to include back-crossing to the Ankole

Milk goats

Some research on imported Toggenburg exotic milk goat and its crosses with Mubende goats was done in the 1960s and 1970s at the Livestock Experimental Station Entebbe

Both the pure Toggenburg and the crosses of Toggenburg x Mubende goats showed promising results in terms of milk yield up to 4 kg per goat per day for the pure Toggenburg and 2 kg for the crossbred goats Furthermore growth rate and mature weight were improved in crossbreds compared with the indigenous Mubende goats

Today a number of women s non-governmental organisations have introduced the Toggenburg breed and its crosses to Uganda notably to Kasese and Bushenyi districts in western Uganda

Finally, a comment on Table 1 showing a virtually stagnant census of goats and sheep in the last 60 years 1934–94 This situation poses a challenge to policy makers and policy implementers It is hoped this conference will discuss and address positively future directions in the breeding nutrition animal health management and economics of small ruminants at the farm and national levels in Uganda as well as in countries represented in this conference

Meanwhile the export market for live goats and sheep in the oil rich Middle East Arab countries appears limitless It is estimated to be of the order of one million small ruminants per annum Therein lies the challenge

Reference

Sacker G D and Trail J C M 1966 Production characteristics of a herd of East African Mubende goats *Tropical Agriculture (Trinidad)* 43 43–51

Opening address

Her Excellency Vice President Specioza Kazibwe

Your Excellencies,

Distinguished Guests

Ladies and Gentlemen

By singular coincidence this happens to be my first address to an international African scientific conference on small ruminants since my assumption of additional duties two weeks ago

You are cordially welcome to Uganda where I understand your mission is to deliberate on Sustainable Small Ruminant Production in Mixed Crop–Livestock Production systems on the African continent

I gather that among the areas for discussion are

a) The role of small ruminants in the conservation of ecology and Africa s food security and

b) The role of women in small ruminant development in Africa

Both these topics are central to Africa s environmental crises and gender resource development the latter of which I am directly responsible for and wish to be advised more on the logistics

Historical perspective

Permit me however to share with you my thoughts on the past, present and future challenges we must overcome together in order to promote social and economic progress through sustainable animal agriculture and food security

From a historical perspective, the root causes of insufficient livestock research and technology development in Africa are manifestations of misorientation of resources by colonial policies The relationship between African people and their socio-economic environment including food resource development, has always been out of balance The foreign policies not only destroyed the traditional and sustainable methods of production but also introduced new modes of production that stressed cash crops for export and profit rather than conservation of the environmental ecology and providing for food security For example

(i) The goat was described as a problem child of African agriculture causing deforestation and soil erosion

(ii) Cash crops such as tobacco and cotton have been cultivated in the rainy season in direct competition for family labour to grow food crops and conserving fodder for livestock

(iii) Coffee, rubber, cocoa, palm oil and sugar-cane plantations took away land that could otherwise have been used for food crop and animal agriculture

Distinguished participants, the historical antecedents of the current environmental and food security crises in Africa should not pass unchallenged Widespread famines on the continent are a consequence of enclave economies and export economies by foreign agencies This indeed facilitated the exploitation of natural and human resources in Africa without due attention to the conservation and regeneration of these resources This is why small ruminants development was sidelined in Uganda during the colonial era Instead, massive importations of fat slaughter cattle from European settler s farms in Tanzania and beef butter and milk from Kenya and white South Africa was pursued

You may wish to recall from history that our pre-colonial ancestors kept goats and sheep as kingpin domestic livestock species in every home They were housed in every hut of an average peasant family in rural Africa They were culturally shared among the entire membership of the African family and their productivity was sustainable

Let me now put it to you, dear distinguished scientists Is it not paradoxical today, that most of our countries are still submerged in the historical consequences of almost four centuries of pre-independence domination? Is it not true that this domineering influence is of unequal scientific and economic relationship, which in turn contributes to environmental stresses that affect livestock and food-crop productivity in Africa?

Putting the historical perspective to its rightful conclusion, I am of the view that there is hardly any African country today without inherited colonial institution legacies and structures, be it in schools, army, research institutions or government business Some of these legacies include urban-biased development, instead of rural farming infrastructures and unbalanced export-oriented strategies, instead of sustainable food-security programmes Technological over-dependence scarcity of appropriately trained manpower and paucity of research information about the indigenous resource base are some of the bottlenecks to Africa s post-independence development and indeed to the growth of small ruminant productivity in Africa

The problems which have their roots in the pre-independence era have today become major constraints to several major aspects of development,

especially in the restructuring of the livestock and food-crop production sectors None of these problems however are amenable to short-term solutions What Africa most urgently needs is to have a strong linkage between training, research and technology-transfer processes African scientists must provide the information needed to formulate realistic policies and agree on the most appropriate development strategies which would be economically viable socially acceptable and environmentally sustainable That way we can forget the colonial past

Present situations

Turning to the present challenges regarding food security, Uganda's average per capita food availability is adequate, although nutritional deficiencies are rampant due to shortages of animal protein sources, such as goat meat, beef, milk, mutton etc Continent-wise, a perplexing contrast exists between Africa's population growth rate of 3 0 to 4 0% and an average food production increase rate of 0 5 to 1% per annum

With a population growth of that magnitude the number of mouths to feed doubles every 20 years For example Africa s human population today is put at 500 million and is expected to shoot up to 1 36 billion by the year 2020 that means an extra 800 million mouths to feed

The challenge is how the 400 million small ruminants in Africa with an average offtake of 20% will contribute to animal protein food security sources Furthermore, what role can sheep and goats play in promoting investment in development of export agriculture (IDEA) after satisfying the national or regional food security needs?

With respect to ecological conservation in a mixed crop–livestock context I urge you, scientists to develop transferable technologies that promote intensive use of animal manure waste and recycling of crop residues agro-industrial by-products and planted fodder resources The technologies should be compiled in simple handbooks and training manuals for farmers, instead of hiding them away in incomprehensible and unattainable international journals

I am aware of the bottom-line concern of research scientists And that is the magnitude of financial resources that African governments invest into research and especially livestock research

The colonial legacies of promoting cash crops for export led to disproportionate allocation of funds into crop rather than animal agriculture Today African countries allocate a dismal 1% of the AGDP [agricultural gross domestic product] into research Uganda's investment into research has been until recently a mere 0 2% of the AGDP These negligible apportionments are largely utilised for payment of salaries rather than procuring equipment and chemicals

This state of affairs must be addressed by governments and donor communities to fully support indigenous scientific and social research programmes Uganda has addressed this problem seriously and we have put in place a national agricultural research organisation (NARO) with three of its six institutes directly addressing livestock resource programmes Uganda also collaborates with several international research centres including the recently concluded agreement with ILCA

Future challenges

Before I conclude let me address the future challenges by pointing out the inevitable the gender (women) role in livestock research and small ruminant development

The first issue is the training of women as animal and food scientists I challenge this forum to produce before me an inventory and percentage of women researchers involved in animal agriculture It is true in Africa that women attend to the chickens, goats, sheep and calves, they also milk cattle, make butter and ghee in predominantly male-owned herds and flocks Participatory social development dictates that the entire family be involved in the ownership, care and maintenance of their resources It is a motivating factor to own an animal and then care for its wellbeing Every member of the family — man, woman and child — should share in the ownership of small and large stock as a basis for economic emancipation be it for school fees, taxation, food security or any other family needs

That is why I recommend, that the best gift to one's wife or one s child s birthday is a cow goat or a chicken I appeal to the professors and researchers to train women scientists and extension workers in animal production I further urge the Small Ruminant Research Network to focus on the women human resource as your partners in implementing your programmes on the African continent

In conclusion, we in the government of the National Resistance Movement do agree that the paucity of well developed indigenous scientific research capacity contributes to food insecurity and environmental degradation which is a reflection of poverty

Uganda happens to be fortunate in that our agricultural potential is quite high And with better appropriate scientific knowledge and environmental management we should be in a position to meet some of the needs of the eastern African region We have substantial surpluses of grain commodities We can equally gain surplus in meat supply including live small ruminants for inter-African trade

Finally I would like to commend the SRNET Co-ordinator and his counterpart team in Uganda for their tireless efforts in bringing about this conference I also wish to thank the distinguished delegates for devoting much of their time to the preparations of the scientific papers and for attending this conference, right here in Uganda I wish all of you fruitful deliberations

I have therefore the pleasure to declare this conference officially open

For god and my country

Thank you

Allocution d'ouverture

Pr Yenikoye Alhassane
President du Comite directeur du Reseau

Excellence Madame la Presidente,

Honorables invites,

Mesdames, Messieurs,

Je suis tres heureux de me trouver aujourd hui dans cette belle ville de Kampala et je suis certain de partager ce plaisir avec vous

Apres Bamenda en janvier 1989 date de creation de notre Reseau, Nairobi en decembre 1990 et Arusha en decembre 1992, nous voici reunis a Kampala dans le cadre de la 3eme Conference biennale du Reseau africain de recherche sur les petits ruminants C'est pour nous l'occasion de faire un bilan du chemin parcouru et de degager pour notre Reseau de nouvelles orientations qui tiennent compte a la fois des contraintes internes et externes a notre systeme de recherche zootechnique en Afrique

Au cours de ses six annees d existence le Reseau a essaye d'atteindre les objectifs qui lui ont ete assignes En effet, a travers son approche de recherche concertee qui favorise par consequent la formation et la circulation de l'information, le Reseau a essaye, d'une part d'ameliorer la qualite des recherches entreprises par ses membres et d autre part, de contribuer a une meilleure coordination de la recherche zootechnique en Afrique

Il a egalement reussi a susciter une prise de conscience significative de l importance des petits ruminants sur le continent en reunissant tous les deux ans une masse critique de chercheurs africains appartenant aux systemes nationaux de recherche agricole Cette prise de conscience est developpee et renforcee par ses diverses publications

Enfin le Reseau a contribue dans une certaine mesure a ameliorer les conditions de recherche de quelques centres nationaux de recherche agricole par un apport financier appreciable obtenu aupres des donateurs

L'une des principales consequences des activites du Reseau sur les systemes nationaux de recherche agricole a ete le renforcement de leur capacite de recherche et nous pouvons affirmer que tant que le Reseau africain de recherche sur les petits ruminants disposera de l appui financier necessaire il continuera a avoir un impact positif sur ces systemes nationaux

L insuffisance de fonds destines a la recherche constitue l une des preoccupations majeures de notre Reseau Cette situation est generale au niveau du continent africain et des pays en developpement En effet, la plupart de ces pays consacrent moins de 0,5% de leur produit interieur brut (PIB) a la recherche-developpement alors que les differents forums internationaux tenus sur ce sujet en recommandent au minimum 1% Cette attitude des Etats a l egard du financement de la recherche est due surtout a l'absence de politique scientifique et technologique La recherche n est pas consideree comme une priorite par les gouvernements africains, en particulier en periode de crise economique

En outre, on constate que dans la plupart des centres nationaux de recherche en Afrique, 70% a 90% des subventions allouees sont absorbees par les charges de personnel Une autre raison de l'insuffisance de financement de la recherche en Afrique est la faiblesse ou l'inexistence dans certains cas de liens entre les institutions nationales de recherche et le secteur productif

Toutes ces difficultes ont des repercussions negatives sur les performances de nos chercheurs et partant de notre Reseau Il est par consequent necessaire de prendre en compte la dimension nationale dans la resolution des problemes de financement de la recherche menee en Afrique par les membres de notre Reseau Chacun d'entre nous, dans la limite de sa sphere de responsabilite au niveau national, doit sensibiliser son gouvernement de façon a ce que la recherche soit integree comme element de la strategie de developpement national A cet effet les mecanismes de financement public et prive de la recherche doivent être revus

Il pourra être propose les recommandations suivantes

1 Allocation des ressources de l Etat a la recherche agricole sur la base de budgets- programmes adaptes aux besoins pluriannuels des chercheurs, pouvoirs publics et societes

2 Mise en place d un Fonds national de la recherche scientifique et technologique pour compenser les subventions absorbees par les charges de personnel Ce fonds sera alimente par l Etat les institutions et offices publics et para-publics les organismes regionaux et internationaux de recherche operant dans les pays

3 Octroi d un regime de faveur en matiere de taxes et d impôts aux instituts nationaux de recherche agricole sur les biens, services et dons afferents au developpement de la recherche

4 Etablissement de liens de partenariat entre les institutions de recherche agricole et le secteur productif

(Petites et moyennes industries) dans le but de faciliter le transfert des resultats de la recherche au secteur productif et de canaliser les fonds gouvernementaux vers ces institutions de recherche

La mise en oeuvre de ces mesures permettra d ameliorer la capacite de recherche de nos systemes nationaux gage de reussite et de durabilite de notre Reseau

Cependant construire une capacite scientifique et technologique presuppose une reponse globale au besoin de reformer le financement et la gestion des systemes nationaux de recherche A cet egard, il est souhaitable que l'aide des donateurs soit orientee a la fois vers les priorites definies dans les plans de developpement socio-economique et culturel des pays du sud et vers la creation et le soutien des reseaux de recherche regionaux et internationaux Les donateurs devraient contribuer egalement au financement des programmes etablissant les liens entre les institutions de recherche et le secteur productif, car c est par le developpement economique a travers la prosperite des entreprises que le systeme de recherche peut beneficier d un financement durable

Enfin, il faut favoriser le systeme de prêt d'assistance technique aupres des bailleurs de fonds (Banque mondiale) pour financer la recherche agricole en Afrique

Nous devons nous organiser au sein du Reseau pour disposer d'une banque de donnees sur les Etats et organismes regionaux et internationaux qui financent la recherche agricole en Afrique

Le bilan des actions entreprises aupres des donateurs et bailleurs de fonds par le Comite directeur depuis la conference d Arusha vous sera presente par le coordonnateur dans son rapport d activite

En tant que jeune reseau nous continuerons a rechercher le soutien de tous pour permettre a notre structure de se developper et de se renforcer

Le Reseau doit mettre a profit ces journees pour elaborer les elements de sa strategie et fixer ses priorites en matiere de production et de sante des petits ruminants dans le nouveau cadre cree en matiere de recherche zootechnique internationale

Au nom du comite directeur du coordonnateur et de tous les membres du Reseau, je voudrais remercier sincerement tous les pays, individus et organisations dont l appui et la comprehension ont permis a notre Reseau de jouer pleinement son rôle au niveau africain

En premier lieu je citerai le CIPEA qui a toujours soutenu financierement et materiellement notre Reseau depuis sa creation Ensuite je citerai la CEE et le NRI qui viennent au premier rang de nos donateurs

Enfin nos remerciements vont aux autorites ougandaises pour le soutien combien utile et important qu elles ne cessent d apporter a notre Reseau nous permettant ainsi de tenir cette 3eme conference biennale dans cette belle et historique capitale Kampala

Vive le Reseau africain de recherche sur les petits ruminants

Vive la cooperation scientifique internationale

SESSION 1

Genetic Resources Enhancement and Utilisation

Biotechnology options for improving livestock production in developing countries, with special reference to sub-Saharan Africa

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Abstract

Techniques of modern biology such as molecular cloning of genes gene transfer genetic manipulation of animal and plant embryo transfer genetic manipulation of rumen microbes chemical and biological treatment of low quality animal feeds for improved nutritive value genetically engineered immunodiagnostic and immunoprophylactic agents as well as veterinary vaccines, *inter alia* are a reality today and are finding their ways into research and development programmes of developing countries Biotechnology is offering unprecedented opportunities for increasing agricultural productivity and for protecting the environment through reduced use of agro-chemicals The major thrust in biotechnology research is currently directed at solving immediate problems of industrialised countries with major investments coming from transnational companies However many of the new discoveries and products will find their biggest markets in developing countries where the potential for improvement in agricultural productivity and health is greatest The importance of biotechnology and its relevance is only slowly being accepted by policy makers in developing countries In the presence of economic crisis strong fiscal constraints rapid social change and constant political instabilities the difficulties associated with major policy changes in developing countries are enormous This paper reviews available biotechnologies with potential application in livestock improvement and identifies those which have been or may be applied in developing countries in general and Africa in particular The review covers biotechnology applications in the areas of animal genetics and breeding including conservation of animal genetic resources animal health physiology of lactation and growth and animal nutrition

Introduction

Developing countries are faced with the challenge to rapidly increase agricultural productivity to help feed their growing populations without depleting the natural resource base Biotechnology is regarded as a means to meet both objectives through addressing the production constraints of small-scale or resource-poor farmers who contribute more than 70% of the food produced in developing countries

Biotechnology can be defined as any technique that uses living organisms or substances from such organisms to make or modify a product to improve plants or animals or to develop micro-organisms for specific purposes Biotechnology is not new Man has used it for thousands of years to manufacture products such as beer wine and bread Conventional plant and animal breeding which involves selection and mating of phenotypically preferred individuals is a good example of age-old application of biotechnology What is new about biotechnology comes from more recent breakthroughs such as recombinant DNA technology and associated techniques monoclonal antibody techniques embryo manipulation technology etc These have enhanced possibilities for manipulating biological systems for the benefit of mankind

Among agricultural and allied fields animal production and health have probably benefitted the most from biotechnology But successful application of biotechnology has generally been limited to developed countries Specifically there are hardly any success stories of the application of biotechnology in the improvement of livestock production in Africa The purpose of this paper is to review available biotechnologies with potential application in livestock improvement and to identify those which have been or may be applied in developing countries in general and Africa in particular In addition the paper gives a broad brush examination of possible reasons for failure of those technologies which have been tried The paper also presents examples of successful application of biotechnology in Africa and the potential role of biotechnology (both old and new) in future livestock development in Africa The paper starts by presenting an overview of biotechnologies with current and/or potential applications in the areas of reproductive physiology genetics and animal breeding animal health physiology of lactation and growth and animal nutrition Given the breadth of the topic not much depth is given to the review of each area Rather an attempt is made to highlight the technologies considered to have current or potential application The paper concludes with a fleeting coverage of issues concerning the potential environmental hazards of genetic engineering and other biotechnologies and the need for their ethical

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evaluation and for an international regulatory mechanism

Overview of available biotechnologies

Reproductive physiology

One of the challenges for genetic improvement is to increase reproduction rates Several reproduction techniques are available The commonest of these are artificial insemination (AI) embryo transfer and associated technologies Measurement of progesterone in milk or blood which is a widely used technique for monitoring ovarian function and for pregnancy tests is also an important technology for managing the reproductive function of the animal

Artificial insemination

No other technology in agriculture except hybrid seed and fertiliser use, has been so widely adopted globally as AI Progress in semen collection and dilution, and cryopreservation techniques now enables a single bull to be used simultaneously in several countries for up to 100,000 inseminations a year (Gibson and Smith 1989) This implies that a very small number of top bulls can be used to serve a large cattle population In addition each bull is able to produce a large number of daughters in a given time thus enhancing the efficiency of progeny testing of bulls The high intensity and accuracy of selection arising from AI can lead to a four-fold increase in the rate of genetic improvement in dairy cattle relative to that from natural mating (Van Vleck 1981)

A wider and rapid use of selected males through AI will accelerate the rate of gender improvement Also use of AI can reduce transmission of venereal diseases in a population and the need for farmers to maintain their own breeding males, facilitate more accurate recording of pedigree and minimise the cost of introducing improved stock However success of AI technology depends on accurate heat detection and timely insemination The former requires a certain level of experience among farmers while the latter is dependent on good infrastructure including transport network, and availability of reliable means of transport

Though AI is widely available in developing countries it is used far less particularly in Africa than in developed countries Its use has been limited largely to exploratory' purposes mainly by research institutions A few countries including Botswana Ethiopia Ghana, Malawi Mali, Nigeria Senegal and Sudan have taken the technology to the field mostly for programmes of upgrading' indigenous stock and as a service to a limited number of commercial farmers keeping exotic dairy cattle breeds A few others have used the technology more widely Kenya and Zimbabwe, for example, have elaborate AI systems which include national insemination services incorporating progeny testing schemes However even these have gone through periods of collapse or serious degeneration and have had to go through rehabilitation phases The Republic of South Africa is probably the biggest user of AI technology in terms of number of inseminations This country also has what is perhaps the best organised progeny testing scheme on the continent

AI technology use is still more generally associated with dairy cattle than other domestic livestock species The limitations of AI use in beef cattle include the difficulty in detecting heat in large beef herds kept on ranches and the less frequent handling of individual cows In sheep and goats the failure to develop a simple non-surgical insemination procedure has prevented extensive exploitation of the technology in sheep (Robinson and McEvoy 1993) However the technical success of laparoscopic intra-uterine insemination has prompted research into less invasive transcervical procedures (Halbert et al 1990, Buckrell et al 1992) Also in Africa research to improve the freezing and-thawing properties of sheep semen is underway in the Republic of South Africa In pigs use of AI is hampered by the inability to successfully cryopreserve boar semen

AI is credited for providing the impetus for many other developments which have had a profound impact on reproductive biotechnology Foote (1982) noted that studies of oestrus detection and ovulation control which evolved out of a need to correctly time inseminations led to the development of embryo transfer technology

Embryo transfer (ET)

Although not economically feasible for commercial use on small farms at present embryo technology can greatly contribute to research and genetic improvement in local breeds There are two procedures presently available for production of embryos from donor females One consists of superovulation followed by AI and then flushing of the uterus to gather the embryos The other called *in vitro* fertilisation (IVF) consists of recovery of eggs from the ovaries of the female then maturing and fertilising them outside the body until they are ready for implantation into foster females IVF facilitates recovery of a large number of embryos from a single female at a reduced cost thus making ET techniques economically feasible on a larger scale Additionally IVF makes available embryos suitable for cloning

The principal benefit of embryo transfer is the possibility to produce several progeny from a female just as AI can produce many offspring from one male For example the average lifetime production of a cow can be increased from 4 to 25 calves Increasing the reproductive rate of selected females has the following benefits genetically outstanding animals can contribute more to the breeding programme particularly if their sons are being selected for use in AI the rate of genetic change can be enhanced with specially designed breeding schemes which take advantage of increased intensity of female selection combined with increased generation turnover transport of embryos is much cheaper than that of live animals risk of importing diseases is avoided facilitates rapid expansion of rare

but economically important genetic stocks, and the stress to exotic genotypes can be avoided by having them born to dams of local breeds rather than importing them as live animals

Embryo transfer is still not widely used despite its potential benefits In developing countries this is mainly due to absence of the necessary facilities and infrastructure Even in developed countries cost considerations still limit the use of commercial embryo transfer in specialised niches or for a small proportion of best cows in the best herds Thus, in North America and Europe, only about one out of 500 calves born in the last decade was from ET (Seidel and Seidel 1992) Commercial embryo transfer is more popular with cattle than other species This is mainly because ET is relatively easier in cattle than the other species and also because it is more economical in cattle (i e cattle are worth more) Additionally the low reproductive rate and the long generation interval of cattle make ET much more advantageous in cattle

Production of several closely related, and hence genetically similar individuals through ET techniques can make critical contributions to research For example a project at the International Laboratory for Research on Animal Diseases (ILRAD) to locate the genes responsible for tolerance of some cattle populations to trypanosomiasis required large numbers of closely related crosses of trypanotolerant and trypano-susceptible cattle Use of ET has made it possible to generate such families thereby facilitating the search for genetic markers of trypanotolerance Additionally, ET could be useful in studying the extent to which a trait is influenced by the embryo (direct component) or the reproductive tract (maternal component)

Embryo sexing and cloning

Although embryo sexing may not have dramatic effects on rates of genetic gain (Colleau 1991, Kinghorn et al 1991) it can considerably increase efficiency Taylor et al (1985) concluded from a study that an all-female heifer system using ET was 50% more efficient than the highest achievable in a traditional system It has been suggested that, if multiple sexed-embryo transfer became as routine an operation as AI is beef operations based on this system could become competitive with pig and poultry production in terms of efficiency of food utilisation

Clones may be produced by embryo splitting and nuclear transfer (Macmillan and Tervit 1990) These offer the possibility for creating large clone families (Woolliams and Wilmut 1989) from selected superior genotypes which in turn can be used to produce commercial clone lines (Smith 1989) However some studies have concluded that cloning of embryos will not increase rates of genetic progress in the nucleus but that it offers considerable advantages in increasing the rate of dissemination of tested superior genotypes in commercial populations (Woolliams 1989) Other potential applications of cloning include efficient evaluation of genotype x environment interactions and testing and/or dissemination of transgenics From a research standpoint production of identical siblings should by eliminating variability among animals, greatly reduce the size and hence the cost of experiments

Hormone use

Use of hormonal assays to *monitor* reproductive function can be rewarding for both research purposes and commercial livestock operations Reproduction can also be *manipulated* using hormonal treatments But while hormonal treatments have produced desirable results in some studies in Africa (Aboul-Naga et al 1992) lack of awareness about their use and the fact that they are not economically viable under most prevailing production circumstances limit their use Progesterone and PMSG treatment and immunisation against androstenedione increased ovulation rate in Ossimi sheep Also exogenous melatonin treatment of barren Rahmani ewes resulted in increased proportion of ovulating ewes and a higher ovulation rate (Aboul-Naga et al 1992) These responses however did not result in increased litter size because of increased ova wastage Thus, in addition to the impracticability arising from prohibitive prices of hormonal preparations and the problems with hormonal administration at farm level there are other technical problems associated with the use of these technologies For example, technologies aimed at increasing litter size in traditional small ruminant production systems should not be applied unless management, including nutrition, can be improved in concert to ensure the survival of the additional progeny

Reproduction can also be manipulated without application of exogenous hormones Aboul-Ela et al (1988) reported that exposing ewes to rams one week prior to mating (the ram effect') increased the percentage of ewes in oestrus (and hence the per cent mated) by 27% Such management approaches offer practical options for increasing annual lamb (or kid) production in situations where other technologies are either not available or not appropriate Accelerated lambing — increasing the number of lambings per year — can also be used to increase annual productivity However, in tropical and subtropical situations where animals depend on seasonally available natural pastures, this practice may not be sustainable Under such circumstances the reproductive cycle tends to be dictated by availability of feeds

Animal genetics and breeding

Genetic improvement of livestock depends on access to genetic variation and effective methods for exploiting this variation Genetic diversity constitutes a buffer against changes in the environment and is a key in selection and breeding for adaptability and production on a range of environments

In developed countries breeding programmes are based upon performance recording and this has led to

substantial improvements in animal production Developing countries have distinct disadvantages for setting up successful breeding programmes infrastructure needed for performance testing is normally lacking because herd sizes are normally small and variability between farms farming systems and seasons are large, reproductive efficiency is low, due mainly to poor nutrition, especially in cattle and communal grazing precludes implementation of systematic breeding and animal health programmes

Multiple ovulation embryo transfer and open nucleus breeding system

Multiple ovulation embryo transfer (MOET) is a composite technology which includes superovulation, fertilisation, embryo recovery, short-term *in vitro* culture of embryos, embryo freezing and embryo transfer Benefits from MOET include increasing the number of offspring produced by valuable females, increasing the population base of rare or endangered breeds or species, *ex situ* preservation of endangered populations, progeny testing of females and increasing rates of genetic improvement in breeding programmes Genetic improvement of ruminants in developed countries has made much progress in the last 35 or so years through the use of large-scale progeny testing of males As has been pointed out, the general failure of extensive use of AI in developing countries has implied that progeny testing schemes cannot be operated with much success In any case the generally small herds/flocks and uncontrolled breeding in communal grazing situations preclude implementation of progeny testing Smith (1988a) suggested that the Open Nucleus Breeding System (ONBS) may be especially valuable for developing countries where the use of AI has been a failure due to the reasons given above

The ONBS concept is based on a scheme with a nucleus herd/flock established under controlled conditions to facilitate selection The nucleus is established from the "best" animals obtained by screening the base (farmers') population for outstanding females These are then recorded individually and the best individuals chosen to form the elite herd/flock of the nucleus If ET is possible, the elite female herd is used through MOET with superior sires to produce embryos which are carried by recipient females from the base population The resulting offspring are reared and recorded and the males among them are evaluated using, as appropriate, the performance of their sibs and paternal half sibs and their own performance From these an elite group of males with high breeding values for the specific trait is selected and used in the base population for genetic improvement through natural service or AI It should be noted that while MOET improves the rate of progress substantially, it is possible to operate an ONBS without ET technology especially in species such as small ruminants, with high reproductive rates Such schemes are being tried for sheep in West Asia by FAO (Jasiorowski 1990) and in Africa (Yapi et al 1994) However availability of AI and ET in addition to increasing rates of genetic gain, enhance the flexibility of the system For example germplasm from other populations can be introduced easily through semen and/or embryos One of the advantages of a nucleus herd is that it provides opportunity to record information on more traits than is possible in a decentralised progeny testing scheme

The ONBS can be used for the improvement of an indigenous or exotic breed It can also be used to improve a stabilised crossbred population The level of the genetic response depends on the size of the scheme (that is number of participating herds/flocks and total number of animals) and the selection intensity

An ONBS can initially be developed to form a focus for national sire breeding and selection activities In time, and with experience, the capacity can be expanded and ET introduced to increase the rate of genetic progress

At one time it was suggested that application of MOET in nucleus breeding schemes could increase animal genetic gains by 30–80% (Nicholas and Smith 1983) More recently it has been concluded that the earlier figures were over-predictions (Keller et al 1990) The over-predictions arose partly because the assumed average number of progeny (eight) per donor female was unrealistically high and partly because of wrong assumptions made about genetic parameters (Keller et al 1990) The realistic average number of live progeny per donor flushed is in the range of 2–3 in sheep and cattle and 6–8 in goats (Macmillan and Tervit 1990) Consideration of these figures suggest that MOET could increase annual genetic gains by 10–20% in large nucleus breeding schemes However costs of operating such schemes in developing countries need to be evaluated before they can be recommended

Indicator traits

Indicator traits are characteristics which are genetically correlated to traits of economic importance and are easier to measure than the latter Such traits are usually not the target of genetic improvements but provide an indirect means of improving a targeted trait Blair et al (1990) reviewed some physiological and/or metabolic characteristics which might be considered as potential indicator traits Traits such as testicular size in rams or bulls or FSH in ewe lambs (Bodin et al 1986) have potential as indirect predictors of fertility Indicator traits can improve genetic response by increasing accuracy of selection and reducing generation interval The value of an indicator trait will depend largely on the magnitude of co-heritability (square-root of the product of heritability of the indicator and of the target trait) and the genetic correlation between the two traits (Woolliams and Smith 1988) Woolliams and Smith (1988) concluded that with high co-heritability, selection for the indicator trait alone can result in greater rates of response than is possible with progeny testing, especially when breeding values are not accurately measured by progeny testing

Packed cell volume (PCV) an indication of the extent of anaemia, is widely used as an indicator trait for

pathological conditions associated with anaemia For example, PCV is currently used at ILRAD and ILCA (International Livestock Centre for Africa) as an indicator of the effect of trypanosomiasis and hence of trypanotolerance, and at ILCA as an indicator of effect of the endoparasite *Haemonchus contortus* and hence as an indicator of resistance to the parasite

Genetic markers and marker-assisted selection

A genetic marker for a trait is a DNA segment which is associated with, and hence segregates in a predictable pattern as, the trait Genetic markers facilitate the "tagging of individual genes or small chromosome segments containing genes which influence the trait of interest Availability of large numbers of such markers has enhanced the likelihood of detection of major genes influencing quantitative traits The method involves screening the genome for genes with a large effect on traits of economic importance through a procedure known as linkage analysis (Paterson et al 1988) The chances of major genes existing for most traits of interest, and of finding them are considered to be high (Mackinnon 1992) The process of selection for a particular trait using genetic markers is called marker assisted selection (MAS) MAS can accelerate the rate of genetic progress by increasing accuracy of selection and by reducing the generation interval (Smith and Simpson 1986) However, the benefit of MAS is greatest for traits with low heritability and when the marker explains a larger proportion of the genetic variance than does the economic trait Lande and Thompson (1990) suggest that about 50% additional genetic gain can be obtained if the marker explains 20% of the additive genetic variance and the economic trait has a heritability of 0 2 MAS also facilitates increased rate of genetic gain by allowing measurement in young stock thereby reducing generation interval

Marker identification and use should enhance future prospects for breeding for such traits as tolerance or resistance to environmental stresses including diseases Already, identification of carriers of genes for resistance and introduction of such genes into a population seems feasible for resistance against *Trichostrongylus colubriformis* and *Haemonchus contortus* (Gogolin-Ewens et al 1990) It should also be possible to eliminate factors predisposing sheep to Listeriosis or Salmonellosis (Blancou 1990) There is also evidence for a major gene for resistance to the cattle tick *(Boophilus microplus)* in a Hereford x Shorthorn cattle line called Belmont Adaptaur (Kerr et al 1994) Research is currently underway at ILRAD to identify genetic markers for tolerance to African trypanosomiasis in N Dama cattle and at ILCA for resistance to endoparasites in Red Maasai sheep

Transgenic animals

A transgenic animal is an animal whose hereditary DNA has been augmented by addition of DNA from a source other than parental germplasm through recombinant DNA techniques Transfer of genes or gene constructs allows for the manipulation of individual genes rather than entire genomes There has been dramatic advances in gene transfer technology in the last two decades since the first successful transfer was carried out in mice in 1980 (Palmiter et al 1982, Jaenisch 1988) The technique has now become routine in the mouse and resulting transgenic mice are able to transmit their transgenes to their offspring thereby allowing a large number of transgenic animals to be produced Successful production of transgenic livestock has been reported for pigs, sheep rabbits and cattle The majority of gene transfer studies in livestock have, however, been carried out in the pig Although transgenic cattle and sheep have been successfully produced, the procedure is still inefficient in these species (Niemann et al 1994)

Transgenesis offers considerable opportunity for advances in medicine and agriculture In livestock the ability to insert new genes for such economically important characteristics as fecundity, resistance to or tolerance of other environmental stresses would represent a major breakthrough in the breeding of commercially superior stock Another opportunity that transgenic technology could provide is in the production of medically important proteins such as insulin and clotting factors in the milk of domestic livestock The genes coding for these proteins have been identified and the human factor IX construct has been successfully introduced into sheep and expression achieved in sheep milk (Clark et al 1990) Moreover, the founder animal has been shown to be able to transmit the trait to its offspring (Niemann et al 1994) To date, the majority of genes transferred into sheep have been growth hormone encoding gene constructs Unfortunately, in most cases the elevated growth hormone levels have resulted into a clinical diabetes situation leading to an early death of the transgenic sheep (Rexroad et al 1990) Transgenic sheep have recently been generated which express the visna virus envelope gene (Clements et al 1994)

The first reports of the production of transgenic animals created a lot of excitement among biological scientists In the field of animal breeding, there were diverse opinions on how the technology might affect livestock genetic improvement programmes Some (Ward et al 1982) believed that it would result in total reorganisation of conventional animal breeding theory while others (Schuman and Shoffner 1982) considered the technology as an extension of current animal breeding procedures which, by broadening the gene pool would make new and novel genotypes available for selection Application of the technology in animal improvement is still far from being achieved However, consideration needs to be given to its potential role in this field Smith et al (1987) presented a comprehensive evaluation of strategies for developing testing breeding and disseminating transgenic livestock in the context of quantitative improvement of economic traits

An important contribution of transgenic technology is in the area of basic research to study the role of genes in the control of physiological processes The understanding of the molecular control of life

processes has important implications for both medicine and agriculture For example the generation (through mutation of an endogenous gene) of an organism which lacks a specific gene is a powerful tool to investigate the function of the gene product This type of genetic analysis has been facilitated by the availability of *in vitro* cultures of embryonic stem cells from mice (Bradley 1994)

Recent advances in *in vitro* technology (*in vitro* fertilisation and maturation) will increase the number of zygotes available for gene transfer purposes This plus the utilisation of embryonic stem cell (Stice et al 1994) and primodial germ cell (Stokes et al 1994) technologies should enhance the efficiency of gene transfer in cattle and sheep considerably

Genetic characterisation of animal genetic resources

Developing countries are endowed with the majority of the global domestic animal diversity — landraces strains or breeds Some livestock breeds in these countries are in immediate danger of loss through indiscriminate crossbreeding with exotic breeds The importance of indigenous livestock breeds lies in their adaptation to local biotic and abiotic stresses and to traditional husbandry systems However most of these animal genetic resources are still not characterised and boundaries between distinct populations are unclear In such cases breeds are defined on the basis of subjective data and information obtained from local communities Reliance on these criteria as the basis for classification for utilisation and/or conservation may be misleading Additionally, historical evidence is not always accurate relying as it often does on subjective judgements Archival research can reveal much about the original type of a breed or strain but it is molecular genetic evidence which is factual and precise It is in this sphere that biotechnology has an important role

Genetic uniqueness of populations is measured by the relative genetic distances of such populations from each other Polymorphism in gene products such as enzymes, blood group systems and leukocyte antigens which have traditionally been used for measuring genetic distance are being rapidly replaced by polymorphism at the level of DNA both nuclear (Jeffreys and Morton 1987) and mitochondrial (Loftus et al 1994) as a source of information for the estimation of genetic distances The first DNA polymorphisms to be used widely for genome characterisation and analysis were the restriction fragment length polymorphisms (RFLP) (Southern 1975) which detect variations ranging from gross rearrangements to single base changes Minisatellites sequences of 60 or so bases repeated many hundreds or thousands of times at one unique locus within the genome have been used to generate DNA fingerprints typical of individuals within species (Jeffreys and Morton 1987) Microsatellites (Weber and May 1989) repeats of simple sequences the commonest being dinucleotide repeats are abundant in genomes of all higher organisms including livestock Polymorphism of microsatellites takes the form of variation in the number of repeats at any given locus and is generally revealed as fragment length variation in the products of polymerase chain reaction (PCR) amplification of genomic DNA using primers flanking the chosen repeat sequence and specific for a given locus (Kemp and Teale 1991) Ease of identification and of sequence determination (Moore et al 1992) and need for only small amounts of DNA are some of the advantages of microsatellites Additionally because microsatellite polymorphisms can be described numerically, they lend themselves to computerised data handling and analyses (Teale et al 1994) Microsatellites can be used in non-PCR systems in a way similar to minisatellite probes (Haberfeld et al 1991)

Randomly amplified polymorphic DNA (RAPD) (Williams et al 1990) has been extensively used for genetic characterisation of a wide range of organisms The technique uses short (up to 10 bases) primers to amplify nuclear DNA in the PCR The procedure does not require knowledge of the sequence of DNA under study primers are designed randomly The basis of the polymorphism detected by this method is that products are either generated in PCR or not

Complete sequencing of the genome is the ultimate form of genetic characterisation Sequencing has traditionally been expensive and laborious but with the advent of automated sequencing this is changing rapidly However sequencing is unlikely to be used as a technique of choice for genetic characterisation

Nei and Takezaki (1994) reviewed statistical methods for estimating genetic distances and for constructing phylogenetic trees from DNA sequence data and concluded that different analytical methods may produce different results Teale et al (1994) commented on what considerations to be made in using DNA polymorphism data for genetic distance estimation and cautioned that great care has to be taken in selecting characterisation methods and in interpreting the resulting data While recognising the importance of the uniparental mode of inheritance of mitochondrial DNA in detecting underlying population structure not discernible from analyses of nuclear DNA, Loftus et al (1994) concluded that mitochondrial DNA analysis may not be sufficient to resolve breed differences within Africa MacHugh et al (1994) suggested that microsatellite polymorphism may be more suitable when trying to discriminate between closely related populations Regardless of which method is used, the ultimate goal in genetic characterisation for conservation is to obtain a measure of available diversity

Conservation of animal genetic resources

The terms conservation, preservation, *ex situ* and *in situ* are used here according to the definition given by FAO (1992) There are several ways differing in efficiency, technical feasibility and costs to conserve animal genetic resources Developing and utilising a genetic

resource is considered the most rational conservation strategy However, there are cases where *ex situ* approaches are the only alternatives *Ex situ* approaches include maintenance of small populations in domestic animal zoos, cryopreservation of semen (and ova), cryopreservation of embryos, and some combinations of these Brem et al (1989) reviewed biotechnologies for *ex situ* conservation

Cryopreservation of gametes embryos or DNA segments can be quite an effective and safe approach for breeds or strains whose populations are too small to be conserved by any other means The safety of these methods has been demonstrated by background irradiation studies For example, studies based on irradiation of mouse embryos exposed to the equivalent of hundreds of years of background mutation showed no detectable damage (Whittington et al 1977)

Regeneration of offspring following transfer of frozen-thawed embryos has been successful for all major domestic species except the buffalo (Teale et al 1994) In cattle the transfer of frozen-thawed embryos is now a commercial practice and embryo survival rate after thawing can be as high as 80% with a pregnancy rate of about 50% Cryopreservation of oocytes followed by successful fertilisation and live births have been achieved in the mouse Cryopreserved bovine oocytes have been successfully matured and fertilised *in vitro* and zygotes developed to blastocyst stage (Lim et al 1991) These trends strongly suggest that long-term cryopreservation of mammalian oocytes is possible (Teale et al 1994)

Respective pregnancy rates of 58 and 50% for fresh and frozen-thawed *in vitro* produced embryos have been reported (Lu et al 1990) Also, calves have been produced from transfer of both split and frozen-thawed *in vitro* produced embryos

Economic aspects of genetic conservation in farm animals has been assessed by Brem et al (1984) The study concluded that costs of *ex situ* live animal conservation was moderate to high while costs of long-term cryopreservation of gametes were low

Development in genetic engineering cryobiology cell biology and embryology will provide techniques that may enhance our ability to preserve germplasm *in vitro* Techniques such as transfer of DNA within and between species and the production of viable transgenic animals are far from practical application However, biotechnology will certainly contribute newer and cheaper methods for preservation such as storage of catalogued DNA At present other than live animal and embryo preservation the other techniques do not allow preservation of genomes in a form which can be reactivated *in toto* at a later stage but they permit the preservation of individual genes or gene combinations for possible future regeneration

Conservation of indigenous animal genetic resources should be one of the priority livestock development activities for developing countries The critical importance of these resources to their owners in developing countries need not be emphasised Their importance to developed countries is also becoming evident as indicated by the increasing importation of tropical germplasm by these countries It is highly likely that these resources will become of increasing importance to the industrialised countries either as sources of unique genes or when environmental concerns necessitate change in production systems Developed countries should thus assist in the conservation and development of these resources Technology for cryopreservation of semen and embryo is sufficiently developed to be applied in developing countries What is missing is financial support to implement conservation programmes Such support has been provided for world-wide conservation activities for plant germplasm There is also a strong case for support of animal genetic resources conservation

Animal health

Disease diagnosis

Successful control of a disease requires accurate diagnosis This has been greatly improved in recent years through developments in biotechnology The most recent major development the finding that it is possible to immortalise individual antibody-producing cells by hybridisation to produce antibodies of a given class, specificity and affinity (i e monoclonal antibodies) has provided a tool that permits the analysis of virtually any antigenic molecule (Kenneth et al 1980) The use of monoclonal antibodies has revealed that the failure of vaccines (e g of rabies) to provide protection in all parts of the world was due to the diversity in the antigenic composition of the causative virus (Wiktor and Koprowski 1980) The (monoclonal antibody) technology is relatively simple and can readily be applied in developing countries Monoclonal antibodies are currently supplied to developing countries directly or in the form of kits and simple reagents for completion of the tests (Ferris et al 1988) For example kits for rinderpest virus diagnosis used in African countries come in this form

The ability to generate highly specific antigens by recombinant DNA techniques has made it possible for an increasing number of enzyme-linked immunosorbent assays (ELISA) to have the capacity to differentiate between immune responses generated by vaccination from those due to infection (Robinson and McEvoy 1993) This has made it possible to overcome one of the major drawbacks of antibody detection tests the fact that, because antibodies can persist in animals for long periods their presence may not indicate current infection ILRAD has developed a technique to overcome this problem in diagnosis of trypanosomiasis The parasite antigen detection test uses monoclonal antibodies raised in laboratory mice (Nantulya and Lindqvist 1989) to capture the parasite antigens which are then revealed by their reaction with a second layer antibody to which is conjugated an easily detectable enzyme This test reveals current infections and facilitates differentiation between the major

trypanosome species This has important implications for disease control especially because of the association of different parasite species with different epidemiological and disease circumstances

The advent of PCR has enhanced the sensitivity of DNA detection tests considerably For example, PCR used in combination with hybridisation analysis, has been shown (Brandon et al 1991) to provide a sensitive diagnostic assay to detect bovine leukosis virus

Other diagnostic techniques include nucleic acid hybridisation (NAD) and restriction endonuclease mapping (REM) As has been indicated above, one of the most valuable features of these molecular techniques is their specificity and sensitivity A good example of the specificity of NAD is its application in distinguishing infections caused by *peste des petits ruminants* (PPR) virus from rinderpest (Lefevre and Diallo 1990), diseases whose symptoms are clinically identical and which cannot be distinguished antigenically with available serological reagents This technique also allows comparison of virus isolates from different geographical locations Detailed overview of biotechnological tools for diagnosis of livestock diseases has been provided by Bourne and Bostock (1992) and Robinson and McEvoy (1993)

Other available diagnostic techniques which may have application in small ruminants and/or cattle include nucleic acid probes (NAP) for heartwater (*Cowdria ruminantium*) *chlamydia psitacci*, Paratuberculosis and Bluetongue (Blancou 1990, Knowles and Gorham 1990), restriction endonuclease reaction (RENR) for diagnosis of *Corynebacterium pseudotuberculosis* (Knowles and Gorham 1990), PCR for characterising subtypes of Bluetongue from different geographical regions (Osburn 1991) monoclonal antibodies (MAB) for differentiating false positive anti-Brucella titres caused by *Yersinia enterocolitica* and true positive anti-Brucella titres in latent infected animals (Haas et al 1990) and MAB for diagnosis of Toxoplamosis, Pasteurellosis, *Mycoplasma* spp, PPR and Boder Disease (Blancou 1990, Lefevre and Diallo 1990) Examples of tropical diseases for which diagnostic tests are available are presented in Table 1 Teale (1991) reviewed the diagnostic techniques that are currently available or which could be developed in the near future

Table 1 *Tropical diseases for which probes and monoclonal antibodies (MAB) are available*

Viral diseases	Bacterial diseases
Rinderpest	Cowdriosis
Peste des petits ruminants	Contagious bovine pleuropneumonia
Bluetongue	Contagious agalactia
African horse sickness	Contagious caprine pleuropneumonia
Foot and mouth disease	Anaplasmosis (*A centrale* and *A marginale*)
Vesicular stomatitis	Haemorrhagic septicemia (only MAB available)

Source Lefevre (1992)

Vaccines

Conventional means of controlling major livestock diseases include chemotherapy vector control, vaccination, slaughter of infected stock, and other management practices (including grazing management and controlled stock movements) Vector control requires continuous application of pesticides These are often unaffordable to farmers in developing country Moreover where these drugs or pesticides are used, resistance by parasites is often encountered and reinfection following administration of drugs against parasitic diseases usually occurs Additionally in many cases drugs are not readily available locally In some cases where they are available, they are ineffective, either because they have been partly preserved or they are not genuine

Immunisation remains one of the most economical means of preventing specific diseases An effective vaccine can produce long-lasting immunity In some cases vaccination can provide lifetime immunity Moreover a small number of doses is usually required for protection Level of infrastructure and logistical support required for a large-scale vaccination programme is such that a successful vaccination campaign can be implemented in remote rural areas In general vaccines offer a substantial benefit for comparatively low cost, a primary consideration for developing countries

Vaccines have conventionally been produced by several methods some of which have become rather static with regard to efficacy safety stability and cost Very effective vaccines against animal diseases such as rinderpest and pig cholera have been in use for more than 20 years and have helped to significantly reduce the incidence of these diseases world-wide However, vaccines of questionable efficacy also exist Impotency instability, adverse side effects and reversion of attenuated organisms to wild (disease-causing) forms represent some of the problems However, research strategies for the development of better cheaper and safer vaccines are constantly being sought Through the use of monoclonal antibodies and recombinant DNA technologies it is now possible to define and produce immunogenic components much more rapidly These technologies are increasingly being used to clarify the pathogenetic mechanisms and immune response to microbial diseases (Wray and Woodward 1990, McCullough 1993) This should lead to the production of more effective vaccines in the future To date many candidate vaccines have been produced by these techniques However, only few of these are being produced commercially

Table 2 summarises some vaccines developed by recombinant DNA technology There are other vaccines under various stages of development The following are of particular relevance to small ruminants recombinant vaccines against Bluetongue and Rift Valley Fever may soon be available for field use (Osburn 1991), a hybrid virus vaccine against Orf (Reid 1989), a thermostable recombinant vaccine against PPR (Lefevre and Diallo

1990) and recombinant vaccines against *Taenia ovis* and Echinococcus (Blancou 1990) tick gut antigens and *Haemonchus* gut antigens produced by molecular techniques offer ways for prophylaxis against these parasites Progress is also being made towards the development of vaccines against Babesiosis and Theileriosis in cattle (Wright 1990) which may indicate prospects for similar immune-prophylaxis becoming available for sheep and goats as well

Table 2 *Example of some novel animal vaccines*

Species	Disease	Producer
Avian	Coccidiosis	Genex and A H Robins
	Newcastle virus	Codon and Salsbury labs
Bovine	Papilloma virus	Molecular genetics
	Viral diarrhoea	California Biotechnology
	Brucellosis	Ribi ImmunoChem
	Rinderpest	USDA and University of California Davis
Swine	Parvovirus	Applied Biotechnology
	Dysentery	Codon
Equine	Influenza Herpes	California Biotechnology
		Applied Biotechnology
Companion	Canine parvovirus	Applied Biotechnology

Sources Van Brunt (1987) Cunningham (1990)

Physiology of lactation and growth

Recombinant bovine somatotropin (BST) is a genetically engineered synthetic analog of the natural growth hormone (Bauman et al 1985) Since the 1970s there have been a number of studies on the effects of BST on milk yield reproductive performance and health as well as its likely effect on humans who consume such milk Under good management and feeding regular BST administration to lactating dairy cows increases milk yield by 15–30% and also increases efficiency of milk production

BST is now readily available and is already in commercial use in the United States However, the appropriateness of BST use to increase milk production in the USA is doubtful as the country already has a milk surplus and the public is also concerned about its effects on health Indeed, the benefit of BST in the USA is perceived to be towards reducing the production costs of large dairy farms, but this could push smaller farmers out of the market The appropriateness of BST use for developing countries is still a matter of debate Those supporting its introduction argue that its use in commercial dairy farms could increase the national milk output Those opposed point out the fact that BST does not improve milk yield in indigenous non-dairy breeds and that its use on crossbred and exotic dairy cattle will require more feeding and that provision of adequate nutrition is already a problem for most dairy operations in developing countries

Whether or not BST affects reproductive performance has not yet been conclusively established Although most reports have indicated nonsignificant effects of BST on reproductive performance, most such studies have been on single lactations the effect of BST on lifetime productivity needs to be investigated Some studies (McBride et al 1990, Phipps et al 1990) have shown that feed conversion efficiency declines in subsequent lactations The study by Phipps et al (1990) also indicated a decline in the incremental amount of milk yield from BST application in subsequent lactations Additionally, the effect of BST on reproductive performance is likely to be more adverse in the presence of higher biotic and abiotic stresses, including nutritional stresses (Burton et al 1990, Lormore et al 1990) There is also need to examine the economics of BST application in view of the known association of its use with mastitis (Burton et al 1990) and other infections BST use is thus bound to be associated with increased use of antibiotics and other veterinary drugs Thus, in evaluating the potential role of BST in developing countries, one needs to consider not only the possible response levels of the cattle in these countries to BST treatment, but also the cost of BST, the amount and cost of other incremental inputs required for effective use of BST, and the milk prices Ultimately the main technical constraint to BST use in developing countries will not only be its cost but the absence of an efficient delivery system current use of the technology requires regular injections

Porcine somatotropin (PST) and recombinant growth hormone stimulatory peptides (e g growth hormone releasing factor, GRF) along with BST have been shown to increase growth rates by 8–38% in cattle sheep and pigs In almost all cases administration of exogenous growth hormones have been associated with increased carcass protein and reduced carcass fat (Hart and Johnson 1986) Other growth promoting agents (e g anabolic steroids and beta agonists) have been shown to have even larger effects but public concerns over the possible residual effects in meats have led to their being banned in most developing countries The use of anabolic implants is however, permitted in some countries such as the USA

Animal nutrition

Nutrition represents one of the most serious limitations to livestock production in developing countries, especially in the tropics Feed resources are inadequate in both quality and quantity particularly during the dry seasons Biotechnological options are available for improving rumen fermentation and enhancing the nutritive value and utilisation of agro-industrial by-products and other forages (Kundu and Kumar 1987)

Fibrous feeds including crop residues of low digestibility constitute the major proportion of feeds available to most ruminants under smallholder situations in developing countries The associated low

productivity can be overcome to some extent by several means among which are balancing of nutrients for the growth of rumen microflora thereby facilitating efficient fermentative digestion and providing small quantities of by-pass nutrients to balance the products of fermentative digestion enhancing digestibility of fibrous feeds through treatment with alkali or by manipulating the balance of organisms in the rumen and genetic manipulation of rumen micro-organisms currently acknowledged as potentially the most powerful tool for enhancing the rate and extent of digestion of low quality feeds Rumen micro-organisms can also be manipulated by adding antibiotics as feed additives, fats to eliminate or reduce rumen ciliate protozoa (defaunation), protein degradation protectors, methane inhibitors, buffer substances, bacteria or rumen content and/or branched chain volatile fatty acids

Increasing digestibility of low-quality forages

Low-quality forages are a major component of ruminant diets in the tropics Thus much progress can be made by improving the forage component of the ration The characteristic feature of tropical forages is their slow rate of microbial breakdown in the rumen with the result that much of the nutrients of the feed are voided in the faeces The slow rate of breakdown also results in reduced outflow rate of feed residues from the rumen which consequently depresses feed intake At present, the main treatment methods for forages such as cereal straws are either mechanical (e g grinding), physical (e g temperature and pressure treatment) or a range of chemical treatments of which sodium hydroxide or ammonia are among the more successful (Greenhalgh 1984)

The lignification of the cell walls prevents degradation by cellulase or hemicellulase enzymes Fortunately, it is possible to use lignase enzyme produced by the soft-rot fungus *(Phanerochaete chrysosporium)* which causes a high degree of depolymerisation of lignin (Tien and Kirk 1983) The enzyme acts like a peroxidase and causes cleavage of carbon–carbon bonds At present the levels of the lignase enzyme produced by the basidiomycete fungi are insufficient for the treatment of straw on a commercial scale However, it is conceivable that the use of recombinant DNA engineering techniques will allow the modification of the lignase genes and associate proteins to increase their efficiency and stability The lignin gene has to date been cloned and sequenced from *P chrysosporium* (Zhang et al 1986, Tien and Tu 1987)

Improving nutritive value of cereals

Moderate protein content and low amounts of specific amino acids limit the nutritive value of cereals and cereal by-products (e g barley is low in lysine and threonine) This is a major limitation in the ration formulation for non-ruminant livestock which necessitates addition of expensive protein supplements There are on-going studies to enhance the low level of lysine in barley by genetically engineering the grain genome (Miflin et al 1985 Shewry and Kreis 1987) Genetic modification through insertion of genes into rice protoplasts and generation of transformed plants has already been achieved

Removing anti-nutritive factors from feeds

Anti nutritive factors in plant tissues include protease inhibitors tannins phytohaemagglutinins and cyanogens in legumes, and glucosinolates, tannins and sanapine in oilseed rape *(Brassica napus)* and other compounds in feeds belonging to the *Brassica* group As with amino acid deficiencies the adverse effects of these compounds are more marked in non ruminants than in ruminants (Chubb 1983) Conventional plant breeding has been used to reduce and, in some cases, eliminate such anti-nutritive factors An example is the introduction of cultivars of oilseed rape which are low in, or free from erucic acid and glucosinolates A combination of genetic engineering and conventional plant breeding should lead to substantial reduction or removal of the major anti-nutritive factors in plant species of importance as animal feeds

Transgenic rumen microbes (see below) could also play a role in the detoxification of plant poisons (Gregg 1989) or inactivation of antinutritional factors Successful introduction of a caprine rumen inoculum obtained in Hawaii into the bovine rumen in Australia to detoxify 3-hydroxy 4(IH) pyridine (3,4 DHP), a breakdown product of the non-protein amino acid mimosine found in *Leucaena* forage (Jones and Megarrity 1986) demonstrates the possibilities

Improving nutritive value of conserved feed

The conservation of plant material as silage depends upon anaerobic fermentation of sugars in the material which in turn is influenced by the ability of naturally occurring lactic acid bacteria to grow rapidly on the available nutrients under the existing physical environment Unless the ensiled material is sterilised lactic acid bacteria are always present However the ensiling conditions may not always be ideal for their development In addition to the number and type of bacteria, other interrelated factors may affect quality of silage including availability of water-soluble carbohydrates the dry-matter content the pH and extent of air exclusion For example, lack of water-soluble carbohydrates may be overcome by wilting the material to raise the dry matter to a level at which less acid is required to stabilise the fermentation The availability of sugars in the material and the rate at which the different micro-organisms multiply also influences the ensilage process

Throughout this century research workers have investigated ways through which the fermentation process in silage making can be controlled in order to improve the feeding quality of the resulting silage Use of additives to restrict the activity of the micro-organisms to stimulate the fermentation by the lactic acid bacteria or simply as nutrients has been one of the approaches Additives used in the early studies included

chloroform, toluene and cresol (to inhibit bacterial growth) and sulphuric acid and hydrochloric acid (to reduce the pH) Indeed, over the last 40 to 50 years, corrosive, acid-containing additives have been widely used in silage making Other fermentation inhibitors which have been studied include organic acids, salts of acids formaldehyde and other aldehydes, sodium hydroxide and antibiotics Of these formic acid is probably the most widely studied and has been reported to have a beneficial effect on the fermentation process and on the nutritive value of silage Sulphuric acid is cheaper than formic acid and is popular in some countries However, acids are a hazard on the farm and can be particularly dangerous if recommended to uninformed farmers Salts of acids are safer to handle but are less effective than the acids from which they are derived

The hazardous nature of some of the chemical additives has necessitated a search for alternative compounds for improving the ensilage process A group of compounds classified as fermentation stimulants have been widely studied These include sugar sources (e g molasses and whey), enzymes and inocula of lactic acid bacteria Molasses is of particular relevance to smallholder farmers in developing countries in the tropics where sugar-cane is produced and processed Enzymes are essential for the breakdown of cell wall carbohydrates to release the sugars necessary for the growth of the lactic acid bacteria Although resident plant-enzymes and acid hydrolysis produce simple sugars from these carbohydrates, addition of enzymes derived from certain bacteria e g *Aspergillus niger* or *Trichoderma viridi* (Henderson and McDonald 1977, Henderson et al 1982) increases the amount of available sugars Commercial hemicellulase and cellulase enzyme cocktails are now available and improve the fermentation process considerably (Hooper et al 1989) However prices of these products preclude their viability for farm level application, especially in developing countries

There are two forms of indigenous lactic acid bacteria the homofermentative type which converts hexose sugars to lactic acid with no loss of dry matter and the heterofermentative type which produces a range of compounds accompanied by loss of dry matter as carbon dioxide Thus, the native bacteria are not the most efficient Considerable research in the USA and Europe has been directed towards the development of microbial silage additives (inoculants) Commercial bacterial inoculants designed to add sufficient homofermentative lactic acid bacteria to dominate the fermentation are now available The objective of using such additives is to ensure the rapid production of the required amount of lactic acid from the carbohydrates present to preserve the ensiled material Most such inoculants contain *Lactobacillus plantarum* with or without other bacteria such as *L acidophilus* *Pediococcus acidilactive* and *Streptococcus thermophilus* In general, the results with bacterial inoculants have been quite variable However with an effective product, it is possible to improve the fermentation of low dry-matter silages and to enhance the efficiency of their utilisation

In order to improve the effectiveness of microbial inoculants in breaking down structural carbohydrates to glucose, detailed knowledge of the lactobacilli bacteria is essential Work already undertaken on the molecular biology of *Lactobacillus plantarum* and other species (Armstrong and Gilbert 1991) suggest that the rapid progress in this area will make it possible to construct novel genes encoding highly active fibre-degrading enzymes Such genes could then be inserted into strains of *L plantarum*

Successful silage making incorporating these technologies can only be achieved with strict adherence to recommended application procedures including rates of additives inoculants etc This technology is available in most developing regions including Africa However it is not fully exploited Indeed, in Africa silage making is still generally restricted to large-scale commercial farms

Improving rumen function

Armstrong and Gilbert (1985) and Forsberg et al (1986) have reviewed the major areas of rumen function which might benefit from transgenic technology These include development of transgenic bacteria with enhanced cellulotic activity capability to cleave lignohemicellulose complexes, reduced methane production capability decreased proteolytic and/or deaminase activities, increased capability for nitrogen 'fixation" and increased ability for microbial production of specific amino acids The first successful transfer of foreign genes into rumen bacteria *(Bacteriodes ruminicola)* was reported by Thomson and Flint (1989) However we are still a long way from commercial production of genetically engineered rumen bacteria

Although several workers have isolated genes encoding plant structural carbohydrate-degrading enzymes from rumen bacteria there are limited reports (Hespell and Whitehead 1990) on the genetic engineering of these microorganisms In contrast to conditions in which single species of organisms are grown in controlled environments and where the energy supply is usually in excess of demand, the rumen environment is very complex competition between different microbial species is intense and energy is usually the limiting growth factor (Russell and Wilson 1988) This is probably the main reason why reintroduction of genetically modified rumen bacteria into their natural habitat has met with variable success (Flint et al 1989) Advances being made in transformation methods for obligate anaerobic bacteria will certainly result in successful genetic engineering of a range of rumen bacteria However, it is not possible to predict if any of these bacteria will be capable of colonising the rumen

It can be concluded that there are several potential opportunities for improving the efficiency of ruminant digestion and possibilities for utilising a wider range of

feeds than is currently possible Modification of rumen microbial population (Hespell 1987 Russell and Wilson 1988, Flores 1989) is one such opportunity However technical difficulties associated with making genetic modifications to individual species of rumen bacteria (Armstrong and Gilbert 1991) hinder progress in this area

Need for biotechnology capacity in developing countries

For the developed countries, the need for biotechnology may be to increase the level of affluence, but for developing countries, it could reduce hunger and starvation The use of bovine somatotropin to increase milk production in economies where farmers are being paid to produce less milk illustrates this point However not all available biotechnologies are appropriate or relevant to all countries Developing countries may need to adapt some of these technologies before they can use them It is therefore important that developing countries develop capacity to maintain a strong base of applied and adaptive research and some level of training to keep abreast with new developments

Biotechnologies which could have application in developing countries are summarised in Table 3 While the applications of some of the available technologies are relatively simple it is unlikely that developing countries will be able to retain those trained to support implementation of biotechnology programmes if adequate financing is not available to provide required equipment chemicals etc to expand or even maintain such programmes

The development of biotechnology capacity in developing countries is also justified in order to support research which is only of interest to them or that which because of restrictions in developed countries can only be done in developing countries For example, veterinary regulations in most developed countries generally prohibit the introduction of biological material (e g infectious agents required for vaccine development) or live animals for research purposes Therefore developed countries must develop the capacity to undertake such research in the relevant countries

The disparity between industrialised countries and developing regions of the world in terms of veterinary biotechnology has been summarised by Lefevre (1992) Out of 152 laboratories involved in veterinary biotechnology in 1991 only 26 are located in 17 countries in Asia Africa and South America Moreover some of these laboratories may not be actively involved in biotechnology but are merely interested in it In sub-Saharan Africa (excluding the Republic of South Africa), only ILRAD (based in Kenya) is actively involved in biotechnology research However, ILRAD s biotechnology work is focussed on only two diseases trypanosomiasis and theileriosis Because the well equipped and adequately funded laboratories doing research in molecular biology are found almost exclusively in developed countries, the gap between the industrialised and developing countries in technical

Table 3 *Possible applications of biotechnology to the solution of problems of livestock production in developing countries*

Problem	Possible solution[1]	Scale of economic impact	Probable time to commercial use years
Animal diseases	New vaccines and new diagnostics	Large	<5
Poor quality forages	Microbial treatment of forages	Moderate	5–10
	Modification of rumen microflora	Moderate/large	>10
	Genetic improvement of forages and their symbionts	Moderate	5–10
Difficulty of implementing selection programmes	Selection in nucleus herds using AI ET embryo sexing	Large	5–10
	Marker assisted selection	Moderate	5–10
Difficulty of maintaining dairy cattle performance after F_1 cross	Use of IVF ET and embryo sexing	Large	>10
	Selection among local breeds using AI MOET	Medium/large	>10
	Development of composite breeds	Large	>10
Cost and environmental challenge to imported cattle	Use of ET to import embryos	Small	<5
Need for increased efficiency in intensive systems	Use of rBST and rPST in dairy and pig production	Large	<5

1 Definitions AI artificial insemination ET embryo transfer IVF *in vitro* fertilisation rBST recombinant bovine somatotropin rPST recombinant porcine somatotropin

Sources Adapted (with additions) from Cunningham (1990) Doyle and Spradbrow (1990)

expertise and relevant research capacity is getting wider and motivated scientists from developing countries with the expertise to carry out sophisticated research are opting to work in laboratories in industrialised countries

Another justification for local capacity in biotechnology research is to provide a home for orphan commodities From biotechnology research standpoint an orphan commodity may be defined as a commodity in which there is or is likely to be little or no investment in modern biotechnology in industrialised countries either because the commodity is not important in temperate areas or because there are no likely profits for transnational companies Thus an orphan commodity is not necessarily a small commodity Banana, plantain, cassava, coconut and tropical fruits are examples of orphan crops (Persley 1990) Most African indigenous animals especially chickens pigs and goats probably fall in this category although some basic research on these species in the developed countries may benefit the African populations as well There is thus a need for biotechnology research capacity for problems that may be unique to developing countries Persley (1990) suggested the establishment of a special funding mechanism to provide support for research on orphan commodities by public and private sector institutions in industrialised and developing countries

Biotechnology adoption and adaptation

The case of artificial insemination

One of the reasons why technologies developed in the industrialised countries tend not to be implemented with much success in developing countries is the failure to recognise the importance of adapting technology to local conditions AI is a good example Where AI technology has been adopted in Africa not much consideration has been given to adapting it to the circumstances in which it is to be applied to ensure sustainability Instead AI uses have been based on sophisticated models intended for countries with good communication and transport systems and with adequate and reliable operating budgets Such AI use programmes have often collapsed and have had to go through several phases of foreign-aid-supported "rehabilitations and, in some cases, have eventually collapsed Government subsidies of the AI system are considered to be another main cause of failure of AI in developing countries Privatisation of the services may change the situation For example, in some of these countries the concept of farmer co-operatives is well developed and applied for specific cash crops or milk marketing AI could easily be run by co-operatives organised in schemes in which farmers are grouped on the basis of such factors as transport requirements and similarity of systems of production Semen can easily be delivered over short distances by motorbikes bicycles horses, donkeys etc Under such circumstances use of fresh semen collected from bulls belonging to the co-operative could be considered This would eliminate the cost of freezing semen Such schemes would make it easier to match genotypes to production systems within a country Indeed such a scheme could form the basis for the genetic improvement of localised indigenous breeds

The case of embryo transfer

Embryo transfer (ET) could have a major impact on cattle breeding in developing countries (Cunningham 1990) especially as part of a nucleus breeding scheme (Smith 1988b) However successful ET requires highly motivated, experienced staff and a high capital investment in facilities, equipment and drugs

In general, the inappropriateness of ET for developing countries is ascribed to lack of infra structure However, in some instances, ET represents a solution to a lack of infrastructure Thus, establishment of multiple ovulation embryo transfer (MOET) is considered an attractive means of genetic improvement where infrastructure for progeny testing is not available

Most developing countries have limited financial resources In addition, equipment and supplies tend to be more expensive than they are in developed countries due to transportation costs import tariffs, lack of hard currency etc These make ET technology prohibitive in these countries However, it is possible to adapt ET techniques to local conditions thereby reducing the cost Seidel and Seidel (1992) pointed out that a lot of the fancy equipment associated with ET are not essential for successful utilisation of the technology For example, fancy freezing equipment are no more effective than dry ice/alcohol baths for freezing embryos as these save labour and are more convenient Similarly, filters are not essential for isolation of embryos, neither are disposable sterile syringes and fancy plastic dishes Thus by combining good imagination with knowledge of basic principles, the technology can be successfully adapted to local conditions Therefore research especially of an applied nature on such technologies by institutions in developing countries is always justified and often essential Moreover, researchers need to be exposed to new technologies or procedures to appreciate the power and limitations of such technologies

Environmental concerns about biotechnology

There is much euphoria about developments in biotechnology and potential benefits but little is said about the risks associated with biotechnology For example genetically modified organisms could create ecological disaster if released into the environment

Biosafety is therefore an issue of great concern for many developing countries In a recent (June 1994) meeting of the Intergovernmental Committee on the Convention on Biological Diversity (CBD 1992), representatives of developing countries pointed out that biotechnology was evolving more rapidly than the capacity of their countries to install effective safety procedures for the handling and use of living modified

organisms and that there was need for adequate and transparent safety procedures to manage and control the risks associated with the use and release of such organisms To deal with the basic ethical questions and the risks associated with genetic engineering regulatory mechanisms should be created and internationally acceptable guidelines or regulations put in place The political and regulatory processes affecting biotechnology and its products must draw upon professional competence of the highest standard In general, however developed countries are lukewarm to the idea of a legally binding international protocol on biosafety, possibly because it is a heavy responsibility with potentially massive cost implications for the technology-rich countries However, biosafety is an issue which must be addressed sooner than later

Acknowledgement

I wish to thank Dr R L Baker for assisting me, at a time of immense pressure in obtaining several critical references used in this paper

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Options biotechnologiques pour l'amélioration de la production animale dans les pays en développement: le cas particulier de l'Afrique subsaharienne

Résumé

Les techniques modernes de biologie telles que le clonage moleculaire et le transfert de genes, la manipulation genetique des cellules animales, le transfert d'embryons vegetaux, la manipulation genetique de la flore microbienne du rumen l'amelioration chimique et biologique des aliments du betail, les applications du genie genetique en immunodiagnostic et en immunoprophylaxie et l utilisation des vaccins dans la lutte contre les maladies animales, etc sont aujourd'hui devenues une realite et s'integrent progressivement dans les programmes de recherche-developpement des pays en developpement La biotechnologie offre des possibilites jusque-la inegalees d accroissement de la productivite agricole et de protection de l environnement grâce a un recul de l utilisation des produits agro-chimiques De nos jours les efforts de recherche biotechnologique visent surtout a resoudre les problemes immediats des pays industrialises grâce a des investissements dus pour l'essentiel aux societes transnationales Toutefois, nombreux sont les nouvelles decouvertes et les nouveaux produits dont les principaux debouches seront dans les pays en developpement, lesquels offrent de meilleures potentialites d amelioration de la productivite agricole et de la sante animale C'est seulement maintenant que les dirigeants de ces pays ont commence a accepter l'importance et l utilite de la biotechnologie Etant donne la crise economique, les graves difficultes de tresorerie les bouleversements sociaux et l'instabilite politique permanente que connaissent ces pays, l'introduction de changements de politique majeurs comporte des risques extrêmement serieux Cette communication examine les biotechnologies a applications potentielles en elevage et identifie celles qui ont deja ete utilisees ou pourraient l'être dans les pays en developpement en general et en Afrique en particulier Elle passe en revue les applications de la biotechnologie a la genetique et a la selection animales y compris la conservation des ressources genetiques, la sante animale, la physiologie de la lactation et de la croissance et la nutrition animale

Influence de la sélection du poids du bélier sur la croissance de la descendance

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Résumé

Afın de mesurer l ımpact de la selectıon du poıds des belıers Djallonke sur le poıds de leurs descendances 200 brebıs Djallonke ont ete mıses a la monte naturelle Ces brebıs, reparties en lots de 20 anımaux chacun ont reçu des belıers selectıonnes du Programme natıonal de selectıon ovıne et des belıers "tout-venant non selectıonnes achetes sur le marche local Le type genetıque (selectıonne ou tout-venant) des belıers n'avaıt pas eu d effet sıgnıfıcatıf sur les poıds de leurs descendances, excepte sur le poıds a 80 jours L'ınteractıon du mode de naıssance des agneaux avec le type genetıque des belıers a eu une ınfluence moderee (P<0,05) sur les poıds a 80 et 180 jours Le type genetıque des belıers et son ınteractıon avec le sexe et le mode de naıssance de l'agneau, ont eu un effet ımportant (P<0,05) sur le gaın moyen quotıdıen (GMQ) entre 30 et 80 jours La descendance des belıers selectıonnes pesaıt respectıvement en moyenne 300, 800 et 500g de plus a 30 80 et 180 jours, ce quı correspondaıt a des gaıns genetıques de 5 6% 9 3% et 3 5% par rapport a la moyenne de poıds des agneaux nes de belıers tout-venant Les agneaux nes de belıers selectıonnes avaıent des GMQ de 9 et 10g/j de plus que les agneaux nes de belıers tout-venant, respectıvement entre la naıssance et 30 jours et entre 30 et 80 jours Le progres genetıque realıse s'elevaıt aınsı a 7,8 et 15,6% par rapport a la moyenne de gaın de poıds des agneaux tout-venant

Mots cles Djallonke, gaın moyen quotıdıen poıds, selectıon

Introduction

La ratıonalısatıon de l'elevage traditıonnel ovın en Côte d Ivoıre s est traduıte en 1976 par l elaboratıon d un Programme natıonal ovın dont le dernıer volet mıs en place en 1984, est le Programme natıonal de selectıon ovıne (PNSO) Cette structuratıon de l elevage traditıonnel avaıt pour objectıfs l encadrement et la formatıon des eleveurs et la productıon de genıteurs ameliores afin d'accroître la productıvıte des elevages ovıns par l'amelıoratıon d un des prıncıpaux parametres, la croıssance du mouton Djallonke L'hypothese selon laquelle la selectıon basee sur le poıds du belıer permet d'accroître la croıssance des ovıns Djallonke ne pouvaıt être verıfiée apres plusıeurs annees de selectıon etant donne qu'une populatıon temoın n avaıt pas ete etablıe L'objectıf de la presente etude est donc de mesurer l ımpact de la selectıon, basee sur le poıds des belıers, sur la productıvıte par la comparaıson des performances de croıssance des descendants de belıers selectıonnes et non selectıonnes (tout-venant)

Matérıel et méthodes

Deux cent (200) brebıs n'ayant subı aucune selectıon ont ete achetees et reparties en 10 lots de 20 anımaux pour une monte naturelle de 45 jours, apres une perıode de quarantaıne au Centre natıonal ovın (CNO) de Beoumı Les montes se sont deroulees du 12 juıllet au 27 août 1994 Cınq lots ont reçu des belıers selectıonnes du Programme natıonal de selectıon ovıne (PNSO) les autres lots des belıers non selectıonnes ou tout venant Les anımaux etaıent conduıts sur du pâturage cultıve de *Panıcum* avant le sevrage puıs sur un pâturage mıxte de *Panıcum* et de savane naturelle apres le sevrage et recevaıent une complementatıon de 210 a 240 g/jour par anımal Celle-cı etaıt composee de 30% de tourteau de coton et de 70% de son de ble Les agnelages se sont deroules pendant la perıode du 6 decembre 1993 au 21 janvıer 1994 Les agneaux nes vıvants ont ete peses a la naıssance puıs mensuellement Dıfferents poıds a âge type aınsı que les gaıns moyens quotıdıens (GMQ) ont ete determınes Ce sont les poıds a la naıssance (PN), a 30 (P30), 80 (P80) et 180 jours (P180) et les GMQ de la naıssance a 30 jours (0–30) de 30 a 80 jours (30–80) et de 80 a 180 jours (80–180) Une analyse de varıance sur les dıfferents poıds a âge type et les GMQ a ete effectuee en utılısant la methode des moındres carres de Harvey (1988) Cette analyse prenaıt en compte le sexe le mode de naıssance de l agneau le type genetıque du belıer (selectıonne ou tout-venant), les ınteractıons du sexe et du mode de naıssance avec le type genetıque et la regressıon lıneaıre du poıds de la brebıs mesure avant les accouplements

Résultats et discussions

Sur les 200 brebis mises a la monte 172 ont agnele ou avorte ce qui correspond a une fertilite de 86% Quinze des brebis ont agnele avant ou peu apres la monte, ces resultats n ont pas ete pris en compte dans les analyses Treize ont avorte et 4 ont eu des mort-nes La prolificite etait de 1,05

Les poids a âge type et les GMQ ont porte sur 147 agneaux Les resultats de l'analyse de variance sur les poids sont presentes au tableau 1 et ceux relatifs aux GMQ au tableau 2 Le sexe et le mode de naissance des agneaux ont eu des effets tres significatifs sur les poids aux differents âges (tableau 1) Le type genetique des beliers n'avait aucun effet sur les poids de leurs agneaux, sauf sur le poids a 80 jours L'interaction du mode de naissance avec le type genetique a eu une influence moderée (p<0,05) sur les poids a 80 et 180 jours Le poids a la naissance n'a ete affecte de maniere significative par aucun des facteurs de variation consideres (tableau 1)

De même que sur les poids a divers âges types les effets du sexe, du mode de naissance et la regression du poids de la brebis etaient importants sur les GMQ a des seuils de probabilite de 1 a 5% (tableau 2) Le type genetique et son interaction avec le sexe et le mode de naissance de l agneau ont eu un effet important (P<0 05) sur le GMQ de 30 a 80 jours (tableau 2) D une maniere generale, la descendance des beliers selectionnes a eu des poids superieurs a celle des beliers tout-venant (tableau 3) A 30 80, et 180 jours, elle avait respectivement en moyenne 300, 800 et 500g de plus, ce qui correspond a des gains genetiques de 5 6% 9 3% et 3 5% qui sont relativement faibles par rapport au taux de 15% rapporte par Fogarty (1994) pour le poids au sevrage d'agneaux en pays tempere Sakul *et al* (1994) attribuent le modeste progres genetique a une alimentation inadequate La superiorite de la descendance des beliers selectionnes a ete d'autant plus accentuee que les doubles surpassaient leurs congeneres issus des beliers tout-venant de 600, 1900 et 1600g respectivement a 30 80 et 180 jours (tableau 3) Les agneaux simples des beliers tout-venant etaient plus lourds que ceux des beliers selectionnes, mais les differences n etaient pas statistiquement significatives Les tendances observees au niveau des poids entre agneaux de beliers selectionnes et agneaux de beliers tout-venant sont les mêmes que pour les GMQ (tableau 4) Les agneaux nes de beliers selectionnes avaient un gain de poids de 9 et 10g/j de plus que ceux

Tableau 1 *Analyse de la variance des poids a age type d agneaux Djallonke*

		Carres moyens			
Sources de variation	Degre de liberte	PN	P30	P80	P180
Sexe (S)	1	0 71*	9 34**	75 18**	219 8**
Mode de naissance (MN)	1	2 33*	62 51**	240 15**	191 5**
Type genetique (TG)	1	0 00	1 16	10 70[1)]	3 6
S * TG	1	0 13	2 02	15 73[1)]	7 9
MN * TG	1	0 15	2 57[1]	22 72*	25 0[)]
Poids brebis	1	1 97*	29 56**	90 52**	161 4**
Residuel	140	11 80	122 17	403 39	645 3
Coef de variation (%)		14 06	15 07	16 44	13 88

** p<0 001 * p<0 01 [1]p<0 05

Tableau 2 *Analyse de la variance des gains moyens quotidiens d agneaux Djallonke*

		Carres moyens		
Sources de variation	Degre de liberte	GMQ 0–30	GMQ 30–80	GMQ 80–180
Sexe (S)	1	5687*	12440**	55027**
Mode de naissance (MN)	1	45619**	22566**	256
Type génétique (TG)	1	1330	185[1]	183
S * TG	1	1327	2551[1]	132
MN * TC	1	1705	3822**	6
Poids brebis	1	18066**	6686**	1011[1]
Residuel	140	107063	77846	34683
Coef de variation (%)		20 04	28 53	30 59

** p< 001 * p<0 0 [1]p<0 05

Tableau 3 *Moyennes des moindres carres des poids a âge type par type genetique des agneaux Djallonke*

Variables	N	Moyennes des moindres carres (kg)			
		PN	P30	P80	P180
Moyenne genérale	147	1 9±0 03	5 5±0 11	9 0±0 20	14 4±0 25
Type génetique					
Selectionne	73	1 9±0 05	5 7±0 15	9 4±0 27	14 6±0 34
Tout venant	74	1 9±0 05	5 4±0 16	8 6±0 29	14 1±0 37
Gain (%)		0	5 6	9 3	3 5
Interaction MN * TG					
Simple					
Selectionne	61	2 1±,0 04	6 4±0 12	10 6±0 22	15 6±0 28
Tout-venant	64	2 1±0 04	6 5±0 12	11 0±0 22	16 1±0 37
Double					
Selectionne	12	2 1±0 04	4 9±0 27	8 1±0 27	13 5±0 62
Tout venant	10	2 1±0 04	4 3±0 30	6 2±0 54	11 9±0 37
Coef regression poids Brebis (g/j kg ^{1})		0 05 ±0 009	0 17 ±0 030	0 30 ±0 054	0 41 ±0 068

Tableau 4 *Moyennes des moindres carres des gains moyens quotidiens par type genetique des agneaux Djallonke*

Variables	N	Moyennes des moindres carres (g/j)		
		GMQ 0–30	GMQ 30–80	GMQ 80–180
Moyenne generale	147	120±3 2	69±2 8	54±1 8
Type genetique				
Selectionne	73	124±4 4	74±3 7	52±2 5
Tout venant	74	115±4 7	64±4 0	55±2 7
Gain (%)		7 8	15 6	5 5
Interaction MN * TG				
Simple				
Selectionne	61	144±3 6	85±3 1	50±2 1
Tout venant	64	145±3 5	89±3 0	54±2 0
Double				
Selectionne	12	104±8 0	64±6 8	54±4 6
Tout venant	10	86±8 9	39±7 6	57±5 1
Coef regression poids brebis (g/j kg ^{1})		4 3±0 88	2 6±0 75	1 0±0 50

issus de beliers tout-venant, respectivement de la naissance a 30 jours et de 30 a 80 jours, soit un progres genetique de 7,8 et 15,6% La superiorite des poids et des GMQ des agneaux nes simples de beliers tout venant est surprenante car on s attendait a une meilleure performance des descendants de beliers selectionnes a tous les niveaux Ces resultats ne concernent qu'une seule serie d agnelages et doivent encore être verifies par les deux autres series d'agnelages prevues

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Effect of ram weight selection on offspring growth

Abstract

Two hundred Djallonke ewes were subjected to natural mating to measure the impact of ram weight selection on offspring The animals were divided into 10 groups of 20 ewes each, and were allocated rams from the National Sheep Selection Programme and other non selected rams acquired on the local market The genetic type (selected or non-selected) of rams had no significant effect on the weight of their offspring, except for weight at 80 days of age The interaction between type of birth of lamb and genetic type of ram had a moderate (P<0 05) effect on 80- and 180-day weight Genetic type and its interaction with lamb sex and birth type had an important effect (P<0 05) on daily weight gain between 30 and 80 days On average lambs from selected rams were 300, 800 and 500 g heavier than lambs from non-selected rams at 30 80 and 180 days, respectively This was equivalent to an average genetic gain of 5 6 9 3 and 3 5% respectively From birth to 30 days and from 30 to 80 days of age, daily weight gains of lambs from selected rams were respectively 9 and 10 g higher than those of lambs from unselected rams This represented a genetic gain of 7 8 and 15 6%, respectively, compared to average daily weight gains of lambs from unselected rams

Genetic analysis of the reproductive performance of West African Dwarf goats in the humid tropics

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Abstract

A total of 587 kidding records of the West African Dwarf (WAD) goats over a period of 10 years (1982–91) were used for this study The mean kidding interval and litter size at birth were 275 68±6 08 days and 1 79±0 05 kids respectively Effect of parity season and year of birth were significant (P<0 05) for kidding interval Parity also had significant effect (P<0 05) on litter size at birth Heritability estimates of 0 35±0 05 and 0 32±0 07 were obtained from sire and sire-dam group, respectively, for litter size at birth The heritability estimate for kidding interval was 0 03±0 01 for the sire-dam group Repeatability estimates of 0 38±0 05 and 0 33±0 03 were obtained for litter size at birth from the dam and sire-dam groups respectively, while 0 06±0 04 and 0 04±0 02 were obtained for kidding interval from dam and sire–dam groups, respectively Selection for multiple birth is likely to result in larger litter size and culling of does for long kidding interval should be based on more than two records

Introduction

Genetic improvement of the small ruminants is imperative considering the improvement in productivity that has been achieved by changes in management practices Van Vlaenderen (1989), Adu et al (1988) and Odubote (1992) among other workers have reported on these improved performances In order to optimise gains from environmental influences, genetic parameters and attributes of the animals for economic traits should be appraised regularly so as to enable breeders to determine the breeding tools of choice

To date only limited published reports (Odubote 1992) have estimated genetic properties for metric traits in goat populations reared in tropical and subtropical environments Specifically, heritability and repeatability estimates are lacking for the Nigerian breeds of goat except for the earlier reports of Odubote and Akinokun (1992) on the West African Dwarf (WAD) goat and Adu et al (1979) on the Red Sokoto goat Due to the availability of more records it became necessary to reappraise the genetic attributes of the WAD goat population

Materials and methods

Records of 587 kiddings from WAD goat matings of 11 sires to 163 does between 1982 and 1991 were used for this study The goats were kept at the Goat Unit of the Obafemi Awolowo University Teaching and Research Farm, Ile-Ife, in the humid tropics of Nigeria The rainfall pattern is bimodal averaging 1205 mm per year

The history and management of the flock have been reported by Odubote (1992) The goats were kept under zero grazing management and stall fed twice daily on a diet consisting of *Panicum maximum Leucaena leucocephala* and *Gliricidia sepium* Concentrates were also fed when available The health care package included dipping, deworming and annual vaccination against peste des petits ruminants (PPR) Animals were treated for pneumonia and diarrhoea when infection occurred Mating was controlled and inbreeding was avoided in the herd

Statistical analysis

The data were analysed by the General Linear Model (SAS 1986) using mixed models to determine the effects of the nth doe of the mth parity mated to the lth sire, producing k^{th} litter size in the jth season of the ith year on litter size at birth and kidding interval

Significant differences between means were determined using Duncan's New Multiple Range Test (Steel and Torrie 1980) The data were adjusted for significant environmental effects before estimating the genetic variance components The variance components were calculated using sire, dam and combined sire–dam groups according to the method of Becker (1968)

Formulae

From sire group

$$h^2 = \frac{4\sigma S^2}{\sigma_S{}^2 + \sigma_E{}^2}$$

From dam group

$$r = \frac{\sigma_D{}^2}{\sigma_D{}^2 + \sigma_E{}^2}$$

From sire–dam group

$$h^2 = \frac{4\sigma S^2}{\sigma_S + \sigma_D{}^2 + \sigma_E{}^2}$$

$$r = \frac{\sigma_D{}^2}{\sigma_S + \sigma_D{}^2 + \sigma_E{}^2}$$

Standard errors for the estimates were computed as described by Falconer (1981)

Results and discussion

The least squares means for kidding interval and litter size at birth are provided in Table 1 The partitioning of the variance components and estimates of heritability and repeatability are shown in Table 2

Kidding interval

The kidding interval ranged from 187 to 478 days Mean kidding interval was considerably high This may be probably due to the transfer of does for other experimental purposes and the control of mating schedule High kidding interval has been associated with controlled mating and confinement (Wilson et al 1989) The results suggest that kidding interval is highly influenced by management restrictions

Some cases of repeat breeders and abortions were observed in the flock There was a significant decrease in the kidding interval from the fifth parity The trend of the effect of type of birth and year of birth on kidding interval is not clear There was, however, a decrease in the kidding interval from 1985 onwards This may be traced to changes in management practices such as culling of does for poor productivity

The repeatability estimates of 0 06±0 04 and 0 04±0 02 obtained for kidding interval are low but not significantly different from those reported earlier by Odubote and Akinokun (1992) Also there was no difference in the estimates using the two approaches of computation The estimate of heritability could not be done because of the negative sire component of variance

Litter size at birth

Contrary to an earlier report on the same flock (Odubote et al 1993), quadruplets were observed in the present study The birth ratio was 37 53 9 1 for singles, twins, triplets and quadruplets, respectively Mean litter size compared favourably with the earlier reports for the WAD breed (Adu et al 1988, Odubote and Akinokun 1992)

Table 1 *Least squares means for kidding interval and litter size at birth in West African Dwarf goats*

	Kidding interval (days)			Litter size at birth (no)		
Variable	N	Mean	SE	N	Mean	SE
Overall mean	316	275 68	6 08	587	1 79	0 05
Season of birth						
Dry	165	260 30[a]	5 74	371	1 84[a]	0 04
Rain	151	291 06[b]	8 13	216	1 73[a]	0 06
Year of birth						
1982	12	276 31[b]	6 11	28	1 65[ab]	0 13
1983	23	364 45[d]	10 23	50	1 70[ab]	0 05
1984	21	317 26[c]	9 68	41	1 68[ab]	0 02
1985	47	264 14[b]	4 70	93	1 59[a]	0 06
1986	62	260 00[b]	5 45	112	1 54[a]	0 04
1987	44	238 94[a]	8 03	91	1 62[a]	0 07
1988	15	266 33[b]	7 04	32	1 67[ab]	0 03
1989	31	253 32[b]	4 93	39	1 89[c]	0 05
1990	32	273 13[b]	6 80	49	1 83[c]	0 03
1991	29	278 55[b]	5 46	52	1 84[c]	0 07
Parity						
1	–	146	–	1 43[a]	0 02	
2	116	282 14[ab]	6 48	148	1 59[ab]	0 04
3	69	304 36[c]	8 41	93	1 72[ab]	0 05
4	53	288 69[c]	8 32	77	1 74[bc]	0 03
5	30	261 04[ab]	5 06	45	1 85[bc]	0 07
6	21	259 78[ab]	6 81	35	1 90[bc]	0 06
7	15	249 68[a]	7 84	23	2 07[de]	0 09
8	8	248 01[a]	5 49	14	2 02[cde]	0 14
9	4	252 04[a]	4 82	6	1 98[cd]	0 13
Litter size at birth						
1	119	261 32[a]	5 64			
2	166	286 45[ab]	3 07			
3	27	265 21[a]	8 45			
4	4	304 16[b]	9 63			

N refers to the number of observations

Means within each class and in each column with different superscripts differ significantly (P<0 05)

SE = standard error of the mean

Table 2 *Partitioning of variance components and estimates of heritability (h^2) and repeatability (r) of litter size at birth and kidding intervals in WAD goats*

	Variance components				
Traits	Sire	Doe	Remainder	r ±SE	h^2±SE
(a) From sire group					
Litter size at birth	0 06*	N/A	0 65	N/A	0 35±0 05
Kidding interval	–12 02	N/A	23 64	N/A	b
(b) From dam group					
Litter size at birth	N/A	0 43**	0 70	0 38±0 05	N/A
Kidding interval	N/A	7 93*	124 24	0 06±0 04	N/A
(c) From sire and dam group					
Litter size at birth	0 05*	0 20**	0 37	0 33±0 03	0 32±0 07
Kidding interval	0 61	3 03	85 62	0 04±0 02	0 03±0 01

N/A = not applicable b = negative variance component estimate set to zero
* P<0 05 ** P<0 01

Litter size at birth tended to improve over the years and with parity (P<0 05) This may be due to the efficiency of reproduction as the doe matures (Levasseur and Thibault 1980) Secondly, since 1987, the management system permitted the culling of does with small litters which may partially account for the significant increase in litter size

The heritability estimates of 0 35±0 05 and 0 32±0 07 obtained for litter size at birth were higher than the earlier estimate of 0 28 (Odubote 1992) for the same flock The estimates were also higher than estimates reported (Adu et al 1979), Ricordeau (1981) and Wilson (1989) for other breeds of goats The extent to which observed differences in a trait are heritable is indicative of the magnitude of expected response to selection Thus, selection would lead to higher litter size at birth However this calls for caution (for the WAD goat) as this may lead to a higher incidence of triplets and quadruplets The benefit of the incidence of triplets and quadruplets should be evaluated in terms of survival of the kids dystocia in the does, effect on kidding interval and body weight of the kid at birth In the present study, no problems were observed to be associated with multiple birth in the flock

The repeatability estimates obtained for litter size were 0 38±0 05 and 0 33±0 03 As a result of the moderate repeatability estimates a single record of a doe can be taken as a fair assessment of its potential Systematic culling of unproductive animals may be the most important management practice to increase the litter size at birth Also breeding males from parents with poor fertility should be avoided since effect of stud buck was observed to be significant (P<0 05) Estimates of genetic parameters for extensively managed goat population are still required

Conclusions

Efforts should be made to reduce the kidding interval by changes in management restrictions especially re-breeding interval Not much reliance can be placed on two subsequent kidding records for culling purposes More records should thus be collected before deciding on culling levels for unproductive does

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Analyse génétique des performances de reproduction de la chèvre guinéenne dans les régions tropicales humides

Résumé

Un total de 587 donnees de parturition de chevres de la zone guineenne collectees sur une periode de 10 ans (1982–1991) ont ete utilsees pour cette etude L'intervalle moyen entre parturitions et la taille moyenne de la portee etaient respectivement de 275 68± 6,08 jours et 1,79±0,05 chevreaux La parite, la saison et l'annee de la naissance avaient un effet significatif (P<0,05) sur l'intervalle entre mises bas La parite avait egalement un effet significatif (P<0,05) sur la portee Les coefficients d heritabilite de la portee etaient de 0,35± 0,05 pour le pere et de 0,32±0 07 pour le pere et la mere Celui de l'intervalle entre parturitions etait de 0,03±0 01 pour le pere et la mere Les coefficients de repetabilite de la portee etaient de 0 38±0 05 pour la mere et de 0 33±0 03 pour le pere et la mere contre respectivement 0 06±0 04 et 0 04±0 02 pour l intervalle entre mises bas La selection pour des naissances multiples devrait permettre d accroître la taille de la portee Enfin, l elimination des femelles pour cause de trop longs intervalles entre parturitions doit être basee sur au moins deux donnees

Preliminary evidence for genetic resistance to endoparasites in Menz and Horro lambs in the highlands of Ethiopia

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Abstract

The Menz and Horro highland sheep breeds are being evaluated at the ILCA Debre Birhan research station in Ethiopia for between and within breed genetic variation for resistance to internal parasites The experimental design involves mating, for each breed, 150 ewes with 10 rams to lamb at the beginning of the dry season (October/November) and the wet season (June/July) This paper reports data collected from birth to weaning on lambs from the first three lamb crops (i e born October/November 1992, June/July 1993 October/November 1993) The traits analysed were birth weight (BWT), weaning weight (WWT), packed red cell volume (PCV) recorded at weaning logarithm transformed faecal egg count (LFEC) recorded at weaning and lamb survival from birth to weaning The effect of both breed and lambing group was significant (P) for all traits analysed Horro lambs were heavier at birth and at weaning, had lower PCV higher LFEC and lower survival rate from birth to weaning than Menz lambs There was a significant interaction of breed by lambing group for all traits except BWT For lamb survival WWT and PCV the interaction took the form of varying magnitude of differences between the breeds in different lambing groups rather than any change in breed ranking For LFEC the breed ranking changed in different groups with the Menz having higher LFEC than Horro lambs in the first lambing group, while the reverse was true in the other two lambing groups There was no evidence from these data that the breed difference in lamb survival was due to resistance to endoparasites There was significant additive genetic direct and maternal variance for BWT and WWT For BWT the estimate of the direct (h^2_A) and maternal (h^2_M) heritability were 0 07±0 06 and 0 34±0 06, respectively, while for WWT the corresponding estimates were 0 04±0 05 and 0 43±0 07 For PCV and LFEC h^2_M was not significant and the overall heritability estimates were 0 34±0 14 and 0 32±0 13 respectively

Introduction

Helminthiasis is of considerable significance in a wide range of agro-climatic zones in sub Saharan Africa and constitutes one of the most important constraints to small ruminant production (ILCA 1991, Over et al 1992) The widespread occurrence of infection with internal parasites in grazing animals the associated loss of production the costs of anthelmintics and death of infected animals are some of the major concerns There are also increasing environmental concerns which may influence anthelmintic usage through consumer demand for animal products and pastures free of chemical residues

Current control methods for internal parasites outside Africa focus on reducing contamination of pastures through anthelmintic treatment and/or controlled grazing In Africa, these control methods are limited by the high cost of anthelmintics, their uncertain availability increasing frequency of drug resistance and limited scope in many communal pastoral systems for controlled grazing (Waller 1991, Mwamachi et al 1995, Tembely et al this conference) It appears unlikely that new broad-spectrum anthelmintics will be available in the near future because of the major costs associated with the development of new products and to date only a few commercial vaccines are available including the lungworm-irradiated vaccine Alternative approaches to control internal parasites are therefore being considered One such approach is utilisation of host genetic variation for resistance

Evidence of genetic variation in sheep and goats for resistance to or tolerance of gastro-intestinal nematodes was first documented 40–50 years ago and this subject has been comprehensively reviewed by Gray (1991), Gray and Woolaston (1991) Baker et al (1992) and Gray et al (1995) The best documented examples of sheep breeds showing resistance to endoparasites in Africa are the Red Maasai sheep in East Africa and the Djallonke sheep in West Africa (Preston and Allonby 1978 Preston and Allonby 1979, Baker et al 1993 Baker et al 1994 Baker 1995)

There are about 23 million sheep and 17 million goats in Ethiopia (FAO 1987) Three-quarters of the national sheep flock is located in the highland regions which receive more than 700 mm of rainfall per year and accommodate three-quarters of the human population Gebrekiros Asegede (1990) compared four breeds of indigenous Ethiopian sheep for their resistance to endoparasites (predominantly *Haemonchus contortus*) at Awassa in southern Ethiopia The breeds evaluated

were the Adal and Blackhead Somali originating from the semi-arid lowland regions and the Horro and Arsi from the humid highlands The Blackhead Somali were the most susceptible to endoparasites while the Arsi were the most resistant

This paper presents some preliminary results from an evaluation of the resistance of Menz and Horro lambs to endoparasites in the highlands of Ethiopia This research is part of an ILCA Pan-African research programme to investigate and characterise genetic resistance to endoparasites in some indigenous sheep and goat breeds in sub Saharan Africa (ILCA 1991, ILCA 1993)

Materials and methods

Experiment site

The Debre Birhan experiment station is located in the central Ethiopian highlands about 120 km NE of Addis Ababa at an altitude of 2780 m above sea level The climate is characterised by a long rainy season (July–September) a short rainy season (February–March) and an extended dry season (October–February) Annual rainfall averages 920 mm Air temperatures range from a near freezing low of 2 4 C in November to 23 3 C in June The pasture at the station is dominated by *Andropogon* grass (*Andropogon longipes*) with variable proportions of *Trifolium* spp A detailed presentation of relevant epidemiological data, including predominant parasites at the experimental station is reported elsewhere (Tembely et al this proceedings)

Experimental animals and management

Menz (indigeneous to the study area) and Horro (introduced from a slightly lower highland area) ewes were oestrous synchronised with progestron sponges left in place for 10 to 12 days to permit for dry and wet season lambings Single sire mating occurred in night pens for 30 days and ewes were allowed to graze together during the day After mating all ewes received concentrate supplement (200 g/head per day) Female lambs were separated from the male lambs after weaning but exposed to the same grazing paddocks in a rotational grazing system until the end of the experiment at the age of 12 months The mating schedule used to produce the lamb crops analysed is presented in Table 1 Grazing management and health intervention programmes are described elsewhere (Tembely et al this conference)

Data recorded

Live weights were recorded on all lambs at birth (BWT) and at weaning (WWT) at 3–4 months of age Blood and faecal samples were collected from all lambs at 1 and 2 months of age and at weaning Packed red cell volume (PCV) was determined using a haematocrit centrifuge Faecal egg counts (FEC) were analysed using the modified McMaster method (MAFF 1977) Additionally faecal samples were bulked by breed and sex and cultured for larvae identification (Hansen and Perry 1990) Though FEC and PCV measurements were taken on all lambs at 1 and 2 months of age and at weaning (at 3 months of age), only the data on weaners is reported in this paper Individual lambs with FEC greater than 2000 eggs per gram (epg) and/or PCV less than 15% at the 2-month sampling were drenched

Statistical analysis

Analyses of fixed effects were performed by least squares (Harvey 1990) The fixed effects model fitted included lamb breed (Menz and Horro) lambing group (3 levels) lamb sex (male and female) lamb birth type (single or twin born), dam parity (first second and later) and the interaction of breed and lambing group In preliminary analyses parity was only significant for BWT and WWT and was excluded from subsequent models for the other traits Birth date was included in the model as a linear covariate when analysing BWT Lamb age was included as a linear covariate when analysing WWT, PCV and FEC Preliminary analyses identified that most other first order interactions were not significant (P>0 05) except for birth type x parity for WWT and lamb age x lambing group for WWT and FEC Survival from birth to weaning was analysed as a binomial variable (0 = dead 1=alive) with the same fixed effect model as for the other traits but with no covariate or dam parity effect in the model FEC was analysed both as an untransformed variable and using a logarithm transformation $\log_e$ (FEC+10) to normalise the distribution of this trait

Heritabilities were estimated by Restricted Maximum Likelihood (REML) using an animal model applying the DFREML software of Meyer (1991) and

Table 1 *Mating and lambing schedules for the three lamb crops analysed*

		No of rams		No of ewes[a)]			No of lambs born	
Group	Mating period	Horro	Menz	Horro	Menz	Lambing season	Horro	Menz
1	May 1992	11	11	276(20)	284(20)	Oct/Nov 1992	124	137
2	January 1993	10[b)]	11	286(20)	274(20)	June/July 1993	116	233
3[c)]	May 1993	11	11	233(20)	224(20)	Oct/Nov 1993	144	201

a) Number of unmated control ewes are in parenthesis

b) One ram died before the second mating season

c) For each breed eight new rams were introduced and three previous ones (groups 1 and 2) retained

fitting the significant fixed effects identified in the fixed model analyses of variance

Results

Tests of significance from analyses of variance overall means and residual standard deviations for the six traits analysed are presented in Table 2 Differences between breeds and lambing groups were significant (P) for all traits analysed, and, with the exception of BWT the interaction of breed by lambing group was also significant (P) The skewed non-normal distribution of FEC is clearly reflected in the high coefficient of variation (CV) of 111% which is reduced to 23 5% when the logarithm transformation is applied (i e LFEC)

The least squares means for breed, lambing group and the interaction of breed by lambing group are presented in Table 3 Horro lambs were heavier at birth and weaning had lower PCV, higher LFEC and lower

Table 2 *Analysis of variance overall mean residual standard deviation and coefficient of variation (CV) for birth weight (BWT) weaning weight (WWT) packed cell volume (PCV) faecal egg count (FEC) logarithm transformed FEC (LFEC) and lamb survival from birth to weaning (SURV)*

Source of variation	BWT (kg)	WWT (kg)	PCV (%)	FEC (epg)	LFEC	SURV (%)
Breed	***	***	***	**	*	***
Lambing gp (LG)	***	***	***	***	***	***
Breed x LG	ns	***	***	***	***	*
Sex	***	**	*	*	*	ns
Birth type (BT)	***	***	***	*	*	***
Dam parity (DP)	***	*	–	–	–	–
Covariate						
Birth date	**					
Lamb age		***	**	***	***	
Lamb age x LG		*	*	***		
BT X DP		***				
Total records	954	783	781	733	733	954
Overall mean	2 42	9 2	35 3	395	2 16	84 5
Residual SD	0 42	1 9	4 4	439	0 51	31 6
CV (%)	17 2	21 0	12 4	111	23 5	37 4

ns = not significant * P<0 05 ** P<0 01 *** P<0 001

Table 3 *Least squares means by breed lambing group and breed x lambing group interaction for birth weight (BWT) weaning weight (WWT) packed cell volume (PCV) anti log of logarithm transformed faecal egg count (ALFEC) and lamb survival from birth to weaning (SURV)*

Effect	No of lambs born	BWT (kg)	WWT (kg)	PCV (%)	ALFEC (epg)	SURV (%)
Breed						
Menz	573	2 16	8 4	35 7	153	85 8
Horro	381	2 50	8 9	33 3	183	73 1
Significance		***	***	***	*	***
Lambing group (LG)						
1	283	2 07	8 7	33 4	137	84 9
2	340	2 75	9 7	34 9	502	94 1
3	331	2 18	7 4	35 2	69	59 3
Significance		***	***	***	***	***
Breed x LG						
Menz 1	149	1 90	8 7	35 6	214	92 3
2	228	2 54	9 0	35 8	353	96 8
3	196	2 02	7 4	35 7	48	68 3
Horro 1	134	2 23	8 8	31 3	87	77 5
2	112	2 92	10 4	33 9	708	91 4
3	135	2 33	7 5	34 6	98	50 3
Significance		ns	***	***	***	*

ns = not significant * P<0 05 ** P<0 01 *** P<0 001

survival from birth to weaning Compared to the two lamb crops which were born at the beginning of the dry season (groups 1 and 3), the wet season lambing (June/July 1993) produced heavier lambs at birth and weaning and had the highest survival rate from birth to weaning However in terms of the parasitological parameters at weaning, the group 2 lambs had the highest LFEC and an intermediate PCV

There was a significant (P) interaction of breed by lambing group for all traits except BWT (Table 3) For lamb survival, WWT and PCV the interaction was manifested by a change in the magnitude of differences between the breeds in different lambing groups rather than any change in breed ranking For example, the considerably higher PCV of the Menz compared to the Horro lambs in the first lambing group (4 3%) declined to 1 9% and 1 1% in the second and third lambing groups, respectively For LFEC the breed ranking changed in different lambing groups, with the Menz having higher FEC than the Horro lambs in the first lambing group and the reverse being the case in the other two lambing groups

Analysis of faecal samples of the lambs born in the dry season (groups 1 and 3) at day 60 showed a low egg count whereas packed cell volume was within the normal range Faecal culture from lambs born in the wet season (group 2) showed that the predominant nematode species included *Ostertagia trifurcata* (54%) *Tricho strongylus colubriformis* (28%) and *Haemonchus contortus* (18%)

Heritability estimates for BWT, WWT, PCV and LFEC are presented in Table 4 For both BWT and WWT there was significant additive genetic maternal variance

Table 4 *Heritabilities[a] for birth weight (BWT) weaning weight (WWT) packed cell volume (PCV) and logarithm transformed faecal egg count (LFEC)*

	Model 1	Model 3	
Trait	$h^2 \pm$ SE	$h^2_A \pm$ SE	$h^2_M \pm$ SE
BWT	0 66 ± 25	0 07 ± 06	0 34 ± 06
WWT	0 10 ± 09	0 04 ± 05	0 43 ± 07
PCV	0 34 ± 14	0 29 ± 13	0 08 ± 09
LFEC	0 32 ± 13	0 30 ± 13	0 04 ± 09

a Heritabilities estimated by DFREML (Meyer 1991)

Model 1 h^2 = total heritability (ignoring maternal additive genetic variance)

Model 3 h^2_A = heritability of direct (additive genetic) component of performance

h^2_M = heritability of maternal (additive genetic) component of performance

Discussion

Breed differences in traits analysed were significant but in general, not of great biological importance except for the difference in survival Estimated breed differences in birth weight weaning weight and survival in the present study are consistent with some previous results from this location (Gautsch 1992)

The general levels of nematode parasite infection was too low for this to be a major cause of sheep mortality in the study Indeed post-mortem results showed that respiratory diseases were the primary causes of death Specifically, the low mean FEC (even for the group 2 lambs) suggests that this level of infection was unlikely to result in major pathogenic effects Optimum conditions for transmission of *Ostertagia Trichostrongylus* and *Haemonchus* are present from July to November (total monthly rainfall of 50 mm or more with mean temperatures between 11 C and 13 C) There is therefore an overlap of the three nematode species However, because of a temperate climate in the highlands, *Ostertagia* and *Trichostrongylus* thrive better than *Haemonchus* which generally predominates in relatively warm climates Thus although the Horro breed had on average lower PCV and higher LFEC values than their Menz contemporaries, there was no direct evidence from these data that the breed difference in lamb survival was due to differential resistance to endoparasites Additionally breed differences in LFEC were not consistent across lambing groups

The low survival of the Horro in this study may be due to lack of adaptation of the breed to this environment Additionally the lower PCV of the breed compared to the mean for the Menz may be due to the fact that the Horro is less adapted to this (higher) altitude although both are highland breeds However, hard data is not yet available to substantiate this speculation

The heritability estimates for indicators of resistance to parasites were not different from values reported elsewhere The average heritability for single FEC measurements from estimates reviewed by Baker et al (1992) was 0 32 while the average estimate for PCV was 0 35 Heritability of the mean of multiple (2 to 3) egg counts recorded in different infections increased to about 0 5–0 6 On the basis of available data, there seems to be substantial within-breed variation in resistance to endoparasites (i e PCV and LFEC) in these lambs at a young age There may be opportunity for within-breed improvement of this trait through selection on either PCV or LFEC

With only one and two lamb crops in wet and dry seasons respectively, the results on lambing group differences are too preliminary for any definite conclusions to be made on seasonal effects The wet season was as would be expected associated with the highest parasite challenge as reflected in faecal egg counts However, this is also the season with the most abundant grazing, best growth performance, and highest lamb survival The estimates of group means for the various traits in this study emphasise the point already made that the level of nematode infections encountered to date at Debre Birhan is not too debilitating

Except for faecal egg counts, the effect of breed x lambing group interactions were of no major practical significance However, no final conclusions can be drawn until more data and additional traits (post-weaning growth PCV, FEC as well as reproduction) are analysed

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Preuves préliminaires de résistance génétique aux endoparasites chez les agneaux Menz et Horro dans les hauts plateaux éthiopiens

Résumé

Des travaux sont actuellement en cours a la station de recherche du CIPEA a Debre Berhan en Ethiopie, sur l'evaluation de la variation genetique de la resistance aux endoparasites chez les races de moutons Menz et Horro des hauts plateaux Le protocole experimental fait intervenir le croisement, pour chaque race, de 150 brebis avec 10 beliers en vue d'un agnelage au debut de la saison seche (octobre/novembre) et de la saison humide (juin/juillet) Le présent article presente les resultats enregistres sur les agneaux issus des trois premiers groupes de naissances (octobre/novembre 1992, juin/juillet 1993, octobre/novembre 1993) Les variables analysees sont le poids a la naissance et au sevrage, l hematocrite au sevrage, la transformation log du nombre d'oeufs par gramme de feces (OPG) au sevrage et le taux de survie des agneaux de la naissance au sevrage La race et la serie d'agnelages avaient un effet significatif (P<0,05) sur tous les parametres etudies Les agneaux Horro avaient des poids a la naissance et au sevrage superieurs a ceux des Menz et un hematocrite plus faible La transformation log de leur OPG etait plus elevee tandis que leur taux de survie de la naissance au sevrage etait plus faible Il y avait une interaction significative entre la race et le groupe d agnelages pour tous les caracteres etudies excepte le poids a la naissance En ce qui concerne le taux de survie des agneaux le poids au sevrage et l hematocrite, les differences dues a l interaction etaient plus ou moins importantes suivant le groupe d agnelages mais l'ordre de succession des races ne changeait pas S agissant en revanche de la transformation log de l OPG, cet ordre changeait selon le groupe Ainsi, cette variable etait plus elevee chez les Menz que chez les Horro dans le premier groupe d'agnelages alors qu'on observait la situation inverse dans les deux autres groupes Rien dans ces donnees ne permettait de dire que la difference entre les taux de survie des agneaux Menz et Horro etait due à la resistance aux endoparasites Les variances genetiques additives directe et maternelle des poids a la naissance et au sevrage etaient significatives En ce qui concerne le poids a la naissance, les coefficients d'heritabilite directe (h^2A) et maternelle (h^2M) etaient respectivement de 0,07±0,06 et de 0,34±0,06 les valeurs corres pondantes etant respectivement de 0,04±0,05 et de 0 43±0,07 pour le poids au sevrage Enfin le coefficient d'heritabilite maternelle n'etait pas significatif pour l'hematocrite et la transformation log de l OPG, les coefficients d'heritabilite totale s etablissant respectivement a 0,34±0 14 et 0,32± 0,13

Morphological characterisation of the Tswana goat

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Abstract

A survey study was conducted in two districts of Botswana to obtain data on the morphological characteristics of Tswana goats There were five different locations chosen, namely Oodi, Artesia and Mochudu in the Kgatleng District and Kopong and Thamaga in Kweneng district In each location, 16 to 20 farmers with goats were randomly selected and records taken on a random sample of 10 goats from each farmer The different body dimensions that were measured included heart girth (HG), diagonal body length (BL), height at withers (HW), body weight (BW) and rump height (RH) Records were also taken on presence of horns (HO), wattles (Wa) and beards (Bd), coat colours (white, black, black and white, brown, brown and white) and hair structure (short coarse, long coarse, short smooth and long smooth) The results showed age-dependent sexual differences in the body dimensions that were measured The apparent wide variation in coat colours and hair structure among Tswana goats observed in this study is indicative of the fact that the breed has not yet been purified through selection breeding and therefore great opportunities exist for its improvement The propensity toward white coat colour and/or white in combination with other colours especially black and brown appears to be an adaptive characteristic of Tswana goats to withstand pronounced seasonal fluctuations in the intensity and duration of light, heat and cold Finally the Tswana goat can be classified as a multicoloured, medium size breed with long lopping ears, short coarse hair structure, predominantly bearded and horned

Introduction

The importance of goats in Botswana cannot be over-emphasised They provide protein food (meat and milk) and quick cash incomes for rural farmers They are in fact the small man s cattle Their adaptive features such as feeding behaviour and disease and heat tolerance enables them to effectively cope with the stressful nature of the vast marginal lands of Botswana Also the recovery capacity of goats from drought is very remarkable due to their efficient reproductive behaviour (twinning coupled with shorter kidding intervals) and variable body size with low maintenance requirements in unfavourable environments (Horst 1984) Although the indigenous goat breeds have been broadly classified into two main groups the long-eared and short-eared (Mason and Maule 1960), more broad meaningful breed documentation on Tswana goats based on their physical body characteristics is rather lacking Therefore this study which is part of a multidisciplinary research programme on the Tswana goat, provides data on the physical body characteristics of indigenous goats of Botswana

Materials and methods

Location of study

The surveys to record the different goat body characteristics were carried out in five different locations, namely Oodi, Artesia and Mochudi in the Kgatleng District, and Kopong and Thamaga in the Kweneng district The total number of goats surveyed in each location varied between 120 and 160 with female goats comprising the greatest number

Data collection and analysis

In each of the five locations, 16 to 20 farmers with goats were randomly selected and records taken on a randomly selected sample of 10 goats from each farmer

The different body dimensions that were recorded included heart girth (cm), diagonal body length (cm), height at withers (cm) and rump height as shown in Figure 1

Records were also taken on presence of horns wattles and beards coat colours (1 white 2 black, 3 black and white, 4 brown, 5 brown and white and 6 mixed colours), hair structure (1 short coarse, 2 long coarse, 3 short smooth and 4 long smooth) and ear types (1 long lopping and 2 reduced ear length) All data collected were analysed by the help of an SAS computer statistical package

Results

Table 1 is the summary of the population structure of sampled goats in different locations of Botswana For each location there were more female goats sampled and measured than male goats Generally over 50% of the female goats were adults in the 37–48 months age group For males more than 50% were less than three years old with most being between 1–12 months

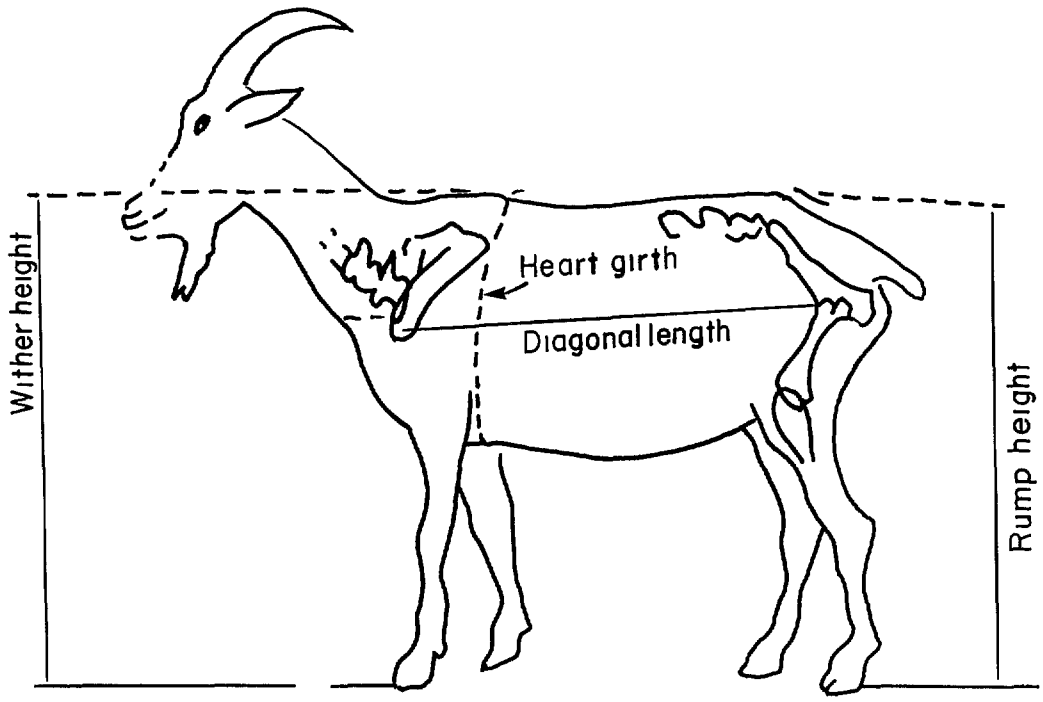

Figure 1 *Positions of measured body dimensions*

Table 1 *Structure of the goat population sampled and measured in different locations in Botswana*

	Locations									
	Oodi		Artesia		Mochudi		Thamaga		Kopong	
Variables	M	F	M	F	M	F	M	F	M	F
Total no of goats	45	1205	39	131	41	114	57	80	40	78
Proportion by age group (%)										
1–12 months	33 3	18 0	51 2	14 5	43 9	10 5	24 6	16 2	40 0	12 8
13–24 months	20 1	10 5	30 8	12 2	31 7	3 5	14 0	5 0	7 5	12 8
25–36 months	13 3	4 8	10 3	15 3	7 3	12 3	15 8	23 8	25 0	20 5
37–48 months	33 3	66 7	7 7	58 0	17 1	73 7	45 6	55 0	27 5	53 9

F = female M = male

Body measurements are summarised in Table 2 It can be noted that there is an age-dependent sexual difference in body weights among Tswana goats The males were heavier than the females after 12 months of age Like body weight, other body measurements increased with age in both sexes However, there were no differences between sexes below three years of age

Results on the incidence of different coat colours are presented in Table 3 The most common coat colours are a combination of white with either black or brown pure colours of black and brown, and mixed colours have the lowest frequencies in Tswana goats The sex of the goat had no influence on its coat colour

The most favoured hairs are the short coarse (SC) ones except in Kopong location where 63% of all goats sampled had long coarse hairs (Table 3) Goats with long smooth hairs (LS) were the least frequent in all locations followed by those with short smooth hairs (SS) Variation in hair structures shows similar patterns in both male and female goats

Information on the incidences of wattles (Wa), beards (Bd) horns (Ho) and ear length (El) among Tswana goats can be found in Table 4 Both sexes of Tswana goats are bearded horned, and have a very noticeable property towards long-lopping earedness The wattled (Wa) and reduced ear-length (Elr) conditions exist among Tswana goats but at low frequency (15%) in both sexes Generally there are slightly more male goats affected by the reduced ear length condition than the female

Discussion

This study sampled more female Tswana goats (69%) than males (31%) and most of the females were adults in the 37–48-month age group This is the reflection of

Table 2 *Body measurements (means ± standard deviations) of Tswana goats of different sex and age groups*

	Age groups (months) by sex*							
	0–12		12–24		25–36		37–48	
Body measurements	M	F	M	F	M	F	M	F
Body weight (kg)[1]	19 23	19 64	25 39	24 14	32 28	29 07	41 97	33 76
	±3 93	±2 73	±4 57	±2 40	±5 49	±2 02	±5 67	±2 09
Heart girth (cm)	63 29	63 86	70 47	68 31	73 50	72 35	83 60	78 03
	±5 90	±6 89	±6 97	±6 37	±8 09	±6 63	±5 67	±5 46
Height at withers (cm)	58 75	58 93	62 84	62 33	67 03	65 55	75 81	67 77
	±4 36	±5 49	±4 93	±4 27	±6 49	±4 11	±6 49	±3 92
Rump height (cm)	61 39	61 57	66 00	64 91	69 50	68 14	77 76	70 15
	±4 34	±5 54	±4 19	±4 58	±7 30	±4 06	±6 55	±3 85
Body length (cm)	53 27	53 26	57 07	56 82	63 25	61 93	70 24	63 14
	±5 39	±5 29	±5 73	±6 27	±6 27	±6 27	±7 78	±5 06

*F = female M = male

1 Weights were predicated from a regression model

Table 3 *Incidence of coat colours and hair structures in Tswana goats from different locations in Botswana*

	Locations				
Characteritics	Oodi	Artesia	Mochudi	Thamaga	Kopong
Goat coat colour (%)					
White	16 7	14 2	28 4	32 0	28 0
Black	7 3	9 4	12 3	7 3	7 6
Black and white	26 6	30 6	25 2	29 2	38 1
Brown	8 0	11 2	14 2	7 3	5 1
White and brown	30 0	27 6	15 5	11 7	13 6
Mixed colour	12 0	7 1	4 5	12 4	7 6
Hair structure (%)					
Short coarse	42 0	72 4	60 0	59 1	17 0
Long coarse	28 7	18 8	36 8	35 0	62 7
Short smooth	26 7	8 2	3 2	3 8	18 6
Long smooth	2 6	0 6	0 0	0 1	1 7

Table 4 *Incidence (%) of wattles beards horns and ear types in different sexes of Tswana goats from different locations*

	Locations									
	Oodi*		Artesia		Mochudi		Thamaga		Kopong	
Characteritics	M	F	M	F	M	F	M	F	M	F
Wattled	6 7	11 4	18 0	9 2	9 8	8 8	5 3	7 5	10 0	12 8
Bearded	57 8	60	69 0	61 8	58 5	63 2	77 2	70 0	70 0	64 1
Horned	75 6	66 7	91 6	69 2	87 7	84 2	70 2	61 3	72 5	68 0
Lopping ears	88 9	97 1	97 4	99 2	97 6	97 4	98 3	98 8	90 0	91 0
Reduced ears	11 1	2 9	2 6	0 8	2 4	2 6	1 7	1 2	10 0	9 8

* F = female M = male

the structure of goat population generally kept by subsistence peasant farmers in the rural areas Generally, rural farmers are artistic breeders who naturally and traditionally know that a constant flock size essentially depends on a large number of reproductively active females that must be kept for long periods of time

Results obtained in the present study on body weight (BW) and other conformational traits (HW HG RH and BL) are concurrent with those obtained by other researchers (Mazumder et al 1983 Ruvuna et al 1988 Bhattacharya 1989) Male goats generally grow faster and are heavier with superior body conformational measurements than female goats Age significantly affects body traits On the basis of body size and height at withers the Tswana goat can be classified as a medium size breed according to one of the goat classification criteria suggested by Devendra and Mcleroy (1988)

Results on coat colours and hair structures revealed that Tswana are multicolored with a variety of hair structures This is an indication that indeed the Tswana breed of goats has not been purified through selective breeding The propensity towards white and/or white in combination with other coat colours, especially black and brown, eminently exhibited by goats used in the present study appears to be an adaptation to the pronounced seasonal fluctuations in the intensity and duration of light, heat and cold experienced in this region The same holds true for the observed variation in hair structures Coat colours and hair structures in goats have an important role to play in the adaptability of animals to different ecological zones (Banerji 1984) This argument is supported by the later assertion of Hemmer (1990) to the effect that animal domestication can be aided by the use of certain coat colours or patterns which are related behaviour through the common metabolic pathway of pigments and catecholamine neurotransmitters Margetin et al (1988) reported a high incidence of short-hairedness (average 96 3%) among goats belonging to two different herds

This study has revealed high frequencies of the bearded (65%) and horned (75%) conditions among Tswana goats Goats affected by the reduced ear condition (ELr) were the least frequent (6%) while occurrence of long lopping ears was the highest (94%) There was a relatively small percentage of almost equal number of wattled female (9 9%) and male (10%) goats These results are in conformity with those of other researchers Margetin et al (1988) reported low and high frequencies of the dominant wattled allelle (0 193) and dominant standard ear length (0 920) conditions, respectively Matassino et al (1984) studied samples of native goat populations in southern Italy and found that 67% and 65% of the goats in this study were bearded and horned respectively

Conclusions

On the basis of the information obtained from the present study it could be concluded that the Tswana goat is a multicolored medium size breed with long lopping ears, short coarse hair structure and pre dominantly bearded and horned, the apparent wide variation in coat colours and hair structure among Tswana goats is indicative of the fact that the breed has not yet been purified through selective breeding and therefore great opportunities exist for its improvement and that the propensity towards white coat colour and/or white in combination with other colours especially black and brown, appears to be an adaptive trait to withstand pronounced seasonal fluctuations in the intensity and duration of light heat and cold

Acknowledgements

The authors are very grateful to the ILCA Small Ruminant Network for the financial support Botswana College of Agriculture (BCA) for the transport provided during the surveys and to all the collaborating farmers who offered their goats to be measured during this study

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Caractérisation morphologique des caprins Tswana

Résumé

Une etude a ete effectuee dans deux districts du Botswana en vue de rassembler des donnees sur les caracteres morphologiques des caprins Tswana Cinq localites ont ete choisies a savoir Oodi, Artesia et Mochudu dans le district de Kgatleng et Kopong et Thamaga dans celui de Kweneng Un total de 16 a 20 paysans possedant des chevres ont ete choisis au hasard dans chaque localite et des donnees ont ete rassemblees sur 10 animaux choisis egalement au hasard dans chaque troupeau Les mesures corporelles relevees sont le perimetre thoracique la longueur de la diagonale du corps la hauteur au garrot, le poids vif et la hauteur de la croupe Ont egalement ete notees, la presence ou non de cornes, de pendeloques et de barbiches, la couleur de la robe (blanc noir, pie noire, brun, pie brune) et la structure du poil (ras et dur long et dur, ras et lisse, long et lisse) Les resultats ont mis en evidence, entre les variables corporelles mesurees, des differences liees au sexe en fonction de l âge Les importantes variations observees dans la couleur et la structure du pelage de ces animaux montre que cette race n'a pas encore ete purifiee par selection et qu elle offre par consequent de grandes possibilites d amelioration La tendance dominante de la couleur blanche, seule ou en combinaison avec d'autres couleurs, notamment le noir et le brun, semble constituer un caractere d'adaptation des caprins Tswana aux importantes fluctuations de l intensite de la lumiere et de la duree d eclairement et aux importants ecarts de temperature observes dans la region Enfin on peut definir les caprins Tswana comme une race multicolore, de format moyen avec de longues oreilles pendantes, le poils ras et dur et une predominance de barbiches et de cornes

Reproductive performance and level of gastro-intestinal parasite infestation in goats on-farm and on-station at Machang'a, Embu, Kenya

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Abstract

Monitoring of an existing pre-experimental observatory herd of Small East African goats was carried out at Machang'a Field Station For comparison, a rapid survey on 25 neighbouring farms was conducted On-station faecal samples were taken from the goats in January, February and June 1994 to establish eggs per gram (EPG) counts The EPG s were low (0–800) in January and February but shot up to as high as 4200 in June The most prevalent helminth species was *Haemonchus contortus* (78%) Reproductive parameters in goats on farms were examined None of the farmers controlled breeding abortions were common (75%) and udder problems featured in 42% of farms Selection of breeding stock was based on visual appraisal Kidding interval averaged 10 months and twinning rates were low (12%) with a high survival rate (88%) Preweaning mortalities were very low Other aspects of the study included feed and water availability, livestock composition and herd structure and reasons for disposal of stock The most prevalent diseases included pneumonia, mange helminthiasis heartwater ectoparasitism (fleas and ticks) and orf The scope for genetic improvement of goats in Machang a is great Farmers require education on production and animal health aspects including ready access to veterinary services

Introduction

Indigenous goat strains and breeds are usually credited for their relatively high tolerance of or resistance to parasitic diseases and harsh environmental conditions including long walking distances, poor quality herbage and long watering intervals However these desirable attributes are usually accompanied by poor growth and carcass traits are usually negatively affected (Cartwright et al 1987 Ruvuna et al 1989)

The mechanisms of inheritance patterns of resistance to internal worms (particularly *Haemonchus*) are not yet fully understood (Bullerdieck 1989, Bain 1991) Also lacking are heritability estimates for resistance and its correlation with other growth, reproductive and dairy traits for indigenous goats in most parts of sub-Saharan Africa Research results of studies conducted locally indicate that considerable variation exists in growth prolificacy fertility, carcass traits and dairy characteristics as well as tolerance For example, Shavulimo (1989) in an artificial *Haemonchus* indoor challenge study, showed that the East African goat breed was more tolerant than the Galla However, some individual Galla goats were even more tolerant of the parasite than their East African contemporaries Ruvuna et al (1989) showed that some goat sires consistently imparted resistance to their offspring

The usefulness of the above observations can only be realised when large-scale characterisation is carried out and genetic parameters generated, showing clear genetic relationships among all traits of economic importance (Baker 1991) It is then that meaningful selection criteria can be set and genetic selection programmes initiated to realise the set improvement objectives

Long-term genetic studies that incorporate animal physiology health and nutrition studies have not often been carried out due to the absence of an inter-disciplinary approach to research, inconsistencies in research funding allocations or anticipation thereof, and lack of appropriate and accurate up to date technologies particularly laboratory supplies and expertise These deficiencies have resulted in research findings that give incomplete pictures either through lack of precision or depth

Inadequate nutrition coupled with high levels of parasite infestation contribute to high reproductive and productive wastage in small ruminant herds regardless of size and production system (Preston and Allonby 1979 ILCA 1988 ILCA 1989 ILCA 1990) Such wastage also slows down genetic progress as select on intensities are substantially reduced

Haemonchus is one of the major internal parasites of economic importance (Allonby 1974 Shavulimo 1989) Haemonchosis reduces productivity through reduced efficiency of nutrient utilisation and growth rate, in addition to mortalities which occur at severe infestation levels Conventional means of controlling

haemonchosis such as grazing management and use of anthelmintics, are either not feasible or ineffective for various reasons These reasons include the use of communally owned and grazed lands anthelmintics that are not only too expensive for an ordinary farmer but are also environmentally hazardous, and the continuous development of resistance to these chemicals by the parasites at rates difficult for new products development to keep pace with

New approaches and long-term alternatives to dealing with this problem include identifying tolerant or resistant individual animals within the local populations followed by efficient and extensive exploitation of such heritable merits in breeding programmes

In order to identify such resistant/tolerant individuals, well designed genetic and breeding experiments that incorporate other related physiological and nutritional aspects need to be conducted This project, through a multi-disciplinary approach aims to yield the much needed prerequisite results for the characterisation of the East African and Galla goat breeds

The objectives of this study are to

- determine and compare variation in infestation rates of endoparasites between and within the East African and Galla goat breeds
- establish the underlying mechanisms involved in resistance/tolerance
- establish the incidence predisposing factors and causes of pre-weaning mortality in goat flocks (the research flock and those of surrounding villages)
- develop economically feasible and versatile production packages for their recommendation to the regional stock keepers

Materials and methods

The main study will revolve around a breeding experiment design that is summarised below

		Females*		
Breed of goat	Males	Wet season	Dry season	Totals
East African	10	160 (10)	160 (10)	320 (20)
Galla	10	160 (10)	160 (10)	320 (20)
Total	20	320 (20)	320 (20)	640 (40)

* The figures in brackets indicate number of females left open as controls

The products of each season's mating will then be randomly subjected to various specific nutrition, artificial and natural helminthiasis challenges, and growth, carcass and reproductive performance measurements taken at both gross and tissue levels Offspring of sires that show differences in tolerance levels will be randomly assigned to all such treatments in order to provide correlation estimates among the different traits Individual animals that are at the extreme ends of the resistance scale and their progeny will further provide materials for molecular genetic studies To fortify the research data base parallel studies on the surrounding farmers flocks are being conducted The detailed protocols are described by Okeyo et al (1991)

Location and environment of the area surveyed

The survey was carried out in Machang a and Mavuria locations of Gachoka Division Embu District in Kenya Twenty-five farmers, each with at least a herd of 10 goats, were interviewed The study area lies in climatic ecozone 4 (arid and semi-arid lands) at an altitude of 700 m above sea level The average daily temperature is 28 C, with a mean annual rainfall of 650 mm, which follows a bimodal pattern The long rains are from October to December and the short rains from March to May The long rains are more reliable for cultivation of food crops

Endoparasite infestation profile

A pre-experimental observatory herd was introduced at the research station in Machang'a and the prevalence of helminthiasis in these goats over the different seasons of the years was monitored Comparative work on the farmers herds was done through a rapid survey of the surrounding farms in the Mavuria Location Seven goats died of heartwater from the Galla breeding herd newly introduced on the research station

Faecal egg counts (EPG) were recorded over various seasons and genera of the helminths identified Different tick species were also identified and their prevalence noted

Others

Land tenure feed and water availability disease prevalence and control animal husbandry practices and general livestock production systems were also addressed

Results and discussion

The preliminary results of the studies carried out so far are summarised in Tables 1 to 4 Eighty per cent of the farmers lived on individually owned land with the remaining 20% living on land owned by the local government (Embu Municipal Council) The acreage of the individually owned farms ranged from 4–37 acres, with an average of 11 acres per farmer

Grazing system, feed and water availability

The grazing system practised was mainly free range, while ensuring that the animals did not graze on cultivated land The grazing hours in the dry season ranged from 8–12 hours with an average of 10 hours In

the wet season this ranged from 8–10 hours with an average of 8 hours This is so because in the wet season feed is readily available and the animals do not need to walk too far for it Also during the wet season, most of the farmers have to work in the farms and hence have to cut down the hours they spend out grazing the animals

About 37 5% of the farmers said they supplemented their animals' diet This is done mainly in the dry season and the supplements given are acacia twigs and pods, and maize stover after harvesting the crop Most of the animals were watered in the seasonal rivers, streams, ponds and dams About 75% of these farmers experienced severe problems during the dry season as most watering points dried up and the animals had to be walked long distances to the existing water sources, such as River Thiba and dams (e g Kiambere dam) Stock numbers are drastically reduced during this period as a result of death by starvation exhaustion and disease

Livestock composition and herd structure

All farmers owned the East African goat breed with a mean of 25 goats per farmer with a range of 10–90 (Table 1) The mean goat herd structure was 4 entire males, 13 females and 8 kids

Most of the farmers identified their animals by ear-notching, one notch for the clan and one for the family Colour and physical characteristics were also used in identification Most of the farmers used visual appraisal and mental records to estimate ages and weights of their animals

Table 1 *The livestock species and average numbers kept by the local farmers*

Livestock species	Average numbers kept
Cattle	11
Sheep	7
Goats	25
Rabbits	4–6 Does
Poultry (chicken)	10–30
Bees	3–5 hives

Reproductive wastage and production performance levels

All the farmers reported that they did not control mating as the does graze together with the bucks Besides it is not uncommon to find several farmers' flocks grazing together There are two breeding seasons per year for the goats according to 80% of the farmers interviewed The age of the does at first kidding ranged from 10 to 24 months with an average of 12 months (Table 2)

Abortions occurred on 75% of the farms with a range of 3–30% of the herd affected The causes, according to the farmers, were poor nutrition during drought, poisoning by feeding on immature acacia pods, helminthiasis, injury during fights and poisoning by certain minerals

Forty-two per cent of the farmers reported that their does experienced udder problems which affected 4–25% of does in a herd The problems were mainly teat injuries, orf lesions and occasional abscesses but there was no clear-cut case of mastitis

On selection of breeding males and females, most of the farmers based their decision on growth rate of the animals, general physical characteristics such as body condition and coat colour, in addition to udder size and twinning rates in the case of females Other factors considered were lineage, strength of hind legs and length of ears The average age of males at time of selection for breeding was 8 months

The interval between kidding and the next service ranged from 2–8 months with an average of 4 months, while the kidding interval ranged from 6–12 months and averaged 10 months (Table 2)

The twinning rates ranged from 0–40% and averaged 12%, with an average of 88% of the twins surviving This survival depended entirely on feed availability at the time of birth Most farms experienced preweaning mortalities, with an average of 12 5% parturient deaths and 26% actual preweaning deaths (Table 2) The causes of the above deaths were, according to the farmers, diseases (46% of cases) mostly helminthiasis and flea infestation, poor nutrition especially during drought poor mothering and predation

Table 2 *The structure performance and health status of goat herds in Machang a and Mavuria areas Embu District Kenya*

Category	Number	AFK[1] (months)	Reproductive wastage (%)			Mortality rate (adults)*	ABR[2] (%)	KI[3] (mo)
			Abortions	Parturient	Preweaning			
Adult females	13	12 (10–24)	3–30	12 5	na	8	12(0–40)	10(6–12)
Bucks (entire)	4	na	na	–	na		na	na
Kids/weaners	8	na	na	–	26		na	na
Total	25	12	3–30	12 5	26	8	12	12

Figures in brackets indicate the ranges of values observed

1 AFK = age at first kidding

2 ABR = abortion rate

3 KI = kidding interval in months

* 46% of adult and kid mortalities were attributed to helminthiasis

na = data not available

by wild animals A few farmers did not know the causes of the deaths

Adult mortalities were also experienced in most of the farms with an average of two deaths during the previous year The major causes of these deaths were diseases such as hepatitis, helminthiasis, mange, pneumonia and in rare cases, trypanosomiasis

All the farmers disposed of does by either sale or exchange (20%) Five goats are equivalent to one cow The main reason for sale of animals was to generate income for school fees, buying food in times of famine and paying hospital bills Other reasons for sale were for destocking and culling Males were mainly culled (in 92% of the farms) for income generation and other reasons such as old age, replacement, infertility, sales for slaughter, destocking and selection against undesirable traits

Disease prevalence and control

The most prevalent diseases affecting goats according to the farmers are listed below

- Pneumonia *(mavuli)* Coughing, anorexia eye and nasal discharge
- Mange *(uvele)* Scratching, dandruff alopecia
- Helminthiasis *(danguru)* Emaciation, rough hair coat, diarrhoea
- Heartwater *(nduru)* Recumbency circling, uneasiness followed by death
- Ectoparasitism

  Fleas *(nthua)* Scratching, loss of condition

  Ticks *(ngova)*
- Orf *(meng e)* Pox lesions around nose and mouth
- Trypanosomiasis *(kamocu)* Wasting then death
- Foot rot *(mavungu)* Lameness

Most of the farmers interviewed said they did not have easy access to veterinary services, and a few used herbal medicine to try and treat the various diseases Hence most illnesses were fatal

However, 83% of these farmers routinely drenched their animals 2–3 times a year while a few only did so when they saw signs of helminthiasis in their animals such as diarrhoea, rough hair coat and presence of worms in faeces Most of the farmers used Wormicid Plus(R), a few used Nilzan(R), and 4% used herbs, for drenching their animals When asked how, in their opinion, livestock production could be improved in the area, the farmers gave the following general answers

1 Improved veterinary services to help in disease prevention and control and construction of dips etc
2 Improved extension services to provide advice on good husbandry practices and information on cross-breeding to upgrade existing stock
3 Improved nutrition of the animals e g by supplementation during the dry season
4 Provision of easily accessible watering points, by digging boreholes and dams

Helminthiasis

East African goats (pre experimental cleaning and observatory herd)

Faecal samples were taken from these goats in January and February 1994 and showed nil or low helminth egg count (range 0–800 EPG) These goats remained healthy during March through to April and started showing unthriftness in May (after end of rains) (Table 3) Faecal samples were taken on the first week of June and found to have high EPG Over 60% had EPG counts of over 1000 and the range was 0–4200 Pooled faecal samples were cultured and larvae identified Seventy-nine per cent of the larvae were *Haemonchus contortus* 12% *Trichostrongylus* spp and 9% *Ostertagia* Six goats had *Moniezia expansa* segments while most samples had coccidia oocysts (Table 4)

The goats were treated with Levamisole hydrochloride and they responded positively (i e recovered) They were healthy until the beginnning of the short rains in mid-October when they again began to show unthriftiness One goat showed submandibular oedema at this period of the year Although they had low EPG s (Table 3), they were still treated as this could have been because most worms were immature and had not started laying eggs Hypobiosis was also suspected since the pastures had not developed and the rainfall was not high enough to support development of infective larval stages in the pastures

From the results in Table 3 it is evident that the EPG s remained low upto the beginning of the rains after which there was an increase in the number of goats with high EPG counts There was a sudden increase in EPG with the rains, a factor which could have been due to hypobiosis

The worms identified showed that the species of major economic importance was *Haemonchus contortus* (Table 4) This worm is known to undergo hypobiosis in unfavourable weather It is also the most pathogenic and was responsible for the sudden unthriftiness observed in these goats with the onset of the rains

Galla goats

These were introduced at the end of August 1994 They were given time to adjust and faecal samples were taken on 14/10/94 The results are shown on Table 3 Pooled samples were cultured for larvae identification The majority were *Haemonchus* followed by *Tricho strongylus* spp and *Ostertagia* spp (Table 4)

Table 3 *The level of helminthiasis challenge in goats during the year at Machang a (on station)*

Month	Number sampled	EPGs[1]	Proportion of herd (%)	Remarks
January	34	0–100	81 0	67 0% (NIL)
	7	200–400	16 7	
	1	>400	3 3	2 42% (>800)
February	23	0–100	54 8	40 5% (NIL)
	15	200–400	35 8	
	4	>400	9 5	5% (>800)
June	7	0–100	14 9	2 1% (NIL)
	10	200–400	21 3	
	17	500–1000	25 5	
	18	>1000	38 3	21% (1800)
October[2]	61	0–100	80 2	56% (NIL)
	16	200–400	18 2	
	1	>400	1 2	2 3% (>900)

1 EPG = eggs per gramme of faecal sample

2 Only Galla goats sampled 1 5 months after introduction to the station

Table 4 *Prevalence (%) of gastro intestinal parasites by species*

Helminth (worm) species	Prevalence (%)[1]
Haemonchus contortus	79
Trichostrongylus sp	12
Ostertagia sp	9
Total	100

1 The percentages are based on actual larval counts following laboratory cultures

Conclusions

From the above observations the following conclusions can be drawn

- Goats form a major proportion of the stock owners' total livestock herds
- There is no organised genetic selection programme in place at stock owners' level
- Reproductive wastage due to various factors (abortions, parturient and preweaning mortalities late age at first kidding, long kidding intervals) is high among the farmers' herds
- Helminthiasis coupled with other opportunistic diseases such as pneumonia were the most common cause of mortalities among the herds
- *Haemonchus contortus* was the major intestinal parasite responsible for the observed helminthiasis
- Poor nutrition and ectoparasite (ticks and fleas) infestation in addition to others were responsible for the observed low productivity in goat herds at farm level
- The level of worm infestation and effect on the animals' health varied greatly depending on the prevailing weather conditions
- Individual animals carried different levels of worms and coped with the burden differently regardless of season of the year

Acknowledgement

The research work was funded by the African Small Ruminant Research Network (SRNET) of ILCA and the authors are grateful for the continued support

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Performances de reproduction et parasitisme gastro-intestinal chez les chèvres en exploitation et en station à Machang'a, dans le district d'Embu (Kenya)

Résumé

Un troupeau pre-experimental de petites chevres d'Afrique de l'Est a ete suivi a la station de recherche de Machang'a Pour les besoins de la comparaison, une enquête rapide a ete effectuee sur 25 exploitations du voisinage En station, des echantillons de feces ont ete preleves en janvier, fevrier et juin 1994 en vue de determiner le nombre d'oeufs par gramme (EPG) Faible (0–800) pour les deux premiers mois, celui ci augmentait, allant même jusqu'a atteindre le chiffre de 4200 en juin L espece d'helminthe la plus repandue etait *Haemonchus contortus* (78%) Il ressort de l'etude des performances de reproduction en milieu reel que les eleveurs contrôlaient la monte que les avortements etaient frequents (75%) et que des cas de mammites etaient enregistres dans 42% des exploitations La selection des reproducteurs etait basee sur une evaluation visuelle L intervalle entre mises bas etait de 10 mois, les taux de naissance gemellaire etaient faibles (12%) alors que ceux de survie etaient eleves (88%) et que les chiffres de mortalite avant sevrage etaient tres faibles Les autres parametres examines par cette etude etaient la disponibilite des aliments et de l eau, la composition et la structure des troupeaux et les raisons de la cession des animaux Les maladies les plus frequentes etaient la pneumonie, la gale, les helminthoses la cowdriose les ectoparasites (puces et tiques) et l echtyma contagieux Les possibilites d amelioration genetique de ces chevres sont elevees Les besoins identifies des paysans sont la formation aux techniques de production et de sante animales et l acces aux services veterinaires

Caractérisation génétique des caprins du Nord-Cameroun

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Résumé

Une caracterisation genetique des caprins basee sur l utilisation des profils genetiques visibles a ete menee sur un echantillon de 1081 animaux dans 28 sites au Nord-Cameroun Tous les patrons pigmentaires identifiés dans l'espece caprine ont ete rencontres dans la zone avec predominance de trois types phaeomelanique, sauvage et eumelanique, les phenotypes tache oculaire et eumelanique et feu etaient les plus faiblement representes Le type d'eumelanine est surtout noir ou illisible Un cinquieme de la population porte la barbiche, et les pampilles sont rares La longueur des cornes est tres variable et le type de cornage ne correspond à aucun de ceux deja decrits Les oreilles sont dressées horizontalement sans bouclure avec une faible representation des ports pedoncule et tombant Le pelage est generalement ras Les valeurs des indices de primarite etaient de 0,77 et 1,0 respectivement pour l'indice de primarite loci en segregation (IPs) et l'indice de primarite au locus agouti (IPa) Cela confirme que les caprins du Nord-Cameroun sont de type primaire L'analyse de la variance de la hauteur au garrot et des indices de gracilite et auriculaire n a montre aucune difference significative entre les sites De même, l'observation des histogrammes a revele l'existence d'une seule population dans la region consideree Cette population est de petite taille avec les valeurs moyennes suivantes HG = 48,6 cm, IGS = 0,87 et IAT =0,49 La grande variation de la taille permet de penser que celle-ci pourrait être augmentee a travers la selection d'animaux adaptes a leur milieu

Introduction

Le cheptel caprin des deux provinces septentrionales du Cameroun se chiffre a environ 1 500 000 têtes, ce qui represente pres de 55% du cheptel national C est la partie du pays qui compte le plus grand nombre de caprins Ceux-ci sont exploites de maniere extensive et la taille des troupeaux est tres variable Les populations caprines de cette region n ont pas encore ete genétiquement caracterisees Depuis quelques annees des efforts sont deployes pour la connaissance de leurs performances zootechniques Dans le cadre du Projet régional de recherche sur les petits ruminants, un inventaire des ressources genetiques a ete entrepris, un sondage rapide, portant sur un effectif reduit, réalise en 1992 par Lauvergne *et al* (1992) a permis d'etablir que la population caprine concernee est de type traditionnel ou primaire Le but de la presente etude est d'approfondir l'analyse genetique des populations de ces deux provinces, analyse basee sur le calcul de certains indices en rapport avec la variabilite exterieure Les objectifs specifiques sont la description phénotypique des populations, l estimation des indices de primarite de maniere a isoler des poches de standardisation, si elles existent, la mesure des hauteurs au garrot et des indices biometriques sur les sites et eventuellement une representation cartographique de tous ces paramètres pris individuellement

Matériel et méthodes

Echantillonnage

Cette etude devait être menee dans chaque Centre zootechnique et veterinaire (CZV) Les troupeaux et les animaux ont ete choisis en collaboration avec les chefs de ces centres charges de contacter les eleveurs de petits ruminants dans les villages relevant de leur ressort Les troupeaux ayant au moins une dizaine de têtes etaient retenus en priorite Le sondage se faisait chez l'eleveur, la taille de l'echantillon par site variait en fonction de la saison car en saison seche,il est difficile de rassembler les chevres laissees en divagation En revanche en saison pluvieuse elles sont attachees au piquet D'une maniere generale, le sondage a porte sur des femelles âgees d'environ 2 ans (au moins deux dents adultes) L utilisation des femelles de preférence aux mâles se justifie par le fait qu'elles passent un temps plus long dans les troupeaux alors que les mâles sont exploites a un âge relativement jeune Cependant, les mâles ont ete examines pour certains parametres tels que la forme des cornes

Protocole de recueil des données

Le profilage genetique a ete realisé a partir des normes etablies par Lauvergne et revisees en 1992 Celles-ci preconisent diverses echelles, notamment pour le cornage (Clutton-Brock, 1981), le patron colore, la

dentition, les panachures la longueur du pelage et le port de l'oreille Par ailleurs un certain nombre de phenotypes sont réperes en termes de presence/absence tandis que d'autres sont mesures

Les donnees sont recueillies a l aide d'une fiche de sondage qui permet de rassembler des informations sur le site, concernant le proprietaire et les differents parametres, au total 12 parametres sont observes et 10 mesures Les mesures ont ete effectuees a l'aide d'une canne-toise et d'un metre ruban Le sondage a ete realise dans 28 localites des deux provinces du Nord-Cameroun et sur un effectif de 1081 animaux

Définition des indices de primarité et des indices biométriques

Pour exprimer le premier stade d'évolution des populations apres la domestication, Lauvergne (1992) a propose l'utilisation de deux indices

- l'indice de primarite 'loci a effet visible en segregation" IPs Il a ete defini comme le rapport du nombre de loci a effet visible en segregation dans l'echantillon (ns) et du nombre total de loci a effet visible Ns identifies dans l espece il varie de 0 a 1
- l indice de primarite alleles au locus agouti IPa Soit Na le nombre total d'alleles en agouti consideres dans une population et na le nombre d'alleles identifies dans cette même population, l'indice de primarite alleles au locus agouti se definit comme suit

  IPa = (na-1)/(Na -1)

- l'indice de gracilite sous-sternal (IGS) rapport du vide sous-sternal sur la profondeur du thorax
- l'indice auriculaire thorax (IAT) longueur de l'oreille sur la profondeur du thorax Le choix de la profondeur du thorax au denominateur des indices biometriques est justifie par sa faible variation d'une population a l'autre et par le fait qu'il permet de s'affranchir des variations de la longueur des jambes

Méthode d'analyse

Une analyse de la variance a ete effectuee sur chacun des trois parametres Les donnees du sondage ont ete traitees sur logiciel SPSS

Résultats et discussion

Les resultats du sondage sont presentes aux tableaux 1 à 5 et aux figures 1 a 3

Profils phénotypiques

Le tableau 1 presente la repartition au locus agouti

Tableau 1 *Frequence des patrons pigmentaires*

Patrons pigmentaires	N	Frequence
Eumelanique	1	16 8
Taches oculaires	1	0 1
Eumélanique et feu	3	0 3
Eumélanique et feu ventre clair	36	3 3
Mantele anterieur	14	1 3
Mantelé posterieur	15	1 4
Chamoise	68	6 3
Sauvage	260	24 1
Phaeomelanique	336	31 1
Illisible	166	15,4

Tous les patrons pigmentaires identifies dans l'espece caprine ont ete rencontres dans la zone, trois sont cependant predominants et representent plus de 70% des caprins Ce sont, par ordre d'importance le phaeomelanique le sauvage et l'eumelanique, les phenotypes tache oculaire et eumelanique et feu etant extrêmement rares Mais la distribution de ces patrons varie d'une localite a l'autre Dans quelques troupeaux, tous les animaux avaient la même couleur pour les phenotypes phaeomelanique et tout blanc chez certains eleveurs surtout transhumants (Mbororo) Cette repartition est differente de celle obtenue lors du premier sondage dans lequel certains phenotypes etaient absents (Lauvergne *et al*, 1992) Elle montre egalement que plus l'echantillon est grand plus la probabilite de trouver tous les phenotypes est elevee Cette repartition est proche de celle de Grupetta *et al* (1988) qui, a Malte ont obtenu un pourcentage plus eleve de phaeomelaniques suivis des eumelaniques D autres auteurs (Dunner et Canon, 1988, Sadorge et Benadjaoud 1988) ont rapporte une predominance patrons phaeomelanique et eumelanique

Le tableau 2 presente la distribution des autres phenotypes visibles Le type d'eumelanine est soit noir soit illisible, le brun etant difficile a determiner Un resultat analogue avait deja ete obtenu lors du premier sondage L alteration pigmentaire foster caracterise par la presence de noisillures autour du museau et à la base des oreilles est presente dans 23% des cas L'alteration pigmentaire dite roan est presente dans plus de 40% de l'echantillon, 5% sont tout blancs Plus de 50% ont une tache blanche sur le patron On dit qu'ils ont une panachure ou une ceinture

Le port dresse horizontal est dominant, le port dresse vertical etant absent, les oreilles sont rarement bouclées (1,7% de caractere rencontre chez des animaux au port tombant ou pedoncule) Le variant oreille raccourcie (Audiot *et al*,1982) n'a pas encore ete observe

La corne est generalement de type illisible, sauf dans 11,7% de la population ou il s'apparente a l'ibex espagnol (Clutton-Brock, 1981) Aucun animal motte n a ete rencontre dans l'echantillon considere mais il existe un certain nombre d'animaux aux cornes courtes

qui n'ont pas ete mesurees car il etait difficile de savoir si celles-ci avaient ete coupees ou non Une tres faible proportion de la population (2%) porte des pampilles Ces observations sont differentes de celles faites dans le bassin mediterraneen et au Bresil ou se rencontre une plus forte représentation des animaux avec barbiche et pampille (Martres et Benadjaoud,1988, Franceschi et Santucci, 1988, Branca et Casu, 1988, Renieri *et al*,1988, Grupetta *et al*, 1988) Un cinquieme de la population porte une barbiche Les mêmes auteurs ont obtenu des pourcentages plus eleves pour la barbiche

Tableau 2 *Profil visible de la chevre du Nord Cameroun*

Caractere	Phenotype	Frequence (%)
Oreilles	dressé	92 9
port	pécondule	6 2
	tombant	0 9
bouclure	presence	0 7
	absence	98 3
Cornes	ibex	11 7
Type	autres	88 3
	présence	100
	absence	0
Pampilles	presence	2 0
	absence	98,0
Barbiche	presence	21 4
	absence	78 6
Poil	ras	97 4
	mi long	2 6
	long	0
Foster	presence	23 5
	absence	76 5
Eumelanine	noir	59 4
	brun	1 9
	illisible	38 7
Alteration	normal	52 3
	roan	42 1
	blanc	5 6
Panachure	presence	39 2
	absence	43 8
	illisible	17 2

Ces résultats sont plus proches de ceux de Zeuh et Bourzat (1993) au Tchad Le pelage est ras et rarement mi-long, aucun animal au pelage long n'a ete rencontre, on peut parler d'un debut de standardisation de ces parametres Ces observations sont totalement differentes de celles de Djorbineva *et al* (1988) qui ont observé une standardisation basee sur la longueur du poil

Indices de primarité

Les tableaux 3 et 4 resument les differents phénotypes en segregation par site utilises dans le calcul des indices de primarite

On observe une certaine variabilite d'un site a l'autre surtout pour l'indice de primarite au locus agouti mais en considerant toute la zone d'etude l'IPa = 1 ce qui traduit une grande variabilite et montre que tous les variants qui ont segrege depuis la domestication de l espece caprine sont presents dans la population du Nord-Cameroun On peut conclure que la population est de type primaire Pour l'indice de primarite des loci en segregation l absence de certains mutants tels que l'absence de cornes et oreilles reduites entraîne une valeur plus faible que celle de l IPA, elle est de 0,77 pour toute la population et varie d'un site a l'autre D'une maniere generale, aux effectifs reduits correspondent de faibles valeurs d'indices de primarite Les valeurs de ces indices sont comparables a ceux obtenus lors du premier sondage au Cameroun et au Tchad (Lauvergne *et al*, 1993) aussi bien dans le bassin mediterraneen qu'au Bresil

Données biométriques

Le tableau 5 presente les moyennes des donnees biometriques de l'echantillon L analyse de la variance de la hauteur au garrot, de la longueur des oreilles et des deux indices biometriques n'a révele aucune difference significative entre les sites La representation graphique des valeurs de ces parametres pris individuellement par des histogrammes (figures 1, 2 et 3) a revele l'existence d'une population normale de grande variabilite, ce qui confirme les resultats de l'analyse de la primarité Cette grande variabilite, qui se traduit par des indices de primarite eleves, offre de grandes possibilites d'amelioration genetique de ces especes, notamment a travers la selection et la creation de diverses races en fonction d'objectifs bien definis tant du point de vue phenotypique que productif

Ces resultats montrent que la chevre du Nord-Cameroun est une chevre de petite taille (hauteur au garrot 2 cm), ce qui est en accord avec les observations anterieures effectuées sur les chevres de la zone soudanienne La variabilite observee sur la hauteur au garrot (35 a 67 cm) permet de penser que la taille de ces chevres pourrait être augmentee grâce a la selection d animaux adaptes a leur milieu

Conclusion

Les caprins du Nord-Cameroun sont une population de type primaire au sein de laquelle il y a eu peu de selection Ce sont des animaux de petite taille avec une hauteur au garrot d environ 50 cm en moyenne de faible gracilite dont la longueur et le type de corne varient beaucoup, generalement sans pampilles, assez souvent barbus avec des oreilles au port dresse horizontal La couleur de la robe est variee et très souvent fauve avec ou sans raie dorsale, ou noire Les robes pies sont frequentes et on note une apparition d'animaux tout blancs Le pelage est souvent ras et quelquefois mi-long Ces resultats confirment les

Tableau 3 *Indice de primarite alleles au locus Agouti (Ipa) par site dans les populations caprines du Nord–Cameroun*

No des sites

PATRONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	42	21	13	19	98	9	21	65	40	34	82	24	10	25
Eumela	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Tac oc	0	0	0	0	0	0	1	0	0	0	0	0	0	0
E feu	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E fvc	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Man	0	0	1	1	1	0	1	0	1	1	1	0	0	0
Mpo	0	0	0	0	0	0	0	1	1	0	1	0	0	0
Cham	1	1	0	0	1	0	1	1	1	0	1	1	0	1
Sauv	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Phéo	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ILL	1	1	1	1	0	0	1	1	1	1	1	1	1	1
na	5	6	5	4	7	4	6	6	5	4	6	4	2	4
Na	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IPA	0 55	0 66	0 55	0 44	0 77	0 44	0 66	0 55	0 66	0 44	0 66	0 44	0 22	0 44

PATRONS	15	16	17	18	19	20	21	22	23	24	25	26	27	28	POP
	54	46	31	104	28	11	32	24	22	53	11	56	51	55	1081
Eumela	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tac oc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E feu	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1
E feu	1	0	0	1	0	0	0	1	1	1	0	0	1	1	1
Man	0	1	0	1	0	1	0	1	1	1	0	0	1	1	1
Mpo	1	0	0	0	1	0	0	1	0	1	0	1	1	1	1
Cham	1	1	1	1	1	0	0	1	1	0	0	1	1	1	1
Sauv	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1
Pheo	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1
ILL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
na	7	6	4	7	6	3	3	7	5	5	2	6	7	7	9
Na	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IPA	0,77	0,66	0 44	0,77	0 66	0 33	0 33	0,77	0 55	0 55	0 22	0 66	0,77	0 77	1

Eumela = Eumélanine
Tac oc = Tache oculaire
E fvc = Eumélanique et feu
Man = Mantelé antérieur
Mpo = Mantelé postérieur
Cham = Chamoisé
Sauv = Sauvage
Phéo = Phaeomélanique
ill = illisible
na = Nombre d allèles présents
Na = Nombre d allèles existants
Ipa = Indice de primarité locus agouti

Tableau 4 *Indice de primarite loci a effet visible en segregation par site dans les populations caprines du Nord–Cameroun*

No des Sites et effectifs

Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Nums	42	21	13	19	98	9	21	65	40	34	82	24	10	25
Agouti	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Eumela	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Roan	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Prosting	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Board	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ear length	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ear car	1	1	0	1	1	0	1	0	1	1	1	1	0	0
Ear cur	1	0	0	0	1	0	1	0	0	1	1	1	0	0
Polled	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Horms Rd	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Hair L	1	1	0	0	1	0	0	0	1	0	1	0	0	1
Wattles	0	0	0	1	1	0	1	1	0	1	1	0	0	0
Sporting	1	1	1	1	1	1	1	1	1	1	1	1	1	1
na	9	8	6	8	10	6	9	7	9	9	10	8	5	7
NS	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Ipa	0 69	0,61	0 46	0 61	0 77	0 46	0,69	0 53	0 69	0,69	0 77	0,61	0 38	0 53

Level	15	16	17	18	19	20	21	22	23	24	25	26	27	28	POP
Nums	54	46	31	104	28	11	32	24	22	53	11	56	51	55	1081
Agouti	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Eumela	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Roan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Prosting	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Board	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ear length	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ear car	0	1	1	1	0	1	1	0	1	0	0	1	0	0	1
Ear cur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Horms Rd	1	0	0	0	1	0	1	1	0	0	1	0	0	1	1
Hair L	0	1	0	0	1	0	0	0	1	1	1	0	0	0	1
Wattles	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sporting	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
na	7	9	7	9	6	7	9	7	8	7	8	8	6	7	10
NS	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Ipa	0 53	0 69	0 53	0 69	0 46	0 53	0 69	0 53	0 61	0 53	0 61	0 61	0 48	0 53	0 53

Eumela = Eumélanine
Ear car = Ear camage
Ear cur = Ear curling
Homs RD = Homs reduction
Hair L = Hair length
ns = Nombre de loci présents
NS = Nombre de loci en segregation
IPS = Indice de primarite loci en segregation
Pheo = Phaeomélanique
ill = illisible
na = Nombre d alleles presents
Na = Nombre d alleles existants
Ipa = Indice de primarité locus agouti

observations d'autres auteurs notamment le fait que les caprins de la région soudanienne sont de petite taille L'absence de quelques caracteres tels que le poil long, l'absence de cornes et les oreilles réduites peuvent s'expliquer par la taille de l'echantillon Il est necessaire d'accroître les effectifs pour augmenter la possibilite de représentation des allèles de faible fréquence Le degre de primarité élevé traduit de grandes potentialites pour la création de diverses races Cette etude se poursuit dans la province de l'extrême-nord située en zone sahelo-soudanienne

Tableau 5 *Quelques parametres biometriques*

Paramètres	Moyenne	E T
Hauteur au garrot	48 62	4 70
Profondeur du thorax	26 30	2 97
Longueur de l oreille		12,66
IGS	0 87	0 21
IAT	0 49	0 0

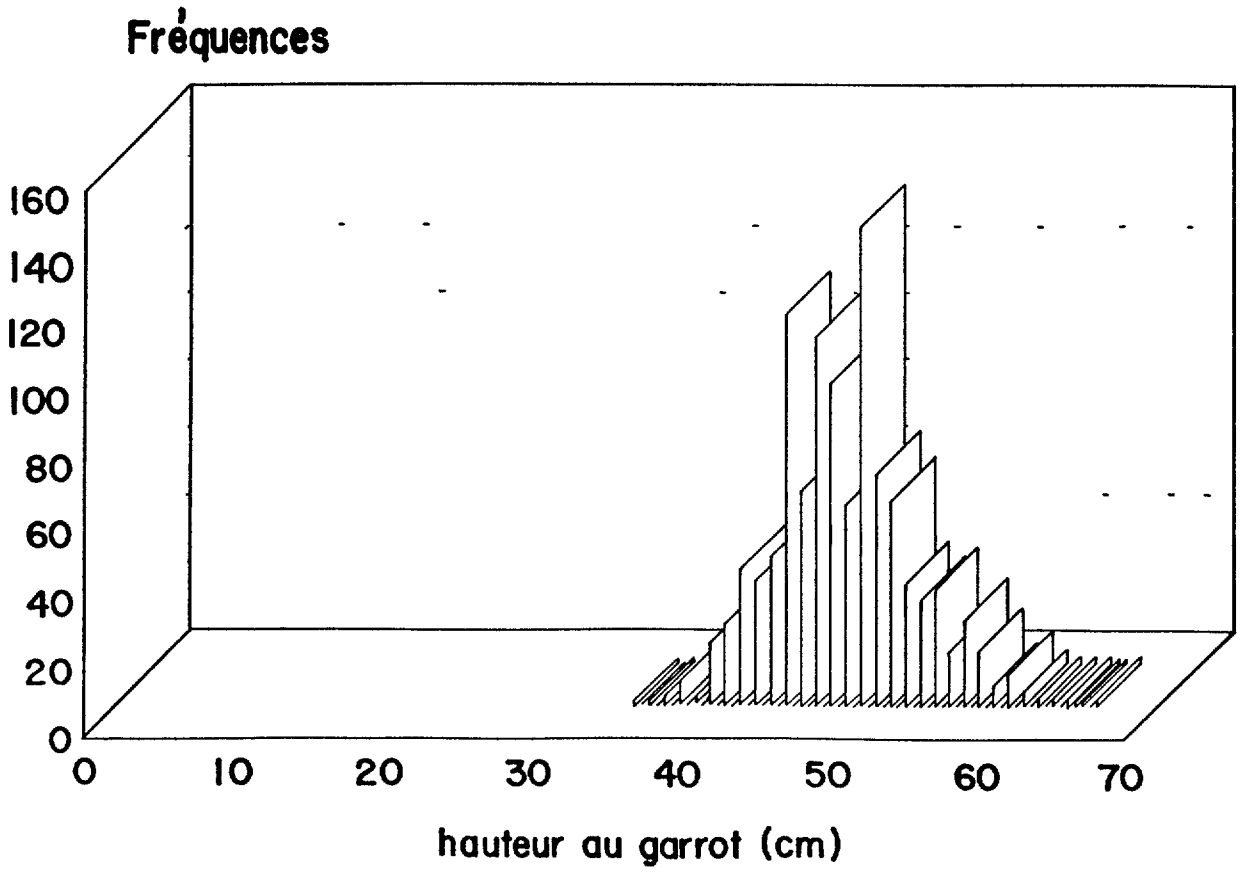

Figure 1 *Histogramme de la hauteur au garrot des chevres du Nord Cameroun*

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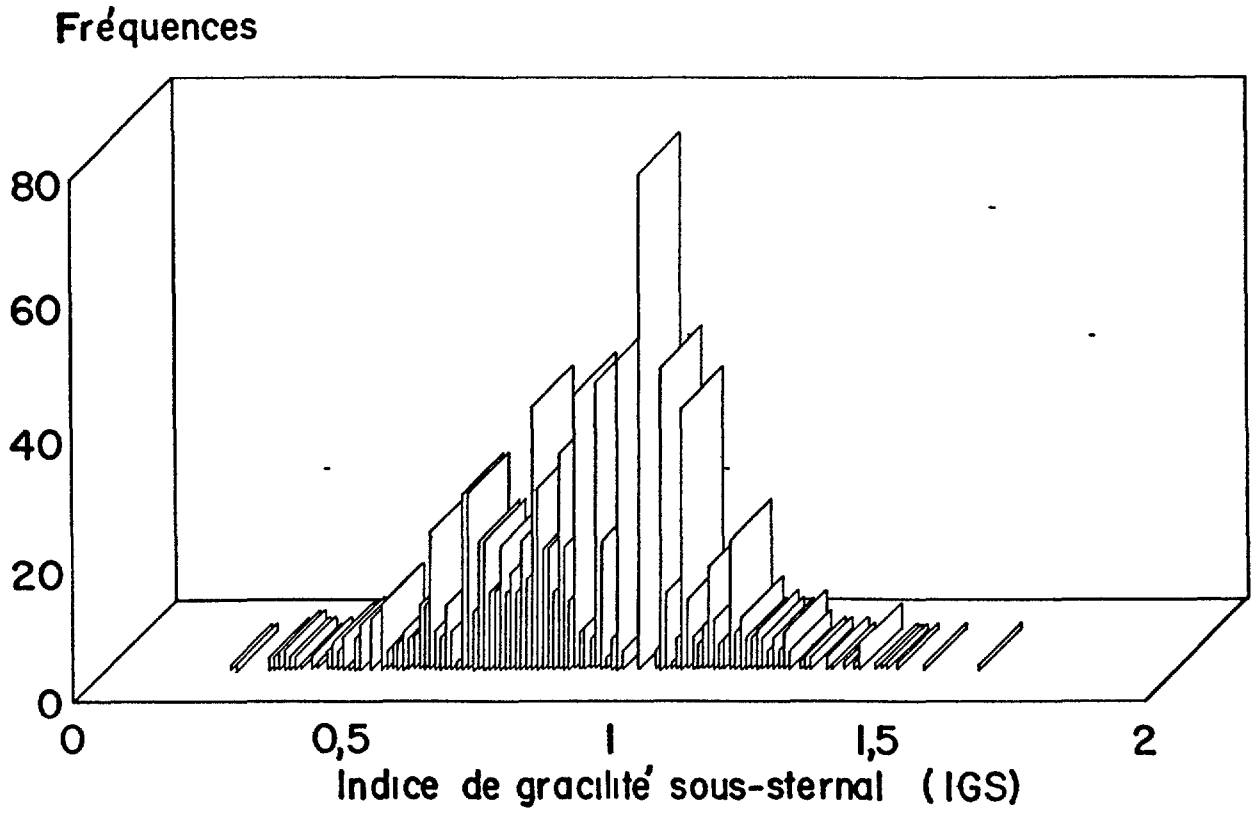

Figure 2 *Histogramme de l indice de gracilite sous sternal (IGS) des chevres du Nord Cameroun*

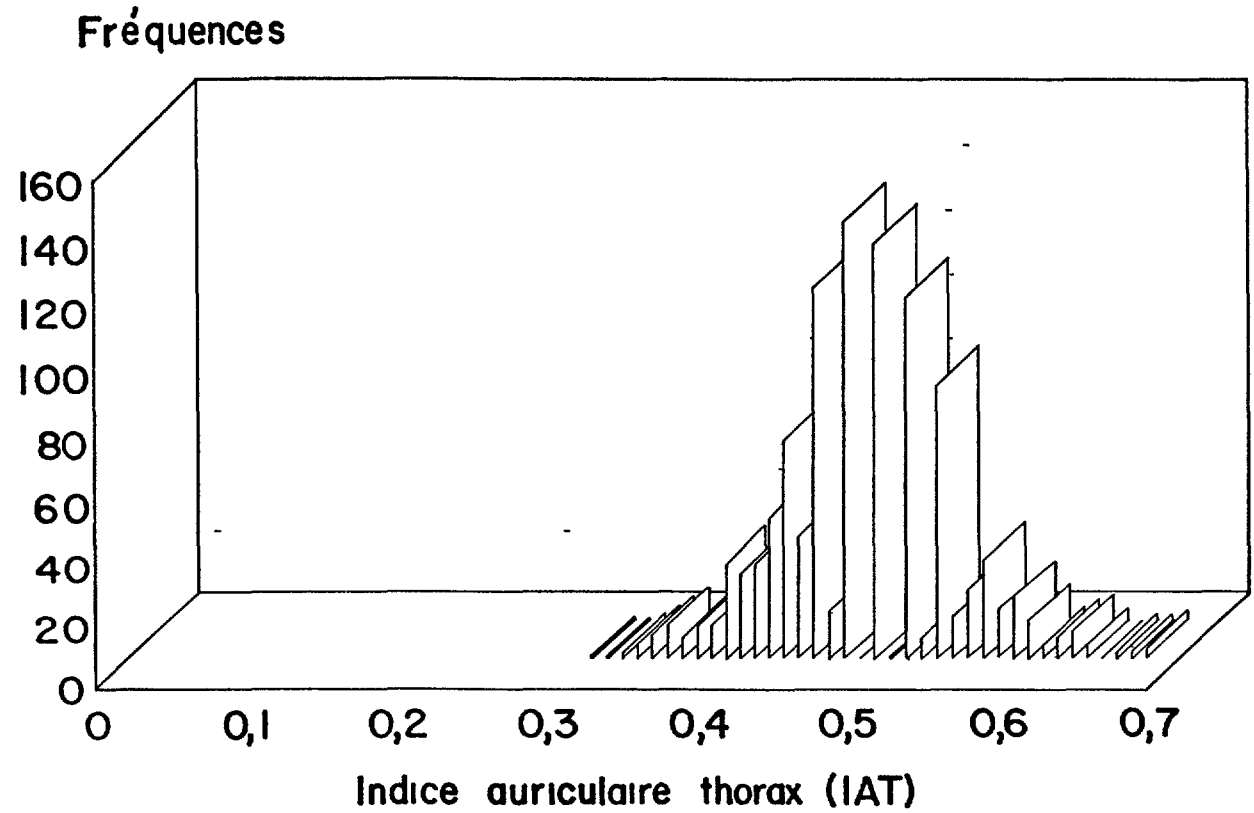

Figure 3 *Histogramme des indices auriculaires thorax des chevres du Nord Cameroun*

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Genetic characterisation of northern Cameroon goats

Abstract

Genetic characterisation of goats based on visible genetic profiles was carried out on 1081 animals at 28 sites in northern Cameroon All colour patterns identified in goat species were found in the area although three of them, namely golden, wild and brown were the most common Phenotypes such as eye spots and brown and red were rare The brown type was either black or mixed A goatee was found in one-fifth of the population and wattles were rare Horn length was variable and horn type was different from the types described so far Ears were of a horizontal upright type without buckle, while pedunculated and drooping types were rare Hair was generally short Primarity indexes were 0 77 and 1 0 for segregation locus primarity index (IPs) and agouti locus primarity index, respectively This confirms that goats in northern Cameroon are of a primary type Analysis of variance for height at withers and slenderness and auricular indexes showed no significant differences between sites A study of bar charts revealed that there was only one goat population in the study area The goats in that population are short with a mean height at withers (HG) of 48 6 cm, an average substernum slenderness index of 0 87 and a mean auricular thorax index of 0 49 Given the large variability in height, it should be possible to increase this parameter through selection of animals adapted to this environment

Phenotypic and genetic parameters of growth traits of Blended goats at Malya, Tanzania

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Abstract

Twenty-five year (1965–89) data on the Blended goats from Malya Research Centre totalling 4799 records were analysed for live weights and growth traits from birth to 72 weeks of age The Blended goat developed in Malya, Tanzania, is a stabilised three-way cross of the Kamorai (55%), Boer (30%) and indigenous (15%) goats Birth weight and weaning weight (16 weeks) averaged 2 47±0 02 kg and 11 14±0 15 kg, respectively Live weights at 24, 48 and 72 weeks of age averaged 12 47±0 26 kg, 16 42±0 32 kg and 25 80±0 43 kg, respectively Average daily gain from birth to weaning, and to 24, 48 and 72 weeks of age averaged 80 0±1 0 g, 59±2 g, 41±1 g and 46±1 g, respectively Year of birth, sex of kid and type of birth significantly (P<0 001) affected birth weight, weaning weight and live weight at 24, 48 and 72 weeks of age Season of birth significantly (P<0 01) affected birth weight and live weight at 48 and 72 weeks of age Age of dam significantly (P<0 01) affected birth weight and weight at 48 weeks of age Heritability estimates for birth weight, weaning weight and weight at 24 weeks were 0 0151±0 036, 0 099±0 39 and 0 0148±0 053, respectively Repeatability estimates for birth weight, weaning weight and weights at 24, 48 and 72 weeks of age were 0 202±0 18, 0 187±0 22, 0 533±0 022 0 016±0 035 and 0 174±0 38 respectively

Introduction

Genetic improvement is an integral part of many goat development programmes in the tropics where breeding policies mostly aim to upgrade local goats by crossbreeding with either temperate or tropical exotic breeds (Lavaraj and Gore 1987 Schmidt 1991) Selective breeding utilising the variability within a population to upgrade that population, is less often a part of such programmes This is due to easy availability of apparently superior stock from elsewhere, and due to difficulties in running field-based performance recording Where local goat breeds are involved the flocks are mainly kept in institutional farms in which low numbers of animals and management constraints limit selection intensity and genetic progress (Devendra and Burns 1983) The potential for genetic improvement is largely dependent on the heritability of the trait and its genetic relationship with other traits of economic importance upon which some selection pressure may be applied Information on heritabilities is essential for planning efficient breeding programmes, and for predicting response to selection

In Tanzania Blended goats are kept mainly for meat production Thus, traits affecting economic viability include those associated with growth Body weight and rate of gain are among the most economically important and easily measured traits of meat animals Although weight is an important objective in selection, knowledge of the phenotypic and genetic parameters of the growth trait upon which to base selection is of utmost importance Genetic and phenotypic parameter estimates are scarce in goats reared under Tanzanian conditions and where such information is available, analytical methods used tend to be inadequate The purpose of this study was to estimate phenotypic and genetic parameters of growth traits in a flock of Blended goats at various stages of growth from birth to 72 weeks of age

Materials and methods

Blended goats are three-way crosses (55% Kamorai, 30% Boer and 15% indigenous), developed at Malya, Tanzania, which were stabilised in late 1960s (Das 1989) Phenotypically, they have large pendulous ears and resemble Anglo-Nubians The records of Blended goats used in this study were collected from Livestock Research Centre Malya which lies at approximately 4 S latitude and 37 S longitude and at an altitude of about 1050 metres above sea level The centre covers an area of 1800 ha of which 1400 ha have natural vegetation of savannah grassland The natural vegetation at Malya comprises *Combretum* wood species and grass species of *Bothriochloa Hyparrhenia Themeda* and *Cynodon* types, a few paddocks are sown to *Chloris gayana* At the centre goats were grazed from 0800 to 1700 hours and were housed indoors at night

Breeding of goats was done in the wet and dry seasons The wet breeding season extended from March to May, while the dry breeding season extended from September to November Lambs were ear-tagged soon

after birth and left to suckle their dams during grazing until weaning at 16 weeks of age Kids were separated by sex at weaning into different weaner flocks Records taken on lambs included birth and weaning weights and weights at 24 48 and 72 weeks of age

Statistical analysis

The 4799 records used in the analyses were collected over 25 years (1965–89) at Livestock Research Centre, Malya The records included weight records from birth to 72 weeks of age The analyses were carried out by fixed effects models using the General Linear Model (GLM) procedure of SAS (1987) The fixed effects included in the model were year and season of birth, sex of kid, type of birth and age of dam The residual mean square was used as the error term to test the significance of all differences evaluated among classes Where analysis of variance depicted significant differences for variables, linear contrasts of least squares means were estimated to test pair-wise differences within factors Heritability and repeatability estimates were computed by the method of paternal half-sib analysis using VARCOMP procedures of SAS (1987)

Results and discussion

Live weight

Overall least squares means of birth and weaning weights were 2 47±0 02 kg and 11 14±0 15 kg respectively, (Table 1) Overall live weights at the age of 24, 48 and 72 weeks were 12 48±0 26 kg, 16 42±0 35 kg and 25 80±0 44 kg, respectively, (Table 2) Year of birth, sex, type of birth and age of dam significantly affected birth and weaning weight Season of birth significantly affected birth weight but was not significant for weaning weight Weights at birth and weaning tended to increase from 1965 to 1975 and thereafter tended to decline However weaning weight showed a small recovery in 1987 Live weights at all ages in the present study are higher than those reported earlier by Das (1989) on Blended goats at the same location when data from four years were analysed

Year of birth, sex and type of birth significantly affected the post-weaning weights at 24, 48 and 72 weeks of age Season of birth was significant for live weights at 48 and 72 weeks but not for live weight at 24 weeks of age Age of dam had significant effects on live weight at 24 and 48 weeks of age but had no effect on live weight at 72 weeks of age Post weaning weights tended to increase from 1965 to 1976 and thereafter declined, in some years, to below the live weight at 1965

The high variation in both pre weaning and post weaning weights due to year of birth can be explained by variations in amount of annual rainfall which in turn influenced pasture production and availability of feed Kids, prior to weaning depend mainly on dam s milk as food, the production of which is directly related to the availability of feeds to does (Peart 1982 Mukundan and Bhat 1983, Groot et al 1993) Seasonal influence on birth weight operates through its effect on the dam's uterine environment mostly in late gestation (Eltawil et al 1970) Season of birth plays an important role in growth performance indirectly through its influence on the dam s nutrition and hence amount of milk available to the unweaned lamb In the post-weaning period its influence is related to its effect on the quality and quantity of pasture available to the weaned kids

Birth weight and live weight at all ages were significantly affected by type of birth in the present study Generally birth weight decreased with increase in litter size Robinson et al (1977) reported that for lambs *in utero*, as the number of foetuses increases, the number of caruncles attached to each foetus decreases, thus reducing the feed supply to the foetus and hence reduction in the birth weight of the lambs

In this study, males were significantly heavier and grew faster from weaning onward, implying that sex effects are more pronounced with age after puberty These have been attributed to hormonal differences between sexes and their resultant effects on growth (Bell et al 1970)

Weaning weight would reflect mothering ability of dam as well as the inherent growth potential Thereafter growth potential would predominate Age of dam was found to have a non significant effect on live weight at 72 weeks of age only, showing that the mothering ability of does had carried over effect up to 48 weeks of age Wilson (1987) found that the effect of age of dam was significant on birth weight and growth rate at pre-weaning and that young ewes tend to produce smaller progenies at birth It is generally known that mothering ability, especially milk production, increases with parity Older ewes are larger in body and tend to be better milkers (Stobart et al 1986) The effect of parity of dam on kids is thus imparted as maternal influence whose direct influence is limited to the nursing period

Growth—average daily gain

Overall average daily gain from birth to weaning and to 24 48 and 72 weeks of age were 77±1 3 g, 59±1 5 g, 41±1 0 g and 46±1 0 g respectively (Table 3) Year of birth, sex, and type of birth significantly affected average daily gain from birth to 72 weeks of age Season of birth had no significant effect on average daily gain except at 48 weeks of age Age of dam had significant effect on average daily gain up to 48 weeks of age Growth of kids tended to increase from year 1965 to 1976 and thereafter declined

It is generally recognised that the early post natal phase of growth in goats is a critical stage because this is the stage when there is little maternal protection and the kid is exposed to environmental stress which limits rate of growth The rate of growth of a kid after weaning however is partly determined by the genetic potential of the kid and the level of environmental influence, especially during the immediate post-weaning stage Pre weaning growth rate was lower than the 94 3 g per day reported by Das and Sendalo (1990) for Blended

Table 1 *Least squares means of birth and weaning weight of blended goat kids at LRC Malya*

	Birth weight (kg)			Weaning weight (kg)		
Factor	N	Mean	SE	N	Mean	SE
Overall	3691	2 47	0 02	2745	11 14	0 15
Year of birth		(0 0001)			(0 0001)	
1965	36	2 48	0 08	17	10 41	0 61
1966	80	2 36	0 05	54	10 58	0 35
1967	47	2 39	0 07	29	9 60	0 49
1968	50	2 62	0 07	29	11 61	0 48
1969	135	2 56	0 05	97	12 28	0 31
1970	105	2 51	0 05	69	11 18	0 34
1971	225	2 42	0 04	173	10 81	0 23
1972	92	3 01	0 06	69	13 00	0 35
1973	161	2 58	0 04	82	11 25	0 30
1974	211	2 57	0 04	139	12 06	0 28
1975	161	2 59	0 05	106	14 38	0 30
1976	241	2 80	0 04	167	13 60	0 26
1977	185	2 63	0 04	156	11 03	0 27
1978	308	2 76	0 04	165	11 37	0 27
1979	202	2 57	0 04	174	10 13	0 25
1980	188	2 44	0 04	180	10 13	0 26
1981	132	2 35	0 05	103	9 46	0 30
1982	196	2 38	0 04	130	9 99	0 27
1983	176	2 27	0 04	163	10 22	0 26
1984	192	2 34	0 04	133	9 82	0 21
1985	122	2 21	0 05	113	10 00	0 30
1986	99	2 13	0 06	92	11 11	0 32
1987	111	2 32	0 05	106	13 70	0 30
1988	134	2 19	0 05	113	9 71	0 30
1989	102	2 36	0 05	86	11 09	0 32
Season of birth		(0 0001)			(0 5438)	
Dry	607	2 39	0 03	450	11 07	0 23
Wet	3084	2 55	0 02	2295	11 25	0 15
Sex		(0 0001)			(0 0001)	
Female	1814	2 37	0 02	1344	10 58	0 16
Male	1877	2 57	0 02	1401	11 70	0 16
Type of birth		(0 0001)			(0 0001)	
Single	2070	2 66	0 02	1567	12 44	0 16
Twin	1621	2 29	0 02	1178	0 16	0 16
Age of dam (years)		(0 0001)			(0 0001)	
<2	17	2 51	0 12	9	12 90	0 80
2+–3	328	2 35	0 03	246	10 16	0 18
3+–4	1063	2 38	0 02	751	0 12	0 12
4+–5	752	2 49	0 02	573	0 14	0 14
5+–6	618	2 53	0 02	475	11 23	0 15
>6	913	2 57	0 02	691	11 15	0 13

SE denotes standard error

kids at Malya Blended goat kids in the present study had higher average daily gain compared to that of Black Bengal goats reported by Singh et al (1983) and Black Bengal x Beetal crossbred goats reported by Kanaujia et al (1986) The mean overall post-weaning growth rate was higher than that reported by Reynolds (1989) for West African Dwarf goats in Nigeria

In the present study single born and male kids grew faster than twin born and female kids It would seem that birth type effects are commonly observed at pasture (Beischer et al 1992) and it is so mainly because of competition for the limited supply of doe milk This is supported by Norton and Banda (1993) who found no

Table 2 *Least square mean weight (kg) of Blended goat kids at 24 48 and 72 weeks of age LRC Malya*

	24 weeks			48 weeks			72 weeks		
Factor	N	Mean	SE	N	Mean	SE	N	Mean	SE
Overall	2011	12 48	0 26	1573	16 42	0 35	1401	25 80	0 44
Year of birth		(0 0001)			(0 0001)			(0 0001)	
1965	11	10 09	1 03	8	15 65	1 25	8	23 22	1 54
1966	37	12 62	0 57	27	17 43	0 70	21	25 01	0 96
1967	18	13 64	0 83	13	16 60	1 02	10	25 67	1 40
1968	16	13 76	0 89	12	17 55	1 07	9	31 20	1 50
1969	37	13 99	0 63	30	18 56	0 75	28	27 20	0 95
1970	30	12 77	0 67	26	16 25	0 76	23	25 24	0 98
1971	88	11 55	0 42	67	15 6	0 52	57	24 74	0 68
1972	35	11 93	0 66	28	18 15	0 78	21	26 86	1 08
1973	36	13 37	0 61	28	16 89	0 72	25	25 84	0 92
1974	83	13 02	0 48	55	18 23	0 62	140	29 56	0 63
1975	137	15 78	0 43	143	19 71	0 50	92	29 46	0 68
1976	182	14 89	0 40	184	16 39	0 48	131	24 67	0 63
1977	40	16 33	0 62	41	15 61	0 68	36	26 57	0 87
1978	65	13 13	0 52	63	15 82	0 60	98	25 25	0 67
1979	144	11 29	0 41	43	14 92	0 66	53	23 95	0 77
1980	172	11 58	0 40	121	14 22	0 51	81	23 82	0 66
1981	58	10 55	0 54	100	15 17	0 53	84	24 76	0 69
1982	145	10 66	0 41	123	13 12	0 50	85	23 95	0 67
1983	140	11 68	0 41	88	14 31	0 54	70	24 26	0 71
1984	76	12 37	0 49	56	16 89	0 61	56	28 27	0 76
1985	96	9 98	0 47	85	13 14	0 56	79	22 45	0 71
1986	93	12 80	0 47	83	18 59	0 56	48	25 26	0 80
1987	99	12 79	0 45	62	18 71	0 59	54	23 37	0 77
1988	104	9 95	0 45	79	16 63	0 57	75	28 73	0 72
1989	69	11 35	0 50	–			–		
Season of birth		(0 7374)			(0 0024)			(0 0090)	
Wet	1708	12 55	0 41	1397	17 26	0 34	1244	26 76	0 42
Dry	303	12 40	0 25	176	15 59	0 53	157	24 85	0 69
Sex		(0 00001)			(0 001)			(0 0001)	
Female	1005	11 77	0 27	820	15 17	0 36	774	23 74	0 45
Male	1006	13 18	0 27	753	17 68	0 37	627	27 87	0 46
Type of birth			(0 0001)			(0 0001)			(0 0001)
Single	1189	13 43	0 27	927	17 58	0 36	801	26 95	0 45
Twin	822	11 53	0 28	646	15 26	0 37	600	24 66	0 46
Age of dam		(0 001)			(0 0019)			(0 1386)	
<2	6	11 49	1 32	3	13 41	1 84	3	23 71	2 26
2+–3	178	12 12	0 29	132	16 23	0 36	119	25 45	0 46
3+–4	541	12 27	0 21	431	16 82	0 26	357	26 09	0 34
4+–5	393	12 61	0 23	313	17 04	0 29	301	26 58	0 37
5+–6	381	13 50	0 23	295	17 61	0 29	248	26 41	0 38
>6	512	12 87	0 22	399	17 42	0 27	373	26 69	0 36

SE denotes standard error

differences in growth between single and twin born kids when subjected to artificial rearing of the kids

Genetic parameters

The heritability and repeatability estimates for live weight and growth rates are presented in Table 4 Heritability estimates obtained in this study were moderate to low for live weights and average daily gain, ranging from 0 099±0 039 for live weight at weaning to 0 153±0 053 for average daily gain from birth to 24 weeks of age Repeatability estimates ranged from 0 004±0 035 for average daily gain from birth to 48 weeks of age to 0 534±0 022 for average daily gain from birth to 24 weeks of age

The heritability estimates in the present study are within the range reported for meat goats by Singh et al (1993) whose heritability estimates for body weights ranged from 0 144±0 149 for 12 months weight to 0 360±0 110 for 6 months weight Heritability for 3 and 9 months weight was calculated as 0 330±0 110 and 0 295±0 107, respectively Roy et al (1989) working on Jamunapari kids raised under semi intensive conditions reported that heritability of body weights at 3 and 12 months were 0 432±0 152 to 0 127±0 116, respectively

Table 3 *Least squares means for average daily gains (g) from birth to weaning and advanced ages of blended goat kid at LRS Malya*

	Weaning			24 weeks			48 weeks			72 weeks		
Factor	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Overall	2745	77	1 3	2011	59	1 5	1573	41	1 0	1401	46	1 0
		(0 0001)			(0 0001)			(0 0001)			(0 0001)	
Year of birth												
1965	17	69	5 2	11	45	6 1	8	39	3 7	8	41	2 9
1966	54	73	3 0	37	61	3 4	27	45	2 0	21	45	1 8
1967	29	64	4 0	18	67	4 9	13	42	2 9	10	46	2 7
1968	29	79	4 0	16	6	5 2	12	44	3 1	9	57	2 9
1969	97	87	2 7	37	68	3 7	30	47	2 1	28	49	1 8
1970	69	77	2 9	30	61	3 9	26	41	2 2	23	45	1 9
1971	173	75	2 0	88	54	2 5	67	39	1 5	57	44	1 3
1972	69	89	3 0	35	53	3 8	28	45	2 3	21	47	2 1
1973	82	77	2 6	36	65	3 6	28	42	2 1	25	46	1 8
1974	139	84	2 3	83	62	2 8	55	47	1 8	140	53	1 2
1975	106	105	2 6	137	78	2 5	143	51	1 5	93	53	1 3
1976	167	96	2 2	182	72	2 3	184	40	1 4	131	43	1 2
1977	156	74	2 3	40	81	3 6	41	38	2 0	36	47	1 7
1978	165	76	2 3	65	62	3 1	63	39	1 7	98	45	1 3
1979	174	67	2 2	144	52	2 4	43	37	1 9	53	43	1 5
1980	180	68	2 2	172	54	2 4	121	35	1 5	98	42	1 3
1981	103	63	2 6	58	49	3 2	108	38	1 5	84	45	1 3
1982	130	67	2 3	145	49	2 4	123	32	1 5	85	43	1 3
1983	163	71	2 2	140	56	2 4	88	36	1 6	70	44	1 4
1984	133	67	2 4	76	60	2 9	56	43	1 8	56	51	1 5
1985	113	69	2 5	96	46	2 8	85	33	1 6	79	40	1 3
1986	92	80	2 7	93	63	2 8	83	49	1 6	48	46	1 6
1987	106	101	2 5	99	62	2 7	62	49	1 7	54	42	1 5
1988	113	67	2 5	104	46	2 7	79	43	1 7	75	53	1 4
1989	86	78	2 7	69	54	2 9	–	–		–	–	
		(0 8839)			(0 5140)			(0 0072)			(0 0197)	
Season												
Dry	450	77	2 0	303	60	2 4	176	39	1 6	157	45	1 3
Wet	2295	77	1 3	1708	58	1 5	1397	44	0 9	1244	48	0 8
		(0 0001)		(0 0001)				(0 0001)			(0 0001)	
Sex												
Female	1344	73	1 4	1005	56	1 6	820	38	1 0	774	42	0 9
Male	1401	81	1 4	1006	63	1 6	753	45	1 1	627	50	0 9
		(0 0001)			(0 0001)			(0 0001)			(0 0001)	
Type of birth												
Single	1567	87	1 4	1189	64	1 6	927	44	1 0	801	48	0 9
Twin	1178	67	1 4	822	55	1 6	646	49	1 1	600	44	0 9
		(0 0001)			(0 0001)			(0 0096)			(0 3040)	
Age of dam												
<2	9	92	6 9	6	53	7 7	3	32	5 4	3	42	4 3
2+–3	246	69	1 5	178	58	1 7	132	41	1 0	119	46	0 9
3+–4	751	72	1 0	541	59	1 2	431	43	0 8	357	47	0 7
4+–5	573	75	1 2	393	60	1 4	313	43	0 8	301	48	0 7
5+–6	475	77	1 2	381	65	1 4	295	45	0 9	248	47	0 7
>6	691	76	1 1	512	61	1 3	399	44	0 8	373	48	0 6

SE denotes standard error

Table 4 *Heritability and repeatability estimates of live weight and growth traits of Blended goat kids at LRC Malya*

Trait	Heritability estimates	Repeatability estimates
Birth weight	0 151±0 036	0 202±0 018
Weaning weight	0 099±0 039	0 187±0 022
Weight at 24 weeks	0 148±0 053	0 533±0 022
Weight at 48 weeks	–	0 016±0 035
Weight at 72 weeks	–	0 188±0 038
ADG[1] up to weaning	0 100±0 039	0 171±0 022
ADG up to 24 weeks	0 153±0 053	0 534±0 022
ADG up to 48 weeks	–	0 004±0 035
ADG up to 72 weeks	–	0 174±0 038

1 ADG = average daily gain

It is clear from the present and other results that post-weaning growth generally has higher heritability estimates than pre weaning growth This would indicate that environmental factors in relation to additive genetic factors had more influence on early kid gains than on gains later in the kid s life This may be attributed to the high maternal influence associated with kid growth performance early in life High maternal influence has a tendency to increase the component of variance environmental to the lamb thereby lowering heritability estimates (Thrift et al 1973) One could concentrate on traits with high heritability as long as there exists a high positive correlation with other traits of economic value

The moderately higher heritability estimates for 24 weeks live weight and gain in this study indicate that to select kids for their own genetic merit for weights and gains, it would be best to use body weight at 6 months of age as the selection criterion rather than weaning weight as is often practised The 6 months liveweight gain should be superior to weaning weight and pre-weaning growth rate since it is much less influenced by maternal effects which tend to obscure the direct additive genetic effect for growth Selection directed towards weights at later ages would maximise response in birth weight and possible increased frequency of dystocia (Thrift et al 1967, Olson et al 1976, Martin et al 1980) However, selection for weights at later ages would be expected to lead to increased yearling weights which is desirable for meat animals, but may be associated with increased maintenance costs for breeding animals

Conclusion

The present results on live weights and growth rates of Blended goats indicate that in order to improve breeding value selection must be based on genotypic rather than environmental superiority Thus variation due to definable environmental effects must be removed by use of suitable adjustment factors It is necessary that all known sources of variation influencing the traits of importance be included in the model of analysis, otherwise the results of the study may not be reliable This can however be done only in on-station recorded flocks

The trait of interest ought to be investigated in the environment under which it is to be typically expressed since this environment may be the one which is necessary for revealing certain desirable or undesirable genes or in contrast the sought after genetic differences may be of little importance or indistinguishable in this environment Statistical techniques presently utilised for the estimation of breeding values in selection programmes rely on estimates of genetic variation within and between traits of economic importance The overall impact of any selection programme will depend on the direct and correlated responses that result from selection on the selection criterion These responses can be predicted *a priori* by using estimates of genetic and phenotypic relationships between all traits of economic importance

It is therefore important that a breeding and selection strategy be developed preferably involving farmers such as Open Nucleus Scheme for further improvement and enhancing dissemination of Blended goats in Tanzania

Acknowledgements

The authors are grateful to the Commissioner for Research and Training, Ministry of Agriculture Tanzania for permission to present the paper The authors are thankful to the Zonal Director, ZRTC (C), Mpwapwa and the staff at the institute for contribution in data collection and classification and also thankful to Animal Breeding and Production Systems ILCA Ethiopia for analysis of data

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Paramètres phénotypiques et génétiques des caractéristiques de la croissance chez la chèvre hybride en Tanzanie

Résumé

Un total de 4799 donnees de poids et de parametres de croissance de la naissance a l âge de 72 semaines rassemblees sur la chevre hybride en Tanzanie sur une periode de 25 ans (1965–1989) ont ete analysees Mise au point en a Malya (Tanzanie), la chevre hybride est un produit stabilise obtenu a partir du Kamorai (55%) du Boer (30%) et de la race locale (15%) Les moyens poids a la naissance et au sevrage (16 semaines) etaient de 2,47±0,02 kg et de 11 14± 0 15 kg respectivement Les poids vifs a l'âge de 24, 48 et 72 semaines etaient respectivement de 12,47± 0,26 kg, de 16,42±0,32 kg et de 25 80±0 43 kg Les gains moyens quotidiens de la naissance au sevrage et a l'âge de 24, de 48 et de 72 semaines etaient respectivement de 80 01±1,0 g, de

59 ±2 g, de 41±1g et de 46±1 g L annee de naissance le sexe du chevreau et le type de naissance avaient un effet significatif (P<0,01) sur les poids a la naissance et le poids vif a l âge de 48 et de 72 semaines L'âge de la mere avait un effet significatif (P<0,01) sur le poids des jeunes a la naissance et a l'âge de 48 semaines Les coefficients d'heritabilite du poids a la naissance, au sevrage et a l âge de 24 semaines etaient respectivement de 0 015± 0 036 de 0 099±0,39 et de 0 014±0 053 respectivement Les coefficients de repetabilite des poids a la naissance, au sevrage et a 24 48 et 72 semaines etaient respectivement de 0 202±0,18, de 0 187±0,22 de 0 533±0,022, de 0 016±0,035 et de 0,174±0,38

Contrôle des performances, sélection des mâles au sein de la race ovine Djallonké et création d'un flock-book

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Résumé

Un programme de selection de beliers Djallonke base sur le noyau de selection du CAT-K constitue de 750 brebis et 100 beliers membres de 10 familles ou lignees, est presente Ce noyau doit s ouvrir et integrer les meilleures fermes ovines ameliorees (FOA) des paysans-eleveurs pour constituer une base de selection Le schema de selection s articule autour d une phase de preselection basee sur le critere poids au sevrage ajuste selon un poids a âge type (PAT) de 90 jours Celui-ci est reajuste en fonction du type de naissance grâce a un coefficient de correction Ce coefficient est egal au rapport entre le poids a âge type moyen de la classe de reference, c'est-a-dire les agneaux nes simples et issus des meres ayant eu plus d une parite et le poids a âge type moyen de la classe des agneaux nes doubles La deuxieme phase de selection intervient a l'âge de 12 mois et est basee sur les poids seuils (P>30, P>25, P>20 kg de poids vif) qui permettent de classer les beliers selectionnes respectivement en 1ere 2eme et 3eme categories Les animaux infestes de trypanosomes avec diminution du taux d hematocrite (<20) sont exclus de la selection Une enquête visant a cibler les meilleures FOA notamment celles appliquant le programme global d'amélioration zootechnique vulgarise, a ete realisee afin de garantir la survie des beliers prêtes et de leurs progenitures

Introduction

Depuis 1980, le Gouvernement togolais finance avec des partenaires exterieurs un vaste programme de developpement de l'elevage des petits ruminants a travers deux volets Le 1er volet "Amelioration de l'elevage traditionnel' vise surtout a ameliorer la couverture sanitaire du troupeau traditionnel (vaccination contre la peste des petits ruminants deparasitages internes et externes) et a assurer la vulgarisation de quelques themes fondamentaux (amelioration de l habitat la ou il existe et sensibilisation a sa construction avec les materiaux locaux dans les zones ou cette pratique n'est pas usuelle chez les paysans, complementation minerale par apport de blocs de sels mineraux) Le 2eme est le volet Promotion d'un elevage de type semi-intensif" a travers les activites d'un Centre d'appui technique (CAT), charge d'elaborer et de proposer au service de vulgarisation des themes techniques eprouves pour promouvoir un elevage moderne de petits ruminants Les elements cles de cette modernisation sont un habitat moderne comprenant abris et parcs, des animaux, une bonne couverture sanitaire, une supplementation alimentaire appropriee l'amelioration genetique une bonne gestion et une exploitation rationnelle des produits Ce 2eme volet repose sur l'encadrement de paysans detenteurs d un effectif minimum d'une vingtaine de brebis au depart et desireux de devenir de veritables exploitants d'elevages modernes d'ovins denommes "fermes ovines ameliorees" (FOA) (Bonneau *et al*, 1990)

Face a l importante demande de geniteurs exprimee par ces paysans dont plus de 40% en manquent (Bonneau *et al*, 1990, Roulleau et Bonfoh 1988), le CAT-K, dont l'un des objectifs est de diffuser le progres genetique enregistre dans son noyau de selection ovine, tente depuis quelques années de formuler et d'executer un programme national de selection ovine base sur un schema de selection a noyau ouvert (Traoré, 1991 Traore et Bonfoh, 1993)

Pour amorcer ce processus, le CIPEA, dans le cadre du Reseau de recherche sur les petits ruminants, a mis en place conjointement avec le PNPE, le protocole de recherche SRNET/REPG/1 intitule "Contrôle de performances et selection des mâles au sein de la race ovine Djallonke et creation d'un flock-book" Les objectifs sont les suivants connaître le potentiel genetique et mettre au point des methodes de son amelioration (criteres de selection) examiner les relations entre l'amélioration de la croissance et l'evolution de la resistance (trypanotolerance), etudier l'impact d'un programme de selection a noyau ouvert sur les parametres de productivite des troupeaux encadres et contribuer a l elaboration d un standard pour la race ovine Djallonke au Togo

Le present rapport fait le point sur la mise en oeuvre de ce protocole Il abordera apres une presentation du materiel et des methodes les resultats preliminaires relatifs a l'action de selection ovine a la station du CAT-K et a l enquête visant à identifier les meilleures fermes ovines ameliorées (FOA) susceptibles d entrer dans la base de selection

Matériel et méthodes

Données écologiques du site de recherche

Le Togo, pays de l Afrique de l Ouest, est situe entre les 6eme et 12eme degres de latitude nord et entre 0 et 2 de longitude est Il est borde au sud par l ocean atlantique et fait frontiere avec le Ghana, le Benin , le Burkina Faso Le Togo est caracterise par deux types de climat Le nord, au dessus du 8eme degre de latitude nord, appartient a la zone de climat tropical de type soudanien c'est la zone de la 'savane derivee" ou secteur preforestier caracterise par une pluviometrie unimodale allant de la mi-mai a la mi octobre et variant entre 1000 et 1300 mm L'humidite atmospherique est maximale en fevrier (41%) Le sud du 8eme degre de latitude nord (ou est localise le CAT-K) jouit d'un climat tropical de transition c'est le secteur forestier guineen caracterise par une saison de pluie bimodale allant de mars a novembre entrecoupee par une secheresse en juillet et août La pluviometrie annuelle moyenne varie de 1100 a 1600 mm Les temperatures fluctuent entre 22 et 32 C

Population animale de la base de sélection

La population animale concernee est de 750 brebis de race Djallonke reparties dans 5 bergeries et de 100 geniteurs confirmes repartis dans 10 familles ou lignees localisees a la station du CAT-K A ce noyau, il faut ajouter les meilleures des 339 FOA encadrees par le PNPE avec un effectif total de 21 089 têtes dont quelque 10,000 brebis (PNPE, 1994)

Conduite des troupeaux

Au CAT K, la population animale en cours de selection est elevee dans des conditions proches de celles d'un systeme d'elevage semi-intensif

- un milieu d'elevage assez bien maîtrise avec comme habitat une bergerie moderne,
- un gardiennage sur pâturage de savane (6 a 8 heures par jour),
- une complementation alimentaire et minerale (graines de coton et blocs de sels mineraux) toute l'annee mais modulee en fonction de la saison de l'etat physiologique et de la categorie animale,
- un approvisionnement adequat en eau,
- une intensite des traitements antiparasitaires similaires a celle du programme de prophylaxie vulgarise
- absence de chimioprevention contre la trypanosomiase,
- lutte contre les parasitoses internes (en debut au milieu et en fin de saison des pluies pour les adultes, a l âge de 1 5 mois et au sevrage a l'âge de 3 mois quelle que soit la saison de naissance pour les jeunes),
- lutte contre les ectoparasites (detiquage tous les 15 jours en saison des pluies et une fois par mois en saison seche) et
- vaccinations contre la peste des petits ruminants (PPR) et l'epididymite contagieuse ovine (ECO)

Reproduction

Les 5 troupeaux de brebis du CAT-K sont menes sur un rythme de 3 agnelages en 2 ans grâce a la mise en oeuvre d un programme de gestion de la lutte par introduction des beliers d'une lignee donnee pour deux cycles de reproduction successifs Durant ces luttes organisees qui durent 45 jours les beliers sont lâches le soir dans le troupeau de brebis qui leur est attribue Les agneaux sont sevres a un âge moyen de 3 mois (90 jours) (Bonfoh 1994)

Sélection

Objectifs

Les objectifs operationnels du programme de selection sont les suivants ameliorer la vitesse de croissance, le format a l'âge adulte des animaux, les caracteristiques de fecondite et de prolificite des brebis ainsi que la viabilite des agneaux et conserver une bonne conformation et une bonne rusticite des produits ameliores de la race ovine Djallonke

Criteres de selection

Le poids au sevrage a l'âge moyen de 90 jours, fortement correle avec le poids a l âge adulte occupe une place de choix dans la preselection La selection definitive a lieu a l âge de 12 mois avec la classification en categories Outre le critere du poids au sevrage tout agneau mal conforme (malformations, defaut d'aplomb, hypogonadisme) ou presentant des caracteres rappelant le type sahelien (longueur de la queue depassant le jarret, pendeloques) est exclu de selection Par ailleurs, dans le but de preserver les qualites de trypanotolerance des animaux de selection, tout animal manifestant des signes de suspicion de la trypanosomiase fait l'objet d'un diagnostic parasitologique dont le but est de mettre en evidence des trypanosomes et d evaluer le taux d hematocrite Les animaux infestes avec diminution anormale du taux d'hematocrite (<20) sont exclus de la selection (Traore et Bonfoh 1993)

Organisation de la selection

La selection comporte 3 etapes principales

- Identification et contrôle des performances de croissance sur tous les agneaux nes des luttes organisees

Tous les agneaux sont identifies a la naissance avec des boucles d'oreilles portant 5 chiffres dont le 1er indique l'annee de naissance (ex 3 pour 1993) le 2eme

le numero de troupeau des meres et le 3eme, le rang de naissance dans l annee Au sevrage, les agneaux preselectionnes sont tatoues a la partie glabre de la queue Ce tatouage sert a les identifier en cas de perte des boucles d'oreilles

- Elevage et contrôle individuel des agneaux preselectionnes a l âge moyen de 90 jours dans le centre de testage des ovins du CAT-K
- Selection definitive des futurs geniteurs a l âge de 12 mois, diffusion et utilisation des beliers selectionnes a partir de l âge de 15 mois (figure 1) (Traore, 1991 Traore et Bonfoh 1993)

Méthode de selection

Selection en station

Phase de preselection le poids au sevrage est ajuste en fonction de l'âge type au sevrage (90 jours) et du type de naissance pour determiner les poids a âge type (Traore et Bonfoh, 1993) En raison de l etalement des naissances (sur 30 a 40 jours) consecutif a la duree de la

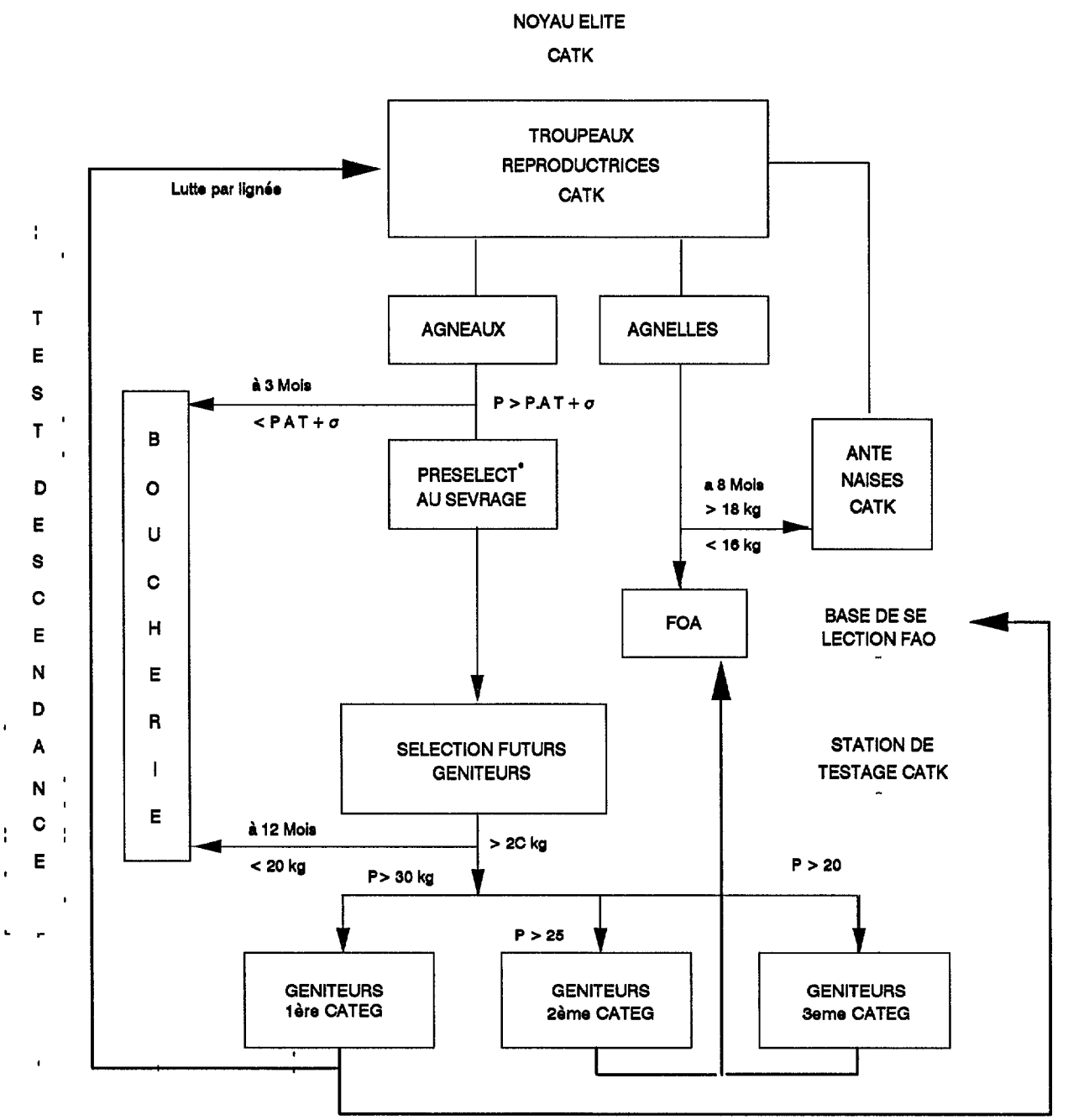

Figure 1 *Schema de selection ovine au centre d appui technique de Kolokope*

periode de lutte au CAT-K (45 jours), le poids a âge type (PAT) individuel de tous les agneaux est ajuste grâce a la formule suivante

$$PAT = \frac{(P_J - pn)}{(J)} \times AT$$

ou

P_J = poids au jour J de sevrage
J = âge de l'agneau a la pesee (en jours)
Pn = poids a la naissance
AT = âge type au sevrage (= 90 jours)

Le reajustement du PAT est principalement applique pour les agneaux nes doubles et eleves comme tels, pour les agneaux nes doubles mais eleves comme simples (suite a la mort precoce de l'un d'eux) un tel ajustement ne se justifie pas, la faiblesse du poids a la naissance etant rapidement compensee Le reajustement du P A T se fait grâce a la prise en compte d un coefficient de correction (CC) obtenu par calcul du rapport entre le poids a âge type moyen de la classe de reference que constituent les agneaux nes simples et issus des meres ayant eu plus d'une parite et le poids a âge type moyen de la classe des agneaux nes doubles Apres ce reajustement des PAT des agneaux concernes, le PAT moyen a 90 jours de l'ensemble des agneaux est calcule ainsi que son ecart-type Ces deux parametres permettent d'etablir les seuils de preselection par troncature" de la population des agneaux candidats a la selection (figure 2), cette methode suppose une distribution normale de la variable ' poids au sevrage" (Traore et Bonfoh, 1993)

Les agneaux dont le PAT est inferieur au PAT moyen plus l'ecart-type ne sont pas retenus pour la selection

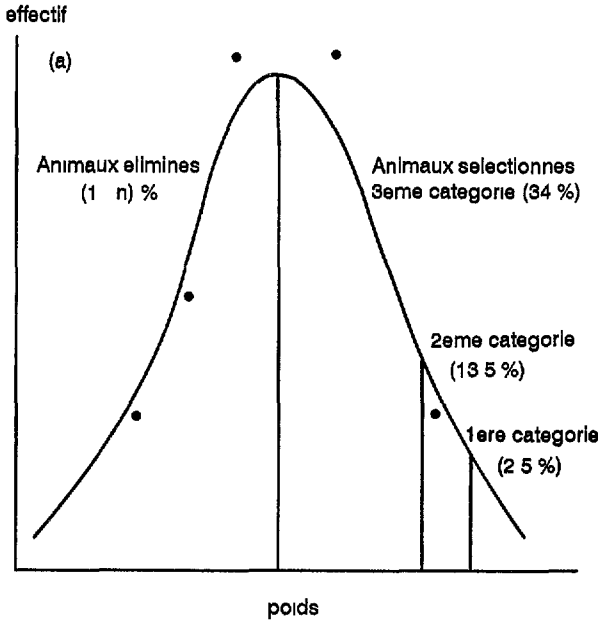

Figure 2 *Seuil de preselection des agneaux a partir du poids au sevrage (Methode par troncature)*

Phase de selection Elle est une phase d elevage des jeunes beliers preselectionnes sur le poids a 90 jours jusqu a l'âge d un an Les contrôles de performance sont realises par les pesees mensuelles la selection definitive a lieu a 12 mois Les beliers selectionnes, repartis en 1ere (P>30 kg), 2eme (25<P<30 kg) et 3eme categories (20>P<25 kg de poids vif) sont mis a leur premiere lutte a l'âge de 15 mois

Présélection en ferme

Dans les fermes ovines ameliorees (FOA) ou l on ne dispose pas forcement du poids individuel des agneaux a la naissance le calcul du PAT se fait suivant les mêmes procedures excepte que ce PAT est nettement surevalue et n a qu'une valeur indicative autorisant cependant des comparaisons entre agneaux au sein d'un troupeau puis entre troupeaux de FOA (Traore et Bonfoh, 1993)

$$PAT = \frac{PJ}{(J)} \times AT$$

Gestion informatique des données

Il convient de signaler qu'une informatisation de la gestion des troupeaux de selection du Centre est intervenue en 1992 (Traore, 1992) Elle repose sur des fichiers crees a partir du logiciel DBase IV etat civil croissance, reproduction, sante, etc Le support de collecte de la base de donnees de croissance est constitue d'un fichier manuel et d un fichier informatique (Lotus 123 et Dbase IV)

Enquête d'identification des paysans- éleveurs

Dans le cadre du protocole une enquête a ete realisee en avril 1994 pour dresser la liste des paysans eleveurs susceptibles de rentrer dans la base de selection L'enquête a ete realisee grâce a l'appui des chefs de secteur du PNPE des regions des Savanes, Kara et Centrale Le but du questionnaire est de permettre l'identification des paysans-eleveurs des FOA qui appliquent de maniere satisfaisante le programme global d'amelioration zootechnique vulgarise par le PNPE et dont les elements essentiels sont

- la maîtrise de l alimentation (gardiennage du troupeau au pâturage pratique d'une complementation alimentaire et minerale optimale),
- application d'un train de mesures sanitaires materialise par le respect du programme de prophylaxie en vigueur, vaccination contre la peste des petits ruminants et contrôle des parasitoses gastro-intestinales et externes

Seuls ces paysans-eleveurs pourront garantir la vie des beliers qui leurs seront prêtes pour les luttes organisees ou contrôlees limiter les pertes de poids des beliers au cours des luttes et favoriser la survie de la

progeniture et l exteriorisation du potentiel genetique des individus (vitesse de croissance avant sevrage) Il convient egalement de signaler que dans le cadre de ce protocole, une mission a ete effectuee en octobre 1993 au Programme national de selection ovine a Bouake en Côte d'Ivoire (Bonfoh, 1993)

Résultats et discussion

Connaissance du potentiel génétique

Les resultats presentes ici proviennent du contrôle de performances de croissance de 2155 agneaux des deux sexes nes de 13 agnelages intervenus entre 1993 et 1994 (tableaux 1 et 2) Ces resultats sont similaires a ceux rapportes par le Programme national de selection ovine (PNSO) de Côte d Ivoire (IEMVT-CIRAD 1990)

Dans un groupe de 698 agneaux mâles candidats a la preselection, 326 dont le PAT a 3 mois est superieur ou egal au PAT moyen de ce groupe plus l'ecart-type ont ete retenus, soit un taux de preselection de 46,70% Par rapport aux agneaux jumeaux le poids au sevrage des agneaux issus de naissances simples est de 25% plus eleve (tableau 2) Sur un total de 176 futurs beliers en phase de selection 56 25% ont ete retenus comme geniteurs a l âge de 12 mois Parmi ceux-ci, 24,43% ont pu être selectionnes comme beliers de 1ere categorie avec un PAT moyen compris entre 32 06±1 76 et 33,1±2,14 kg Par ailleurs, 31,81% ont ete retenus comme beliers de 2eme categorie avec un PAT moyen compris entre 26,9±1,30 et 28,32± 0 89 kg Le taux de selection enregistre en bout de chaîne ou 14,18% des animaux ont ete retenus comme beliers ameliorateurs peut être considere comme relativement severe le niveau de performance des FOA ne justifiant pas une telle pression de selection

Le PNSO dans son bilan d activites de selection de 1984 a 1988, indique que les poids moyens a l'âge de 12 mois est de 37 kg pour les beliers de 1ere categorie et de 31 kg pour ceux de 2eme categorie Les taux de selection ont fluctue au cours de cette même periode entre 48 et 73% des agneaux preselectionnes Ce niveau eleve des resultats du PNSO serait lie au systeme d'alimentation intensif pratique au cours de l'elevage des animaux pour la selection (apport de ration composee d'un concentre constitue de 30% de tourteau de coton et de 70% de son de ble – de foin de panicum T58 et de sels mineraux) Un tel systeme se traduira par des coûts de production plus importants

L analyse preliminaire des 8 cycles de reproduction de 1993 donne les principaux parametres zootechniques suivants

- taux de prolificite 144,09%,
- taux de fecondite 125 06%,
- taux de mortalite avant sevrage 8,6%,
- taux de mortalite apres sevrage 1,30%,
- taux de mortalite des brebis 1,23%

Pour ces mêmes agnelages, les poids moyens a la naissance des 1312 agneaux produits en fonction du sexe et du type de naissance sont les suivants

mâles	simples (n = 276)	=	2,22 ± 0 43 kg
	doubles (n = 404)	=	1,75 ± 0,35 kg
femelles	simples (n = 245)	=	2,05 ± 0,37 kg
	doubles (n = 396)	=	1,71 ± 0,32 kg

Sélection et trypanotolérance

Il convient de signaler que dans le domaine de l'étude des relations entre l amelioration de la croissance et l'evaluation de la resistance (trypanotolerance) une enquête protozoologique avec mesure du taux d hematocrite, a ete realisee avec l'appui du Projet de lutte contre la trypanosomiase animale au Togo, chez 113 beliers selectionnes du CAT-K âges d'environ 2 ans Les resultats preliminaires donnent un taux de prevalence de 49,55% avec 19,46% de cas pathologiques (hematocrite inferieur à 25) Il faut signaler que des cas d'oedeme testiculaire et d orchites ont ete enregistres chez des beliers trypanosomes lesquels ont reagi tres favorablement a un traitement trypanocide avec du di-aceturate de diminazene (Trypan ND)

Contribution à l'élaboration d'un standard pour la race ovine Djallonké au Togo

Dans ce cadre et pour une meilleure exploitation des beliers selectionnes du CAT-K, un catalogue des beliers reproducteurs a ete cree Ce catalogue presente l'etat civil de l'animal, sa vitesse de croissance (GMQ aux differents âges types), sa robe et sa hauteur au garrot

Etude de l'impact d'un programme de sélection à noyau ouvert sur les paramètres de productivité des troupeaux encadrés

Jusqu'a present, la selection s'opere dans le noyau du CAT-K La diffusion du progres genetique a consiste en la vente des beliers de 2eme et 3eme categories aux fermes ovines ameliorees (80 beliers vendus en 1993 et mi 1994) La phase de prêt de beliers de 1ere categorie aux meilleurs paysans-eleveurs des FOA n a pas encore demarre L enquête visant a cibler cette categorie de paysans-eleveurs susceptibles de rentrer dans la base de selection permettra à court terme de mettre en oeuvre les actions devant conduire a la mise a exécution d'un programme de selection a noyau ouvert La majorite des elevages enquêtes ne satisfont plus le niveau technique requis pour une ferme ovine amelioree (elevage

Tableau 1 *Parametres zootechniques et taux de preselection des agneaux mâles*

	Troupeau de brebis														
	No 1			No 2			No 3			No 4			No 5		
Parametre	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3
Prolificite	152 38	134 58	145 25	156 20	156 19		154 83	131 65	145 58	145 18	112 50		137 0	144 27	148 55
Fecondite	130 08	119 33	124 37	147 37	138 97		128 94	122 0	125 31	130 66	99 35		98 56	124 00	125 76
Mortalite des agneaux avant sevrage %	13 24	8 48	16 37	4 32	27 37		16 78	12 06	23 21	4 21	21 33		7 69	8 72	25 84
Poids moyen a la naissance (mâles et femelles) (kg)	1 85	1 87	1 62	1 99	1 67		1 88	1 93	1 67	2 12	2 00		1 90	1 76	1 66
Taux de preselection des agneaux mâles a l âge de 3 mois %	52 63	51 38	*	48 86	37 93		50 0	35 89	*	43 33	45 76		52 38	50 70	*

A1 Agnelle No 1

* En phase de préselection

Tableau 2 *Poids a âge type au sevrage en fonction du type de naissance et sexe*

Type de naissance et sexe	Troupeaux de brebis									
	No 1		No 2		No 3		No 4		No 5	
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
Mâles										
• Simples	20 06*	12 13±2 38	10 69±3 07	7 93±2 04	S+D*	11 54±1 93	9 62±2 54	7 78±1 75	16 22±2 98	10 06
• Doubles	16 08	9 66±2 13	8 38±2 25	6 61±1 96	20 04±4 21	10 06±1 99	7 44±1 80	5 74±1 34	15 49±4 22	7 50
Coefficient de correction	1 25	1 26	1 27	1 20	1 27	1 15	1 29	1 36	1 29	1 41
Femelles										
• Simples	S+D*	11 16±1 51	7 61±1 70	6 41±1 64	S+D*	11 02±2 29	7 12±1 67	6 82±1 73	16 09±3 33	8 98±1 96
• Doubles	17 67±3 15	9 08±1 70	5 56±1 39	5 29±1 67	15 99±4 24	9 03±1 52	5 41±1 64	5 97±1 38	14 71±1 74	6 86±1 66
Coefficient de correction	–	1 23	1 37	1 21	1 16	1 22	1 32	1 14	1 32	1 31

* âge type= 120 jours
âge type = 90 jours
S ± D = agneaux simples et doubles

semi-intensif) Les problemes rencontres peuvent se resumer comme suit

- insuffisance voire absence de complementations alimentaire et minerale
- manque d'equipements zootechniques (mangeoires, abreuvoirs) dans les bergeries,
- faibles effectifs de reproductrices (<50),
- fréquence des vols d'animaux, et
- affichage de mauvais resultats zootechniques (taux de mortalite des jeunes >25%)

14 paysans-eleveurs de la Region des savanes possedant 634 brebis, 10 paysans-eleveurs de la Region centrale possedant 514 brebis et 3 de la Region de la Kara avec 103 brebis soit un total de 27 paysans-eleveurs ont ete preselectionnes et seront soumis a une 2eme phase d'enquête afin d'arrêter la liste definitive des FOA de la base de selection

Les objectifs de cette 2eme phase d enquête sont les suivants

- revoir la situation sanitaire des troupeaux et juger de la capacité de l'eleveur a mettre en oeuvre le programme de prophylaxie et de complementations alimentaire et minerale,
- evaluer les possibilites de pâturage et d'abreuvement des animaux, et
- obtenir l'avis definitif du paysan-eleveur sur sa participation aux contrôles de performance en ferme et sur les modalites de cession des agneaux preselectionnes au CAT-K

Conclusion

L'amelioration genetique du format du mouton Djallonke par la selection des beliers peut donner de bons resultats dans le processus d'amelioration de la productivite des troupeaux encadres Les criteres de preselection (poids vif au sevrage a l'âge de 90 jours) et de selection (poids a l'âge adulte de 12 mois) sont tres pertinents Le calcul du poids moyen a âge type et son ajustement a l'aide des facteurs de correction tenant compte du type de naissance ont pu être réalises Les actions d amelioration genetique ont ete essentiellement mises en oeuvre en station

Un total de 698 agneaux ont ete soumis en 1993 au contrôle des performances de croissance, 46,70% ont ete preselectionnes comme futurs beliers et 14,18% retenus comme beliers ameliorateurs Les poids moyens de ces beliers a l'âge de 12 mois sont de 33 1 ± 2,14 kg pour les beliers de 1ere categorie et 28,32 ± 0,89 kg pour ceux de 2eme categorie La prise en compte de la 3eme categorie de selection conformement a ce qui a ete propose dans le programme d'optimisation de la selection ovine au CAT-K est tout a fait justifiee La mise en oeuvre du programme d amelioration genetique en milieu villageois au sein des elevages traditionnels d'ovins en voie d'amelioration bute sur certains obstacles, notamment

- le fait que les troupeaux individuels sont de petite taille
- la maîtrise insuffisante de l'alimentation (gardiennage du troupeau au pâturage),
- la frequence des vols d'animaux, et
- l'application incorrecte du programme de prophylaxie en vigueur

Dans le cadre de la creation de la base de selection, il importe donc de mettre en place des mesures tant sur le plan du reequipement des bergeries en mangeoires et en abreuvoirs que sur l approvisionnement en intrants d'elevage

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Tableau 3 *Poids des beliers selectionnes a l âge de 12 mois Troupeau d origine*

Troupeau d origine	Béliers sélectionnés				Taux de selection (%)
	1ère categorie		2ème categorie		
	Nombre	Poids (kg)	Nombre	Poids (kg)	
1	14	32 17 ± 1 42	10	28 12 ± 1 62	80 0
2	4	33 1 ± 2 14	9	27 71 ± 1 27	30 23
3	13	32 38 ± 1 92	12	28 28 ± 1 71	80 64
4	3	32 33 ± 2 05	8	28 32 ± 0 89	28 20
5	9	32 06 ± 11 76	17	26 9 ± 1 30	78 78
Taux de sélection	24 43%		31 81%		56 25

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Performance monitoring and selection of males in West African Dwaf sheep and inception of a flock-book

Abstract

A Djallonke ram selection programme based on a CAT-K selection nucleus comprising 750 ewes and 100 rams from 10 families or lines is presented This nucleus should integrate the best improved sheep farms of mixed farmers to become a selection base The selection scheme comprises a preselection phase based on "weaning weight" adjusted by a 90-day standard weight This is in turn adjusted by the birth type using a correction coefficient This coefficient is the ratio between the weight at average standard age of the reference class, i e single lambs born from multiparous mothers, and the weight at average standard age of the class of twin lambs The second phase of selection took place at 12 months of age and was based on the threshold weights (W>30, W>25 and W>20 kg) used to divide selected rams into 1st 2nd and 3rd categories Animals infected with trypanosomes with reduced PCV (<20) were excluded from the selection A survey aimed at identifying the best improved sheep farms especially those using the general livestock improvement programme being recommended, was carried out in order to guarantee the survival of both the borrowed rams and their offspring

SESSION 2

Production Systems, Policy and Economics

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Some constraints to small ruminant production among small-scale farmers in Laikipia West

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Abstract

A sample of 65 small-scale farms was selected from two of the subdivided ranches in the arid and semi-arid lands of west Laikipia The objective of the study was to determine among other things, some of the constraints to small ruminant production in the study area The study reveals that the major constraints to small ruminant production were diseases (mainly pneumonia and helminthiasis) and shortage of water for livestock Insufficient grazing was not seen by the respondents as a constraint although observations showed that the area was overgrazed especially the unoccupied farms

Introduction

It is estimated that 82% of the population in Kenya lives in the rural areas In Laikipia this estimate is even higher, at 91% (GOK 1991) Most of the people are small-scale farmers living on former European ranches many of which have been subdivided into small scale farms The farm sizes range from one to 10 hectares which makes small-scale farming in the district significant However many of the ranches from which these farms are carved were used for extensive livestock production and are thus not suitable for rain-fed agriculture

Small-scale farmers in the arid and semi-arid lands (ASAL) face many challenges in generating household incomes One way of helping them increase this income is through promotion of small ruminant production It has been reported that in this area small ruminant production provides close to one-third of the small scale farmers net farm incomes (Mucuthi et al 1992) However there are constraints that hinder maximising returns or minimising costs in their production Therefore the objective of the study was to identify some of these constraints to small ruminant production in the study area

Materials and methods

In 1990 there were 28 former European ranches and five government settlement schemes in Laikipia West that were in various stages of settlement and/or subdivision Subdivision was completed in eight of the ranches and maps were available Two of these ranches were selected for this study Each ranch was subdivided into four equal subclusters and the farthest two subclusters to each other i e one subcluster from each ranch was chosen as the starting point The farms or sampling units were not sampled randomly within the subclusters but systematically from a randomly selected corner of the subcluster

Using this method, 65 respondents who were defined as small-scale farmers were interviewed They represented 9% of the potential respondents in each ranch Herd size (50 small ruminants and 10 cattle) instead of land size was used to classify small-scale farms, though recognising that land size is the standard measure of farm classification Herd size was used because Kohler (1987a) found that in West Laikipia, small scale farmers owned no more than 50 small ruminants and 8 head of cattle No prior appointments were made for interview visits, but efforts were made to interview the husband or the wife or in default, the *de facto* head of the farm Otherwise, the enumerator moved to the next farm Each respondent interviewed was asked general questions relating to small ruminant production and specific questions on constraints to small ruminant production

Results and discussion

The respondents identified mortality through disease, shortage of water for livestock stock theft, difficulty in getting herders and lack of enough grazing as the main constraints to small ruminant production Mortality through disease (53%) and lack of enough water for livestock (21%) were the most significant constraints to small ruminant production Other studies also indicate that diseases are among the most significant constraints to small ruminant production in this area (GOK 1990 Herren 1990)

The mortality rates recorded from this study were 12% and 27% for mature and young small ruminants respectively These rates are lower than those reported in other studies done in the same area (Kohler 1987a, Kohler 1987b, Herren 1990) The lower rates noted in this study may be associated with the fact that the data were based on events recalled by the respondents, rather than recorded information

Since the respondents gave accounts of deaths that may have occurred in the previous 12 months it was possible for them not to recall some of the death events especially if there were many or very few deaths and early in the year It is also worth noting that the proportion of respondents that reported no deaths was quite high for both mature (24%) and young (50%) stock It is also common knowledge that sick animals are, in some cases slaughtered before they die and the meat consumed or sold and thus not reported as a death event

Of the known causes of mortality (Table 1), the pneumonia complex including contagious caprine pleuropneumonia (CCPP) was the main cause of small ruminant mortality, especially among mature stock Helminths and diarrhoea were other important causes of mortality, with young stock being the most susceptible to them Earlier studies in the area made similar observations (Herren 1990) Kimaru (1993) noted that helminths can be predisposing factors to deaths from pneumonia It is possible, therefore, that the high death rates resulting from pneumonia may have been partly caused by helminth infection particularly in the young stock

Table 1 *Main causes of mortality in small ruminants as reported by respondents*

	Mature stock		Young stock	
Cause	Frequency (%)		Frequency (%)	
Pneumonia complex	27	69 0	10	40
Helminths	3	8 0	5	20
Malnutrition	1	2 5	–	–
Diarrhoea	1	2 5	7	28
Unspecified causes	7	18 0	3	12
Total	39	100 0	25	100

Input cost analysis of available data shows that the respondents spent over half of their total input costs for small ruminant production on anthelmintics (Table 2) This is not commensurate with the level of mortality attributed to helminths (Table 1) The reasons for the observed disparity may be attributed to the following observation Only 37% of the respondents who used anthelmintics administer them in accordance with the manufacturers' recommendations Of the others, 30% under-dosed, thus making the drugs ineffective and 33% over-dosed thus incurring unnecessary expenses

Table 2 *The mean cost of inputs used in small ruminant production*

	Input costs per head (KS)		
Type of input	Mean	Range	Total inputs (%)
Anthelminths	11 30	0–38 00	62
Treatment drugs	5 00	0–40 00	28
Minerals	1 80	0–6 50	10
All Inputs	18 10	0–64 90	100

KS = Kenya shillings

In an environment such as the ASAL the identification of water shortage as a second major constraint to livestock production was not unexpected The area has no permanent rivers, except for a small spring in Mukuru which itself does not provide enough water to meet the demands for both livestock and humans In addition the dams are not centrally located nor were they enough to cater for the whole area On the average the livestock travelled a distance of 7 and 10 kilometres to water at Salama and Mukuru respectively

Furthermore the dams were not well managed as livestock were watered at the same points that humans drew water for drinking Due to this interference by livestock, which also caused erosion around the dams, the dams silted Therefore, to alleviate the water shortage problem, it is necessary to improve dam management de silt the existing dams, and construct new ones

Insufficient grazing was not seen by the respondents as a major constraint to small ruminant production It was only rated third in significance However stocking rate calculated using field data for respondents with less than 50 head of small ruminants and less than 10 head of cattle gave a different picture

The sampled respondents had a total of 1496 tropical livestock units (TLUs) comprising 835 TLUs of cattle and 661 TLUs of small ruminants The area available for grazing was calculated as 4217 ha including 2175 ha in the unsettled land and 2042 ha settled but uncultivated land (Table 3) This gives a stocking rate of 2 8 ha per TLU which was less than the recommended stocking rate range of 3–5 ha per TLU for this area (Jaetzold and Schmidt 1982) When the stocking rate was calculated using only the grazing land available in the settled land the results were even more dramatic with the stocking rate dropping to 1 4 ha per TLU

Table 3 *Estimates of grazing land available its carrying capacity and its use in the study area*

Type of land and use	Hectares
(1) Total land available	5578 0
(2) Settled area 61% of (1)	3403 0
(3) Grazing in settled land 60% of (2)	2042 0
(4) Grazing in unoccupied land 39% of (1)	2175 0
(5) Total grazing land (3)+(4)	4217 0
(6) Stocking rate	
• all available grazing (5)/total TLU	2 8
in settled farms only (3)/total TLU	1 4
(7) Recommended carrying capacity	3–5

Insufficient grazing was apparent when the grass cover in the occupied and unoccupied farms was compared Grass cover was determined by the amount of bare soil observed We estimated less than 10%

10–30% and 30–50% bare soil for good medium and bad grass cover, respectively Using this estimate it was found that 59% of the occupied farms had good grass cover, and only 11% had poor grass cover The unoccupied farms had medium soil cover or worse The observation indicates that, there will soon be very little grass available in the unoccupied farms Therefore sufficient grazing for these farmers was only an illusion An alternative source of feed to supplement grazing is necessary

It was observed that only 27% of the respondents gave any form of supplementary feed to small ruminants because there was still grazing available in the unoccupied farms However, there is need to improve the amount of feed available This can be done by either of three possible ways, namely improving the productivity of the available grazing, destocking or upgrading with better small ruminant breeds like Dorper crosses This latter may encourage reduction in stock numbers

Since lack of enough grazing, at least for small ruminants, was not seen as a significant constraint to production, it will be difficult to convince the respondents to plant large areas of land with fodder for small ruminants, especially where the fodder will compete with food crop production and for labour Nonetheless a start should be to encourage farmers to use crop residues and improve the storage quality of available crop residues for instance maize stover through preservation Planting fodder trees like leucaena and sesbania along the fences and on terraces will also increase the amount of feed available

Conclusions

1 The main constraints to small ruminant production are pneumonia, CCPP and helminths Hence animal diseases are a limiting factor for small ruminant production

2 Small-scale farmers are not conversant with the administration of anthelmintic drugs This caused increased costs of inputs and is likely to precipitate helminths resistance to the drugs

3 Though small-scale farmers do not consider insufficient grazing a significant constraint there is evidence of overgrazing in the study area especially in the unoccupied farms Additionally grazing will be a major constraint when the unoccupied plots are occupied

Recommendations

1 Farmers should be trained to follow guidelines for the use of the anthelmitics or other drugs, the recommended use of the various anthelmintic drugs for different zones, as is the case with acaricides, should be studied This zoning will help the small scale farmers to remember drug dosage rates and it will also reduce the likelihood of the development of resistance to these drugs by helminths

2 The number of dams need to be increased and dam management improved

3 Action should be taken to correct the problem of overgrazing

4 To expand the feed base for their livestock farmers must be encouraged to feed crop residues to the livestock They should also be trained to preserve these residues for strategic interventions during drought or long dry spells

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Etude de quelques obstacles à la production des petits ruminants chez les petits éleveurs de Laikipia-Ouest

Résumé

Cette etude a ete realisee sur un echantillon de 65 petites exploitations agricoles de deux ranchs des terres arides et semi-arides de l'Ouest Laikipia Elle avait pour objectif de determiner entre autres certains des obstacles a l elevage des petits ruminants dans la region Il ressort des resultats enregistres que les maladies, notamment la pneumonie et les helminthioses et le manque d eau pour l abreuvement des animaux constituaient les principales contraintes au deve loppement de l elevage des petits ruminants dans cette region Les personnes interrogees ne consideraient pas le manque de pâturage comme un obstacle même si les observations effectuees ont revele que les terres etaient surpâturees, notamment les zones inoccupees

Sheep rearing under tree crop plantation in Ghana's forest zone: Problems and prospects

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Abstract

A study was conducted to identify the potential of and constraints to integrating sheep into tree crop plantations in Ghana Nine farmers who practised the system wholly (Group 1) or partly (Group 2), and five other sheep owners who were not practising it (Group 3), were interviewed and their husbandry practices observed Management standards were poor among all groups Diarrhoea, foot rot and skin conditions were common Fertility and prolificacy varied within flocks Within groups prolificacy reflected breed composition the Djallonke and Ouda being more prolific than Nungua Blackhead derivatives Constraints to adopting integrated sheep-tree crop plantation production included theft of animals while grazing crop damage by straying animals remoteness of plantations, lack of capital high cost of breeding stock and absentee ownership Suggestions are made for enhancing the adoption of the technology

Introduction

Cover crops are planted under tree crop plantations to control soil erosion improve soil fertility and smother weeds These covers however, grow rapidly tending to choke the tree crops, and have to be kept in check through expensive labour use On the other hand they can be converted into meat (Hodges 1983 Devendra 1991) Manure from the livestock also cuts the fertiliser bill Besides, the technology diversifies farm produce thus reducing risk and intensifying land use

Stock rearing under tree crops therefore affords Ghana, and indeed the West African subregion, an opportunity to expand the sheep industry in the forest zone without altering the farmer's main activity of crop production Citrus and oil palm rank after cocoa as the main cash crops in the forest zone of Ghana Most households keep some sheep and there is a long history of integrating sheep into tree crops on agricultural stations

Following are a few examples of sheep integration into tree crop plantations at agricultural station level in different regions of Ghana

Wilson and Lansbury (1958) cited the 1938 investigations into the nutritive quality of leguminous cover crops under tree crops in the Central Region These authors also reported on sheep grazing under citrus plantations at Asuansi and Mankessim Agricultural Stations Data on weather conditions and herbage quality during that study are given in Tables 1 and 2, respectively Green herbage yield averaged 20 8 t/ha per year Stocking rate was about 13 6 sheep/ha, and in the 11 months liveweight gain aggregated to 90 7 kg/ha in Djallonke sheep

At the University of Ghana's Agricultural Research Station (ARS) in Okumaning-Kade in the Eastern Region, oil palm, citrus, cola, mango and avocado plantations were established for agronomic studies in the late 1950s Sheep were introduced in 1972 to take advantage of the lush cover crops *Centrosema* and *Pueraria* constitute the main diet of the animals in these plantations However, a wide range of volunteer forbs and grasses, e g *Panicum maximum*, are also selected as cultivated leguminous cover crops diminish with heavy grazing Table 2 gives the chemical composition of the top three forages at the ARS The high quality of these forages is apparent, although the Ca P ratio of the legumes is slightly high On account of dwindling herbage biomass due to the dense overhead canopy of many old plantations, the stocking rate dropped from 11–18 sheep/ha in 1972 to 3 sheep/ha

Table 1 *Summary of meterological data at Asuansi and Kade*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (Mean)
Asuansi													
Temp (C)	25	26	26	27	25	24	23	23	24	25	25	25	(25)
Rain (mm)	25	31	170	160	185	276	60	40	82	216	115	68	1458
Okumaning Kade													
Temp (C)	26	27	27	27	26	25	24	24	25	26	26	26	(26)
Rain (mm)	43	59	147	165	188	298	186	99	132	188	152	64	1720
Rainy days	4	4	13	14	16	20	18	14	16	19	15	7	160

Sources Asuansi data adapted from Wilson and Lansbury (1958) and Kade data adapted from ARS files

Table 2 *Chemical composition of some grazed cover crops at Asuansi and Kade*

	Asuansi*	Kade**		
	Centrosema	*Centrosema*	*Pueraria*	*P maximum*
Dry matter (%)	25 4	16 7	21 5	21 9
As % of dry matter (DM)				
Digestibility (Dig)	53 5	–	–	–
Crude protein (CP)	20	22 1	20 0	14 8
Digestible CP	3 2	–	–	–
Crude fibre	30	–	–	–
Ash	6 2	–	–	–
Neutral detergent fibre (NDF)	–	60 7	69 8	74 8
Hemicellulose	–	60 1	22 5	31 3
Cellulose	–	30 8	33 1	36 9
Lignin	–	13 2	13 5	36 9
Phosphorus (P)	0 21	0 21	0 20	0 19
Calcium (Ca)	1 35	0 51	0 45	0 28
Magnesium (Mg)	0 23	0 15	0 16	
Potassium (K)	1 58	2 00	2 27	2 80
PPM of DM				
Zinc (Zn)	–	26 0	29 3	20 0
Copper (Cu)	–	11 3	11 3	2 0
Manganese (Mn)	–	360	320	187

* Source Wilson and Lansbury (1958)

** Source Fianu and Adjorlolo (unpublished)

today The breeds are mainly Djallonke and Nungua Blackhead derivatives Flock performance in 1990 92 was as follows average birth weight, 2 3±0 17 kg, preweaning liveweight gain, 80 5±3 4 kg, post-weaning gain, 27 g/d, yearling weight, 20–30 kg, fertility, 93 2% of ewes exposed, fecundity, 130% of ewes exposed, lamb crop, 94 4% of lambs born, lamb mortality, 5 6% of lambs born alive

As part of the UNDP-Ghana Government Sheep and Goat Development programme, Djallonke sheep were introduced into a palm plantation at Juaso, in the Ashanti Region, from 1978 to 1992 Here again, animals weighed 16 kg at six months compared with eight months elsewhere (Oppong-Anane 1981)

Notwithstanding the demonstrated potential of integrating sheep production into tree crops by the work at these stations, few farmers in Ghana have adopted this technology The objective of this study was therefore to find out why this technology is not widely adopted and to suggest ways to facilitate its wide adoption

Methodology

With the help of agricultural veterinary officers and some farmers, nine sheep flocks integrated into plantation tree crops were identified The farmers were interviewed with a questionnaire as a guide Each plantation was visited several times to observe the animals between September 1992 and January 1993 Three other holdings were studied, which were not using the technology but had sheep and plantations

Results

Profiles of respondents and their farms

Five farmers (Group 1) were rearing sheep exclusively under their oil palm plantations Four others (Group 2) used plantations but also occasionally grazed their stock on wasteland while three (Group 3) only used wasteland (Table 3) No sheep were being reared under citrus and cocoa plantations Because goats tended to roam farther afield causing more frequent crop damage than sheep, only all-sheep flocks were selected for all groups The sheep breeds encountered were 60% Djallonke 29% Ouda and its crosses 7% Nungua Blackhead X Djallonke crosses and 4% Yankasa crosses All the Nungua Blackhead derivatives were found in Group 1

The ages of the 12 farmers ranged from 33–74 years of age Their formal education varied from nil to tertiary Their plantations sizes ranged from 3 to 16 ha and their flock sizes ranged from 7 to 58 head Flock sizes were, however, larger for groups 1 and 2 Only three of the 12 farmers were full time farmers, the others had additional occupations

Animals are grazed under plantations for a number of reasons, namely to use the copious feed resources and keep down weeds, to derive extra income especially for meeting emergency expenses such as school fees, hospital bills etc, and to furnish meat for festivities such as Christmas and Easter celebrations The flocks in Group 1 were managed by men whereas those in groups 2 and 3 were tended by women and children

Table 3 *General information on respondents*

Farmer no	Age (yrs)	Sheep nos	Farm size (ha)	Land tenure	Formal education	Other jobs
Group 1						
1	51	50	16	Family	GCE A	Civil Service
2	61	30	4	Abunu	Elementary	None
3	45	25	8	Family	Technical	Mechanic
4	60	58	16	Buy	BSc	Accounts
5	52	15	16	Wife	Elementary	Diamonds
Group 2						
6	74	14	3	Family	Nil	Tailor
7	47	21	5	Abunu	Elementary	None
8	62	18	8	Family	Diploma	Lumber
9	70	26	10	Family	Elementary	None
Group 3						
10	36	7	–	–	Commercial	Trader
11	33	19	–	–	Elementary	Trader
12	38	14	4	Family	Nil	Diamonds

Flock housing and feeding

Pens were generally fenced with planks of timber and roofed with thatch or salvaged aluminium sheets The floors were earthen or concrete Water was provided in the pens *ad libitum*

For groups 1 and 2 grazing was from 1000 to 1830 hours and stocking rates varied from 0 92 to 7 35 head/ha with an average of 3 67 head/ha Grazing was continuous as the pastures were not subdivided Flocks in Group 3 were all in Kade town and by law had to be penned from 0900 to 1600 hours and were released thereafter to scavenge for food around town Supplementary feeding and feed supplements used varied within and between groups For example, in Kade (Table 4), except for one farmer in Group 1, all farmers feed cassava and plantain peels as supplements to their animals Corn grain supplementation was more popular among farmers who did not use their plantations for grazing their animals These farmers did not, however, supply salt licks to their animals as observed for farmers in groups 1 and 2

Although only three farmers had planted *Centrosema* and *Pueraria*, these plants were highly frequent in all the plantations studied Herbage species grazed under the palms included the following *Aspilia africana Asystasia gangetica Centrosema pubescens Euphorbia hirta E heterophylla Panicum maximum P laxum, Phyllanthus muellerianus* and *Pueraria phaseoloides*

Breeding management

The mating ratio was 3 to 9 ewes per ram One flock in Group 3 had no ram and depended on other 'scavenging' flocks for ram service Breeding was year round but 76%

Table 4 *Feeding regime and reproductive performance of sheep in Kade area*

		Supplement						Adult	
Farm no	Grazing hours	Peels*	Corn	Browse	Salt	Fertility (%)	Prolificacy (%)	Lamb (%)	Mortality (%)
Group 1									
1	6 5	+	–	–	+	96 3	140	22 9	2 0
2	5 0	+	+	–	+	100	160	50 0	0 0
3	6 0	–	–	+	–	180	7 1	0 0	0 0
4	7 0	+	+	–	+	87 5	140	7 5	3 4
5	6 5	+	–	–	+	88 9	150	33 3	6 7
Group 2									
6	5 0	+	–	+	+	83 3	180	55 6	0 0
7	5 5	+	–	+	+	81 8	170	13 3	0 0
8	4 5	+	–	–	–	100	160	40 0	0 0
9	3 5	+	+	–	–	80	180	26 7	0 0
Group 3									
10	4 0	+	+	–	–	100	150	0 0	0 0
11	4 0	+	+	–	–	89 5	160	18 1	0 0
12	3 5	+	+	–	–	100	160	25 0	0 0

* Peels of plantain and cassava + indicates supplement used

of the ewes lambed every eight months 20% twice a year, and 4% once a year Neonate lambs were penned for 2 to 3 weeks and allowed to graze only around the pens In four farms, lambs dropped in the rainy season were provided with heat in the pen for the first two weeks, by burning firewood every night

Health maintenance

Farmers in Group 3 never consulted a veterinarian but those in Group 2 called the vet during crises, e g severe diarrhoea while farmers in Group 1 consulted the ARS vet almost monthly Common health problems were helminthiasis, foot rot, skin disorders, inappetence, coughs, fractures and cuts Ethnoveterinary practices were noted in all groups, for example, sulphur drugs, known as 'M&B' were given with charcoal for diarrhoea, foot rot was treated with lime juice and skin disorders with shea butter Overall mean lamb mortality (Table 4) was significantly (P<0 05) higher in Group 2 (33 9%) than in groups 1 (24 2%) and 3 (14 4%) Adult mortality (0–6 7%) noted in Group 1 was from injuries inflicted by farmers whose crops had been damaged by the animals

Reproductive performance

Fertility (number of lambing ewes as a percentage of ewes exposed to the ram) was 96 5% in Group 3, 90 5% in Group 1 and 86 3% in Group 2 (Table 4) The differences were not significant (P>0 05) Lambs born as a percentage of ewes lambing (prolificacy) ranged from 140–180% On average, the flocks in Group 2 were the most prolific (173%) followed by those in groups 3 (157%) and 1 (154%) Prolificacy was also highest in flocks dominated by Djallonkes and Oudas as these are inherently more prolific than the Nungua Blackhead Fertility and prolificacy varied remarkably with flocks within groups

Farmers' perceptions of impediments to adoption

The following are the indicated constraints to the adoption of integrated tree crop–sheep production technology among smallholder farmers The percentage of respondents indicating each constraint is indicated in brackets

- Theft of animals bars absentee farmers from integrating sheep into their palms (92%)
- Crop damage by sheep (83%) leading to their being killed and to quarrels with neighbours (53%)
- Lack of credit to enable the farmer to put up pens and a farmstead (75%)
- Scarcity and high cost of breeding stock (75%)
- Dearth of dedicated shepherds that tend the animals (67%)

Remoteness of plantations from the town made it difficult to sell animals reared (42%)

Researchers' perceptions of the constraints

Technical know-how

The Ghanaian farmer is basically a crop producer and not a livestock husbandman Certainly the technology of integrating sheep into tree crops poses peculiar technical challenges that must be properly addressed through strong extension support

Lack of business attitude towards livestock rearing

Fianu (1993) argues that the main hindrance to adopting livestock innovation is the lack of a business attitude to livestock and that this is rooted in the culture of Ghanian farmers Thus a plantation owner will regularly cart his crop to distant markets but not his animals

Credit is not an issue for residing on the plantation either, for most farmers normally take up residence in a makeshift shelter when they break new ground to develop crop farms They do not seek credit for it Only a commitment to livestock rearing as a business will motivate the farmer to live on his plantation on account of his sheep

Prospective farmers, land tenure and credit

Prospective farmers present a different problem They face both land tenure and credit constraints in starting a plantation None of the palm farmers studied had any problem with land acquisition because they were members of the land owning group by birth or marriage, or had share-cropping arrangements with the caretakers However the two farmers who had 50% share-cropping arrangements (ABUNU) reported frequent queries from various members of the royal family Generally foreigners face serious barriers to land acquisition for plantation tree crops or livestock rearing Those gaining access to land through marriage also stand the risk of eviction on the demise of their spouses

Lack of capital is a further constraint for prospective farmers Most prospective farmers are youths with the technical know-how but without collateral Yet it is such farmers who can readily break through the cultural barriers to commercial stock rearing

Conclusions

Sheep integration into plantation tree crops has a great potential in Ghana and West Africa in general The full realisation of this potential, however, demands a comprehensive extension package to specifically popularise animal rearing as a business Then the complementarity between tree crops and livestock can be seen as an extra bonus to tree cropping The probable major problems to be addressed by the package are outlined below

Land tenure State intervention by acquiring blocks of land for lease to prospective farmers could help

Credit Recognition of professional diplomas as forms

of collateral has not always worked The loopholes can, however, be tightened and co-operatives made conduits for such credit which must be largely in kind

Cost of inputs The scarcity of breeding stock is partly because owners are unwilling to sell, and partly because Government breeding farms cannot cope with the demand The answer lies in 'outgrowers selected to multiply stocks from breeders for sale to other farmers Further, the high cost of veterinary drugs serves as a challenge to develop traditional herbal remedies Ethnoveterinary practices need to be enhanced

Diseases A high rate of helminthiasis, foot rot coccidiosis and ectoparasite infestation is fostered by the humid conditions under the plantation canopy Their control should be central in the technological package and manure should be composted before being applied to the crops to check the recycling of helminths

Canopy closure This will drastically reduce feed production after the 12th year of existence Crop residues could come to the rescue here It may also be possible to reopen the canopy by judicious pruning of palm fronds or felling of some palm trees Alternatively the trees may be widely spaced so as to avoid total canopy closure However, these need to be researched into, to work out the economics of accepting crop losses for lamb increases

Overgrazing This will increase erosion hazard through soil compaction and cause a population explosion of *Chromolaena adorata* and other weeds Crops like citrus, may suffer debarking There will therefore be a need for regular farm visits by technical personnel to advise on grazing pressure

Damage to arable crops This could be prevented by fencing To cut down costs, live fences could be planted using the tree crops

Mixed species Other species of animals like goats cattle and poultry could be tried However cattle could choke to death by swallowing fallen citrus fruits, especially if they are mature but not ripe

Record keeping This should be part of the package so as to avoid subsidising the animals from crop sales or vice versa

Marketing animals Regular and prompt marketing of animals when they reach economic maturity is a *sine qua non* for any significant improvement in animal production It could even be made a condition for access of the package by interested farmers

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L'élevage ovin sous arboriculture dans la zone forestière du Ghana: problèmes et perspectives

Résumé

Cette etude a ete effectuee pour identifier les possibilites d'integration de l'elevage ovin a l'arboriculture au Ghana ainsi que les obstacles eventuels a l adoption de cette innovation Neuf paysans qui pratiquaient le systeme integralement (groupe 1) et partiellement (groupe 2) et cinq autres proprietaires de moutons qui ne le pratiquaient pas (groupe 3) avaient etaient interroges et leurs modes d elevage observes Les normes de gestion utilisees etaient mediocres dans tous les trois groupes etudies Les diarrhees, le pietin et les dermatoses etaient frequentes Les taux de fertilite et de prolificite etaient differents selon le groupe considere Au sein des groupes la prolificite dependait de la race de l animal, les Djallonke et les Ouda etant plus prolifiques que les individus issus de Nunga a tête noire Les obstacles a l adoption de l integration de l elevage ovin a l arboriculture sont entre autres le vol des moutons au pâturage les degats causes aux cultures par les animaux egares l eloignement des plantations arboricoles le manque de capitaux, le coût éleve des reproducteurs et l'absenteisme des proprietaires Des suggestions ont ete avancees pour promouvoir l adoption de cette technologie

Système traditionnel d'élevage caprin sur le plateau central du Burkina Faso

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Résumé

Soixante onze (71) troupeaux de petits ruminants de quatre villages de la savane du plateau central du Burkina Faso ont ete suivis pendant deux ans pour mieux caracteriser le systeme traditionnel d'elevage caprin Les résultats obtenus montrent que le systeme d'elevage pratique est tres rudimentaire, avec divagation des chevres en saison seche et absence de complementation alimentaire en sus des pâturages naturels, de soins sanitaires, et d'infrastructure adequate 50,7% des troupeaux sont composes de chevres uniquement, contre 36,6% constitues de moutons et de chevres 33,8% ont plus de 10 têtes de caprins chacun, 29,5% ont entre cinq et 10 têtes, et 36,6% en ont moins de cinq Entre 25 et 28% des animaux par troupeau sont des mâles, soit un ratio de 1 mâle pour 3 femelles Les animaux de 6 a 18 mois sont les plus nombreux, suivis de ceux de 18 a 36 mois Le poids vif moyen a 3 ans est de 20,69±0,67 kg Le GMQ pendant les 120 premiers jours est de 131,1 g/j contre 19,2 g/j de 0 a 3 ans

Introduction

Le systeme traditionnel demeure la pratique dominante parmi les modes d'elevage des petits ruminants au Burkina Faso Cela est encore plus vrai en ce qui concerne l'espece caprine locale, pratiquement delaissee sans soins nutritionnels ou sanitaires, alors qu'elle constitue le troupeau numeriquement le plus important et economiquement le plus exploite par les eleveurs et agro-pasteurs du pays La presente etude a ete entreprise compte tenu du poids economique (consommation menagere, caisse de menues depenses domestiques) et socio-culturel (rites coutumiers, mariages, baptêmes), ainsi que de la tres large repartition des caprins dans les exploitations paysannes du Burkina Faso Elle vise essentiellement a promouvoir une meilleure connaissance des pratiques traditionnelles utilisees sur le plateau central du pays dans l elevage et l exploitation des chevres de race locale

Méthodologie

L enquête a couvert soixante onze (71) troupeaux avec une fiche-questionnaire completee par des pesees mensuelles systematiques sur chaque animal recense Les quatre (4) villages-sites de cette etude (Kamboinse, Pabre Sogodin, Sakoula) sont situes sur le plateau central du Burkina Faso, en zone subsaheliennne, et reçoivent annuellement entre 400 a 600 mm de pluies Les temperatures varient de 45 C en saison seche chaude a 8–10 C en saison froide et la vegetation est de type savane arbustive

Résultats

Mode de conduite du troupeau

Bien que les agro-pasteurs de la zone soient tous sedentaires, la divagation reste une caracteristique dominante pour les caprins Elle est totale en saison seche, alors qu en hivernage, les animaux sont surveilles plus ou moins etroitement pour eviter les degâts aux cultures

Les types d'élevages

L'etude de la repartition des especes exploitees au sein des elevages suivis (tableau 1) revele que 50,7% des troupeaux sont constitues exclusivement de caprins, 36,6% comprennent des ovins et des caprins 2,8% des bovins et caprins, 8 4% les trois especes, alors que seul 1,4% des troupeaux sont constitues exclusivement d ovins

Infrastructures d'élevages

66% des elevages enquêtes disposent d'une case au toit de paille comme abri pour l'ensemble des especes presentes Ce local est souvent trop etroit pour l'effectif qui y loge, mal aere et surtout jamais balaye Le fumier s entasse donc jusqu a son ramassage au debut de l'hivernage pour la fumure des champs

Alimentation et soins de santé

La base de l alimentation des animaux reste le pâturage naturel avec des herbacees notamment *Loudetia togoensis Andropogon gayanus Cenchrus sp* , et les ligneux Seuls les moutons de case, les vaches laitieres et les bovins a l engrais reçoivent les SPAI, les fanes d arachides et de niebe, et les tiges de sorgho recolte Les caprins n'en reçoivent pas Deux eleveurs sur les 71 donnent la pierre a lecher artisanale a leur animaux Celle-ci est remplacee chez les autres par le sel gemme

Tableau 1 *Types d elevages pratiques dans les quatre villages (Kamboinse Pabre Sakoula et Sogodin)*

		Types d elevages						
Villages	Nombre total de troupeaux enquêtés	Bovin	Ovin	Caprin	Ovin + caprin	Ovin + bovin	Bovin + caprin	Bovin + ovin + caprin
Kamboinsé	13	0	0	6	4	0	–	3
Pabré	13	0	1	4	6	0	1	1
Sakoula	30	0	0	19	9	0	–	2
Sogodin	15	0	0	7	7	0	1	0
Total (%)	71 (100%)	0	1(1 4%)	36(50 7%)	26(36 6%)	0	2(2 8%)	6(8 5%)

En matiere de sante, 4% des eleveurs enquêtes ont eu recours une fois aux deparasitants gastro-intestinaux modernes Aucun n a jamais vaccine ni detique ses chèvres

Taille du troupeau

La repartition des troupeaux selon les effectifs caprins par exploitation est presentee au tableau 2 Dans les villages de Kamboinse et Sakoula respectivement 53,3% et 43,3% des troupeaux ont plus de 10 têtes de chevres, alors qu'a Pabre et Sogodin, respectivement, 53,8 et 60% des troupeaux ont moins de cinq têtes

Structure du troupeau

Sex-ratio des troupeaux

La proportion de mâles par troupeau est de 22 2% a Kamboinse, 31,9% a Pabre 28% a Sakoula et 27,8% a Sogodin Dans l'ensemble de la zone etudiee, la moyenne est de 27 5% de mâles par troupeau, c'est-a-dire environ 25,0% mâles et 75,0% femelles (tableau 3)

Pyramide des âges

Les figures 1A, 1B, 1C et 1D presentent les histogrammes des effectifs caprins en fonction de l'âge des animaux pour chaque village Les animaux de 6 a 18 mois sont les plus nombreux, suivis de ceux de 18 a 36 mois d'âge Les animaux âges (plus de 36 mois) sont nettement moins nombreux surtout chez les mâles ou il n en existait pratiquement pas

Evolution pondérale des chèvres

A l âge d un mois, le cabri pese en moyenne 3,25 0,24 kg contre 20 69±0 67 kg a 3 ans La figure 2 montre la courbe-type d'evolution ponderale de la chevre Mossi" en elevage traditionnel selon le sexe On observe une legere superiorite (non significative a 5%) des femelles par rapport aux mâles Le tableau 4 presente les gains moyens quotidiens (GMQ), qui sont de 57,2 g/j et 73 8 g/j respectivement pour les mâles et les femelles de 0 a 4 mois

Tableau 2 *Importance relative des troupeaux selon leur effectif caprin par village*

	Effectif par troupeau			
Villages	Effectif total	Moins de 5 têtes	5 a 10 têtes	Plus de 10 têtes
Kamboinse	13	3 (23 %)	3 (23%)	7 (54%)
Pabré	13	7 (54 %)	3 (23%)	3 (23%)
Sakoula	30	7 (23 3%)	10 (33 3%)	13 (43 3%)
Sogodin	15	9 (60 %)	5 (33 3%)	1 (6 7%)
Total	71	26 (36 6%)	21 (29 6%)	24 (33 8%)

Tableau 3 *Sex ratio au sein des elevages traditionnels de chevres des villages de Kamboinse Pabre Sakoula et Sogodin (Plateau central du Burkina Faso)*

Sexe	Kamboinse	Pabré	Sakoula	Sogodin	Moyenne
Taux de mâles	22 15	31 98	28 00	27 80	27 50
Taux de femelles	87,85	68 02	72 00	72 20	72 5

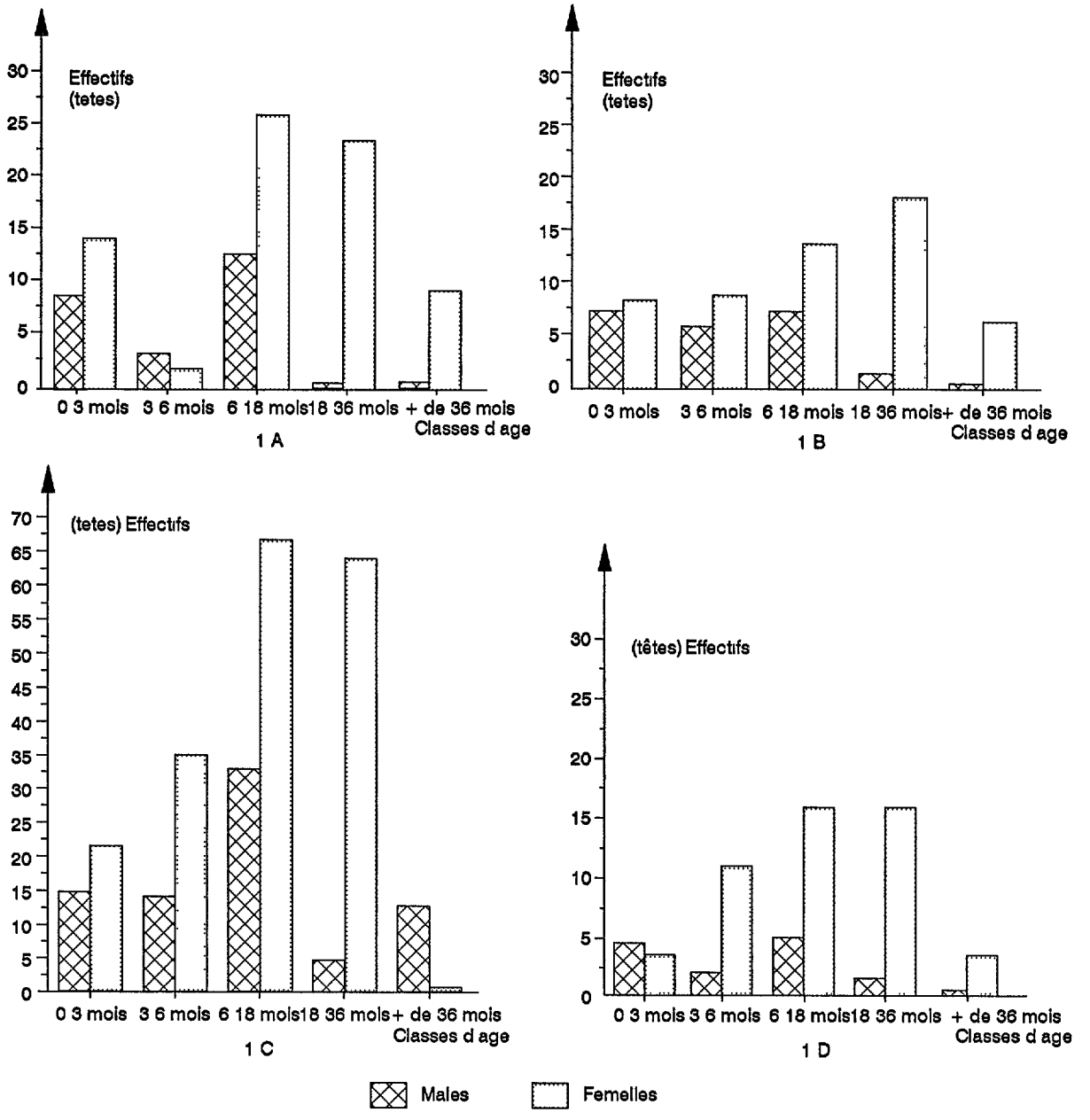

Figure 1 *Sex ratio au niveau des villages de 1A Kamboinse 1B Pabre 1C Sakoula 1D Sogodin*

Tableau 4 *Gain moyen quotidien (GMQ en g/j) de caprins Mossi en systeme d elevage traditionnel (Plateau central du Burkina Faso)*

Periode	Mâles	Femelles	Mâles et Femelles
0–120 j	57 2	73 8	131 1
0–180 j	42 5	48 2	90 0
0–300 j	41 8	40 1	81 9
0–360 j	36 6	37 4	74 0
0–18 mois	29 6	29 3	58 9
0–2 ans	23 7	25 2	97 8
0–3 ans	–	19 2	19 2

Ce parametre baisse a environ 29 g/j pour la periode de 0 a 18 mois Compte tenu de l absence de mâles de plus de 36 mois on a pu calculer le GMQ pour cette tranche d âge Dans les autres cas les femelles croissent generalement plus vite que les mâles tandis que le GMQ baisse au fur et a mesure que l âge des animaux avance quel que soit le sexe

Discussion et conclusion

Le systeme d'elevage traditionnel des caprins du plateau central du Burkina Faso peut être classé comme systeme agro-pastoral selon les categorisations

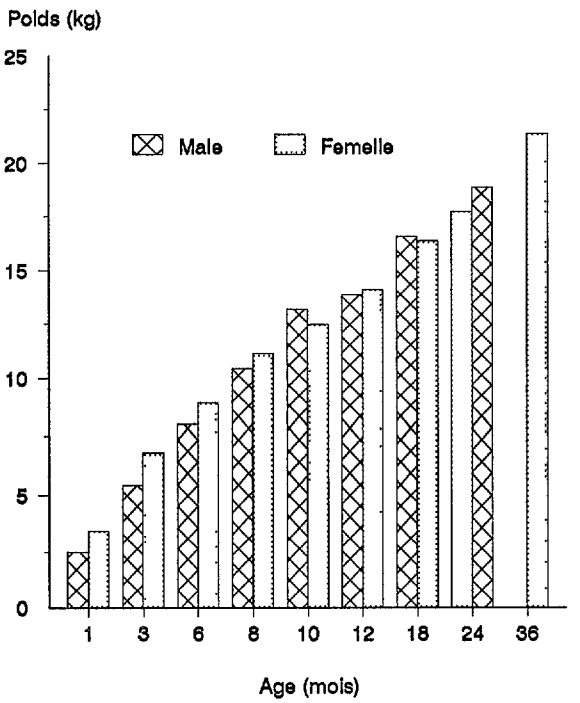

Figure 2 *Evolution ponderale des chevres elevees sous systeme traditionnel du plateau central*

proposees par Wilson, de Leeuw et de Haan (1983), car 10 a 50% des revenus des menages de ce systeme viennent des produits de l elevage Le ratio ovins/caprins dans cette etude est nettement a l'avantage des caprins Un tel rapport a ete egalement etabli par Wilson (1991), qui precise qu'il varie selon la region 1 pour 11 en Zambie et en Centrafrique 1 pour 2 au Nigeria, 1 pour 8 au Swaziland A l inverse le Senegal et la Mauritanie ne comptent qu'un caprin pour 2 a 3 ovins Le sex-ratio d'un mâle pour trois femelles observe ici s accorde avec celui rapporte par Wilson (1986, 1987) et Peacock (1983) pour la sous-region ouest-africaine Cela est probablement dû a la trop rapide et intense exploitation des mâles, alors que les femelles sont gardees le plus longtemps possible pour l extension du troupeau L'absence de soins zoo-sanitaires pour les caprins contrairement aux ovins qui font l objet d'un suivi relativement meilleur au sein des elevages traditionnels étudies, est une caracteristique que rapportent egalement Charray *et al* (1980) et Bourzat (1985) Mais, il existe des regions d'Afrique, notamment a l'est et au sud du continent ou, compte tenu de l'importance tres nette de la chevre dans la micro industrie et l'artisanat local, cet animal fait l'objet d'une plus grande attention sur le plan aussi bien sanitaire que zootechnique (Wilson, 1978 Wilson et Ole Maki, 1989)

Les resultats enregistres ici sur le suivi des poids vifs et la croissance des caprins sont similaires a ceux rapportes par Bourzat (1985) dans la même region, mais inferieurs a ceux de Mombeshora *et al* (1985) et Hale (1986) sur les chevres locales du Zimbabwe, et Bizimungu (1986) sur les caprins du Rwanda-Burundi Les conditions tres difficiles d'elevage et l'encadrement technique trop sommaire des exploitations caprines de la zone de la presente etude expliquent sans doute les performances enregistrees Il convient toutefois de noter que ces performances bien qu apparemment faibles, notamment pour la croissance (GMQ), revelent d'importantes potentialites intrinseques de la race locale Cela suggere qu avec un minimum d'amelioration du systeme d elevage actuel (conduite, alimentation, soins de sante, gestion des effectifs, hygiene des locaux) on peut s attendre a une production plus substantielle (viande lait peaux fumier)

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Traditional goat management systems in the central plateau of Burkina Faso

Abstract

Seventy-one small ruminant flocks in four villages in the savannah area of Burkina Faso central plateau were monitored for two years to better characterise the traditional goat production system Results showed that this system was very rudimentary It was characterised by free roaming during the dry season, non-supplementation of natural pastures, lack of veterinary care and inadequate infrastructure Animals in 50 7% of the flocks were only goats while 36 6% of flocks had both sheep and goats There were more than 10 animals in 33 8% of the flocks while 29 5% had between 5 and 10 and 36 6% had less than 5 Between 25 and 28% of animals per flock were males, hence a sex ratio of one male to three females Six to 18-month old animals outnumbered those aged 18 to 36 months Average 3-year live weight was 20 69±0 67 kg while average daily weight gain for the first 120 days was 131 1 g/d compared to 19 2 g/d from birth to 3 years of age

Enquête sur l'élevage caprin dans les hauts plateaux de l'Ouest-Cameroun

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[1]Ministere de l'agriculture, Yaounde (Cameroun)

Résumé

Une enquête a ete menee a l'aide d'un questionnaire structure aupres de 116 menages choisis au hasard et repartis dans 25 villages de la province de l'Ouest-Cameroun Les eleveurs enquêtes etaient pour la plupart analphabetes (62,9%) avec un âge moyen compris entre 31 et 60 ans (81,5%) L'elevage des chevres est une activite essentiellement masculine (97,47%) Sur un effectif de 548 caprins observes, 22 sont des boucs 353 des chevres et 173 des chevreaux La taille moyenne des troupeaux est de 6,8 animaux par menage Le systeme d'elevage est de type extensif, avec divagation permanente (5%), laquelle disparaît au profit de la divagation avec claustration saisonniere (84%) et de la claustration permanente (11%) Le type genetique caracterise par 1 à 1,5 mise bas par an repartie sur toute l'année (26,09%), en saison seche (62,31%) ou en saison des pluies (11,60%), appartient a la race naine d Afrique occidentale Les problemes alimentaires et sanitaires sont les principaux obstacles au developpement de cet elevage

Introduction

Au Cameroun les petits ruminants sont eleves dans toutes les zones géoclimatiques Leurs rôles socio-economiques sont bien connus (Vallerand et Branckaert, 1975) Le cheptel caprin de la province de l'Ouest est estime a 21% du cheptel national (Minepia, 1987) La forte densite de la population humaine (plus de 200 hts/km dans certaines regions) ainsi que la pratique d une agriculture de plus en plus intensive ont donne lieu a une occupation quasi permanente des terres de cette zone Malheureusement on ne dispose guere d'information sur les consequences de ce phenomene sur la distribution et la gestion du betail dans la region La presente etude a ete conçue pour collecter et analyser des donnees sur le systeme d'elevage caprin ainsi que sur les principaux problemes et les obstacles rencontres dans ce domaine dans la region des hauts plateaux de l Ouest-Cameroun

Matériels et méthodes

Caractéristiques géoclimatiques de la zone d'étude

La province de l'Ouest est une region de hauts plateaux dont l altitude varie de 1400 a 2000 m Les sols sont volcaniques par endroits et le climat est de type soudano-guineen modifie par l altitude La temperature varie de 16 a 27 C, l'humidite relative oscille entre 49 et 97%, et la pluviometrie, de l ordre de 1600 mm par an, est repartie sur une seule saison des pluies (mars-novembre) La vegetation est de type savane arbustive avec quelques galeries forestieres

Collectes des données

L enquête a ete menee au moyen d un questionnaire structure aupres de 116 menages repartis dans 25 villages de tous les departements de la province Les donnees ont ete rassemblees entre janvier et mars 1992 avant le redecoupage administratif qui a vu le nombre de departements de la province de l'Ouest passer de six a huit Les aspects couverts par le questionnaire se rapportent a certaines caracteristiques demographiques des enquêtes ainsi qu'aux informations techniques et economiques pouvant influer sur l'elevage caprin Les donnees ont ete analysees a l aide de la statistique descriptive

Résultats

Profil socio-économique des enquêtés

Les proprietaires de caprins sont generalement d un âge avance (tableau 1) L âge moyen varie d un departement a l autre Cependant, pour l'ensemble de la province, plus de 80% des eleveurs de caprins avaient entre 30 et 60 ans Le proprietaire de chevres est en general un chef de famille bien installe au village et dont la taille du troupeau depend souvent du nombre d enfants en âge de s'occuper des animaux Les plus jeunes eleveurs (7%) âges de 20 a 30 ans, sont des

heritiers obliges de par les coutumes locales, de s installer au village

Le niveau d etude est en general tres bas 62,90% des eleveurs etant illettres, donc incapables d enregistrer des donnees fiables sur leurs animaux 23,3% d entre eux ont fait l'ecole primaire ou suivi une formation rapide dans un centre de formation professionnelle (Station d elevage de Kounden INADES formation et centre de Bafang), 12,9% ont beneficie d'un enseignement secondaire alors que seuls 0,9% d entre eux ont le niveau universitaire (tableau 1) Malgre le faible niveau d'alphabetisation les eleveurs semblent assez receptifs aux innovations susceptibles d'ameliorer la productivite de leurs animaux

Tableau 1 *Repartition par âge et niveau d education des eleveurs de caprins de la Province de l Ouest Cameroun*

Caracteristiques	% des eleveurs
Age (annees)	
21 – 30	6 60
31 – 40	18 50
41 – 50	27 30
51 – 60	35 70
>60	11 90
Total	100 00
Niveau	% des eleveurs
Illettre	62 90
Primaire et formation rapide*	23 30
Secondaire	12 90
Universitaire	0 90
Total	100 00

* INADES Formation Station de Kounden Centre de formation professionnelle de Bafang

L'elevage des chevres est apparu comme une activite essentiellement masculine, 97,47% des eleveurs etant des hommes contre seulement 2,53% de femmes

Taille et structure des troupeaux

En moyenne, 68% des menages enquêtes elevent des chevres (tableau 2)

Des proportions plus importantes sont observees dans les departements du Noun (90%) Nde (89%) Bamboutos et Menoua (78%) Le sex ratio de 1 16 est tres faible dans la province, avec 22 boucs seulement, surtout des jeunes, contre 353 chevres adultes Dans la Menoua le sex-ratio est de 1 24 Les troupeaux se caracterisent par une tres faible proportion de chevreaux par rapport aux meres (173 chevreaux pour 353 chevres) soit un rapport de 1 chevreau pour 2 chevres adultes

La taille moyenne du troupeau pour l'ensemble des menages de la province avoisine 7 Le coefficient de correlation entre la taille du troupeau et celle des menages, de 0,40, est significatif a 0,1% et indique que le nombre de caprins dans les menages est proportionnel a la main-d'oeuvre disponible et peut-être aussi aux besoins de consommation

L'origine des animaux de fondation varie d'un menage a l'autre Ainsi, 80% des eleveurs ont achete leurs animaux, alors que 28,4% et 25 3% les ont obtenus respectivement sous forme de don et d'heritage de leurs parents Alors que 61 34% des eleveurs pratiquent cette activite pour un but essentiellement financier 36,97% le font par tradition et 1,69% pour l autoconsommation Même si de plus en plus, pour la majorite des paysans enquêtes le rôle economique de l'activite predomine, l elevage des chevres reste encore de type "tirelire que le proprietaire n'exploite qu'en periodes de difficultes economiques (maladies, obseques, scolarite des enfants impôt, etc)

Système de gestion des troupeaux

Le systeme d'elevage est de type extensif (tableau 3) avec divagation permanente (5%) divagation et claustration saisonniere (84%), et claustration permanente (11%) Aucun des eleveurs enquêtes n'est specialise dans l engraissement ou la reproduction et, en general la même personne produit des chevreaux, les eleve en vend quelques-uns et garde quelques animaux pour la reproduction

Des logements ou des abris individuels sont amenages pour les chevres dans 37% des cas Quelques-unes sont mises au piquet le soir sous les verandas ou dehors derriere les habitations (20%), ou tout simplement dans la case d habitation du propriétaire,

Tableau 2 *Structure de la propriete des caprins par departement dans la province de l Ouest Cameroun*

Departements	Ménages			Animaux Adultes		Chevreaux	
Effectifs	Enquêtes	% eleveurs		Chevres	Boucs	Sex ratio	Moyen[a]
Noun	10	90 0	23	2	1 12	11	4,0
Bamboutos	37	78 2	91	6	1 15	44	5 0
Haut-Nkam	16	31 2	50	3	1 17	25	15 6
Menoua	23	78 3	122	5	1 24	62	10 5
Mifi	21	52 7	37	3	1 12	17	5 6
Nde	9	88 9	30	3	1 10	14	5,9
Total Ménages	116	68 1	353	22	1 16	173	6,8

a Propriétaire seulement

cuisine et dependance (23%) Il arrive cependant que de grands troupeaux soient sans abri, mais enfermes dans un enclos pendant la nuit (20%)

Tableau 3 *Systemes de gestion des troupeaux de chevres dans la province de l Ouest Cameroun*

Départements	Divagation permanente (%)	Confinement saisonnier (%)	Confinement permanent (%)
Noun	2 2	93 0	5 0
Bamboutos	0 0	87 0	13 0
Haut Nkam	10 0	83 0	7 0
Menoua	0 0	83 0	17 0
Mifi	0 0	76 0	24 0
Nde	16 0	84 0	0 0
Ensemble de la Province	4 67	84 33	11 0

Dans 25,57% des elevages, les chevres ne reçoivent aucune complementation alimentaire La majorite des paysans (74,43%) donnent cependant aux animaux une complementation sous forme de mais ou de dechets de cuisine (epluchure de banane, de patate)

Les principaux symptômes pathologiques frequemment observes chez les chevres sont rapportes au tableau 4

Tableau 4 *Principales causes de mortalite observees chez les chevres de la province de l Ouest Cameroun*

Causes	% des eleveurs*
Pneumonie et maladies respiratoires	60 6
Diarrhees	57 2
Dermatoses	37 6
Affections des pieds	18 8
Accidents	16 2
Avortements	29 7
Morts subites	5 1

* Un eleveur peut relever plusieurs causes

Les pneumonies et les maladies respiratoires representent les affections les plus mentionnees par les eleveurs (60 6%) suivies des diarrhees (57 2%) et des dermatoses (37,6%) Les avortements (29 7%), sans être des maladies a proprement parler sont regulierement cites et sont les consequences de saillies precoces des jeunes femelles aggravees par le stress nutritionnel Les accidents rapportes (16 2%) concernent les animaux ecrases par des vehicules ou tombes dans des pieges tendus aux animaux sauvages Les morts subites (5%) sont dues a l'ingestion de plantes toxiques ou de produits chimiques (pesticides insecticides, etc) ou a des causes non identifiees

Peu d'eleveurs beneficient des services des divers centres zootechniques et veterinaires (CZV) dissemines dans la province Ainsi, la protection sanitaire des animaux n'est assuree que par 24 05% d'entre eux Les prestations obtenues se limitent d ailleurs au deparasitage externe (5%) interne (13%) ou a la fois externe et interne (6%)

Performances de reproduction

Prolificite

Le tableau 5 donne les differents types de naissances enregistrees dans la zone d etude Il montre que 12% des chevres ont donne des naissances simples, alors que 88% des naissances sont multiples dont 61% de naissances doubles, 25,97% de naissances triples et 1,3% de naissances quadruples

Age a la premiere mise bas

Un pourcentage non negligeable d'eleveurs (36 71%) ignorent l âge a la premiere mise bas de leurs animaux (tableau 5) Pour 29,11% d'entre eux, cet âge se situe entre 11 et 18 mois les autres le situant plutôt entre 18 et 24 mois (22,78%) et même entre 24 et 36 mois (11,39%)

Distribution des mises bas au cours de l'année

Pour 62 31% des eleveurs de la province, les mises bas ont lieu en saison seche, tandis que 26,09% estiment qu elles ont lieu toute l'annee et que pour 11,60% d'entre eux, elles sont plutôt concentrees en saison des pluies (tableau 5) Dans la pratique cependant, on sait que la chevre locale peut mettre bas toute l annee

Tableau 5 *Performance de reproduction des chevres de la province de l Ouest Cameroun*

Caracteristiques	%
a) Type de mise bas	
Simple	11 69
Double	61 04
Triple	25 97
Quadruple	1 30
Total	100 00
b) Age (mois)	
11–18	29 11
18–24	22 78
24–36	11 39
Inconnu	36 71
Total	100 00
c) Periode	% des éleveurs
Toute l annee	26 09
Saison sèche	62 31
Saison des pluies	11 60
Total	100 00
d) Niveau	% des eleveurs
1	74 36
1 5	19 23
2	6 41
Total	100,00

Nombre de mises bas/chèvre/an

Le nombre de mises bas par chevre et par an est tres variable Il est de 1 pour 74,36% des eleveurs de 1,5 pour 19 23% d'entre eux et de 2 pour les 6,41% restants (tableau 5) Toutefois, dans les conditions traditionnelles de cet elevage, ou le sevrage est naturel et n'intervient qu a l'assechement du lait maternel et lorsque le chevreau est deja capable de ruminer (4–5 mois d'âge), il est pratiquement impossible d enregistrer 2 mises bas/chevre/an Le chiffre de 1 a 1,5 mise bas par an et par chevre semble donc plus indique

Age de reforme des chèvres

La reforme des chevres dans cette province est dictee par le nombre de mises bas effectuees par l'animal chez son proprietaire L'âge de reforme varie de 2 a 10 ans et constitue la duree de vie reproductive de la chevre, l'eleveur conservant une bonne reproductrice aussi longtemps que possible

Discussion

L'âge avance des proprietaires est dû soit a un certain desinteressement des jeunes de cette activite, soit au manque de moyens financiers ou a l'exode des jeunes vers les villes Le nombre limite de femmes dans ce secteur s'explique probablement par la coutume qui leur impose l'elevage des volailles et reserve celui du gros betail aux hommes Toutefois, les choses semblent evoluer de plus en plus de femmes etant desormais proprietaires de gros betail

La faible proportion des chevreaux par rapport aux meres pourrait être lie au faible taux de fertilite en rapport avec une mauvaise repartition des boucs dans la region, a la mise au piquet saisonniere des boucs mais aussi a un taux eleve de mortalite des jeunes avant l'âge d'un an (24 a 32%)

Dans le Haut-Nkam une faible proportion d'eleveurs (31 25%) detiennent des effectifs plus importants (15,6%) qu'ailleurs dans la province (Noun, Nde, Mifi) ou l'activite est tres repandue mais avec des effectifs reduits Dans la Menoua par contre, l elevage des chevres est tres repandu et les effectifs par exploitation sont importants

Du fait de l'explosion demographique et de l'extension consequente des zones de culture source de nombreux conflits entre paysans, la divagation avec claustration en saison de cultures devient le mode de gestion le plus repandu Mais la claustration permanente semble constituer la tendance generale Toutefois, contre toute attente, des pertes de poids de l'ordre de 15 a 20% sont enregistrees pendant la saison des pluies Les difficultes rencontrees pour alimenter correctement les animaux pendant cette claustration saisonniere sont beaucoup plus liees a l'exiguite des parcelles individuelles et peut être aussi a une mauvaise gestion de l'espace, qu'a un manque de fourrage de bonne qualite Les mortalites enregistrees pendant la periode de claustration sont imputables en partie au moins, a la pluie, responsable de nombreux cas de pneumonie signales

Les problemes sanitaires observes sont peut-être lies soit a l eloignement des centres zootechniques veterinaires generalement bases dans les centres urbains soit a la non utilisation des medicaments et vaccins dont le conditionnement en doses multiples (flacons de 250 a 1000 doses) est inadapte aux besoins des eleveurs qui ne possedent que 7 animaux seulement en moyenne De plus, la taille reduite des troupeaux n'encourage pas les eleveurs a faire appel aux CZV dont les agents sont perçus par les paysans beaucoup plus comme des collecteurs d'impôts que comme des partenaires Le regroupement des paysans en cooperatives d'eleveurs pourrait être une solution

Les types de naissance obtenus dans cette etude se rapprochent de ceux rapportes ailleurs en Afrique (Buadu 1972, Mathewman 1977 cites par Okello et Obwolo 1985 Wilson,1976) Les moyennes d âge a la premiere mise bas enregistrees sont proches de celles obtenues sur d'autres chevres tropicales et subtropicales (CIPEA 1979 cite par Okello et Obwolo,1985, Wilson, 1976, Haumesser et Coll 1975, Devendra 1970)

La concentration des mises bas en saison seche pourrait être associee au confinement saisonnier des animaux qui liberes apres les recoltes, reprennent leurs activites sexuelles vers la fin de la saison des pluies avec pour consequence des mises bas en fin de saison seche

Conclusions et recommandations

La chevre joue un rôle important dans la vie des populations de la province de l Ouest Cameroun et ce comme source de proteines la viande de chevre etant plus appreciee que celle de boeuf L elevage caprin constitue une epargne sur pied facilement mobilisable Le rôle socio culturel de la chevre utilisee pour des dons, la dot, des sacrifices des impôts etc est important mais mal evalue compte tenu du caractere ponctuel de ces pratiques Du point de vue de la gestion du troupeau, la chevre utilise des ressources alimentaires tres diverses et traverse en general la saison seche sans grand dommage Son rythme de production est plus eleve que celui des bovins et ovins locaux Sur un plan strictement economique tout produit obtenu de la production caprine peut être considere comme un benefice dans la mesure ou en dehors de l achat de l'animal, l'eleveur n'investit que tres peu dans cette speculation

Les principaux obstacles a la production caprine dans la province de l'Ouest concernent l'alimentation, le logement, la sante et le manque de capitaux Des recherches devraient porter sur une meilleure evaluation de la productivite de la chevre locale notamment la fecondite l'intervalle entre mises bas, la vitesse de croissance et la maturite sexuelle, lesquels peuvent constituer des facteurs d amelioration Une selection rigoureuse et le croisement devraient permettre de decanter la population caprine de la province de tous les

animaux improductifs ou peu productifs On pourrait aussi envisager l'introduction de chevres a potentiel genetique superieur pour accroître les potentialites des animaux locaux Avec l extension des cultures de contre-saison qui occupent les terres pendant la saison seche, la chevre s'accommodera de moins en moins d un elevage de type extensif La claustration permanente semble être a moyen terme l'unique alternative pour la survie de cette activite Il est donc fondamental que l eleveur de caprins de la province de l Ouest-Cameroun change de mentalite quant au rôle reel de la chevre et s'emploie a revoir sa methode de production Par exemple, une meilleure gestion de l'espace reduit des exploitations individuelles, notamment par l'introduction des techniques d'agroforesterie telles que la culture en couloirs des plantes fourrageres pourrait permettre d'ameliorer le disponible alimentaire et la qualite de la ration Une etude plus serieuse devrait être menee pour inventorier les principales maladies des chevres et proposer un programme de prophylaxie adapte

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Survey on goat production in the high plateau area of western Cameroon

Abstract

A survey of goats was carried out using a structured questionnaire in 116 randomly selected households in 25 villages of western Cameroon province Most pastoralists interviewed were illiterate (62 9%) and aged between 31 and 60 years (81 5%) Goat production was mainly a male activity (97 4%) Out of a total of 548 animals studied, 22 were males, 353 were females and 173 were kids Average size of flocks was 6 8 animals per household The production system was extensive with permanent free roaming (5%) progressively giving way to free roaming with seasonal penning (84%) and permanent penning (11%) The genetic type is the West African Dwarf goat It is characterised by 1 to 1 5 kiddings a year, occurring all year round (26 09%), during the dry season (62 31%) or the rainy season (11 60%) Feed and health constraints were identified as the major obstacles to livestock development in this system

Goat production in Botswana: Factors affecting production and marketing among small-scale farmers

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Abstract

Through government programmes, the goat population among small-scale farmers increased from 0 6 million in 1973 to 2 12 million goats by 1990 Yet goat sales and consumption levels are very low Production and marketing are plagued by a number of constraints, including lack of funds for investments in proper facilities, long distances to markets and risks

Introduction

Livestock production in Botswana is a very important socio-economic activity The cattle industry is the principal sector with a major contribution to beef export to the EEC market However cattle ownership is highly skewed with 10% of the population owning 60% of the national herd in 1990 and 40% of the population not owning any cattle (MFDP 1991) The semi-arid climate of the region combined with its low population density provide a great opportunity for livestock production Also lack of alternative investment opportunities in rural areas has promoted investment in livestock (Chernichovsky et al 1985, MFDP 1991) For smallholder (traditional) farmers more investments are made in the small stock sector Over 80% of the small stock, 70% of which are goats are in the hands of traditional farmers (MoA 1991) Women, who are among the poorest own more goats than their male counterparts who have more resources and can afford to own cattle Ownership of goats by the poorer sector of farmers is encouraged by the government through a number of projects/policies and programmes discussed later in this paper

Since all the traditional farmers live in the communal lands (70% of the total area) most of the goats are found in these areas Here extensive grazing is practised and very little controlled grazing is done About 5 0 million animals (2 6 million cattle 2 2 million small stock and 0 2 million donkeys) were found in these areas in 1990

The role of the Government of Botswana (GOB)

Some of the objectives set by the GoB in the small stock subsector are

- To improve rural nutritional and income status through increased productivity of milk and meat, and sales through improved management and genetic potential
- Assist the marketing of small stock through improving handling and marketing facilities
- Use projects like AI, ram subsidy (Boer goat was introduced to improve the indigenous goats), Financial Assistance Policy (a grant of up to P 25,000 to start a goat or sheep project is given to a farmer, and women are given priority) and pricing policy as an incentive to promote the smallstock sub-sector
- Through the implementation of service to livestock owners in communal areas programme (SLOCA), provide technical assistance to Botswana Cooperative Union (BCU) responsible for livestock management and marketing An increase in prices of small stock through BCU, increased animals sent to the official market, the Botswana Meat Commission (BMC) from 334 goats in 1982 to 4127 goats in 1983 and to 41,997 in 1989 (MFDP 1991)
- Build dams and assist syndicates in costs of drilling boreholes with a minimum of P 20,000 This is necessary because there is very little surface water
- Establishment of 10 trek routes covering a total of 2540 km (MFDP 1991) to assist those farmers who trek their animals to BMC or municipal abattoirs Each of these routes has watering and kraaling facilities and a kilometre yard to hold sick and weak animals
- Provide disease control measures like free vaccination from common diseases, cordon fences in production areas and the establishment of six main Livestock Advisory Centres (LACs) and 25 subsidiaries

The national production and marketing situation

In 1985 over 99% (1 1 million goats) of the goats were in the hands of traditional farmers on 53,000 farms By 1990 the number of farms owning goats had increased to 68,900 with 2 1 million goats Most farms own between 1 and 30 goats Statistics show, however, that

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goats do better (because they are browsers) during dry seasons and droughts than during wet seasons, e g in 1968 there were 1 9 million goats but this number was reduced to 0 6 million during the wet year of 1973 During the 1982–87 drought years, the goat numbers increased dramatically Causes of these losses during wet seasons were investigated in surveys and results are discussed later in this paper

The composition of the national flock over three periods is shown in Table 1 Although the number of female adult goats has been increasing slowly, it has remained in the region of 50% of the total flock However, the proportion of female kids born is declining

of age, home consumption of goat meat increased only slightly (Table 2) This has not improved protein intake as planned

The increased attention given to goat production was meant to minimise or terminate the huge sheep products imports from South Africa (SA) and increase exports of goat live animals and meat However, due to low offtake rates Botswana still imported over P 12 million worth of sheep meats in 1991 (CSO 1992) while goat exports to SA in 1985 and 1986 were only worth P 10,228 68 and P 19,287 63, respectively Now this SA market for goats has collapsed This will limit the sale of Botswana goats especially since the domestic market is very small This is reflected in the reduced total

Table 1 *Goat composition and performance*

	Year ('000 goats)					
	1985		1988		1990	
Age	Male	Female	Male	Female	Male	Female
>1 year	163 2	575 8	235 1	853 2	307 8	1132 8
% of total	14 7	51 9	14 3	52 1	15 2	55 8
<1 year	168	201 3	259 2	291 6	263 2	326 4
% of total	15 5	18 2	15 8	17 8	13 0	16 1

Source MoA (1985 1988 1990)

National figures also show low and stagnated productivity and marketing parameters (Table 2) While the birth rate increased during the wet years of 1988/89 the death rate increased too Sales of goats increased only slightly over the three periods investigated The increase is attributed to the implementation of a pricing policy during the period, where price/100 kg CDM was raised to approach that of cattle (Table 3) Although the aim was to increase offtake rates of these farmers, the commercial farmers' offtake rate of between 12–15% has never been attained by traditional farmers

Also, while the population of Botswana increased tremendously from 0 9 million in 1981 to 1 3 million in 1990, with 50 6% of them being children under 15 years

Table 2 *Production and marketing of the national flock*

	Year		
Variables	1985	1988	1990
Production parameters (%)			
Birth rate	40 6	45 8	40 2
Mortality rate	19 7	21 0	19 7
Marketing indicators (%)			
Offtake rate	3 1	4 4	5 6
Home consumption	5 2	6 9	7 5
Purchases	2 5	1 7	2 1

Source MoA (1985 1988 1990)

Table 3 *Comparison of average price for cattle and goats 1986–93 on cold dressed mass (CDM) basis*

	Price in Pula[1]				
	Cattle		Goats		
Year	100 kg	Average/animal	100 kg	Average/animal	Exchange rate[2] Pula against US$
1986	153 30	290	na	40 33	0 544
1987	166 64	328	na	49 98	0 639
1988	218 46	455	219 28	51 87	0 517
1989	276 65	599	253 14	58 11	0 534
1990	296 38	632	270 45	57 72	0 534
1991	302 92	611	252 32	48 08	0 482
1992	291 44	520	259 44	54 10	0 443
1993*	334 66	644	313 20	59 87	0 408

na = not applicable * up to June

Sources 1 CSO (1993) 2 Bank of Botswana (1993)

number of animals slaughtered in both the BMC and municipal abattoirs (Table 4)

Table 4 *Slaughter of goats between BMC[1] and municipal abattoirs (MA)*

Year	BMC	MA	% MA slaughter of total
1987	30728	2916	8 7
1988	25717	2076	7 5
1989	31888	5087	13 8
1990	20670	5603	21 3
1991	13915	5993	30 1
1992	6396	874	51 8
1993[2]	2047	na	na

1 BMC = Botswana Meat Commission

2 Up to June

Source CSO (1993)

Farmers' situation

Farmers' objectives

Farmers' objectives sometimes conflict with those of the government, and since it is the farmers who make production and marketing decisions, problems are experienced in implementation of government projects/ policies and programmes Examples of these conflicts are

1 The culture of keeping animals as wealth hinder the objective of increasing offtake rates This renders the price policy ineffective as far as small farmers are concerned From the surveys done in the Gaborone region (1993/94) only 2% of the farmers sold any goats These were sold only when need for cash arose

2 Competition for inputs with a number of other enterprises (crop production and off-farm activities) deprive goat production of the necessary resources needed to improve productivity (e g labour, finance, feed etc)

Production constraints

Major production constraints identified by the study were

- Poor housing All animals (on average 40 cattle 15 goats and 13 donkeys) are housed together at all times of the year in open kraals made of thorny branches These kraals are never cleaned and most last for over 4 years This results in outbreak of diseases during wet seasons resulting in an average loss of 11 kids/farmer per annum
- High mortality of the exotic Boer goats introduced through the ram subsidy programme due to poor management and inability to fulfil the conditions required for such breeds because of the high costs involved
- The large numbers of animals kept in these villages lead to overstocking and severe overgrazing especially in winter where natural pasture is reduced to zero This results not only in inadequate feed but also in poorer quality pastures each year Since supplementary feeding is hardly done due to the costs involved (it costs P 8 70/50 kg bag of sorghum bran, P 6 35/35 kg bag of salt and P 23 50/50 kg bag of stock feed), starvation and insufficient feeding results in high losses
- The high costs of veterinary services, long distances to LACs, lack of transport and short supply of some drugs requiring farmers to go to SA for them, prohibit constant and continuous use of these services
- Few veterinary assistants (VAs) Although the NDP 7 (1991–97) requires that there be a VA to farmer ratio of 1 240 the study found the ratio in this area to be 1 429, with an average distance of 8 km between farmers, most VAs do not have any transportation means
- Insufficient family labour and unreliable hired labour to cover all the activities performed at the same time on the farms (crop production, livestock production of various types and requirements, and off farm activities) Hired labour is unreliable due to increased construction activities and better opportunities across the border in SA A study done by Ministry of Agriculture (MoA 1992) showed that each farmer requires a total of 208 man-days (124 man days for crops and 84 for livestock), during the labour peak months of December–May when crops are growing Our study found each family has an average of eight members but only three adults equivalent are available for work at all times of the year and two adults equivalent only for part of the days This is because 55% of the members were found to be under 15 years old and spend much of their time at school The adults, most of whom are women, are over 58 years of age These women have only 5% of their time devoted to livestock activities They spend 12 7% on crop activities, 63% on household chores and 19 3% on off farm activities (beer brewing, basket making etc) It is evident that hiring of labour is necessary if all activities have to be performed efficiently However the cost of hiring is prohibitive as it costs a farmer P 0 92/hour for livestock labour and P 0 97/hour for crops

This has resulted in poor management due to labour shortages resulting in straying of animals, loss through diseases and poor nutrition

Inadequate water sources and long distances to dams or boreholes have forced some of these farmers to water their animals in municipal sewage ponds (9% of the farmers)

Marketing constraints

Farmers claim that BMC prices are low (Table 3) as compared to private agents who do not look at the grade of the animal and pay P 100/goat (1993) However, this unofficial channel is not reliable

Long distances to abattoirs, poor roads and lack of transport The study discovered that most farmers especially women do not own trucks that could ease their transport problems (Table 5) The type of transport owned is inappropriate for transporting goats Hiring of trucks could cost a farmer up to P 200/trip But most earn only an average of P 3307 or US$ 1272 p a (Mrema 1994) This restricts the number of trips to be made to the market

Table 5 *Types of transport owned*

Mode of transport	% of farmers			
	Owned		Hired	
	Female	Male	Female	Male
Tractor	13	16	–	19 3
Donkey carts	17	25 3	–	–
Truck (lorry)	13 7	37 2	37	21 5

Most of the goats sold are of grades B_1 and B_2 and the prices of these are lower (Table 6) These low grades are caused by long distances walked to abattoirs insufficient feeding and poor quality pastures among other reasons This has led to the belief that if goats are kept longer they fetch higher prices

Delays in payment or problems in cashing cheques issued by official channels (BMC and its agents) also act as deterrents to use of these official outlets

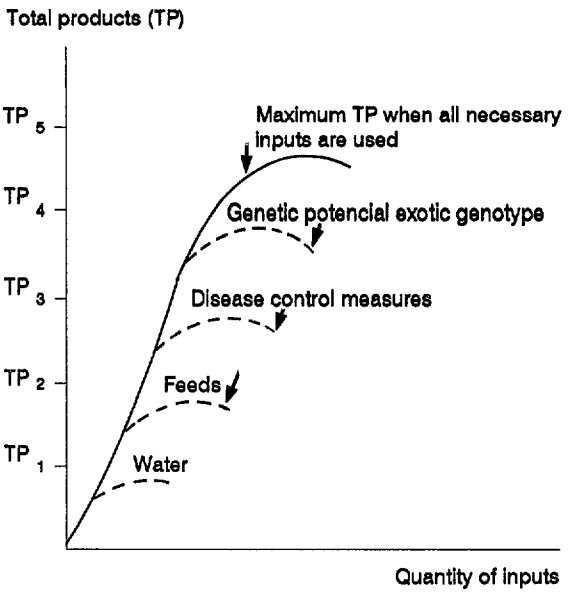
Table 6 *BMC prices (Pula) for goats according to grade 1982–85*

Grade	Year		
	1982	1983	1985
Super	153	215	237
A_1	144	202	223
A_3	96	135	149
B_1	134	187	206
B_2	124	174	192
B_3	96	135	149

Those in Super and A grades are young goats with less than two permanent incisors while those in B grade are older with more than two permanent incisors

Source Molefe (1985)

It is evident therefore that in order for maximum output to be realised from goats, farmers need to use all the necessary inputs (resources), e g water, feed, disease control and genetic improved technology at the optimum level as portrayed by Dillon s model (Figure 1) Falling short of this combination as is the case with most farmers the results are generally below the maximum output or product Other factors not in the model like marketing and institutional factors play a major role in determining level of production and marketing



Source McLeod (1989)

Figure 1 *Relationship between various inputs used and livestock production*

Conclusion and recommendations

The GoB is spending large amounts of money to achieve its set objectives of increased income and nutrition for poorer farmers, import substitution etc However since the farmer is the decision maker on how much of each resource (time inputs, finances etc) to allocate to many competing ends, and since he is faced with a number of his own objectives and constraints on the farm, sometimes the intended results are never achieved Production marketing and institutional constraints have resulted in low production and offtake and hence low incomes all discouraging farmers from increasing inputs to goat production This vicious cycle needs to be broken

It is therefore imperative that since most of the African small-scale farmers suffer the same fate governments, institutions and farmers work together to first identify problem areas and solve them in order to give way for appropriate policies and technologies to work

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Elevage caprin au Botswana: facteurs de variation de la production et de la commercialisation au niveau des petits éleveurs

Résumé

Grâce aux efforts du gouvernement du Botswana, les effectifs caprins des petits eleveurs sont passes dans le pays de 0,6 million en 1973 a 2,12 millions des 1990 Et pourtant, les niveaux de vente et de consommation des produits de l'elevage caprin sont tres bas La production et la commercialisation de ces produits se heurtent a un certain nombre d'obstacles, y compris le faible niveau d'investissements dans les infrastructures adequates, l'eloignement des marches et les risques

Profitability and income contribution of small ruminant production to rural African households: A case study of Kgatleng and Kweneng districts in Botswana

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Abstract

This study evaluates the profitability and relative income contribution of small ruminant production to rural African households The analysis is based on 1991/92 farm management survey data on 114 smallholder households from Kgatleng and Kweneng districts in Botswana Budgetary and household income analyses were used to estimate the profitability of the small ruminant production and its relative household income contributions The results show that small ruminant production is both profitable and economically viable It returned an average income of P 23 00 per animal to the small ruminant owning households Also it provided a return of 34% on capital invested in the enterprise Its contribution of 15% to the household income was substantial, exceeding similar contribution from crop production by 58% Smallholder farmers in the area should, therefore, exploit the potential benefits of small ruminant production to increase their household income by allocating more resources to its improvement Furthermore, policy makers researchers and farmers should be made aware of the economic viability of small ruminant production in the country and elsewhere in Africa

Introduction

The importance of livestock in Botswana's economy has long been recognised It is a major source of income and employment for most of the rural dwellers who are the majority of the estimated total population of 1 5 million people in the country (MoA 1991) Livestock primarily cattle are one of the main sources of foreign exchange generated by the agricultural sector (MoA 1989) The total population of cattle goats and sheep in the country is estimated at about 2 7 2 1 and 0 3 million respectively (CSO 1991)

The cattle industry in the country has been well developed This is because it has since the country s independence in 1967, been receiving considerable attention with respect to research marketing and other institutional support from the government which in turn is mainly due to the preferential trade arrangement granted to the country's beef export by the European Economic Community (EEC) Ironically, the distribution of cattle ownership in the country is very skewed with 30–40% of the rural households without any (MoA 1991, Panin et al 1993) By contrast, almost every rural household owns at least a unit of small ruminant (Fane 1992) In spite of the popularity of small ruminants among the rural households as reflected in their ownership distribution, available evidence indicates that the small ruminant production system receives relatively little attention in terms of the above mentioned services rendered to that of cattle (Fane 1992) This is despite the fact that the small ruminant production system has proved to be suitable to the prevailing harsh climatic conditions in the country (Molefe 1987)

Lack of information on the profitability of the small ruminant production enterprise as well as on its income contribution to the rural folks is assumed to be the principal reason for the non-recognition of its importance by the policy makers and relevant institutions and hence the resulting little attention given to its improvement in the country The purpose of this paper is to contribute to the literature on the relative economic importance of the small ruminant production enterprise in African rural households by assessing both its profitability and income contributions to the rural folks

Study area, data collection and analysis

The data on which the analysis is based were drawn from a farm management survey carried out in six villages from Kweneng and Kgatleng districts in Botswana Two and four villages were selected from Kweneng and Kgatleng districts, respectively The two villages from Kweneng were Gabane and Metsimotlhabe and the four from Kgatleng were Oodi, Morwa, Bokaa and Modipane The villages were similar in terms of socio-economic characteristics The selection of the study area was justified by the fact that small ruminants are more popular in the area than many other areas in the country

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The two districts are located in the south-eastern part of the country and the selected villages are within a 20–40 km radius of Gaborone, the capital of Botswana Like the rest of the country, the rainfall of the study area is varied in its distribution with an annual mean ranging from 400–500 mm The vegetation of the area is tree savannah The economy of the area is mainly based on subsistence farming with about 90% of its total labour force directly or indirectly engaged in agriculture (Panin et al 1993) Mixed crop and livestock farming is the common practice of the inhabitants Cultivated areas ranged from 1–14 ha with an average of 6 ha per household The major crops of the area are sorghum, maize, beans and millet with sorghum being the most important single crop in terms of cultivated area and utilisation Productivity of both food crops and forage is relatively low in the study area as in other areas in the whole country

The profitability of the small ruminant production enterprise was estimated using the budgetary analytical method The budgetary analysis was based on cost and returns data of only small ruminant household owners The total small ruminant owning household was 102 The deciding factor for the inclusion of a particular household in this sample of 102 was that the household owned at least a unit of one of the small ruminant species For the enterprise budget, the costs and returns were estimated for the period under review

Total costs were obtained by estimating both the operating cost and the fixed cost The operating cost consists of the cost of the variable inputs used by the farmers This cost included the expenses on medicines, water, dipping feeding and replacement of the stock The fixed cost was obtained by valuing the family labour, the most single important fixed input under the smallholder sheep and goats farming system in the area Attempts to use the depreciation method to estimate the annual cost of kraal revealed insignificant values hence these were excluded from the current analysis Also an average interest rate of 12% representing the then market rate for capital was used to reflect the opportunity cost of capital tied up in the form of investment in sheep and goats

The returns were obtained by estimating the total value of production which included the value of animals sold and consumed by the households as well as the value of milk sold and consumed The farm gate prices for a unit of each product was used for the computation of the home consumed products

Primary data were collected from 114 randomly selected smallholder households from the six selected villages through interviews with the aid of structured questionnaires during the 1991/92 cropping season Information on several aspects of crop–livestock farming was collected as well as other socio-economic variables such as income transfers from other family members residing and working outside the villages

Results and discussion

Ownership and distribution of small ruminants

The ownership of the small ruminants among the total 114 households studied is presented in Table 1 As clearly shown in the table, goats were more widely owned than sheep About 90% of the sample households possessed at least a unit of goat as compared with only 27% of the same sample households who owned sheep Also, the percentage of households owning any one of the two species of animal was the same (90%) as goat owning households Mixed flock of sheep and goats enterprise was found to be practised by only 27% of the households in the area The average number of goats owned across all households was 19 This varied greatly between the households as reflected in the standard deviation (SD = 18 1) Sheep flock size also varied considerably among the households, ranging between 0 and 64 head with an average of only 2 7 (SD = 7 7) As regards total number of all ruminants per household the average flock size was 21 7 with standard deviation of about 22

Table 1 *Ownership of small ruminants in Kgatleng and Kweneng districts in Botswana 1991/92 (n=114)*

Variables	Species		All ruminants
	Goats	Sheep	
Per cent of households owning at least one small ruminant	89 5	27 2	89 5
Mean flock size	19 0	2 7	21 7
	(18 1)[a]	(7 7)	(21 4)
Range	0–93	0–64	0–110

a Figures in brackets are standard deviations

Table 2 presents the frequency distribution of number of animals for only ruminant owning households The total number of households owning goats sheep and both species together were 102 31 and 102 respectively The data in the table reveal very striking information In general, the frequency distribution of the two species of animals was highly skewed with a majority of the households owning between 1 and 10 units of animals However, the skewness is highly pronounced among sheep owning households More than two-thirds (68%) of all sheep owning households possessed between 1 and 10 units of sheep In contrast only 38% of all households with goats had similar units of animals The proportion of households that owned more than 60 units of each species of animal or both together was relatively smaller at 5 3 and 7% each for goats sheep and both, respectively

Given that profitability per animal as reported by Mpho (1993) is much higher for goats enterprise than sheep it is not surprising to find out that smallholder

households in the study area keep a very small number of sheep relative to goats Another probable reason for the discrepancy between both species sizes might be that the adaptation potential of goats to the prevailing harsh climatic conditions in the country may be higher than that of sheep

Table 2 *Per cent distribution of number of ruminants among owning households Kgatleng and Kweneng districts Botswana 1991/92*

	% households owning		
Number of animals (range)	Goats	Sheep	All ruminants
1–10	38 2	67 8	33 3
11–20	24 5	22 6	23 5
21–30	14 7	6 5	17 6
31–40	8 8	n a*	8 8
41–50	4 9	n a	3 9
51–60	3 9	n a	5 9
61–70	3 9	3 2	3 9
>70	1 0	n a	2 9

n a = not applicable

Overall, higher numbers of goats are kept by the households than sheep, suggesting that goats are more popular in the study area than sheep Similar observations from various studies conducted in the same area and surroundings has been made by Mpho (1993) Fane (1992) and Panin (1994)

Small ruminant enterprise profitability analysis

The results of the budgetary analysis for the small ruminant enterprise are presented in Table 3 On average the small ruminant production enterprise earned a household a total net profit of P 561 00 On a per animal basis, an appropriate measure for the profitability, the return per animal was P 23 00

This suggests that a small ruminant production enterprise is profitable However, profit *per se* may not be the best measure of how efficiently the factors of production have been utilised The best measure of efficiency is that which recognises the returns per unit of input Since capital has been identified as one of the constraints to increased agricultural production in the area (Panin and Mahabile 1994) the return per Pula of capital tied up in the small ruminant enterprise was calculated This was to help in assessing whether it is worth investing in such enterprise as capital has an opportunity cost Capital here is referred to as the value of the total average number of sheep and goats owned by a household Data in Table 3 show that the return to capital was considerably high, about 34%, exceeding the interest rate by almost 65%

Table 3 *Small ruminant enterprise budget per household in the Kgatleng and Kweneng districts in Botswana 1991/92*

Variables	Total value (Pula)
A Revenue	
Sales from	
Animals	385 98
Milk	207 51
Value of home consumed	
Animals	184 80
Milk	432 90
Subtotal A	1221 19
B Operating cost	
Medicines	35 37
Water	20 23
Dipping	18 99
Feeding	8 17
Replacement	35 37
Subtotal B	100 81
C Fixed cost value of family labour	360 00
D Interest on capital	199 36
E Total cost of enterprise (B+C+D)	660 17
F Net enterprise profit (A E)	561 02
G Profit per animal	23 18
Percentage return on capital*	33 77

* = (561 02/1661 3) 100 = 33 77

Income contribution of small ruminants

The summary of the farm household income analysis for the small ruminant owning households is presented in Table 4 The net household income is derived from the total net revenues from crop and livestock production as well as non-farm employment The average net household income for the year under review amounted to P 6306

The relative contributions of the various income sources are shown in column three of Table 4 The contribution from agriculture (livestock and crops) amounted to 55 3% of total household income This finding contradicts the result of Panin et al (1993) who found out that contribution of non-farm employment sources (53%) in the same area was higher than that of agriculture (47%) The discrepancy might be due to the difference in the sampling procedure While Panin et al (1993) considered income of all selected households irrespective of one owning animals or not the current analysis focused only on households owning small ruminants

Comparison between crop and livestock incomes reveals that while livestock accounted for 49% of total net income, crop production contributed a mere 6% Within the livestock sector, cattle contributed the highest (33%) Nevertheless, the contribution of small ruminant is substantial, amounting to 15% This exceeds the contribution from crops by 58% This finding provides enough evidence for the smallholder farmers to reallocate some resources from crop production to

small ruminant production if only they view profitability and efficient utilisation of resources as their main goals

Table 4 *Summary of farm household income analysis for Kgatleng and Kweneng districts in Botswana 1991/92*

Income source	Amount (Pula)	% contribution
A Net crop revenue	389 0	6 2
B Net livestock income		
Small ruminants	921 0	14 6
Cattle	2102 7	33 3
Others	78 7	1 2
Subtotal	3102 4	
C Net farm income (A+B)	3491 4	
D Off farm income	2814 2	44 6
E Total net household income (CD)	6305 6	

Conclusions

The study has examined the profitability and contribution of small ruminant production as an enterprise to rural household incomes The analysis was mainly based on 1991/92 data on 102 small ruminant owning households from Kgatleng and Kweneng districts in Botswana It is evident from the results that small ruminant production is both profitable and economically viable It accounts for a substantial share (15%) of the total average rural household income Its contribution to the household income exceeds that of crop production by 58% Smallholder farmers should exploit the potential benefits of small ruminants by allocating more resources to their improvement

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Rentabilité et contribution de l'élevage des petits ruminants au revenu des ménages ruraux en Afrique: étude de cas des districts de Kgatleng et Kweneng au Botswana

Résumé

Cette etude evalue la rentabilite de l'elevage des petits ruminants et sa contribution au revenu des menages ruraux en Afrique L analyse est basee sur les donnees d'une enquête de gestion agricole effectuee en 1991/1992 sur 114 menages de petits exploitants des districts de Kgatleng et Kweneng au Botswana Des analyses du budget familial et du revenu des menages ont servi a evaluer la rentabilite de l'elevage des petits ruminants et sa contribution relative audit revenu Les resultats ont montre que l elevage des petits ruminants est une activite a la fois rentable et economiquement

viable Elle procure aux menages un revenu moyen de 23 pula par animal Par ailleurs, sa rentabilite est de 34% du capital investi Sa contribution, estimee a 15% du revenu du ménage, etait substantielle et depassait de 58% en termes relatifs celle de la production vegetale Les petits eleveurs de cette zone devraient par conséquent profiter des avantages potentiels de l'elevage des petits ruminants pour accroître leurs revenus en allouant des ressources accrues a l amelioration de cette activite Enfin, tout doit être mis en oeuvre pour amener les dirigeants, les chercheurs et les paysans a prendre conscience de la viabilite economique de l'elevage des petits ruminants dans le pays et ailleurs en Afrique

Facteurs de variation de la production laitière des caprins en milieu peul

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Résumé

Cette etude sur les facteurs de variation de la production laitiere des caprins en milieu peul a ete effectuee dans la zone des Niayes de Dakar (Senegal) Les parametres de reproduction, de croissance de mortalite et de production laitiere y sont analyses L âge des femelles a la premiere parturition est de 16 mois l'intervalle entre mises bas est de 280 jours et la taille moyenne de la portee est de 1,36 chevreau Le quotient de mortalite (32 4%) est eleve La lactation dure 184 jours et la production prelevee s'eleve a 31 kg La production caprine joue un rôle socio-economique important en procurant des revenus assez substantiels et en participant a la couverture des besoins en proteines animales

Introduction

Au Senegal, les Peul entretiennent des troupeaux de bovins et de petits ruminants Dans leurs systemes d elevage, l espece caprine joue un rôle socio-economique important Le destockage facile permet a l eleveur de bien adapter ses ventes a ses besoins immediats en argent De la sorte, la chevre joue le rôle de tirelire, que ne pourraient remplir en aucun cas les bovins, representant un capital bien trop eleve C est sa petite taille qui en fait egalement un animal de choix pour les sacrifices et les dons Sa reproduction rapide (maturite sexuelle precoce, grande prolificite, dessaisonnement) est un atout dans un pays qui comme le Sénegal connaît des secheresses successives Elle permet de compenser les fortes mortalites et assure ainsi au moins l autorenouvellement des troupeaux même dans les conditions les plus difficiles

Dans les systemes de production peul le lait est egalement un produit important avec deux finalites l autocosommation et la commercialisation Ce lait, riche en proteines de haute valeur nutritive contribue a la satisfaction des besoins en proteines animales des populations rurales et constitue une source de revenus pour les populations proches des centres de consommation C est dans le souci d'ameliorer cette production laitiere caprine qu'un programme de recherche a ete initie en 1992 par l'Institut senegalais de recherches agricoles (ISRA/LNERV) avec le concours financier du Centre international pour l'elevage en Afrique (CIPEA) L'etude preliminaire a comme objectif d'une part, d etudier les facteurs de variation de la production laitiere caprine en milieu peul afin d identifier les contraintes et d'autre part, de faire des recommandations susceptibles d'ameliorer cette production

Matériels et méthodes

Localisation

Ces travaux sont effectues au niveau des communautes rurales de Sangalkam et de Sebikotane situees a environ 40 a 50 km au nord-est de Dakar dans le departement de Rufisque Par rapport au reste du pays, la zone des Niayes possede un microclimat particulier caracterise par des temperatures moyennes moderees (21,4 C en janvier-fevrier et 28 C en octobre) et une humidite relative assez elevee (toujours superieure a 50%) On distingue une saison humide (juillet-octobre) et une saison sèche A Sangalkam, la pluviometrie etait de 365,6 mm entre 1984 et 1993, contre 541 mm de 1941 a 1970 avec des variabilites interannuelles de 14% L elevage et l'agriculture sont par consequent les deux principales activites economiques, le maraîchage constituant la plus dominante Cette etude couvre huit villages et vingt eleveurs

Matériel animal

Les animaux sont à l origine trypanotolérants car la region etait infestee de glossines avant les campagnes de lutte menees par le Laboratoire national de l'elevage (Toure, 1981 Toure 1983) La race caprine exploitee dans la zone periurbaine de Dakar est un produit du metissage entre la chèvre guineenne et celle du Sahel le pourcentage de sang de cette derniere allant croissant

Collecte des données

Suivi individuel des performances

La methode utilisee pour la collecte et la gestion des donnees est celle du Programme pathologie et productivite des petits ruminants (PPR)" initie par

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l Institut sénégalais de recherches agricoles (I S R A) et le C I R A D -E M V T Ce programme "Panurge' basé sur un système de contrôle et de suivi des performances individuelles, est destine a fournir une estimation de la productivite des races locales en elevage traditionnel (Faugere et Faugere, 1993)

Les troupeaux sont visites tous les quinzes jours Les donnees enregistrees sont les suivantes

- Suivi de la demographie du troupeau (reproduction, exploitation, mortalites) et suivi sanitaire
- Contrôle bimensuel de la production laitiere Seules les quantites de lait prelevees par le berger sont notées Le contrôle laitier s'effectue avec des pots de mesure La conversion en poids a ete faite en multipliant les quantites obtenues par la densite moyenne du lait (1,035)
- Suivi de la croissance des chevreaux par des pesees mensuelles de la naissance a 1 an

Chaque action menee sur le terrain est consignee sur une fiche Les donnees recueillies sur ces fiches sont ensuite transcrites sur un "fichier manuel" comportant une fiche par animal Chaque fiche contient les informations concernant le deroulement de la carriere de l'animal depuis son entree dans le troupeau jusqu a sa sortie La coherence des informations recueillies est testee sur ce fichier manuel avant la saisie sur le fichier informatique

Enquêtes a l'echelle des troupeaux

- Suivi des recettes et des depenses liees a la production laitiere caprine par des enquêtes mensuelles,
- Suivi des pratiques de conduite sur parcours enquêtes biannuelles sur les pâturages utilises les temps de parcours,
- Sondage sur la valeur alimentaire des parcours naturels en 1992 et 1993 prelevements mensuels de biomasse herbacee sur 12 sites identifies, determination de la matiere seche et analyse bromatologique Sur chaque site la biomasse est mesuree a l'aide d'un peson sur cinq bandes d'un metre carre prises au hasard Ensuite un echantillon est preleve pour faire l'objet d'une analyse chimique

Analyse des données

Le systeme de gestion des donnees du programme Panurge genere automatiquement certaines variables comme l'intervalle entre mises bas, le poids a âge type et le GMQ Il assure une sortie des donnees sous plusieurs formats transferables au choix sur des logiciels d'analyse Les donnees des enquêtes ont ete saisies sur Dbase,et les analyses effectuees grâce au logiciel "Statistical Program of Social Science" SPSS Version 4 0 Il permet d'effectuer des analyses statistiques sur des effectifs generalement inegaux et non proportionnels Les modeles d analyse de variance multifactorielle generalement utilisés sont de la forme

$$Y = XB + e$$

ou Y est un vecteur d observations relatives a la variable expliquee
X est une matrice des coefficients fixes pour le caractere considere,
B est un vecteur inconnu des effets fixes des facteurs testes, et
e est un vecteur inconnu des erreurs aleatoires normalement distribuees

Résultats et discussions

Peuplement animal

Structure démographique

La figure 1 represente la structure demographique des caprins suivis au 31 juillet 1994 Les troupeaux sont essentiellement constitues de femelles, qui representent 75% de l'effectif total Leur carriere est longue, 3% des femelles depassent l'âge de sept ans La base large denote une fecondite elevee Les mâles sont exploites tres jeunes Les boucs âges de plus d un an representent 22% des mâles

Propriété des animaux

Les caprins appartiennent aux femmes qui en detiennent 80% Contrairement aux bovins, le confiage est rare chez les caprins et ne concerne que 13% du cheptel Les proprietaires sont les membres de la famille, des parents ou amis des villages voisins

Conduite des troupeaux

La conduite des troupeaux est l'ensemble des pratiques mises en oeuvre par les eleveurs sur leurs animaux en vue d'assurer leur entretien et de les mettre en condition de realiser les performances qu'ils en attendent (Landais, 1987) On distinguera ici les pratiques d'alimentation (conduite au pâturage, complementation et abreuvement) de logement de traite et de conduite de la reproduction

Alimentation et abreuvement

Les pâturages naturels constituent les principales ressources alimentaires des animaux dans la zone La productivite de la strate herbacee est faible, voire nulle pendant 8 mois sur les 12 de l annee Les prelevements de biomasse effectues sur 12 sites en 1992 et 1993 ont revele une production faible comprise entre 500 kg et 800 kg de matiere seche par hectare La strate ligneuse est composee de *Maytenus senegalensis* d'*Acacia albida*, de *Parinari macrophyla*, de *Crateva religiosa*

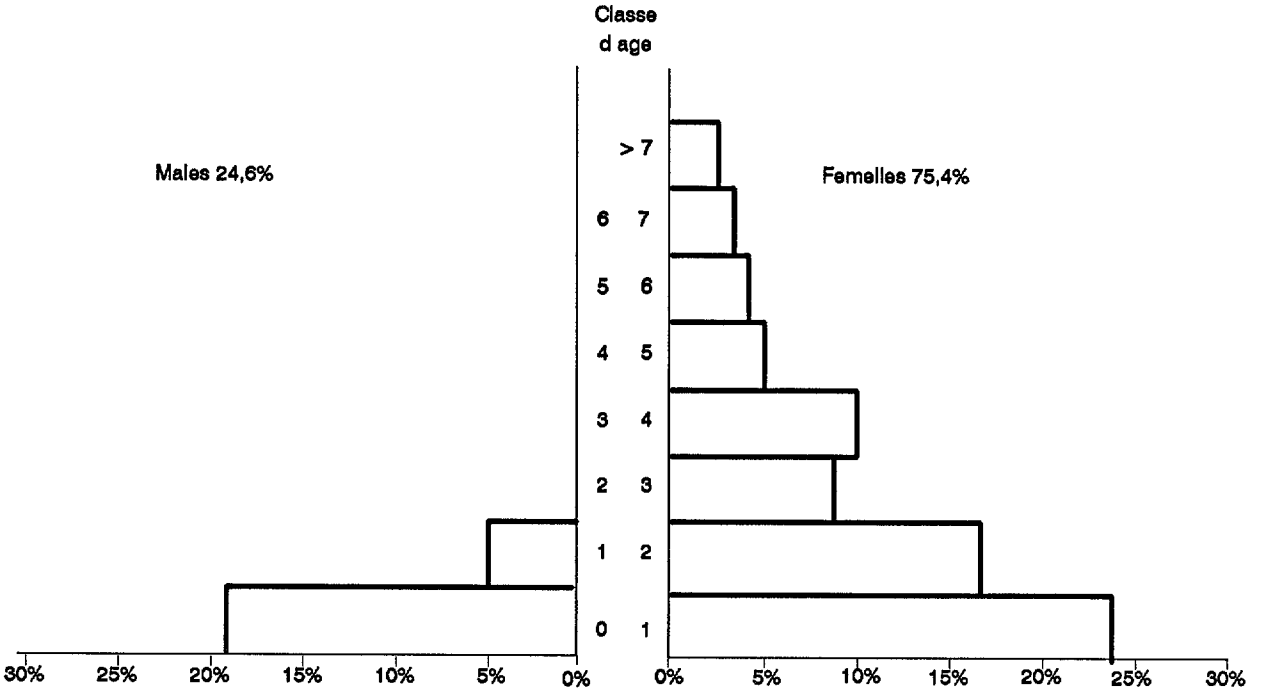

Figure 1 *Structure demographique des caprins etudies*

Les caprins sont conduits au pâturage le matin vers dix heures et ramenes vers dix-neuf heures pendant la saison sèche ou 17 heures pendant la saison des pluies L abreuvement se fait une fois par jour pendant la saison seche, durant la saison des pluies, les animaux peuvent beneficier de l'eau des mares Au retour du pâturage, la complementation est presque inexistante les producteurs estimant que les caprins sont des animaux resistants Trois eleveurs pretendent complementer les animaux les plus faibles et les femelles allaitantes avec essentiellement du foin de brousse Les sous-produits de maraîchage sont distribues en priorite aux bovins et ovins

Traite

La traite manuelle des chevres s'effectue une fois par jour, le matin, avant le depart du troupeau pour le pâturage Elle est pratiquee dans 90% des cas par les femmes

La descente du lait chez la chevre n est pas stimulee par la tetee Les chevreaux n ont acces a la mamelle qu une fois la traite terminee Elle demarre une semaine a un mois voire deux apres la mise bas en fonction de la saison de la taille de la portee et du rang de mise bas Toutes les femelles ayant mis bas ne sont pas traites La decision de traire une femelle depend de son potentiel estime par l éleveur ainsi que du nombre de petits a allaiter Les primipares sont rarement traites Le sevrage est naturel et intervient entre 5 et 6 mois Il peut être cependant precoce lorsque la femelle redevient gravide rapidement Tous les eleveurs ne pratiquent pas la traite Cinq (5) d'entres eux l'ont abandonnee en raison de leurs effectifs faibles (2) ou parce qu ils estiment les conditions d exploitation peu favorables a une production laitiere soutenue (3)

Reproduction

Les mâles et les femelles ne sont separes que les soirs lorsqu'ils sont attaches au piquet Les mâles en âge de reproduction n'ayant ete ni vendus, ni retenus pour la reproduction, sont castres par les methodes traditionnelles La castration demeure cependant une pratique rare en raison de l exploitation precoce des mâles L accouplement se fait donc en monte naturelle et toute l annee

Logement

Les caprins sont parques au piquet en plein air pendant toute la nuit et generalement a l'interieur des concessions pour permettre une surveillance plus rapprochee a cause des vols

Conduite sanitaire

Le traitement des differentes pathologies se fait par les methodes traditionnelles Les agents de l elevage ne sont jamais sollicites et les animaux ne sont pas deparasites La vaccination contre les maladies n est pas systematique car elle est payante Les eleveurs suivis ne l ont jamais demandee

Résultats et discussions

Dans la zone periurbaine de Dakar, les caprins sont exploites dans des conditions alimentaires et sanitaires difficiles Les producteurs n'ont pas change leurs pratiques de conduite malgre la presence d'une production animale intensive dans la region

Reproduction

Répartition des mises bas

La repartition des naissances est bimodale (figure 2) avec une periode principale des naissances entre novembre et janvier (42,8% des naissances), une seconde periode entre fevrier et juin (40,2% des naissances) et enfin une saison avec peu de naissances, de juillet a octobre (17% des naissances) Les saillies fecondantes des chevres sont plus frequentes entre juin et août c'est-a-dire en fin de saison seche et en debut de saison des pluies Cela est lie a la disponibilite des feuilles et gousses d'arbres tels que l'acacia en fin de saison seche et l'abondance du pâturage en août Les saillies sont egalement frequentes entre septembre et janvier c'est-a-dire en fin de saison des pluies et en debut de saison seche froide Cette periode reste toujours favorable sur le plan alimentaire

Les femelles ayant mis bas entre juillet et octobre ont ete fecondees entre fevrier et mai Elles ne sont pas nombreuses a cause des conditions alimentaires plutôt defavorables (pleine saison seche) Dans le nord du Senegal, Faugere *et al* (1989) observent une periode de mise bas en saison seche 60 a 70% des naissances ont lieu en quatre mois (decembre a mars) tandis qu'au sud les mises bas ont lieu toute l'annee avec deux regroupements des naissances (mars-avril-mai et septembre-octobre-novembre)

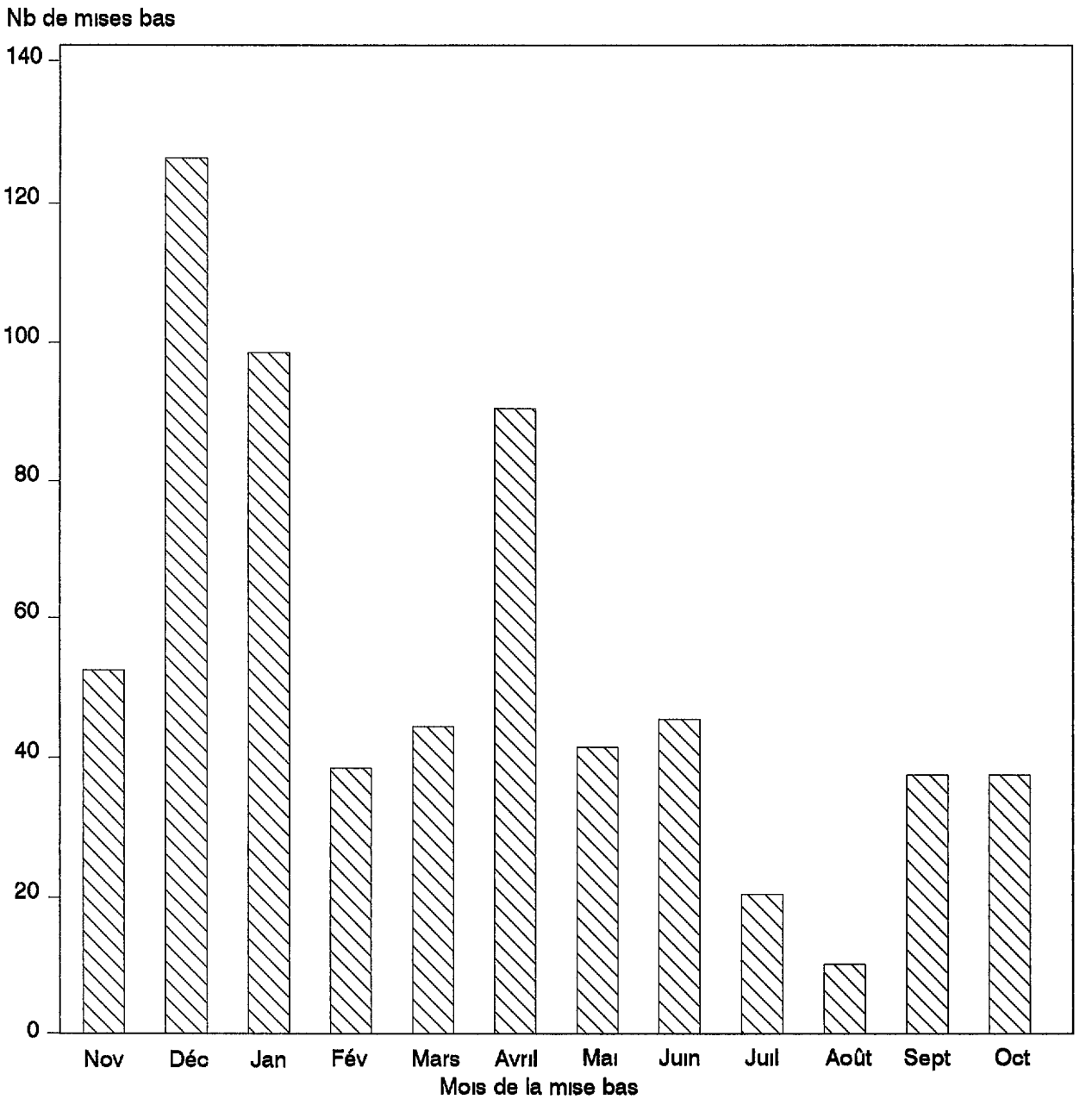

Figure 2 *Repartition des mises bas au cours de l annee*

Pour toutes les analyses, statistiques ulterieures on distinguera une saison I (novembre a janvier) une saison II (fevrier a juin) et une saison III (juillet a octobre)

Age à la première mise bas

La moyenne generale de l'âge a la premiere mise bas est egale a 469,02±135,7 jours soit environ seize (16) mois Cet âge est superieur a celui de 361 jours rapporte par Faugere *et al* (1988) dans la region de Kolda mais inferieur a celui de 522 jours rapporte par Faugere *et al* (1989) dans la region de Louga

Intervalle entre mises bas

L'intervalle moyen entre mises bas est de 280 45 ± 94,9 jours soit environ neuf (9) mois Il est inferieur a celui de 367 jours rapporte par Faugere *et al* (1989) a Louga mais superieur a celui de 248 ± 8 jours rapporte par Faugere *et al* (1988) dans la region de Kolda Cependant, il est comparable au chiffre de 283 jours observe par Berger cite par Moubinou (1990)

Ce parametre est influence par plusieurs facteurs

- La saison de mise bas influence (P<0,05) l intervalle entre chevrotages Les intervalles les plus courts sont obtenus pendant la saison III (hivernage) car la quantite et la qualite du fourrage disponible permettent une reprise rapide des activites sexuelles des femelles Les chevres ayant mis bas au cours des saisons I et II ont des inter valles entre mise bas plus longs Cela serait dû au fait que le disponible fourrager se rarefie progressivement de la saison seche froide a la saison seche chaude
- L annee de mise bas a une influence tres significative (P<0 01) sur l intervalle entre mises bas L'intervalle le plus court est relatif aux mises bas de 1993
- Le rang de la mise bas a une influence significative (P<0 05) sur l'intervalle entre mises bas Celui-ci diminue progressivement de la 1ere a la 4eme mise bas Ce resultat correspond a celui rapporte par Faugere *et al* (1988) dans la region de Kolda Cette diminution progressive est peut-être a lier a la croissance des femelles lesquelles atteignent leur poids adulte a partir de la 4eme mise bas

Prolificite

La portee moyenne est de 1 36 chevreau un chiffre compris entre ceux de 1 24 rapporte par Faugere *et al* (1989) a Louga et de 1 50 enregistre par Faugere *et al* (1988) dans la region de Kolda

Performances de croissance

Poids moyen et gain moyen quotidien

Les poids moyens et les GMQ enregistres sont présentes aux tableaux 1 et 2 et les courbes de croissance a la figure 3

Tableau 1 *Poids moyens (kg) en fonction de l âge*

Age (mois)	Femelles	Mâles
Naissance	1 7± 0 4 (n=78)	2 2± 0 6 (n=41)
1	4 4± 1 2 (n=319)	4 6± 1 2 (n=335)
3	8 1± 1 8 (n=283)	8 7± 2 2 (n=296)
6	12 5± 2 6 (n=234)	13 2± 3 (n=197)
9	15 8± 3 2 (n=152)	16 8± 3 1 (n=102)
12	19 1± 3 (n=78)	20 3± 3 2 (n=36)

Tableau 2 *Gain moyen quotidien (GMQ) par classe d age*

Classe d âge	Femelles	Mâles
1–3 mois	61 4± 22 (n=274)	66 7± 26 (n=281)
3–6 mois	45 6± 19 (n=232)	50 9± 25 (n=192)
6–12 mois	38 9±12 (n=78)	38 7± 11 (n=36)

La croissance des chevreaux entre un et douze mois est superieure a celle enregistree a Louga et Kolda mais inferieure a celle observee a Kaolack (CIRAD-EMVT 1991) Le poids adulte des femelles (a partir de la 4eme mise bas) atteint 25±2 kg sur 140 observations, une moyenne inferieure a celles de 31 kg observee a Kaolack et de 27 kg enregistree a Louga mais superieure a celle de 23 kg rapporee a Kolda (CIRAD-EMVT, 1991)

Facteurs de variation de la croissance

L'analyse de variance montre que la saison de naissance a un effet significatif a tous les âges De l'âge d'un a trois mois, les chevreaux nes en saison III sont plus lourds du fait du disponible alimentaire en saison des pluies Par contre a douze mois les petits nes en saison I deviennent plus lourds du fait de l effet de la croissance compensatoire pendant la saison des pluies L'annee de naissance a un effet hautement significatif (P<0,001) sur les poids des animaux âges de un a trois mois Les pluviometries enregistrees en 1992 et 1993 sont faibles Mais la repartition en 1993 est meilleure et la disponibilite en herbe du pâturage s'est prolongee jusqu'au mois d'avril de l annee 1994 D'autres facteurs peuvent jouer tels que la temperature, l'hygrometrie, etc

L'analyse de variance montre que le mode de naissance a un effet significatif sur la croissance des chevreaux âges d'un a 12 mois Les triples sont plus legers que les jumeaux et encore plus que les produits simples La difference est plus nette à trois mois (1 kg de moins que les jumeaux 1 9 kg de moins que les produits simples) Cela peut s expliquer par le fait que la production maternelle serait insuffisante pour couvrir totalement les besoins de deux ou trois produits Ce phenomene est signale par Faugere *et al* (1988) qui precisent cependant que les doubles et triples en pâtiraient moins longtemps du fait d une aptitude plus precoce a utiliser le fourrage, ce qui a egalement ete constate ici sur les GMQ entre trois et six mois (P<0 05)

Chez les caprins, l'effet du sexe sur le poids est hautement significatif (P<0 001) a tout âge Les mâles

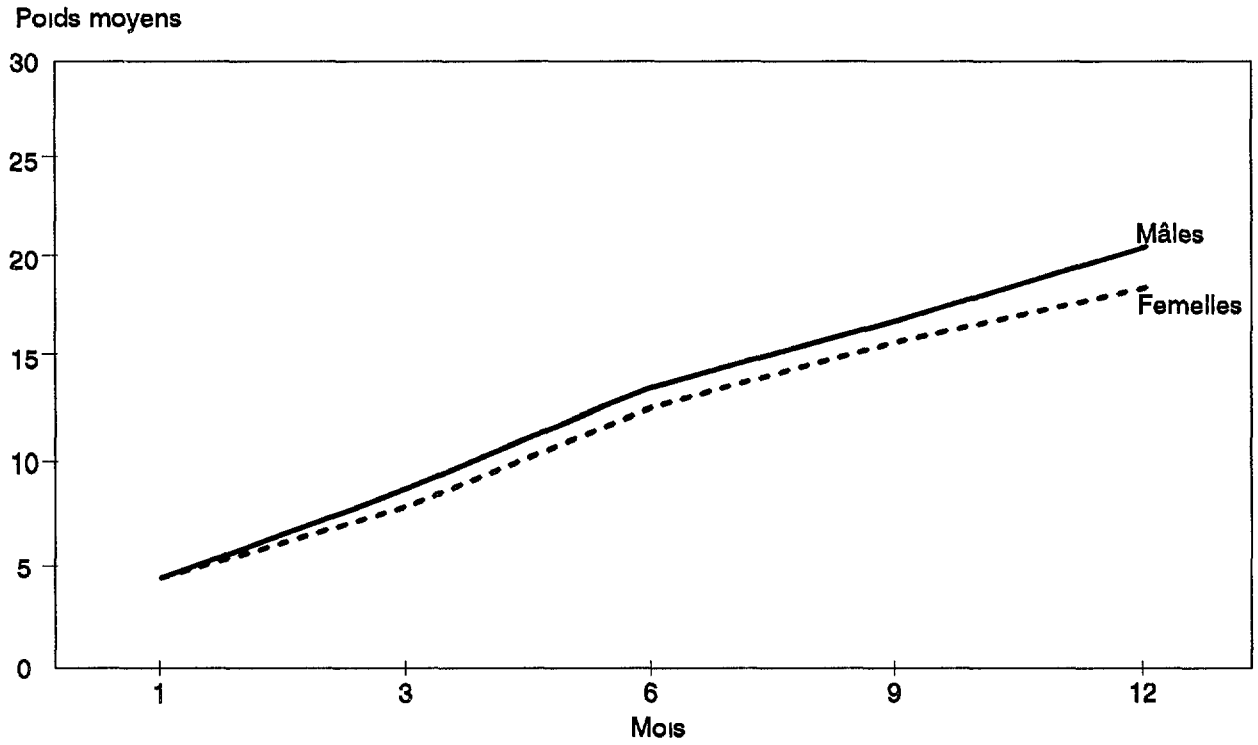

Figure 3 *Courbe de croissance des chevreaux*

sont legerement plus lourds a un mois (200 g) et la difference augmente regulierement pour atteindre 1,2 kg a douze mois Les mâles prennent plus rapidement du poids que les femelles entre 1 et 3 mois Cela est dû au fait qu'ils naissent plus lourds et sont plus competitifs que celles ci pour l utilisation du lait maternel Par la suite, la difference de GMQ s'estompe progressivement Les mâles atteignent plus rapidement leur poids adulte tandis que les femelles sont en pleine phase de croissance En plus il faudrait tenir compte de la prise de poids supplementaire liee a la 1ere gestation chez les femelles

L'effet du rang de mise bas est hautement significatif (P<0,001) au cours des trois premiers mois de la vie Au 1ere mois, les produits de meres multipares sont plus lourds que ceux des primipares A partir du 2eme mois, les chevreaux issus des primipares deviennent plus lourds Cette situation s'explique par le fait que chez les primipares la traite est rare et la prolificite est inferieure a celle des multipares Generalement, le lait est entierement disponible pour un chevreau Le poids plus faible au 1er mois des produits de primipares peut être lie a la production laitiere plus faible des meres

Le troupeau a un effet hautement significatif (P<0,001) a tout âge Ce phenomene s'explique par les pratiques d'elevage differentes d'un eleveur a un autre

Mortalité

Données generales

La figure 4 presente la repartition des mortalites en fonction de l'âge au deces L'analyse de cette repartition permet d'identifier une periode de mortalite sous la mere de la naissance jusqu'a 3 mois (55 1%) Cette perte sous la mere est principalement due aux maladies (gâle) et aux troubles de la croissance

La figure 5 presente l'evolution de la mortalite des animaux au cours de l'annee Pendant le mois de mai, on enregistre 19,5% de mortalite Cette perte en fin de saison seche est probablement liee a l affaiblissement des femelles en lactation suite au manque de ressources alimentaires pendant cette saison Les pertes en saison des pluies correspondent a des mortalites d'animaux sevres essentiellement a la suite de diarrhees

Quotient de mortalite

La mortalite est appreciee sur un effectif initial l'estimateur est donc un quotient de mortalite (et non un taux) Compte tenu du fait que les animaux (surtout les mâles) sont exploites de maniere precoce le calcul du quotient tient compte des animaux "emigres' On admet que les animaux exploites ont ete en moyenne exposes au risque de mourir pendant la moitie de la periode consideree et que chacun compte pour un demi-sujet dans la population exposee Les quotients de mortalite sont calcules pour les quatre classes d âge de 3 mois pour tenir compte de la variation du taux d'emigration en fonction de l'âge C est a partir de ces quatre quotients qu'a ete calcule le quotient de mortalite de la classe 0–12 mois Pour cette etude, on dispose d'une cohorte d'animaux nes entre mars 1992 et septembre 1993

Le tableau 3 presente les quotients de mortalite par classe d'âge et par sexe Pour la classe 0–12 mois la mortalite des mâles est plus elevee (25,8%) que celle

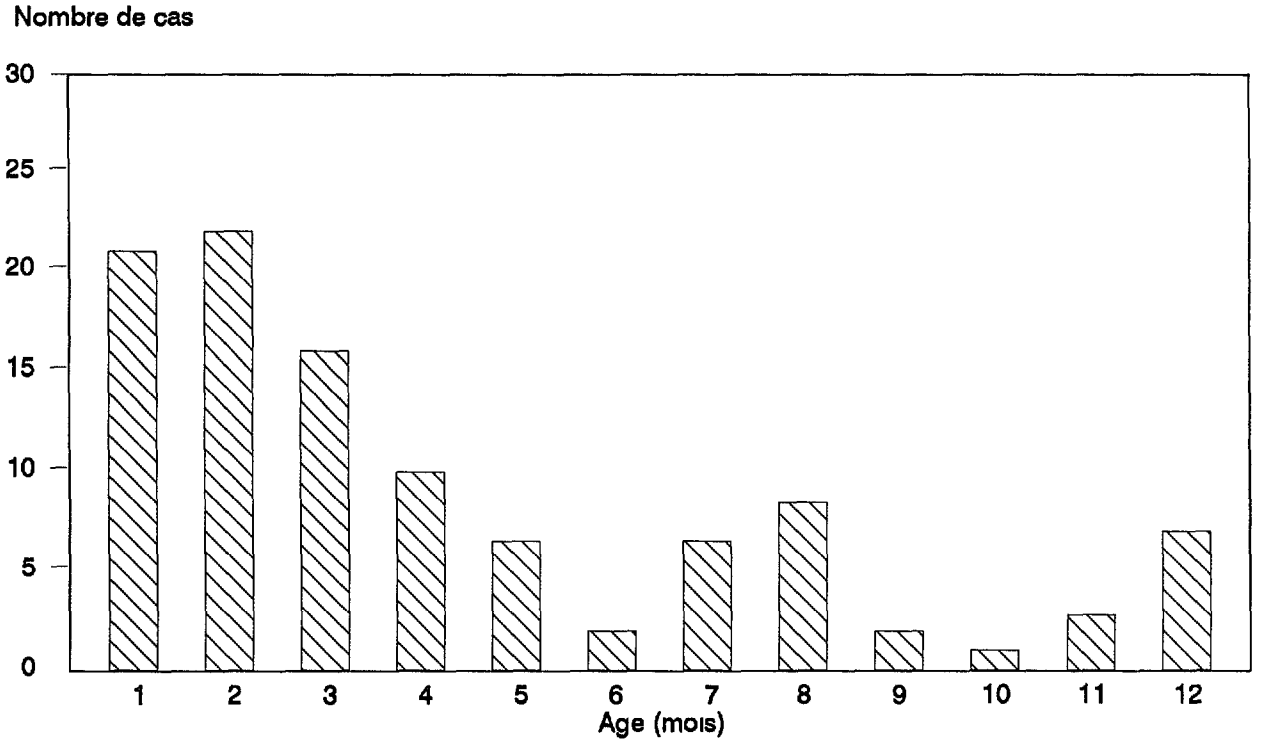

Figure 4 *Mortalite des chevreaux entre 0 et 12 mois*

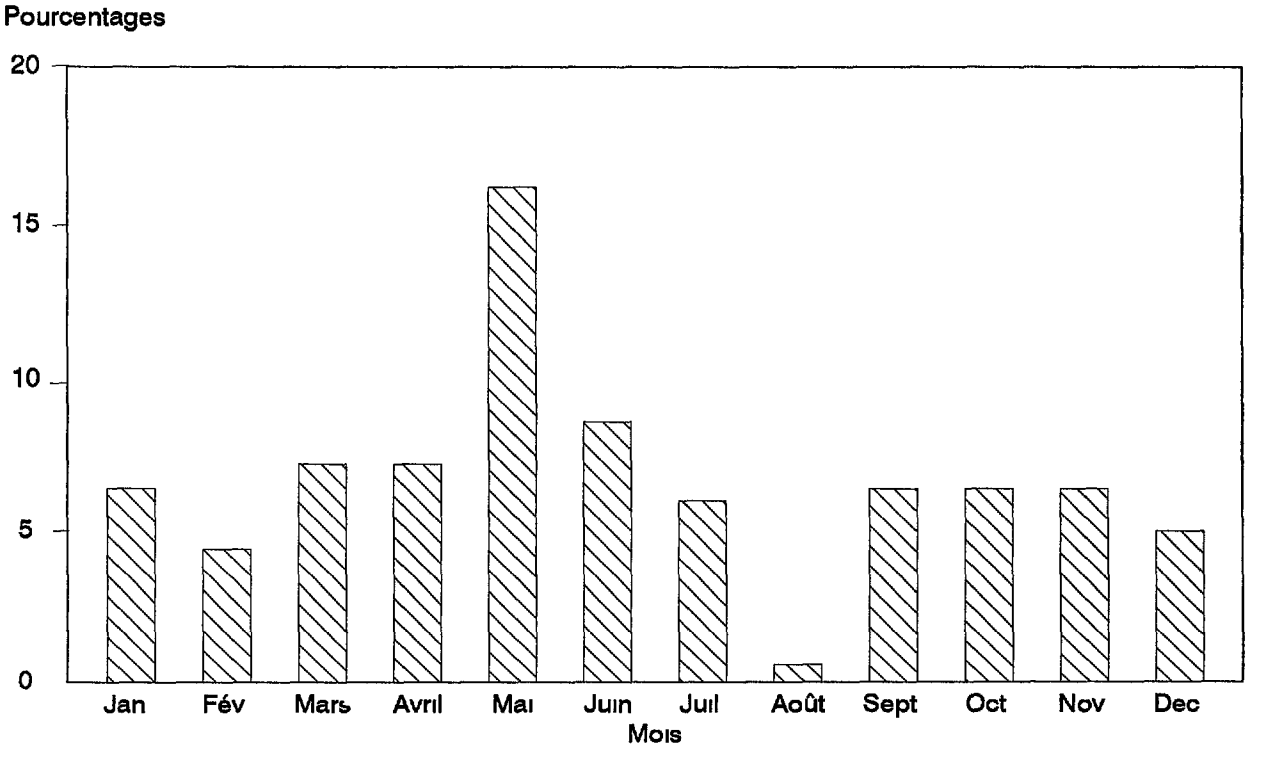

Figure 5 *Evolution des mortalites au cours de l annee*

des femelles (23 7%) Le quotient général pour les deux sexes est de 32,4% Pendant l annee, la mortalite des mâles est plus elevee que celle des femelles, mais les différences ne sont pas statistiquement significatives (P>0 05) Pour les animaux des deux sexes, la mortalite varie avec l âge et est plus importante entre 0 et 3 mois avant de diminuer pendant le reste de l'annee Ces quotients de mortalite mâles et femelles sont inferieurs a ceux rapportes par Faugere *et al* (1988) dans la region de Kolda (47% et 30%, respectivement pour les mâles

Tableau 3 *Quotient de mortalite par classe d âge et par sexe*

	Femelles				Mâles				Totaux			
Classes d âge	I	M	Em	Qm	I	M	E	Qm	I	M	E	Qm
0–3 mois	177	25	1	14 1	187	34	3	19 1	364	59	4	16 3
3–6 mois	151	10	2	6 6	150	10	13	7 0	301	20	15	6 8
6–9 mois	139	13	5	10 0	127	8	20	6 8	266	21	25	8 3
9–12 mois	121	6	14	5 3	99	5	23	5 8	220	11	37	5 5
0–12 mois	177	–	–	23 7	187	–	–	25 8	364	–	–	32 4

Qm = quotient de mortalité théorique
I = effectif initial
M = animaux morts
E = animaux exploités

et les femelles) Le quotient annuel pour les animaux des deux sexes est compris entre les resultats de Louga (25%) et ceux de Kolda (32%) (IEMVT-CIRAD, 1991) Les quotients de mortalite annuelle selon la saison de naissance sont de 32,8% pour la saison I, 33,2% pour la saison II et 29,2% pour la saison III La saison de naissance ne semble pas influencer de maniere significative le quotient de mortalite (chi^2 =5 99 avec ddl=2)

Chez les caprins, le taux de naissances gemellaires est eleve Cet avantage n'est il pas contrebalance par un taux de mortalite eleve? En moyenne, 29 5% des naissances sont simples et 35,6% sont multiples La taille de la portee 3 a ete rattachee a la 2 en raison d'un effectif initial faible La difference entre les portees des naissances simple et multiple n'est pas statistiquement significative (P<0,5)

Causes de mortalite

Le tableau 4 presente les causes de mortalite par âge

La premiere remarque est le pourcentage eleve des causes de mortalite non identifiees (37%) Le fait que l'eleveur ne puisse pas dire s'il s agit de l evolution d une maladie ou d un accident montre que le contrôle des animaux est difficile

La seconde remarque est l'absence des maladies transmises par les tiques telles que l'anaplasmose, affections repandues dans la zone (Gueye *et al* , 1986) L'interloculeur est un element important dans la qualite de l'information recueillie Les enfants, qui assurent la conduite au pâturage d'ou des animaux ne reviennent pas n ont pas ete associes aux enquêtes Et pourtant ils auraient peut-être pu donner des precisions sur l'etat et les signes deceles sur l'animal avant son deces Par ailleurs des visites tous les 15 jours nous semblent eloignees pour permettre aux techniciens d'identifier toutes les maladies qui peuvent avoir des formes d'evolution aigue Le programme PPR a d'ailleurs instaure un suivi sanitaire a raison d une visite tous les trois jours (Moulin, 1993)

Production laitière

Il n'a pas ete possible d estimer la quantite de lait consommee par les chevreaux En milieu traditionnel, il est tres difficile d'utiliser la methode de la double pesee du chevreau avant et apres la tetee Les resultats de recherche en station qui seront disponibles prochainement permettront d estimer la quantite de lait consommee par les chevreaux en fonction de la croissance

Tableau 4 *Causes de mortalite par classe d âge*

Causes	Age (mois)							
	0–3	3–6	6–9	9–12	12–24	>24	Total	%
Accident	4	7	4	1	5	4	25	8 7
Malnutrition troubles de la croissance	36	8	2	2	4	0	52	18 1
Maladies dont	38	24	17	6	13	6	104	36 1
gale	14	10	10	2	5	3	44	15 3
diarrhée	12	4	1	0	2	0	18	6,2
Troubles respiratoires	3	3	0	2	0	1	9	3,1
Maladies non identifiées	9	7	6	2	7	2	33	11,5
Causes non identifiees	31	19	10	5	13	29	107	37,1
Total	109	58	33	14	35	39	288	100
%	37,8	20,1	11,5	4 9	12,2	13,5	100	–

Donnees générales

La duree moyenne de lactation est de 184±71 jours soit environ six (6) mois chiffre voisin de celui de 180 jours rapporte par Charray *et al* (1980) sur la chevre sahelienne Chez la chevre de Massakory, elle est de 135 ± 6 jours sur 173 observations avec des extrêmes de 54 et 155 jours (Charray *et al,* 1980) La production laitiere moyenne prelevee est de 31±11 kg avec un minimum de 11 kg et un maximum de 56 Kg Quant a la duree moyenne de la traite, elle est de 140±65 jours Enfin, la production laitiere moyenne prelevee par jour de traite est de 273±162 g avec un minimum de 61 g et un maximum de 557 g

Facteurs de variation de la quantite de lait prelevee

Le stade de lactation influence la quantite de lait traite (figure 6) Les quantites de lait prelevees par jour sont maximales entre la 4eme et la 6eme semaines Ensuite, elles diminuent progressivement la baisse etant plus forte au-dela de la 14e semaine

La saison de mise bas a une influence hautement significative (P<0 001) La quantite de lait traite apres les mises bas de saison des pluies est plus importante Cela est lie a la disponibilite et a la bonne valeur nutritive de l'herbe La duree de la traite est plus longue Cette production laitiere diminue si la mise bas intervient en saison seche froide les caprins beneficiant d un pâturage de qualite moyenne Elle devient mediocre avec une mise bas de saison seche chaude, l alimentation etant la contrainte majeure

Le rang de la mise bas a un effet significatif (P<0,05) sur la production laitiere Les femelles primipares subissent une pression de traite moins forte que les multipares La production laitiere augmente avec le rang de lactation Cela est a lier a la diminution progressive des besoins de croissance des femelles au fur et a mesure qu'elles s approchent du poids adulte Les femelles allaitant deux chevreaux produisent autant de lait trait que celles qui n'en allaitent qu'un Ces resultats corroborent les observations de Koussou et Bourzat (1993) et de Chamchadine (1994)

Le troupeau a un effet hautement significatif (p<0 001) sur la quantite de lait traite Une etude plus poussee des pratiques d'elevage s avere indispensable pour expliquer ces differences

Traite et croissance des chevreaux

Il convient de signaler qu au tableau 7, on n'a pas represente les deux sexes separement car il n y a pas eu d'interaction entre la pratique de traite et le sexe

L effet de la traite sur la croissance des chevreaux est significatif (P<0,05) entre le 2eme et le 6eme mois periode au cours de laquelle la difference de poids va de 300 a 800 g Ce phenomene peut s expliquer par le fait que la traite commence generalement au-dela d'un mois apres la mise bas et se termine vers cinq a six mois Les

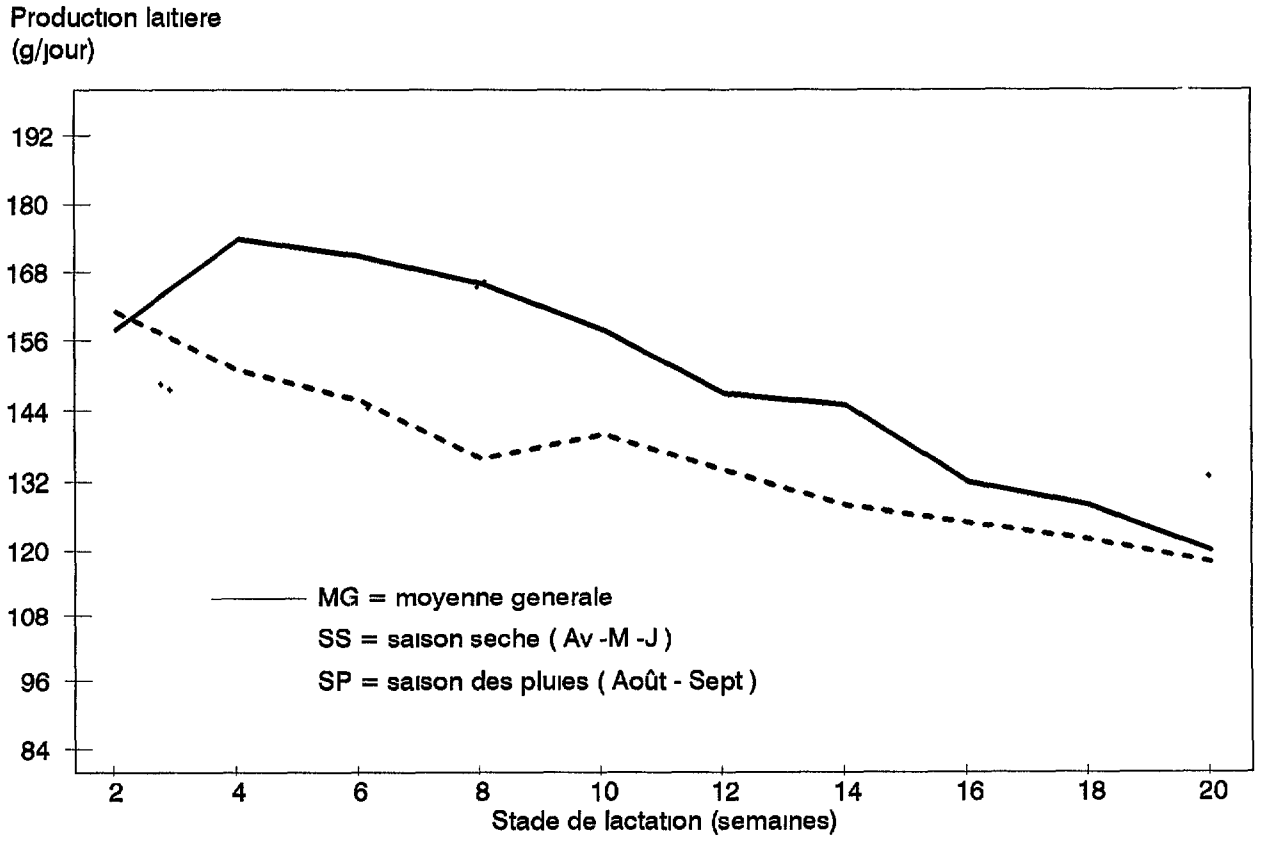

Figure 6 *Quantite de lait prelevee en fonction du stade de lactation*

Tableau 5 *Analyse de variance de la quantite de lait prelevee par jour de traite duree de la traite et production laitiere totale prelevee*

	Production prelevée totale		Durée de traite	Production prelevee/jour de traite
Facteurs de variation	DDL	CM	CM	CM
Saison MB	2	367*	8826*	27758***
Durée MB	2	622*	5312 NS	16925**
Rang BM	4	145NS	4887 NS	10495*
Eleveur	9	545**	7892*	12324***
Intervalle entre				
MB	4	336 NS	5162 NS	2353 NS
NBP 1 mois	2	520 NS	3582 NS	10349 NS
NBP 2 mois	2	100 NS	4012 NS	23398 NS
NBP 3 mois	2	240 NS	3802 NS	180 NS

*=P<0 05 **=P<0 01 ***=P<0 001 NS = non significatif CM = carres moyens DDL = degre de liberte MB=mise bas

chevreaux issus de meres non traites beneficient de toute la production laitiere maternelle Cette difference de poids diminue graduellement apres six mois, les chevreaux dependant moins du lait maternel

Traite et mortalite des chevreaux

Il ressort du tableau 7 que la pratique de la traite a une influence sur la mortalite des chevreaux, influence qui n'est significative (P<0,1) que pour la classe d'âge 0–3 mois La pratique de traite reduit les quantites de lait disponibles pour les produits allaites Cela entraîne des poids plus faibles (tableau 6) et donc des troubles de la croissance et des risques de maladies plus eleves

Economie de l'élevage caprin

Flux d'animaux

Le taux d'immigration, rapport entre le nombre d'animaux entrant dans un troupeau et le nombre moyen d'animaux pour une periode consideree (Landais *et al* , 1986) est de 2,8% par an Les Peul achetent rarement des caprins L'achat porte en particulier sur des femelles le plus souvent jeunes (moins de deux ans)

En deux annees de suivi, 318 caprins ont ete exploites soit un taux annuel de 21,2% Ce taux est faible compare a ceux rapportes pour la zone sahelienne ou il varie entre 33 et 50% (Faugere *et al* , 1989) Il est proche cependant des taux de 26% enregistres dans la zone du delta au nord du Senegal (Tourrand 1993) et de 23% observes en Mauritanie (François, 1989) Les ventes et les abattages representent respectivement 61 et 32% des sorties Les dons et trocs sont rares et n'interessent que 7% des animaux Ce taux assez faible peut s'expliquer par l'importance de la traite dans la zone periurbaine de Dakar En effet, on a observe que plus l eleveur a du lait de vache et de chevre moins il vend d animaux En effet, la vente de lait procure des revenus qui permettent d'entretenir quotidiennement le menage (prise en charge des repas) Donc la vente d'animaux n intervient que lorsque survient un besoin plus important (maladie voyage, achat d habits etc) Les eleveurs qui ne pratiquent pas la traite exploitent 29% de leur cheptel caprin, contre 19% pour ceux qui prelevent le lait

Le taux d'exploitation des boucs de l'ordre de 47%, est nettement superieur a celui des femelles lequel est de 11% Pour les chevres François (1989), Faugere *et al* (1989) Tourrand (1993) ont rapporte des taux d'exploitation voisins, compris entre 10 et 13% Les mâles sont exploites en priorite par rapport aux femelles Ils representent 65% et 55% respectivement des ventes et des abattages Cette preference pour les mâles peut s'expliquer par leur meilleure vitesse de croissance et par consequent par une bonne valorisation a la vente En

Tableau 6 *Influence de la traite sur la croissance des chevreaux*

	Poids (kg)					
Pratique	1 mois	2 mois	3 mois	6 mois	9 mois	12 mois
Absence de traite	4 5±1 1	6 8±1 6	8 8±1 9	13 4±2 8	16 7±3	19 7±2 6
Traite	4 5±1 3	6 5±1 7	8 3±2 3	12 6±2 9	16 1±3 2	19 3±3 3
Différence de poids	NS	0 3	0 5	0 8	0 6	0 4
Niveau de signification	0	*	*	*	NS	NS

NS= non significatif

* = p<0 05

Tableau 7 *Influence de la traite sur les quotients de mortalite*

	Classe d age (mois)				
	0–3	3–6	6–9	9–12	0–12
Traite	17 6	6 9	8 4	5 1	33 3
Absence de traite	12 2	6,3	7 1	5 3	27 6
Difference	5 5	0 6	1 3	0 2	5 7
Niveau de signification	+	NS	NS	NS	+

NS= non significatif

+ = significatif a 10%

effet ils sont vendus plus chers (1500 a 2500 F CFA de plus) que les femelles

La figure 7 presente la distribution mensuelle des animaux exploites L exploitation est plus forte pendant les fêtes religieuses (Tabaski et Tamxarit) qui ont eu lieu entre mai et juin au cours des deux dernieres annees En effet, 37% des sorties ont eu lieu durant ces deux mois de l annee

Valorisation du lait

Dans la zone d'etude, une partie du lait de chevre est vendue a une petite unite artisanale de production de fromage Le reste, melange au lait de vache, est vendu caille dans les marches de la region de Dakar L'auto consommation existe, mais est difficile a evaluer en raison de son caractere occasionnel En effet les eleveurs des zones periurbaines consomment plus volontiers du riz, et rarement d'importantes quantites de lait (preparation de couscous et de bouillie)

Revenus monetaires

Les charges monetaires sont faibles en elevage caprin La main-d oeuvre familiale est exclusivement utilisee pour la gestion du troupeau (conduite au pâturage, traite, transformation et commercialisation du lait) L'achat de medicaments ou d'aliments n a pas ete observe durant le suivi Les frais d achat de cordes ne depassent guere 1000 F CFA par troupeau et par an Les achats d'animaux sont rares comme indique plus haut et ne représentent en moyenne que 6600 F CFA par troupeau et par an En moyenne, les depenses monetaires par troupeau s'elevent a 7800 F CFA

Dans cette zone les produits de la vente du lait et des animaux sont pris en compte les peaux et le fumier ne sont pas valorises financierement Devant la difficulte rencontree pour estimer les quantites autoconsommees par rapport a celles vendues, on a considere la quantite totale de lait produit (estimation des contrôles bimensuels) dans le calcul des recettes Le prix moyen du litre de lait en 1992 et 1993 etait de 283 F

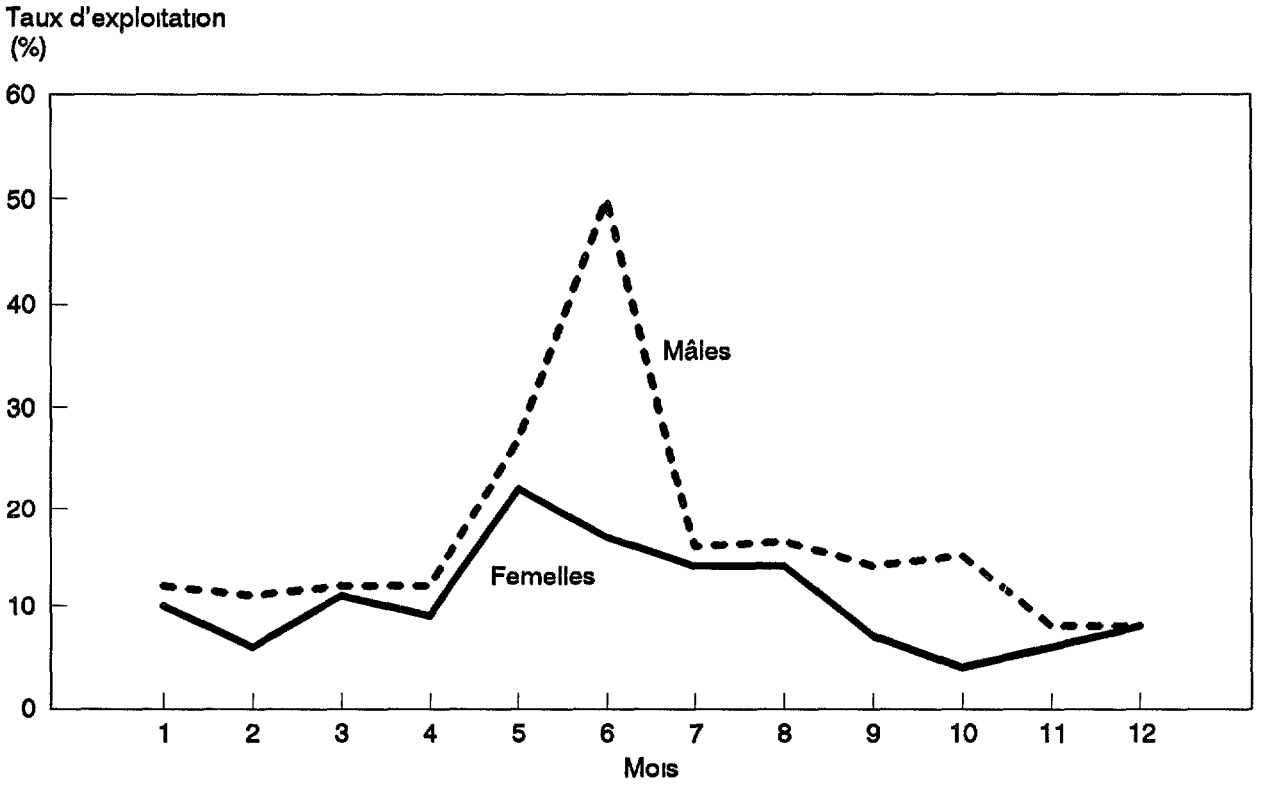

Figure 7 *Evolution mensuelle des exploitations*

CFA par litre Ce prix est variable selon que la femme de l'eleveur vend le lait au marche ou a un intermediaire Les recettes de la vente de lait s'elevent en moyenne a 115000 F CFA par an et par troupeau Cette somme equivalait avant la devaluation a 6 mois de salaire d'un berger travaillant dans l'elevage intensif et a pres de 4 mois de salaire d un ouvrier qui gagne le SMIG (salaire minimun interprofessionnel garanti, soit 30000 F CFA)

Le prix moyen de vente des caprins est de 8400 F CFA Les recettes de la commercialisation des animaux s elevent en moyenne a 44800 F CFA par an Cette somme serait de 73500 F CFA si tous les animaux exploites etaient destines a la vente

Les eleveurs qui ne pratiquent pas la traite vendent en moyenne deux animaux de plus que les autres et ont un quotient d'exploitation entre 0 et 12 mois (26,3%) superieur a celui de leurs homologues qui traient leurs animaux (23%) Ils gagnent ainsi 60900 F CFA par an contre 40500 F CFA pour ceux qui font la traite Cette difference de recettes pourrait s expliquer par la production d animaux plus lourds a 6 mois chez les eleveurs non producteurs de lait

L'elevage caprin genere des revenus assez substantiels de l'ordre 53400 F CFA pour les eleveurs qui ne pratiquent pas la traite et 148000 F CFA pour les autres, soit respectivement pres de 3 mois et 8 mois de salaire d'un berger travaillant dans la zone Les caprins constituent donc une importante source de revenus pour les producteurs

La prise en compte des evolutions d effectifs aurait permis d'estimer la valeur du cheptel accumule pendant la periode d'etude en comparaison avec la valeur du cheptel exploite Une evaluation economique plus complete aurait permis de mieux analyser le rôle de la fumure organique dans la productivite de la partie vegetale de l exploitation La fonction sociale des caprins n'est pas bien appreciee Pourtant, les eleveurs abattent en moyenne 3,3 animaux par an a l'occasion des ceremonies familiales et autoconsomment du lait

Conclusion

L'objet de cette etude est d'analyser la production laitiere caprine en elevage traditionnel et ses facteurs de variation On a constate pour l'ensemble des parametres etudies (reproduction croissance mortalite) que les resultats obtenus sont intermediaires entre ceux de la zone de Kolda au sud et celle de Louga au nord du pays La race exploitee (croisement race sahelienne-race guineenne) et les conditions climatiques intermediaires pourraient être des facteurs explicatifs La production laitiere prelevee (31±11 kg) ne peut être comparee aux chiffres rapportes dans la bibliographie existante car la quantite consommee par le ou les chevreaux n'a pas ete prise en compte Neanmoins, la quantite de lait traite est fortement influencee par les facteurs du milieu, la saison l'annee, le rang de mise bas et surtout le troupeau

L'alimentation est un des facteurs limitants pour la production laitiere Pendant l hivernage, cette production est elevee du fait de la disponibilte d'un pâturage abondant de bonne qualite Cependant, en saison seche surtout chaude la production est faible Pour pallier ce deficit, une complementation s impose surtout pour les femelles allaitantes L abreuvement doit être egalement assure pendant cette periode

Comme l alimentation la sante est un facteur de premiere importance La mortalite des jeunes est tres elevee et entrave de maniere directe l'augmentation de la production laitiere dans la mesure ou la disparition precoce du ou des chevreaux entraîne presque automatiquement l'arrêt de la traite Un suivi sanitaire du troupeau est indispensable pour garantir une productivite maximum

Ces deux facteurs constituent donc les principaux obstacles a l augmentation des productions caprines La levee de ces contraintes pourrait permettre d'ameliorer sensiblement la productivite laitiere en milieu eleveur La suite des recherches doit donc s'inscrire dans cette dynamique

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Remerciements

Les auteurs remercient M Bigot, Babene et MBodj du Service des cultures fourrageres pour leur precieuse aide dans l'identification des types de parcours et la methodologie de prelevement de biomasse, le personnel du laboratoire de chimie du LNERV pour les analyses bromatologiques effectuees, le programme PPR du LNERV pour leur appui dans l'utilisation du logiciel PANURGE M Keba Diao, observateur, pour ses efforts soutenus pour la qualite du suivi, tous les eleveurs de la zone de Sangalkam et de Sebikotane cette etude n'aurait pu aboutir sans leur consentement et leur participation, et enfin Mme Coumba Sow et Mr O Bougaleb pour leur remarquable travail dans la mise en forme de ce document

Factors affecting goat milk production in a Fulani area

Abstract

This study of the factors of variation in goat milk production in Fulani systems was carried out in the Niayes area of Dakar, Senegal Reproduction, growth mortality and milk production parameters were analysed Age at first kidding was 16 months and kidding interval was 280 days Average litter size was 1 36 kids and mortality quotient was high at 32 4% Lactation length was 184 days while milk offtake per lactation was 31 kg Goat production plays an important social and economic role in this area, providing substantial income and contributing to people's animal protein needs

SESSION 3

Management and Health

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Contagious caprine pleuropneumonia: Diagnosis and control

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Abstract

Contagious caprine pleuropneumonia is a disease with high morbidity (80–100%) and mortality (60–80%) rates Rapid diagnosis of this devastating disease is essential for its immediate containment A pen side diagnostic test — latex agglutination — based on the carbohydrate elaborated by *Mycoplasma capricolum* subsp *capripneumoniae* (Mccp) has been described One way to contain and control the disease is through vaccination A liquid vaccine is presently in use However, freeze-dried saponin killed Mccp has been shown to confer protective immunity of over 12 months The freeze-dried antigens are stable one year after storage at 4 C or 22 C This indicates that a freeze-dried vaccine is feasible and indeed preliminary field trails have indicated that a freeze dried vaccine confers protective immunity

Introduction

Contagious caprine pleuropneumonia (CCPP) is a cause of major economic losses to goat production in at least 30 countries in Africa and Asia containing a total goat population of more than 300 million Classical, acute CCPP is caused by *Mycoplasma capricolum* subspecies *capripneumoniae* (Mccp) (MacOwan and Minette 1976) originally known as Mycoplasma F38 This mycoplasma was first isolated from the lungs of goats with pleuropneumonia in Kenya and demonstrated to cause CCPP (MacOwan and Minette 1976) Subsequently, Mccp has been isolated in other countries including Chad, Ethiopia, India, Oman, Sudan, Tunisia, Turkey and Uganda and pleuropneumonic disease indistinguishable from naturally occurring CCPP has been experimentally reproduced with Mccp by several research groups The disease is characterised by fibrinous pleuropneumonia with increased straw-coloured pleural fluid Morbidity and mortality rates may reach 100% and 80% respectively Close contact among goats is necessary for spread of the disease (MacOwan and Minette 1976)

Diagnosis

The diagnosis of outbreaks of CCPP is complicated by other infectious agents causing similar syndromes Pleuropneumonic disease resembling Mccp-associated CCPP can also be produced by *Mycoplasma mycoides* subsp *capri* (Mmc) and caprine variants of *M mycoides* subsp *mycoides* (Mmm) Mmc was originally considered to be the cause of CCPP, but its full importance as a pathogen of goats has now become doubtful, both because of the discovery of the Mccp and because many isolates previously classified as Mmc have subsequently been found to be caprine variants of Mmm Mmc has been isolated from several countries in Africa and Asia, and from Australia The disease reproduced experimentally with Mmc is largely restricted to the thoracic cavity, with or without a septicaemic phase and death In contrast, caprine variants of Mmm generally causes a syndrome which may include not only pleuropneumonia but also mastitis, polyarthritis, keratoconjunctivitis, acute septicaemic death, sometimes with symptoms of the central nervous system, and abortion Mmm is a major cause of disease in goats in USA, France, Israel and India Experimentally, the disease caused by Mccp differs from that produced by Mmc and Mmm in being readily contagious and fatal to susceptible goats, not affecting sheep or cattle, not producing local oedematous reactions when injected subcutaneously, and being characterised histo-pathologically by an interstitial, intralobular oedema of the lung compared with the thickening of the interlobular septa which is seen with Mmc and Mmm (Kaliner and MacOwan 1976) *Pasteurella haemolytica* (both biotypes A and T) and *P multocida* have also been associated with pleuropneumonia in goats, although experimental evidence of their pathogenicity in this host is meagre

Diagnosis of CCPP can be divided into field and laboratory diagnosis Because this devastating disease occurs in epidemics it is essential that the diagnosis be achieved very quickly so that control measures such as treatment of the sick goats and vaccination of those at risk is carried out immediately Therefore, proper field diagnosis is paramount

Field diagnosis

Field diagnosis is achieved through

- Observation of the presenting clinical signs which include fever (40–42 C), coughing dyspnea, high morbidity (about 100%) and high mortality of about 70% Post-mortem examination will reveal fibrinous pleuropneumonia accompanied with

increased pleural fluid and enlarged and oedematous mediastinal lymph nodes

- Latex agglutination test (LAT) (Rurangirwa et al 1987b) This test is based on a polysaccharide isolated from Mccp (Rurangirwa et al 1987a) which is used to sensitise latex beads The sensitised latex beads are then used to detect serum antibodies from goats infected with CCPP (Rurangirwa et al 1987b) The specificity of LAT was assessed using WM25 monoclonal antibody which is specific for Mccp (Rurangirwa et al 1987c, Belton et al 1994) and reacts with the polysaccharide (Rurangirwa et al 1992) The specificity of LAT was further confirmed by evaluating specific growth inhibiting rabbit antisera to various mycoplasma isolates (Rurangirwa et al 1987c)

The sensitised latex beads are stable at 4 C, room temperature and 37 C for over one year Thus the long shelf-life of the beads at different temperatures makes it possible to prepare large amounts which can be stored until used The latex agglutination test is an excellent procedure for the diagnosis of CCPP and can be run in two minutes on samples of whole blood or serum, requires no sophisticated equipment or storage facilities and is adaptable to any laboratory or field conditions — an example of a pen-side diagnostic test The test is carried out by mixing a drop of the sensitised beads with a drop of blood or serum from the suspected animal on a glass slide for one minute and the results read visually and recorded as positive or negative LAT combined with presenting clinical signs and necropsy indicating fibrinous pleuropneumonia is confirmatory of Mccp associated CCPP

Laboratory diagnosis

Several serological tests including complement fixation (MacOwan and Minette 1976) passive haemagglutination (Muthomi and Rurangirwa 1972) and enzyme-linked immunosorbent assay (Wamwayi et al 1989) detect serum antibodies to Mccp However, routine use of these tests is constrained by lack of equipment and trained personnel Similar constraints are encountered in the use of DNA probes (Taylor et al 1992, Thiaucourt et al 1992) and PCR (Bascunana et al 1994)

Culture, isolation and characterisation of Mccp This procedure which takes a minimum of 10 days is too slow to be of any practical use in the containment of CCPP outbreak

Control

Since the disease occurs in epidemics antibiotic treatment, as the only control measure would be very uneconomical Therefore, efforts have been directed towards controlling the disease by vaccination This section documents developmental stages of the CCPP vaccine presently in use The first immunisation trial using Mccp was carried out by MacOwan and Minnette (1978) They inoculated 20 goats intratracheally with a high-passage culture of Mccp On contact challenge of the inoculated goats one month later, 11 of the 20 vaccinated goats were protected, whereas all 20 control goats contracted CCPP The results provided an indication that goats could be protected against CCPP by using Mccp

While investigating the effect of streptomycin in goats with natural and experimental CCPP caused by Mccp (Rurangirwa et al 1981a) it was found that goats treated with streptomycin on the 3rd day of temperature elevation (>4 C) recovered from the disease and became completely immune to reinfection with Mccp (Rurangirwa et al 1981a) Serum samples from such recovered goats caused *in vitro* growth inhibition of Mccp (Rurangirwa et al 1981a) This observation led to a series of experiments in which goats were immunised with sonicated F38 antigens in different adjuvants which included Freund's complete adjuvant, Freund's incomplete adjuvant and aluminium hydroxide (Rurangirwa et al 1981b, Rurangirwa et al 1984)

It was demonstrated that protective immunity in goats could be induced by using sonicated Mccp antigens in Freund s complete and/or incomplete adjuvants The immunity was present for at least six months after vaccination (Rurangirwa et al 1984) Aluminium hydroxide, like antigen alone, provided only 20% protection (Rurangirwa et al 1984) Thus, an unequivocal protection of goats against CCPP with sonicated Mccp antigens in an oil adjuvant was demonstrated Although oil adjuvants are not suitable for use in food animals use of Freund s complete and/or incomplete adjuvants demonstrated that Mccp organisms disrupted by sonication and injected with an appropriate adjuvant would induce protective immunity in goats against CCPP

A pilot experiment revealed that saponin could be used as an adjuvant for Mccp vaccines This finding was very important because saponin does not cause obvious tissue damage Thus a series of experiments were carried out using saponin as an adjuvant to assess

- immunogenic stability of Mccp after lyophilisation
- immunogenicity after storage at 22 C and 4 C
- the duration of immunity induced by a single dose of the lyophilised Mccp

Lyophilisation trials (Rurangirwa et al 1987d)

Since lyophilised vaccines are easy to store and transport a preliminary study was undertaken to find out if lyophilised Mccp would induce protective immunity in goats against CCPP Eight goats were immunised with 8 mg/ml of freeze dried Mccp in saponin to inactivate the organism and serve as adjuvant The goats received a similar immunisation 21 days later Two months after initial immunisation, the vaccinated and control goats were challenged by contact exposure Six of the control goats and only one of eight vaccinated goats died of CCPP These results led to the conclusion that lyophilised Mccp antigens could protect goats

against CCPP caused by Mccp when an optimal immunising dose is used with an appropriate adjuvant

Determination of minimum immunising dose of lyophilised Mccp (Rurangirwa et al 1987c, Rurangirwa et al 1987d)

Seven groups of five goats each were immunised with different doses containing 0 015 0 075, 0 15, 0 20 0 375, 0 750, and 1 50 mg protein of lyophilised Mccp using saponin as an adjuvant An eighth group of five goats was immunised with the highest dose (1 50 mg) without adjuvant A ninth group of control goats was immunised with saponin in phosphate-buffered saline (PBS), pH 7 4 All the goats were immunised again four weeks later The immunised goats, along with control goats, were contact challenged four weeks after the second immunisation

The mean time for the control goats to develop pyrexia of 40 C was 14±1 5 days after exposure to infected goats and all the control goats died of CCPP The goats that were immunised with 1 5 mg Mccp antigen without saponin had an incubation period similar to that of the control group Two goats immunised with the lowest amount of lyophilised Mccp (0 015 mg in saponin) died of CCPP One goat given 0 075 mg in saponin also died of CCPP There was no pyrexia nor any signs of disease in the goats that were immunised with >0 15 mg in saponin except in one of the group immunised with 0 375 mg, which had a temperature reaction 40 days after contact exposure and died of CCPP six days later The results indicated that the minimum immunising dose that fully protected all goats in a group was 0 15 mg

Immunogenic stability of lyophilised Mccp stored at 22°C and 4°C for 3, 9 and 14 months (Rurangirwa et al 1987c)

In order to check the stability of the antigen upon storage, antigen (lyophilised Mccp) was stored at 4 and 22 C for up to 14 months Goats were immunised with two doses of the minimum immunising dose (0 15 mg) of the antigen after storage for 3 and 14 months at 22 C and after 3, 9 and 14 months at 4 C The immunised goats, together with corresponding controls, were challenged by contact exposure three weeks after the booster dose Lyophilised Mccp kept for 3, 9 and 14 months induced protective immunity in all the immunised goats The average mean time for the non-immunised control groups of goats at 3 9 and 14 months to develop pyrexia were 15 17 and 22 days after contact exposure to the infected goats respectively There was no indication of CCPP in the immunised goats

Duration of immunity induced by a single dose (Rurangirwa et al 1987c)

Three groups of 30 goats each were immunised with single doses of 0 15, 0 30 and 1 2 mg of the lyophilised Mccp containing saponin as an adjuvant A fourth group was injected with saponin in PBS Ten goats from each group were subsequently exposed to virulent challenge by contact 3, 6 and 12 months later All the goats immunised with a single dose of 0 15 mg were protected Those immunised with a single dose of 0 3 mg were protected, except in one case when at 12 months a goat reacted and died of CCPP Two goats in the group immunised with 1 2 mg also died of CCPP — one from the group challenged at 6 months, and the other from the group challenged at 12 months

Three major conclusions were drawn from the results of these immunisation trials

1 Lyophilisation and storage of Mccp at 22 C or 4 C did not affect its immunogenicity

2 Large quantities of lyophilised Mccp could be produced and stored at 22 C or 4 C for <14 months without affecting immunogenicity

3 Duration of immunity induced by a single minimum immunising dose of 0 15 mg lyophilised F38 was >12 months Thus, the vaccine developed for CCPP can be lyophilised has a minimum dose of 0 15 mg and a shelf-life of >14 months when stored at 22 C or 4 C and induces immunity lasting over 12 months

Preliminary field test of the lyophilised vaccine (Rurangirwa et al 1991)

One hundred and fifteen, one-year-old goats from a single farm were screened for antibodies to Mccp using a latex agglutination test (Rurangirwa et al 1987b) and 100 of them which lacked antibody to Mccp were purchased Fifty of the goats were immunised subcutaneously with a single dose (0 15 mg) of the lyophilised saponin killed CCPP vaccine (Rurangirwa et al 1987e) while the remaining 50 were left as unimmunised controls All the goats were maintained on the same farm for two months and then transported to Kabete Veterinary Laboratory for contact challenge The challenge was carried out by housing the 100 goats with five goats infected with Mccp by endobronchial intubation (MacOwan and Minette 1976) During contact challenge, the two groups were grazed during the day and housed at night together with the five experimentally infected goats All goats were examined daily and their rectal temperatures recorded An autopsy was performed on any goat that died, the gross lesions recorded and specimens of affected organs taken for isolation of mycoplasma and bacteria The trial was carried out for four months after challenge and the surviving goats were euthanased and autopsies carried out Mycoplasma were isolated using Newing s tryptose broth (Gourlay 1964) and their identity as Mccp was confirmed by growth inhibition (Rurangirwa et al 1987c)

Twelve vaccinates and 14 controls died of diarrhoea due to salmonella infection during the acclimatisation period of three weeks at the Kabete Veterinary Laboratory leaving 38 vaccinates and 36 controls for contact challenge None of the dead goats

had lung lesions and no Mccp were isolated from lung or lymph node tissues Thirty control goats developed pyrexia at a mean of 39 (±14 3 SD) days after exposure Twenty-seven of the 30 affected control goats died of CCPP at a mean 8 1 (±2 33 SD) days after pyrexia began and three recovered Four months after contact challenge, the three recovered control goats were euthanased, they had adhesions of the cardiac and apical lobes to the thoracic wall but Mccp organisms were not isolated from their tissues The remaining six control goats had no signs of disease and when they were euthanased and examined at the end of four months, there were no lesions and Mccp organisms were not isolated from their tissues

Failure of six of 36 control goats to contract CCPP is in contrast to containment experiments in which almost 100% infection occurred in the contact challenges (Rurangirwa et al 1987e) A morbidity and mortality rate of 60 to 80% has been reported for the field outbreaks of CCPP (MacOwan and Minette 1977) The experimental conditions for the present study were set to mimic field conditions as opposed to containment throughout the experimental period Therefore, the failure of six controls to show any signs of disease may be attributed to a less severe challenge than was previously used (Rurangirwa et al 1987e) The recovery of the three control goats from CCPP after showing clinical signs indicates that a small number of goats may recover from CCPP, especially if they are not subjected to movement stress in search of food and water

All the surviving vaccinates withstood the challenge There was a temperature elevation in two of the goats (41 and 62 days after challenge) which returned to normal after two days There was no pyrexia and no signs of disease in the remaining 36 vaccinated goats during the four-month experimental period At the end of the experiment active lesions were not seen in the 36 euthanased vaccinated goats without clinical signs and Mccp was not isolated from their tissues However, in the two vaccinates which had a temperature reaction, adhesions were present in the thoracic cavity, but Mccp was not isolated from their tissues This finding may be related to individual variation or to other unknown causes Similar observations have been reported before (Rurangirwa et al 1987e)

In conclusion one dose of lyophilised Mccp vaccine induced an immunity in goats that protected totally against mortality and was 95% efficacious against clinical disease In the two vaccinated goats that had pyrexia, no detectable carrier state resulted Therefore, this vaccine is suitable for use in control programmes for CCPP

The vaccine has not yet been lyophilised for general use in the field although the same formulation in liquid form is in use Plans are now well advanced to freeze-dry the vaccine

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La péripneumonie caprine contagieuse: diagnostic et contrôle

Résumé

La pleuropneumonie caprine contagieuse est une maladie a taux eleves de morbidite (80–100%) et de mortalite (60–80%) Seul un diagnostic rapide permet de maîtriser cette affection devastatrice Un test de diagnostic sur le terrain utilisant l agglutination des particules de latex et base sur les glucides elabores par *Mycoplasma capricolum* sous-espece *capripneumoniae* (Mccp) a ete decrit La vaccination peut permettre de lutter contre cette maladie et de la contrôler Un vaccin liquide est actuellement utilise Toutefois il a ete demontre que des souches de Mccp lyophilisees tuees a la saponine pouvaient proteger les animaux par immunite pendant plus de 12 mois Les antigenes lyophilises sont stables pendant un an a une temperature de conservation de 4 ou 22 C Cela signifie qu on peut en obtenir un vaccin lyophilise De fait des essais preliminaires en milieu reel ont permis d'etablir qu'un vaccin obtenu par lyophilisation conferait une immunite protectrice

A survey of pathological conditions in slaughtered goats at Zaria slaughter houses

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Abstract

The prevalence of disease constitutes a serious impediment to small animal production in Nigeria For an effective goat disease control programme it is pertinent to have a record of common diseases prevalent in an area The knowledge of the extent to which the public is exposed to certain zoonotic diseases through goat meat consumption is equally useful in preventive medicine Accordingly, slaughter houses in Zaria were visited between January and December 1992 to collect information on pathological conditions found in goats slaughtered during the period Records were kept on sex, breed, foetal wastage and on results of laboratory tests on faeces and worms collected from the disease organs A total of 7644 goats were examined Helminthiasis constituted 17 52%, pneumonia 4 8%, peste des petits ruminants 3 5%, and abscesses in liver, lung and kidney 3 2% of the pathological conditions noted Of the 1200 organs infected with diseases 300 (25%) portions were slaughtered while 900 whole organs were condemned Twenty-five whole carcasses were condemned Foetal wastage was estimated at 16 58% of the 3057 does slaughtered *Mycobacterium* sp, *Salmonella* sp, *Staphylococcus aureus* and *Bacillus cereus* isolated from the disease organs were of public health importance Some suggestions are made for improving the meat inspection practices of the slaughter houses and providing better education to the butchers and goat traders

Introduction

The consumption of animal protein by the average Nigerian is very low (Olayide et al 1972, Gefu 1982) Beef meat constitutes the major source of meat consumed in Nigeria Recently beef has become very expensive causing a shift to small ruminants particularly goats

The prevalence of disease constitutes a serious impediment to small animal production in Nigeria by causing high mortality and low production in flocks ILCA (1979) reported a kid mortality rate of 36 2% in Bendel State in Nigeria Molokwu (1982) expressed doubt on the production target indicated for goats in 1986 because of the high kid mortality and high disease prevalence in Nigerian goats

For an effective goat disease control programme it is pertinent to have a record of common diseases prevalent in an area The knowledge of the extent to which the public is exposed to certain zoonotic diseases through goat meat consumption is also useful in preventive medicine

Slaughter houses provide excellent opportunities for detecting diseases of both economic and public health importance Accordingly, the present survey reports on the diseases prevalent in goats slaughtered at Zaria between January 1992 and their public health significance, and highlights the administrative problems encountered during the survey

Materials and methods

The slaughter houses in Zaria were visited between January 1992 and December 1992 Data were collected on the pathological conditions found in goats slaughtered during the period

Enquiries were made from the trained meat inspectors regarding formal ante-mortem examination Hindrances to standard meat inspection and facilities provided for effective inspection were appraised Records were kept of the sex, breed, foetal wastage, diseases encountered and approximate age of the goats Aging was based on the method of Miller and Robertson (1959)

Post-mortem inspection was done by visual observation and palpation and by incision of suspected organs Furthermore, specimens of disease organs, faeces and adult worms were collected for laboratory studies for definitive diagnoses

Results

A total of 7644 goats were examined of which 60 1% were males and 39 99% were females Table 1 represents the disease conditions and their percentage incidence The commonest disease conditions were helminthiasis (17 52%) pneumonia (4 80%) peste des petits ruminants (3 50%) and abscesses in liver lung and kidney (3 2%) Table 2 shows the common causes of condemnations in the organs Of the 1200 organs infected with diseases 25% portions were salvaged while 75% whole organs were condemned Five whole carcasses were condemned for generalised tuberculosis and 20 goats were found dead before slaughter hence 25 whole carcasses were condemned Table 3 shows that

Table 1 *Disease conditions observed in slaughtered goatsin Zaria between January and December 1992*

Disease conditions	Number of goats examined	Number with disease condition	% incidence
Pneumonia	7644	366	4 80
Peste de petits ruminants	7644	267	3 50
Haemonchosis	7644	948	12 40
Trichostrongylosis	7644	336	4 40
Coccidiosis	7644	38	0 50
Cysticercosis	7644	76	1 00
Abscess (liver lung and kidney)	7644	244	3 20
Hydatidosis	7644	38	0 50
Mastitis	3057	62	2 03
Hygroma	7644	26	0 35
Cirrhosis	7644	90	0 90
Emaciation	7644	97	1 27
Mange	7644	57	0 75
Pericarditis	7644	83	1 09
Tuberculosis	7644	6	0 08
Foetal wastage	3057	98	3 20

Table 2 *Common causes of organ condemnation in goats in Zaria slaughter houses (January to December 1992)*

Reason for condemnation	Organs		Portion salvaged	Whole organ condemned
	Type	No		
Pneumonia	Lungs	300	120	180
Peste des petits ruminants	Intestines	55	0	55
Metritis	Uterus	24	0	24
Abscesses	Liver lung, kidney	240	48	216
Mastitis	Mammary gland	84	0	84
Cirrhosis	Liver	60	0	60
Pericarditis	Heart	72	0	72
Splenomegaly	Spleen	24	0	24
Gastroenteritis	Abomasum intestines	72	0	72
Tuberculosis	Lymph node lungs kidney intestines	5	0	72
Caseous lymphadenitis	Head	84	0	84
Miscellaneous	Liver kidney intestine uterus	156	132	24
Total		(1200)	300	900

507 pregnant does were slaughtered representing foetal wastage of 16 58% The breeds were equally affected in terms of foetal wastage The ages of these slaughtered goats ranged from 1 to 5 years

The laboratory study findings are shown in Table 4 Bacteria isolated included *Pasteurella multocida*, *Salmonella* spp, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus cereus*, *Escherichia coli*, *Corynebacterium pseudotuberculosis*, *Pseudomonas* spp, *Proteus* spp, and *Mycobacterium* spp

Table 3 *Breed and sex distribution of slaughtered goats and the incidence of foetal wastage*

Breed	Sex		Pregnant does	Foetal wastage %
	Bucks	Does		
Red Sokoto	3771	2516	417	16 57
Kano Brown	585	383	63	16 45
Dwarf goat	231	158	27	17 08

Table 4 *Bacteria cultured from condemned tissues of slaughtered goats at Zaria*

Type of bacteria	Source
Staphylococcus aureus	Udder joints uterus liver lung kidney and lymph nodes
Salmonella sp	Lung intestine
Bacillus cereus	Udder, lymph nodes
Pasteurella multocida	Lungs uterus
Escherichia coli	Intestine lungs
Staphylococcus epidermidis	Lung, uterus
Corynebacterium pseudotuberculosis	Parotid lymph nodes lung
Pseudomonas sp	Uterus
Proteus sp	Uterus

Discussion

Research scientists in Nigeria have not paid sufficient attention to goat production and diseases of goats The potential of goats as meat producers has recently been recognised in the country It is when the diseases affecting goats are identified and their epidemiology understood that meaningful preventive and production programmes can be formulated

This study may be valuable in the area of monitoring conditions that are public health hazards Most of the observed conditions leading to condemnation of organs in this survey are accepted as zoonoses (Schwabe 1969)) The implication being that the public has been saved from acquiring these deadly and debilitating disease especially tuberculosis hydatidosis and cysticercosis

The low incidence of some of the conditions reported may indicate the less significant role they play as goat diseases in this area

Helminthiasis particularly haemonchosis, accounted for 12 4% of the total disease condition encountered This certainly calls for improved control and preventive measure such as regular deworming and avoidance of fadama area for grazing Akerejola et al (1979) estimated the economic loss due to round worms in Zaria and Kano areas in sheep and goats to be 60 million Naira

Peste des petits ruminants (kata) which accounted for 3 5% of the disease incidences is of great economic importance A mortality rate of 50% or more has been reported (Akerejola et al 1979) Nduaka and Ihemelandu (1973) put the mortality rate at 100% in very young goats

Salmonella spp *Staphylococcus aureus* and *Bacillus cereus* isolated from goat organs are of public health importance This calls for erection of modern abattoirs with laboratory and cold storage facilities These facilities will help in ensuring that only wholesome goat meat is passed for human consumption

The lack of ante-mortem examination by meat inspectors in this area has serious public health implications considering the zoonotic bacteria isolated from the goat organs The high incidence (16 58%) of foetal wastage could have been reduced if there were proper ante-mortem examination Pregnant doe recovery schemes may be pursued

The findings of this study suggest that meat inspection practices require some improvement The hostile attitude of the butchers and goat traders has resulted in the lenient nature of meat inspection For example some generalised abscess conditions requiring more serious attention such as total condemnation were just trimmed off and passed for consumption

A source of disease spread to the slaughter house workers and perhaps the community is the practice of stealing and consuming diseased meat by the slaughter house workers It is hereby recommended that proper burning or burying of diseased meat should be mandatory This will also reduce the incidence of consuming diseased meat by many birds and carnivorous pet animals

Finally education of both butchers and goat traders is necessary so that they can see the need for thorough goat meat inspection There is need to improve hygienic conditions at the slaughter houses so as to reduce meat contamination The butchers and goat traders should be encouraged to seek veterinary assistance for their sick animals

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Etude des conditions pathologiques rencontrées chez les caprins abattus dans les abattoirs de Zaria

Résumé

Les maladies animales constituent un serieux obstacle au developpement de l'elevage des petits ruminants au Nigeria La mise en place d'un programme efficace de lutte contre les maladies des caprins passe par une bonne connaissance des affections les plus frequemment rencontrees dans la region consideree Il importe par ailleurs de connaître les risques que courent les populations humaines exposees a certaines maladies animales A cet effet, des visites des abattoirs de Zaria ont ete oganisees entre janvier et decembre 1992 en vue de collecter des informations pertinentes sur les conditions pathologiques rencontrees chez les caprins abattus au cours de cette periode Des donnees etaient conservees sur le sexe et la race des animaux les pertes foetales, les resultats des analyses de selles et les vers preleves sur les organes malades Un total de 7644 caprins ont ete examines Les helminthiases constituaient 17 52% des maladies observees contre 4,8% pour la pneumonie, 3,5% pour la peste des petits ruminants et 3,2% pour les abces du foie des poumons et des reins Sur les 1200 organes malades observes 300 soit 25% etaient partiellement atteints tandis que dans les 900 autres cas 1 organe etait irrecuperable, au même titre que cinq carcasses entieres Des pertes foetales avaient ete enregistrees sur 16,58% des 3057 femelles abattues Les pathogenes comme *Mycobacterium* sp, *Salmonella* sp, *Staphylococcus aureus* et *Bacillus cereus*, isoles des organes atteints, revêtent beaucoup d'importance en matiere de sante publique Des propositions ont ete avancees en vue d'ameliorer les methodes d'inspection de la viande des abattoirs et d ameliorer la formation des bouchers et des vendeurs de chevres

Fascioliasis and nutrient metabolism in pregnant and non-pregnant sheep

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Abstract

The effect of experimental fascioliasis on voluntary feed intake (VFI), organic matter digestibility (OMD), nitrogen retention (NR), rate of liveweight changes and lamb birth weight was studied in 23 open and 17 pregnant Menz ewes The infection was imposed by oral dosing with 500 metacercariae of *Fasciola hepatica* in pregnant ewes at six weeks post-breeding and in open ewes All animals were housed in concrete floored pens and assigned to four treatment groups infected pregnant (PI, n=9), non-infected pregnant (PC, n=8), infected open (OI n=11) and non-infected open (OC n=12) Infected animals became anaemic as from week 8 post-infection (p i) and *F hepatica* eggs were first observed in the faeces from the 11th week p i During the nitrogen retention trial (13th week p i), organic matter intake (OMI) and digestibility coefficients were not affected by fascioliasis All parasitised ewes exhibited higher urinary nitrogen resulting in lower nitrogen retention and lower weight gains when compared with control ewes Lamb birth weights from infected dams were lower (P<0 05) compared to the control dams It was concluded that under the conditions of the present experiment, while feed intake and digestibility coefficients were not affected, rates of liveweight changes were negatively affected by fascioliasis Nitrogen balance was lower in infected ewes without a corresponding reduction in feed intake

Introduction

The present study argues the relevance of a multi-disciplinary approach necessary for sustainable animal production in Africa During the 2nd Biennial conference of the African Small Ruminant Network, our previous research findings were reported on the effect of trypanosomiasis (Akinbamijo and Reynolds 1994) This paper reports a composite part of a study of the genetic resistance to endoparasites using the Ethiopian Menz sheep

Helminthic infections pose a significant problem to grazing livestock world-wide (Boray 1969 Dargie 1980) affecting the intake, digestibility and the utilisation of absorbed nutrients The interaction between parasites and feed intake and utilisation has raised many unanswered questions in animal production science *Fasciola hepatica* a parasite of considerable veterinary and economic importance, is known to cause considerable reduction in the digestibility of nutrients and overall productivity in the hosts (Hall 1985) In recent years, more and more work is now being focused on the nutritional physiology of the parasitised animal in an attempt to explain the deleterious effects or exonerate the potential of genetic resistance to endoparasites of small ruminants

The impaired productivity during Ovine fascioliasis is thought to be a result of the reduced feed intake and poor feed utilisation often observed in parasitised hosts (Sykes and Coop 1976, Sykes and Coop 1977, Dargie et al 1979)

This paper reports the first results of *F hepatica* infection on feed intake, digestibility coefficients, nitrogen retention and liveweight changes in pregnant and open Menz sheep The influence of fascioliasis on foetal survival and lamb birth weight was also studied

Materials and methods

Animals

Forty adult cycling ewes with a mean live weight of 23 9 kg (range 18 2–28 6, SD = 2 61) were selected from a flock of on-station reared sheep of the Menz breed To provide uniformity in weight and conformation all the ewes were allocated into 10 blocks of four animals each on weight basis In each block, two ewes were allotted at random to two main groups of infected and control groups Thereafter, these two main groups were subdivided within block to 'pregnant' and 'open' ewes This grouping resulted in infected pregnant (PI), non-infected pregnant (PC), infected open (OI) and non-infected open (OC) groups

All animals were drenched with fenbendazole and triclabendazole against nematodes and trematodes respectively, and vaccinated against pasteurellosis and

clostridial infection at the beginning of the study Animals in groups PI and PC were oestrus synchronised with prostaglandin (Dinoprost thromethanine Lutalyse) Oestrus animals on heat were bred instantly with rams wearing colour markers

Feeding and housing

All ewes were stall-fed and offered hay *ad libitum* In addition, each animal received 300 g/d of a supplement consisting of 60% wheat bran + 40% *Guizotia abyssinica* (noug) The chemical composition of the feed offered is presented in Table 1 During the experiment, all animals were fed at 0900 h daily Water and mineral lick were always available

Animals were housed in pens with concrete floors throughout the experiment except during two digestibility and nitrogen retention trials, when they were housed in wooden cages

Live body weight

Liveweight changes were assessed by weighing at the beginning of the experiment and subsequently at weekly intervals Weighing was done after an 18-hour abstinence from food to avoid variation in gut fill Lamb birth weights were taken within 12 hours of birth or as soon as the dam had completed drying the lamb Packed cell volume (PCV) was measured by the capillary micro-haematocrit method at the beginning of the experiment and weekly thereafter

Parasitological techniques

Laboratory-reared *F hepatica* metacercariae (Baldwin Aquatics, California, USA) were used in the experiment At the start of the experiment animals in groups PI and OI were inoculated orally with 500 metacercariae of *F hepatica* enclosed in single gelatin capsules As from two weeks pre-infection, faecal samples were collected per rectum and analysed for faecal egg count (FEC) on a weekly basis using the McMaster Technique

Digestibility and N-balance procedure

The digestibility and nitrogen retention trial was conducted on all animals during the 13th week post-infection (p i) Total feed ingested faeces and urine voided were collected for seven consecutive days after a 14-day adaptation period Feed refusals were weighed just before fresh feed was offered Urine was collected in a plastic bowl containing 10 ml of 50% hydrochloric acid Urine, feed, ort and faecal samples were collected per period and sampled The samples were frozen (in the form they were collected or offered) until required for analysis Samples of feed offered and refusals and fresh faeces were analysed for dry matter (DM), ash and nitrogen while urine was analysed for nitrogen only The procedures described in AOAC (1975) were followed Appropriate statistical procedures as described by Akinbamijo and Reynolds (1994) were used

Results

Parasitised ewes indicated a significantly lower PCV (as from weeks 8 till 11 p i) compared with non-parasitised ewes Figure 1 Mean differences (P<0 001) between initial and final PCV (%) values on group basis are –5 0, –1 0, 1 1 and 1 3 (RSD 2 99) for groups PI, PC, OI and OC, respectively Faecal egg count conducted from week 11 through 14 p i was higher (P<0 05) in the pregnant ewes varying from 60 to 170 eggs per gram (Figure 2)

Data on feed intake and nitrogen retention at 13 weeks p i are presented in Table 1 Although pregnant ewes consumed slightly more (P<0 05) OMI than open ewes, there was no significant difference in intake due to fascioliasis Also digestibility coefficients and faecal nitrogen did not differ for all groups There was no

Table 1 *Mean estimates of intake digestibility and nitrogen balance of experimental ewes (Trial 2 late pregnancy)*

	Groups				
Variables	PI	PC	OI	OC	RMS
n	9	8	11	12	–
Metabolic size	11 2	11 9	11 2	10 9	1 12
Intake (g/kg$^{0\ 75}$)					
Dry matter	71 6	72 2	62 5	66 4	6 42
Organic matter	66 8	65 6	60 0	62 8	5 61
Digestible organic matter	29 1	29 3	29 4	31 1	4 40
Nitrogen	1 00	1 01	0 89	0 94	0 10
Dry matter digestibility (%)	42 9	44 4	44 6	46 6	0 05
Organic matter digestibility (%)	44 5	46 6	48 7	49 6	0 05
Urinary nitrogen (g/kg$^{0\ 75}$)	0 24	0 23	0 26	0 23	0 051
Faecal nitrogen (g/kg$^{0\ 75}$)	0 69	0 68	0 62	0 64	0 069
N balance (g/kg$^{0\ 75}$)	0 073	0 100	0 003	0 07	0 064

PI = infected pregnant PC = pregnant non infected OI = infected open OC = open uninfected RMS = residual mean square

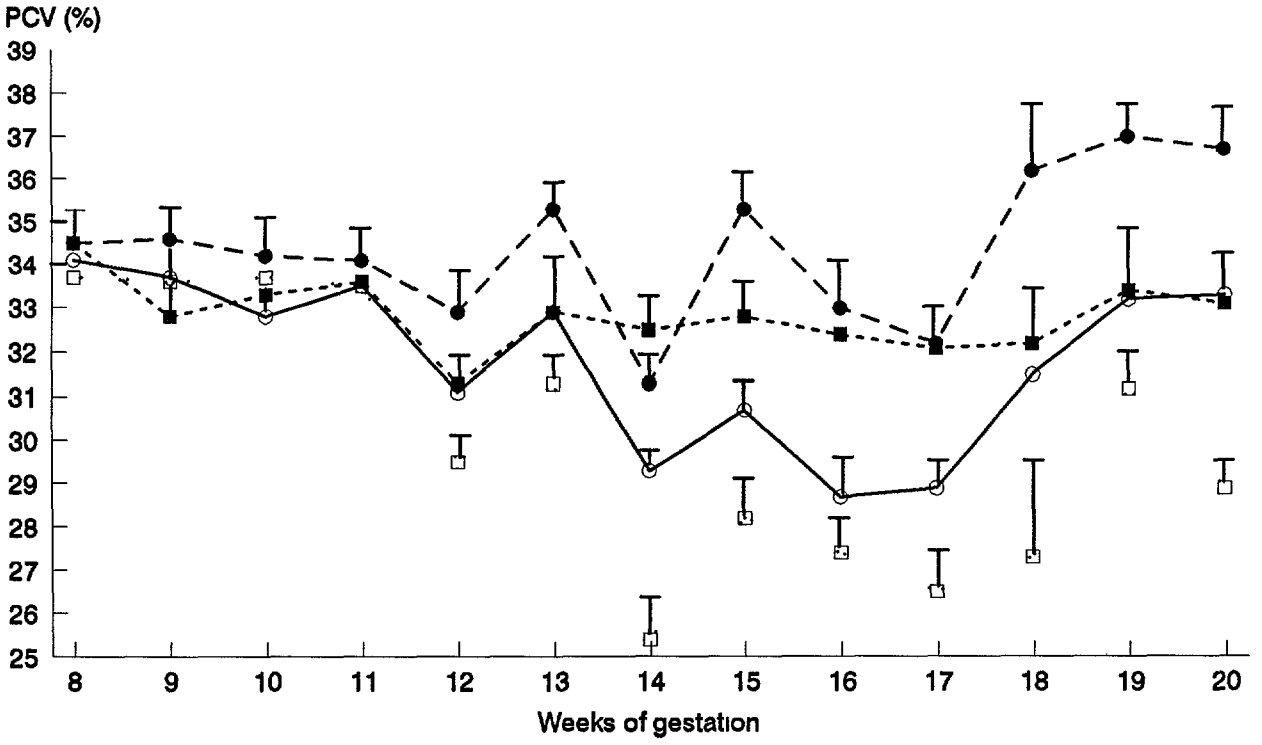

Figure 1 *Mean (±SE) sequential changes in packed cell volume of* F hepatica *pregnant infected (group PI□) pregnant non infected (group PC■) open infected (group OI ○) and open uninfected (group OC ●) Menz sheep*

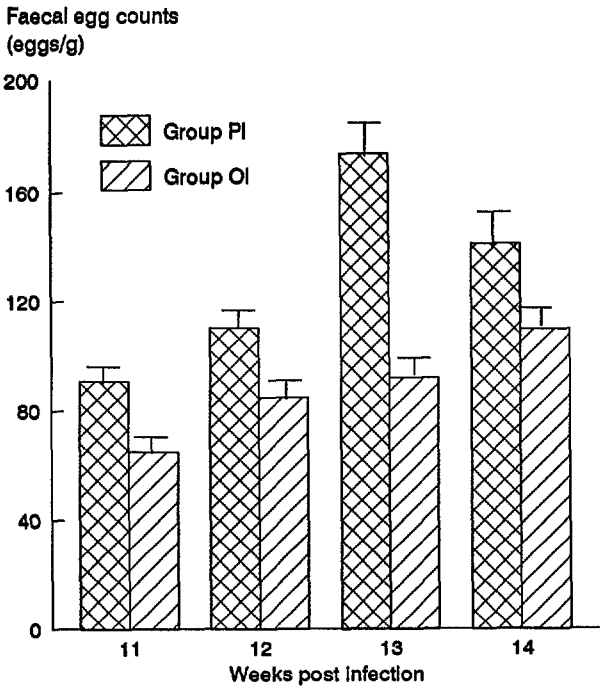

Figure 2 *Mean (±SE) faecal egg count for pregnant (group PI) and open (group OI) sheep*

significant difference between nitrogen balance of infected and non-parasitised pregnant animals Open infected ewes however, retained less (P<0 001) nitrogen when compared with control ewes

The relationships between nitrogen retention and DOMI for pregnant ewes are 0 382 (SE 0 033) + 0 0152 (SE 0 003) DOMI r^2 = 80% for PI, and –0 262 (SE 0 022) + 0 0117 (SE 0 003) DOMI r^2 = 70% for PC Regression equations for open ewes are 0 337 (SE 0 035)+ 0 0115 (SE 0 002) DOMI r^2 = 79% for OI, and –0 385 (SE 0 032) + 0 0149 (SE 0 003) DOMI r^2 = 77% for OC

Accordingly, infected ewes would require a higher DOMI to attain nitrogen equilibrium than would control animals The intercepts of pregnant ewes also differ significantly implicating high N losses from infected ewes

Result of the linear regression analysis of rate of liveweight change showed that, while intercept was not affected by treatment imposed on the ewes the regression coefficient was affected Predicted rates of gain were 24 3, 44 3, 14 3 and 17 1 (RSD = 0 011) g/d for PI, PC OI and OC groups, respectively In effect PC ewes gained more weight when compared with PI ewes but the difference between OI and OC did not attain statistical significance In general average daily gains during the experiment show that parasitised animals gained less weight than did the control animals (Figure 3) The difference in rate of liveweight change between open and bred ewes was significantly influenced by pregnancy, infection and the interaction between both factors

Infected pregnant ewes had lower live weights before lambing and birth weights of lambs from PI ewes were affected by fascioliasis Lamb birth weights observed in this study were 1 63 versus 1 89 kg (SE = 0 07) for groups PI and PC, respectively

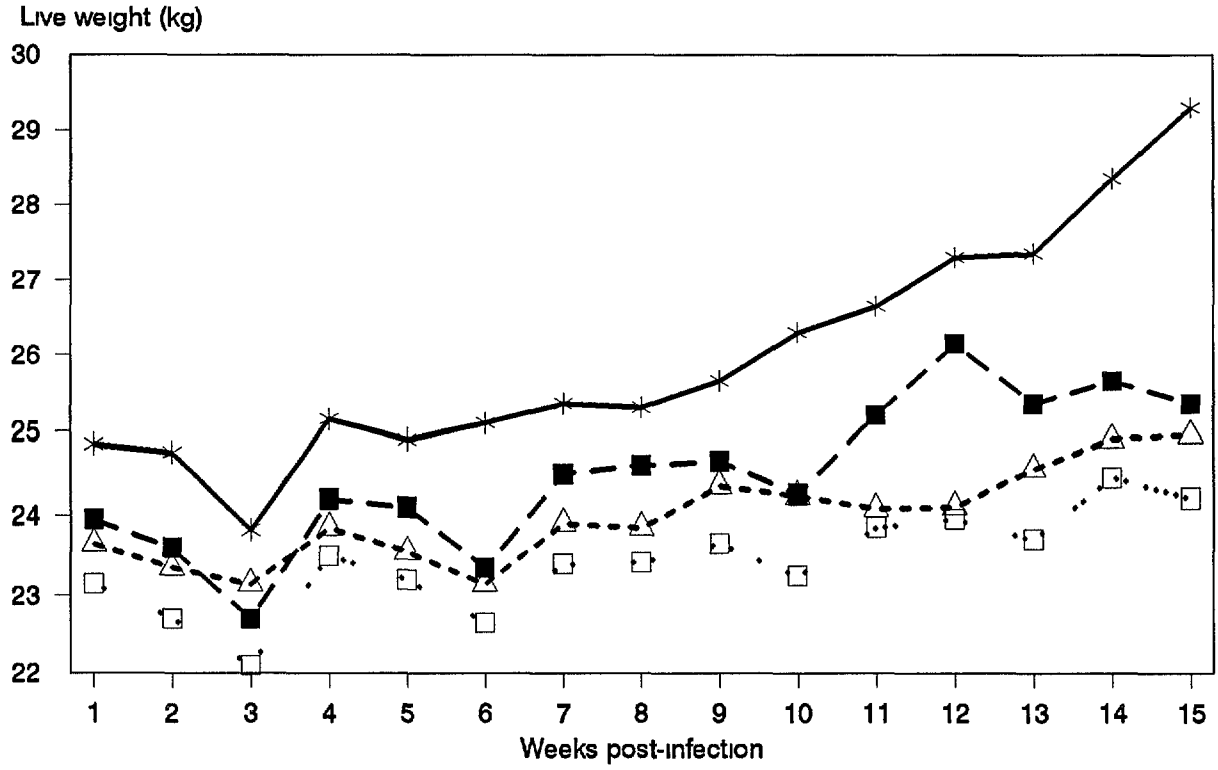

Figure 3 *Mean changes in live body weight patterns of* F hepatica *infected pregnant (group PI □) pregnant non infected (group PC ■) open infected (group OI ○) and open uninfected (group OC ●) Menz sheep*

Discussion

Virtually all the published work on nutrition and host-parasite interactions indicates that the feed intake of a parasitised host is lower than that of its uninfected counterpart (Berry and Dargie 1976, Dargie et al 1979, Sykes et al 1980) Contrary to previous findings in sheep infected with *F hepatica*, DMI in this study was not affected by fascioliasis

Although the level of DMI was high the digestibility coefficients were low and unaffected by fascioliasis The digestibility coefficients obtained in this experiment are a reflection of the quality of basal diet offered (roughly 65% of poor quality hay) and hence the low DOMI observed in the digestibility trials Previous reports in the literature on DMD during fascioliasis are conflicting Hawkins and Morris (1978), Sykes et al (1980) and Sinclair (1975) found no effect of *F hepatica* on the DMD in sheep carrying up to 400 flukes This infection load was compatible with our infection dose With the low intake of digestible organic matter reported in this study and assuming 26 g DOMI/kg$^{0.75}$ per day (ARC 1980) for maintenance, available DOMI in excess of maintenance requirement was at best 15% maintenance requirement

An important consequence of the infection in this study is that the feed conversion efficiency was substantially depressed by fascioliasis This is evident in the inferior nitrogen retention of infected sheep without a concomitant reduction in feed intake and digestibility Variations in feed intake and urinary nitrogen excretion have been widely attributed to infection in parasitised animals (Sykes et al 1980, Akinbamijo et al 1992) High urinary nitrogen excretion provides evidence that fascioliasis has a detrimental effect on nitrogen metabolism In infected ewes, nitrogen retention was significantly lower when compared with control ewes due to high excretion of urinary nitrogen The main effect of the infection was to lower the efficiency with which apparently digested and metabolised N was retained Roseby (1970) and Hawkins and Morris (1978) reported that in sheep infected with 500 metacercariae (an infection dose similar to our choice), feed conversion was considerably depressed and rate of liveweight gains were reduced without matching reduction in feed intake

The different regression equations of nitrogen retention on DOMI also support the view that efficiency of utilisation of nutrients was doubtlessly lower in infected ewes Although no digestive disturbances were found, infected ewes did not retain nitrogen as much as uninfected ewes given the same amount of DOMI Infected pregnant ewes gained less weight and used body reserves to offset cost of infection and pregnancy At the same level of DMI, non-parasitised ewes gained more body weight and maintained better body condition until term During the third trimester, to compensate for the increased foetal demands, pregnant ewes consumed more DM and retained more nitrogen than did open ewes (Adu 1975 Osuagwuh and Aire 1990) and nitrogen retention did not differ between PI and PC ewes While the PI ewes seemingly gained in retaining similar quantities of nitrogen as PC ewes, they lost out on lamb

birth weight and body condition Open ewes also had different nitrogen balances between infected and uninfected animals

Mean birth weight of lambs born by infected ewes was 14% lower than that of lambs from uninfected ewes This difference strengthens the notion that animal productivity in terms of foetal development and lamb crop are affected by fascioliasis

The onset of reduction in efficiency in feed utilisation, drop in PCV and low rate of liveweight gains all of which occurred in concert argue for a detrimental effect of *F hepatica* in sheep

In conclusion this study demonstrated that under the conditions of the present experiment (adult menz sheep with probable acquired immunity) feed intake and digestibility coefficients were not affected by fascioliasis The differences in the weight gain due to fascioliasis in pregnant and open ewes reflects the lower efficiency of feed utilisation in infected ewes as is typical of *F hepatica* infected sheep Nitrogen retention (as an index of utilisation of DOMI) was lower in infected open ewes without parallel reduction in feed intake

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La fasciolose et le métabolisme nutritionnel chez les brebis gestantes et non gestantes

Résumé

L'effet d'une facsiolose experimentale sur l'ingestion volontaire, la digestibilite de la matiere organique, la retention d azote, le rythme de changement du poids et le poids des agneaux a la naissance a ete determine chez 40 brebis dont 23 etaient vides et 17 gravides Les animaux ont ete infectes par voie orale avec 500 metacercaires de *Fasciola hepatica*, les sujets gravides ayant ete contamines six semaines apres la fecondation Tous les animaux avaient ete loges dans des enclos au sol cimente et alloues a quatre groupes de traitement les sujets gravides infectes (PI, n=9), les sujets gravides non infectes (PC, n=8), les animaux vides infectes (OI, n=11) et les sujets vides non infectes (OC, n=12) Les animaux infectes souffraient d'anemie des la 8eme semaine apres l'infection et des oeufs de *F hepatica* etaient observes dans leurs feces des la 11eme semaine apres l infection Il ressort des resultats de l'essai de retention de l azote (13eme semaine apres l infection) que la fasciolose n avait pas d'effet sur l'ingestion de matiere organique et la digestibilite Tous les animaux infectes avaient un taux d azote urinaire eleve, d'ou une retention d azote plus faible et gagnaient moins de poids que les sujets temoins Le poids a la naissance des agneaux nes de brebis infectees etait inferieur (P<0,05) a celui des petits issus de femelles temoins En conclusion, on peut dire que dans les conditions de l'experience, la fasciolose n'avait aucun effet sur l'ingestion alimentaire et la digestibilite mais ralentissait la croissance Le bilan azote etait plus faible chez les brebis infectees sans que cela soit associe a une baisse de l'ingestion alimentaire

Small ruminant management practices and control of helminthosis under traditional production systems in the cool Ethiopian highlands

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Abstract

Formulation of cost-effective preventive control programmes for helminth infection in small ruminants should be based on sound epidemiological knowledge of the time relationship between contamination of pastures and the seasonal availability of infective larvae in a given geographic area Epidemiological data generated from an on-station experiment involving the use of tracer lambs and monitoring of pasture contamination levels in the central Ethiopian highlands clearly showed a distinct seasonal pattern of nematode infection in sheep Investigations into the occurrence and implications of periparturient rise in tricho-strongylid egg output in breeding ewes over the lambing and lactation period are discussed A trial to determine the seasonal pattern of egg development and larval survival on pasture was carried out over a period of 12 months Preliminary findings from this study suggest that the relatively short larval survival times (6 to 8 weeks) present an opportunity for manipulation of the parasite population dynamics in the cool tropics Results from the combination of these different studies serve as a basis for medium-term control strategies in this environment and others with similar climatic conditions Because these strategies will depend heavily upon the use of anthelmintics, it is likely that, if understood by extension workers and accepted by farmers they will form a basis for development of programmes for preventing production losses due to parasitism in young stock by reducing the number of treatments and therefore the risk of development of anthelmintic resistance Alternative control measures are also discussed

Introduction

Helminthosis in small ruminants is of considerable significance in a wide range of agroclimatic zones of Africa and affects production through losses due to mortalities and reduced weight gain (Graber 1965 Schillhorn van Veen 1973, Allonby and Urquhart 1975, Scott and Goll 1977, Ogunrinade and Ogunrinade 1980, Fabiyi 1987 Bekele et al 1992) and other losses of production However, the effects of helminth infections on production of particular livestock species depend mostly upon the age of the animals, the breed, the parasite species involved and the intensity of the worm population within the definitive host Several factors are known to determine the epidemiological patterns of the associated disease conditions These include weather conditions husbandry practices, and the physiological status of the animal (e g periparturient rise in nematode egg output)

The development of nematode eggs to infective larvae and the survival of these larvae on pasture are influenced by temperature, rainfall and other environmental conditions Investigations carried out on nematode larvae ecology in some parts of sub-Saharan Africa (Dinnik and Dinnik 1961, Cheijina and Fakae 1984 Onyali et al 1990, Chartier 1991) and in Europe, Australia and the Pacific islands (Southcott et al 1976, Donald et al 1978, Banks et al 1990, Besier and Dunsmore 1993) have shown that the rate of development and the longevity of eggs vary at different temperature and humidity and in different geo-ecological regions

The significance to lambs of the post-parturient rise in worm egg output of ewes for worm burdens acquired by lambs has been reported by several authors (Taylor 1935, Crofton 1954, Brunsdon 1964, Gibbs 1967, Connan 1968, Brunsdon 1970, Connan 1976 Gibbs and Barger 1986, Agyei et al 1991) Two schools of thought exist on the possible mechanisms underlying this phenomenon Connan (1968), and O'Sullivan and Donald (1970) believe that increased faecal egg counts and worm numbers in periparturient ewes are attributable to a temporary impairment of acquired immune responsiveness in lactating ewes resulting from increased susceptibility to new infection on increased prolificacy of female worms and resumed development of previously arrested larvae However, Michel (1974, 1976) suggested that the phenomenon could be explained by a mere delay in adult worm mortality in lactating animals

The seasonal availability and abundance of the free living stage of sheep nematodes is a key factor in the

occurrence and severity of parasitic infection Studies on larvae ecology are helpful in designing more rational control programmes

In the central Ethiopian highlands, sheep are kept under traditional management within a mixed farming system The animals depend mostly on grazing with no supplement and minimum health interventions Farmers maintain one to three rams which continuously run with the flock with no control of mating and breeding occurs year round with seasonal peaks in conception patterns (Mukasa-Mugerwa et al 1986) Two lambing seasons are observed around June–July and October–November Twenty-five to 30% of the rams are castrated between 1 to 3 years of age Lambs are weaned at 3 to 4 months of age

The objectives of this study were to (i) determine seasonal patterns of development and survival of *Haemonchus contortus* and *Trichostrongylus colubriformis* eggs to infective larvae (L_3) on pasture and to study the relationship between such patterns with environmental factors, (ii) define the availability to sheep of metacercaria and infective nematode larvae resulting from seasonal contamination in the central highlands of Ethiopia, and (iii) provide pertinent epidemiological information for designing strategic helminth control programmes

Materials and methods

Experimental site

The Debre Birhan Experiment Station is located in the central Ethiopian highlands about 120 kms NE of Addis Ababa at an altitude of 2780 m above sea level (latitude 39 E, longitude 10 N) The climate is characterised by a long rainy season (July to September) a short rainy season in February/March and an extended dry season from October to February The average annual rainfall from 1979 to 1992 was 920 mm while the average monthly minimum air temperature ranges from 2 4 C in November to 8 5 C in August The average monthly maximum air temperature ranges from 18 3 C in September to 23 3 C in June The vegetation in the station is dominated by *Andropogon* grasses (*A longipes*) with variable proportions of *Trifolium* spp

Nematode larvae development and survival on pasture

To study the development and survival of nematode free living stages on pasture an area was fenced off to prevent entry of any animals and was divided into 39 plots each measuring one square metre The plots were separated by iron sheets and drainage ditches to avoid cross-contamination during heavy rainfall The grass was cut as needed to maintain the herbage at a height and density similar to the grazing paddocks Pure cultures of *H contortus* and a combination of *H contortus*, *T colubriformis* and *Ostertagia trifurcata* were used to infect 3- to 6-month-old lambs to serve as donors Two plots were randomly selected every month and uniformly contaminated with faeces obtained from the donor lambs Each plot received a total of 2 million eggs at a time Three plots remained uncontaminated to serve as controls

Seasonal helminth parasite infection in grazing sheep

To study the population dynamics of helminths in sheep, a total of 84 parasite-free lambs were raised in a slatted floor barn Six lambs were released monthly on to contaminated pasture at the age of eight weeks for a period of one month from July 1992 to June 1993 The animals were re-housed in parasite free pens for variable periods of time Three out of the six lambs were slaughtered two weeks post-grazing to assess the level of nematode infections The remaining three lambs were also slaughtered 12 weeks after a period of grazing to determine the seasonal pattern of trematode infection A group of 6 two-month old permanent tracers was allowed to graze for 12 months and were slaughtered at the age of 48 weeks Five lambs were kept indoors to serve as controls The following year the experiment was repeated and involved 93 lambs of which 6 were turned out to pasture on a monthly basis re-housed for a period of 3 to 12 weeks and slaughtered for nematode and trematode worm counts Concurrently, a group of 18 two month-old lambs were released on to pasture at the beginning of the experiment (July 1993) and were slaughtered in different seasons (i e the long rainy season the dry season and the short rainy season) to assess the cumulative nematode burden on lambs Three lambs raised in worm-free condition were kept indoors and served as controls

Grass samples were also collected fortnightly from the paddocks grazed by the lambs for determination of the level of the pasture contamination by infective (L_3) larvae

Periparturient rise of faecal egg output in breeding ewes

From May 1992 to May 1993 a total of 795 Horro and 782 Menz ewes were mated to 35 and 36 rams (20 to 22 ewes per ram) respectively following synchronisation using progesterone-impregnated sponges A group of 120 ewes were left unmated (controls) to investigate the periparturient rise phenomenon over the lambing/lactating period in the wet and dry seasons During the third mating season (May 1993), three rams per breed were retained from the previous sire group and eight new rams per breed were introduced Faecal egg count (FEC) packed cell volume (PCV) and body weight measurements were monitored in breeding ewes (groups 2 and 3) at mating, at 3 months post-mating, two weeks before lambing, four weeks after lambing, eight weeks after lambing and at weaning

Table 1 *Recommended time of anthelmintic treatment for sheep in the central Ethiopian highlands*

	Ewes			Lambs		
Month	Pan/ Nilv	Fas/ Zan	Yom	Pan/Nilv	Fas/Zan	Yom
June			Yom			
July*	Nilv					
August						
September	Nilv	Zan		Nilv		
October					Fas+Nilv	Yom
November**		Fas				
December		Fas				
January					Fas	

* First expected lambing

** Second expected lambing

Pan = Panacur (fenbendazole) Nilv = Nilverm super (levamisole) Fas = Fasinex (triclabendazole) Zan = Zanil (oxyclosanide) Yom = Yomesan (niclosomide)

Results

Preliminary observations on the development and survival of nematode free living infective stage showed that eggs deposited in experimental plots had undergone development from July (highest yield of infective stage) to November (lowest yield) (Figure 1) Neither eggs nor

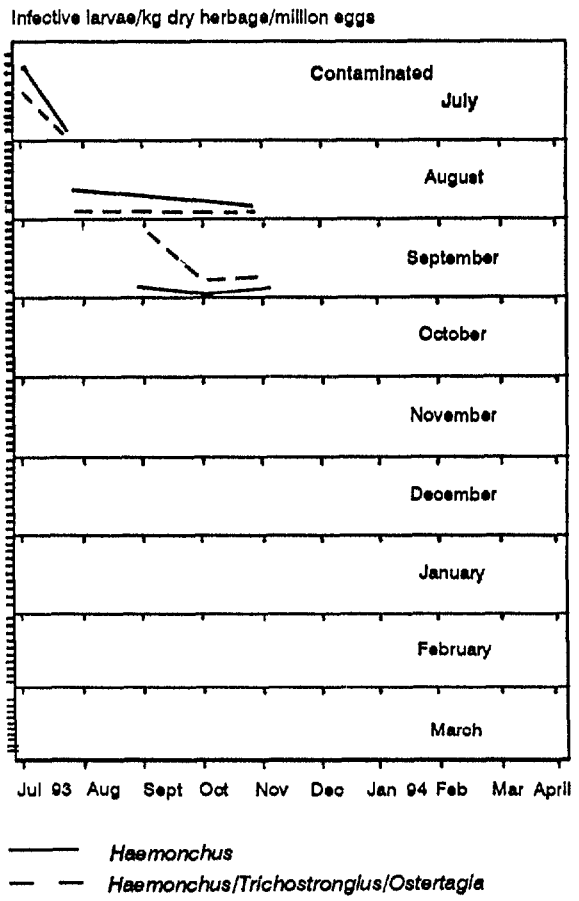

Figure 1 *Development and survival of nematole infective stages on pasture*

L_3 were present from deposited faeces three months following deposition of eggs No eggs developed into larvae from those deposited on pasture between October and March

Worm counts in tracer lambs during the two-year study period (July 1992–July 1994) were similar in pattern (Figure 2) The three main trichostrongylid nematode parasites identified in order of predominance were *Ostertagia trifircata*, *Trichostrongylus colubriformis* and *Haemonchus contortus* The large intestine sheep pinworm, *Skrjabinema ovis* (although non-pathogenic), was consistently abundant throughout the study period Worm burden peaked in September and October Lung worms, *Dictyocaulus filaria*, were present in lambs but in relatively small numbers Observations on the same tracer lambs indicated that transmission of *Fasciola hepatica* took place between September and January with a peak in December If the animals were left untreated they generally died from the infection

Peak numbers of larvae were observed in grass samples collected during the month of August throughout the study period A gradual decline in pasture larval count over the subsequent 3 months (September October and November) was followed by a non-detectable level of larvae until the beginning of the next rainy season with a few larvae observed in May 1992 (Figure 2) Species composition was consistent from August to November with a predominance of *Ostertagia* *Trichostrongylus* and *Haemonchus* *Oesophagostomum* was recorded in a few cases

Preliminary analysis of FEC in breeding ewes showed significant ($P<0\ 05$) season and breed effect A periparturient rise in FEC was observed in both breeds before and after parturition in both the wet and dry seasons but was more pronounced in the wet season (Figures 3, 4 and 5) Body weight and PCV were significantly affected during late pregnancy Acquisition of newly infective larvae may have largely

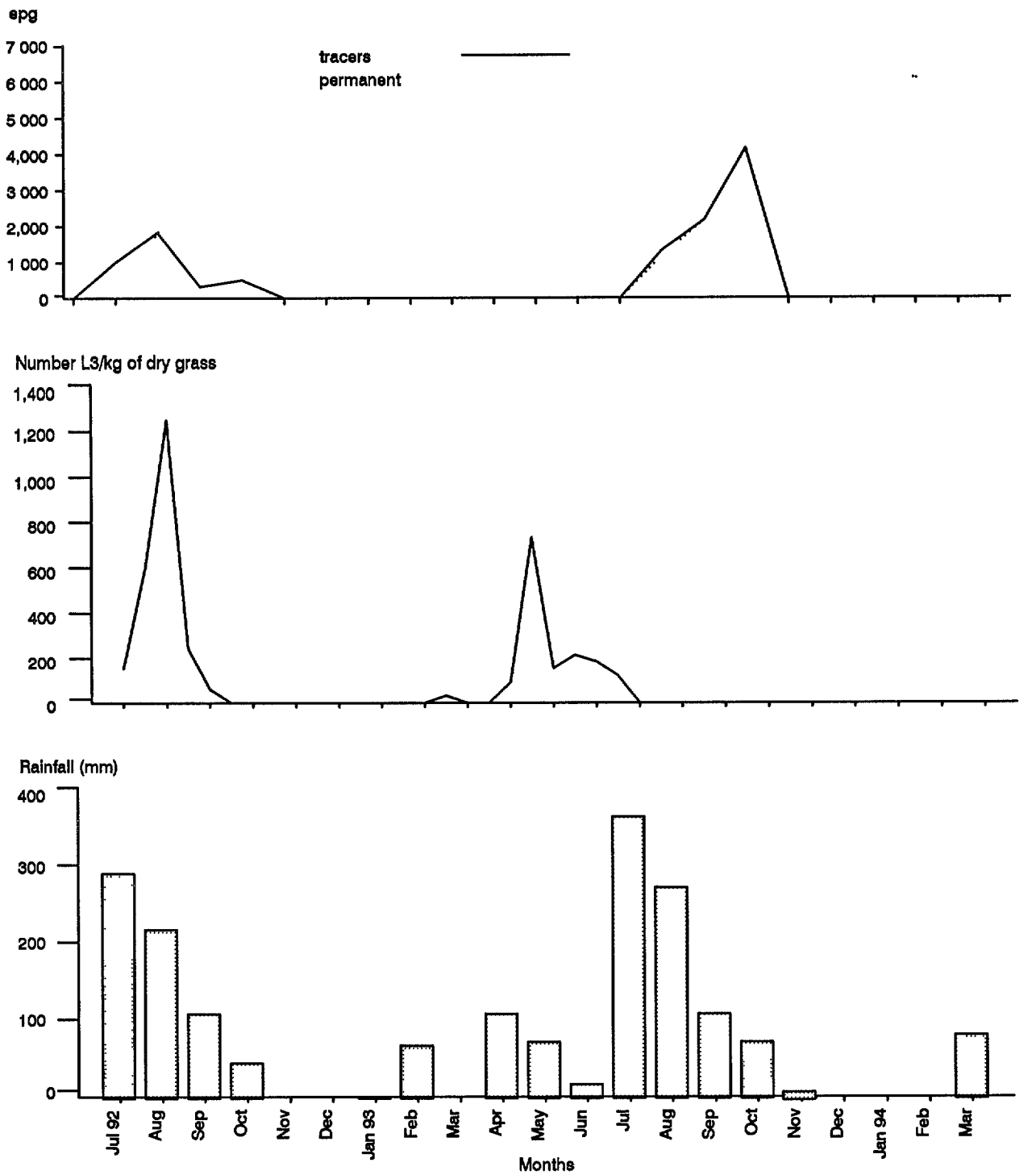

Figure 2 *Monthly rainfall availability of infective larvae on pasture and mean FEC in tracers and permanent lambs*

contributed to the periparturition rise in faecal egg count because of substantial rainfall recorded in the wet season in 1993 Faecal culture from the ewes at different periods of the year indicated the predominance of *Trichostrongylus colubriformis* (48%) followed by *Ostertagia trifurcata* (33%), *Haemonchus contortus* (17%) and *Dictyocaulus filaria* (0 8%) with no distinct seasonal patterns

Discussion

Ostertagia trifurcata, *Trichostrongylus colubriformis* and *Haemonchus contortus* were found to be the dominant nematode species in central Ethiopian highlands in association with the liver fluke *Fasciola hepatica* and tapeworms *Monezia* spp

Number of nematode larvae on pasture increased with the onset of the rains (June) peaked in

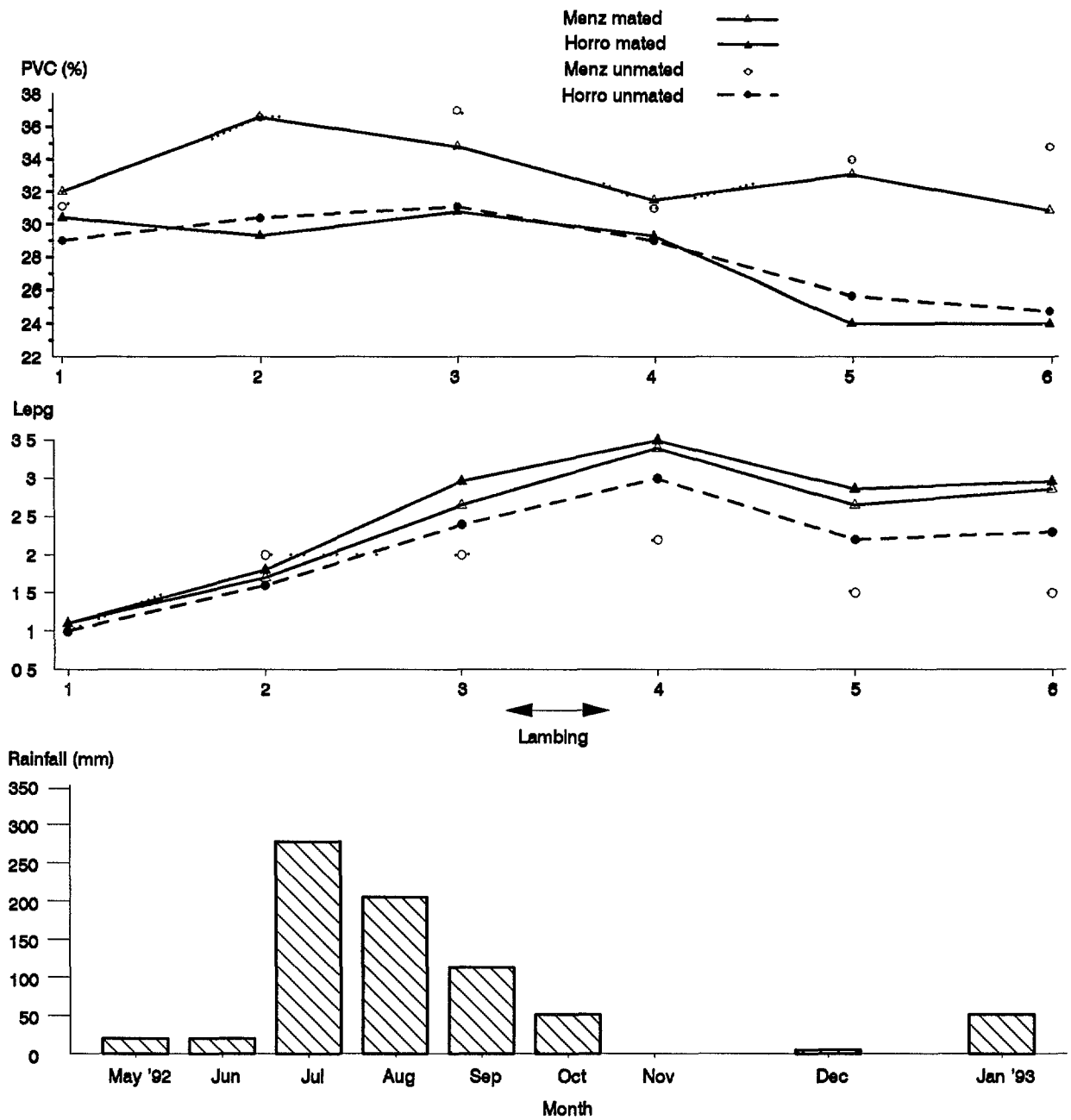

Figure 3 *Faecal egg counts and PCV values in lactating and unmated control ewes (wet season lambing 1992)*

August/September and progressively decreased to an undectable level in the dry season Worm burden in lambs born in the wet season followed the same pattern The critical time for preventive measures to initiate treatment for different classes of stock is shown in Table 1 Treatment of breeding ewes for nematode infections with an effective broad-spectrum anthelmintic (Panacur^R or Nilverm^R super) at the start of the rainy season (late June/early July) should substantially reduce pasture contamination around parturition and will prevent newly born lambs from being exposed to heavily contaminated pasture A second treatment is advisable in September/October (beginning of the dry season) to reduce the effects of any infection from residual larvae The first treatment for fascioliasis with Zanil^R is recommended in August to clear up adult liver flukes acquired during the previous grazing season A second and third treatment should be applied in November/December and January/February with Fasinex^R to remove both developing immature and adult flukes acquired during the current grazing season

With regard to the lambs and yearlings born in the wet season, the first treatment against gastro-intestinal nematodes should be considered in August/September when the pasture larvae count is at a maximum followed by a second treatment in November For lambs born in the dry season, the treatment schedule should be as for adult sheep, that is in July and September of the

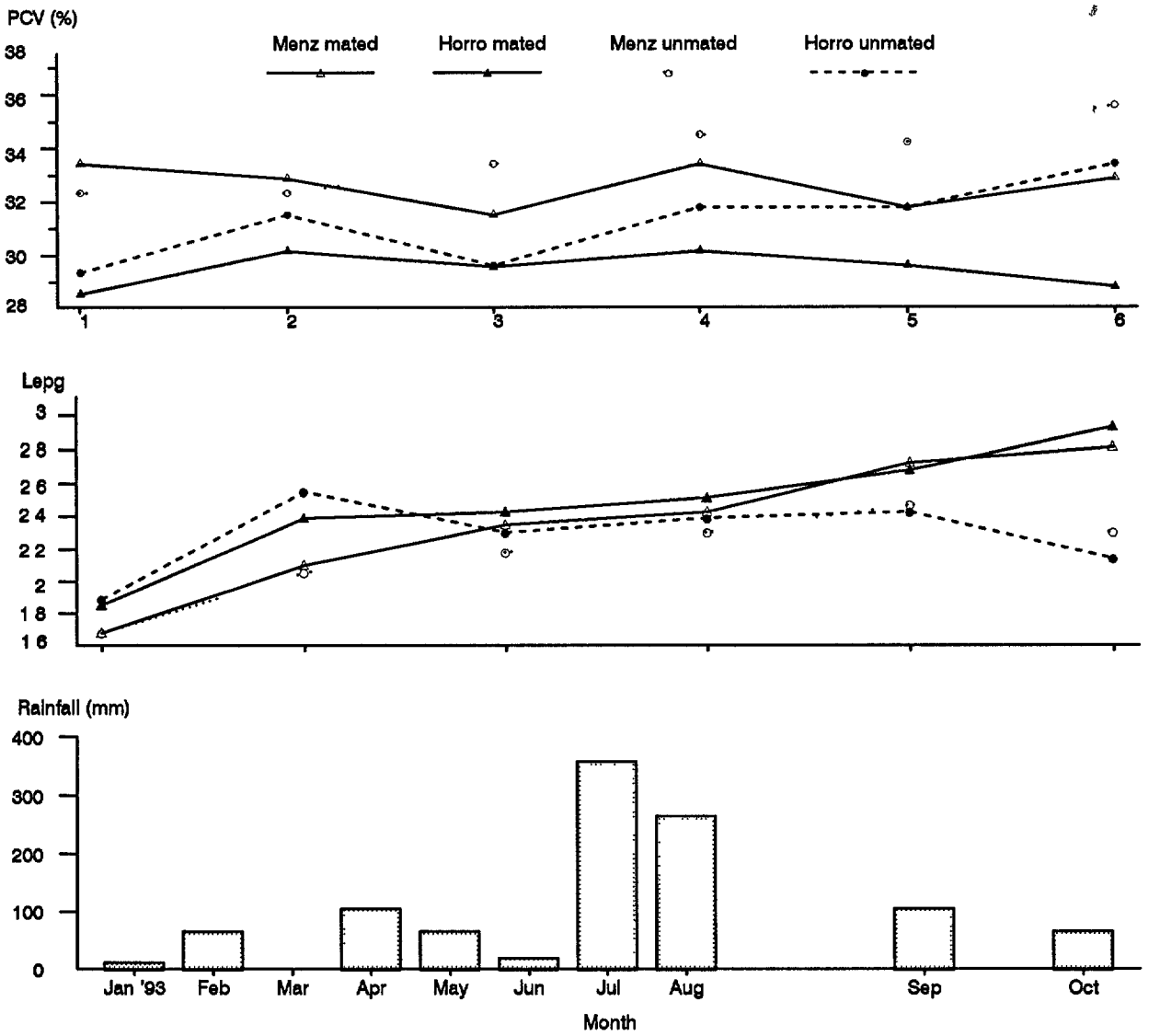

Figure 4 *Faecal egg counts and PCV values in lactating and unmated control ewes (dry season lambing 1993)*

following year Although results from the present study cannot be broadly applied to all agro-ecological zones of the tropics, the data can be used in computer models (e g Barnes and Dobson 1990) to simulate grazing systems for a quick and cheap screening of different control programmes

The value of short-term pasture spelling would, in practice, be minimal in the Debre Birhan area particularly during the wet season Our study has shown that the time of survival of infective larvae on pasture varies between six and eight weeks between July and November However, management systems allowing flocks to move to new grazing areas within the limit of that time may provide relatively safe pasture Barger et al (1994) working with goats reported encouraging results on rotational grazing systems in the wet tropical environments of the Pacific islands

Alternate grazing by sheep and cattle has also been advocated as a useful means of controlling internal parasites in Australia (Morley and Donald 1980) but may be of little relevance in extensive grazing systems where sheep and cattle are grazed together It is unlikely that development of new anthelmintics will take place in the near future Only four distinct groups of broad anthelmintics, namely the benzimidazoles, levamisoles morantel and the avermectines have reached the market in the past 50 years Thus alternative control measures should be considered The use of mixtures or combinations of anthelmintics could be considered in control programmes when resistance to one or more of the drug families has developed Success in dealing with the problem of anthelmintic resistance depends on persuading farmers to modify their worm control practices In particular farmers should be made aware that high frequency of treatment, under-dosing and continuous use of one anthelmintic group will lead to rapid development of resistant strains

A convenient means for the application of small amounts of highly potent anthelmintics over a prolonged period of time is the use of controlled release capsule

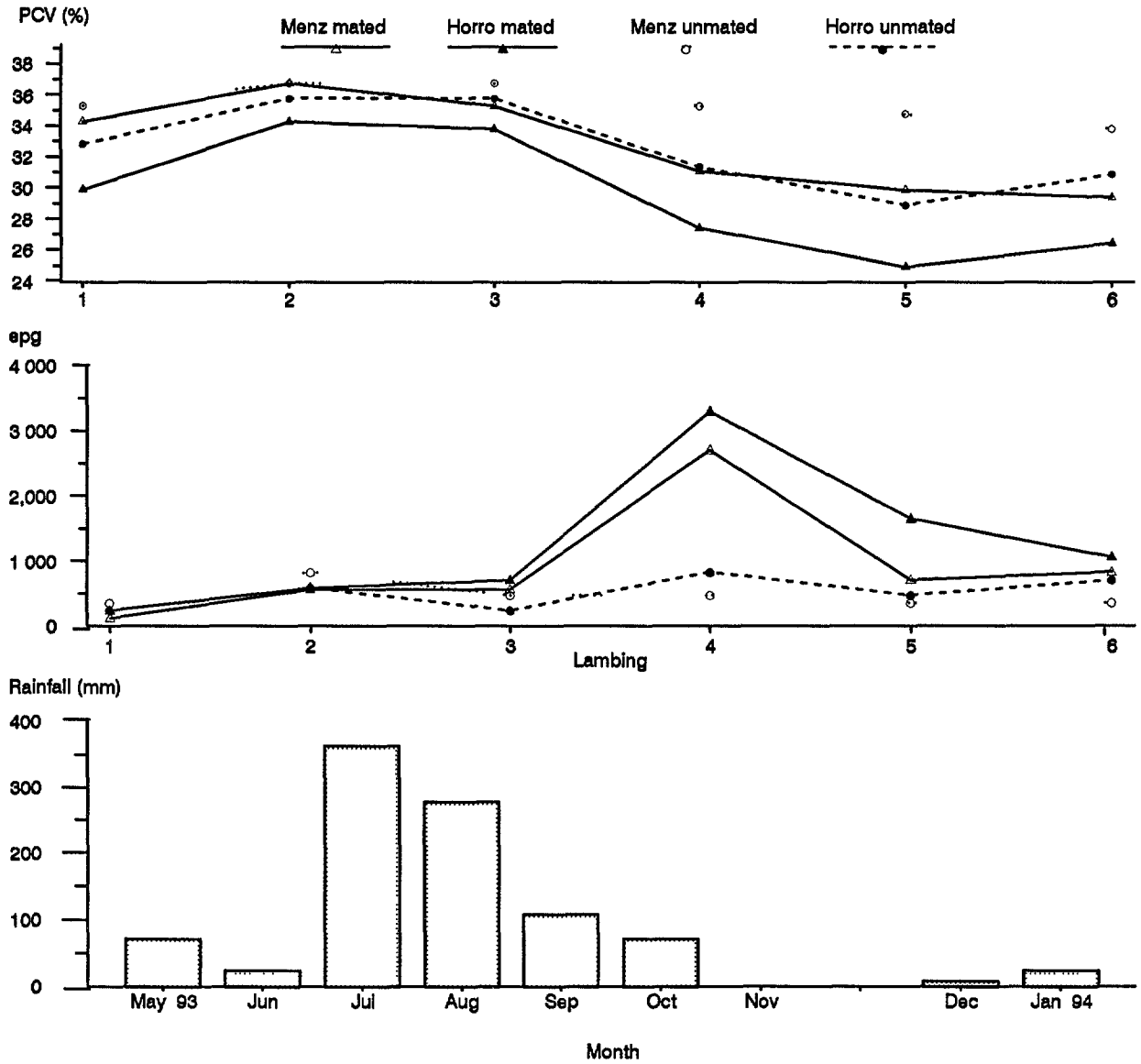

Figure 5 *Faecal egg counts and PCV values in lactating and unmated control ewes (wet season lambing 1993)*

technology It has been shown that a capsule designed to prevent pasture contamination for about 100 days at critical times produces dramatic effects on the epidemiology of nematode infections (Anderson 1990) The use of the capsules increases the certainty of success of preventive control programmes because, in contrast to conventional treatments, rapid reinfection cannot occur within the lifetime of the capsule despite the occurrence of weather conditions conducive to the transmission of infection

Another method for controlling internal parasites is the use of vaccines To date little success has been achieved in the development of protective immunity against helminth infection with vaccines but the future looks promising (Smith and Smith 1993, Smith et al 1994) The only commercially available and effective helminth vaccine is the irradiated/attenuated larvae vaccine for the prevention of bovine pneumonia caused by the lung worm *Dictyocaulus viviparus* (Peacock and Poynter 1980) Laboratory model system using similar vaccines against a wide range of gastro-intestinal parasites may also be rewarding (Lloyd 1981) Failure to immunise against helminth parasites has generally been attributed to a deficiency in the immunogenicity of vaccines

There is also an increasing body of evidence of genetic variation for resistance to endoparasites in sheep and goats (Baker et al 1992) This has prompted increased interest in the possibility of selecting breeds or strains of animals which are genetically resistant to worm parasites (Dineen 1985 Gray 1991)

Conclusion

Epidemiological knowledge its application in grazing management whenever feasible and access to anthelmintics of high efficacy are key factors for the success of controlling helminth infections in domestic ruminants Predictive models based on more complete

information on the ecology of helminth infection and anthelmintic resistance, climate and local management factors should provide a basis for improved control schemes, whether based on chemotherapy, management and immunisation in regions with similar climatic conditions While these studies are being undertaken, current efforts targeted at the identification and future exploitation of sheep breeds resistant to endoparasites should help minimise the reliance on frequent treatment with anthelmintics

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Mode de gestion des petits ruminants et lutte contre les helminthoses dans les systèmes d'élevage traditionnel des régions fraîches des hauts plateaux éthiopiens

Résumé

L'elaboration de programmes coût-efficaces de prevention des infections helminthiques chez les petits ruminants doit reposer sur une bonne connaissance epidemiologique des relations temporelles entre la contamination des pâturages et la presence de larves infectieuses dans une zone geographique donnee Les donnees epidemiologiques d un essai en station avec utilisation d'agneaux traceurs et observation des niveaux de contamination des pâturages dans les hauts plateaux du centre de l Ethiopie ont clairement mis en evidence le caractere saisonnier des infections de nematodes chez les ovins Des etudes effectuees sur l augmentation du nombre d oeufs de trichostrongylides et ses consequences chez les brebis reproductrices a l agnelage et au cours de la lactation ont ete analysees Un essai de 12 mois a éte effectue sur la saisonnalite du developpement embryonnaire et la duree de vie des larves sur les pâturages Les résultats preliminaires de ces travaux ont montre que les larves vivaient peu de temps (six a huit semaines), ce qui devrait permettre de manipuler la dynamique de la population des parasites dans ces regions tropicales fraîches Les resultats de l ensemble de ces etudes servent de base a des strategies de lutte a moyen terme dans ce type de milieu et dans des regions aux conditions climatiques analogues Bien maîtrisees par les agents de vulgarisation et acceptees par les eleveurs ces strategies, qui reposeront essentiellement sur l utilisation d anthelminthes pourraient en permettant de diminuer le nombre de traitements constituer la base de strategies de prevention des pertes de production dues au parasitisme chez les jeunes Cela permettra de limiter les risques de developpement de la resistance aux anthelminthes Enfin d autres methodes possibles de lutte ont egalement ete examinees

Pertes en reproduction, chlamydiose, brucellose et toxoplasmose en élevage extensif traditionnel de chèvres guinéennes au Sénégal

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Résumé

Cette etude a ete conduite sur des chevres guineennes en elevage extensif traditionnel dans la zone soudanienne du Senegal La repartition des sujets seropositifs a la chlamydiose a *Chlamydia psittaci*, aux brucelloses a *Brucella ovis* et a *Brucella abortus* et a la toxoplasmose a *Toxoplasma gondii* a ete etablie sur 12 cas de mortalites neo-natales, 20 cas d'avortements et 11 cas de mises bas de produits chetifs Sur ces 43 cas de pertes en reproduction, on a note des prevalences serologiques de 80% en chlamydiose de 10% en brucellose a *Brucella abortus*, de 23% en brucellose a *Brucella ovis* et de 58% en toxoplasmose Les implications des infections a l'origine de ces differents types de pertes sont discutees en fonction de leur repartition

Introduction

Des tests serologiques ont ete realises sur 43 cas de pertes en reproduction Les infections a la chlamydiose (*Chlamydia psittaci*), aux brucelloses (*Brucella abortus*) et *Brucella ovis* et a la toxoplasmose (*Toxoplasma gondii*) ont ete recherchees Ces pertes en reproduction etaient des cas de mises bas de produits chetifs, d'avortements et de mortalites neo-natales L'objectif est de comparer le statut serologique de ces trois groupes de chevres vis-a-vis de chacune de ces infections afin de determiner leur lien particulier avec un type de perte plutôt qu'avec un autre

Matériels et méthodes

Cette etude a ete effectuee sur des chevres pluripares de race guinéenne Les prelevements ont ete effectues de novembre 92 a mars 93, periode couvrant le premier des deux pics annuels de mise bas Les chevres utilisees appartiennent a 21 eleveurs etablis sur 13 villages satellites de la ville de Kolda Il s agit de prélevements uniques de sérum, realises dans un delai maximum de 8 jours suivant l'evenement clinique assimile a une perte en reproduction

Les serums ont ete conservés par congelation jusqu'a la fin de la periode de collecte puis testes Les tests serologiques utilises ont ete la fixation du complement en micromethode pour la chlamydiose, la brucellose a *Brucella abortus* et la brucellose à *Brucella ovis* et l'immunofluorescence indirecte pour la toxoplasmose Les seuils de positivite retenus ont ete la dilution au 1/4 pour la chlamydiose (Akakpo 1987), au 1/8 pour les deux types de brucellose (Akakpo, 1987) et au 1/16 pour la toxoplasmose (Pangui, 1993)

Les types de pertes retenus sont les suivants

- avortements mise bas de morts-nes ou interruption de la gestation non rapportee a une cause alimentaire, toxique ou accidentelle
- chetivite mise bas d'animaux au poids au contrôle inferieur ou egal à 1,4 kg (limite etablie sur la base de la moyenne des poids recueillis le jour même de la naissance, estimee a 2,2 kg) ou avec un tres faible entrain a la tetée Ces produits meurent generalement avant l'âge de 3 mois
- mortalite neo-natale cas de chevreaux nés normaux mais qui meurent dans les jours suivant la mise bas

Les prevalences serologiques par type de perte ont eté comparees a l aide du programme calcstat du logiciel Epiinfo (Dean, 1988) Les valeurs des probabilites de l'hypothese nulle ont ete determinees suivant les cas par le test du khi carre ou par le contrôle d'exactitude de Fisher (Dean, 1988)

Résultats

La repartition des cas de seropositivite suivant les types de pertes est presentee au tableau 1 La chlamydiose et la toxoplasmose ont les plus fortes prevalences globales, soit respectivement 79 et 58% Les prevalences de la toxoplasmose et de la brucellose a *Brucella ovis* presentent les plus importantes variations d'un type de perte a un autre Ces taux sont nettement superieurs a ceux obtenus sur un echantillon aléatoire de 40 femelles caprines en 1991 dans la zone de Kolda a savoir 13,6% en toxoplasmose (ELISA), O%

Tableau 1 *Repartition et prevalence de la chlamydiose de la brucellose et de la toxoplasmose en fonction du type de perte en reproduction*

Variables	*Chlamydia*		*V ovis*		*B abortus*		*Toxoplasma*	
	+	–	+	–	+	–	+	–
Chetivite	9	2	2	9	1	10	5	4
	82%		18%		9%		56	
Mortalite	10	2	2	10	1	11	9	2
neo natale	83%		16%		8%		82%	
Avortement	15	5	6	14	2	18	8	10
	75%		30%		10%		44%	
Total par resultat	34	9	10	33	4	39	22	16
	79%		23%		9%		58%	
Total teste	43		43		43		38	

en brucellose (*Brucella abortus* par seroagglutination) et 3,5% en chlamydiose (fixation du complement en micromethode)

Discussion

En comparant par le test du khi carre les seropositifs aux seronégatifs on constate que la toxoplasmose, avec une probabilite seuil de 14%, differencie le mieux les trois types de perte (tableau 2)

En effet, la mise bas de produits chetifs accompagne souvent des etats d'infection par des germes a tropisme genital connus aussi pour leur effet abortif C est le cas de la toxoplasmose et de la chlamydiose (Debenedetti & Waldeland, 1989)

Pour ces diverses raisons, il est convenu de regrouper les pertes par chetivite et par avortement, dont les statuts serologiques face a la toxoplasmose sont les plus proches, pour les comparer aux pertes par mortalite neo natale (tableau 3)

Tableau 2 *Probabilites de prevalences equivalentes entre les differents types de pertes*

	Probabilites en % de l hypothese nulle			
Organisme	avortement chetivite mortalite	chetivite X mortalite	chetivite X avortement	avortement X mortalite
Chlamydia	pX2 82	2pF 100	2pF 100	2pF 68
B ovis	pX2 61	2pF 100	2pF 67	2pF 68
B abortus	pX2 98	2pF 100	2pF 100	2pF 100
Toxoplasma	pX2 14	2pF 33	2pF 69	2pF 6 4

X2 = probabilité seuil selon le test du khi carre

2pF = probabilité bilatérale de Fisher

Les prevalences de la toxoplasmose distinguent le mieux les trois types de perte avec une probabilite de l'hypothese nulle de 14%

En fait, c'est entre les pertes par mortalites et les pertes par avortements que les differences de prevalences en toxoplasmose sont les plus marquees, l'hypothese nulle ne depassant pas 6,4%

Par ailleurs, les prevalences en toxoplasmose chez les chevres qui avortent et celles qui mettent bas des produits chetifs sont plus proches qu'entre les premieres et celles qui perdent leurs produits nes normaux par mortalite, la probabilite de ne pas differencier les premieres est de 69% contre 33% pour les secondes Cette observation, sous reserve du faible effectif teste, corrobore les connaissances acquises en matiere de pathogenie des avortements infectieux

Tableau 3 *Repartition de la toxoplasmose lors de mortalites neo natales et lors d avortements ou mises bas de produits chetifs*

	Toxoplasmose		
Type	+	–	Total
Chetivite avortement	19	4	23
Mortalite neo natale	15	5	20
Total	34	9	43

La probabilite de l'hypothese nulle, apres test du khi carre, n est que de 8%

Ces resultats statistiques permettent de retenir que la toxoplasmose est chez les chevres pluripares, un

facteur de risques de pertes par mortalite neo natale plutôt que de pertes par avortement ou chetivite

Conclusion

Ce suivi serologique et clinique a permis d etablir que la toxoplasmose contribue plus aux mortalites neonatales qu'aux autres types de perte Cette contribution decelee sur un si faible echantillon est sans doute tres importante (Schwartz, 1989) Aucune conclusion definitive ne peut par contre être retenue quant au rôle des infections brucelliques ou chlamydiennes dans l'avenement d'un type de perte plutôt que d'un autre

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Reproduction losses, chlamydiosis, brucellosis and toxoplasmosis in a traditional extensive West African Dwarf goat system in Senegal

Abstract

This study was carried out on West African Dwarf goats in extensive traditional livestock production systems in the subhumid zone of Senegal Animals tested seropositive for chlamydiosis caused by *Chlamydia psittaci*, for brucellosis caused by *Brucella ovis* and *Brucella abortus* and for toxoplamosis caused by *Toxoplasma gondii* in 12 cases of perinatal mortality, 20 cases of abortions and 11 cases of birth of substandard offspring, respectively Of these 43 cases of reproductive losses, serological prevalences of 80%, 10% 23% and 53% were recorded and were due, respectively, to chlamydiosis to brucellosis caused by *Brucella abortus* and *Brucella ovis* and to toxoplasmosis The implications of these infections for these reproductive losses were discussed in relation to their distribution

Diseases of small ruminants in Botswana 1983–92

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Abstract

The paper highlights the diseases of goats and sheep that are endemic in Botswana based on conditions diagnosed and recorded by the National Veterinary Laboratory at Gaborone between 1983 and 1992 The most predominant diseases were helminthosis coccidiosis, heartwater, abortions and rabies Abscesses, pneumonia/pleuritis mineral deficiencies and keratoconjunctivitis were also common Other prevalent conditions included, skin parasites including ringworm, enterotoxaemia, salmonellosis, mastitis, septicaemia bluetongue contagious ecthyma (Orf), balano-posthitis footrot, haemoparasites and poisoning Poor husbandry and unfavourable environmental factors played a role in disease occurrence There was demand for more work to determine causes of abortions pneumonia/pleuritis and eye infections and improved diagnostics for botulism and heartwater

Introduction

This paper is a retrospective study of disease occurrence in goats and sheep in Botswana during a 10-year period (1983 to 1992) based on clinical cases diagnosed and reported from the field and confirmed at the National Veterinary Laboratory (NVL) at Gaborone Botswana The NVL provides a comprehensive diagnostic service thereby contributing to the surveillance of diseases affecting animals in Botswana

In Botswana it would appear that weather and climatic conditions greatly influence disease occurrence Rainfall and temperature influence the quality and quantity of available grazing and drinking water and thus the conditions of the animals The latter has direct bearing on susceptibility and resistance of animals to diseases (Carles 1983)

When Botswana experiences drought, livestock travel long distances in search of grazing and water Deaths due to starvation and stress induced diseases have been reported Under the prevailing husbandry practices, sheep and goats have low economic and social value and farmers deworm/treat or vaccinate them less often than they do cattle In general livestock condition in Botswana is mostly poor during the winter months of June to August especially in the communal areas (District Reports 1988–92)

The present study was meant to look at the changing patterns of small ruminant diseases to further understand disease causation treatment prevention and control, and evaluate methods of disease detection

Materials and methods

Samples were collected from the field from disease cases for virology, bacteriology, histopathology, serology, haematology, biochemistry, parasitology and toxicology and submitted to NVL with clinical history on designated laboratory submission forms Each collection of samples from one or more animals from each farm or locality was designated as a batch of samples and allocated a laboratory number with known species code Batches of specimens were subjected to the appropriate comprehensive laboratory diagnosis for suspected agents or analysed for mineral deficiencies or haematology profiles Post-mortem examinations were also performed on carcases of small stock at NVL and appropriate samples submitted for diagnosis Samples for laboratory diagnosis originated from all veterinary districts (Figure 1)

Results

During 1983–92, the total annual number of specimen batches submitted to NVL from the field increased over three times to a peak of 1148 batches in 1989, declining gradually to 683 batches in 1992 Differing degrees of confirmations were obtained for different conditions

High levels of confirmations were achieved for abscesses and rabies at 86% and 82%, respectively, relative to 8 5% for abortions/stillbirths (Table 1)

Figure 2 shows the commonest important diseases with the highest frequencies

Helminthosis and/or coccidiosis were the commonest diseases of small ruminants and occurred all year round (Figure 3) with a tendency for peak infestations to occur during the first and last quarters of the year These periods coincided with summer rains and high temperatures and humidity suspected to be conducive for parasite activity The commonest worms identified included *Haemonchus contortus* *Oesophagostomum colombianum* and *Trichostrongylus* spp

Heartwater due to *Cowdria ruminantium* is an important tickborne disease with recorded losses ranging from single isolated cases to dozens of deaths among goats or sheep per flock throughout the year in the eastern part of the country where the vector tick *Amblyomma hebraeum* was consistently detected Seasonal peak incidences of heartwater were recorded during March and September when humidity and temperature were high

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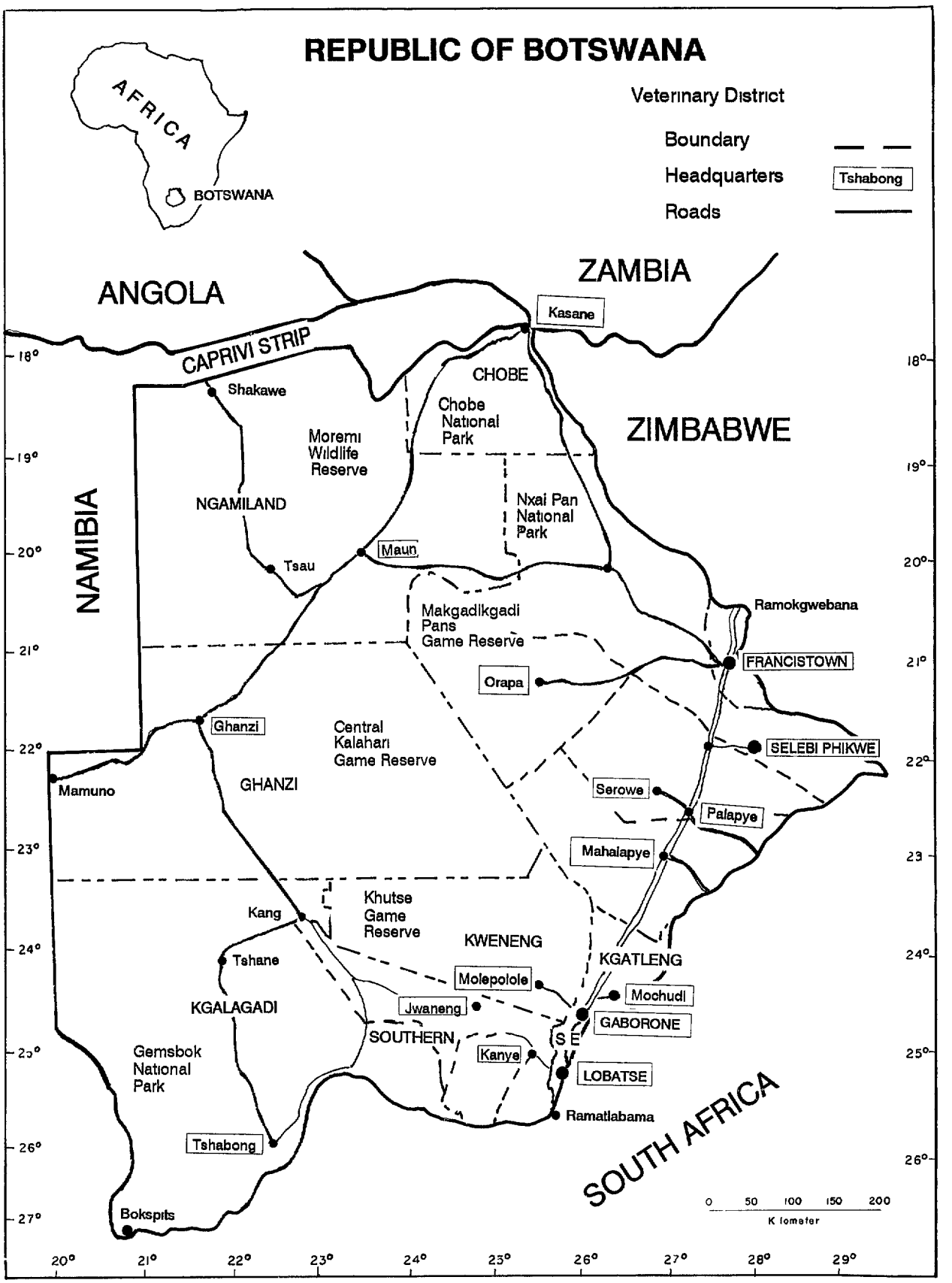

Figure 1 *Veterinary districts and headquarters*

Reported abortions, stillbirths and neonatal deaths varied annually with periods of dramatically increased cases Starvation, malnutrition, intestinal parasites and winter conditions when small ruminants were in poor body condition were suspected to have been responsible for the peaks of 'winter abortion storms' (Figure 3)

Table 1 *Comparisons of laboratory confirmation of cases in goats and sheep 1988–92*

Disease condition	Year and no positive/total cases and percentages					Average % positive
	1992	1991	1990	1989	1988	
Abscesses	13/13	22/24	4/5	42/52	2/34	
(% positive)	(100)	(91 6)	(80)	(80 8)	(67 6)	84 0
Rabies	44/50	54/66	57/66	20/26	19/24	
(% positive)	(88)	(81 8)	(86 4)	(76 9)	(79 2)	82 46
Heartwater	49/82	119/168	64/127	1163/223	78/96	
(% positive)	(59 8)	(70 8)	(50 4)	(73 1)	(81 3)	67 08
Pneumonia/pleuritis	4/9	9/13	11/95	22/22	12/32	
(% positive)	(44 4)	(69 2)	(11 6)	(100)	(37 5)	
Conjunctivitis	5/9	14/16	2/6	4/11	1/9	
(% positive)	(55 6)	(87 5)	(33 3)	(36 4)	(11 1)	44 78
External parasites	8/9	7/29	7/20	8/70	4/18	
(% positive)	(88 9)	(24 1)	(35 0)	(11 4)	(22 2)	36 32
Abortions/stillbirths	6/48	6/31	5/87	2/68	1/50	
(% positive)	(12 5)	(19 4)	(5 7)	(2 9)	(2)	8 5

There were 225 positive rabies cases in small ruminants during 1983–92, ranking about fourth behind bovine, canine and wildlife rabies The number of rabies cases increased gradually to about five times of those detected a decade ago (Figure 2)

Mineral deficiencies among small stock comprised mostly hypophosphataemia resulting in abnormalities in locomotion, there were fewer cases of hypocupraemia leading to cases of sway back or paralysis of the hind quarters Goitre, a consequence of iodine deficiency was detected intermittently in the

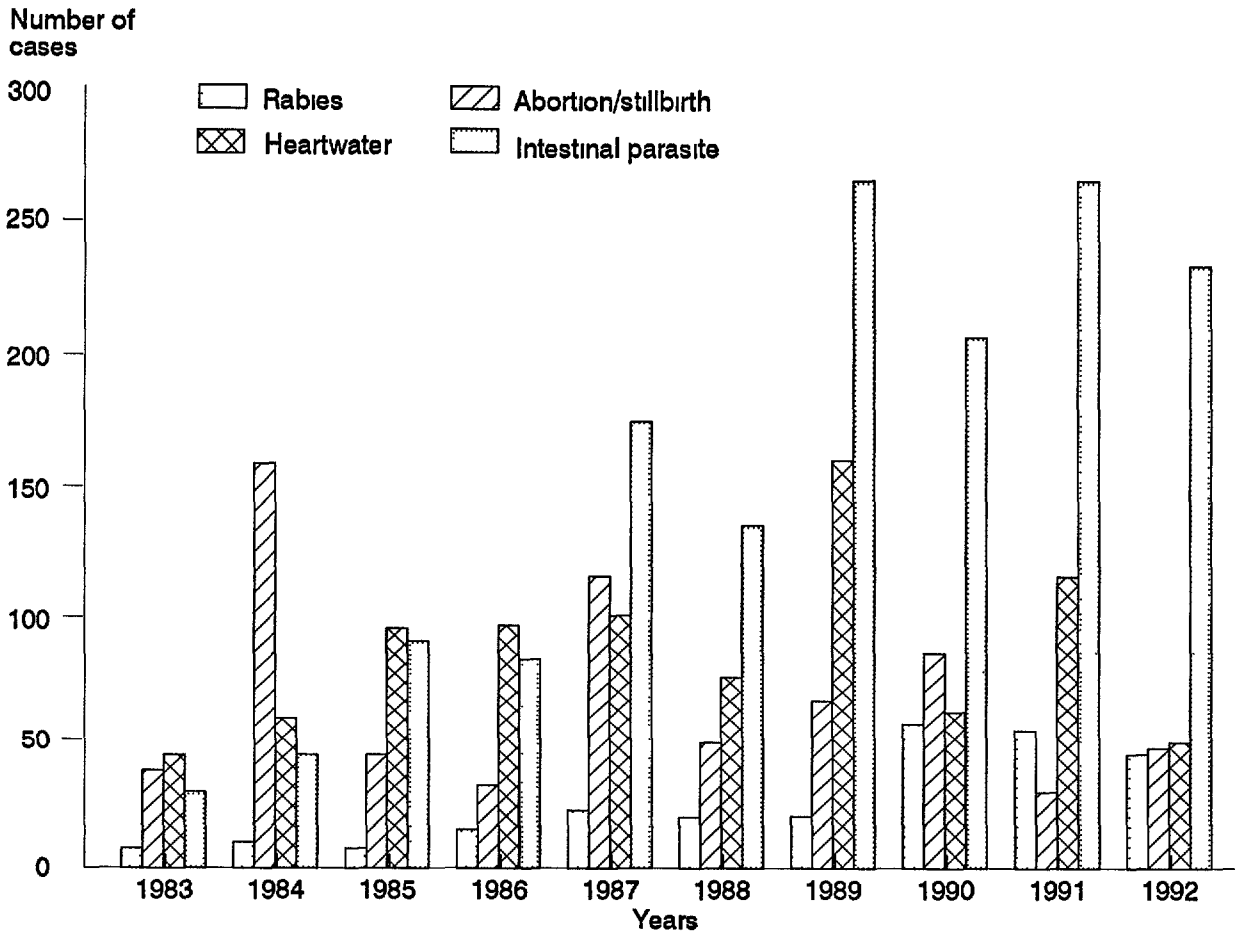

Figure 2 *Confirmed cases of helminthosis coccidiosis heartwater and rabies with total cases of abortions 1983–92*

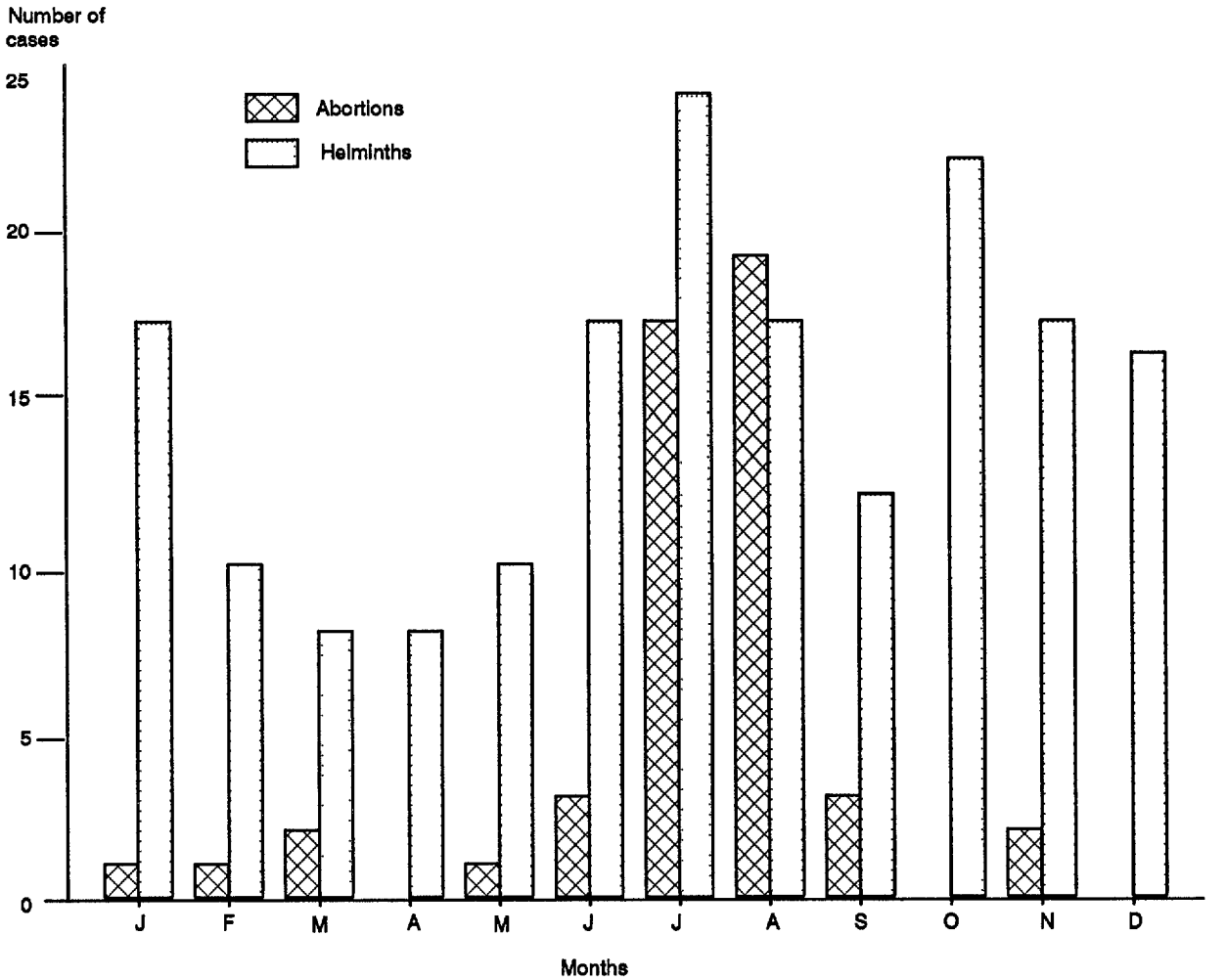

Figure 3 *Seasonal distribution of caprine and ovine cases 1992*

endemic areas of Maun and Orapa districts In addition, a few fatal cases of starvation were reported annually particularly in the winter season and during periods of drought Pneumonia/pleuritis often reported as pasteurellosis, was commonly diagnosed in the field but these cases were largely negative for *Pasteurella multocida* and *P haemolytica*, the known common causal agents Pasteurellosis induced by the stress of shipping small ruminants, developed along classical lines where the animals developed pneumonia and *P multocida* was recovered from the typical lesions

Moraxella bovis or *Branhamella ovis* were recovered from 44 8% of the eye infections (Table 1) Variations in sampling of infected cases and treatment of cases before sampling appeared to affect recovery rates of infectious agents

Sheep scab, a notifiable condition caused by *Psoroptes ovis*, appeared to be endemic and restricted to the southern districts *Demodex* mites, lice infestation with *Linognathus stropsis* and different types of ticks (*Amblyomma hebraemum Boophilus* spp, *Hyalomma* spp and *Rhipicephalus* spp) were also recorded Streptothricosis/dermatophilosis, caused by *Dermatophilus congolensis* and ringworms were reported sporadically

Miscellaneous diseases with lower occurrences included enterotoxaemia (47 cases) mastitis (86), septicaemia (57) viral diseases, bluetongue and contagious ectyma orf (47) balano-posthisis (Pizzle rot) and haemoparasites *Anaplasma* and *Theileria* being of questionable pathogenicity Botulism diagnosis was dependent on clinical signs particularly during the drought periods linked with hypophosphataemia leading to craving for bones containing botulism toxin

Cases of poisoning caused by *Pavetta harbori* and *Dicaptalum cymosem* were more commonly encountered with minimal available grazing

Discussion

Laboratory findings at NVL have shown that some conditions persistently occurred and recurred with high frequency in sheep and goats during 1983 to 1992, namely helminthosis/coccidiosis, heartwater, abortions/stillbirths and rabies These conditions no doubt represent important causes of loss to the small ruminant industry

The predominance of these diseases may partly be due to poor husbandry where deworming for intestinal parasites and tick control measures are haphazard, being instituted only when diseases were suspected (District Reports 1988–1992) Also, the finding of low total protein or albumin levels in sera of aborted animals strengthens the suscipion that malnutrition or starvation plays an important role in most instances of abortion (Report NVL 1983–92) There is need, therefore, to determine the roles of nutrition and/or infectious agents in abortions in small ruminants in Botswana

Notably, vaccination against heartwater is problematic it is costly, causes direct losses following inoculation, is unreliable as breaks in immunity are common increases the number of carriers of *Cowdria*, requires strict supervision and is difficult to carry out on a large scale (Windsor 1987, Camus and Barre 1988) Nevertheless, vaccination is considered a useful means of preventing heartwater without eradicating the total tick population in an endemic area Suggestions have been made for the need to develop attenuated strains of *Cowdria* by culture *in vitro* or research on strains low in virulence (Camus and Barre 1988) For diseases where vaccination of small ruminants was increasingly being practised (District Reports 1988–1992), the number of laboratory confirmations were lower, namely enterotoxaemia, botulism and pasteurellosis In the case of pasteurellosis, other causes excluding *Pasteurella multocida* or *P haemolytica* have been postulated but remain unproven (Report NVL 1983–92)

Lack of simple reliable and sensitive tests hinder heartwater diagnosis and there is need to develop tests to detect *Cowdria* in living animals (Camus and Barre 1988)

It would appear that good husbandry practices directed towards reduction of mortalities on the farm together with improved clinical and laboratory diagnosis and research into the aetiology of important diseases of small ruminants and improved methods of their diagnosis and control are needed in Botswana Since the important diseases of small ruminants are endemic elsewhere in sub-Saharan Africa, local and regional collaborative efforts with additional international support, would be beneficial in tackling similar problems

Acknowledgement

The field and laboratory diagnosis and compilation of the reports were carried out by staff of the Department of Animal Health and Production of the Government of Botswana This paper is presented with permission of the Director of Animal Health and Production

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Les maladies des petits ruminants au Botswana: 1983–1992

Résumé

Cet article passe en revue les maladies des ovins et caprins consideres comme endemiques au Botswana sur la base des symptômes observes et decrits de 1983 a 1992 par le Laboratoire national veterinaire de Gaborone Les affections les plus frequentes etaient les helminthiases les coccidioses les cowdrioses les avortements et la rage Les abces, les pneumonies/pleurites, les carences minerales et les kerato-conjontivites etaient egalement frequentes Les autres maladies rencontrees sont les ectoparasites y compris la teigne ainsi que les enterotoxemies, les salmonelloses, les mastites, la septicemie, la fievre catharrale du mouton l'echtyma contagieux les balano-posthites le pietin les hemoparasites et les cas d empoisement Les modes de gestion inappropries et les mauvaises conditions de milieu favorisent l apparition des maladies Des travaux supplementaires s averent indispensables pour determiner les causes des avortements des pneumonies/pleurites et des maladies des yeux et pour ameliorer le diagnostic du botulisme et de la cowdriose

The interaction between animal nutrition and parasites: Studies with experimental trypanosomiasis in sheep

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Abstract

The present study investigated the role played by improved nutrition in the development of pathophysiological effects of trypanosomiasis in sheep given two levels of protein intake It was observed that feed intake was not influenced by either the diet or infection The intensities of parasitaemia as measured by the buffy coat method indicated that there was a tendency for the animals receiving the high protein diet to sustain more parasite numbers than those receiving the low protein diet The infected animals on a high protein diet gained weight at the same rates as the uninfected controls However, infected animals on low protein diet showed marked retardation of growth compared to the uninfected controls Both groups of infected animals exhibited similar degrees of anaemia but following treatment, those on the high protein diet recovered much faster than those on the low protein diet It was concluded that improved nutrition in form of higher protein intakes ameliorates the adverse effects of trypanosomiasis and also enhances the rate of recovery following chemotherapy

Introduction

Parasites particularly gastro-intestinal helminths and protozoa are a major constraint to animal productivity throughout the world In many tropical countries protozoan diseases are of major importance One protozoan disease in particular trypanosomiasis, is the single most important constraint to animal production in ub-Saharan Africa It has been frequently suggested that the nutritional status of the host can influence the pathogenesis of parasitic infection and it is generally accepted that well-nourished animals withstand parasitism better than those that are less adequately fed (Whitlock 1949, Gibson 1963)

There have been numerous anecdotal accounts of the importance of host nutrition in the pathogenesis of trypanosomiasis in ruminants although until very recently these have remained unsubstantiated Thus, it has been frequently reported from the field that during the dry season trypanosomiasis becomes more severe when the quality and quantity of nutrition is particularly low This has recently been investigated in The Gambia by offering supplementary feeding during the dry seasons to trypanosome-infected N'Dama cattle (Agyemang et al 1990, Little et al 1990) As a result of the supplementary feeding it was found that the severity of the disease as judged by the degree of anaemia, was significantly reduced

It is possible that diet may not only influence host resistance to either the initial infection or re-infection but may also affect the ability of the host to withstand the pathophysiological consequences of infection Unfortunately, the few studies that have been conducted to examine these interactions in the past have often been unsatisfactory because of inadequate controls or poorly formulated diets More recently attempts have been made to overcome these difficulties and a clearer picture of the interaction between host nutrition and the pathophysiological consequences of parasitic infections has started to emerge

The present study was designed to investigate the influence of host nutrition on the pathogenesis of trypanosome infection in sheep

Materials and methods

Experimental animals, feeding and housing

Male castrate lambs, aged six months, were purchased from a local hill farm in the west of Scotland The basic diet consisted of a mixture of shredded sugar-beet pulp (SBP), barley siftings and a mineral/vitamin trace element mixture Soya-bean meal (SBM) was added to the high protein (HP) diet only The mean proximate analyses of the two diets are shown in Table 1

Table 1 *Mean proximate analyses and calculated metabolisable energy of the high protein (HP) and low protein (LP) experimental diets (g/kg DM)*

	Diet	
Dietary composition	HP	LP
Dry matter (g/kg)	880	880
Crude protein	176	81
Crude fibre	169	192
Ether extract	5	4
Ash	77	80
Organic matter	923	920
ME (Mj/kg DM)	9 8	10 1

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The lambs were housed in individual pens on a concrete floor and wood shavings were used as bedding The daily allowance of 1 kg fresh matter (FM) was offered in two feeds at 0900 and 1600 h The residue was collected the following morning and weighed to give the actual amount of feed consumed

Five litres of water were offered each morning and the residue was recorded the following morning

Chemical analyses of feed

Representative samples of the experimental diets were analysed periodically using standard procedures (MAFF et al 1981)

Experimental infection

The animals were infected with *Trypanosoma congo lense* 1180 (GRVPS 57/6), a cloned derivative of an isolate made in Serengeti, Tanzania as described by Nantulya et al (1984) The trypanosomes were obtained from irradiated mice during the first rising parasitaemia Mice were bled by cardiac puncture and their blood was pooled An estimate of parasitaemia was made on the pooled sample, which was then diluted with phosphate buffered saline (PBS) containing 1 5% glucose at pH 8 0 to give $1X10^5$ trypanosomes in 3 ml of PBS Each sheep received 3 ml of the inoculum via the jugular vein

Parasitological, haematological and biochemical techniques

The techniques used to collect blood samples for parasitological, haematological and blood biochemical examination have been described previously (Katunguka-Rwakishaya et al 1992a)

In brief, trypanosomes were detected by the dark ground buffy coat method (Murray et al 1977), and the intensity of parasitaemia was graded from 0 to 5 as described by Paris et al (1982)

Experimental design

Eighteen Scottish Blackface lambs were involved in this study They were divided into two groups of nine animals each, on the basis of their live weights and PCV, and introduced to either a low protein (LP) or a high protein (HP) diet After 4 weeks on their respective diets, six animals from the low protein group (LPI group) and six animals from the high protein group (HPI) were infected with *T congolense* while three animals from each dietary group acted as uninfected controls (LPC and HPC)

Seventy days after infection (DAI), three animals from the HPI group (HPIT) and three animals from the LPI group (LPIT) were treated with isometamidium chloride at a dose rate of 1 mg/kg by deep intramuscular injection and the animals were monitored for a further 21 days

Statistical methods

Comparisons between groups were achieved by using one-way analysis of variance followed by the Newman-Keuls multiple range test Intensities of parasitaemia were evaluated by the non-parametric Mann-Whitney test These statistics were performed using the Animal Designs 1 (Data International Service Glasgow) and Minitab (Ryan Penn State University) Programmes P values <0 05 were considered significant

Results

Feed and water intake

The mean feed intake for animals in the HPI group was 0 93±0 03 kg/d while the LPI group consumed 0 98±0 02 kg/d between 0 and 70 DAI This difference was not statistically significant Control animals consumed 1 kg/d The mean water intake of the LPI group was 2 10±0 07 litres/d while HPI group consumed 2 51±0 10 litres/d (P<0 05) Mean water consumption in control groups was not different The LPC group consumed 2 30±0 11 litres/d while HPI group consumed 2 31±0 10 litres/d

Parasitaemia

The prepatent period in both groups was the same, i e 7–9 days after infection Following patency, parasitaemia fluctuated considerably with a tendency to be higher in HPI than in LPI group (Figure 1)

Body weight

Infection was associated with greater retardation of growth in the LPI group compared to the LPC group (Figure 2) The gain in live weight of the LPI group was significantly lower than that of the LPC and HPI groups However the HPI and HPC groups grew at similar rates There were no significant differences between the weights of control animals

Packed cell volume (PCV)

Infection caused significant decreases in PCV values of both infected groups compared with their controls (Figure 3) The decline in PCV values commenced with the appearance of trypanosomes in circulation and both groups of infected animals showed similar degrees of anaemia The PCV values in control animals fluctuated between 0 32 and 0 40 litres/litre There were no nutritional influences

Mean corpuscular volume (MCV)

Following infection both infected groups showed significant increases in MCV compared to their uninfected controls however the increase was significantly greater in the HPI group than in LPI group In the HPI group the mean MCV increased from

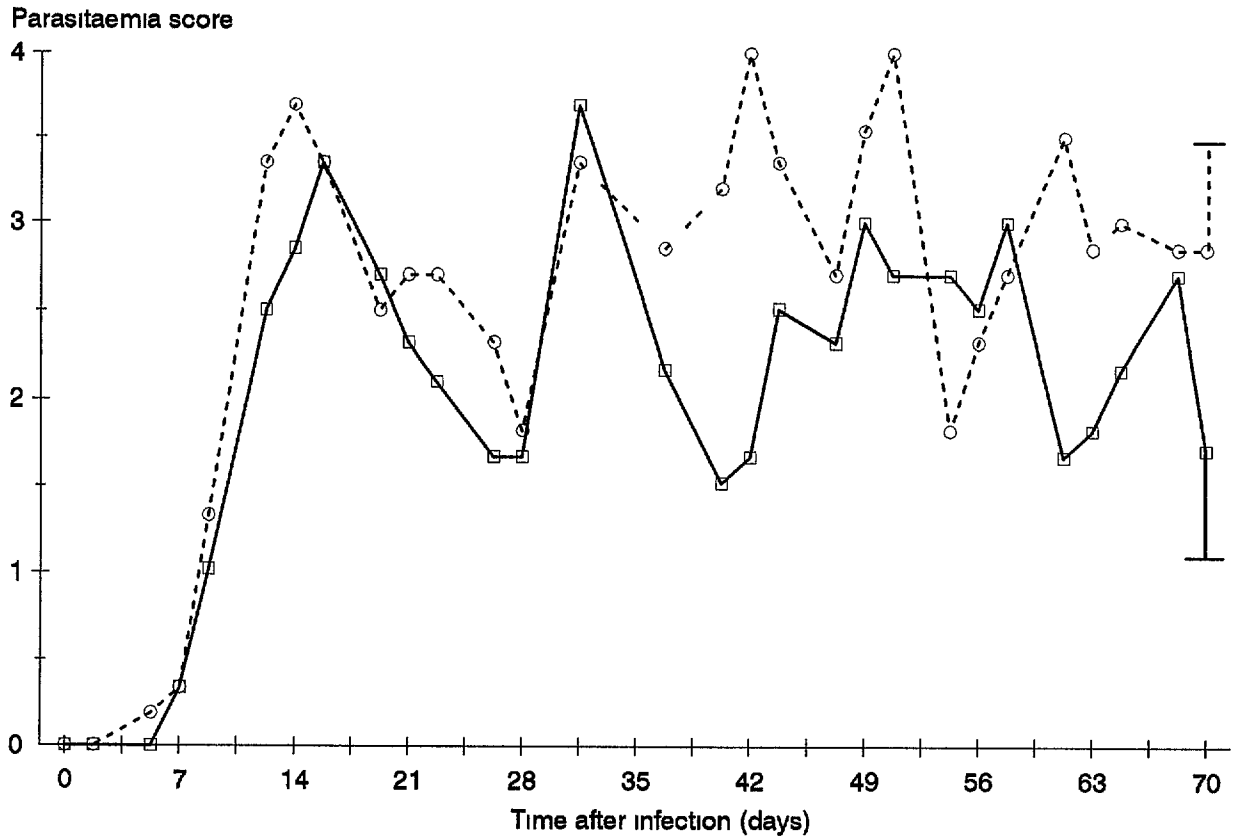

Figure 1 *Parasitemia scores of sheep infected with* T congolense *and given either a high (– –O– –) or a low protein (– –□– –)*

31 2±0 3 flat 0 DAI to 38 5±1 2 fl at 29 DAI In the LPI group, the MCV values increased from 31 0±0 7 fl at 0 DAI to 35 0±0 6 flat 36 DAI before decreasing to 32 3±0 7 at 68 DAI

In control groups the MCV fluctuated between 30 0±0 6 and 33 0±0 6 fl with no significant differences between LPC and HPC groups

Plasma albumin concentration

The mean plasma albumin concentration decreased significantly in both groups of infected sheep and also showed dietary influences In the HPI group, plasma albumin decreased from 36 2±0 4 g/litre at 0 DAI to 28 7±0 9 g/litre at 21 DAI In the LPI group, it decreased from 30 8±0 7 to 26 3±0 6 g/litre and tended to recover thereafter

In the control groups plasma albumin concentration fluctuated between 28 3 and 32 0 g/litre in the LPC and between 32 7 and 36 3 g/litre in the HPC group The values in the HPC groups were significantly higher than those in the LPC group

Response to treatment

Body weight Following treatment both groups of infected animals gained weight The LPIT group gained 0 7 kg while the HPIT group gained 1 8 kg during the 3 weeks after treatment The LPC and HPC groups increased by 1 2 and 1 8 kg, respectively, in the same period

Packed cell volume Both groups of infected animals showed an improvement in their PCV values following treatment, however, the rate of recovery was moderately faster in the HPIT group By 20 days after treatment the PCV values of the HPIT group were 0 33±0 01 litres/litre while those of the HPC group were 0 32±0 01 litres/litre The values in the LPIT group were 0 28±0 01 while controls were 0 32±0 01 litres/litre

Discussion

In the present study, it was shown that improved nutrition in the form of increased protein intake had a marked influence on rates of growth, intensity of parasitaemia blood biochemical changes and rate of recovery from anaemia following administration of isometamidium chloride

In agreement with the findings of Little et al (1990), it was observed that improved nutrition did not affect the prepatent periods Following the appearance of trypanosomes in circulation there was a tendency for parasitaemia to be higher in the HPI group The reasons for this are not clear but may be due to readily available nutrients like proteins and lipids

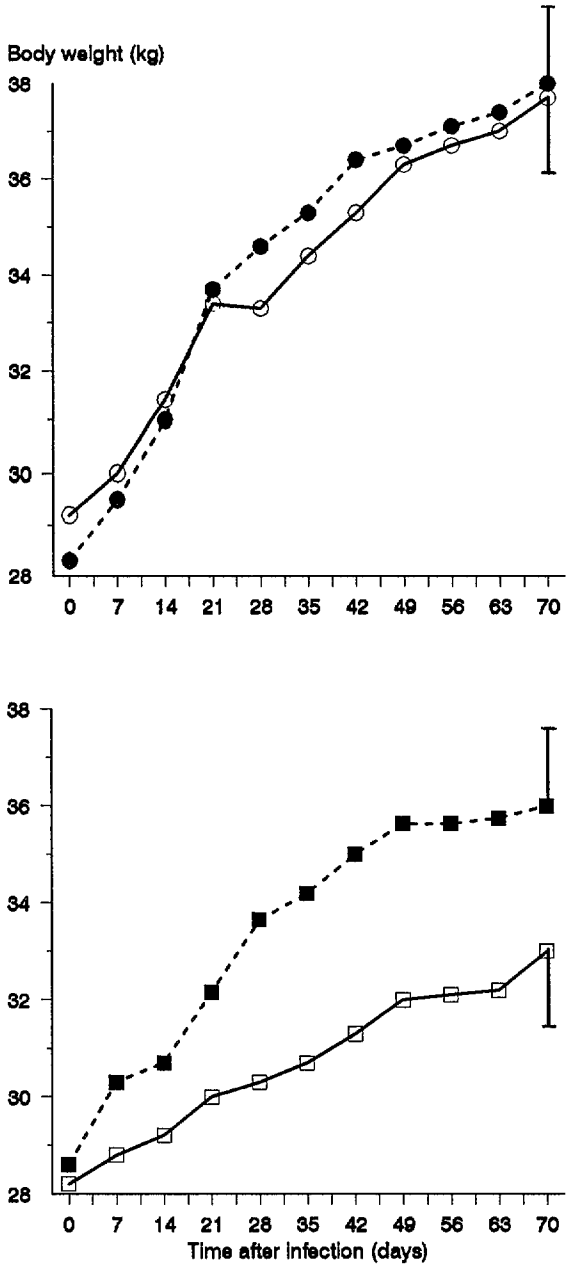

Figure 2 *Body weights of sheep infected with* T congolense *and given either a high (– –○– –) or a low (– –□– –) protein diet and of their respective uninfected controls (—●— —■—)*

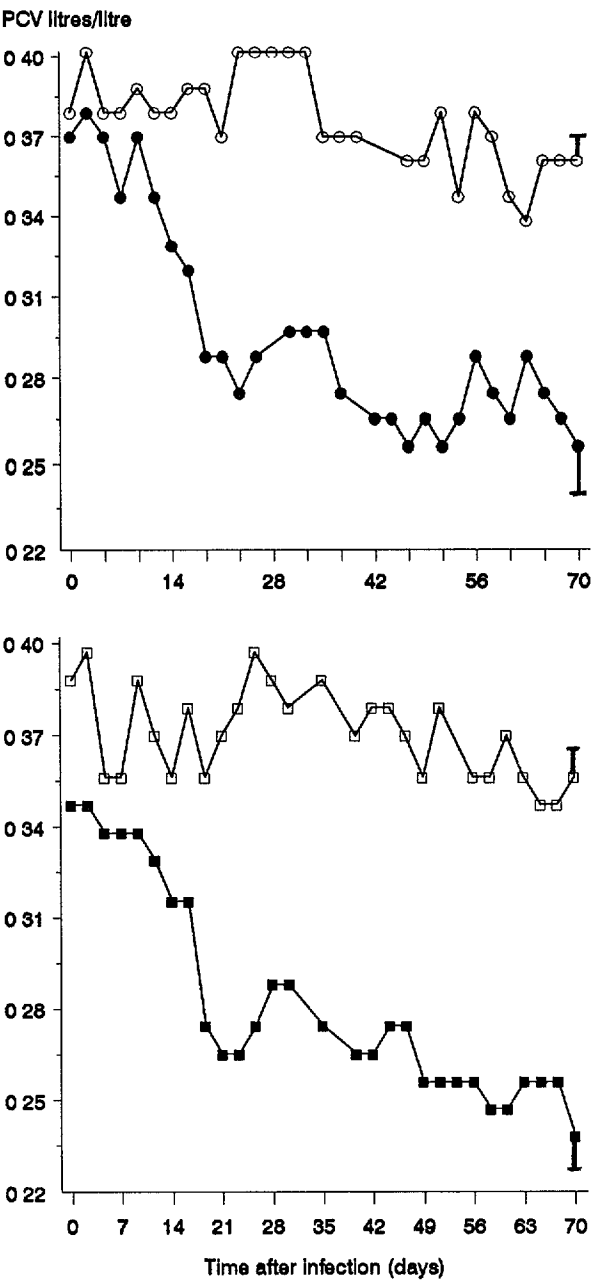

Figure 3 *Packed cell volumes (PCV) of sheep infected with* T congolense *and given either a high (—●—) or a low (—■—) protein diet and of their respective uninfected controls (– –○– – – –□– –)*

Greater retardation of growth was observed in the LPI group while HPI and HPC groups grew at similar rates These findings agree with those of Hecker et al (1991) for Djallonke sheep and those of Agyemang et al (1990) for N'Dama cattle exposed to natural fly challenge Verstegen et al (1991) and Zwart et al (1991) observed that development of fever during a course of trypanosome infection is associated with increased heat production and increased metabolisable energy for maintenance The consequence of this is that the proportion of feed that would be used for growth is reduced as it is metabolised to provide extra energy for maintenance The animals on a low protein diet would suffer this effect much more than those on a high protein diet and this may manifest in the form of greater retardation of growth than animals on HP diet

Similar degrees of anaemia were recorded in two groups of infected animals This observation is in agreement with that of Agyemang et al (1991) for N'Dama cattle However, Little et al (1990) reported that the rate of development of anaemia in N Dama cattle inoculated with *T congolense* and supplemented with groundnut cake was slower than in unsupplemented cattle In contrast to this report the present study has shown that improved nutrition does not influence trypanosome establishment and the rate of

development of anaemia The anaemia in HPI was macrocytic while it was nomacytic in the LPI group This finding suggests enhanced erythropoietic activity as a response to infection in the HPI group This may be responsible for the observed faster recovery from anaemia in this group

Infection caused significant hypoalbuminaemia in both dietary groups but it appeared greater in the LPI than in the HPI group At the same time control animals on HP diet had significantly higher plasma albumin concentration than those on LP diet It has been suggested that uptake of albumin-bound fatty acids and lipoproteins (Vickerman and Tetley 1979) and haemodilution (Katunguka-Rwakishaya et al 1992b) may account for the decrease in plasma albumin concentrations in trypanosome infected animals

In conclusion, this study has shown that improvement of host nutrition is important in moderating the severity of pathophysiological effects of trypanosomiasis and also influences the rate of recovery from anaemia following chemotherapy

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Interaction entre l'alimentation animale et les parasites: études sur la trypanosomiase expérimentale chez les ovins

Résumé

Cette etude examine le rôle d une meilleure alimentation dans le developpement des effets patho-physiologiques de la trypanosomiase chez des ovins recevant deux rations, l'une a taux eleve, l'autre a faible taux de proteine La teneur en proteine et l'infection n'avaient aucun effet sur l'ingestion L'intensite de la parasitemie, mesuree par la methode du buffy coat, a indique que les animaux recevant la ration a taux eleve de proteine supportaient generalement un niveau de parasitemie plus eleve que ceux recevant la

ration a faible teneur Les animaux infectes recevant la ration a taux eleve gagnaient du poids au même rythme que les sujets temoins A l'inverse les sujets recevant la ration a faible taux de proteine accusaient un important retard de croissance par rapport aux temoins Les deux groupes d'animaux infectes souffraient d'anemie au même degre mais la teneur elevee en proteine etait associee a un retablissement plus rapide En conclusion on peut dire que l amelioration de l alimentation des animaux grâce a l'accroissement du taux de proteine alimentaire permet de contrer les effets de la trypanosomiase et d'accelerer la guerison par chimiotherapie

SESSION 4

Feeding and Feeding systems

The effect of variety and amount offered of chopped sorghum stover on the performance of sheep

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Abstract

Forty-eight individually fed Menz highland rams were used in a 2x2 factorial treatment design to measure dry-matter (DM) intake and liveweight [mass M] change over 42 days [d] 16 of the rams were used to measure digestibility Factors investigated were amount of stover offered (25 or 50 g DM/kg M d) and variety (bird resistant [BR] or non-bird resistant [non-BR]) of stover Stover was offered in chopped form Rams were provided with water and mineral lick but no other supplement The leaf and leaf-sheath contents of BR and non-BR stovers were 566 and 477 g DM/kg DM respectively, although the aim had been to have identical leaf and sheath contents The chemical composition of the stovers were similar Stover intake (g DM/kg M d) was not affected by variety (P>0 05) but was significantly (P<0 001) improved by doubling the amount offered (BR25 23 9 BR50 31 6 non-BR25 23 7, non-BR50 31 6, s e d 0 95) Increasing the amount of stover offered increased the amount refused (25 offer rate 66 g DM refused/kg DM offered, 50 offer rate 385 g DM refused/kg DM offered) For both varieties, the increase in intake on doubling the offer rate was largely explained by a greater intake of leaf and leaf sheath Rams offered stover at 50 g DM/kg M d maintained live weight, those offered stover at 25 g DM/kg M d lost weight (BR 16 1 g/d, non-BR 25 3 g/d) There was a trend for digestibilities of DM, organic matter (OM) and NDF to be lower for BR stover (OM digestibility g/kg BR25 532 BR50 544 non-BR25 581 non-BR50 559 s e d 23 6) It is concluded that chopped sorghum stover offered generously at 50 g DM/kg M d with minerals but no other supplement is a sustainable feeding strategy for maintaining weight in near-adult rams

Introduction

Increasing the amount of crop residue offered to sheep to allow the animals to refuse up to 500 g/kg offered instead of the conventional 100 to 200 g/kg offered has been shown to increase intake and growth rate in studies with barley straw in the UK (Wahed et al 1990) and sorghum stover in Ethiopia (Aboud et al 1990) The improvements in intake and growth were considered to be due to animals consuming a greater amount of the more digestible leaf and sheath components because of being given the opportunity to select

Stover from bird resistant [BR] sorghum was shown to be less digestible than that from non-bird resistant [non-BR] sorghum due to the presence of anti-nutritive phenolics in BR sorghum (Reed et al 1987) However recent results at ILCA (Aboud et al 1990) indicate that the high phenolics in stover from BR sorghum may not be a problem provided animals are given the opportunity to select against the pigmented, high-phenolic fractions Furthermore, studies by Osafo (1993) showed large differences between stover varieties in their content of leaf and sheath, nutritive value comparisons of sorghum stover varieties need to recognise this The present experiment aimed to compare the intake and digestibility of BR and non-BR sorghum stovers of comparable leaf and sheath contents when offered at two contrasting rates It was postulated that intake and digestibility would be lower for BR than for non-BR stover particularly when offered at the lower rate

Materials and methods

Experimental design

Forty-eight growing individually-fed Menz highland rams (aged 15–20 months) were used in a 2x2 factorial design with 12 replicates per block over 42 days Factors were amount of stover offered (25 or 50 g dry matter [DM] of stover per kg live weight [mass M] daily [d]) and variety of sorghum stover (BR, non-BR) Rams were blocked for M From day 35 to 42 rams in blocks

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1, 4, 8 and 12 were placed in metabolism crates for measuring digestibility

The four treatments were BR stover offered at 25 g DM/kg M d [BR25] or 50 g DM/kg M d [BR50] and non-BR stover offered at 25 g DM/kg M d [Non-BR25] or 50 g DM/kg M d [Non-BR50]

Feed preparation, feeding and weighing

In light of other studies (Osafo 1993) it was planned to use BR stover variety Seredo and a non-BR stover variety Dinkamash, both grown at one site However, hailstorms caused a dramatic drop in stover yields which necessitated using a mixture of stovers from Seredo grown at two sites (Debre Ziet and Melkassa) and a mixture of stovers from Dinkamash (grown at the two sites) and a non-BR variety, 76T123, grown at Debre Zeit Stovers from each variety and site were chopped separately using a tractor mounted Alvan Blanch "Maxi" Chaff cutter (PTO rotating at 2000 rpm) and later bulked at feeding

Rams were individually fed in pens with slatted floors Half the stover was offered at 0800 h and the other half at 1400 h No protein supplement was given Water and mineral lick were offered *ad libitum* Non-fasted live weights of rams were recorded weekly

Daily samples of refused stover per animal, were bulked weekly resulting in six samples of refused stover per animal Daily samples of offered stover were bulked weekly

Digestibility trial

Total faeces of the 16 rams in blocks 1, 4, 8 and 12, housed in metabolism crates at day 35, were collected over a 7-day period to measure digestibility Faecal samples for each ram, bulked over 7 days, were stored at –4 C for subsequent analysis

Chemical analyses and botanical composition

Faeces and stover were analysed for DM, ash and nitrogen using procedures described by AOAC (1984) Neutral detergent fibre (NDF) was determined using the method of Goering and Van Soest (1970) The botanical composition of the BR and non-BR stovers was determined by hand separation into the leaf and sheath ['leaf'] and stem fractions

Statistical analysis

The results of both the feeding and the digestibility trials were analysed as a 2x2 factorial design using SAS

Results

Chemical and botanical composition of stover offered

The chemical compositions of BR and non-BR stovers offered were similar (Table 1) Despite aiming for identical contents 'leaf' content of BR stover was somewhat higher (P<0 0140) than that of non-BR stover

Liveweight change

Liveweight change was not affected by stover variety (Table 2) Rams offered 50 g DM stover/kg M d maintained their weight whereas those offered 25 g DM/kg M d lost weight the weight-change differences were highly significant

Table 1 *Chemical and botanical composition of stovers offered to and refused by rams*

	Feed offered				Feed refused (g/DM/kg M d)							
Variables	BR	± s e	NBR	± s e	BR 25	BR 50	Non BR 25	Non BR 50	s e d	V	A	VxA
Chemical												
Dry matter (g/kg)	913	5 3	907	14 5	914	911	915	906	1 26	*	***	**
Ash (g/kg DM)	128	0 3	138	7 8	119	108	136	110	8 26	ns	**	ns
Crude protein (g/kg DM)	49	8 8	53	7 5	29	31	54	51	3 78	***	ns	ns
Neutral detergent fibre (g/kg DM)	679	8 8	670	4 2	754	736	727	721	13 38	*	ns	ns
Botanical												
Leaf + sheath [leaf'] (g DM/kg DM)	566	14 7	477	26 2	146	257	112	182	30 4	*	***	ns
Stem (g DM/kg DM)	434	14 7	523	26 2	854	743	888	818	30 4	ns	***	ns

ns = non significant * = significant (P<0 05) ** = significant (P<0 01) ***= significant (P<0 001)

BR = bird resistant NBR = non bird resistant V = variety A = amount

Table 2 *Treatment effects on intake selection and liveweight change*

Variables	BR25	BR50	Non BR25	Non BR50	s e d	V	A	VxA
No of rams	12	12	12	12				
Initial weight [M] (kg)	20 1	19 9	20 0	20 1	0 14	ns	ns	ns
Growth rate (g/d)	16 1	4 0	25 3	3 5	6 2	ns	***	ns
Stover offered (g DM/d)	537	1011	548	1019				
Stover offered (g DM/kg M d)	22 4	48 1	25 3	49 7				
Stover refused (g DM/d)	59	383	74	386	15 6	ns	**	
Stover intake (g DM/d)	478	628	474	633	16 0	ns	***	ns
Stover intake (g DM/kg M d)	23 9	31 6	23 7	31 6	0 948	**	***	ns
Fractions								
Leaf' offered (g DM/d)	298	561	250	465				
Stem offered (g DM/d)	239	450	298	555				
Leaf' intake (g DM/d)	289	464	242	394	10 5	**	***	ns
Stem intake (g DM/d)	188	165	233	239	12 7	***	ns	ns

ns = non significant * = significant at (P<0 05) ** = significant (P<0 01) *** = significant (P<0 001)

BR = bird resistant NBR = non bird resistant V = variety A = amount

Table 3 *Effects of variety of stover and amount offered on intake and digestibility*

Variables	BR 25	BR 50	Non BR25	Non BR 50	s e d	V	A	FxA
Live weight [M] (kg)	17 8	17 0	17 8	18 2	0 43	ns	ns	ns
Stover offered (g DM/d)	619	1067	622	1093				
Stover offered (g DM/kg M d)	32 1	55 3	33 7	54 5				
Stover intake (g DM/d)	558 0	676 4	543 7	669 8	32 7	ns	***	ns
Stover intake (g DM/kg M d)	28 9	35 0	29 3	33 5	0 91	ns	***	ns
DM digestibility (g/kg)	495 5	511 6	549 1	532 6	23 3	ns	ns	ns
OM digestibility (g/kg)	531 6	543 8	581 4	559 0	23 6	ns	ns	ns
NDF digestibility (g/kg)	553 1	551 2	606 2	574 1	29 2	ns	ns	ns

ns = non significant *= significant (P<0 05) **= significant (P<0 01) ***= significant (P<0 001)

BR = bird resistant NBR = non bird resistant V = variety A = amount

Stover intake

There was no difference in stover intake due to stover variety, but there was a large increase in intake due to doubling the amount of stover offered (Table 2) Doubling the amount of stover offered increased intake of 'leaf' Stem intakes were generally the inverse of 'leaf intakes, but only variety differences were significant

Fractions offered and consumed

Intake of leaf' was affected by both variety and amount of stover offered (Table 2) Doubling the amount of stover offered increased intake of leaf Stem intakes were generally the inverse of 'leaf' intakes, but only variety differences were significant

Digestibility Table 3 shows the effects of treatments on digestibility, intakes during the faecal collection period are also shown There were no significant treatment effects on the digestibility of DM, organic matter [OM] or NDF although there was a tendency (e g NDF P=0 0991) for digestibilities to be lower for BR than non-BR stover

Discussion

For the levels of stover offered the results did not totally confirm the hypothesis, as there was no effect of stover variety on intake growth or digestibility and there was no interaction between variety and amount of stover offered The failure to demonstrate the hypothesised lower intake and digestibility of BR stover compared to non-BR stover was possibly contributed to by the fact that the BR stover contained more leaf than non-BR stover The non-significant tendency for digestibility to be lower in BR compared to non-BR stover suggests that though BR stover may have been of lower nutritive value, the effect was possibly masked by the higher content of 'leaf in BR stover There is need for further comparisons of BR and non-BR stovers of comparable leaf' content and at a lower level of offer

However, the results showed a clear improvement in intake and liveweight change when the amount of stover offered was doubled, confirming the earlier work of Aboud et al (1990) and Wahed et al (1990) The present results also demonstrate that the increase in intake on doubling the amount of stover offered was largely due to a greater intake of 'leaf' It is notable that this was achieved with the stover offered in chopped form

Offering stover at 50 g DM/kg M d was associated with stover refusal rates of nearly 400 g/kg of stover offered Such large quantities of refused stover do not present disposal problems in countries such as Ethiopia as the refusals are readily used as fuel for domestic cooking and for other purposes (Osafo et al 1991)

An informal survey of farmer practices in Ethiopia (Osafo et al 1991) indicated that farmers fed sorghum stover to sheep as a sole feed, i e without protein supplement Therefore, in the present experiment, no supplement was offered apart from mineral lick The results demonstrate an important practical feeding strategy namely that chopped sorghum stover, offered at a high rate (50 g DM/kg M d), with mineral lick is sufficient to maintain weight of rams aged 15 to 20 months It is concluded that chopped sorghum stover offered generously, with minerals but no other supplement is a sustainable feeding strategy for maintaining weight in near-adult sheep

Acknowledgement

The authors wish to express their appreciation to ILCA and NRI for financial support and the Institute of Agricultural Research, Melkassa, Ethiopia for providing the sorghum stover

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Effet de la variété et de la quantité de paille de sorgho offerte sur les performances des ovins

Résumé

Quarante-huit beliers Menz des hauts plateaux alimentes individuellement ont ete utilises dans une experience factorielle 2x2 destinee a evaluer l'ingestion de matiere seche (MS) et les variations du poids vif sur une periode de 42 jours, 16 d entre eux ont en outre servi a des mesures de digestibilite Les parametres etudies etaient la quantite de paille offerte (25 ou 50 g de MS par kg de poids/jour) et la variete de la paille selon qu'elle provient de sorgho resistant (BR) ou non (non-BR) aux oiseaux granivores La paille etait servie sous forme hachee Les beliers ne recevaient en plus que de l eau et de la pierre a lecher Les varietes BR et non-BR contenaient repectivement 566 et 477 g de MS de feuilles et de gaines par kg de MS de paille bien que l'objectif initial fût d'avoir des teneurs identiques des deux varietes Leur composition chimique etait analogue L ingestion (en g de MS/kg de poids/jour) etait independante de la variete (P>0,05) de la paille mais augmentait significativement (P<0 001) lorsqu on doublait les quantites offertes (BR25 23 9 BR50 31,6, non-BR25 23,7, non-BR50 31 6 ecart-type 0,95) L accroissement de ces quantites entraînait une augmentation des refus (taux de refus 25 66 g de MS/kg de MS offert 50 385 g de MS/kg de MS offert) L'augmentation de la quantite ingeree lorsqu'on doublait les quantites offertes s'expliquait essentiellement par une consommation accrue de feuilles et de

gaines La paille a 50 g de MS/kg de poids/jour permettait le maintien du poids tandis que celle a 25 g de MS entraînait des pertes de poids (BR 16,1 g/jour, non-BR 25,3 g/jour) Les taux de digestibilite de la MS, de la matiere organique (MO) et des parois cellulaires etaient generalement plus faibles pour la paille BR (taux de digestibilite de la MO en g/kg BR25 532, BR50 544, non-BR25 581, non-BR50 559, ecart type 23 6) On peut conclure que l offre de paille de sorgho hachee a hauteur de 50 g de MS/kg de poids/jour avec de la pierre a lecher sans autre complement est une strategie viable d alimentation permettant de maintenir le poids de beliers presque adultes

Effect of feed supplements on weight gain and carcass characteristics of intact male Mubende goats fed elephant grass *(Pennisetum purpureum) ad libitum* in Uganda

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Abstract

Twenty intact male Mubende goats were randomly divided into five groups of four goats each Each group was randomly assigned one of the treatments resulting into a complete randomised design All the animals were individually fed elephant grass (E) used as basal diet *ad libitum* Treatments were isonitrogenous amount (10 g N/d) of banana peels (BP), maize bran (MB), cottonseed cake (CSC) and fresh *Leucaena* leaves (LL) offered as supplements Water and mineral blocks were offered *ad libitum* At the end of the feeding trials (186 days) the goats were sacrificed for carcass analysis and the various body parts and organs were measured Final live weights did not differ significantly between treatment groups (P>0 05) although goats fed on CSC were heavier than the rest Empty body and dressed carcass weights differed significantly (P<0 05) in goats fed on different diets Dressing percentage in goats fed LL, MB and CSC were similar and significantly higher (P<0 01) than in goats fed on BP and E alone The pH of the carcass was similar across all treatments Weights of the head, full gut empty gut, blood kidney and omentum fats did not differ significantly (P>0 01), however weights of skin pluck and feet differed significantly (P<0 01) Various carcass components were highly correlated with live weight across all diets suggesting that all the diets did not severely alter the allometry of growth

Introduction

The economic importance of goats in the provision of animal proteins in developing countries has been extensively reviewed elsewhere (Devendra 1981) Meat from small ruminants accounts for almost 30% of the meat consumed in Africa (Reed et al 1988) In Uganda goats provide about 23% of the total red meat produced and goat meat ranks second only to beef in sales However, in terms of palatability and delicacy, it is preferred to beef It is possible that goats could play a leading role in the provision of animal proteins to supplement other sources such as from beef, chicken, pork and fish

Goats are produced in Uganda using traditional practices where goats are either tethered or left to roam, browsing and grazing on whatever they can find (Okello and Obwolo 1984) The main feed resources for goats are natural pastures consisting of legumes and browse tree species During the dry season, grazing land is scarce and pastures are deficient in energy, proteins and minerals This is aggravated by lack of alternative feed during this critical period (Okello and Obwolo 1984)

In Uganda banana peels (BP) crop residues, cottonseed cake (CSC) and maize bran (MB) (agro-industrial by-products) can supply readily fermentable carbohydrate and energy needed for increasing growth rate in goats Due to their low fibre contents they can be consumed in adequate quantities to also meet the nitrogen requirement for the growing goat without need for additional supplementation

A study was initiated to evaluate BP, MB CSC and *Leucaena* (LL) as supplements to elephant grass (E) in goat production The evaluation included chemical analysis of feeds and carcass study

Materials and methods

Twenty young intact male Mubende goats (4–6 months of age) purchased from a market in Kampala were used Each goat was identified with a numbered ear tag and individually confined in a metabolic cage with a slatted floor All animals were given prophylactic treatments for endo- and ectoparasites They were given 14 days for adaptation to respective diets before the beginning of data collection The goats were randomly divided into five groups of four goats each Each group was randomly assigned one of the five dietary treatments resulting into a complete randomised design Treatments were isonitrogenous amount (10 g N/d) of BP MB, CSC and LL offered as supplements to E which was the basal diet fed *ad libitum* to all animals The control group had no supplement Water was available *ad libitum* and each animal had access to a mineral block

Proximate analysis

Samples of feeds were dried at 60 C for 48 hours in an oven The dry samples were ground to pass through a 2 mm screen A 0 5 g portion of each sample in duplicate was analysed according to AOAC (1980) Neutral-detergent fibre (NDF) and ash were determined according to Goering and Van Soest (1970)

Intake and growth

Feeding commenced at 0800 h and collection of feed refusals was done 24 h later Feed offered and refusals from each animal were weighed Samples of each diet were taken for subsequent dry matter determination and chemical analysis Intake was calculated as the difference between feed offered and refused corrected for dry-matter content

Each goat was weighed at the beginning of the experiment and every successive seven days thereafter Average daily gains (g/d) were calculated as differences between final and initial body weights divided by number of days of feeding

Carcass analysis

At the end of the feeding trials (186 days) the goats were sacrificed Before slaughter, live weight and skin thickness were measured body condition score was assessed according to Pettit et al (1988) The animals were decapitated and blood was drained into a bucket and the weight of blood was measured

The decapitated animals were flayed by gentle tearing of skin from the carcass to ensure that fat and muscle tissues did not adhere on to the skin The legs were cut at the fetlock joints Weights of skin, head and legs were measured and carcass value was assessed on the scale 0–3 as follows 0 = emaciated carcass, 1 = lean carcass, 2 = moderate fatty carcass and 3 = full fatty carcass The carcasses were eviscerated and the gut and pluck were removed and weighed Omentum was carefully removed and weighed The gut content was removed by flushing the gut with running water The empty gut and dressed carcass were weighed separately Kidney fat with capsule was removed and weighed Thickness of brisket fat and longismus dorsi muscle and pH of the carcass were measured

Statistical analysis

The difference in feed intake average daily gain and carcass components were examined by analysis of variance for a complete randomised design using the STATGRAPHICS statistical package Differences between means were compared using Duncan s multiple range test Body and carcass cutting relationship with live weight were examined by simple linear regression analysis of variance

Results and discussion

The chemical composition of the feeds in Table 1 indicate that high moisture and low protein contents rank banana peels as the least favourable diet for ruminants Low dietary protein content inhibits rumen microbial activity with resultant low intake of roughage and sub-optimal supply of protein to the animal In this respect elephant grass and maize bran are marginally below the critical level (1 6 g N/100 g) of dry feed nitrogen required for proper rumen function (Elliot and Topps 1963)

Intake

Table 2 summarises the voluntary feed intakes of animals in the different treatment groups Dry-matter intake is an important factor in the utilisation of roughage by ruminant livestock and is a critical determinant of energy intake and performance in small ruminants (Devendra and Burns 1983) Further more it is important that feed supplements should not adversely affect intake of basal roughage diet Goats fed the control diet consumed the highest amounts of the basal diet The lack of significant differences in total dry-matter intake indicates strong substitution of the basal diet by the supplements

Growth

Low growth rate is acknowledged to be the major limiting factor in goat production and the plane of nutrition can markedly improve weight gain, the degree of response varies with breed or type (Devendra and Burns 1983) In this experiment goats fed on leucaena leaves supplement and elephant grass alone lost weight

Table 1 *Chemical composition of feed ingredients offered to intact male Mubende goats fed elephant grass* ad libitum *as basal diet*

Feed	Dry matter (g/kg)	Dry matter (g/kg)			
		Nitrogen	NDF*	Ether extract	Ash
Elephant grass (E)	288 0	15 6	551 1	35 0	90
Banana/peels (BP)	133 2	11 0	449 1	42 5	69
Maize bran (MB)	856 7	15 6	393 0	45 0	44
Cottonseed cake (CSC)	885 5	34 4	462 1	78 0	140
Leucaena leaves (LL)	314 0	30 4	479 3	29 0	76

* NDF = neutral detergent fibre

Table 2 *Intake (g/d) in male intact Mubende goats fed on* ad libitum *elephant grass (*Pennisetum purpureum*) with or without supplements of* Leucaena luecocephala *leaves maize bran banana peels and cottonseed cake*

Diets							
Parameters	*Leucaena* leaves	Maize bran	Banana peels	Cottonseed cake	Elephant grass	SEM	Significance
Elephant grass	335±21 0[bc]	311±17 5c	356±11 0[b]	336±12 5[bc]	404±16 0[a]	7 1	**
Supplement intake(DM)	119±14 5[b]	222±44 9a	127±41 8[b]	175±25 9[ab]	–	13 6	***
Total dry-matter intake	454±33 8	533±57 7	483±50 0	511±270	404±16 0	17 6	ns
Total organic matter intake	353±31 4	439±44 6	445±46 5	470±25 0	370±14 8	15 3	ns

ns = P>0 05 * = P<0 05 ** = P<0 01 *** = P<0 001

Values with the same superscript in a row do not differ significantly

with negative growth rates of –3 8 g/d and –3 2 g/d, respectively (Table 4) Digestible organic matter intake indicates that energy was limiting on the growth of these animals (Table 2) The negative growth rates recorded by goats fed on elephant grass alone was attributed to the insufficient amount of energy and protein in the grass Meanwhile goats fed on maize bran supplement virtually maintained weight indicating that they received only adequate nutrient for maintenance The best growth rate of 30 1 g/d was recorded in goats fed the cottonseed cake supplement This feed supplement provided energy and protein which are critical for the growth of goats The growth rate however, is lower than values obtained (91 g/day) in Uganda by Wilson (1958) but it is similar to values obtained in West African Dwarf goats (Zemmelink et al 1985, Reynolds 1989) Ademosun et al (1985) also recorded growth rates that were higher than values obtained in this experiment

Carcass characteristics

Body condition score and carcass value were subjective assessment Condition score reflects subcutaneous fat deposits which is lower in goats than in sheep (Naude and Hofmeyr 1981) It also reflects muscular development and coverage of the ribs Similarly carcass value was assessed according to visible subcutaneous fat coverage and leanness of the meat Body condition score and carcass value were better in goats fed on maize bran and cotton seed cake These findings were reflected in the objective measurements of fat deposits in the omentum kidney and brisket as well as in the thickness of the longismus dorsi muscle

Empty body weight and dressed carcass weight are functions of live weight (Fehr et al 1976) Table 3 shows that various carcass components and body parts (except skin thickness) were highly correlated with live weight across all diets, suggesting that all the diets did not severely alter the allometry of growth Goats fed on cottonseed cake and maize bran produced dressed carcasses which were significantly heavier (P<0 01) than carcasses from goats fed on the other three diets (Table 4) These differences were associated with differences in fat deposits in the omentum, kidney and brisket

Table 5 shows that gut contents in goats fed on elephant grass with *Leucaena* leaves were higher than those of goats fed the other diets The least gut contents were those of goats fed maize bran

Goats fed maize bran and cottonseed cake were heavier than the rest and they also had the heaviest legs and skin, suggesting that the two components were functions of final body weight It was observed that goats fed on cottonseed cake and maize bran had more omentum and kidney fats

Table 3 *Regression coefficients (y= a+bx) of body part and carcass components in intact male Mubende goats*

	Regression coefficients			
Body part	a	b	r^2	Significance level
Empty body weight	–2 02	0 86	0 905	***
Head weight	0 4	0 04	0 586	***
Skin thickness	0 2	0 00125	0 066	ns
Feet weight	0 2	0 02	0 638	***
Pluck weight	–9 5	0 04	0 716	***
Dressed carcass	2 2	0 55	0 891	***
Full gut weight	2 0	0 18	0 283	**
Empty gut weight	–0 02	0 18	0 282	**
Longismus dorsi thickness	0 7	0 04	0 209	*
Testicular circumference	12 25	0 05	0 475	**
Gut content	2 03	0 17	0 283	*

ns = P>0 05 * = P<0 05 ** P<0 01 *** P<0 001

Table 4 *Body weight carcass characteristics and meat pH of intact male Mubende goats fed elephant grass with or without supplements*

	Diets						
Parameters	E	LL + E	MB + E	BP + E	CSC + E	SEM	Significance level
Body weight gain (kg)	–0 6±0 9^{b}	–0 7±0 7^{b}	1 2±1 7^{b}	2 2±1 8^{b}	5 62±1 5^{a}	0 6	*
Body condition score	1 3±0 3^{b}	1 0±0 0^{b}	1 5±0 3^{b}	1 3±0 7^{b}	2 5±0 3^{a}	0 14	*
Carcass value	1 0±0 0^{b}	1 0±0 0^{b}	1 5±0 3^{b}	1 3±0 7^{b}	2 5±0 3^{a}	0 13	*
Empty body weight (kg)	10 4±0 7^{b}	11 6±0 4^{b}	14 3±1 3^{a}	11 5±0 9^{b}	16 8±1 9^{a}	0 53	*
Dressed carcass weight (kg)	5 6±0 4^{b}	6 6±0 3^{b}	8 4±0 9^{a}	6 1±0 6^{b}	9 5±1 1^{a}	0 33	**
Dressing percentage	53 5±1 2^{b}	56 7±0 6^{a}	58 5±1 4^{a}	53 0±0 2^{b}	57 0±0 7^{a}	0 53	**
Carcass pH	6 0±0 2	6 6±0 2	6 0±0 4	6 4±0 1	5 9±0 3	0 11	ns

ns = P>0 05 * = P<0 05 ** = P<0 01

Values with the same superscript in a row are not significantly different (P>0 05)

E = elephant grass LL = *Leucaena* leaves MB = maize bran BP = banana peels CSE = cottonseed cake SEM = standard error of means

Table 5 *Weights of organs body parts omentum and kidney fat gut content and blood of intact male Mubende goats fed on elephant grass with or without supplements*

	Diets						
Parameters	E	LL + E	MB + E	BP + E	CSC + E	SEM	Significance
Head weight (kg)	1 01±0 04	1 20±0 04	1 24± 0 09	1 0±0 05	1 33±0 15	0 04	ns
Skin weight (kg)	0 94±0 07^{c}	0 93±0 03^{c}	1 25±0 12^{b}	0 92±0 09^{c}	1 51±0 13^{a}	0 04	**
Feet weight (kg)	0 48±0 03^{bc}	0 53±0 03^{b}	0 63±0 01^{a}	0 45±0 03^{c}	0 60±0 05^{a}	0 01	**
Pluck weight (kg)	0 55±0 06^{c}	0 58±0 03^{c}	0 74±0 06^{b}	0 60±0 03^{c}	0 88±0 08a	0 03	**
Full gut weight (kg)	5 01±0 24	6 04±0 46	4 33±0 55	5 05±0 10	4 84±0 91	0 25	ns
Empty gut weight (kg)	1 24±0 11	1 23±0 04	1 54±0 15	1 58±0 12	1 79±0 27	0 07	ns
Gut content weight (kg)	3 78±2 00^{b}	4 81±0 43^{a}	2 79±0 42^{c}	3 47±0 07^{bc}	3 05±0 66^{bc}	0 19	*
Blood weight (kg) (kg)	0 60±0 9	0 64±0 02	0 75±0 05	0 65±0 03	0 86±0 13	0 04	ns
Kidney fat weight (g)	21 4±7 8	23 8±7 5	167 5±44 4	90 3±30 5	237 5±123 3	28 3	ns
Omentum fat weight (g)	36 1±17 2	37 0±7 0	342 8±103 5	146 3±65 2	405 0±196 2	48 3	ns

ns = P>0 05 * = P<0 05 ** = P<0 01

Values with the same superscripts in a row do not differ significantly

E = elephant grass LL = *Leucaena* leaves MB = maize bran BP = banana peels CSE = cottonseed cake SEM = standard error of the means

Table 6 *Skin brisket fat and longismus dorsi muscle thickness (cm) and testicular circumference (cm) of intact male Mubende goats fed on elephant grass with or without supplements*

	Diets						
Parameters	E	LL + E	MB + E	BP + E	CSC + E	SEM	Significance
Skin	0 22±0 01	0 22±0 01	0 23±0 01	0 23±0 01	0 21±0 01	0 00	ns
Brisket fat	0 71±0 22^{bc}	1 39±0 29^{a}	1 20±0 10^{ab}	1 64±0 21^{a}	0 66±0 04^{c}	0 10	*
Long dorsi muscle	1 23±0 16^{b}	1 44±0 09^{ab}	1 33±0 18^{b}	1 64±0 04^{a}	0 99±0 01^{c}	0 05	**
Testicular Circumference	19 25±0 75^{bc}	20 50±0 79^{b}	19 67±1 20^{bc}	23 88±0 43^{a}	18 38±0 38^{c}	0 32	***

ns = P>0 05 * = P<0 05 ** = P<0 01 *** = P<0 001

Values with the same superscripts in a row do not differ significantly

E = elephant grass LL = *Leucaena* leaves MB = maize bran BP = banana peels CSE = cottonseed cake SEM = standard error of means

pH normally indicates the keeping quality of the meat Lack of significant differences between treatment groups suggests that keeping quality was not affected by the different feeds

Testicular circumference was bigger in goats that were fed on cottonseed cake and maize bran Regression analyses of measurements of body parts on the live weight were highly correlated, suggesting that the apparent dietary effect on testicular circumference was associated with difference in live weight of the goats fed on the different diets

Conclusion

The critical nutrients for enhancing growth of goats seem to be sufficient amounts and the right combination of energy and protein In this respect maize bran and cottonseed cake seem to be better feed supplements in providing these nutrients These agro-industrial by-products are abundant in Uganda and their use will greatly increase meat production from goats

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Effet de la complémentation sur le gain de poids et les caractéristiques de la carcasse chez des boucs entiers Mubende recevant de l'herbe à éléphant (*Pennisetum purpureum*) *ad libitum* en Ouganda

Résumé

Vingt boucs entiers Mubende ont ete divises au hasard en cinq groupes de quatre animaux chacun Chaque groupe a ete soumis de maniere aleatoire a l'un des traitements prevus dans le cadre d'un plan en blocs aleatoires complets Tous les animaux etaient individuellement alimentes avec de l'herbe a elephant servie *ad libitum* Les traitements consistaient en l'apport d'un complement proteique fournissant 10 g d'azote par jour sous forme de pelures de bananes, de son de mais, de tourteau de coton ou de feuilles vertes de *Leucaena* L'eau et la pierre a lecher etaient offertes *ad libitum* A la fin de l'essai d alimentation (186 jours), les animaux avaient ete abattus, leurs carcasses etudiees et diverses parties du corps et divers organes peses Les poids vifs finals n etaient pas significativement differents entre les groupes de traitement (P>0,05) même si les animaux alimentes avec du tourteau de coton pesaient plus que les autres En revanche les poids vides et les poids des carcasses parees etaient significativement differents (P<0,05) entre les groupes Les rendements a l'abattage des animaux alimentes avec des feuilles de *Leucaena*, du son de mais et du tourteau de coton etaient similaires mais significativement superieurs (P<0 01) a ceux des sujets recevant des pelures de banane ou uniquement de l'herbe a elephant Le pH de la carcasse etait independant du traitement Les poids de la tête des boyaux pleins ou vides du sang des reins et de la graisse de l'epiploon etaient peu differents (P>0,01) alors que ceux de la peau de la fressure et des pattes etaient significativement differents (P<0,01) Toutes rations confondues, il existait une forte correlation entre les poids de diverses parties de la carcasse et les poids vifs, ce qui signifie que ces regimes n'avaient pas beaucoup altere l'allometrie de la croissance de ces animaux

Performances des agneaux Mossi en alimentation extensive, semi-intensive et intensive

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Résumé

Deux essais d'alimentation ont ete conduits pour evaluer les performances d'ovins mâles entiers de race Mossi Pour le 1er essai, 24 agneaux ont ete repartis au hasard en 4 lots de six animaux Le traitement des lots 1 et 3 correspond a la pâture libre avec berger (PL), celui des lots 2 et 4 a la pâture au piquet (PP) les lots 1 et 2 n ont pas reçu de complementation tandis que les lots 3 et 4 ont reçu 25% de leurs besoins totaux en matiere seche (sous forme d un concentre constitue de 50% de son de ble et de 50% de tourteau de coton) La duree du suivi ponderal des animaux a ete de 70 jours Pour le 2eme essai, 40 agneaux maintenus en stabulation permanente ont ete repartis en un lot temoin de quatre sujets et trois lots de douze animaux recevant une complementation a niveau energetique eleve (E), moyen (M) ou faible (F) correspondant respectivement a 0 8 0 6 et 0,4UF/kg de MS L'evolution ponderale des animaux a ete suivie pendant 12 semaines et des abattages ont ete realises tous les 30 jours pour evaluer le rendement en carcasse Dans le 1er essai, la pâture libre se revele superieure a la pâture au piquet (GMQ de 53,02 g contre 27,28 g) tandis que l'effet de la complementation se traduit dans les deux types de conduite par une amelioration du gain moyen quotidien (GMQ) de 68,5% La meilleure performance a ete observee dans le lot 3 (pâture libre avec complementation) Dans le 2eme essai les lots E M et F ont enregistre des GMQ respectivement de 79 58 35 54 et 8 75g la difference entre les lots E et F est statistiquement significative (P<0 05) Les abattages ont montre que le lot E presentait des rendements en carcasses superieurs et une incrustation de gras de toilette d'autant meilleure qu ils sont abattus plus tard Dans cette etude, les performances du mouton Mossi ont ete modestes quel que soit le systeme d alimentation On observe par ailleurs que le systeme de conduite et la teneur en energie de la ration ont une influence marquee sur la croissance des agneaux

Introduction

Durant la saison pluvieuse, les petits ruminants appartenant a des agriculteurs-eleveurs sont souvent attaches par des cordes a des piquets ou des buissons, sur des aires non cultivees dans d'autres cas, ils pâturent librement, sous la garde d'enfants D'autre part, la complementation est peu frequente en saison pluvieuse, la valeur fourragere des graminees naturelles etant consideree comme bonne a cette periode Cependant, certains eleveurs entretiennent des beliers en stabulation permanente avec une alimentation intensive, en preparation de la fête de la Tabaski Quelques etudes ont ete conduites au Burkina Faso afin d'evaluer l'impact de certains facteurs alimentaires sur les performances de croissance des ovins (Dumas et Raymond, 1974, Bourzat *et al* 1983, Nianogo 1992) L etude presentee ici a pour objectif d'evaluer les parametres suivants chez les ovins de race Mossi

- l influence de la complementation et de l'entravement sur la croissance en cours de la saison pluvieuse,
- l effet des niveaux energetiques croissants sur la consommation volontaire, la vitesse de croissance et les rendements des carcasses et
- l'effet de la duree de la conduite intensive sur les rendements des carcasses et l'etat d'engraissement

Matériels et méthodes

Deux essais ont ete conduits sur des ovins de race Mossi a Gampela station experimentale de l Universite de Ouagadougou situee en zone nord soudanienne region caracterisee par une pluviometrie annuelle de 677mm (Soma, 1992) La vegetation est une savane claire arbustive et arboree Sur la station, la phytomasse maximale du parcours utilisable (plus de 300 ha) varie de 6 200 a 7 630 kg de MS/ha (Achard, 1993), avec une charge reelle d'environ 3,2 ha/UBT

Essai n°1

Vingt quatre agneaux âges de 6 a 8 mois et pesant en moyenne 15,31 kg ont ete repartis au hasard en quatre lots de six pour cette etude en factoriel randomise Deux facteurs ont ete etudies

1 Le mode de conduite les animaux pâturent sur les parcours naturels sept heures par jour, soit librement sous la garde d un berger soit attaches a un piquet par une corde de 4 metres de long

2 Le regime alimentaire deux lots sur les quatre ont ete conduits en regime extensif (sans complementation), les deux autres (regime semi-intensif) ont reçu au retour du pâturage un melange de son de ble et de tourteau de coton en proportions egales, apportant 0,83 UF (unite fourragere) et 23,48% de matiere azotee digestible (MAD) par kg d aliment Les besoins journaliers en matiere seche par animal ayant eté estimes a 500 g (Riviere, 1991), les quantites distribuees etaient en moyenne de 125 g/jour/animal, soit une couverture de 25% des besoins en matiere seche Le coût du kilo de melange etant de 33,75 FCFA, celui de la ration journaliere de chaque animal s est donc eleve a 4,22 FCFA

Les animaux ont eu une periode d adaptation de 14 jours et les observations proprement dites qui ont suivi ont dure 70 jours (de juillet a septembre)

Essai n°2 (tableau 1)

Quarante agneaux mâles entiers pesant en moyenne 13 71 kg ont ete retenus pour cet essai Les animaux ont reçu des traitements prophylactiques et sanitaires au debut de l'etude vaccin, detiquage vermifugation au panacur

Ils ont ete repartis au hasard en dix groupes de quatre, pour ensuite être assignes aleatoirement a l'un des quatre lots suivants

- un lot temoin (T) avec quatre ovins, abattus des le debut de l'essai,
- trois lots de douze animaux recevant l'une ou l'autre des trois rations a niveau energetique eleve (E) , modere (M) ou faible (F) avec respectivement 0,8 , 0,6 et 0,4 UF/kg de MS

Les quantites distribuees journalierement representaient environ 3,5% du poids vif des animaux Des abattages suivis de decoupe des carcasses selon la methode de Boccard et Dumont (1955) ont ete realises au 30eme, 60eme et 90eme jours de l'essai a l'abattoir frigorifique de Ouagadougou apres une mise a jeun des agneaux pendant 24 heures A chaque abattage quatre sujets ont ete tires au hasard dans chacun des trois lots E, M, et F

Apres les deux essais, le complement, les differentes rations, le foin et les refus ont ete analyses pour determiner les teneurs en matiere seche (MS),

Tableau 1 *Schema experimental de l essai n 2*

	Niveau energetique de la ration		
Paramètre	Eleve (E)	Modere (M)	Faible (F)
Animaux			
Nombre de têtes	12 00	12 00	12 00
Poids vif moyen (kg) extrêmes 12 4 et 14 8 kg	13 77	13 55	13 81
Ingredients ' (en % de la M S)			
Tourteau de coton	18 00	12 00	9 00
Graines de Coton	1 00	0 00	0 00
Son de blé	6 00	25 00	0 00
Graines de dolique	0 00	10 00	0 00
Sorgho grains	34 00	2 00	0 00
Urée	0 00	0 00	2 00
NaCl	0 00	1 00	1 00
Foin Pp	21 00	10 00	43 00
Coquilles d'huîtres	1,00	1 00	0,00
Coques de graines de coton	19 00	39 00	45 00
Total	100 00	100 00	100 00
% concentré	60 00	50 00	11 00
Teneur théorique en énergie (UF/kg de MS)	0 80	0 60	0 40

NB Le foin de *Pennisetum pedicellatum* a été récolté fin août début septembre 1991 (stade physiologique montaison épiaison)
MS = matière sèche

matiere organique (MO), matieres grasses (MG) et matiere azotee brute (MAB) selon les methodes de l'A O A C (1984) et pour la lignocellulose ou ADF, les fibres NDF, la lignine ou ADL et la cellulose selon les methodes decrites par Robertson et Van Soest (1981) Les animaux ont ete peses une fois par semaine, pendant 90 jours L'analyse statistique a ete realisee a l aide du logiciel S A S (1982) Les moyennes ont ete separees grâce au test de Scheffe

Résultats

Essai n°1

Le concentre servi durant l essai n 1 a ete completement consomme par les animaux L analyse chimique du complement a donne une composition proximale de 95% de MS, et des taux de la matiere seche en matiere azotee brute (MAB) de 5 51%, en lignocellulose (ADF) de 15,76%, en fibres NDF de 32,31%, en la lignin ou lignin ADL de 4,49% et en cellulose de 11,18%

Les principaux resultats sont resumes au tableau 1 On note une superiorite du regime semi-intensif sur le systeme extensif (le GMQ est de 61,07 g contre 19,23 g quel que soit le mode de gardiennage) et une superiorite du gardiennage sur la pâture au piquet avec des GMQ de 53 02 g et 27,28 g respectivement

Essai n°2

Croissance et consommation volontaire Le foin utilise contenait 88,47% de MS dont 90 18% de MO, 6,69% de MAB, 44,06% d ADF, 71,91% de NDF 4,96% d'ADL, 1,80% de matiere grasse et apportait 0 65 UF/kg de MS La composition des concentres est presentee au tableau 2 Les quantites de MS ingerees par les agneaux sont comparables et sont de 2,90 , 3,00 et 3 19% du poids vif respectivement pour les lots E, M et F la consommation d'eau (1,22 a 1 47 litres par jour et par animal) n a pas ete affectee par le facteur ration Au cours de l'essai, les meilleures performances de croissance ont ete observees au niveau du lot ot E avec un GMQ de 78,58 g (tableau 2) Ce dernier est significativement superieur (P<0,05) a celui du lot F durant toute la periode de l'essai

Performances a l'habillage les donnees des habillages (tableau 3) sont specifiques a chaque lot et suivant le rang d'abattage Les rendements carcasse varient de 32,3 a 44,86% Les plus eleves sont observes chez les ovins du lot E Ces rendements ont augmente entre le 1er et le dernier abattage pour les lots E et M, par contre ceux du lot F sont inferieurs a celui du lot temoin au premier et au 2eme abattage Les differences entre les rendements carcasse du lot E au 3eme abattage et ceux du lot F a tous les rangs d abattage sont statistiquement signi- ficatives (P<0,05), il en est de même pour les graisses c'est-a-dire le gras de toilette et le gras perirenal

Importance relative des regions corporelles les poids moyens des differents morceaux augmentent avec la duree de l'essai, a quelques exceptions pres au sein de chaque lot (tableau 4) Les animaux ayant reçu une alimentation a niveau energetique eleve et abattus plus tard presentent les regions corporelles aux poids les plus eleves Au dernier abattage, le poids moyen de la poitrine et celui du collier etaient significativement plus eleves (P<0,05) dans le lot E que dans le lot F

Tableau 2 *Composition chimique des concentres et evolution ponderale des agneaux*

Parametre	Lots E	Lots M	Lots F	Erreur Standard
Composition chimique des concentres				
MS	90 33	90 10	88 98	–
MO	94 67	91 74	93 91	–
MAB	16 44	13 75	16 44	–
ADF	22 06	32 49	51,70	–
NDF	40 03	52 04	69 90	–
ADL	6 21	7 75	13 76	–
MG	4 20	3 87	4 60	–
UF/kg de MS	0 90	0 74	0 50	–
Performances				
Poids initial (kg)	13 77a	13 55a	13 81	0 28
Poids final (kg)	20 39a	16 14ab	14 56b	1 02
QMQ (g/jour) en 12 semaines	79 58a	35 54a	8 75b	10 07
Consommation volontaire (kg MS/100 kg de PV)	2 90a	3 00	3 19a	–

NB Les moyennes figurant sur la même ligne et affectées de la meme lettre ne sont pas significativement différentes (P<0 05)

Tableau 3 *Poids des parties de la carcasse (en g)*

	Lots/Rang de decoupe									
	Temoin	E			M			F		
Parametres		1	2	3	1	2	3	1	2	3
Demi carcasse	2187 50d	274 88	3781 25	4425 00abcd	3065 00	3029 21	3175 45	2335 83b	2274 38c	2546 25a
Gigot	678 75b	850 00	114 38	1273 75	932 50	940 00	939 37	727 50	718 75c	820 00
Selle	125 00	150 62	207 52	236 25	183 95	149 17	160 00	126 67	137 50	130 62
Fillet	151 87c	191 25a	285 00	360 00abcde	225 00	238 33	250 62	153 33	153 12d	183 12b
Carre couvert	190 37a	242 37a	369 37	404 37a	283 12	290 83	283 75	210 83	28 12	210 62
Carre decouvert	138 75b	160 62	235 62	280 00ab	186 87	190 00	199 37	157 50	138 75b	163 12
Epaule	457 50a	543 75	700 62	821 87abc	586 87	580 00	620 00	485 83	469 37b	501 87c
Poitrine	205 00c	276 25a	373 12	497 50abcdef	304 37b	300 00	331 25	215 00	190 62f	235 62c
Collier	223 12e	290 62a	458 12	450 00abcde	328 12	324 17	380 00	242 59d	250 00b	275 62c
% Categorie 1	52 38b	50 05	52 36	51 38ab	51 91	53 46	50 90	50 41	53 54a	53 01
% Categorie 2	27 29c	25 35	24 84	24 92abc	25 03	25 44	25 88	26 62	26 74b	26 20a
% Categorie 3	19 66d	19 75a	21 82	23 47abcd	20 21	20 58	22 46	18 96c	19 38b	20 15
Carcasse	4406 25c	5511 26	7611 25	8882 50abc	6174 00	6081 67	6380 00	4718 33	4580 00b	5172 50a
Rendement	36 37g	38 12a	41 51jk	44 86abcdef	37 89b	39 77	42 76ihg	33	33 86jeh	37 00c
Graisse perirenale	8 75dh	27 50	100 00fgik	146 25abcde	55 00	56 67	83 75	10 00ci	5 00efg	17 50bk
Gras de toilette	–	–	141 25	248 75ab	125 00	60 00	95 00	–	8 75b	11 25a

Les moyennes de la même ligne affectees de la même lettre sont significativement differentes (P<0 05)

Tableau 4 *Influence du regime et du mode de conduite sur la croissance des agneaux*

	Regime				Effets principaux		
	Conduite		Conduite				
Parametres	Libre	Piquet	Libre	Piquet	Regime	Conduite	Erreur Standard
Poids par semaine (kg)							
0	15 22a	15 22a	15 44a	15 37a	N S	N S	0 50
10	17 15a	15 98b	20 93a	18 42d	P<0 05	N S	0 69
GMQ par semaine (g)							
1–5	59 90a	17 05b	94 19c	46 48d	P<0 05	P<0 05	7 93
6–10	-4,76a	4 74b	62 76c	40 86d	P<0 05	P<0 05	6 86
1–10	27 57a	10 90b	78 48c	43 67d	P<0 05	P<0 05	6 70

Toutes les moyennes figurant sur la même ligne et ne portant aucun indice commun sont significativement differentes (P<0 05)

Discussions

Croissance des agneaux en régime extensif et semi-intensif

La croissance enregistree en regime extensif est comparable a celle de 31,71 g/jour rapportee par Nianogo (1992) sur la même station pour des agneaux ne recevant que 5% de complementation Elle est egalement similaire a celle observee par l IMVT (Soma 1992) en elevage extensif chez le mouton Mossi au Yatenga et a Kaya (28,2 g/jour) En regime semi-intensif, la croissance observee se rapproche de celle observee par Nianogo et Nassa (1992) avec 60% de concentre sur les ovins de même race eleves dans des cages de digestibilite et recevant du foin a base de *Pennisetum pedicellatum* Elle est cependant inferieure a la croissance observee (90 g/jour) par Berger (1979) en Côte d'Ivoire chez des ovins Djallonke recevant une quantite *ad libitum* de concentres au retour du pâturage La superiorite du systeme semi-intensif s'explique aisement car un complement apporte une quantite constante d'energie et d'azote, alors que la qualite (teneur en azote et digestibilite) du pâturage baisse regulierement de juillet a septembre

Quant au gardiennage, il permet aux animaux de selectionner les meilleures especes sur le pâturage en combinant ainsi differentes ressources Dans ces conditions, les ressources offertes sur une surface donnee sont contingentes des autres ressources disponibles au même moment et du comportement des animaux guides par le berger (Auricoste *et al*, 1983)

La pratique de l'attache au piquet engendre un effet nefaste au niveau de la vegetation du parcours En effet le piquetage engendre une forte pression dans un rayon determine par la longueur de la corde Il entraîne la destruction des especes consommees, ce qui compromet leur fructification, et un durcissement du sol par pietinement ce qui freine la germination Tout cela favorise l'envahissement de la zone par des especes non appetees et entraine une forte degradation de la vegetation des pâturages en ces points

Influence du niveau énergétique de la ration (essai n°2)

Le croît moyen journalier de 8,75 g du lot F est comparable a celui observe chez les ovins sur pâturage de saison seche, sans complementation Cette faible performance peut s'expliquer par le faible apport en energie digestible de la ration F Le GMQ (gain moyen quotidien) de 26,27 g du lot M est superieur a celui rapporte par Nianogo (1992) chez des ovins de la même station recevant seulement 5 a 10% de complementation La croissance du lot E (79 58 g/jour) est inferieure a celle de 114 a 1348/jour obtenue par Sawadogo (1991) avec la même race et des rations similaires de 114 a 1348/jour Cependant les sujets utilises par Sawadogo (1991) etaient plus jeunes (4–6 mois) et avaient une consommation volontaire de MS plus elevee (3,74 a 3,80% du poids vif) Les rendements observes dans cette etude sont relativement faibles probablement en raison de la courte durée de l'essai Sawadogo (1991) a obtenu des rendements carcasse vrais de 46 a 50% en vingt semaines d'alimentation intensive

Lorsque la teneur energetique de la ration est faible (lot F) les agneaux Mossi privilegient le developpement en valeur relative des morceaux de 1ere et 2eme categories au detriment de la 3eme 19,49% contre 21 08 et 21 68% respectivement pour les lots M et E

Conduite intensive, semi-intensive et extensive

La comparaison des resultats obtenus durant les deux essais fait ressortir les points suivants

- la croissance des agneaux attaches a un piquet et ne beneficiant d'aucune complementation est faible et similaire a celle observee avec une ration contenant 0,4 UF/kg de MS,
- l'apport d un complement couvrant 25% des besoins en MS permet une croissance equivalente a celle observee avec une ration complete contenant 60% de concentres, si les agneaux sont libres de leurs mouvements sur le pâturage,
- la croissance d'agneaux recevant une ration complete avec 0,6 UF est intermediaire entre celle observee en conduite libre sans complementation et celle observee en conduite entravee avec complementation

Pendant la periode de l'essai, les ovins etaient vendus a un prix moyen de 250 F CFA/kg vif Avec la complementation les animaux ont consomme l equivalent de 4,22 F de concentre par jour pour un gain additionnel de 50,91 g/jour pour le pâturage libre (soit + 12, 725 F CFA/jour) et de + 32 77 g/jour pour le pâturage au piquet (soit +8,193 F CFA/jour)

En ne tenant compte que du coût de l'aliment, la marge brute journaliere serait donc de + 8,5075 F CFA dans le 1er cas et de 3 9725 F CFA dans le 2eme On peut par consequent estimer que la complementation est une operation susceptible d'être rentable pour le producteur Il apparaît plus rentable de complementer l'alimentation des animaux en saison pluvieuse que de leur offrir une ration complete Cependant, il est fort possible de constituer des rations moins cheres pour les ovins si l on evite des cereales comme les graines de sorgho

Conclusion

Il ressort des resultats de cette etude que le piquetage est un systeme a n'utiliser que pendant la saison des pluies (protection des cultures) et dans les zones ou la main-d'oeuvre est limitee Dans ce cas les

animaux doivent, non seulement disposer d'une corde assez longue pour leur donner acces a un grand rayon de pâture mais egalement être deplaces frequemment, afin de favoriser les repousses, et d'ameliorer la qualite des elements ingeres On devrait egalement observer un intervalle minimum de 20 jours entre deux piquetages consecutifs au même point Pour être efficace ce systeme doit être couple avec une complementation Cependant, cette derniere est utile seulement si le coût des concentres et les objectifs de production le permettent

La complementation alimentaire se revele necessaire si l'on veut obtenir des resultats performants quel que soit le mode de conduite des animaux Compte tenu de son faible coût (4,22 F CFA/jour/animal) et du gain financier escompte elle presente un attrait certain pour les producteurs Un tel systeme permettrait de valoriser les concentres qui sont largement disponibles durant la saison pluvieuse

Les performances de croissance, le rendement carcasse et le degre d'engraissement des agneaux Mossi dependent de la quantite d'energie digestible ingeree, quel que soit le systeme d'alimentation Il appartient au producteur de choisir la methode de gestion des ressources disponibles en fonction de la saison et du niveau de remuneration du marche

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Performance of Mossi lambs in extensive, semi-intensive and intensive nutrition systems

Abstract

Two feeding trials were carried out to assess the performance of entire Mossi male sheep In the first trial 24 lambs were randomly divided into four groups of six animals each Groups 1 and 3 were allowed to graze freely with a herder (PL) whereas groups 2 and 4 grazed while tethered (PP) Groups 1 and 2 were not supplemented while groups 3 and 4 received 25% of their total dry-matter needs as concentrates containing 50% wheat bran and 50% cottonseed cake Body weight was monitored for 70 days for all animals In the second trial 40 permanently housed lambs were divided into a control group of four animals and three groups of 12

lambs each The treatment groups received three energy level diets, i e high (E), medium (M) or low (F) corresponding to 0 8 0 6 and 0 4 feed unit per kg DM respectively Weight performance was monitored for 12 weeks and some animals were slaughtered every 30 days to assess carcass yield Results from the first trial indicated that free grazing was superior to tethered grazing with average daily weight gains of 53 02 g and 27 28 g respectively In both cases, supplementation increased daily weight gain by 68 5% Group 3 lambs recorded the best performance Results from the second trial showed that average daily weight gains were 79 58 35 54 and 8 75 g, respectively, for E, M and F groups, with a significant difference (P<0 05) between E and F Carcass studies indicated that animals in group E had higher carcass yields and that incrustation of their epiploon fat improved with delayed slaughter Mossi sheep performance was rather modest in these studies and both the feeding system and the dietary energy level had a marked effect on lamb performance

Evolution de la note d'état corporel et de quelques paramètres biochimiques chez des agnelles Foulbé à différents stades physiologiques au Nord-Cameroun

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Résumé

Quatre lots de 60 agnelles Foulbe âgees de 7 a 9 mois ont éte constitues en avril 1993 en vue d'etudier l'effet de la complementation proteique et minerale de même que des soins sur la note d'etat corporel (NEC) et le poids en liaison avec les parametres metaboliques (uree et glucose) et hematologiques (hemoglobine et hematocrite) Le lot A a reçu complementation et soins, le lot B complementation sans soins le lot C des soins sans complementation et le lot D ni complementation ni soins Les animaux ont reçu 200 g de tourteau de coton par tête et par jour jusqu en août et de la pierre a lecher en permanence dans le parc de nuit Les traitements sanitaires ont consiste en deux deparasitages internes au debut et a la fin des pluies et un deparasitage externe chaque fois que l'on a note la presence de tiques sur les agnelles Une vaccination contre la PPR a ete effectuee en octobre Le poids et la NEC ont ete enregistres mensuellement sur toutes les agnelles et les parametres metaboliques et hematologiques ont ete mesures sur 20 agnelles par lot Deux essais de determination de l'ingestion volontaire de fourrages par les agnelles ont ete effectues l un au cours de la phase de croissance et l'autre durant la gestation Pendant toute l'etude la complementation alimentaire a permis une augmentation tres significative du poids et un gain de NEC chez les agnelles On a note une correlation positive entre le poids et la NEC des agnelles (r = 0,48 P<0 001) Au cours des phases de croissance et de gestation, la complementation a permis une augmentation significative de la quantite de matiere seche fourragere volontairement ingeree Pendant la phase de gestation il n y a pas eu d effet de la complementation ni des traitements sanitaires sur l ingestion volontaire et la digestibilite du fourrage par les agnelles mais ces deux traitements ont augmente considerablement leur consommation d eau (P<0 05) La complementation a ete associee a une augmentation (P<0 05) des concentrations plasmatiques d uree et de glucose chez les agnelles Cette etude a montre que la NEC reflete mieux que le poids, l'etat nutritionnel des agnelles gestantes Les dosages de l'uree plasmatique et du taux d'hematocrite peuvent être des operations de routine dans l'evaluation de l'etat de nutrition azotee et des troubles parasitaires chez les ovins Une complementation proteique post-sevrage et pendant la saison seche associee a un plan de prophylaxie leger permet a moindre coût une croissance soutenue et le maintien du bon etat general des agnelles sur pâturages naturels

Introduction

Dans la zone soudano-sahelienne du Cameroun, les petits ruminants souffrent d'une sous-alimentation severe en saison seche due a la rarete de l'herbe et de l'eau L'analyse des premiers resultats du suivi zootechnique mene depuis trois ans dans les elevages traditionnels montre que le taux de fecondite est relativement faible, se situant a 92% et 112%, respectivement pour les moutons et les chèvres (Ngo Tama *et al*, 1991) De fortes mortalites d'ovins de tout âge pouvant atteindre 80% dans certains troupeaux, dues aux symptômes respiratoires, mais aussi a des causes non pathologiques ou inconnues, ont ete enregistrees Des carences alimentaires pourraient être des causes predisposantes a cette mortalite ou responsables de la faible productivite des petits ruminants en milieu paysan Les besoins nutritifs des ovins et en particulier des femelles, coincident rarement avec les apports alimentaires Suite aux agnelages qui interviennent souvent au cours de la periode defavorable que constitue la saison seche, les femelles sont obligees de mobiliser leurs reserves corporelles pour faire face aux besoins energetiques de lactation L interêt de ces reserves est connu, notamment chez les femelles reproductrices Dedieu *et al* (1989) et Torre *et al* (1991) ont note une relation positive entre les reserves corporelles et les taux d ovulation de fertilite et de prolificite chez les ovins Les reserves corporelles sont un bon indicateur de l etat nutritionnel et sont evaluees visiblement sur une echelle de notation de l etat corporel (Russel *et al*, 1969) La connaissance des variations de ces reserves a travers la note d'etat corporel (NEC) est necessaire pour les integrer dans des programmes de complementation alimentaire des ovins L objectif de cette etude etait de determiner l'impact des complementations alimentaires et des traitements sanitaires sur l'evolution de la NEC et du profil metabolique a differents stades physiologiques

ainsi que leurs relations avec la satisfaction des besoins alimentaires des agnelles

Matériels et méthode

Site

L'etude a ete menee a la station de l'Institut de recherches zootechniques et veterinaires (IRZV) de Garoua au Nord-Cameroun La latitude est de 9,3 N et la pluviometrie annuelle avoisine 990 mm avec pres de 50% des pluies entre juillet et août La pluviometrie a ete normale pendant la periode d'etude (946 mm) L'annee peut être divisee en 3 saisons une saison seche chaude de février a mai, une saison des pluies de mai a septembre et une saison seche froide d'octobre a janvier Le pâturage est un pâturage naturel avec des graminees perennes dominantes comme *Andropogon gayanus Hyparrhenia rufa Cynodon dactylon Spermacoa stachydea Jardinia congoensis* et *Heteropogon contortus* D'autres especes annuelles interessantes sont *Loudetia togoensis Pennisetum pedicellatum, Tephrosia bracteolata, Eragotris tremula* et *Bracharia spp* Des arbres et arbustes contribuent aussi a la biomasse consommable des ovins, particulierement pendant la saison seche lorsque l'herbe devient rare et de faible valeur nutritive Les plus frequents sont *Daniellia oliveri, Afzelia africana, Prosopis africana Ficus spp Grewia spp Stereospermum kunthianum, Crossopterix febrifuga* et *Vitex simplex*

Matériel animal

En janvier et fevrier 1993, 350 agnelles de race locale Foulbe, âgees de 3 a 4 mois ont ete achetees juste apres le sevrage Pendant la periode de quarantaine elles etaient identifiees avec les boucles Allflex^R, vermifugees au Valbazen^R et detiquees a l'Ectopor^R Deux techniciens ont ete imities a la notation de l etat corporel (NEC) des ovins Une grille de note a ete mise au point allant de 1 a 4, avec des ecarts de 0,25 La NEC a ete determinee par palpation des regions dorsale, lombaire et autour de la queue, et par appreciation de l'aspect general de l'animal (Russel *et al* 1969) La NEC consideree etait la moyenne des notes donnees par les deux techniciens (attribution d'une note concertee) La note 1 etait assignee aux agnelles tres maigres, sans tissus musculaires ou adipeux entre la peau et l'os, et avec les côtes et les apophyses visibles a distance La note 2 etait attribuee aux animaux maigres, avec les apophyses sensibles au toucher La note 3 etait assignee aux sujets moyennement gras, avec une faible epaisseur de muscle et de gras et la note 4 a ceux ayant une bonne couverture de muscle et de gras

Constitution des lots expérimentaux

A la fin de la quarantaine en avril 1993, les animaux ont ete peses pendant 3 jours consecutifs Sur 350 agnelles, 240 etaient retenues sur la base du poids, de l âge et du phenotype (robe et facies d ovin Foulbe) Elles etaient regroupees en 60 blocs de 4 agnelles par stratification sur la base de leur poids et de leur NEC Les agnelles de chaque bloc etaient ensuite affectees de façon aleatoire a 4 lots experimentaux, de maniere a avoir des lots homogenes de 60 animaux chacun Le poids moyen initial etait de 17,20,36 kg et la NEC de 2,830 09 Les traitements suivants ont ete appliques lot A complementation avec traitements prophylactiques (pratiques ameliorees), lot B complementation sans traitements prophylactiques lot C traitements prophylactiques sans complementation, lot D ni complementation ni traitements prophylactiques (lot temoin)

L'etude s'est deroulee en 3 phases correspondant aux stades physiologiques periode post-sevrage (avril - août 1993) periode de croissance (août – decembre 1993) et periode de gestation (4 premiers mois janvier – avril 1994) La complementation consistait en 200 g de tourteau de coton compose de 40,8% de proteines brutes, 14,6% de parois cellulaires ou NDF et 13,1% de lignocellulose ou ADF par agnelle et par jour distribue en groupe, d'avril au debut d août et ensuite de decembre a avril 1994 La pierre a lecher (55% de poudre d'os, 40% de sel, 4% de complement mineral et vitamine, et 1% de ciment) etait disponible en permanence dans le parc de nuit pour les lots A et B Les traitements prophylactiques consistaient en deux deparasitages internes au debut et a la fin des pluies (mai et octobre respectivement) et un deparasitage externe chaque fois que l on notait la presence de tiques sur les agnelles Les animaux ont ete vaccines contre la PPR en octobre Les 4 lots ont ete eleves separement gardes chacun par un berger cependant une rotation des lots dans 4 bergeries etait effectuee tous les mois afin d annuler les effets ' berger et bergerie dans l analyse statistique des donnees Les animaux pâturaient deux fois par jour, de 8 a 12 h et de 14 a 17 h L'abreuvement avait lieu a 12 h et a 16 h

Collecte des données

Toutes les donnees ont ete collectees le même jour, une fois par mois le matin avant la pâture et la distribution du complement L'influence de la complementation et des traitements prophylactiques sur la variabilite des parametres sanguins a ete evaluee A cet effet quatre-vingts agnelles ont ete choisies au hasard dans les quatre lots soit 20 agnelles par lot Du sang avait ete preleve a la veine jugulaire sur ces agnelles dans deux tubes dont le premier contenait du fluorure de lithium et servait a la determination de la teneur en glucose tandis que le second contenait de l EDTA, et servait a determiner l'uree, l'hematocrite et l hemoglobine Les analyses de glucose, d uree et d hemoglobine etaient effectuees au Centre Pasteur de Garoua par spectrophotometrie sur analyseur automatique Coûter^{TM} La mesure du taux d'hematocrite etait effectuee au laboratoire de l'IRZV en utilisant une centrifugeuse a hematocrite

Deux essais de mesure de l'ingestion volontaire de fourrage par les agnelles ont ete effectues En decembre 3 agnelles par lot, soit 12 au total ont ete placees dans des cages de digestibilite pendant 6 jours d adaptation et 6 jours de collecte totale de feces, de fourrage et de refus Pendant la phase de gestation en avril les agnelles munies de sacs a feces ont ete placees dans des parcs individuels pour une 2eme phase de collecte La quantite d'eau ingeree a ete mesuree La matiere seche des fourrages, du refus et des fèces etait determinee apres sechage a l'etuve pendant 48 h a 60 C

Traitement statistique des données

Les donnees ont ete traitees par analyse de variance des mesures repetees utilisant la procedure "General Linear Model' (SAS/STAT, 1990), sur micro-ordinateur Sur chacune des variables a expliquer ont ete testes les effets complementation (COMPL), traitements prophylactiques (MEDIC) et l'interaction COMPL x MEDIC Des correlations ont ete calculees entre les parametres hematologiques, le poids et la NEC

Résultats

Evolution du poids et de la note d'état corporel

L' evolution du poids et de la NEC des agnelles pendant les trois phases de l'etude est presentee a la figure 1 et au tableau 1 Pendant la phase post-sevrage, la complementation a permis une augmentation tres significative du poids des agnelles (P<0 01) Par contre, les soins et l'interaction complementation-soins n'ont pas influence l evolution ponderale La complementation a entraîne une augmentation de la NEC (P<0,05)

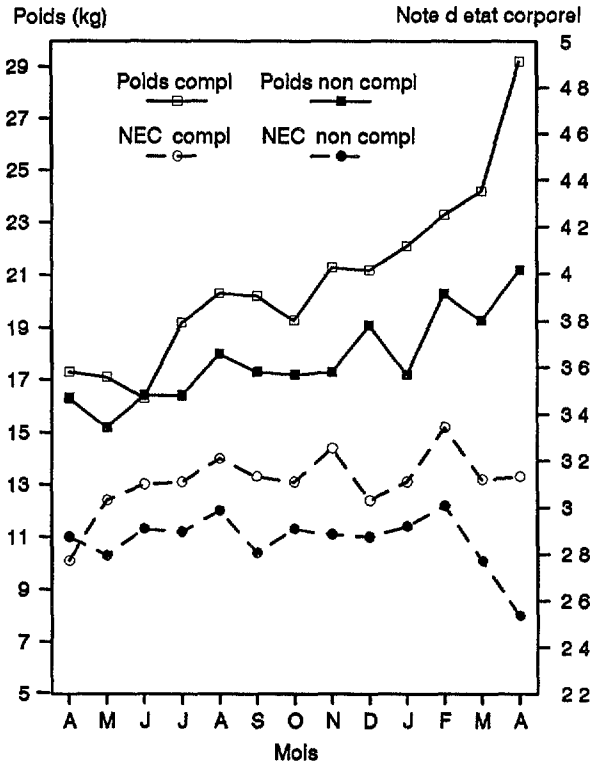

Figure 1 *Influence de la complementation proteique sur l evolution du poids et de la note d etat corporel des agnelles Foulbe*

En revanche, les traitements prophylactiques et l interaction avec la complementation n ont pas eu d influence significative La correlation entre le poids et la NEC au cours de cette phase etait faible (r=0,46 , P>0,1) Au cours de la phase de croissance, des gains de

Tableau 1 *Effet de la complementation proteique et des traitements prophylactiques sur le gain moyen quotidien (GMQ) et le gain de note d etat corporel (GNEC) des agnelles*

	Lot				
Parametres	A	B	C	D	E T M [1]
Etat initial					
Poids (kg)	17 5	17 8	16,9	16 5	0 5
NEC	2 88	2 73	2 78	2 96	0 13
Periode post-sevrage					
GMQ (g/j)	20[a]	22[a]	8[b]	–3c	4
GNEC	0 08[a]	0 56[b]	0 14[a]	0 01[a]	0 13
Phase de croissance					
GMQ (g/j)	26[a]	8b	5[b]	6b	3
GNEC	0 40[a]	–0 04[a]	0 10[a]	0 17[b]	0 09
Phase de gestation					
GMQ (g/j)	53[a]	82[b]	12[c]	26[d]	4
GNEC	0 05[a]	0 25[b]	–0 20[c]	–0 45[c]	0 09
Etat final					
Poids (kg)	27 7[a]	31 5[b]	21 3[c]	21 7[c]	0 8
NEC	3,12[a]	3,23[a]	2,79[b]	2,30[c]	0,07

1 Ecart type de la moyenne

Les moyennes d une même ligne suivies de lettres differentes sont significativement differentes (P<0 05)

poids etaient dus a l effet residuel de la complementation, des traitements prophylactiques et a leur interaction (P<0,01) De la même maniere, la NEC a ete signicativement ameliioree par l'effet residuel de la complementation (P<0 01) et des traitements prophylactiques (P<0,05) A la mise en reproduction en janvier, les agnelles complementees etaient de 27% plus lourdes et avaient une NEC plus elevee que les sujets non complementes (figure 1) On a note une forte correlation entre le poids et la NEC au cours de cette phase (r=0 79 , P<0,01) Pendant la phase de gestation, la complementation a permis un gain de poids tres significatif (P<0 01) Par contre, les traitements prophylactiques seuls ou associes a la complementation n'ont pas eu d'effet sur le gain de poids pendant cette periode La NEC a ete ameliioree par la complementation, les traitements prophylactiques et leur interaction (P<0,05) En avril 1994, apres une annee d'etude, les agnelles complementees etaient 38% plus lourdes que celles non complementees (figure 1) La correlation entre le poids et la NEC etait faible pendant cette periode (r=0,46 , P>0,1)

Utilisation du fourrage

L'utilisation du fourrage est resumee au tableau 2 Pendant la phase de croissance, la complementation a permis une augmentation significative (P<0,05) de la quantite de matiere seche totale volontairement ingeree (MSTVI) Le taux de digestibilite du fourrage ingere (DFVI) est reste remarquablement identique dans les quatre lots, permettant ainsi au complement d'augmenter (P<0,01) considerablement la quantite de matiere seche digestible ingeree Ni les traitements sanitaires, ni leur interaction avec la complementation n ont ameliore la MSFVI et la MSTVI ou leur digestibilite Pendant la phase de gestation (avril 1994) ni la complementation ni les traitements sanitaires n ont eu d'effet sur l'ingestion volontaire et la digestibilite du fourrage Ces deux parametres ont cependant considerablement augmente (P<0 05) la consommation d'eau des agnelles

Evolution des paramètres métaboliques et hématologiques

L'evolution des taux d uree et de glucose sanguins pendant les trois phases physiologiques des agnelles est representee aux figures 2 et 3 et au tableau 3

Pendant la phase post-sevrage, la complementation a ete associee a une augmentation significative de la teneur plasmatique d uree et de glucose (P<0 01), alors que les traitements prophylactiques n'ont eu aucun effet sur ces parametres Les deux traitements et leur interaction n'ont pas influence la teneur en hemoglobine et le taux d'hematocrite (tableau 3)

Il y a eu une forte correlation positive entre les taux d'uree et de glucose (r = 0,68 , P<0,01) et entre la teneur en hemoglobine et le taux d'hematocrite (r = 0 69, P<0,01) Pendant la periode de croissance il n'y a pas eu d effet residuel de la complementation sur les taux d'uree et de glucose Cependant, la teneur en uree et le taux d hematocrite ont ete fortement augmentes par les traitements prophylactiques (P<0,01) On a note une correlation positive tres significative entre la teneur en hemoglobine et le taux d'hematocrite (r=0,92 P<0,01) Pendant la phase de gestation, les agnelles complementees ont conserve un niveau plus eleve d'uree (P<0,01) et de glucose (P<0,05) que celles non complementees Les traitements prophylactiques n'ont pas eu d'effet sur la teneur plasmatique d'uree mais leur interaction avec la complementation l'a considerablement augmentee (P<0 01) Le taux d'hematocrite a augmente avec la complementation et avec son interaction avec les traitements prophylactiques (P<0 01) La teneur en hemoglobine a ete ameliioree par la seule complementation (P<0,01) On a note une correlation positive significative entre la NEC et la

Tableau 2 *Influence de la complementation et des traitements prophylactiques sur l utilisation du fourrage par les agnelles*

	Etat physiologique/Lot									
	Croissance					Gestation				
Parametres	A	B	C	D	ETM[1]	A	B	C	D	ETM[1]
Poids vif (kg)	21 0	22 5	20 5	19 8	1 21	23 8[a]	28 8[b]	21 7[a]	20 5[a]	2 4
MSFVI[2] (kg/100 kg)	5 09	4 86	3 94	4 52	0 42	4 81[ab]	3 69[a]	6 06[b]	0 68	4 37[ab]
MSTVI[3] (kg/100 kg)	6 00[a]	5 72[a]	3 94[b]	4 52[b]	0 43	5 64	4 37	4 37	6 06	0 70
DFVI[4] (%)	71 5	75 4	72 1	73 3	2 46	72 3	70 1	61 6	72 8	4 99
MS[5] digestible (g/kg$^{0\,75}$)	95[a]	96[a]	61[b]	70[b]	7 6	123	100	93	128	13 8
Consommation d eau (l/j)						3 72[a]	2 70[b]	2 54[b]	1 98[b]	0 24

Ecart type de la moyenne

[ab] Pendant un stade physiologique donne les moyennes de la meme ligne suivies de lettres differentes sont significativement differentes (P<0 05)

[2] Matiere seche fourragere volontairement ingeree

[3] Matiere seche totale volontairement ingeree

[4] Digestibilite du fourrage volontairement ingere

[5] Matiere seche

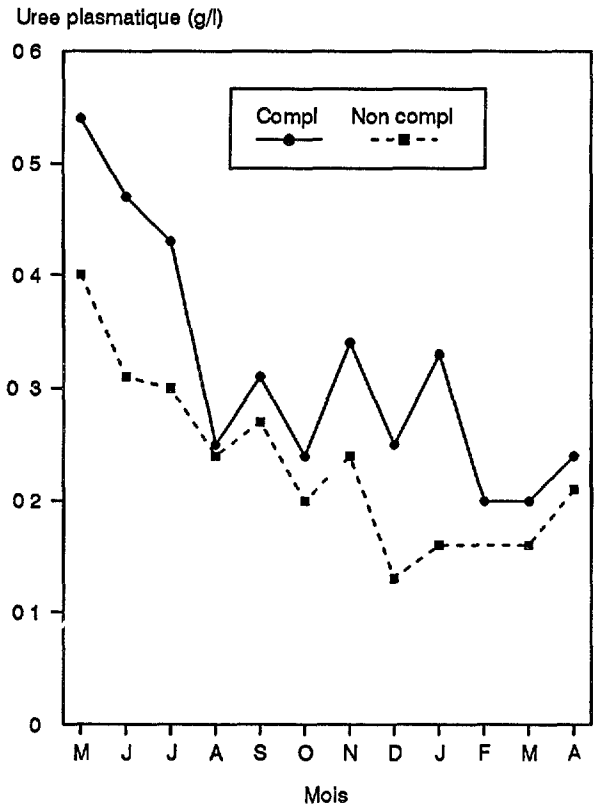

Figure 2 *Influence de la complementation proteique sur l evolution de l uree plasmatique chez les agnelles Foulbe*

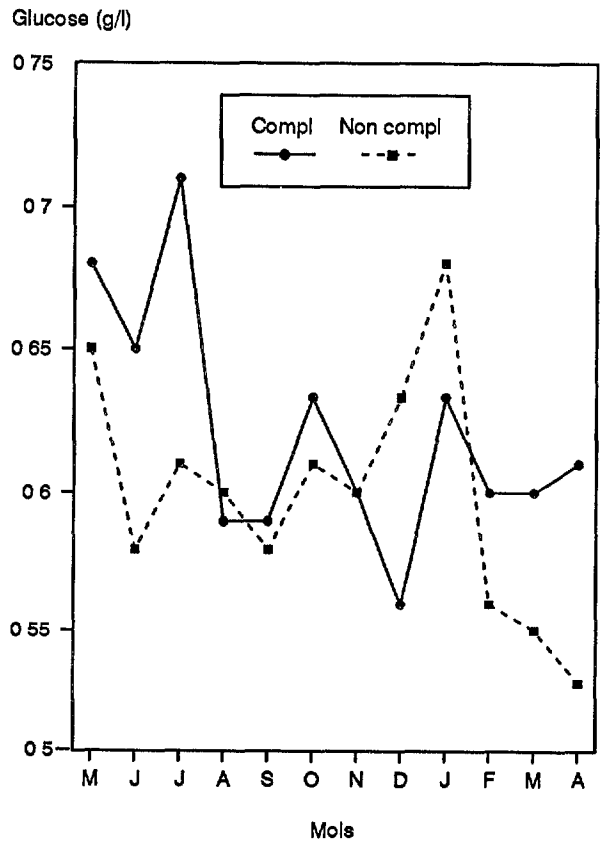

Figure 3 *Influence de la complementation proteique sur l evolution du glucose chez les agnelles Foulbe*

teneur en hemoglobine (r=0,58 P<0 05) ainsi qu entre celle-ci et le taux d hematocrite (r=0,69 P<0 01) Tout au long de l etude on a observe une correlation positive entre les taux d uree et de glucose (r= 0 38 , P<0 01) et entre l hematocrite et l'hemoglobine (r=0 74 P<0,01)

Discussion

Les resultats de cette etude ont permis de mettre en evidence une tres forte liaison entre l'evolution du poids et celle de la NEC pendant la phase de croissance des agnelles Cela est en accord avec les conclusions de Sanson *et al* (1993) qui ont obtenu une telle correlation (r=0 89) entre le poids et la NEC des brebis sur pâturage dans l'ouest des Etats-Unis Cependant, au cours des phases physiologiques plus delicates de post-sevrage et de gestation la liaison a ete plutôt faible Pendant la phase de gestation par exemple, les agnelles gagnaient du poids mais leur NEC baissait Ce gain de poids etait associe a la croissance du foetus alors que la baisse de NEC etait due a la qualite mediocre des pâturages incapables de satisfaire les besoins energetiques et proteiques des animaux , cela contraignait les agnelles a mobiliser leurs reserves corporelles pour faire face aux besoins accrus de gestation La baisse de NEC etait plus importante chez les agnelles non complementees de sorte qu a la fin de l'etude en avril, elles avaient une NEC moyenne de 27% inferieure a celle des sujets complementes Ces resultats laissent croire que pendant la gestation et dans certaines situations de stress, la NEC est un meilleur indicateur du niveau des reserves corporelles que le poids Cela est en accord avec les resultats de Purroy *et al* (1987) et Sanson *et al* (1993) qui ont montre que la NEC etait beaucoup plus correlee a la quantite des lipides et des proteines corporelles que le poids vif chez les ovins La NEC avant la mort pour les 82 cas enregistres etait de 2 290 80, contre 3,040 22 pour les agnelles vivantes et complementees (Njoya et Awa, 1994) Cela laisse croire qu'il y a eu une mobilisation des reserves corporelles pour faire face aux stress auxquels les agnelles etaient exposees avant la mort L on peut envisager, dans les conditions du Nord-Cameroun, une note cible d'au moins 3 Dedieu *et al* (1989) ont preconise une note de 3,2 pour les elevages ovins de Cevennes (France) Un mauvais etat corporel des agnelles non complementees les predisposerait a des avortements, des mises bas d agneaux chetifs non viables une mauvaise production laitiere ou des retours tardifs des chaleurs et par consequent a une mauvaise carriere reproductrice On pourrait envisager d utiliser la NEC pour porter un diagnostic rapide de l etat nutritionnel des ovins en zone soudano-sahelienne

L augmentation de la matiere seche totale volontairement ingeree par les agnelles complementees (tableau 2), sans effet depressif sur la digestibilite du fourrage, laisse croire que les complements proteiques et mineraux sont necessaires pour ameliorer l appetit des agnelles pour les fourrages grossiers base essentielle de l alimentation des ruminants tropicaux Ces resultats

Tableau 3 *Influence de la complementation et des traitements prophylactiques sur certains parametres biochimiques d agnelles Foulbe a différents stades physiologiques*

	Stade physiologique														
	Post-sevrage					Croissance					Gestation				
Parametres	A	B	C	D	E T M [1]	A	B	C	D	E T M [1]	A	B	C	D	E T M [1]
Uree (g/l)	0 49[a]	0 47[a]	0 33[b]	0 34[b]	0 03	0 31	0 36	0 29	0 25	0 04	0,27[a]	0 27[a]	0 14[b]	0 21[a]	0 03
Glucose (g/l)	0 68[a]	0 68[a]	0 63[b]	0 60[b]	0 02	0 60	0 61	0 59	0 61	0 01	0,60	0 60	0 58	0 60	0 02
Hematocrite (%)	29 7	29 6	30 3	29 4	2 76	25 9[a]	24 6[a]	25 6[a]	23 1[b]	0 86	26 3[ab]	26 8[a]	26 2[ab]	24 4[b]	0 79
Hemoglob (%)	9 93	9 60	9 80	9 47	0,37	8 88	8 50	8 85	8 10	0 30	9 36[a]	9 34[a]	9 08[a]	8 26[b]	0 24

1 Ecart type de la moyenne

[ab] Pendant le même stade physiologique les moyennes de la même ligne suivies de lettres differentes sont statistiquement differentes (P<0 05)

sont en accord avec ceux obtenus sur des bovins dans la même station (Njoya, 1992) ou la complementation avec du tourteau de coton avait permis d augmenter la consommation et l utilisation des pâturages naturels Cependant, au cours de la gestation, la quantite de MS digestible ingeree etait identique quel que soit le traitement Les agnelles non complementees avaient un niveau d'ingestion beaucoup plus eleve que lors de la phase de croissance On aurait espere une chute de consommation tout comme l'avaient aussi remarquee Sykes et Field (1972) en Australie chez des ovins recevant une ration pauvre en proteines On peut considerer que l'augmentation de l'ingestion de fourrage par les agnelles non complementees est un mecanisme destine a leur permettre de satisfaire leurs enormes besoins energetiques et proteiques de gestation

La complementation alimentaire a augmente les chiffres de glycemie et d'uremie et les traitements prophylactiques ont eu tendance a augmenter ceux d'hemoglobine et d'hematocrite Les taux d'uree et de glucose ont evolué en fonction des saisons Ils etaient faibles en saison seche indiquant ainsi des situations de carence pendant cette periode de l annee et ce, malgre une consommation de fourrage relativement elevee Cela a ete confirme visiblement par la baisse de la NEC des agnelles entre fevrier et avril (figure 1) L'augmentation du niveau d uree avec la complementation est en accord avec les observations rapportees par Sykes et Field (1973) qui ont souligne son rôle comme indicateur de l'alimentation proteique Même pendant la premiere moitie de la saison des pluies ou le niveau proteique des pâturages etait le plus eleve, les agnelles ont eu un taux d'uree plasmatique plus eleve La reponse a une complementation proteique par le gain de poids et de NEC laisse croire que les pâturages naturels de la zone soudano-sahelienne sont carences en proteines La faible teneur en glucose associee a une faible NEC des agnelles non complementees (figures 1 et 3) confirme son rôle comme indicateur de la carence en energie Cela est en accord avec les conclusions de Stephenson et Bird (1992) et de Honhold *et al* (1992) qui ont montre que la concentration du glucose plasmatique etait le meilleur indicateur de l alimentation energetique des ruminants sur pâturages Les foetus dependent de l'approvisionnement en glucose pour leur survie (Stephenson et Bird, 1992) Le niveau de glucose chez l'agnelle gestante peut indiquer le statut nutritionnel du foetus, et par consequent prevenir des situations de carence pouvant entraîner des avortements ou la naissance de produits chetifs non viables

Conclusion

Cette étude a permis d evaluer la note d'etat corporel des agnelles en relation avec le poids au cours d'une annee, pendant trois stades physiologiques differents et sous l'influence des facteurs alimentaires et sanitaires Elle a montre que la NEC etait le reflet de l'etat nutritionnel et pendant la gestation, etait le meilleur indicateur des reserves corporelles La complementation alimentaire devrait être necessaire lorsque la NEC des ovins est inferieure a 3 Les dosages de l'uree plasmatique et du taux d hematocrite peuvent être effectues de façon routiniere dans un but clinique respectivement dans l'evaluation de l etat de nutrition azotee et des troubles parasitaires des ovins Foulbe Le gain de poids et de NEC et le profil metabolique des agnelles complementees indiquent que les pâturages naturels de la region sont carences en proteines notamment pendant la saison seche En zone soudano-sahelienne, une complementation proteique post-sevrage en saison seche associee a un plan de pro phylaxie leger permet a moindre coût une croissance soutenue et un maintien de l'etat general des ovins sur pâturages naturels Les autres avantages esperes sont l'amelioration de la viabilite et de la carriere de reproduction des animaux

Remerciements

Nous remercions Messieurs Njifotie, Kammengni, Nassourou et Awahmukalah de l IRZV de Garoua, pour la collecte des donnees Nos remerciements vont egalement au Dr Daniel Bourzat (CIRAD-EMVT), Directeur du Projet regional de recherches sur les petits ruminants (Cameroun-Niger-Tchad) pour l'appui logistique qu'il nous a apporte ainsi qu'au Dr Bernard Faye du Laboratoire d ecopathologie, INRA, Theix (France) pour ses conseils techniques et la lecture critique de cet article

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Monitoring body conditions and some biochemical parameters in Foulbe ewes in various physiological stages in northern Cameroon

Abstract

The effects of supplementation and prophylactic treatment on body condition and biochemical parameters of weaner ewes were evaluated on 240 weaner Foulbe ewes randomly allotted to 4 treatments of 60 ewes each (treatment A supplementation with prophylaxis, treatment B supplementation without prophylaxis, treatment C prophylaxis without supplementation, and treatment D neither supplementation nor prophylaxis) Supplemented groups received 200 g of cottonseed meal per ewe per day Treated groups were dewormed at the beginning and at the end of the rainy season Animals were sprayed whenever ticks were found on them and vaccinated against "peste des petits ruminants" (PPR) Body weight and condition score of all ewes were taken every month Blood samples were taken monthly from 20 ewes per treatment for the determination of urea, glucose, hematocrit and hemoglobin values Two digestibility trials were carried out, one during the growing phase and the other during the gestation phase Weight gain and body condition were improved by supplementation throughout the study There was a positive correlation between weight gain and body condition (r = 0 48 P<0 001) Forage dry-matter intake increased with supplementation during the growing phase but not during gestation However, water intake increased (P<0 05) with supplementation during gestation Blood urea and glucose increased with supplementation (P<0 05) This study shows that during gestation body condition is a better indicator of the nutritive status of ewes than body weight It also indicates that urea and hematocrit values could be used routinely to assess the protein status and parasite burden in ewes Protein supplementation associated with twice-a-year deworming and regular deticking can allow a steady growth and good body condition score of weaner ewes grazing Sudano-Sahelian pastures

Effet de la supplémentation de la paille de brousse avec différentes proportions de fane de dolique sur la production de viande ovine

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Résumé

L'effet de la supplementation de la paille de brousse avec differentes proportions de fane de dolique (*Lablab purpurus* variete Highworth) sur la production de viande ovine a ete evalue en utilisant des beliers castres de race Toronke pesant en moyenne 37,14 ± 6,21 kg Les niveaux d'apport de fane de dolique initialement prévus dans les rations etaient de 0, 25, 50 et 75% mais les proportions finales observees ont ete de 0, 39,39, 70,67 et 84,62% L'ingestion totale d'aliment a varie en fonction du niveau de supplementation en fane de dolique (p<0,05) L'augmentation de la proportion de fane dans la ration s'est traduite par une amelioration de l'ingestion totale de matiere seche Les performances ponderales ont varie (p<0,05) en fonction de la proportion de fane de dolique dans les rations Les trois rations contenant respectivement 0, 39 39 et 70 67% de fane de dolique ont occasionne des pertes de poids Seule celle contenant 84,62% de fane a occasionne un gain moyen quotidien de 2 g Cependant, le taux de matieres azotées totales des rations comportant 70 67 et 84,62% de fane de dolique est dans les normes couramment admises pour les essais d engraissement L apport d'energie est reste faible et semble être le facteur limitant de meilleures performances ponderales L'analyse coût/benefice de l'operation a permis de degager un revenu additionnel positif

Introduction

L'alimentation apparaît comme la contrainte majeure aux productions animales au Mali en general et dans la region de Kayes en particulier Le disponible fourrager n'est de bonne qualite et en quantite suffisante que pendant une courte periode de l annee c'est-a-dire l'hivernage qui va de juillet a septembre Les systemes d'alimentation sont principalement bases sur l'utilisation des pâturages naturels et des residus de culture Pendant la saison seche, les ruminants alimentes exclusivement avec des pâturages naturels et des chaumes de cereales perdent du poids, ce qui indique que ces aliments sont de faible valeur nutritive (Pearce *et al*, 1988) L'utilisation de concentres comme supplements generalement recommandes pour ameliorer le niveau d'energie et de proteines dans les fourrages lignifies est difficilement applicable au niveau des paysans Cependant il importe de prevenir les pertes de production au niveau des paysans en utilisant des techniques simples et les aliments disponibles La supplementation des fourrages pauvres avec des fanes de legumineuses permet d'ameliorer la digestibilite (Devendra, 1982), l'ingestion (Mosi et Butterworth, 1985) ou les deux a la fois (Minson et Milford, 1967 Lane, 1982 Moran *et al*, 1983, McMeniman *et al*, 1988, Ngwah et Tawah, 1992)

La presente etude vise a comparer l'effet de differents niveaux d'apport de fane de dolique sur l'ingestion et le gain de poids de moutons alimentes avec de la paille de brousse

Matériels et méthodes

Caractéristiques géoclimatiques

L'essai a ete conduit a Kayes, a la Station de recherche zootechnique du Toronke (SRZ/T), dans la zone semi-aride du Mali Les precipitations moyennes annuelles sont de 600 a 800 mm et sont essentiellement concentrees sur la periode de juillet a septembre La zone presente des pâturages naturels constitues principalement de graminees et representant la base de l alimentation du betail Les activites economiques sont axees principalement sur l agriculture et l elevage

Matériels

Animaux

Un total de vingt quatre moutons mâles castres, de race Toronke, preleves du troupeau ovin de la SRZ/T et pesant en moyenne 37,14 ± 6,21 kg, ont ete utilises pour cet essai

Rations alimentaires

Quatre rations a base de paille de brousse, supplementees avec differentes proportions de fane de dolique ont ete utilisees dans cette etude Les niveaux d apport de fane de dolique initialement prevus etaient de 0, 25 50 et 75% de la ration totale Cependant les proportions finales observees etaient de 0, 39,39, 70 67 et 84 62% La paille de brousse en provenance des alentours de la ville de Kayes est essentiellement composee de *Schenefeldia gracilis* et de *Schizachyrium exile* La fane de dolique a ete produite par le programme de cultures fourragères de la SRZ/T La pierre a lecher KNZ rouge a éte utilisee comme complement mineral et vitaminique Sa composition etait la suivante P 11%, Mg 1,26%, NaCl 41,7%, Ca 9,0%, Fe 1,0%, Co 100mg/kg, I 200mg/kg, Mn 1200mg/kg, Cu 450mg/kg, Vitamine A 140000 UI/kg, Vitamine D3 28000 UI/kg et Vitamine E 50 UI/kg

Méthodes

Les vingt quatre moutons vaccines contre la pasteurellose et deparasites au Panacur (fenbendazole de methyle) ont ete repartis au hasard en 8 lots de 3 animaux chacun Chacune des 4 rations a ete assignee au hasard a 2 lots soit 6 moutons Les animaux etaient alimentes deux fois (08h et 18h) par jour pendant 60 jours Ils avaient libre acces a l'eau et a la pierre a lecher Les quantites d'aliments ingerees ont ete mesurees par pesee des quantites offertes et des quantites refusees Les variations de poids ont ete evaluees par pesee des moutons tous les 15 jours Des echantillons d aliments ont ete analyses au laboratoire de nutrition animale de Sotuba Les analyses chimiques ont porte sur la matiere seche (MS), les matieres azotees totales (MAT = azote * 6,25), la matiere grasse (MG), la cellulose brute (CB), les cendres (C), le calcium (Ca) et le phosphore (P) Les donnees ont ete traitees par analyse de variance (randomisation totale)

Tableau 1 *Composition chimique de la paille de brousse et de la fane de dolique utilisees dans l essai*

Elements	Paille de brousse	Fane de dolique
Matiere sèche (%)	90 55	86 30
Matieres azxotees totales (%MS)	2 90	10 28
Cellulose brute (%MS)	40 41	31 69
Matere grass (%MS)	0 61	1 48
Cellulose brute (%	6 23	10 95
Phosphore (%MS)	0 32	0 16
Calcium (%MS)	0 20	0 73

Résultats et discussions

Composition chimique

La composition chimique de la paille de brousse et de la fane de dolique est presentee au tableau 1 Ce tableau montre que les caracteristiques nutritionnelles de la paille de brousse et de la fane de dolique diffèrent en plusieurs points La fane de dolique a des teneurs plus elevees en PB, MG, C et Ca mais plus faibles en CB et en P que la paille de brousse

Ingestion de matière sèche

L effet de la supplementation de la paille de brousse avec de la fane de dolique est presente au tableau 2 Ce tableau montre que l'ingestion totale d'aliment depend du niveau de supplementation en fane de dolique ($p<0$ 05) L augmentation de la proportion de fane de dolique s'est traduite par une amelioration de l'ingestion totale de MS Ce resultat est conforme a ceux rapportes par de nombreux autres auteurs Ngwa et Tawah (1992) ont montre que l'addition de petites quantites de fane de legumineuses donnait de meilleurs resultats sur l'ingestion de la paille de riz comparee a l'utilisation de l azote non proteique Mosi et Butterworth (1985) dans une serie d experiences ont

Tableau 2 *Effet des differents niveaux de supplementation de la paille de brousse avec de la fane de dolique*

	Rations (Lot)			
Elements	1	2	3	4
Effectifs	6	6	6	6
Poids moyen initial (kg/tête)	40 07	34 24	37 00	35 86
Poids moyen final (kg/tête)	34 80	30 45	34 43	35 97
Gain moyen quotidien (g/tête)	94[a]	60[b]	46[c]	2[d]
Ingestion de paille (kg/tête)	0 60	0 40	0 22	0 14
Ingestion de fane de dolique (kg/tête)	0 00	0 26	0 53	0 77
Ingestion total (kg/tête)	0 60[a]	0 66[b]	0 75[c]	0 91[d]
Porportion de fane (%)	0 00	39 39	70 67	84 62

Les chiffres de la meme ligne suivis de lettres différentes sont significativement differents au seuil de 5%

trouve que la supplementation des chaumes de cereales (mais, orge et ble) avec une fane de legumineuse (*Trifolium tembense*) ameliorait l'ingestion totale de matiere seche L'augmentation de l'ingestion de matiere seche par addition de fane de legumineuse a ete rapportee par d'autres auteurs (Minson et Milford, 1967, Lane 1982 Moran *et al* 1983)

Performance pondérale

Il ressort du tableau 2 que les performances ponderales ont varie ($p<0,05$) en fonction de la proportion de fane de dolique dans les rations Dans les trois rations contenant respectivement 0 39,39 et 70,67% de fane de dolique, les moutons ont enregistre des pertes de poids estimees a 94, 60 et 46 g respectivement De nombreuses etudes confirment que les fourrages de qualite mediocre (paille de brousse et chaumes de cereales) sont si pauvres en proteines et en energie digestible qu ils ne peuvent satisfaire les besoins d entretien des animaux Seul le lot recevant 84 62% de sa ration en fane de dolique a connu un gain moyen quotidien de 2 g

Le gain de poids est proportionnel a la teneur de la ration en fane de dolique Ce phenomene s explique d abord par le taux d'azote tres faible des deux premieres rations La litterature rapporte un taux minimum de 8% de matieres azotees totales pour un bon fonctionnement du rumen C'est aux proportions de 70,67 et 84,62% de fane de dolique que les rations contiennent au moins 8% de MAT

La perte de poids du lot 3 (70,67% de fane de dolique) et le gain de poids du lot 4 (84 62% de fane de dolique) s'expliquent principalement par un deficit energetique des rations

Analyse coût/bénéfice

Grâce aux efforts conjugues de la recherche et des services de vulgarisation, la fane de dolique est actuellement produite par une large proportion d'agro-eleveurs et occupe la premiere place des cultures fourrageres vulgarisees au Mali L'hypothese retenue pour l'analyse est basee sur le fait que la ration contenant 84,26% de fane de dolique a permis non seulement d assurer les besoins d'entretien mais aussi un gain quotidien de 2g Le regime sans fane de dolique a occasionne une perte de poids de 94g Cependant la ration contenant 84 26% de fane permet non seulement d eviter une telle perte de poids mais d assurer un gain de 2g/j

Le gain potentiel a ete de 5 760g ((94 + 2) 60j) La valeur ajoutee est de 4665 Fcfa (5,76kg x 900 Fcfa) La quantite de fane de dolique ingeree etant de 46kg (0 77kg 60j), son coût est de 4 370 Fcfa (46kg x 95 Fcfa), soit un revenu additionnel positif de 295 Fcfa (4 665 Fcfa – 4 370 Fcfa)

Conclusion

Cette etude montre que la supplementation de la paille de brousse avec de la fane de dolique ameliore l'ingestion de matiere seche et le gain de poids des moutons Cependant, même avec une proportion elevee de fane de dolique (84,62%) dans la ration, le gain de poids a ete faible (2g/tête/jour) En effet, le taux de matieres azotees totales des rations contenant 70,67 et 84 62% de fane est dans les normes couramment admises pour les essais d'engraissement L'apport d'energie est reste faible et semble être le facteur limitant les performances ponderales L'analyse financiere de l'operation montre que le revenu additionnel est positif Cependant pour une intensification de la production de viande ovine, l apport d'un aliment energetique serait necessaire

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Effect of supplementing bush straw with various levels of lablab haulm on mutton production

Abstract

The effect of bush straw supplementation with various levels of *Lablab purpureus* var Highworth haulm on sheep meat production was assessed on castrated Toronke rams weighing 37 14±6 21 kg on average Planned lablab haulm rates in the diets were 0, 25, 50 and 75% but actual observed proportions were 0, 39 39, 70 67 and 84 62% Total feed consumption varied according to the proportion of lablab haulm (P<0 05) in the diet Increasing haulm level improved total dry-matter consumption Weight performance also varied (P<0 05) according to the level of lablab haulm in the diet The diet containing 84 62% haulm resulted in a 2 g average daily weight gain The other three diets caused weight losses However total nitrogen contents of the two diets with 70 67 and 84 62% lablab haulm were in line with accepted standards for fattening trials Energy content was low and seemed to be the limiting factor for better weight performance A cost-benefit analysis gave a positive income balance

Compensatory growth in Horro lambs of Ethiopia

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Abstract

Compensatory growth response to liberal concentrate supplement of Horro lambs previously kept on poor natural pasture in the dry season was studied Partial feed conversion efficiency (FCE) and variation in carcass characteristics were also studied The total experimental period consisted of three phases of 63 (Phase 1), 49 (Phase 2), and 74 (Phase 3) days There were four groups (1 to 4) of 10 lambs each Group 4 was the unsupplemented control while the other three groups received high levels of supplement in the third phase after each of them were kept unsupplemented either in both of phases 1 and 2 (Group 3) or in Phase 1 alone (Group 2) or in neither of the two phases (Group 1) In Phase 1, Group 1 lambs gained 1 5 kg live weight while lambs in the other groups lost 2 0 kg In phases 2 and 3, lambs in groups 2 and 3, respectively, showed compensatory growth Liveweight differences between groups 1, 2 and 3 observed in previous phases became non-significant in the last phase Partial FCE was higher in lambs which showed compensatory growth than in continuously growing lambs, particularly when liveweight differences between them became non-significant All carcass measurement showed highly significant (P<0 01) correlation with live weight (coefficients ranging from 0 66 to 0 99) The study showed that under conditions where dry season supplementary feeding is impractical, Horro lambs can be maintained on grazing alone and subsequently fed supplements This enables the lambs to benefit from compensatory growth and better partial FCE compared to lambs that are allowed to grow continuously under supplementation

Introduction

Animals subjected to a period of undernutrition often exhibit very high growth during subsequent realimentation (McManus et al 1972 Thornton et al 1979) This phenomenon, known as compensatory growth has very important implications in countries that depend largely on grazing to support animal production (Drew and Reid 1975)

In the Ethiopian highlands, sheep are raised on natural pasture and crop residues There is annual fluctuation in the quality and quantity of these feed resources Galal et al (1981) suggested lambing during the month of May (start of the main rainy season) as one possible lamb production system This would allow lambs to be grown and weaned, and kept until the age of five months on good pasture But after this age they face the poor pasture conditions of the dry season

The current experiment was designed to study compensatory growth in weaned lambs which were maintained unsupplemented on poor natural pasture during the dry season for various periods, and then fed liberal concentrate supplement to finish them

Materials and methods

Location

The study was carried out at the Bako Agricultural Research Center (09 6'N, 37 09'E, and 1650 m asl) of the Institute of Agricultural Research, Ethiopia The Center receives a mean annual rainfall of about 1170 mm out of which 80% falls in the months of May to September, and has mean maximum and minimum temperatures of 28 C and 13 C, respectively

Animals and experimental treatment

Lambs used in this study belong to the Horro breed of sheep (Galal 1983) Forty weaned lambs of both sexes with mean live weight and age of 17 8 kg (SD=3 16) and 132 days (SD=11 6), respectively, were randomly assigned to 4 treatment groups (1 to 4) The whole experimental period (2 December 1988 to 6 June 1989) was divided into three phases of 63 (Phase 1) 49 (Phase 2), and 74 days (Phase 3) Lambs in Group 1 were supplemented throughout the experimental period those in Group 2 were supplemented in phases 2 and 3 and those in Group 3 were supplemented in Phase 3 only Lambs in Group 4 received no supplement throughout the experiment

Feed and management

The amount of concentrate supplement fed in the first two phases was 150 g/head per day while in the third phase it was 333 g/head per day The supplement was estimated to contain 21 5% crude protein (CP) and 3 05 Mcal metabolisable energy (ME) per kilogram of dry matter (DM)

All lambs were kept as one flock each day of the experiment and grazed from 0830 to 1700 hours on poor natural pasture which had an estimated yield of 4 8 t/ha with a DM content of 60% at the beginning of the experiment Each evening the animals were separated into their respective treatment groups

Carcass measurement

Sixteen male lambs (3, 5, 4, and 4 from groups 1, 2, 3 and 4, respectively) were selected at the end of the experiment for the measurement of carcass and non-carcass parts, weights, and the determination of dressing percentage Shrunk live weight of the lambs was taken just before slaughter after they were deprived of water and feed for about 36 hours

Statistical analysis

Analytical procedure for a completely randomised design was used to analyse between treatment differences in live weight and weight gain Means were separated using the least significant differences (LSD) procedure (Gomez and Gomez 1984) Relationship between weight measurements of the various carcass parts and live weight was determined by regression procedures

Partial feed conversion efficiency (FCE) of supplemented lambs was calculated from the total amount of supplement offered and liveweight gain obtained above those of unsupplemented lambs

Results

Five lambs (two from Group 1 and one from each of the remaining groups) died from unknown causes before the end of the experiment and were excluded from the analysis

Table 1 shows that in Phase 1 lambs in Group 1 gained an average of 1 5 kg live weight while lambs in groups 2 3 and 4 lost an average of 2 0 kg Upon supplementation in Phase 2, lambs in Group 2 gained significantly (P<0 05) more weight (3 9 kg) than lambs in group 1 (2 3 kg) which received supplementation from the start (group 1, 2 3 kg) or unsupplemented lambs in groups 3 (0 8 kg) and 4 (0 9 kg) Group 3 lambs gained significantly (P<0 05) more weight (10 8 kg) than all the lambs in remaining groups (8 7, 9 1 and 4 9 kg for groups 1 2 and 4 respectively) in the third phase After the start of supplementary feeding live weight of previously unsupplemented lambs approached live weight attained by lambs receiving concentrate supplement from the start (Figure 1) However, the difference in gain between groups 1, 2 and 3 was found to be non significant after the first 55 days of Phase 3

Table 2 shows the response in gain due to supplementation and partial FCE of lambs given supplementary feed For the whole experimental period lambs in Group 3 had a better partial FCE (4 18) than lambs in groups 1 (4 82) and 2 (4 78) The observed superiority in conversion efficiency, however declined as liveweight differences reached non-significant levels (last 19 days of Phase 3)

Table 3 shows mean weight and carcass characteristics of the treatment groups All weights have shown a tendency to increase with increase in live weight Pooled regression of shrunk live and carcass weights, dressing percentage and weight of other parts on live weight was found to be highly significant (P<0 01) with correlation coefficients ranging from 0 66 to 0 99 Fat deposition as measured by omental and kidney fat (weighed together), and tail weight were also highly correlated with live weight (T=0 8 and r=0 7 respectively)

Table 1 *Liveweight changes and daily weight gains during each phase and the whole experimental period (mean±SE)*

	Treatment group				
	Overall	1	2	3	4
Number of lambs	35	8	9	9	9
Initial weight kg	17 8±0 53	17 9±1 51^{a}	17 9±0 96^{a}	17 9±1 04^{a}	17 4±0 95^{a}
WEP1 kg	16 6±0 52	19 4±1 12^{a}	15 5±0 96^{b}	16 2±0 83^{b}	15 5±0 80^{b}
WEP2 kg	18 5±0 56	21 7±1 11^{a}	19 4±0 99^{ab}	17 0±0 78^{bc}	16 4±0 58^{c}
WEP3 kg	26 9±0 76	30 4±1 10^{a}	28 5±1 11^{a}	27 8±0 78^{a}	21 3±0 81^{b}
GP1 kg	–1 2±0 31	1 5±0 43^{a}	–2 4±0 45^{b}	–1 7±0 48^{b}	–1 9±0 36^{b}
GP2 kg	1 9±0 23	2 3±0 19^{b}	3 9±0 28^{a}	0 8±0 20^{c}	0 9±0 21^{c}
GP3 kg	8 4±0 45	8 7±0 46^{b}	9 1±0 67^{b}	10 8±0 67^{a}	4 9±0 25^{c}
Total gain kg	9 1±0 61	12 5±0 59^{a}	10 6±0 60^{b}	9 8±0 50^{b}	3 9±0 26^{c}
First 55 days of P3 kg	7 1±0 41	7 1±0 52^{b}	7 7±0 72^{b}	9 4±0 55^{a}	4 3±0 30^{c}
Last 19 days of P3 kg	1 3±0 13	1 6±0 18^{a}	1 4±0 26^{a}	1 4±0 27^{a}	0 6±0 23^{b}

WEP1 2 3 = weight at the end of phases 1 2 3

GP1 2 3 = weight gain in phases 1 2 3

Row means with different superscripts are significantly different (p<0 05)

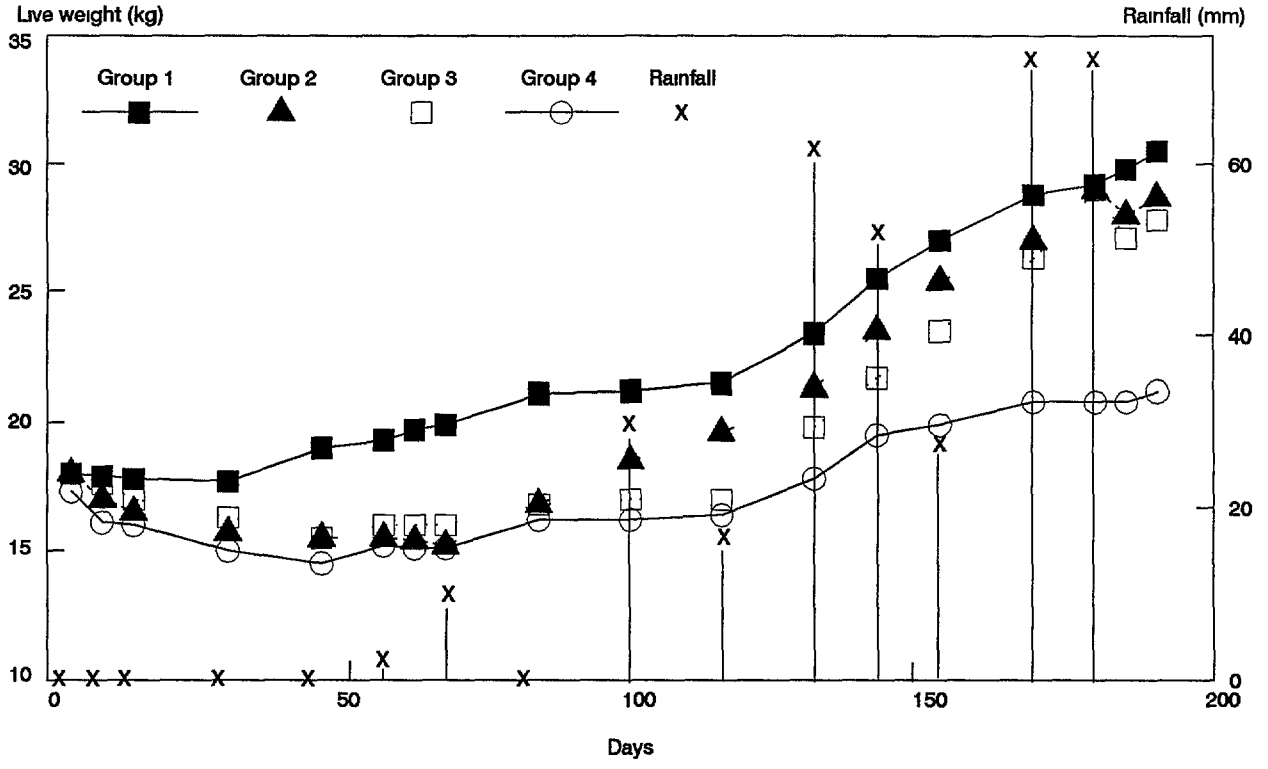

Figure 1 *Growth curves of lambs in the different groups and rainfall in the respective period*

Table 2 *Gain response to supplementation quantity of supplementary feed offered and partial feed conversion efficiency*

	Treatment group		
	1	2	3
Mean gain over unsupplemented			
Phase 1[a]	3 50	–	–
Phase 2[b]	1 45	3 05	–
Phase 3[c]	3 80	4 20	5 90
Total	8 60	6 70	5 90
First 55 days of Phase 3	2 80	3 40	5 10
Last 19 days of Phase 3	1 00	0 80	0 90
Total supplementary feed given			
Phase 1	9 45	–	–
Phase 2	7 35	7 35	–
Phase 3	24 67	24 6	24 67
Total	41 47	32 02	24 67
First 55 days of Phase 3	18 33	18 33	18 33
Last 19 days of Phase 3	6 33	6 33	6 33
Partial FCE			
Phase 1	2 70	–	–
Phase 2	5 07	2 41	–
Phase 3	6 49	5 87	4 18
Total	4 82	4 78	4 18
First 55 days of Phase 3 FCE	6 55	5 39	3 59
Last 19 days of Phase 3	6 33	7 92	7 03

a = gain over mean gain of groups 2 3 and 4

b = gain over mean of groups 3 and 4

c = gain over mean gain of group 4

Discussion

Lambs given no supplementary feed and grazed on natural pasture in the dry season lost weight while the supplemented lambs gained weight This shows that under Bako conditions natural pasture alone cannot maintain weight or support growth of lambs in the dry season Galal et al (1981) made a similar observation for the same sheep breed kept on cultivated pasture in the dry season when the stocking rate was high

Upon supplementation, previously unsupplemented lambs which had lost weight gained more than the continuously supplemented lambs Similar compensatory responses have been reported for Yankasa sheep (Lakpini et al 1982) and for Black Head Persian and Massai lambs (Massae and Mtenga 1992) On the contrary Galal et al (1981) found no difference in growth rate of previously unsupplemented Horro lambs and continuously supplemented lambs during a final phase of *ad libitum* indoor feeding of a ration composed of 75% concentrate and 25% hay However in the study of Galal et al (1981) the ration type and the feeding regime could have resulted in differential adaptation and intake level between the two groups

Upon supplementary feeding, the partial FCE of previously unsupplemented lambs was higher than the partial FCE of lambs supplemented continuously Ørskov et al (1976) had reported similar improvements in FCE in sheep Massae and Mtenga (1992) had also found a non-significant but superior trend in FCE of realimented lambs compared to those fed high level

Table 3 *Carcass measurement values and dressing percentage and correlations with live weight*

Measurement	Overall	Treatment group 1	2	3	4	r^2
Live weight kg	27 7	31 7	28 1	29 5	22 4	
Slaughter weight kg	25 8	29 8	26 5	27 2	20 8	0 99**
Carcass weight kg	11 9	14 3	12 2	2 6	9 2	0 98**
Dressing out %	42 8	44 9	43 1	42 7	40 9	0 66**
Tail weight kg	0 7	0 8	0 8	0 7	0 5	0 70**
Skin weight kg	2 6	3 2	2 8	2 7	2 0	0 94**
Viscera full kg	5 6	5 8	5 9	6 1	4 7	0 78**
Legs, kg	0 57	0 62	0 58	0 61	0 47	0 86**
Internal organs[1], kg	1 24	1 32	1 25	1 32	1 10	0 92**
Omental and kidney fat kg	0 06	0 08	0 07	0 06	0 04	0 80**
Head, kg	1 90	2 20	1 80	2 00	1 60	0 81**

1 = liver lung and trachea heart kidney (fat free) and spleen weighed together

2 = correlation of carcass measurements with live weight

** = Significant at P<0 01 level

supplement continuously Graham and Searle (1975) however, found no difference between FCE of realimented and continuously fed sheep Difference in composition of gain between realimented and continuously fed animals has been reported (McMannus et al 1972, Drew and Read 1975) and as composition may vary with age and weight differences in these factors may explain the discrepancy in the literature

All carcass measurement and dressing percentage values have shown a tendency to increase with weight and correlation coefficients pooled over all the treatments were very high The strong correlation between the various carcass measurement values and live weight suggests that within the growth stage of lambs in this study, similar live weights achieved either by compensatory or continuous growth can yield a carcass with similar composition and proportion of parts Previously, Galal et al (1981) reported significant differences between realimented and continuously fed lambs in carcass weight and dressing percentage and fat deposition measurements, but liveweight differences were also significant

Conclusion

Horro lambs grazing on poor natural pasture during the dry season and given no supplementary feed were found to lose weight Upon subsequent supplementary feeding the lambs showed compensatory growth and caught up with live weights of continuously supplemented lambs There was no serious effect of compensatory growth on carcass characteristics, while it improved partial FCE The results of this study suggest that in the dry season unsupplemented lambs grazing on natural pasture can tolerate weight losses of at least 10% with no long-lasting effect and upon subsequent supplementation they can experience compensatory gain with high FCE

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La croissance compensatrice chez les agneaux Horro en Ethiopie

Résumé

Cette etude porte sur la croissance compensatrice d'agneaux Horro precedemment eleves sur pâturages naturels de qualite mediocre au cours de la saison seche et recevant *ad libitum* un complement de concentre L'efficacite de la conversion partielle des aliments et les caractéristiques des carcasses ont egalement ete examinees La periode d'essai a ete divisee en trois phases de 63 (phase 1), 49 (phase 2) et 74 (phase 3) jours Quatre groupes (1 a 4) de 10 agneaux chacun ont ete constitues Le groupe 4 etait le groupe temoin et n'avait reçu aucun complément alimentaire Les trois autres groupes avaient reçu des niveaux eleves de complement au cours de la phase 3 alors qu'ils n'en n'avaient pas du tout reçu soit au cours des phases 1 et 2 (groupe 3), soit de la phase 1 uniquement (groupe 2) ou durant l'une des deux phases (groupe 1) Au cours de la phase 1 les agneaux du groupe 1 avaient gagne 1,5 kg alors que ceux des autres groupes avaient perdu 2,0 kg Au cours des phases 2 et 3 les agneaux des groupes 2 et 3 respectivement ont connu une croissance compensatrice Les differences de poids observées entre les groupes 1, 2 et 3 pendant les phases precédentes n'etaient plus significatives au cours de la derniere phase Le coefficient d efficacite de la conversion partielle des aliments etait plus eleve chez les agneaux ayant enregistre une croissance compensatrice que chez ceux dont la croissance etait continue, notamment lorsque les differences de poids vif entre eux n'etaient plus significatives Il y avait une correlation tres significative (P<0,01) entre toutes les mesures des carcasses et les poids vifs, les coefficients variant de 0 66 a 0,99 Cette etude montre que lorsque la complementation de saison seche est impraticable les agneaux Horro peuvent être eleves uniquement sur pâturages naturels et recevoir des complements par la suite Cela leur permet d'enregistrer une croissance compensatrice et d utiliser plus efficacement les aliments que si leur croissance avait ete maintenue grâce a une complementation

Effects of 'browse plus' on the utilisation of *Colophospermum mopane* (mopane) browse by sheep

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Abstract

In two experiments using indigenous sheep the effects of 'browse plus' (mixture of polyethylene glycol [PEG], polyvinylpyrrolidone [PVP] and a mineral and vitamin mix) on intake and digestibility of bushmeal (BM) was determined In the first experiment bushmeal special (BMS) (BM plus 'browse plus') intake was higher (P<0 05) than BM when both diets were offered *ad libitum* At similar levels of intake, dry-matter and organic-matter digestibilities were higher (P<0 05) for BMS than for BM There was no apparent difference in N metabolism between animals receiving the two diets In the second experiment BM and BMS did not increase (P>0 05) hay intake and nutrient digestibility when fed as supplements to grass hay Total dry matter intake and N retention were increased (P<0 05) No lesions were observed on the gastro-intestinal tract liver and kidneys of the animals receiving BM or BMS It was concluded that BM and BMS could serve as feed resources for ruminants

Introduction

Drought feeding strategies have included the intensive use of browse because trees are less susceptible to climatic fluctuations than herbaceous plants Browse usually has higher crude protein content than grasses (Dube and Ncube 1993) However, the presence of secondary compounds, mainly polyphenolics/tannins, limits the feeding value of the browse through depression of intake and digestibility (McLeod 1974) Tannins bind with dietary enzymatic and microbial protein to form insoluble complexes that are not degraded in the rumen, resulting in reduced digestibility and intake Information on fate of tannin–protein complexes post-rumen has been variable Kidney, liver and gastro-intestinal tract damage in animals consuming tanniferous forage has been reported (Bailey 1978)

Polyethylene glycol (PEG) and polyvinyl-pyrrolidone (PVP) preferentially bind with tannins resulting in the reversal of tannin effects on forage utilisation Response to PEG depends on the type of tannin and the tannin PEG ratio (Strachan et al 1988)

Drought tolerant *Colophospermum mopane* (mopane) is prevalent in the southern and western lowveld regions of Zimbabwe where fallen dry leaves and pods are an important feed resource for both domestic and wild ungulates Fresh leaves are rarely browsed probably due to the presence of secondary compounds During the severe drought of 1992 mopane browse (leaf and fine stem) was fed to cattle as bushmeal (BM, mopane browse comprising leaf and fine stem) by crushing and mixing with maize bran, molasses and coarse salt in the ratio 53 8 30 15 1 2 (Triangle Limited) 'Browse plus' (Agricura Zimbabwe) crystals were added at a rate of 100 g/t of BM to make bushmeal special (BMS) Browse plus contains PEG, PVP and a vitamin and mineral mix Animal responses to feeding of both BM and BMS have not been studied The current study was undertaken to determine the effect of feeding BM and BMS as sole feeds or as supplements to poor quality hay on nutrient utilisation and clinical status of the kidneys, liver and gastro-intestinal tract of sheep

Materials and methods

Preparation of feeds

BM and BMS were obtained wet from Triangle Limited On arrival at the station they were sun-dried before feeding Natural pasture hay was cut during the dry season and was of poor quality

Animals and feeding

Ten 2-year old indigenous wethers (average weight 41 1±1 0 kg) were used in the first experiment Animals were drenched with an anthelminthic (Ranide, Agricura Zimbabwe) before being housed in metabolism crates which allowed separate collection of faeces and urine The animals were blocked on the basis of live weight and randomly allocated to either BM or BMS within each block Feed was offered *ad libitum* in two equal meals at 0800 and 1600 h and the amount offered was 115% of the previous day s intake Water was offered three times a day

A 21-day adjustment period was followed by a seven-day collection period At the end of the first collection period animals receiving BMS remained in the experiment for another 14 days divided equally into

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adjustment and collection periods Their dry-matter (DM) intake was, however restricted to the same level as those on BM

In the second experiment 14 two-year old wethers (average weight 40 0±1 0 kg) were used The animals were blocked on the basis of live weight and the diets were randomly allocated to the animals within the blocks Hay alone was fed to four animals while each of the supplements was fed to five animals Animals received 200 g/head per day of the supplement The supplement was offered during the first 30 minutes of feeding Hay was then offered at 115% of the previous day's intake A 21-day adjustment period followed by seven days of sampling was used

During the collection periods refusals and urinary and faecal output were recorded Refusals were pooled over the collection period for each animal and stored at room temperature awaiting analysis Ten per cent of the faeces were oven-dried at 55 C to determine dry matter content Urine was collected in vessels containing 25 ml of 1N H_2SO_4 to reduce loss of ammonia Ten per cent of the urine was stored at –20 C for subsequent chemical analysis At the end of the feeding period three animals from each treatment were slaughtered for visual detection of lesions on the liver, kidneys and the gastro-intestinal tract

Laboratory methods

Feed, refusals and faecal samples were ground to pass through a 1 mm screen for determination of organic matter (OM) and nitrogen using standard procedures (AOAC 1984) Neutral-detergent fibre (NDF) was determined using the method described by Goering and Van Soest (1970) Urine was analysed for nitrogen content using the Kjeldahl method

Statistical analysis

Analysis of variance on all data was carried out using a model that included the effect of diet (Genstat 1988)

Results

The chemical composition of the hay BM and BMS is shown in Table 1 The N contents of BM and BMS were similar but were higher (P<0 05) than those of the hay However, the hay had higher (P<0 05) NDF content There was no apparent damage to the liver kidneys and the gastro-intestinal tract of the animals from the two experiments

Chemical composition of bushmeal (BM) bushmeal special (BMS) and grass hay (GH) used in the study

Chemical components	BM	BMS	GH
Dry matter	9 1	90 4	94 2
Organic matter	90 2	906 5	940 8
Nitrogen	15 0	15 0	4 3
Neutral detergent fibre	547 4	555 9	841 1
Acid detergent fibre	307 1	311 9	nd

Dry matter as % of wet weight other constituents as g/kg dry matter

nd = not determined

Intake

Animals readily ate both BM and BMS When offered *ad libitum* DM intake from BMS (1 4 kg/head per day) was higher (P<0 05) than that from BM (1 3 kg/head per day) (Table 2) Table 3 shows intake of various nutrients

Nutrient intake dry matter and organic matter digestibility and N retention by sheep fed bushmeal (BM) and bushmeal special (BMS)

Parameters	BM	BMS[1]	BMS[2]	SED
Intake (g/head per day)				
Dry matter	1268 5[a]	1242 7[a]	1404 0[b]	61 8
Organic matter	1158 2	1156 2	nd	23 8
NDF	690 3	631 5	nd	18 0
Apparent digestibility (%)				
Dry matter	58 8[a]	68 2[b]	60 1[a]	1 5
Organic matter	59 9[a]	70 3[b]	nd	1 6
N balance (g/head per day)				
N eaten	20 6[b]	18 6[a]	nd	0 2
N in faeces	8 0	6 9	nd	1 0
N in urine	1 7	2 1	nd	0 3
N balance	10 9	9 7	nd	1 0
N faeces/N urine	5 0	3 5	nd	1 2

1 BMS = BMS dry matter intake restricted to that of BM *ad libitum*

2 BMS = BMS fed *ad libitum*

Values are means of five observations SED = standard error of differences of means

NDF = neutral detergent fibre nd = not determined

Within row means with different superscripts differ significantly (P<0 05)

when grass hay was supplemented with BM and BMS Supplementation did not reflect grass hay intake (P>0 05) However, animals receiving supplements ate more total DM and OM than those fed grass hay alone (P<0 05) Supplementing with BM did not increase (P>0 05) NDF intake while supplementation with BMS resulted in higher (P<0 05) NDF intake than the control

Dry matter and OM digestibility

In the first experiment, when BM and BMS intakes were similar, DM and OM digestibilities were higher (P<0 05) in animals receiving BMS (Table 2) However, when BMS was fed *ad libitum,* DM digestibility was similar for the two diets In the second experiment DM and OM in the three diets were digested to a similar (P>0 05) extent (Table 3)

Nitrogen balance

In Experiment 1 nitrogen balance was measured in animals consuming similar amounts of BM and BMS Animals receiving BM ate more N (P<0 05) than those receiving BMS (Table 2) However, faecal and urinary N output and the relation between the two was not affected by diet (P>0 05) Nitrogen retained by the animals on the two diets was similar (P>0 05) In Experiment 2, supplementation of veld hay increased (P<0 05) N intake although N intake by the groups receiving supplements was similar (P>0 05) (Table 3) Faecal and urinary N output were similar (P<0 05) for all three diets and N retention was higher (P<0 05) in the groups receiving supplements than in those fed hay alone

Discussion

Although no tannin assay was carried out on BM or BMS, Walker (1980) stated that mopane browse has high levels of tannins These are implicated in the reluctance of livestock to eat fresh mopane browse In the current study animals readily consumed both BM and BMS indicating the improved palatability due to maize bran, molasses and salt It is generally accepted that polyphenolics/tannins interfere with forage nutrient utilisation by animals through their protein-precipitating ability which causes reduced intake and digestibility of most nutrients (McLeod 1974, Barry and Duncan 1984, Woodward and Reed 1989)

Reversal of tannin effects on nutrient utilisation by PEG observed in this study has been reported by other workers Barry and Manley (1984) reported increased OM digestibility when they sprayed tanniferous *Lotus pedunculatus* (lotus) fresh herbage with PEG In another study Strachan et al (1988) observed increased DM intake and unchanged digestibility by sheep consuming a mulga (*Acacia aneura*) diet with PEG inclusion However, Nunez-Hernandez et al (1991) observed no effects of PEG on OM intake and digestibility by goats and sheep fed mountain mahogany (*Cercocarpus montanus*)

The similarity in N metabolism between animals consuming BM and BMS was not expected Despite higher N intake by animals receiving BM, faecal and urinary N and N retention were not different This is contrary to the findings of Nunez-Hernandez et al (1991) who observed reduced faecal N and increased urinary N when animals consuming mountain mahogany were given PEG Increased excretion of N through faeces by

Table 3 *Nutrient intake dry matter and organic matter digestibility and nitrogen retention by sheep fed grass hay (GH) supplemented with 200 g/head per day of bushmeal (BM) or bushmeal special (BMS)*

Parameters	GH alone	GH+BM	GH+BMS	SED1	SED2
No of animals/treatment	4	5	5		
Intake (g/head per day)					
GH	626 3	602 2	675 2	51 4	48 4
Total dry matter	626 3[a]	713 6[b]	752 5[b]	27 2	25 6
Organic matter	588 0[a]	655 0[b]	707 6[b]	25 4	23 9
Neutral-detergent fibre	513 8[a]	544 5[a]	589 8[b]		
18 3	17 3				
Apparent digestibility (%)					
Dry matter	48 4	49 2	51 0	3 2	3 0
Organic matter	51 3	49 5	53 4	3 1	2 9
Nitrogen balance (g/head per day)					
N intake	3 1[a]	5 1[b]	5 1[b]	0 1	0 1
N in faeces	3 1	3 3	3 8	0 3	0 3
N in urine	1 1	1 1	0 7	0 2	0 3
N balance	–1 1[a]	0 7[b]	0 6[b]	0 8	0 7
N faeces/N intake	1 0[b]	0 7[a]	0 7[a]	0 1	0 1

SED1 = standard error of differences of means of unequally replicated treatments

SED2 = standard error of differences of means of equally replicated treatments

Within row means with different superscripts differ significantly (P<0 05)

animals fed high tannin forage was also observed by Barry and Duncan (1984) when they fed lotus to sheep The increase in faecal N is due to the formation of indigestible protein–tannin complexes (Woodward and Reed 1989)

Total DM intake increased with BM and BMS feeding with no effect on basal diet intake and DM and OM digestibilities Strachan et al (1988) and Nunez-Hernandez et al (1991) observed increased DM and OM intake with no effect on digestibility Strachan et al (1988) postulated that rate of rumen turnover is increased by PEG inclusion The level of PEG used in this study (±0 1 g/head per day) is not expected to have had profound effects on digesta flow kinetics The higher N retention on supplementation was due to higher N intake

The comparison of published results with the current study needs to be viewed with caution Tannin–PEG–protein interactions are affected by many factors such as tannin molecular weight and structure protein type (Scalbert 1991) and PEG molecular weight In the studies reviewed different forages were used with different levels of PEG complicating the interpretation of results It is likely that polyphenolics present in mopane browse are different to those in the forages used by the other workers

Conclusion

This study confirms other research findings that PEG reverses the effects of polyphenolics/tannins on nutrient utilisation, largely through improved nutrient digestibility Both BM and BMS could serve as dry season feed resources although longer feeding periods are required to have conclusive results on physiologic effects Research into methods of encouraging *in situ* feeding of mopane browse warrant investigation in view of the costs of making bushmeal

Acknowledgements

The assistance of Agricura and Mr J Stambolie of Triangle Limited in providing the feeds, and the Nutrition Section staff at Matopos Research Station in looking after the animals is acknowledged Thanks to Drs T Smith and S Sibanda for comments on the draft of this paper

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Effet d'un mélange "ligneux plus" sur l'utilisation du foin de *Colophospermum mopane* chez les ovins

Résumé

Deux essais ont eté effectues pour determiner l'effet d'un melange appele 'ligneux plus' (polyethylene-glycol, polyvinylpyrrolidone et melange vitaminique) sur l'ingestion et la digestibilite du foin de brousse (feuilles et tiges finement haclees de *Colosphorpermum mopane*) Dans la premiere experience, l'ingestion de l'aliment compose (foin + melange) etait plus elevee (P<0,05) que celle du foin seul lorsque les deux aliments étaient offerts *ad libitum* Avec le même niveau d'ingestion, les digestibilites de la matiere seche et de la matiere organique de l'aliment compose etaient meilleures (P<0,05) que celle du foin Il n'y avait aucune différence apparente dans le metabolisme azote des animaux recevant les deux rations Dans la seconde experience, la consommation de foin de brousse et d'aliment compose, servis en complement de foin de graminee, n'augmentait (P>0,05) ni l'ingestion du foin ni la disgestibilite de ses elements nutritifs La consommation totale de matiere seche et la retention de l'azote augmentaient (P<0,05) Aucune lesion n'avait ete observee dans l'appareil digestif, le foie et les reins des animaux recevant du foin de brousse ou l'aliment compose On peut donc conclure que ces deux produits peuvent être utilises pour l'alimentation des ruminants

Effect of castration and diet on performance and feed utilisation in Saanen goats

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Abstract

Growth performance, digestibility and water intake studies were conducted on growing Saanen male and castrate goats The goats were either fed ad libitum a barley-based concentrate diet or lucerne pellets There were little castration and diet effects from arrival to weaning Males grew faster (222 vs 183 g/day), had a lower conversion ratio (3 13 vs 4 11 g DM/g gain) and higher dry-matter intake (751 vs 744 g/day) than castrates However, in the 24 5 to 36 5 kg liveweight period, castrates were superior to male goats in most parameters studied Digestibility coefficients were higher in the barley-based diet Dry-matter intake as a percentage of live weight ranged from 2 51 to 3 86 Nitrogen was better retained in goats on barley concentrate Goats consumed water at 8 to 12% of their live weight, higher values being for goats fed lucerne

Introduction

There is scarce information on the effect of castration on growth rate and feed utilisation in goats Differences in the rate of gain between castrates and intact males are unclear In cattle and sheep, it has been conclusively shown that entire male animals grow faster and utilise feed better than castrated animals (Bradfield 1968 Hedrick 1968, Turton 1969, Field 1971, Price and Yeates 1971) In contrast with this view, Mackenzie (1970) working with British Toggenburg goats concluded that castration makes full use of the meat potential of surplus goats as castrated goats grow faster and are heavier than entire male goats In corroboration with this view Kyomo (1978) found that castrated Small East African goats were heavier than entire males from weaning to 72 weeks of age However, Nitter (1975) found that male German Fawn breeds of goats grew faster than castrates, a conclusion also reached by Louca et al (1977) with Damascus goats The potential for growth and feed utilisation in Saanen entire male and castrate goats based on concentrate and grass diets has not been documented The aim of the present study was therefore to investigate the effects of castration and diet on performance of Saanen goats

Materials and methods

Sixty male (entire) and six castrated British Saanen goats were used in an experiment to test the effect of castration (entire males vs castrates) and the diet (barley-based concentrate vs lucerne pellets) on growth performance and feed utilisation in a 2x2 factorial experiment Animals were purchased from farmers at 2–3 days of age and were randomly allocated to the four treatments Arrival weight was obtained by weighing the kids on the day of collection from the farms around Reading University (UK) where the experiment was conducted Castration took place at 11±1 days of age using rubber rings Besides the treatments, all kids were fed artificial milk (Denkavit Lamb 211) *ad libitum* from arrival to weaning at 35 days of age

The barley-based concentrate and lucerne pellets were fed *ad libitum* The barley diet consisted of milled barley, soybean meal, fish meal molassine meal, ground limestone, salt and Isaac Spence minerals at 800, 100, 50, 30 15, 4 and 1 g/kg dry matter respectively Each 1000 g of Isaac Spence minerals consisted of 105 5 g Ca 34 7 g P, 97 9 g Na, 150 8 g Cl, 137 5 g Mg, 9 7 g Fe, 0 8 g Mn 0 13 g Co, 0 21 g I and 110,000 IU Vitamin D (manufacturer's specification) The barley diet was not pelleted Lucerne was dehydrated, milled and pelleted at the Reading University Farm and measured 30 mm long and 10 mm thick Animals were individually penned and water was available all the time Animals were weighed weekly and dry matter intake was recorded

Six entire male and six castrate goats from weaning to 24 5 kg live weight were randomly allocated to the two diets for digestibility nitrogen utilisation and water intake studies There was an 8-day collection period, during which daily intake of feed and water were measured Faecal and urine outputs were also recorded Faecal and urine samples were preserved according to Schneider and Flatt (1975) AOAC (1975) methods were used in analysing the chemical components of samples

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Results

The chemical analyses of the barley concentrate and lucerne diets are shown in Table 1 The two diets were almost isocaloric and isonitrogenous in content

Table 1 *Chemical composition of the diets (g/kg dry matter)* [1]

Chemical composition	Barley concentrate Mean±SD	Lucerne pellets Mean±SD
Dry matter (g/kg air dry weight)	900±4	900±12
Crude protein	199±3	199±5
Ether extract	27±1	26±1
Ash	65±5	98±1
Calcium	18±1	31±5
Phosphorus	4±0 3	2±0 8
Lignin	14±2	89±8
Energy (MJ/kg DM)	18 62±0 79	18 68±0 29

1 Mean of eight samples

Castration and diet had no significant (P>0 05) effects on growth and feed utilisation from arrival at the University Farm (4±0 5 days of age) to weaning at 35 days of age (Table 2) From weaning to attaining 24 5 kg live weight, entire male goats grew (39±9 g/day) faster (P<0 001) than castrates There was no effect (P>0 05) of castration on daily feed consumption but because castrates took a longer time (16 days) to reach the target weight of 24 5 kg they consumed more dry matter Castrate goats were less (P<0 001) efficient in utilising their feed than entire male goats Goats fed the barley concentrate diet grew (25 g/day) faster (P<0 001) than those fed lucerne Daily dry-matter intake was higher (P<0 001) in goats fed lucerne, but they utilised the feed less efficiently compared to goats on barley concentrate (P<0 001)

There was a change in male status effect on most characteristics studied in the 24 5 to 36 5 kg liveweight range Castrate goats grew (49±21 g/day) faster (P<0 05) than the males Castrate goats also ate more dry matter (P<0 05) and more but not significant (P>0 05) metabolisable energy The trend in performance of goats fed barley concentrate within the 24 5–36 5 kg growth

Table 2 *Effect of castration and diet on performance of goats in different weight periods* [1 2]

	Castration			Diet		
Parameters	Male	Castrate	SED	Barley	Lucerne	SED
Weight from arrival to weaning						
No of animals	30	30		30	30	
Weight at weaning (kg)	8 16	8 10	0 31	7 98	8 27	0 31
Daily DM intake (g)	184	182	10	183	183	10
Daily energy intake (MJME)	3 73	3 84	0 16	3 81	3 76	0 16
Growth rate (g/day)	130	125	10	124	128	10
FCR (g DM/g gain)	1 44	1 49	0 09	1 49	1 44	0 09
Weight from weaning to 24 5 kg						
No of animals	24	24		24	24	
Weight at weaning (kg)	7 91	7 75	0 34	7 62	8 05	0 34
Actual weight at 24 5 (kg)	26 03	25 59	0 44	25 42	26 48	0 48
Age at 24 5 kg (days)	117	132	5 0**	118	131	5 0*
Daily DM intake (g)	751	744	30	605	830	30
Daily energy intake (MJME)	7 67	7 50	0 24	7 72	7 45	0 24
Growth rate (g/day)	222	183	9***	215	191	9*
FCR (g DM/g gain)	3 13	4 11	0 16**	3 13	4 39	0 16***
Weight from 24 5 to 36 5 kg						
No of animals	12	12		12	12	
Actual weight at 24 5 kg	25 29	25 02	0 32	24 94	25 37	0 32
(kg)				174	11 48	0 57
Actual weight at 36 5 kg	37 84	38 00	0 16	37 84	38 00	0 16
(kg)						
Age at 36 5 kg (days)	194	184	9**	174	204	9**
Daily DM intake (g)	1094	1290	76**	1055	1334	76*
Daily energy intake (MJME)	10 99	12 69	0 59**	12 19	11 48	0 57
Growth rate (g/day)	185	234	21 7**	237	182	21 7*
FCR (g DM/g gain)	5 94	5 51	0 56	4 45	7 32	0 56***

1 Animals on arrival weighed 4 0–4 45 kg

2 * = P<0 05 ** = P<0 01 *** = P<0 001 Figures without asterisks are not significantly different P>0 05

period was similar to earlier periods Animals on barley concentrate grew faster by 55±22 g/day (P<0 05) ate less (1055 vs 1334 g) dry matter and slightly more (12 19 vs 11 48 MJ) metabolisable energy and utilised their feed more efficiently compared with those offered lucerne

In general, digestibility coefficients were not affected by castration (P>0 05) although there was a tendency for castrates to exhibit lower digestibility coefficients (Table 3) However differences in digestibility coefficients in favour of goats fed barley concentrate were significant (P<0 001) Goats on barley concentrate consumed dry matter which was equivalent to 2 51% of live weight while goats on lucerne consumed dry matter which was 3 86% of live weight

Fehr et al 1976 with Alpine goats) Thus a great potential apparently exists for improving tropical breeds of goats by crossing with European breeds provided proper consideration is given to management and feeding

The influence of castration on pre-weaning growth rate was small and non-significant in agreement with the findings of Peters and Heaney (1974) Performance of kids was not influenced by dam milk yield as they were artificially reared The performance characteristics in the weaning to 24 5 kg interval in favour of males have been reported in other breeds of goats (Nitter 1975 Louca et al 1977) and in cattle and sheep (Turton 1969) This is attributed mainly to sex hormones (Turton 1969 Field 1971) The claim by Mackenzie (1970) and, more recently, by Kyomo (1978) that castrates grow faster

Table 3 *Digestibility as influenced by castration and diet*

	Castration			Diet		
	Male	Castrate	SED	Barley	Lucerne	SED
No of animals	6	6		6	6	
Daily intake						
Dry matter (9)	946	1056	74	775	1222	74***
DM (% live weight)	2 95	3 46	0 14*	2 51	3 86	0 14***
Gross energy (MJ)	17 62	19 59	1 38	14 43	22 78	1 38***
Crude protein (g)	185	206	14	154	236	14***
Digestibility coefficients (%)						
Dry matter	68	66	0 9	77	58	0 9***
Organic matter	70	68	09	79	59	0 9***
Energy	69	67	0 9	78	58	0 9***
Protein	75	73	0 8	80	68	0 8***

* P<0 05 *** P<0 001

Goats fed barley concentrate were more efficient (P<0 001) in nitrogen utilisation than goats fed lucerne (Table 4) The differences between male and castrate goats were small (P>0 05) Castration had no effect on voluntary water intake (Table 4) Goats fed lucerne consumed more water (P<0 001) in absolute amount as a proportion of live weight and per kg dry matter Lucerne fed goats consumed about one and a half times as much dry matter and about twice as much ash as consumed by goats fed the barley concentrate

Discussion

Diets in the present study were formulated in such a way as not to be limiting in energy and protein according to nutrient requirements of growing dairy goats (Devendra and McLeroy 1982) It can be concluded that from birth to weaning, the growth rate of Saanen goats can range from 124 to 130 g/day while from weaning to 24 5 kg live weight and from 24 5 to 36 5 kg live weight expected growth rate can range from 183 to 222 and 182 to 234 g/day, respectively Similar growth rate values have been reported with other dairy goat breeds in Europe under intensive systems (Ladipo 1973 with a mixture of dairy goats, Nitter 1975 with German goats, than males is difficult to reconcile with the present findings

An interesting and important aspect in the present study is the reduced growth rate observed for male goats in the 24 5 to 36 5 kg liveweight period which was accompanied by slight reduction in feed intake Similar reduction in growth rate in male goats have been observed in Damascus goats (Louca et al 1977) and is attributed to breeding season effect which was in August to October in the present study The observation that feed conversion ratio (FCR) in goats increases with increasing live weight (Fehr et al 1976 Louca et al 1977) is corroborated by the findings of this study

The results tend to suggest that lucerne-fed goats increased their dry matter intake in an attempt to sustain the same metabolisable energy intake as that of goats on barley concentrate although they failed to compensate fully During the weaning to 24 5 and 24 5 to 36 5 kg intervals daily dry matter intake was 37% and 26% more for lucerne-fed than for barley-fed goats, respectively The metabolisable energy concentration in barley was 33% greater than that in lucerne However, the intake of the lucerne diet was so high that ME intakes from barley diets were only 4–6% greater than those from the lucerne diets Digestibility coefficients of 0 75–0 82 have been

Table 4 *Nitrogen retention and water utilisation as influenced by castration and diet*

	Castration			Diet		
Parameters	Male	Castrate	SED	Barley	Lucerne	SED
No of animals	6	6		6	6	
Dry matter intake (g/day)	946	1051	84	775	1222	84***
Ash intake (g/day)	76	89	7	50	115	7***
Nitrogen retention						
g/day	9 20	10 66	1 07	9 97	9 89	1 07***
% intake	32 78	33 56	1 93	40 29	26 05	1 93***
% digested	43 19	44 99	2 65	49 94	38 25	2 65
Daily intakes						
Water (kg)	2 58	2 76	0 05	1 53	3 82	0 05***
Water (kg/kg DM)	2 72	2 62	0 48	1 97	3 12	0 48***
Water (% live weight)	8 00	9 0	1 58	4 94	12 16	1 58***

*** = P<0 001

quoted for barley diets, and 0 55–66 for lucerne (Ørskov et al 1974, Waiman 1977) These values are similar to those in the present study

Voluntary food intake as percentage of live weight is a much used measure of intake capacity The dry matter intakes of 2 51–3 86% obtained in the present study are in agreement with those reported in other breeds of goats as reviewed by Devendra and McLeroy (1982) The elevated proportion of nitrogen appearing in the urine and faeces of goats fed lucerne as reflected in less nitrogen retention is suggestive of a greater extent of formation of ammonium and other related non-protein nitrogenous substances in the rumen and hind gut which were absorbed and subsequently lost via the kidney and undigested protein

Water intake increases with increase in dry matter intake (Anand 1961) The present study shows that the goat is no exception It has been recommended that at environmental temperatures of 15 C and 15–20 C, water intake for growing lambs should be 2 00 and 2 50 kg/kg dry matter consumed respectively (Devendra and McLeroy 1982) A similar value of 2 52–2 62 kg/kg dry matter was obtained in the present study for a mean temperature of 17 C Higher water intake for goats fed lucerne in the present study may have been simply a reflection of higher dry matter and ash intakes by the animals

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Effet de la castration et du régime alimentaire sur les performances et l'utilisation des aliments chez les caprins de la race de Saanen

Résumé

Les performances de croissance, la digestibilite et la consommation d'eau de jeunes boucs Saanen entiers et castres ont ete etudiees Ils recevaient *ad libitum* soit des concentres a base d orge soit du fourrage condense de luzerne L effet de la castration et de l alimentation etait insignifiant jusqu au sevrage Les mâles entiers croissaient plus vite (222 contre 183 g/jour), avaient un taux de conversion alimentaire plus faible (3 13 contre 4 11 g de MS/g de gain de poids) et consommaient plus de matiere seche (751 contre 744 g/jour) que les castrats Toutefois, entre 24,5 et 36,5 kg de poids vif, ces derniers etaient superieurs aux mâles entiers pour la plupart des parametres etudies La digestibilite de la ration a base d orge etait plus elevee La consommation de matiere seche equivalait a 2 51 a 3 86% du poids vif La retention d azote etait plus elevee chez les animaux recevant du concentre d orge Enfin, la consommation d eau equivalait a 8 a 12% du poids vif, avec des taux plus eleves pour les animaux recevant du fourrage de luzerne

Calliandra leaf meal in goat rations: Effects on protein degradability in the rumen and growth in goats

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Abstract

A study was carried out to evaluate the value of *Calliandra* leaf meal as a soybean meal supplement for goats Goats on 75 and 100% *Calliandra* meal diets consumed more dry matter and utilised the feed more efficiently (P<0 05) that goats on other diets Compositing *Calliandra* leaf meal with soybean meal enhanced the uptake and utilisation of both supplements by providing a better amino acid profile The results show that while *Calliandra* alone can provide the required nitrogen for growth and feed utilisation efficiency, its nutritive value is enhanced when fed together with soybean meal

Introduction

Calliandra calothyrsus is one of the multi-purpose tree species that has been intensively evaluated in Uganda since 1989 under the agroforestry programme The use of the crop for fodder is impeded by low production of forage biomass within smallholdings and its high tannins and related polyphenols content These compounds make the leaves astringent and poorly digestible

Preliminary investigation (Ebong et al 1992) indicated that astringency and adverse effects on digestibility can be negated by compositing the forage with soybean meal (SBM) The objective of the present study was to examine the effect of levels of substitution of *Calliandra* leaf meal (CLM) for SBM on animal performance, especially in relation to energy and nitrogen retention

Materials and methods

Animals and treatment

Thirty-six young intact male goats were used in a growth trail of 70 days These were stratified according to body weight and randomly allocated to six dietary treatments *ad libitum* elephant grass (diet 1), *ad libitum* elephant grass plus pure SBM (diet 2), 25 75 SBM CLM (diet 3), 50 50 SBM CLM (diet 4) 75 25 SBM CLM (diet 5) pure CLM (diet 6) All composites were made isonitrogenous by addition of maize bran The amounts of maize bran added was calculated using the Pearson Square method

Daily feed offers and refusals were weighed and sampled for subsequent analysis Live weight of each animal was measured at weekly intervals for 10 weeks Thereafter four animals from each treatment group were selected randomly and fitted with faeces and urine collection harnesses Total collection of faeces and urine was undertaken for four days following an adaptation period of five days Samples of urine and faeces from each animal were taken and bulked across the days of collection for subsequent analysis

Chemical analysis

Samples of feed and faeces were analysed for dry matter (DM) nitrogen (N) (AOAC 1980) neutral-detergent fibre (NDF), acid-detergent fibre (ADF), lignin and fibre bound nitrogen (Goering and Van Soest 1970)

Calculations

Intake components were calculated as difference between offers and refusals corrected for dry matter contents of the feeds Digestibility was calculated as the proportion of dry matter intake (DMI) not recovered in the faeces Growth rate was calculated as the regression coefficient of weekly body weights on days of feeding (ADG) Feed conversion efficiency (FCE) was calculated as the ratio of intake per gram of body weight gain These parameters were examined by Least Square Analysis of Variance using the Statgraphics programme Means were compared by Duncan's Multiple Range Tests (Gomez and Gomez 1984)

Results

The chemical composition of the feeds is shown in Table 1 The results indicate that the attempt to realise isonitrogenous feed treatments was not successful This may have been due to improper mixing, mixing was undertaken by hand It was not possible to carry out analysis before the feeding trial

Average DM intake and average daily weight gain (ADG) during growth are shown in Table 2 Both parameters differed significantly (P<0 001) between diets Goats fed on 75 and 100% CLM had the highest

Table 1 *Chemical composition (g/kg DM) of feed fed to goats in the growth trial*

Chemical composition	Diets					
	1	2	3	4	5	6
OMI	948 3	956 9	935 4	948 4	946 7	935 4
Nitrogen	15 7	56 7	34 9	39 2	43 7	33 3
NDF	707 2	182 7	224 3	202 1	191 1	242 5
ADF	425 2	173 6	174 3	175 3	168 8	164 0
Lignin	232 6	117 5	133 1	254 0	149 1	144 5
Ash	51 8	33 1	64 6	51 8	53 3	64 6

OMI = organic matter intake NDF = neutral detergent fibre ADF = acid detergent fibre

Table 2 *Dry matter intake (g/d g/kg$^{0\ 75}$) average daily gain (g/d) and feed conversion efficiency (FCE g feed/g body weight gain) in goats fed elephant grass (*Pennisetum purpureum*) with or without supplements*

Parameters	Diets						
	1	2	3	4	5	6	SE
DMI (g/d)	456 8±23 0^{d}	366 4±19 3^{e}	595 3±18 5^{ab}	529 6±19 0^{bc}	473 0±19 0^{cd}	658 9±87 4^{a}	14 4
Kg$^{0\ 75}$	67 2±3 1^{bc}	54 5±2 8^{d}	81 3±2 9^{a}	71 9±2 5^{b}	65 0±2 2^{c}	79 4±2 9^{a}	1 1
ADG (g/d)	27 1±4 0^{d}	44 9±6 5^{c}	83 9±7 8^{b}	103 3±8 9^{a}	67 0±12 9^{bc}	58 6±9 8^{c}	3 6
FCE (g/g gain)	17 6±2 6^{a}	10 2±1 4^{b}	6 7±0 5^{bc}	4 8±0 4^{c}	9 7±3 7^{b}	10 0±1 5^{c}	0 8

FCE = g feed/g weight gain values in a row with the same superscript do not differ (P>0 05) SE = standard error of the means

DM intakes These values decreased progressively with increasing levels of SBM in the diet With the exception of diet 2 (100% SMB) and diet 5 (75% SBM) all supplements increased DMI significantly (P<0 05) above the intake of control animals

Average daily gain also differed between diets (P<0 001) Supplementation increased average daily gain by 1 5- to fivefold The highest daily gains were observed in animals supplemented with diet 4 (50 50 SBM CLM) The differences in performance were also reflected in feed conversion efficiency (P<0 01)

Estimates of nutrient intakes digestibility and N retention (NR) during the metabolic trial period are shown in Table 3 DM (P<0 05) and N (P<0 001) intakes differed significantly between diets The highest DM intake and OMI were observed in the control goats and those fed on diet 6 (100% CLM) The lowest DM intake and OMI values were observed in the animals fed on diet 4 (50 50 SBM CLM) A strong quadratic trend was also evident

The highest N intakes were observed in goats fed diets 2 and 6 (75 and 100% SBM, respectively) Values were observed in animals fed diets 3, 4 and 6 (25, 50 and 100% SBM respectively) were similar to each other

DM and OM digestibility and digestible organic matter intake (DOMI) did not differ between diets (P<0 05) (Table 3) All values were notably high (666 g/kg DM) However, apparent N digestibility differed between diets (P<0 01) but no consistent trend was established (Table 3) The lowest N retention values were obtained in animals fed the control diets 1 and 4 (no supplement and 50% SBM, respectively) Similar retention values were observed in diets 2, 3, 5 and 6 these were not different from one another

Discussion

This experiment is a follow-up of the preliminary trial reported earlier (Ebong et al 1992) It has confirmed that compositing enhances intakes of both SBM and CLM The mechanisms involved have not been adequately investigated The experiment also confirmed that on its own, *Calliandra* can supply the N required to increase growth and possibly milk yields However, the nutritional value can be improved by compositing with SBM

However the association of enhanced growth rate and feed efficiency with lower N retention values was not expected Possible explanations include improved amino acid balance partition of energy between fat and protein deposition, or specific tissue metabolism and development notably the gut, liver, skin and muscle These tissues have variable contributions to total body

Table 3 *Intake (g/d) and digestibility (g/kg DM) and nitrogen retention (g/d) in growing goats fed* ad libitum *elephant grass (*Pennisetum purpureum*) and supplements consisting of complementary proportions of soybean meal (SBM) and* Calliandra calothyrsus *leaf meal (CLM)*

	Diets						
	1	2	3	4	5	6	SE
Intake							
Elephant grass	468 2±34 6^{a}	616 6±27 8^{c}	275 7±24 6d^{e}	217 8±34 4^{e}	239 6±21 8^{e}	398 2±33 3^{b}	12 2
Supplements	–	268 9±34 2^{b}	372 6±20 5^{a}	368 2±39 2^{a}	370 9±38 9^{a}	284 9±33 5^{b}	12 5
Total DM	684 2±34 6^{a}	524 3±26 9b^{c}	603 3±26 9^{ab}	504 6±57 3^{c}	545 1±47 2^{bc}	667 6±35 2^{a}	17 1
Total OM	611 2±27 1^{a}	493 8±46 5^{bc}	572 1±25 5^{ab}	478 9±68 3^{ab}	512 2±44 3^{bc}	631 6±35 2^{a}	16 6
Total N	10 2±0 5^{c}	19 3±2 1^{a}	16 7±0 7^{ab}	16 5±2 2^{ab}	19 0±1 7^{a}	15 5±1 0^{b}	0 6
Digestibility							
DM	77 8±24 9	758 8±24 5	729 2±19 0	687 8±37 5	728 1±23 8	686 7±22 9	10 2
OM	739 9±26 6	771 2±23 1	784 2±19 0	720 1±32 1	789 7±27 7	711 1±21 0	10 1
App	846 9±13 7^{b}	897 0±21 9^{a}	794 4±15 5^{cd}	766 1±32 4^{d}	825 2±22 1^{bc}	803 6±24 4cd	8 8
Dig OMI	459 2±32 2	389 0±45 4	452 9±27 2	366 8±62 9	417 2±43 2	452 4±31 6	16 5
NR	7 3±1 8^{ab}	11 1±8 9^{a}	10 3±2 3^{a}	5 3±9 4^{b}	11 8±7 3^{a}	11 5±3 2^{a}	–

Values in a row with the same superscripts do not differ (P>0 05) SE = standard error of the means

pool of N and fractional synthesis rates Indication of these required destructive sampling which was not done

Growth rates observed in goats fed supplements in this trial is rarely cited (Ebong 1990) It indicates that goats respond to improved nutrition However, the economic justification of such interventions needs to be investigated further The efficiency is likely to be enhanced in breed and nutritional improvement programmes

Acknowledgements

The work was funded by the International Livestock Centre for Africa (ILCA) and co-ordinated by AFRNET Samples collected in the study were analysed at the Faculty of Agriculture and Forestry, Makerere University, Kampala The *Calliandra* feed was supplied by the AFRENA (ICRAF) project at Kalengere We are grateful to Mr Robert Obonyo-Oker and John Kigongo who dutifully attended to the animals

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Les feuilles de *Calliandra* dans la ration des caprins: effet sur la dégradation des protéines du rumen et la croissance des animaux

Résumé

Une etude a ete menee pour estimer la valeur des feuilles de *Calliandra* comme complement du tourteau de soja pour l'alimentation des caprins La consommation de matiere seche et l efficacite de l'utilisation alimentaire des animaux recevant 75 et 100% de feuilles de *Calliandra* etaient superieures (P <0,05) a celles des sujets recevant les autres rations L apport simultane de feuilles de *Calliandra* et de tourteau de soja ameliorait la consommation et l utilisation de ces deux complements grâce a un meilleur profil d'acides aminés Les resultats montrent que, bien que les feuilles de *Calliandra* puissent a elles seules fournir l azote necessaire a la croissance et a l'efficacite de l'utilisation alimentaire, leur valeur nutritive est amelioree par l'apport simultane de tourteau de soja

Comparative evaluation of stylo (*Stylosanthes guianensis*) hay and concentrate as protein supplement for West African Dwarf sheep fed basal diet of elephant grass (*Pennisetum purpureum*)

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Abstract

An investigation was carried out to assess the comparative values of stylo (*Stylosanthes guianensis*) hay and concentrate as protein supplements for growing West African Dwarf sheep Three groups of sheep (12–15 months old with an average weight of 13 20 kg) were fed elephant grass (*Pennisetum purpureum*) alone (EG) or the grass and supplemented with either 200 g stylo hay (SH)/head per day or 140 g concentrate (CC)/head per day (each containing 27 12 g crude protein) The animals were fed in individual metabolism cages for 70 days It was observed that dry-matter intake increased significantly (P<0 05) when EG (45 06 g/day/kgW$^{0\ 75}$) was supplemented with SH (66 16 g/day/kgW$^{0\ 75}$) or CC (71 29 g/day/kgW$^{0\ 75}$) This same trend was also observed with crude protein intake, dry-matter (DM) and crude-protein (CP) digestibility The proportion of dietary nitrogen retained by sheep was similar for groups fed SH (61 47%) and CC (61 39%) Sheep fed CC gained 78 g/day compared to 60 and 9 g/day, respectively, for those fed on EG plus SH and EG only The high cost of concentrates makes them unaffordable by smallholders with limited resources, but SH production in smallholder farms is feasible and can provide a good quality protein supplement that could stimulate high weight gains in growing sheep

Introduction

The increasing population density in the West and North-West provinces of Cameroon is responsible for the continuous decline in the size of smallholder farm holdings in the region Mogavero (1986) indicated that in small farm areas of 1 8 ha intensive agriculture based on Arabica coffee vegetables food crops raffia palm and small livestock such as sheep, goats pigs and poultry is practised Ducret and Grangaret (1986) reported that land is exploited to the maximum and is often cultivated continuously without fallow Two crop cycles are common during the rainy season, the second cycle is limited to a third of the farmland, involving fewer crops and producing lower yields Crop associations are complex such that the coefficient of land occupation ranges from 250–400% The productivity of crop associations is often high (the land equivalent ratio ranging from 140–2305), ensuring on the average adequate feeding for 12 persons/ha, and may provide surplus for sale in some areas Livestock density is estimated at 0 5–0 6 tropical livestock units/ha cultivated

With such an intensive system of production, it is necessary to urgently evolve strategies of production that sustain adequate crop yields and at the same time ensure high productivity of livestock Introduction of forage legumes into the farming system has been suggested as one of the strategies for ensuring the sustainability of livestock and crop yields in this region Forage legumes do not only contribute to sustaining soil fertility but also provide better quality feed for livestock in the farming system, if available feed resources are judiciously managed Animals that are confined during the cropping season to avoid crop damage, can be adequately maintained on farm feed resources Excess forage legume produced during the growing season can be conserved as hay for dry season feeding, when animal feed is scarce The objective of this study was to compare the performance of West African Dwarf sheep fed stylo hay (SH) and concentrate (CC) as protein supplements to an elephant grass (EG) basal diet

Materials and methods

Fifteen West African Dwarf male sheep weighing 13 25±1 85 kg on average with ages ranging from 12 to 15 months were used in the trial They were dewormed and sprayed against external parasites before the trial started The animals were randomly divided into three groups of five animals each Each group was allocated to a treatment in a randomised complete block design After a one-week adaptation period to different diets, the experimental period started The initial body weight of each animal was determined Each animal was kept and fed in a separate metabolism cage during the entire experimental period of 70 days

The three experimental rations were fresh elephant grass (*Pennisetum purpureum*) fed alone (EG) as a control, elephant grass plus stylo (*Stylosanthes*

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guianensis) hay (EG+SH) and elephant grass plus concentrate (EG+CC) Fresh elephant grass ranging from 1–1 5 months cut on a daily basis was used as the basal diet The forage was manually cut with a machete and chopped into pieces of about 10 cm before feeding to the animals Two hundred grams of SH and 140 g of CC (each containing 27 12 g crude protein) were fed to each animal in the treatments already designated, in the morning at 0800 hours The total daily allocation of fresh elephant grass (2 kg/day) was fed in two equal instalments at 0900 hours and 1600 hours The compositions of EG, SH and CC are shown in Table 1 The concentrate was made up of 74% maize, 24% unextracted ground soya bean, 0 5% common salt, and 0 5% bicalcium phosphate Fresh water and salt licks were provided *ad libitum* All animals were weighed once a week throughout the experiment The animals were weighed at 0700 hours before the morning feed was served The amount of feed and refusals were monitored daily in order to estimate intake Samples of fresh elephant grass, supplements and refusals were collected daily and their dry matter content determined They were subsequently bulked on a weekly basis, ground and a sample of 500 g reserved for chemical analysis

During the last two weeks of the experiment, a digestibility and N-balance trial was carried out Faecal collections were carried out in order to estimate the digestibility of the rations At 0800 hours total faecal output was collected, weighed, mixed thoroughly and 10% of each day's collection was used for dry matter determination Subsequently, the samples collected over the seven-day period were combined ground to pass through a 1 mm sieve and stored in a plastic bag for chemical analysis The total urine output in 24 hours was collected in plastic jars containing 5 ml concentrated hydrochloric acid It was mixed thoroughly and 10% of the day's collection stored in sample bottles in a deep freezer The urine samples collected over a seven-day period were bulked before analysis for urinary nitrogen

Table 1 *Chemical composition of feeds*

Proximate components	Elephant grass	Stylo hay	Concentrate
Dry matter %	21 46	88 04	88 01
Organic matter (% DM)	88 10	92 09	96 44
Crude protein (% DM)	11 56	13 56	19 69
Crude fibre (% DM)	31 00	29 50	3 50
Ether extracts (% DM)	1 44	4 03	6 45
NFE (% DM)	44 10	45 00	66 80
Ash (% DM)	11 90	7 91	3 56

Analysis of feeds, refusals faeces and urine were carried out according to the methods of AOAC (1980) Data were analysed using the general linear model of the Statistical Analysis System (SAS 1985) software Differences between treatments means were detected with the Duncan s multiple range test

Results and discussion

Feed intake, digestibility and liveweight gain values are indicated in Table 2 There were significant (P<0 05) differences in DMI based on metabolic weight by animals fed unsupplemented diets and those provided the basal diet supplemented with either SH or CC Mafwere and Mtenga (1992) made similar observations that protein supplements of lablab meal in diets containing 11 36, 13 22 15 and 16 73% crude protein resulted in dry matter intakes of 58 7, 64 8, 69 5 and 72 0 g/day/kgw$^{0\ 75}$, respectively Van Soest (1982) indicated that protein supplementation tends to improve intake by increasing N supply to the rumen microbes This has a positive effect in increasing microbial population and also improves the rate of breakdown of digesta When the rate of breakdown and passage of digesta increase, there is a corresponding increase in feed intake

The trend of organic matter (OM) intake was similar to that of dry-matter intake (DMI) Organic-matter intake by sheep fed EG only was 39 70 g/day/kgW$^{0\ 75}$ and supplementation with SH and CC

Table 2 *Feed intake and digestibility by West African Dwarf sheep fed elephant grass and protein supplements*

Parameters	Treatments		
	EG	EG+SH	EG+CC
Feed intake (g/day)			
Dry matter	640 76±28 63	799 40±13 53	698 33±23 49
Organic matter	278 09±18 80	470 06±7 81	495 04±23 02
Crude protein	36 49±2 47	63 73±0 94	73 55±3 03
Feed intake (g/day/kgW$^{0\ 75}$)			
Dry matter	45 06±3 86^{c}	66 15±4 50^{b}	71 27±2 79^{a}
Organic matter	39 70±3 40^{c}	58 97±4 02^{b}	64 12±2 54^{a}
Crude protein	5 21±0 44^{c}	7 99±0 55^{b}	53±0 40^{a}
Digestibility (%)			
Dry matter	56 61±4 97^{b}	69 32±2 07^{a}	72 49±1 59$_{a}$
Organic matter	59 89±4 58^{b}	71 51±1 90^{a}	75 05±1 63^{a}
Crude protein	62 02±4 17^{a}	77 79±1 45^{b}	82 30±1 24^{a}

EG = elephant grass SH = *Stylosanthes* hay CC = Concentrate

Row means with different superscripts are significantly different (P<0 05)

Table 3 *Nitrogen utilisation by West African Dwarf sheep fed elephant grass (EG) and protein supplements of stylo hay (SH) and concentrate (CC)*

Parameters	EG	EG+SH	EG+CC
N intake (g/day)	5 83–00 40[b]	10 20–0 15[b]	11 76–0 48[a]
Faecal-N (g/day)	2 20–0 15[a]	2 28–0 10[a]	2 09–0 23[a]
Urine N (g/day)	0 73–0 09[c]	1 65–0 17[b]	2 46–0 09[a]
Absorbed N (g/day)	3 63–0 47[c]	7 92–0 24[b]	0 68–0 28[a]
Retained N (g/day)	2 90–0 40[c]	6 27–0 12[b]	7 22–0 20[a]
% absorbed N	62 26	77 65	82 31
% retained N	49 74	49 74	61 39

Means in a row with the same letter superscript are not significantly different (P>0 05)

resulted in a significant (P<0 05) increase in intake to 58 97 and 64 12 g/day/kgW$^{0\ 75}$, respectively

Crude-protein intake (CPI) was significantly (P<0 05) different between various experimental treatments Animals on the control treatment consumed 5 21 g crude protein/day/kgW$^{0\ 75}$ whereas those fed SH and CC had an intake of 7 99 and 9 53 g/day/kgW$^{0\ 75}$, respectively

Dry-matter digestibility of sheep on EG only was 56 61% Supplementation of the forage with SH and CC as protein sources significantly (P<0 05) improved dry-matter digestibility to 69 32 and 72 49%, respectively However, there was no significant difference in dry-matter digestibility between treatments receiving protein supplements Butterworth (1985) also reported that dry-matter digestibility was improved when roughage was supplemented with legume or concentrate

The trend of organic-matter digestibility was similar to that of dry matter Crude-protein digestibility was significantly (P<0 05) different between all the experimental treatments with the highest digestibility coefficient recorded for sheep fed the CC supplement (82 30%) followed closely by those fed SH (77 59%) and then those fed EG (62 02%)

Nitrogen intake by sheep fed EG only (5 53 g/day/kgW$^{0\ 75}$) was significantly (P<0 05) lower than grass supplemented with SH or CC with intakes of 10 20 and 11 76 g/day/kgW$^{0\ 75}$, respectively (Table 3) Faecal-N was statistically similar for all treatments Significant (P<0 05) differences were also observed for urinary-N absorbed-N and retained-N with sheep fed SH and CC supplement, and these treatments were also significantly (P<0 05) higher than the control When absorbed-N was expressed as a percentage of N-intake, the efficiency of N absorption was 62 26, 77 65 and 82 31%, respectively, for sheep on the control ration, SH and CC supplemented diets However, when retained-N was also expressed as a proportion of N-intake, there was no significant difference between the efficiency of N-retention by sheep on SH (61 47%) and CC (61 39%) supplemented diets, but these diets were significantly (P<0 05) superior in efficiency of N-retention than grass alone fed to sheep

Average weight gains of sheep maintained on EG only were low (9 g/day) whereas those fed grass plus SH gained 60 g/day, and those on CC supplement gained 78 g/day (Table 4) The differences between these treatments were significant (P<0 05) The significant difference in liveweight gain between the control and supplemented treatments may be attributed to increased crude protein intake Kay and MacDearmid (1973) indicated that a dietary crude-protein content of 11% was ideal for normal weight gain by sheep and goats From this study, it is evident that higher levels of dietary crude protein are required for higher weight gains by sheep These results agree with reports by Mafwere and Mtenga (1992) who observed that as dietary crude-protein level was increased from 11 36 to 13 22 15 and 16 73%, corresponding growth rates of 34 14, 65 65, 68 01 and 70 5 g/day, respectively were obtained for weaned lambs fattened on *Chloris gayana* hay and lablab meal as protein supplement

Table 4 *Liveweight changes in West African Dwarf sheep fed elephant grass (EG) and protein supplements of stylo hay (SH) and concentrate (CC)*

Parameters	EG	EG+SH	EG+CC
Initial weight (kg)	13 20±1 86	13 96±1 73	12 60±1 56
Final weight (kg)	13 86±1 73	18 10±1 64	18 04±1 25
Weight change (kg)	0 66±0 21	4 18±0 73	5 44±0 36
Average daily gain (g/day)	9±3[c]	60±10[b]	78±5[a]
Average body weight (kg)	13 53±1 79	16 03±1 65	15 32±1 40
Metabolic weight (kgW$^{0\ 75}$)	7 04±0 70	8 00±0 61	7 73±0 54

Means in the same row with the same letter superscript are not significantly different (P>0 05)

Conclusion

It may be concluded from this study that in the absence of concentrate smallholder farmers can provide 200 g/day of stylo hay supplement to yearling lambs to obtain significant increases in feed intake, utilisation and weight gain

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Evaluation comparative du foin de stylo (*Stylosanthes guianensis*) et d'un concentré utilisés comme compléments protéiques chez des moutons Djallonké recevant une ration à base d'herbe à éléphant (*Pennisetum purpureum*)

Résumé

Une etude a ete effectuee pour comparer la valeur du foin de stylo (*Stylosanthes guianensis*) et d un concentre comme complements proteiques pour des moutons Djallonke Trois groupes d'animaux âges de 12 à 15 mois et pesant en moyenne 13,20 kg ont ete observes Ils recevaient de l'herbe a elephant (*Pennisetum purpureum*) seule ou avec un complement proteique apportant 27 12 g de proteines brutes par animal et par jour Ce complement etait sous forme de foin de stylo (200 g/tête/jour) ou de concentre (140g/tête/jour) Les animaux ont ete eleves dans des cages metaboliques individuelles pendant 70 jours L'ingestion de matiere seche augmentait de maniere significative ($P<0,05$) lorsque l'herbe a elephant (45,06 g/jour/kg de $P^{0\,75}$) etait complementee avec du foin de stylo (66,16 g/jour/kg de $P^{0\,75}$) ou du concentre (71,29 g/jour/kg de $P^{0\,75}$) Cette tendance prevalait avec la consommation de proteines brutes, de matiere seche (MS) et la digestibilite des proteines brutes La retention d azote alimentaire etait similaire que les animaux reçoivent du stylo (61 47%) ou du concentre (61 39%) Avec le concentre le gain de poids etait de 78 g/jour contre 9 et 60 g/jour respectivement pour les animaux recevant de l'herbe a elephant seule ou complementee avec du stylo Alors que les concentres compte tenu de leurs coûts eleves, sont hors de la portee des petits paysans aux ressources limitees la production de stylo ne devrait leur poser aucun probleme particulier et leur permettrait d'obtenir un complement proteique de bonne qualite capable de guarantir des gains de poids eleves aux ovins en phase de croissance

The effect of supplements of crop residues and agro-industrial by-products on the growth performance of Swazi goats

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Abstract

Goat production in Swaziland is characterised by low offtake resulting from lack of management of rangelands and seasonal fluctuations in feed resources Periodic droughts and extensive dry spells in winter which cause nutritional stress result in low productivity of the goats The aim of the study reported here was to assess the growth response in young male Swazi goats grazed on natural pastures to supplementation with maize stover, sugar-cane tops and dry pineapple pulp The major findings from the study were that (a) the growth rates in goats under natural grazing can be improved by protein supplementation (b) dried pineapple pulp has considerable potential as an energy feed for goats (c) higher growth rates can be achieved by supplementing the pineapple pulp with protein (d) maize stover and sugar-cane tops, in their present form, have limited possibility for improving weight gains in goats

Introduction

Goats play a very important role in Swazi custom and culture as well as in the economy (Ogwang et al 1994) However goat production is characterised by low offtake resulting from poor management of the rangelands and seasonal fluctuations in feed resources Periodic droughts and extensive dry spells in winter cause severe feed shortages resulting in under-nourishment and low productivity among the animals Any effort to improve their nutrition could therefore enhance productivity and utility

The study reported here is the second phase of a research project being conducted under the African Small Ruminant Research Network on the use of crop residues and agro-industrial by-products by smallholder farmers in Swaziland The main objective of the study was to measure the growth response of goats to supplementation with maize stover sugar-cane tops and dried pineapple pulp

Methodology

Animals and treatment

At the start of the study, 63 indigenous male goats were bought from local farmers and assembled for acclimatisation at the University farm Eleven goats died of heartwater and worm infestations within a three-week period The remaining goats were subsequently treated on a monthly basis with Deadline to control the heartwater and Panacur to control worms and diarrhoea No deaths occurred thereafter

Out of the remaining 52 goats, 48 were selected for the experiment based on age and weight The age range, based on dentition, was from 14 to 23 months Individual goat weights varied from 12 to 29 kg at the start of the feeding period The goats were grouped according to age and weight from which they were randomly assigned to the treatments indicated in Table 1

Table 1 *Assignment of goats (in groups of 4) to the different dietary treatments*

Dietary treatment	Levels of protein supplement		
	0 g	80 g	160 g
Grazing only	(4)	(4)	(4)
Grazing + maize stover	(4)	(4)	(4)
Grazing + sugar cane tops	(4)	(4)	(4)
Grazing + pineapple pulp	(4)	(4)	(4)

The goats were grazed on natural pastures from 1100 to 1600 hours after which they were given the crop by-products and water *ad libitum* overnight The protein supplement was given at 0800 hours

The goats were weighed at two-week intervals and intakes of the crop residues and supplement were monitored on a regular basis

Feed composition

The dominant grass species grazed were *Hyparrhenia filipendula H dissoluta Heteropogon contortus Eragrostis racemosa Bothriochloa insculpa* and *Brachiaria brizantha* while the shrub species included *Acacia nilotica A caffra Terminalia phanerophlebia Melia azedarach Combretum apiculatum* and *Dichrostachys nyassana* The chemical composition of the grass and shrub species during the study period is presented in Table 2 together with those of maize stover (MS), sugar-cane tops (SCT) and dried pineapple pulp (DPP) The protein supplement was prepared by mixing

Table 2 *The chemical composition of natural grazing and crop by products*

Feeds	DM (%)	CP (% DM)	CF (% DM)	EE (% DM)	Ash (% DM)	NFE (% DM)
Grass	95	3 5	31 3	0 7	4 7	59 8
Browse	93	10 7	13 9	–	5 7	–
Maize stover	92	4 2	34 4	2 1	4 4	54 9
Sugar cane tops	92	4 2	34 3	2 2	6 9	52 4
Pineapple pulp	92	3 4	16 1	1 6	4 2	74 7

DM = dry matter CP = crude protein CF = crude fibre EE = ether extract NFE = nitrogen free extract

a commercial concentrate with yellow maize to give a high protein concentrate (HPC) mixture with an average protein content of 26%

Results and discussion

Daily intakes of MS SCT and DPP without protein supplementation and monitored weekly from mid-September to November 1994 are presented in Figure 1

The daily intakes of MS and SCT were similar averaging about 80 g over the eight-week period However, intake of DPP was much higher reaching a peak of 750 g per day in the sixth week MS and SCT are known to be low quality roughages which contribute little to animal production unless subjected to some physical or chemical treatments Dried pineapple pulp appears to be a good source of energy for the goats

There was no evidence of any dramatic improvement in intake of MS and SCT and DPP through protein supplementation (Figures 2, 3 and 4) At a low level of protein supplementation the intakes of MS and DPP were slightly depressed

Changes in live weights of the Swazi goats over a 75-day period under different dietary treatments are presented in Table 3

High level protein supplementation improved growth rate in goats grazed on natural pastures only as well as those fed crop-resides in addition to grazing Growth response to protein supplementation was more remarkable under grazing only and when grazing was combined with the feeding of DPP The better improved growth rates observed in goats grazed on natural pastures only and those given DPP in addition to grazing suggest that protein was more limiting in those circumstances than was the case in animals fed SCT and MS in addition to grazing (Table 1) The DPP could also have been better utilised because of its low crude fibre content and high energy potential compared to SCT and MS

Conclusions

Growth rates in goats under natural grazing can be improved if supplemented with adequate protein It seems then that under the grazing conditions studied protein could be a more limiting factor for goat

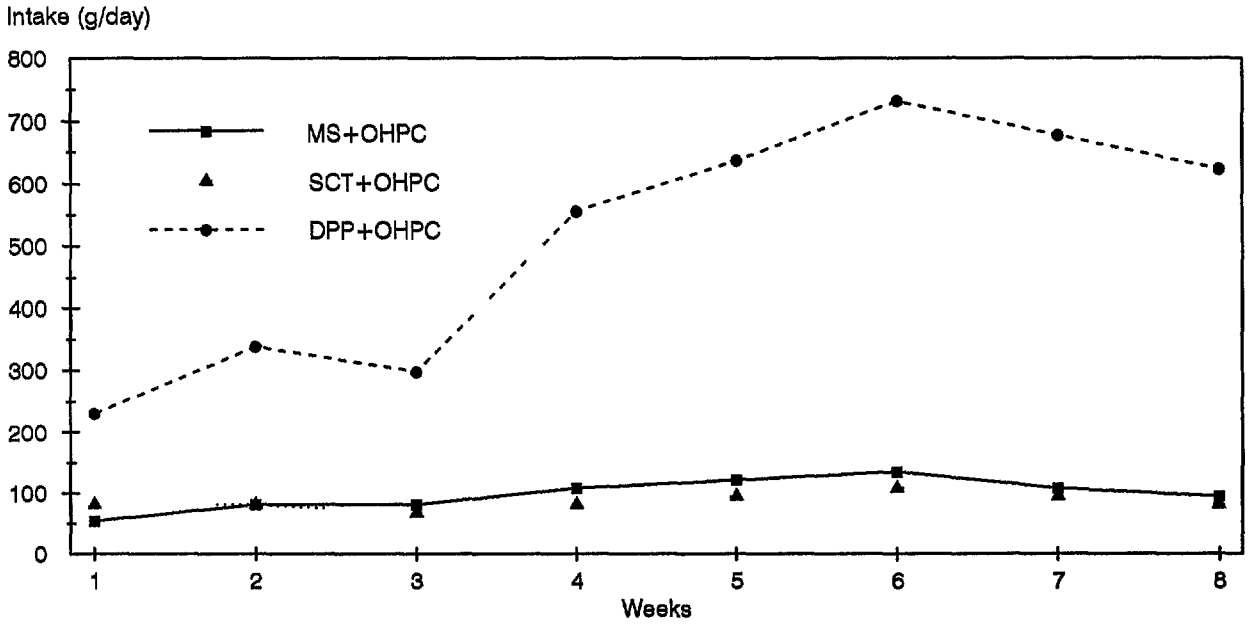

Figure 1 *Changes in daily intake of crop residues with time*

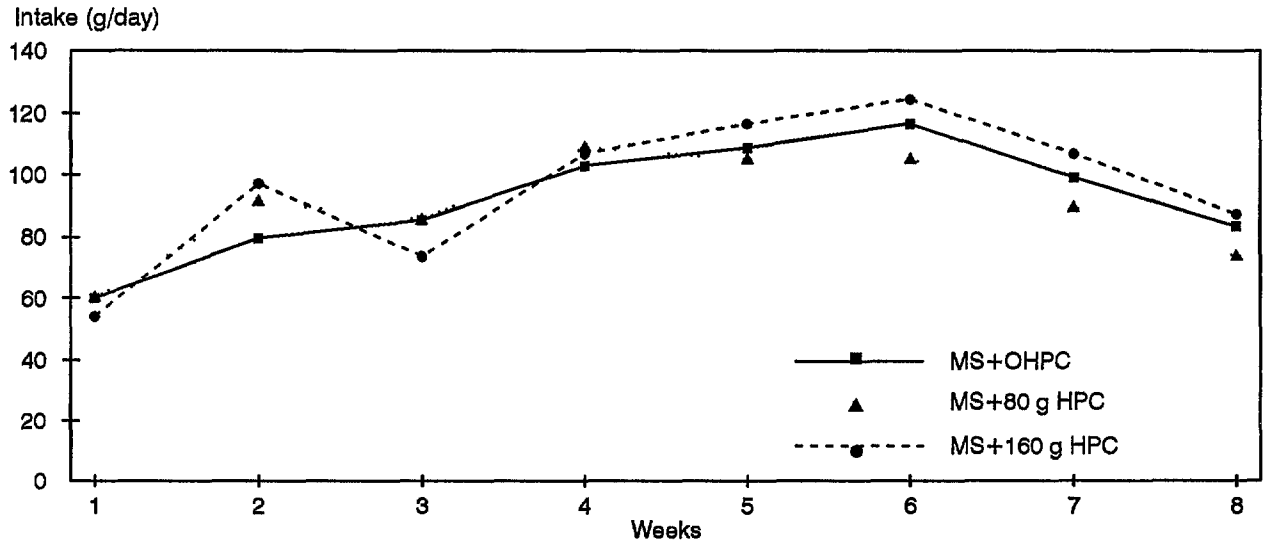

Figure 2 *Change in daily intake of maize stover with time*

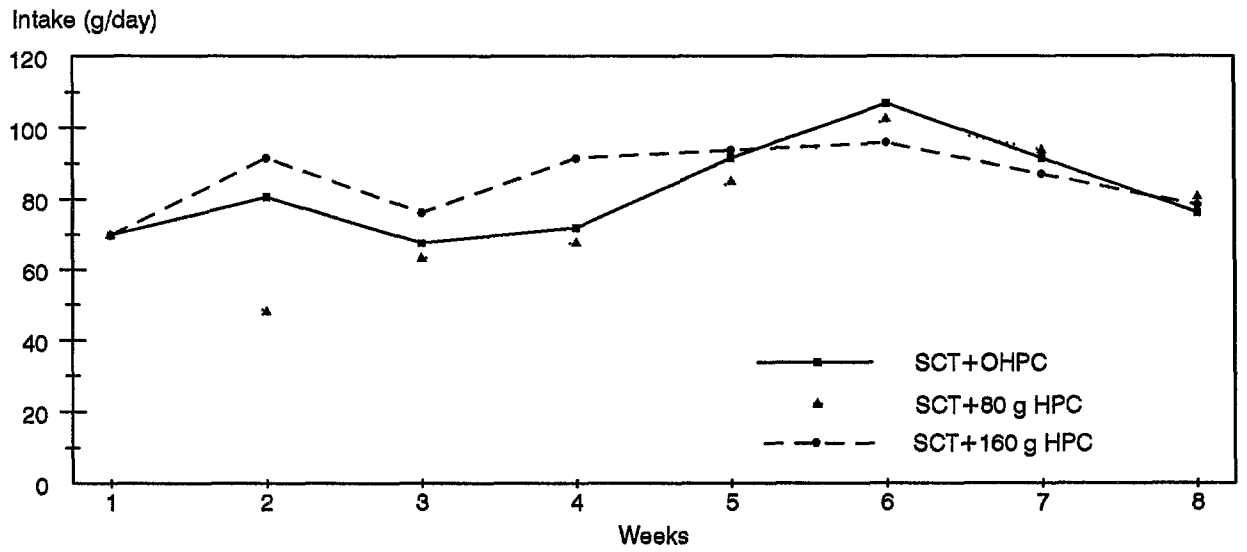

Figure 3 *Daily intake in sugar cane tops with time*

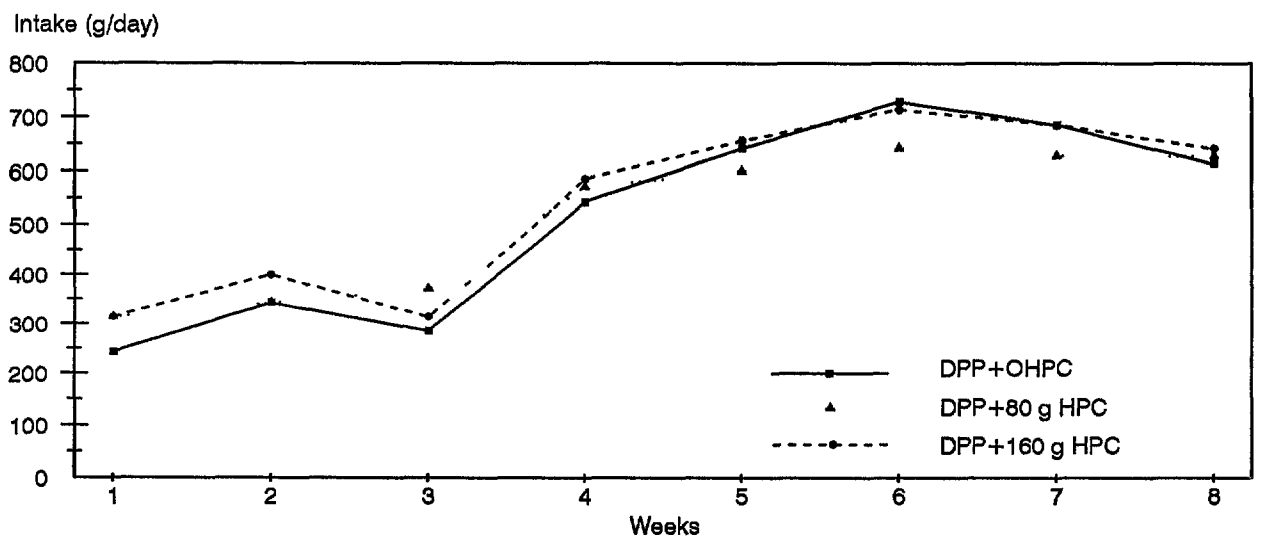

Figure 4 *Changes in daily intake of dried pineapple pulp with time*

Table 3 *Changes in live weight of goats under different dietary treatments*

	Level of protein supplement*					
	0 g		80 g		160 g	
	AWC (kg)	ADG (g)	AWC (g)	ADG (g)	AWC (kg)	ADG (g)
Grazing only	4 9	65 3	4 7	62 7	6 1	81 3
Grazing + maize stover	2 4	32 0	2 7	36 0	3 5	47 7
Grazing + sugar cane tops	2 5	33 3	3 1	41 3	3 6	48 0
Grazing + pineapple pulp	4 5	60 0	6 1	81 3	6 3	84 0

* AWC = average weight change ADG = average dietary gain

production than energy There is therefore a need to explore cheap and easily available protein sources When protein is available, the energy requirement can be further supplemented with DPP Maize and sugar-cane tops have limited possibilities for improving weight gains in goats unless subjected to some physical or chemical treatments

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Effet d'une complémentation de résidus de récoltes et de sous-produits agro-industriels sur les performances de croissance des caprins Swazi

Résumé

L'elevage caprin est caracterise au Swaziland par une faible production, due a la mauvaise gestion des parcours et aux fluctuations saisonnieres des ressources alimentaires du betail Les secheresses periodiques et les longues periodes seches l hiver entraînent des stress nutritionnels nuisibles a la productivite des caprins La presente etude vise a evaluer la croissance de jeunes boucs Swazi eleves sur pâturages naturels complementes avec du foin de tiges de mais, de bouts blancs de canne a sucre et de pulpes d ananas sechees Il ressort des resultats enregistres que a) la complementation proteique ameliore la croissance des caprins eleves sur pâturages naturels b) les pulpes sechees d ananas constituent une excellente source potentielle d'energie pour les caprins c) la complementation proteique des pulpes d ananas accelere la croissance des animaux et d) sous leur forme actuelle les tiges de mais et les bouts blancs de canne a sucre n'ont qu'un effet limite sur la croissance des caprins

Species abundance, food preference and nutritive value of goat diets in the semi-arid lands of east-central Kenya

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Abstract

The key forage species and nutrient composition of forage species preferred by free-ranging East African goats in rangelands of eastern-central Kenya were determined One hundred and five forage species were identified including 30 tree, 29 shrub, 20 grass and 25 forb species Shrubs and short trees were the most preferred forage species and thus formed the bulk of the goat diets Ironically the forage species most preferred by the goats were not necessarily the most abundant on the ground, indicating that ease of accessibility and palatability may be important determinants for choice of a forage specie That grasses and forbs were the least preferred could be largely explained by the fact that goats are naturally browsers

Introduction

Raising of livestock by pastoralists, agro-pastoralists or commercial ranchers is the single most important economic activity in the arid and semi-arid lands (ASAL) of Kenya Over two-thirds of Kenya (approximately 492,100 km^2) is classified as ASAL More than half of this area receives less than 370 mm of variable rainfall annually and is further characterised by variability in pasture and water availability During the peak of the rainy season feed resources available to animals are high in quality and quantity and animals gain weight fairly fast Conversely, at the peak of dry spell, available forage resources are too low in quality and quantity and animals inevitably lose weight Important domestic animals in ASAL include, cattle, sheep, goats and camels

Recent increases in the human population due to better living standards, have been accompanied by increases in total livestock numbers in the ASAL especially among pastoralists who to a large extent depend on these animals for their subsistence Increase in human population in high potential areas has also resulted in migration of people to the ASAL in search of arable land In addition, among the indigenous communities, there is a growing tendency towards a more cash-oriented economy as evidenced by subdivision of communal lands into small individual parcels and acquisition of title deeds Thus families are increasingly becoming sedentary but on land units too small to meet their food needs There is therefore overstocking resulting in range degradation especially around settlements and cultivated areas

Even with individualisation of land ownership diminishing household land units and the terminal breakdown of traditional communal grazing systems, livestock production remains the mainstream economic activity for these areas In order to make meaningful recommendations to land owners on proper management of these lands, especially under the currently emerging land use/ownership paradigms, range managers ought to have a thorough knowledge of the most suitable kinds of animals, their nutrient requirements forage preferences and quality of available forage

Information on food habits of pastoral livestock in the East African ASAL is scarce Livestock select their diet from a complex mixture of plant species and/or plant parts (Arnold 1960 Arnold 1962) Why an animal selects one plant and not another is still a puzzle Choice varies widely and seems to depend on availability Diet selection may modify the species composition of the pastures in the long run (Illius 1986) with the potential danger of lowering the quality of the diet Continued grazing pressure increases the number of unpreferred plant species at the expense of the preferred species (Tadingar, personal communication, 1984) Due to wide temporal and spatial variation in forage preference and nutrient composition of diets selected by different kinds of ruminants, research information generated from a given area and kind or class of animals, has limited inference (space) and should not be applied to too wide an area It is therefore, important to establish local food habits and nutrient composition data bases for the various types of domestic and wild animals utilising particular range types

The main purpose of this study was to determine the key forage species and nutrient composition of diets selected by free-ranging East African goats in rangelands of eastern-central Kenya

Materials and methods

Study area and procedures

The study was conducted at the University of Nairobi's Machang'a Field Station situated approximately 150 km east of Nairobi and next to Kamburu Dam on the eastern

bank of upper Tana river The station is approximately 500 ha in area and lies at 1 S latitude 37 E longitude and about 700 m altitude However the study was limited to a 20 ha area fronting the Embu–Kitui main road The area gently rises from the Kamburu Dam to the top of the ridge

The mean annual rainfall is 650 mm coming in two seasons — March through May, short rainy season and October through December long rains Soils on the station are developed from undifferentiated types of gneisses of Basement System They are well drained, shallow dark red to yellowish red stony loamy sand to clay (Kenya Soil Survey, Misc Soil Paper M 19, 2nd impr Nairobi 1979) Machang'a vegetation is described as bushed shortgrass savannah with buffel grass (*Cenchrus ciliaris*) and horsetail grass (*Chloris roxburghiana*) predominant Saltbush is a common palatable shrub suitable for re-establishing pasture on overgrazed and eroded places (East African Livestock Survey Atlas, 1967) Recommended stocking is about three hectares per livestock unit (LU)

Species composition and relative abundance

At the beginning of the November/December wet (green) season of 1993, botanical composition and relative abundance of both herbaceous and woody plant species layers were determined This involved the use of line intercept method, where 10 transects, 100 m long by 200 m apart, were laid across the slope and all herbaceous plant species intercepted by the tape identified Herbaceous layer determination involved the quadrat method, where ten 1 m^2 quadrats were laid at equal intervals along each transect Each quadrat was further subdivided into four quarters and different plant species occurring in each quarter identified enumerated and recorded For trees and shrubs above 2 m high 10 m x 10 m quadrats were used and different species occuring within each quadrat identified, counted and recorded The relative abundance for each plant species was calculated as follows

$$\text{Relative abundance of sp A} = \frac{\text{Number of times sp A occurred}}{\text{No of times all sp occurred}}$$

To convert number of plants per m^2 into number of plants per ha, the density value is multiplied by 10,000 m^2

Number of bites and time spent on individual species

The method used to study forage preference involved close observation of randomly selected animals (one at a time) as they grazed with the others A base flock of 45 East African goats was used from which one animal was selected for the bite count study The selected goat was closely followed and observed by two enumerators who recorded the number of bites and time spent on each plant species as the goat grazed or browsed A bite was taken as the act of breaking off or picking up a piece of forage The time spent by the animal feeding on one individual plant without walking one full step was estimated in seconds and recorded The animal was observed for 30 minutes beginning at 0930 hours

The flock was grazed in different areas and a different goat was randomly selected for observation so that different goats were used on the five grazing units The five goats selected during the first round of grazing rotation qualified as experimental animals for subsequent replicates This observation procedure was repeated for as long as there was no noticeable change in the vegetation i e until the rains began if it was a dry-season grazing, or until the dry season set in if it was green-season grazing

Forage digestibility and chemical composition

Plant material representative of that selected by the goats was hand-clipped, sun dried for three days and then oven dried at 40 C for four days The dry forage samples were ground in a Wiley Mill using a 1 mm screen The material was later chemically analysed for NDF, ADF (Van Soest and Wine 1967), N P, Ca, Mg, K, Na Zn Cu and Fe (AOAC 1975) Digestibility estimates using the nylon-bag technique (Ørskov et al 1980) for 48 hours incubation was also conducted

Results and discussion

Vegetation Botanical composition

Tables 1a and b give an inventory of the plant species occurring in the study area and their relative density (plants/ha) One hundred and five plant species were identified comprising, 30 trees 29 shrubs 20 grasses and 25 forbs Since the survey was conducted soon after the onset of the short rains, a large number of tree and shrub seedlings was observed

The most dominant tree species within the study area was *Acacia brevispica* Others included *Combretum zeheri Commiphora riparia Terminalia brownii Grewia villosa Acacia nilotica Boswelia* sp, *Lannea flocesca* and *Commiphora boviniana* in that order The most dominant shrub was *Hermania alhiensis* Others, in order of importance were *Grewia bicolor, Gnidia latifolia Premna hilderbrandtii Dichrostachys cinerea Acalypha fruticosa and Maytenus putherlickioides* Of the grasses, annuals dominated the site due to their oppotunistic nature The most dominant grass species was *Aristida keniensis*, followed by *Eragrostis caespitosa* and *Latipes senegalense* Most of the perennial grasses had not come up Among the forbs *Ocimum* sp was most dominant followed by *Rhoicissus tridentata Pentas* sp *Stylosanthes aspera* and *Acanthospernum hispidum*

Table 1a *Average plant population density (plants/ha) of trees and shrubs in the study area*

Trees	Plants/ha	Shrubs	Plants/ha
Acacia etbaica	10	*Withania somnifera*	10
Acacia brevispica	65	*Triumfetta* sp	40
Lannea triphylla	35	*Grewia bicolor*	80
Combretum molle	35	*Sida ovata*	45
Walbergia sp	10	*Combretum aculeatum*	45
Grewia villosa	40	*Premna hilderbrandtii*	75
Acacia nilotica	40	*Indogofera schimperii*	15
Acacia mellifera	20	*Indigofera lupatana*	5
Commiphora riparia	50	*Acalypha fruticosa*	70
Boswelia sp	40	*Grewia similis*	35
Commiphora africana	35	*Hibiscus calyphylla*	15
Zanthoxylum chalybea	5	*Aspangus racenosus*	40
Terminalia brownii	50	*Hermania alhiensis*	220
Acacia tortilis	5	*Ormocarpum trichocarpa*	50
Combretum zeheri	55	*Cassia singueana*	15
Acacia hockii	25	*Dichrostachys cinerea*	75
Steganotaenia araliaceae	5	*Thumbergia holstii*	10
Ochna inermis	10	*Tephrosia villosa*	20
Albizia amara	10	*Ipomoea kituensis*	5
Lannea floccosa	40	*Maytenus putherlickioides*	70
Commiphora boviniana	40	*Ormocarpum kirkii*	5
Commiphora campestris	10	*Gnidia latifolia*	80
Terminalia spinosa	5	*Hoslundia opposita*	25
Dalbergia melanoxylon	10	*Indigofera clifordiana*	15
Euphobia nyikae	25	*Crotolaria gooformis*	40
Commiphora schimperii	5	*Croton dichogamus*	5
Makhamia sp	15	*Rutya fruticosa*	5
Entada abyssinia	5	*Hibiscus micranthus*	20
Lonchocarpus sp	10	*Zimania americana*	5
Cordia gharaf	5		

Table 1b *Average plant population density (plants/ha) of grasses and forbs in the study area*

Grasses	Plants/ha	Forbs	Plants/ha
Setaria verticilata	t*	*Rhoicissus trindentata*	5
Dactyloctenium aegyptica	2	*Ocimum* sp	80
Brachiaria reptans	1	*Pentas* sp	5
Aristida keniensis	6	*Stylosanthes fruiticosa*	5
Enteropogon macrostachys	2	*Achranthes aspera*	3
Eragrostis superba	1	*Solanum incanum*	3
Chloris virgata	t	*Alternthera pungens*	2
Eragrostis caespitosa	3	*Acanthospernum hispidum*	4
Latipes senegalense	3	*Commelina benglhelensis*	t
Heteropogon controtus	t	*Tribulus terestris*	1
Michrochloa kunthii	2	*Pupalia lappaceae*	1
Themeda triandra	t	*Convolvulus favinosus*	1
Digitaria macroblephera	2	*Oxygonum sinuatum*	t
Chlorisroxburghiana	t	*Indigofera spicata*	t
Digitaria gazensis	1	*Ocimum bacilicum*	1
Latipes senegalenses	t	*Tephrosia pumila*	t
Aristida adoensis	1	*Blepharis hildebrandtii*	t
Digitaria falutina	1	*Phyllanthus maderaspatens*	t
Tragus berteronianus	1	*Barleria proxima*	t
Rhynchelitrum roseum	t	*Asystasia schimperi*	t
Aristida sp	t	*Hibiscus micranthus*	t
		Rhoicissus triandenta	t
		Zornia glachidiata	1
		Bidens pillosa	1
		Ipomoea oenothrae	t

* t = trace amounts (<0 05 plants/ha)

Forage preference

Shrubs and short trees were the most preferred forage plants and hence formed the bulk of the goat diets (Table 2) The five most preferred shrubs were *Maytenus putterlickioides Premna hildebrandtii Hoslundia opposita Dichrostachys cinerea and Combretum aculeatum* in that order However, these plants were not the most abundant on the ground suggesting that the plants/grazable plant parts were possibly both more accessible and palatable and therefore more seriously sought after by the goats Only *Premna* sp showed a close relationship between its relative preference and its abundance on the ground — third and second, respectively

Table 2 *Mean number of bites and time (in seconds) spent on various forage species within the study area*

Forage species	Mean number of bites	Mean time spent
Maytenus putterlickioides (s*)	31	44
Ochna inermist (t)	24	36
Premna hildebrandtii (s)	23	30
Hoslundia opposita (s)	21	31
Dichrostachyus cinereas (s)	18	24
Combretum aculeatums (s)	18	20
Acacia hockii (t)	15	19
Grewia bicolor (s)	14	22
Acacia mellifera (t)	14	17
Thumbergia holstii (s)	13	16
Acalypha fruticosa (s)	13	16
Barleria proxima (g) f	13	18
Combretum molle (t)	11	20
Ocimum spp (f)	10	13
Grass (bulked)	8	10
Boswelia hilderbrandtii (t)	7	10
Hermania alhiensis (s)	4	11

*s = shrubs t = tree g = grass f = forb

Among the trees *Ochna inermis* and *Acacia* sp were the two most preferred plants *Ochna inermis* ranked second to the most preferred shrub *Maytenus putterlickioides Ochna* sp however ranked low in availability on the ground Grasses and forbs were least preferred which is because goats are naturally browsers and these plants were least abundant on the study area

Table 3 represents correlation and regression of the number of bites (preference) on nutrient components (ADF, NDF, IVDMD N P and Na) There was a positive and significant correlation between ADF N and Na with number of bites P showed a significant negative correlation

ADF, N and Na had a significant positive causal (regression coefficient) effect on preference NDF, IVDMD and P had no significant causal relationship with preference although P and digestibility had insignificant negative regression coefficients (–1 83 and –0 12, respectively) on preference It can therefore be concluded that the different plant species were more preferred due to relative contents of ADF, N or Na and less preferred due to relative P contents (Tables 3 and 4)

A multiple regression analysis showed that the most important components that influenced preference in this study were N (0 55) and P (–3 16) NDF (0 25) and ADF (0 23) were less important due to large standard errors associated with the estimates Conversely although the partial regression coefficients of digestibility (–0 13) and phosphorus (–3 16) were negative the estimates were insignificant due to large standard errors Work is continuing in this area and with more data, a clearer picture of these relationships will become evident since it is possible that other components of the diets such as saponins and tannins that were not considered in this study could have played a major role in determining the relative dietary preference

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Table 3 *The correlation and regression coefficients between plant species preference and nutrient components*

Nutrient component	Correlation coefficient	Simple regression coefficient	Partial (multiple regression coefficient)
ADF(%)*	0 3400	0 35 (0 27)	–0 23 (0 59)
NDF(%)	0 0001	0 16 (0 21)	0 25 (0 49)
IVDMD(%)	–0 2700	–0 12 (0 11)	–0 13 (0 21)
Nitrogen (N)	0 3000	0 30 (0 29)	0 55 (0 41)
Phosphorus (P)	–0 0500	–1 83 (1 83)	–3 16 (4 28)
Sodium (Na)	0 3400	0 34 (0 03)	0 06 (0 03)

* ADF = acid detergent fibre NDF = neutral detergent fibre IVDMD = *in vitro* dry matter digestibility

Table 4 *Nutritive value of some of the forage plants preferred by goats at Machang a*

Plant species	ADF %	ADF %	Ca (g/kg)	Mg %	K (mg/kg)	Na (mg/kg)	Zn (mg/kg)	P	N
Premna hildebrandtii	26 73	35 80	8 15	1 6	15 7	272	67	2 3	23 4
Grass (bulked)	27 96	35 58	4 5	1 8	17 1	116	34	2 5	14 6
Indigofera spicata	28 98	35 53	55 3	6 2	13 3	61	32	–	–
Acacia ataxanthe	23 63	36 90	20 0	3 8	7 6	75	54	–	–
Boswelia hilderbrandtii	30 43	42 97	1 7	6 8	7 6	95	54	1 0	10 8
Aspilia mossambiscensis	30 43	42 97	32 1	4 3	24 9	48	64	1 6	29 8
Maytenus putterlickioides	38 97	46 89	15 5	4 6	7 5	163	31	0 8	18 2
Combretum sp (bulk)	30 93	36 92	8 2	3 1	10 4	48	26	3 0	21 0
Crotolaria goodformis	20 39	36 14	10 3	2 5	17 6	34	64	–	–
Acacia hockii	22 21	36 21	11 2	1 9	8 7	–	28	0 8	13 3
Tephrosia villosa	35 48	53 28	11 4	2 5	10 4	55	41	–	–
Uchna inermis	34 96	55 91	19 8	3 4	4 9	20	23	0 8	25 1
Dichrostachys cineria	44 24	55 10	12 2	2 8	7 2	109	25	–	–
Grewia bicolor	36 50	59 92	19 8	3 9	11 5	41	20	2 0	21 9
Stephania abyssinica	31 25	49 20	11 7	2 5	20 5	41	50	–	–
Lantana camara	24 62	56 49	19 7	6 7	18 8	48	38	–	–
Dalbergia melanoxylon	38 15	67 47	14 7	2 9	14 5	82	12	–	–
Acacia mellifera	28 06	51 71	17 6	3 6	12 6	129	28	2 8	27 6
Acacia tortilis	46 44	52 39	12 8	2 9	12 6	88	24	–	–
Combretum aculeatum	27 64	48 21	15 1	2 3	11 5	82	73	3 0	21 0
Ocimum sp	28 15	44 53	16 1	4 6	21 6	55	61	1 8	25 9
Barleria proxima	39 63	53 93	39 5	5 9	10 1	109	35	1 8	20 5

ADF = acid detergent fibre

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Abondance des espèces, préférences alimentaires et valeur nutritive des rations des chèvres des terres semi-arides du centre-est du Kenya

Résumé

Les principales especes fourrageres et la composition nutritive des plantes preferees des chèvres d Afrique de l Est en parcours libre sur les pâturages du centre-est du Kenya ont ete determinees Cent cinq espèces fourrageres ont ete identifiees, y compris 30 arbres 29 arbrisseaux, 20 graminees et 25 especes herbacees non gramineennes Les arbrisseaux et les arbres de petite taille etaient les plantes préferees des chevres et constituaient par consequent l essentiel de leur ration Curieusement les especes preferees n etaient pas necessairement les plus abondantes ce qui indique que la facilite d acces et l'appetibilite pourraient être d importants determinants du choix des animaux Le peu de faveur dont jouissaient les graminees et les autres especes herbacees pourrait s'expliquer par la preference naturelle des caprins pour les ligneux

SESSION 5

Performance and Reproduction

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Possible impact of disease and reproductive wastage on the productivity of tropical small ruminants: An overview

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Abstract

Small ruminants contribute significantly to meat (and sometimes milk) production in Africa and hence in meeting the current shortfall created by the fast rising human population Flock productivity may, however, be affected by a wide range of disease problems and reproductive wastage The impact of disease may be through mortalities and abortions or through morbidity and such subclinical effects like weight loss or reduced gains, reduced carcass weight and quality and the cost of time and money involved in controlling or overcoming the effects of disease Thus, a top priority in operating successful small ruminant enterprises must be adequate attention to health problems and the causes of reproductive wastage Losses due to mortality often have severe and easily quantifiable economic impact, but losses in production due to morbidity are commonly underestimated because they are difficult to estimate This paper provides a background against which specific effects of the role of health problems and reproductive wastage on production can be discussed

Introduction

The problem

Five major trends are taking place today which need to be recognised to put this presentation into perspective First, there is a rapidly growing human population in the world's developing regions, illustrated for sub-Saharan Africa (SSA) in Table 1 In comparison to Latin America and Asia where the rate of human population increase respectively peaked at 2 8% and 2 4% annually in the 1955-60 and 1975–80 period and has since declined to 2 3 and 1 7% today the SSA population increase peaked to 2 8% in 1990–95 and is only just beginning to show some decline A rapidly growing population is frequently associated with insufficient human nutrition and low intake of food of animal origin Meat consumption in developed countries is for example six times as high as in developing countries and the disparity in milk consumption is over sevenfold (Krostitz 1991) Significantly these gaps appear to be increasing

Second, the rapid SSA human population increase has tended to reduce regional economic growth For instance per capita GDP decreased 2 2% in the 1980s resulting in lower personal incomes Third, the rates of urbanisation as people move from rural to city locations in developing countries are growing at a faster rate that the overall rate of population increase (Table 2) But fortunately, forth, rapid urbanisation often tends to influence animal agriculture partly because of changing patterns in food demand brought about by the increased purchasing power of the city people Such a positive trend ought to create better markets for farm products and increase commercialisation of agriculture In fact, mean response in the demand for milk, meat and eggs is estimated at 8, 9 and 9 5%, in contrast to 2% for cereals, whenever urban peoples' income has increased by 10% (Jahnke 1982) However, fifth, rural farmers are already also asking for higher income for their products

Table 1 *Human population projections for sub Saharan Africa 1990–2025*

Year	Population (millions)	Annual growth rate (% 5 year period)
1990	498	–
1995	580	3 1
2000	676	3 1
2005	784	3 0
2010	902	2 8
2015	1028	2 6
2020	1159	2 4
2025	1294	2 2

Source Winrock (1992)

The projected target

The present low supply of animal products in the developing regions is unfortunately against the background that 52% of world cattle 77% of buffaloes 24% of sheep and 63% of goats are found in the tropics Meat production efficiency estimated as kg meat per livestock unit is just 118 kg in SSA in contrast to 123 in Africa as a whole 126 in Asia and 135 in Latin America All are however, still lower than the 155 average for all developed countries

To meet the rising demand for animal products from indigenous sources, the World Bank estimates that animal production (meat and milk) must increase by 4% per year until 2025 to feed the population improve nutrition and eliminate imports At this rate milk

production would reach 19 million tonnes and cow and goat milk 43 million tonnes Ruminant livestock including small ruminants, are expected to account for 60% of the expected increase in meat production and almost all of the milk The rest of the meat will come from poultry and pigs Currently, about 66 million sheep and 55 million goats are slaughtered annually for meat in Africa from respective populations of 206 and 171 millions About 57% of the sheep and 65% of the goats in SSA are found in the arid/semi-arid agro-ecozone, 22 and 26%, respectively, in the humid/subhumid ecozone and 21 and 9%, respectively, in the highlands (ILCA 1987) The most rapid livestock population growth rate of 2 2% is taking place in the subhumid/semi-arid ecozone, followed by 1 0% in the highlands and just 0 2% in the arid areas

Technical constraints to production

Ruminant livestock are primarily raised under traditional systems characterised by low inputs These systems cannot produce the increased amounts of crop and livestock products for the projected increases in human population It is estimated that unless steps are taken to address major technical constraints to production and if current use of inputs remain unchanged, the land area required to support the population by the year 2010 would have to be expanded by more than 100 million ha, or 5% (FAO 1986)

Table 2 *The rate of urbanisation as per cent of the total population in sub Saharan Africa 1960–2025*

Year	% urban
1960	11 8
1965	13 7
1970	15 9
1975	18 8
1980	22 0
1985	25 4
1990	29 0
2000	36 3
2010	43 5
2025	54 2

Source Winrock (1992)

Major technical constraints to livestock production include inadequate feed supply, poor animal health, low-yielding animal genotypes and minimal levels of management In particular the need for increased human food and cash crop production in the tropics has reduced the size of grazing lands and land for intensive fodder production This has made nutrition a major constraint to livestock production Undernutrition further increases the risk to animals of disease

Temperate ruminant animals are adapted to feed sources of relatively high fibre content but sufficiently unlignified to provide most dietary energy in the form of cellulosic carbohydrates In these modern management regimes animals have access to well balanced arrays of nutrients, and the level of production is largely determined by intake levels But this is not necessarily so among tropical animals Tropical pastures and/or crop residues are often deficient in essential nutrients particularly trace elements and nitrogen needed by rumen microbes for efficient growth (Leng 1990) It is also possible that a low protein energy ratio that results from this translates into a high heat increment in the rumen and high metabolic heat production in the body, which at times interacts with climate to produce heat stress which in turn reduces feed intake Overall reproduction and productivity are thus further compromised Inability to feed animals adequately throughout the year is the most important technical constraint for most traditional animal farmers And, feed availability and cost will be the major determining factor as to whether the 4% annual increase target in production can be met

Disease constraints of small ruminants

Although indigenous breeds of goats and sheep are fairly well adapted to the tropical environments, the majority of animals are raised traditionally under extensive free-roaming management systems with no specialised input into housing care nutrition or disease treatment or prevention A small percentage of animals are however, raised intensively, sometimes even under a cut-and-carry system of management Here, animals are afforded better shelter, nutrition and health care and often achieve higher productivity The type and impact of diseases on production varies with the level of management

Common diseases

Table 3 lists the more important and common diseases of small ruminants by etiological agent Diseases significantly reduce animal productivity irrespective of ecological zone

Contagious caprine pleuropneumonia (CCPP) and peste des petits ruminants (PPR) are widely distributed diseases which unless properly controlled can limit animal production over wide areas Parasitic and viral infections are mainly vector transmitted and their prevalence is therefore largely influenced by the environment No effective vaccine or chemotherapeutic control method is currently available for most of these ailments It is estimated that SSA's annual losses due to mortality alone may be equivalent to 2 billion dollars with about that same amount due to losses in morbidity

Table 3 *Some common diseases of sheep and goats*

Infectious	Broncho pneumonia contagious caprine pleuropneumonia (CCPP) caseous lymphadenitis contagious ecthyma enteritis peste des petits ruminants
Parasitic	Coccidiosis helminthiasis mange trypanosomiasis tick borne disease
Nutritional	Energy and protein deficiencies
Reproductive	Abortions, metritis, perinatal mortality stillbirths mastitis
Traumatic	Hernias, fractures

Parasitic infestations

Some studies have noted that the extensive grazing system of management for most sheep and goats, results in animal faeces being deposited widely which significantly reduces the chances of infection with third stage larvae (ILCA 1979) This would support the observation by Smith et al (1986) that despite being irregularly drenched, parasitic gastro-enteritis (PGE) in goats was negligible and clinically unimportant in housed goats maintained on slatted floors However, other investigations have found a high incidence of PGE among roaming animals (Adeoye 1985, Ndamukong 1985)

Haemonchus contortus is the most important species of helminth parasites responsible for PGE in most ecozones except the cool highlands It causes high mortality particularly among young animals in the wet season Other species include *Ostertagia Tricho strongylus Cooperia Nematodirus* and *Oesophagostomum*

Coccidial oocytes are common in the faeces of grazing animals but clinical cases are more overshadowed by helminthiasis Mortality rates of up to 6% have been observed in confined goats (Otesile et al 1983)

Literature reports are available of small ruminant infection from *Babesia motasi, Anaplasma ovis A marginale Trypanosoma vivax* and *T congolense* (Sadiq 1985, Smith et al 1986, Opasina 1987) There is, however, no definite association between the serological demonstrations of these infections and clinical disease

On the other hand the mange mite *(Sarcoptes, Chorioptes and Psoroptes* spp) is common, sometimes with incidence of 24 to over 80% even for roaming animals (Akinboade 1982 Adeoye 1985) With regular washing this may be reduced to under 5% (Smith et al 1986)

Bacterial and mycoplasmal diseases

Pneumonia is easily the most important bacterial health problem to small ruminant production, being responsible for 6 to 31% of morbidity rates (Ndamukong 1985, Njau et al 1988) In addition to verminous pneumonia caused by lung worms micro-organisms commonly associated with small ruminant pneumonia are *Mycoplasma mycoides Pasteurella multocida Streptococcus* spp, *Staphylococcus aureus* and *Corynebacterium pyogens*

Gastro-enteritis is a fairly common ailment of goats and sheep The extent to which this is attributable to bacteria is, however, difficult to ascertain This is because enteritis is also commonly associated with helminthiasis and dietetic diarrhoea The other condition that can be mentioned is *Caseous lymphadenitis* which may have a morbidity rate of 13 to 18% especially in confined goats (Addo 1982, Smith and van Houtert 1988) It tends to have low mortality

Viral diseases

The two most common viral diseases of small ruminants are contagious ecthyma (Orf) and peste des petits ruminants (PPR) with morbidity rates of 50 to 100% Mortality rates are often high for PPR but low for Orf

Metabolic disorders

Metabolic disturbances like pregnancy toxaemia, mineral deficiencies and rickets have occasionally been observed They are more likely to occur among confined institutional flocks with limited regard to proper house design, emphasising the role of management system and level on the spectrum and impact of diseases on production

Effects of disease on inputs

The effects of disease on inputs revolve around the cost of treatment or prophylaxis This includes drugs chemicals and vaccines plus the cost of application and/or veterinary care The cost will accumulate substantially in case treatment must be repeated or performed regularly (e g for tick or tsetse control), or when animals must be gathered over long distances for treatment

Reproductive problems of small ruminants

Common problems

The major reproductive problems of confined or free-roaming small ruminants include abortions still births agalactia mastitis metritis dystocia and perinatal mortality (Falade and Sellers 1976 Smith and van Houtert 1988)

Many of the above problems are associated with systemic diseases that lower the overall performance of the animal, while others specifically cause foetal mortality abortion or male infertility Foetal mortality and abortion can be caused by vibriosis (due to *Camphylobacter fetus intestanalis*), salmonellosis (due to *Salmonella abortus ovis* and *S dublin*), *Listeria monocytogenes, Chlamydia,* sheep ticks (*Ixodes ricinus*)

carrying tick-borne fever, Border disease, mycotic abortion, Q' fever (*Coxiella burnetti*) and *Toxoplasma gondii* It is noteworthy that *Brucella abortus* is not a major cause of abortion in sheep

Infertility in male animals may arise from infectious epididymitis (caused by *B ovis* and *Actinobacillus seminis*)

Effects of disease on output

The effects of disease on output may be direct or indirect Direct losses include mortality and morbidity Overall losses due to livestock mortality in sub-Saharan Africa have been estimated at US$ 2 billion (de Haan and Bekure 1991) Losses due to morbidity as reflected by reduced growth, lactation, work output and reproduction (judged by lambing interval, lambing percentage, and delayed puberty etc) are probably of the same magnitude This is best reflected by offtake rates for meat, the main purpose for which small ruminants are raised, which remain low (32%) in Africa Furthermore, mean carcass weight is only 12–13 kg per head with the result that regional annual mutton/lamb and goat meat production in Africa is only 880 and 653 t/year

Another important effect of disease on production is that many times diseases alter the value of the animal by changing its conformation or rendering the products unfit for human consumption The products are therefore condemned for human use Furthermore, substantial revenue is lost annually because of the failure of many potential producers to meet the sanitary requirements of lucrative export markets

Among the more indirect effects of disease is the inability of farmers or producers to utilise favourable grazing lands or resources, adopt new systems of animal management, introduce more productive genotypes or fully utilise specific animal products such as draft power because the presence of disease increases the fear for subsequent morbidity or mortality

Diseases may also indirectly affect production through restrictions imposed on animal products as a result of treatment or vaccination, and the implementation of control regulations following the outbreak of certain diseases The latter may range from the enforcement of animal movement to the actual slaughter of sick animals or even those in contact Where animals are restricted in their movement, it is not uncommon for overgrazing to follow as another complication

Combined effects of disease and reproductive wastage on production

The impact of disease and reproductive wastage on small ruminant (sheep and goat) production is best estimated by the annual reproductive rate (RR) which is defined as the number of lambs or kids weaned per ewe (or doe) of reproductive age per year This estimate is influenced by litter size (S), lamb mortality (M) and lambing interval in years (I) as follows RR = S(1–M)/I The trait is thus significantly influenced by litter size, young mortality interval between parturitions and morbidity

Litter size

Litter size in tropical sheep ranges from 1 0 to 1 5 indicating that twinning rate in sheep ranges from 0 and 50% But mean litter size may be less than 1 indicating that the rate of pre- and perinatal losses in the form of stillbirths is greater than the twinning rate in the flock There are some recognised prolific breeds in Africa, e g the West African Dwarf and the Moroccan D'Man breed which commonly deliver two or more young

Litter size is largely determined by ovulation rate but is also modified by fertilisation rate and embryonic and foetal losses For example, although the ovulation rate of D'Man ewes averages 2 5, only about 42% of the eggs develop to full-term foetuses Ovulation rates vary among breeds, increase with ewe age up to 6–7 years and among seasonal breeders are greatest in the first half of the breeding season The trait is highly repeatable within individuals

Young mortality and the role of the dam

Young mortality rates in sheep and goats from birth to weaning range from 5 to more than 50% and represent a serious reduction in biological efficiency because resources invested by and in dams to initiate and maintain pregnancy are wasted Major causes of mortality include starvation–mismothering–exposure (the SME syndrome), pneumonia, enteritis, accidents, navel infection and septicaemia (Njau et al 1988, Jordan and LeFevre 1989, Chaarani et al 1991)

Because starvation and enteritis are two of the most important causes of neonatal mortality, it is necessary to ascertain if lambs/kids receive adequate colostrum and subsequent nutrition Maternal behaviour is therefore very critical to the newborn immune and nutritional status The ability of dams to recognise and bond with their young occurs during the initial sensitive period, a narrow window of time limited to the first few hours Dam ability to recognise progeny increases with parity and is often impaired by overcrowding (Alexander 1984, Poindron et al 1984)

Significance of maternal behaviour in young survival varies with management strategy and environmental conditions But whatever the subtle signals may be, failure of the maternal–neonatal bond in the first few hours may result in poor maternal behaviour and failure to nurse adequately The trait is probably also genetically influenced but this has not been adequately investigated in tropical breeds

Among other dam traits commonly associated with reduced young viability and survivability is weight and body condition score during gestation Adequate nutrition not only improves conception rates at mating, it increases young birth weight and decreases perinatal mortality (Alexander 1984 Holst et al 1986 Barlow et

al 1987, Jordan and LeFevre 1989, Yapi et al 1990, Mukasa et al 1994) Low nutrition in early pregnancy also results in 90-day foetuses with smaller linear body measurements (Parr et al 1986)

Placental size is a reasonably good index of placental function Decreased placental size limits foetal growth (Bell 1984) Placental weights vary widely due to endocrine factors, nutrition, heat stress, and such maternal factors as age and genotype Although the number of cotyledons is also quite variable, foetal weight is more correlated to the functional cotyledon weight and the chorio-allantoic weight (Hinch et al 1985, Parr et al 1986)

Finally newborn rectal temperature is an important factor for survival (Peeters et al 1991) Many times, perinatal death results from the inability to maintain adequate body temperature outside the uterus Barlow et al (1987) concluded that lambs which died had a significantly lower average body temperature one half hour after birth than those which survived Wind conditions often tend to exacerbate the heat loss

Young adaptation to cold stress

During cold exposure many metabolic hormones like thyroid hormone, growth hormone, insulin, glucagon, gut hormones and adrenal hormones may be involved in altering intermediary metabolism These may be influenced by somatostatin In fact, growth potential of young lambs can be maintained during cold stress by active immunisation against somatostatin Somatostatin activity in lambs is suggested to be concentrated in the lower gut where it may be involved in nutrient absorption This has also been reported for humans, dogs and rats These observations have important implications for neonatal mortality rates among sheep raised in the high altitude tropics and may provide useful tools for selecting for perinatal survival

Flock productivity indices

Despite some limitations, productivity indices can be used to measure the level of flock productivity Illustrated below for a study that involved Menz ewe lambs (Mukasa et al 1994), initial lamb weaning weight and subsequent parturition interval were used to construct three indices (Fall et al 1982, Wilson 1983, Wilson et al 1985) as follows

Index I = (total live weight of litter at 90 days x 365)/subsequent parturition interval in days

Index II = Index I/post-partum dam weight (ppwt) in kg

Index III = Index I/ppwt$^{0\ 73}$ of dam (kg)

Index I is derived in kg per ewe and represents lambing interval as a percentage of a year and considers lamb performance until weaning Because the dam is the source of major input up to weaning, productivity was also assessed in g per kg dam weight (Index II) or in kg per kg metabolic weight (Index III) Indices for ewes whose offspring died before weaning were zero the zeros being incorporated in the means and standard errors for the variables under consideration The mean value of Index I was 11 0±0 87 kg Index II was 520±41 g and Index III was 1 18±0 09 kg Because Indices II and III are calculated in terms of dam body weight or metabolic weight, it becomes possible to gauge the efficiency of available feed utilisation

Future prospects

Disease through morbidity and mortality and poor reproduction largely manifested as reproductive wastage, significantly reduces flock productivity and may make small ruminant rearing uneconomic The following sequence of measures is suggested to minimise the impact major causes of disease and low reproduction must be identified followed by the application of appropriate and well thought out prophylactic measures to control diseases and minimise reproductive wastage

The type of package recommended will, therefore, among others vary with production system, farmer acceptability, drugs and vaccine availability and cost and disease profile etc, particularly if the other management inputs are adequate

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Un aperçu des conséquences possibles des maladies et des pertes en reproduction sur la productivité des petits ruminants des régions tropicales

Résumé

L'elevage des petits ruminants assure une part non négligeable de la production de viande (et parfois de lait) en Afrique, contribuant ainsi à reduire les déficits alimentaires dus a la croissance demographique rapide La productivite de ces animaux est cependant affectee par de nombreuses maladies et par les pertes en reproduction Ces affections entraînent la mortalite des animaux, des avortements des cas de morbidite et des manifestations subcliniques y compris les pertes de poids, les retards de croissance le faible poids et la qualite mediocre des carcasses, sans oublier le temps et les ressources consacres a la lutte et aux traitements Par consequent, certains des principaux problemes a resoudre dans le domaine de l'elevage des petits ruminants concernent la sante animale et les causes des pertes en reproduction Les pertes imputables a la mortalite ont generalement des consequences economiques serieuses et faciles a mesurer alors que celles dues a la morbidite sont souvent sous-estimees car difficiles a evaluer Cet article examine les criteres a prendre en compte pour evaluer les consequences specifiques des problemes sanitaires et des pertes en reproduction

Growth and partition of fat depots in male British Saanen goats

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Abstract

Thirty-four male British Saanen goats were reared on milk substitutes and then given a barley-based concentrate diet *ad libitum* They were slaughtered serially at birth (3 5 kg), weaning (9 5 kg), 24 5, 36 5, 48 5 and 72 5 kg live weight Weights of fat depots were recorded With the exception of channel fat, all fat depots increased significantly (P<0 001) with increasing slaughter weight Growth coefficients were greater than 1 (P<0 001), highest for subcutaneous fat (1 887), followed by gut fat (1 802) dissected fat (1 687) intermuscular fats (1 619) and lowest for channel fat (1 127) Relative to total fat, greatest change in proportion of fat occurred between birth and 24 5 kg of live weight There was little consistent change in proportion of subcutaneous fat relative to change in total body fat

Introduction

Fat growth and development in farm animals is of importance from several points of view Firstly, as a reserve of energy, fat can determine the survival of the animal in periods of food scarcity Secondly, as a major carcass tissue it may affect the complex industry of meat production, including feeding, deciding on the optimum slaughter weight, and grading of the carcass and meat quality In the latter context, some fat depots are more valuable than others, e g subcutaneous and intermuscular fat are more desirable than kidney and gut fats Within fat depots in the carcass, fat in the expensive joints, provided it is not in excess is more valuable than fat in less expensive joints Thirdly, Adler and Wertherimer (1968) discounted statements that fat is a passive organ and pointed out that lipogenesis occurs mainly in the adipose tissues Fourthly the rigid relationship between body weight and muscle and bone demonstrated by Butterfield (1974) and Berg and Butterfield (1976), implies that the use of genetic and environmental factors in manipulating body composition is likely to have greater effects on the proportion of fat than on other carcass tissues

Defining the pattern of fat growth in breeds of goats is therefore essential to an understanding of body and carcass composition problems associated with production and marketing Goat carcass value is influenced markedly by both amount and distribution of fatty tissue depots In cattle, several studies have shown that the partitioning of fat among the depots is influenced by slaughter weights (Berg and Butterfield 1976) Growth and partition of fat depots in goat carcasses has not been studied thoroughly and results from controlled experiments are particularly scarce This study attempts to define growth and distribution of fat depots in male British Saanen goats slaughtered at different weights

Materials and methods

A total of 34 male Saanen goats were purchased at birth and serially slaughtered at birth (3 5 kg), weaning (9 5 kg), 24 5, 36 5, 49 5 and 72 5 kg live weights at Reading University farm The animals were artificially reared on Denkavit Lamb ewe milk replacer until weaning at 35 days of age The milk replacer contained (g/kg DM) 245 crude protein, 200 oil 2 5 fibre 30,000 IU vitamin A 14 000 IU vitamin D_3 and 30 IU vitamin E After weaning they were fed *ad libitum* fattening barley-based concentrate diet consisting of (g/kg DM) barley (750), flaked maize (50), soyabean meal (100), fish meal (50), molasses (30), limestone (15), salt (4) and mineral supplements (1) The diet contained 228 g/kg DM crude protein and 17 4 MJ/kg DM of gross energy

The animals were slaughtered and kidney fat gut fat and channel fat (fat found around pelvis bones) from the whole animal were separated and weighed Subcutaneous and intermuscular fat were obtained by dissecting both the right and left sides of the carcass Dissected fat weight was obtained by summing up weights of subcutaneous and intermuscular fat

Mean weights of the various fat depots were expressed as a percentage of empty body weight (EBW = live weight – gutfill weight) and analysed Fat depots were also expressed as a percentage of total fat weight Data for each fat depot were transformed to logarithms to establish part and whole allometric relationships of

the type $Y = ax^b$ where Y is the fat depot weight x is EBW, and b is the growth coefficient describing proportionate growth of fat in a depot to EBW

Results

Mean weights and mean weights expressed as percentages of empty body weight of various fat depots at six grouped slaughter weights are shown in Table 1 With the exception of channel fat weight at slaughter had a significant (P<0 001) effect on the proportion of all fat depots Both the absolute weight and the proportions of these fat depots increased with increase in slaughter weight However, the increase in proportions was small in the liveweight range of 24 5 to 49 5 kg

In the allometric equations for growth of fat depots relative to empty body weight (Table 2), the growth coefficients were significantly greater than 1 00, indicating that, as empty body weight increased, the proportion of these fat depots increased, confirming the results by direct comparison of percentages in Table 1

More of the variation in fat depot weights could be accounted for by variation in empty body weight using allometric equations The largest growth coefficient was for subcuteneous fat, showing it to be the latest developing depot while kidney and channel fat were the earlier developing depots

The relationship between the various fat depots was also studied by expressing weights of fat as a percentage of total body fat (Table 3) Total body fat proportion progressively increased with increasing empty body weight (Table 3) The proportion of intermuscular fat relative to body fat showed little consistent change with increase in total fat weight At birth, most of the fat was accumulated in three major depots gut kidney and intermuscular (Table 1) With increase in total body fat, the most notable change was the increase in proportion of subcutaneous fat (Table 3) The increase was accompanied by a decrease in the proportion of kidney fat Table 3 also indicates that the major changes in proportions of fat depots occurred early in life, i e before total body fat exceeded 2 4 kg (corresponding to 24 5 kg live weight)

Discussion

The present findings agree with the literature on goats (Wilson 1958, Ladipo 1973), sheep (Hammond 1932, Gaili 1976) cattle (Jones 1976 Berg et al 1978) and pigs (Richmond and Berg 1972) in that most of the fat depots increased in weight at a faster rate than body weight The results in the present study indicate that subcutaneous

Table 1 *Mean weights (g) and mean weights expressed as percentages (%) of empty body weight (in brackets) of various fat depots* [1 2]

	Slaughter stage						
Component	Birth	Weaning	24 5 kg	36 5 kg	49 5 kg	72 5 kg	SED
No of animals	4	4	8	8	8	2	
Gut fat	27 (0 82)	157 (1 75)	901 (4 36)	1680 (5 24)	2695 (6 28)	6268 (9 47)	0 40***
Total channel fat	8 (0 26)	22 (0 25)	69 (0 33)	116 (0 36)	138 (0 32)	256 (0 39)	0 04
Total kidney fat	27 (0 82)	99 (1 11)	289 (1 40)	705 (2 19)	1039 (2 43)	2651 (3 99)	0 06***
Subcutaneous fat	6 (0 21)	133 (1 49)	433 (2 11)	796 (2 49)	953 (2 22)	3157 (4 78)	0 37***
Intermuscular fat	27 (0 82)	163 (1 81)	657 (3 20)	1138 (3 55)	1758 (4 11)	3623 (5 47)	0 27***
Dissected fat	33 (1 03)	296 (3 30)	1090 (5 31)	1934 (6 03)	2706 (6 33)	6780 (10 25)	0 50***

1 For ease of tabulation standard deviations and coefficients of variation are excluded

2 SED = Average standard error of difference (percentage data only)

*** = significant at P<0 001

Table 2 *Allometric regression equations showing growth of fat depots relative to empty body weight* [1]

Component	b log x + a	SED	R^2
Gut fat	1 802x*** – 11 262	0 036	98 77
Total channel fat	1 127x* – 7 044	0 057	92 32
Total kidney fat	1 455x*** – 8 813	0 055	95 61
Subcutaneous fat	1 887x*** – 12 956	0 103	91 26
Intermuscular fat	1 619x*** – 9 734	0 039	98 14
Dissected fat	1 687x*** – 9 930	0 053	96 93

1 * ** *** indicate that the b value is significantly different from 1 00 at P<0 05 P<0 01 or P<0 001 respectively

Table 3 *Partition of body fat depots in male goats slaughtered at different live weights*

Slaughter weight group	Number of animals	Total body fat (g)	Total body fat as % of EBW	Fat depots as % of total body fat				
				Intermuscular	Subcutaneous	Kidney	Channel	Gut
Birth (3 5 kg)	4	95	2 93	27 65	7 00	28 33	8 87	27 99
Weaning (9 5 kg)	4	575	6 41	28 24	23 24	17 32	2 90	28 30
24 5 kg	8	2350	11 40	27 98	18 51	12 28	2 98	38 25
36 5 kg	8	4435	13 82	25 67	17 95	15 85	2 61	37 92
49 5 kg	8	6583	15 35	26 71	14 46	15 83	2 08	40 91
72 5 kg	2	1599	24 10	22 70	19 83	16 56	1 62	39 29

fat grows faster in post-natal life than all other fat depots a finding similar to those of Palsson and Verges (1952) and Gaili (1976) using lambs Kirton et al (1972) also noted that, apart from omental fat subcutaneous fat was the last fat depot to mature Whilst the order of fat depot development was similar to those of cattle (Williams 1978), it was slightly different from that given by Palsson and Verges (1952), who described gut fat as slower growing than intermuscular fat Kirton et al (1972) also found channel and intermuscular fat in male lambs to be early maturing

The present results also contrast sharply with those reported by Ladipo (1973) using a mixture of male dairy goat breeds slaughtered between 22 and 54 kg live weight He reported fat depots to increase in the following order of increasing rate subcuteneous, gut (caul and mesenteric) fat intermuscular fat, and finally visceral fat (kidney, channel and heart fat) Per unit of empty body weight, the growth rates of intermuscular and visceral fat depots in Ladipo s study were twice that of subcutaneous fat The fact that Ladipo (1973) used a mixture of breeds merits interpretation of the results with caution, because breed differences have been observed in fat growth rates and distribution in farm animals (Berg and Butterfield 1976)

Relative to total body fat, gut fat was the largest contributor to the total fat reaching a peak at about 2 4 kg total body fat, corresponding to 24 5 kg live weight (Table 3) This fat depot, together with that of the kidney and channel fat, is usually trimmed off the carcass in lambs and cattle and sold as cooking fat The ratio of dissected carcass fat (subcutaneous plus intermuscular fat) to other fat depots of the body may therefore be a more important criterion in determining meat quality in goats and was 1 87 1 06 0 87 0 77 and 0 74 at birth (3 5 kg) weaning (9 5 kg) 24 5, 36 5, 49 5 and 72 5 kg live weight respectively Table 3 demonstrates that the greatest change in proportions of the various fat depots occurred between birth and 24 5 kg live weight in male Saanen goats This period may, therefore, be critical in the study of genetic and environmental factors affecting growth and distribution of fat depots

Subcutaneous fat made the least contribution at birth but rose sharply to its mature proportion at weaning The conclusion by Ladipo (1973) that proportions of intermuscular fat decreased with increase in carcass fat can be interpreted to correspond to the 24 5 to 72 5 kg liveweight interval in the present study

Conclusion

The present study shows that the various fat depots in goats grow faster relative to empty body weight They also grow at different rates relative to each other There is however, need for further studies taking into account breed and nutrition influences in fat growth and distribution

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Croissance et répartition des dépôts adipeux chez des boucs de la race de Saanen anglaise

Résumé

Trente quatre boucs de la race de Saanen anglaise ont ete alimentes avec un substitut du lait puis avec un concentre a base d'orge servi *ad libitum* Ils ont ete abattus en serie a la naissance (3,5 kg), au sevrage (9,5 kg) puis aux poids vifs de 24,5 kg, 36 5 kg, 48 5 kg et 72,5 kg Leurs depôts adipeux ont ete peses A l'exception de celui de la graisse pelvienne, les poids de tous les autres types de depôts ont augmente significativement avec l accroissement du poids a l'abattage Les coefficients d accroissement etaient superieurs a 1 (P<0,001) le chiffre le plus eleve correspondant a la graisse sous-cutanee (1,887) suivie de celle des boyaux (1,802), de la graisse de dissection (1 687) et des graisses intermusculaires (1,619), la valeur la plus faible etant celle du gras de bassin Par rapport a la graisse totale les plus grands changements dans la proportion de graisse etaient intervenus entre la naissance et le poids vif de 24 5 kg Enfin il n y avait pas de correlation claire entre les changements de la proportion de graisse sous-cutanee et ceux de la graisse totale

Etat de la situation sanitaire des produits laitiers commercialisés dans la zone périurbaine de N'Djaména

P Bornarel N Boulbaye, P Hugoo et K Gaou

Résumé

Des echantillons de lait frais (17) lait caille (37) beurre solide (5) et beurre fondu (7) sont preleves sur 11 marches dans un rayon d'environ 100 km autour de N'Djaména Les laits proviennent soit de vaches (37), soit de chevres (11) soit sont un melange des deux (6) Les beurres sont tous d'origine bovine Pour la flore bacterienne globale, les laits frais comportent 10^4 germes par millilitre et les laits cailles au moins 10^7 L acidite ne semblait pas avoir influe sur la proliferation des germes Les beurres fondus presentent une flore globale plus importante (2 10^6 germes par gramme) que celle des beurres solides (10^4) peut-être par suite de manipulations et transvasements plus nombreux Il s agit de germes non pathogenes notoires qui proviennent de l'environnement par suite d une serie de manipulations sans precautions au cours de la chaîne de production Des champignons et levures ont ete isoles et identifies Il faut envisager de poursuivre cette etude bacteriologique en analysant chaque etape de la chaîne de production afin de degager des donnees pratiques pour une amelioration

Introduction

Dans les pays africains les produits laitiers jouent un rôle important dans l'alimentation humaine Le Tchad n'echappe pas a la regle avec une predilection pour le lait des petits ruminants Les conditions d exploitation de ces produits mal definies, risquent de se prêter a la multiplication et a la diffusion de germes dont certains pourraient se reveler dangereux pour la sante humaine D'autres germes, non identifies comme pathogenes mais presents en grand nombre pourraient perturber les techniques de production de certains produits destines à la commercialisation Il y aurait donc la une possibilite d intervenir pour une amelioration tant qualitative que quantitative avec bien sûr une incidence economique

Matériel et méthode

Prélèvements

Les prelevements ont ete realises au niveau des marches de la zone periurbaine de N'Djamena, dans un rayon de 100 km environ qui correspond a la zone d'intervention du Projet regional de recherche pour les petits ruminants pour son etude globale sur la production laitiere L'etude a porte sur le lait et le beurre tels qu'ils sont commercialises, donc consommes Le lait se presente sous forme de lait cru ou caille Il est conditionne soit dans des calebasses avec couvercle soit dans des bidons en plastique servant surtout a transporter le produit jusqu a N'Djamena Au moment de l achat ces laits sont transvases dans le recipient apporte par l'acheteur Quant au beurre, il se rencontre soit sous forme de petits morceaux conserves dans des calebasses contenant du petit lait ou du lait caille, soit sous forme liquide appelee beurre fondu conservee dans des bouteilles Les laits etudies etaient du lait de vache ou de chevre ou un melange des deux Quant aux beurres, ils etaient exclusivement d origine bovine (tableau 1) Les prelevements ont ete realises dans des pots steriles de maniere aleatoire, en fonction de la proposition des commerçants, ce qui explique le desequilibre entre les differentes formes Les echantillons ont ete mis au froid dans un recipient isotherme et transportes au laboratoire pour traitement immediat

Analyse microbiologique

Les techniques utilisees sont des methodes classiques et correspondent, en matiere d'hygiene alimentaire, aux recommandations de la legislation française publiee au Journal officiel (Anonyme 1991) Cette analyse concerne les bacteries, les levures et champignons, mais les virus ne sont pas recherches (Beerens et Luqest 1987, Bourgeois et Leveau, 1991, Carter and Cole, 1990, Collectif, 1969, Nevot 1947)

Les bacteries sont considerees selon trois criteres

- presence normale c'est la flore dite acidifiante ou lactique utile pour une transformation ulterieure du lait frais cru Elle est constante dans le beurre De ce point de vue sont recherches *Lactobacillus* et *Streptococcus* (gelose MRS et gelose Rogosa)
- pollution les germes de l environnement trouvent dans le lait un excellent milieu de culture Il faut donc les rechercher systematiquement, d une maniere globale Ensuite il faut isoler et identifier ceux qui peuvent être dangereux selon les criteres de l hygiene alimentaire

La recherche porte sur les germes fecaux (enterobacteries en general et *Salmonella* en particulier,

Tableau 1 *Nature nombre origine et repartition des echantillons de laits et de beurres etudies*

	Lait		Beurre		
Espèces	Frais (N)	Caille (N)	Solide (N)	Fondu (N)	Total
Vache	Boutelfil (5)	Djermaya (3)		Karal (1)	
	Dougui (1)	Douguya (8)		Karme (1)	
		Gredeya (3)		Mandelia (1)	
		Karal (4)		Massaguet (4)	
		Karme (5)			
		Limia (4)			
		Mandelia (3)			
		Massaguet (1)			
Sous total	6	31	5	7	49
Chèvre	Lamadji (1)	Djermaya (5)			
	Djermaya (5)				
Sous total	6	5	***	***	11
Mélange	Lamadji (5)	Djermaya (1)			
Sous total	5	1	***	***	6
Grand total	17	37	5	7	66

*** = non disponible

streptocoques fecaux) et *Pseudomonus* (gelose VRBG DCLS, bouillon selenite, de ROTHE de LITSKY), sur les germes anaerobies sulfito-reducteurs (gelose TSN), sur les levures et champignons (gelose de SABOURAUD avec et sans chloramphenicol)

- pathologie c'est-a-dire celle de l'animal producteur ou de l'eleveur, avec une attention particuliere pour les risques de zoonose

L'attention s'est portee plus particulierement sur *Staphylococcus* (milieu de CHAPMAN, de BAIR-PARKER, sur *Brucella* (milieu BAM) et sur *Mycobacterium* (milieu de LOZENSTEIN-JENSEN, de COLESTSOS)

Les bacteries sont denombrees selon deux modalites test au bleu de methylene et comptage sur gelose PCA (plate count agar') avec une serie de trois dilutions de facteurs 10 preparees en tenant compte des resultats du test au bleu de methylene

Résultats

Numération des bactéries

Les valeurs moyennes (en germes/ml), regroupees par type de lait et par origine sont presentees au tableau 2 Le lieu de prelevement n apporte aucune information significative

La methode au bleu de methylene (BM) presente une bonne correlation avec le comptage en milieu gelose et constitue un bon outil pour la pratique courante D un point de vue general, la flore bacterienne semble moins abondante dans les beurres que dans les laits, en particulier les laits cailles La flore acidifiante a pu être cultivee sur milieux adaptes (gelose MRS, gelose ROGOSA) ce qui permet d'avoir un ordre de grandeur de la flore de pollution contamination Les resultats en valeurs moyennes, sont exprimes en germes/gramme (tableau 3)

Tableau 2 *Denombrement des bacteries dans le lait (germes/ml)*

Type	Origine	N	Bleu de methylene	gelose PCA
Lait frais	vache	6		
	chèvre	6		
	melange	5	de 5 h a 5h15	de 10^4 à 1 8 10^4
Lait caillé	vache	31		
	chevre	5	de 30 mn a 1 h 30	$\geq 10^7$
	melange	1	de 6 10^6 à 10^7	

Tableau 3 *Denombrement des bacteries dans le beurre (germes/gramme)*

Type	flore globale	pollution/contamination
Solide	8 9 10^3	4 9 10^3
Fondu	1 9 10^6	8 7 10^4

Isolement et identification

Cette phase a porte sur les bacteries les levures et les champignons Une grande variete de germes a ete isolee dans les laits mais aucun d'entre eux ne s est revele être un agent pathogene majeur (tableau 4) Une attention toute particuliere a ete accordee aux contaminants fecaux et aux staphylocoques (risque de contamination d'origine humaine) *Aucun des bacillus* isoles n'etait Bacillus anthracis, agent du charbon, une anademie majeure au Tchad Par ailleurs, les recherches de germes anaerobies ont toutes ete negatives, de même que celles de germes comme *Yercinia Listeria Corynebacterium* auxquels une attention toute particuliere a ete accordee sur milieu Brucella Agar Modifié (BAM) Deux souches ont ete isolees a partir de deux prelevements distincts de laits cailles de vache (Karal, Linia) Les colonies sont apparues apres trois semaines en atmosphere enrichie en gaz carbonique et avec une technique a deux milieux (solide et liquide) Les colonies sont petites circulaires convexes translucides, de couleur miel Les germes sont des coccobacilles GRAM negatifs immobiles a catalyse positive, réduisant les nitrates indole negatif reaction au rouge de methyle et de Voges-Proskauer negative, ruee negative On peut conclure a une forte suspicion de *Brucella*

Les resultats relatifs aux beurres sont identiques a ceux enregistres sur les laits, avec presence d une flore globale remarquable mais sans identification de germes notoirement dangereux (tableau 5)

Tableau 4 *Isolement et identification de germes dans les laits*

	Type de lait			
	Frais		Caille	
Origine	Bacteries (N)	Champignons et levures	Bacteries (N)	Champignons et levures (N)
Vache	[6]	***	[31]	
	Serratia (1)		Achromobacter (1)	Candida (7)
	Enterodacter (6)		Acinetobacter (3)	Saccharomyces (5)
			Enterobacter (4)	Trichosporon (1)
			Escherichia (2)	
			Pseudomanas (2)	
			Micrococcus (1)	
			Staphylococcus (12)	
			Brucella (2)	
Chèvre	[5]		[5]	
	Klebsiella (3)	Candida 3	Erwinia (1)	Candida (3)
			Pseudomonas (3)	Trichosporon (1)
Mélange	[6]		[1]	
	Klebsiella (1)	Candida (3)		
	Pseudomonas (1)			***

*** = non isolés [N] = nombre d échantillons (N) = nombre de souches étudiées

Discussion

Echantillonnage

Il n'y a pas eu, des le depart, de plan d'echantillonnage elabore integrant, en vue d'une etude, des parametres comme le lieu de recolte, la saison ou les modalites de production On profitait d'une sortie sur le terrain pour un autre travail, pour prelever les echantillons a condition de revenir rapidement au laboratoire pour traitement immediat Il est peu probable qu'un nouvel echantillonnage plus important de laits cailles de melange entraîne une modification fondamentale des resultats de numerations acquis le lieu de prelevement n'apportant pas une information discriminante, même s'il y a des variations de production d'une region a l'autre

Tableau 5 *Isolement et identification de germes dans les beurres*

Types	N	Bacteries	Champignons et levures
Solide	5	NC	Trichosporon
Fondu	7	NC	Candida (2)

NC = bacteries de pollution non caractéristiques

Compte tenu des conditions de travail il etait impossible de trouver des produits laitiers provenant des autres especes (mouton dromadaire) Pour cette etude l'espèce d'origine du produit n'a ete determinee que sur la base de l'affirmation du vendeur

Numération

La flore bacterienne globale est moins elevee pour les laits frais que pour les laits cailles quels que soient l origine et le lieu de recolte Il est frequemment admis que l'acidité du lait caille pourrait detruire les germes Cette forme de presentation du lait semble assurer une conservation acceptable puisque le produit peut être commercialise pendant une semaine apparemment sans gêne connue pour le consommateur Si les germes qui se sont multiplies ne sont pas des bacteries pathogenes notoires, leur abondance est cependant le signe que l'hygiene minimale de base n'est pas respectee, d'ou de fortes possibilites de risques

Les essais de culture de la flore lactique ayant tous ete negatifs avec les laits qu ils soient frais ou cailles on ne pouvait donc ni la caracteriser, ni la comparer a la flore de pollution/contamination Malgre une enquête poussee (verification des protocoles, des manipulations des reactions, essais avec des souches temoins) on n'a pu trouver aucune explication liee a la technique utilisee Il faut donc chercher ailleurs Le fait que la preparation du lait caille soit toujours effectuee par chauffage prolonge a temperature elevee pourrait expliquer la disparition de cette flore microbienne specifique Etant donne que cela concerne les deux types de lait, on peut penser que tout le lait produit subit ce chauffage, mais une partie seulement serait transformee en lait caille le reste etant commercialise sous une forme appelee a tort donc, lait frais Au retour du marche, le lait frais invendu serait transforme a son tour en lait caille pour une conservation plus longue et une commercialisation ulterieure

L'abondance de la flore microbienne dans les laits cailles a necessite l'utilisation de dilutions tres elevees pour le comptage en milieu gelose (PCA) Devant des resultats aussi eleves, le milieu utilise a ete systematiquement verifie en incubant les boîtes de petri avant inoculation Il n y avait pas de pollution prealable

En ce qui concerne les beurres, compte tenu des conditions d'echantillonnage restreint, on ne peut que parler de la tendance generale observee a savoir que le beurre fondu paraît plus bacillifere que le beurre solide, une situation imputable peut-être aux manipulations supplementaires et aux transvasements qu il a subis

Champignons et levures

Les champignons et les levures n ont pas fait l'objet d'une numeration mais leur presence est assez constante dans l'ensemble des prelevements (Vanbreuseghem, 1966) Il est difficile d'en tirer une conclusion pratique particuliere car ce sont des elements permanents de l'environnement Ils traduisent eux aussi le fait qu'au cours des manipulations le lait est tres souvent expose a l air ambiant

Identification

Pour ne pas surcharger la presentation, on s'est limite aux germes isoles et etudies pouvant presenter un certain interêt (qualite, pathologie) (Pilet *et al* 1987) Les recherches infructueuses ou resultats "negatifs interpretes comme une absence, seront cependant pris en consideration pour l'analyse

Aussi bien dans les laits que dans les beurres, les contaminants fecaux sont extrêmement rares et c est une bonne chose car on pouvait craindre que certaines pratiques d'elevage (comme par exemple le fait de badigeonner les mammelles avec de la bouse pour empêcher les jeunes de teter), ajoutees au manque d hygiene deja constate n'entraînent une pollution importante par cette categorie de germe Nous relevons cependant la presence d *Escherichia (E coli)* et de *Klebsiella (K pneumoniae)* En particulier *E coli* peut se fixer sur le materiel et s y developper creant ainsi une source constante de pollution si on ne procede pas a une sterilisation efficace entre deux operations Tous les germes identifies sont saprophytes et/ou commensaux, en general ubiquistes et pathogenes occasionnels opportunistes dans des conditions bien particulières (sujet debilite, milieu hospitalier) Les germes cites sont ceux habituellement rencontres dans les ouvrages traitant de bacteriologie alimentaire Malgre toute l attention portee a sa recherche, aucune souche de *Salmonella* n a ete isolee

A partir des colonies de la flore globale, de nombreuses bacteries se sont revelees être, elles aussi, des commensales ou des saprophytes sans pouvoir pathogene Pour être plus proche de la realite il vaut mieux dire qu elles n'ont pu être associees a aucun etat morbide

Il faut noter que *Staphylococcus aureus* un germe a caractere plus pathogene et d origine humaine n'a pas ete isole De même, aucun *Mycobacterium* n'a non plus ete isole Cela peut amener a penser que dans les conditions de travail on n a pas ete confronte avec la tuberculose Une etude particuliere sera effectuee dans le cadre d'un autre protocole

En ce qui concerne les *Brucella* l identification des deux souches n a pas ete confirmee par le laboratoire du Centre national d'etudes veterinaires et alimentaires (CNEVA) de Maisons Alfort, probablement en raison d'une erreur de transmission La suspicion subsiste cependant et le probleme devrait être repris pour lever le doute Ce volet sera execute dans le cadre d un autre programme

Conclusion

D'un point de vue analytique, on constate la presence d une flore microbienne globale abondante mais sans agent pathogene majeur (bacteries, levures et

champignons) Cependant en matiere d hygiene alimentaire, l'experience montre que les risques sont d'autant plus grands que les germes sont plus nombreux Par ailleurs on ne peut degager aucune conclusion en ce qui concerne le facteur saison alors que le parametre lieu de recolte ne semble avoir aucune influence Enfin, la composition exacte des laits de melange est inconnue

D un point de vue prospectif il importe d'effectuer une etude bacteriologique des techniques de production (traite recipients eau), en relation avec les techniques de transformation, pour en degager des consignes pour le producteur, le vendeur et le consommateur, de realiser une enquête epidemiologique aupres des services de sante publique sur les pathologies en relation avec la consommation des types de laits etudies de definir la composition des laits de melange, en integrant les laits en poudre reconstitues proposes sur les marches de N Djamena, d'envisager les bases techniques d une legislation en matiere d hygiene alimentaire et d'apporter des elements aux etudes de type economique pour calculer l incidence des interventions preconisees (materiel, desinfection, sterilisation, pertes etc) et des contrôles de qualite

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Health status of milk products marketed in peri-urban areas of N'Djamena

Abstract

Samples of fresh milk (17) sour milk (37), solid butter (5) and liquid butter (7) were collected from 11 markets in a 100-km radius around N Djamena Milk samples were obtained from cows (37), goats (11) or both (6) while all butter samples came from cattle Total bacterial count for fresh milk samples was 10^4/ml and at least 10^7/ml for sour milk samples, acidity did not seem to affect bacteria proliferation Liquid butter bacterial count (2 x 10^6/g) was higher than that of solid butter samples (10^4/g) perhaps due to more handling and transfers These bacteria were well known non-pathogenic bacteria originating from the environment as a result of a series of careless handling during processing Some fungi and yeast species were isolated and identified This bacteriological study should continue through a step-by-step analysis of the production chain to identify practical data needed for the improvement of the system

Performances de reproduction et accroissement numérique du cheptel ovin dans deux noyaux d'élevage traditionnel en zone soudano-sahélienne au Mali

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Résumé

L'elevage des petits ruminants s etend sur toutes les zones agro-ecologiques du Mali Les etudes relatives a ces ovicaprinae sont peu nombreuses, d'ou une connaissance insuffisante des contraintes majeures au developpement de cet elevage Cette etude fut entreprise pour combler en partie cette lacune Elle fut basee sur le contrôle des performances individuelles de reproduction dont la methodologie est presentee Les femelles suivies etaient precoces avec un âge moyen a la premiere parturition de 16 ± 1,4 mois, tres fertiles (taux de fertilite = 132 %) mais peu prolifiques (taux de la portee = 1 08 ± 0 03) Leur bonne fertilite pourrait s expliquer par l'intervalle entre agnelage assez reduit (243±16 1 jours) Le taux de viabilite de la naissance au sevrage etait de 85% Le troupeau, l'annee de mise bas la saison de la mise bas precedente et le numero de la portee influencent ces principales composantes de la productivite numerique Le facteur alimentaire semble être le determinant majeur de l'expression de celles-ci La necessite d une complementation alimentaire en periode de soudure est discutee et, l organisation de la lutte apparaît comme une alternative particulierement interessante Les strategies d'exploitation semblent differentes selon les proprietaires Toutefois les ovins constituent une forme de recours pour la gestion du "risque ' et pour la consolidation a des degres divers des rapports sociaux a travers les differentes formes d'exploitation En conjonction avec le faible taux d exploitation du cheptel et la maîtrise des mesures de prophylaxie sanitaire, les bonnes performances de reproduction autorisent une croissance numerique moyenne de 58% des effectifs Les consequences de cet accroissement sont evoquees de même que les moyens (destockage cultures fourrageres etc) a mettre en oeuvre afin d assurer le developpement de l elevage

Introduction

Avec pres de 13 millions de têtes en 1991, l elevage des petits ruminants touche toutes les zones agro-ecologiques du Mali Ils ne fournissent cependant que 17 % de la viande consommee estimee a 25 000 tonnes (Statistiques des abattages contrôles en 1991, Rapport annuel Direction nationale de l'elevage) Les carcasses ovines representent le tiers de cet approvisionnement Les premieres etudes pertinentes sur ces ovicaprinae ont demarre au debut des annees 1980 dans la zone semi-aride Les principaux resultats obtenus ont fait l'objet de multiples publications (Wilson *et al*, 1983, Wilson, 1986) Des etudes sont actuellement en cours en station sur le mouton Toronke a Kayes et sur le mouton du Sahel a Niono Tous ces travaux sont loin de couvrir la diversite agro-ecologique des milieux d'elevage en relation avec la diversite biologique Globalement, en depit de leur importance numerique, les petits ruminants ont en general ete l'objet de tres peu de programmes de recherche par rapport aux bovidae Il en resulte une connaissance parcellaire et pas mal de lacunes en ce qui concerne la connaissance des contraintes majeures au developpement de leur elevage Afin de contribuer a combler cette lacune, un protocole de contrôle des performances individuelles a ete mis en place dans deux noyaux d'elevage traditionnel en zone soudano-sahelienne En caracterisant les potentialites des animaux (reproduction et croissance) en tenant compte des caracteristiques environnementales, on pourrait, en accord avec Flamant (1988) identifier les caracteres qui expriment une reponse du materiel animal aux contraintes du systeme d'élevage La presente communication se limite a l'expose des performances zootechniques de reproduction et a l evaluation de la dynamique des troupeaux Le choix de la reproduction n'est pas fortuit car elle constitue la cle de voûte de toute production animale et conditionne, en partie, le renouvellement du troupeau L'accroissement de la productivite d'un troupeau – du moins dans sa composante numerique – voire de l'elevage en general, passe incontestablement par l'amelioration de la reproduction et sa maîtrise constitue un outil privilegie pour realiser des progres genetiques

Matériel et méthodes

Matériel animal

Deux noyaux de troupeaux ovins eleves dans un village agro-pastoral en zone soudano-sahelienne ont fait l'objet d'un suivi periodique hebdomadaire continu sur deux cycles annuels Les caractéristiques generales

(structure et mode de conduite des animaux) ont ete deja decrites (Niare et Sangare, 1992) Aussi, n expose-t-on ici que la methodologie de collecte des donnees relatives a la reproduction

Lors du recensement au cours duquel tous les animaux presents furent individuellement identifies a l aide de boucle auriculaire les principales caracteristiques (âge sexe et carriere reproductrice pour les femelles) de tous les animaux ont éte consignées dans une fiche speciale Les informations relatives aux agnelages etaient enregistrees chaque semaine lors du passage regulier et systematique de l'observateur Ce sont, outre le nom de l'observateur, le troupeau et la date du contrôle, le numero de la brebis, sa date de mise bas, le numero de la portee, le mode de naissance et le nombre de produit(s) ne(s) vivant(s) Au total, 172 agnelages et 73 intervalles entre agnelages ont ete repertories dans les deux noyaux Au cours du même passage, les sorties intervenues (abattages ventes, dons, mortalites, pertes et confiages) etaient egalement consignees dans une fiche appropriee

Méthodologie d'analyse

A partir de la base de donnees brutes ainsi recueillies, les paramètres zootechniques suivants ont ete calcules l'âge a la premiere mise bas (APMB), l'intervalle entre agnelages (IEA), le taux de fertilite (TdF), la taille de la portée (TdP) et les taux de viabilite des agneaux (TdV) Le taux de viabilite perinatale est obtenu en divisant le nombre d'agneaux nes vivants par femelle par la taille de sa portee L'influence des facteurs de variation tant intrinseques qu'extrinseques sur ces variables zootechniques a ete estimee par analyse de variance Le modele croise a effet fixe a ete utilise Sa formule mathematique generale est la suivante

$$V_{ijk} = + \alpha_i + \beta_j + E_{ijk} \text{ ou}$$

V_{ijk} est la performance zootechnique de la reproductrice k appartenant aux facteurs i et j

μ est la moyenne

α_i repesente l effet du ieme niveau du premier facteur (tableau 1) Par exemple pour la variable IEA, le facteur troupeau a 2 niveaux

β_j represente l'effet du jeme niveau du second facteur analyse (tableau 1)

E_{ijk} designe la residuelle d esperance nulle

L homogeneite de la répartition mensuelle des mises bas a ete testee a l'aide du khi-deux La signification des differences entre taux de survie a ete appreciee par comparaison des proportions

L'evolution des effectifs des troupeaux tient compte de l'exploitation de la mortalite et des entrees d'animaux (confiages, dons, naissances) Une combinaison lineaire de ces parametres permet une evaluation du croît numerique annuel qui traduit la dynamique des effectifs des troupeaux Ce parametre a ete calcule comme suit

Cr = (R–1)*100 ou

R = Eff_{t+1}/Eff_t est le rapport des effectifs au temps t+1 et t,

Cr = croît numerique annuel en %

Résultats

Performances de reproduction

Les performances zootechniques de reproduction constituent la principale composante de la productivité numerique d'un troupeau Aussi, importe-t-il de les evaluer et d'en connaître les variations

Age a la premiere mise bas (APMB)

L âge moyen des agnelles au premier agnelage etait de 16 6±1,4 mois (n = 31) avec un coefficient de variation de 24% Cet âge varie de façon tres significative ($F_{1\ 28}$ = 8 97, P<0,01) en fonction de l'annee de mise bas qui explique 25% des variations totales (R^2 = 0,25) Il est de 18,6±1 9 mois en 1989 contre 14,6±1,5 mois en 1990 Globalement, l'âge d'entree en reproduction est, par contre, independant du troupeau d'appartenance

Tableau 1 *Liste des variables etudiees facteurs et niveaux des facteurs analyses*

Variables	Facteurs analyses	Niveaux des facteurs
APMB	Troupeau	2
	Annee de mise bas	2 1989 et 1990
	Troupeau	2
IEA	Saison de la mise bas precedente	3 nov fevrier
		mars-juin
		juil octobre
TdP	Troupeau	2
	Numero de la portee	8 (1–8)

Intervalle entre agnelages (IEA)

L'intervalle moyen entre mises bas est de 243± 16,1 jours (n = 73) soit 8 mois avec une variabilite individuelle relativement plus grande traduite par un coefficient de variation de 29% L'IEA est tres significativement influence par la saison de la mise bas precedente ($F_{2\ 69}$ = 9,34 P<0,01) qui explique le tiers de la variation totale (R^2 = 0,33) Les legeres differences observees dans les performances intertroupeaux semblent dues au hasard L'intervalle moyen entre agnelages est plus faible lorsque la mise bas precedente a eu lieu en fin de saison seche (232,44 ± 22 jours) et pendant la saison des pluies (225,30 ± 25 jours) que pendant la saison seche fraîche (315,07 ± 36 jours)

Taux de fertilité (TdF)

Le taux de fertilite global sur un cycle annuel de suivi etait de 132% Ce taux varie d un troupeau a l'autre Il etait en effet de 106% pour le troupeau I et de 158% au sein du second troupeau Dans les deux troupeaux, la distribution mensuelle des agnelages n'etait ni reguliere ni uniforme sur toute l'annee d apres le test de khi-deux (P<0,05) Pres de la moitie des naissances sont enregistrees au cours du trimestre septembre-octobre-novembre En prolongeant jusqu en mars, la proportion de mises bas est de 4/5 (figure 1) En outre, les resultats du même test montrent une totale absence d'homogeneite dans la repartition mensuelle des agnelages d'une annee sur l'autre

Taille de la portee (TdP)

La taille moyenne de la portee etait de 1,08 ± 0,03 agneaux (n=161) avec un coefficient de variation de 23% Cette variable zootechnique est influencee significativement par l'effet troupeau ($F_{1\ 153}$ = 6 24 P<0,05) et tres significativement par l'effet numero de la portee ($F_{7\ 153}$ = 3 18 P<0,01) La taille de la portee au sein du troupeau I etait de 1,04± 0,05 contre 1,15± 0,07 dans le second L influence de l'effet numero de la portee se traduit par une augmentattion graduelle de la taille de la portee a partir du 3eme agnelage (1,03) Elle est maximum au 6eme agnelage (1,26) et diminue ensuite

Taux de viabilite

Le taux de viabilite perinatale est en moyenne de 99% Independant de l'annee de mise bas, il ne depend ni de l'effet troupeau ni de celui de la saison de mise bas Au cours des deux annees de suivi, les mortalites (0–6 mois) ont constitue un phenomene particulierement marque Elles ont represente 33 et 49% des sorties respectivement en 1989 et 1990 Le taux moyen global etait de 85% Les mortalites etaient dues essentiellement a des maladies et eventuellement a des accidents Parmi toutes les maladies, la pasteurellose etait la principale cause de deces des agneaux Toutefois, les causes diverses (inconnues ou dues probablement a des carences nutritionnelles, conjonctivite rikettsiose intoxication-indigestion-ballonnement) etaient aussi preponderantes dans le second troupeau ou, en revanche, aucun cas de pneumonie n'a ete suspecte (tableau 2)

Le taux de viabilite des mâles dans les deux troupeaux etait de 80% contre 84% pour les femelles Le taux global de viabilite des agneaux etait de 79% dans le troupeau I contre 84 dans le second Enfin, de 90% en 1989 il etait tombe a 80% en 1990 L'ecart entre ces deux

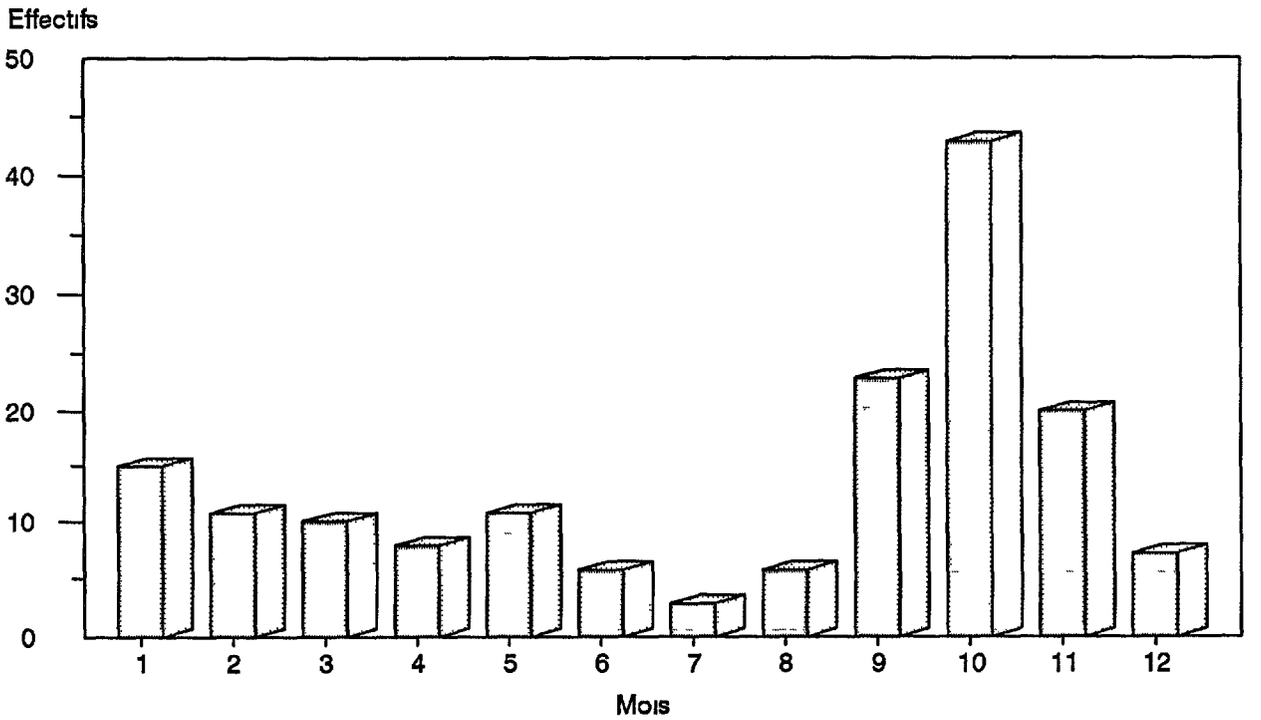

Figure 1 *Repartition mensuelle des agnelages*

annees etait statistiquement significatif contrairement aux differences entre sexes ou entre troupeaux

Tableau 2 *Causes suspectees de mortalite des agneaux avant le sevrage*

	Causes de mortalite		
Troupeau	Pasteurellose	Pneumonie	Diverses
I	52 4%	14 2%	33 3%
II	44 4%	00 0%	55 5%

Dynamique des troupeaux

La dynamique des troupeaux c'est-a-dire la variation de leur taille depend essentiellement des taux d'exploitation et de mortalité et des possibilités de reconstitution, qu'elles soient internes, c'est-a dire liees aux performances de reproduction ou externes a travers les diverses formes d'acquisition du betail

Taux d'exploitation

En 1989, avec des effectifs exploites de 17 et 9, les taux d'exploitation representaient 8% et 31% respectivement pour les troupeaux I et II L annee suivante, ils ont ete de 6% et 32% respectivement pour des effectifs assez proches (31 et 30)

Les ventes destinees a couvrir les besoins d'argent, les abattages et les dons ont constitue les principales causes de cette exploitation Les abattages ont surtout lieu lors des ceremonies religieuses (fête de la tabaski ou Aid El Kebir) de mariage ou de baptême Il existe une difference assez marquee entre les troupeaux suivis quant aux strategies d'exploitation Ainsi, en 1989, les abattages ont porte sur 63% des effectifs exploites dans le troupeau I Ce taux chute a 25% en 1990 alors que celui des ventes avait augmenté pour atteindre 50% Dans le troupeau II en revanche, les ventes ont represente plus de la moitie des effectifs exploites quelle que soit l annee (56% en 89 contre 80% en 90)

Croît numerique

Sur la base des flux d entree et de sortie, l'accroissement global sur les deux annees de suivi des effectifs a ete de 68% pour le troupeau I et de 48% pour le troupeau II Cet accroissement global a connu cependant une fluctuation interannuelle variable selon le troupeau

En effet, dans le troupeau I l'augmentation d effectifs en 1990 a ete relativement moderee (23%) par rapport a celle de 1989 (36%) Par contre, l'effectif du troupeau II a baisse de 9% de 1989 a 1990 alors qu'en fin de cette campagne (1989), le croît etait de 62%, soit presque le double de celui du troupeau I au cours de la même periode

Discussion

Age à la première mise bas

Avec un âge a la saillie de 9 a 11 mois, les agnelles etaient relativement precoces L âge a la premiere mise bas est conforme a celui de beaucoup d'autres races ovines sahelienne comme le mouton du Macina avec 16,5 mois (Wilson *et al*, 1983) ou le mouton sedentaire du Niger, type Oudah avec 16 mois (Charray *et al*, 1980) Les agnelles paraissent plus precoces que le mouton Peul-peul senegalais ou l'âge a la premiere parturition est de 24 mois, le mouton a longue queue grasse du Rwanda qui agnelle pour la premiere fois a l'âge de 713 (Wilson et Murayi, 1988) ou les brebis croisees (Djallonke x type sahelien) au Ghana (Kabuga et Akowuah 1991) En revanche avec cet âge moyen de 16,6 mois, elles paraissent moins precoces que les agnelles du sud-est de la Côte d'Ivoire (Armbruster *et al*, 1991a) Dans ce cas, les conditions d'elevage differentes pourraient expliquer les differences d'âge a la premiere parturition L'effet troupeau n influe pas sur cette variable zootechnique La non signification de ce facteur ne paraît guere surprenante car redondant avec l'effet annee de mise bas En fait, l'effet "troupeau recouvre diverses pratiques inherentes au mode de gestion de l'exploitation (soins de sante, mesures d hygiene alimentation complementation logement pratiques d'elevage, etc) L'âge a la premiere mise bas relativement faible des agnelles agnelant en 1990 (nees en 1989) pourrait s'expliquer par l'effet benefique de la complementation effectuee dans les troupeaux au debut de l'annee 1990 (Niare et Sangare, 1992) Les agnelles nees en 1989 auraient donc peut-être beneficie de cet apport supplementaire d'aliment concentre a l'approche de leur puberte ou pendant celle ci Si l'annee ou la saison de naissance des agnelles leur permet d agneler a un âge relativement precoce (Wilson et Murayi, 1988) toute complementation a l'approche de la puberte paraît tout aussi benefique

Intervalle entre agnelages (IEA)

En plus de leur precocite les brebis avaient un intervalle moyen assez reduit entre agnelages Ce resultat obtenu sur la base de suivi regulier et periodique confirme les observations empiriques des agro-eleveurs de la zone selon lesquelles l'IEA est d'environ 8 mois (Niare *et al*, 1991) De même Armbruster *et al* (1991a) ont egalement observé un intervalle comparable chez des ovins du sud est de la Côte d'Ivoire Ces resultats sont conformes a ceux du mouton Djallonke eleve au Cameroun et dans le Nord de la Côte d'Ivoire En definitive, ces resultats prouvent qu'il est possible d'obtenir trois agnelages en deux ans dans les conditions actuelles d'elevage ce qui peut être un atout majeur pour le developpement de l'elevage ovin en zone tropicale

Chez les brebis dont la mise bas precedente a eu lieu entre novembre et fevrier, c'est-a-dire au cours de

la saison seche fraiche, l'intervalle entre agnelages est plus eleve que chez celles agnelant en saison seche chaude ou pendant la saison des pluies La rarete de l'herbe au cours de la longue et difficile periode de saison seche que traversent ces brebis, explique la longue periode precedant le retour des chaleurs suivies de fecondation A l inverse, les brebis qui mettent bas peu avant ou pendant la saison des pluies beneficient des conditions nutritionnelles requises pour revenir en oestrus et être saillies plus rapidement Ces resultats confirment l'influence de la saison de la derniere mise bas sur l'IEA observee par d'autres auteurs (Charray, 1986, Wilson et Murayi, 1988) dans un même milieu ou au sein d'un même troupeau

Taux de fertilité

Sur un cycle annuel le taux de fertilite moyen de ces brebis etait nettement superieur a celui des brebis Djallonke de Côte d'Ivoire ou du Cameroun (Charray, 1986) Cette bonne fertilite n est peut-être pas independante de l'intervalle assez court observe entre agnelages Ainsi, en l'absence de toute systematisation de la complementation alimentaire dans ces troupeaux traditionnels, il n'est pas rare qu'une femelle sur trois en moyenne mette bas deux fois dans l annee

La repartition irreguliere des naissances mensuelles d'une annee sur l'autre est ici un artefact lie a l irregularite du suivi En effet suite a des interruptions involontaires le contrôle des performances n a pu se derouler correctement entre mai et juillet 1990 L'absence de suivi au cours de cette periode expliquerait cette heterogeneite d'une annee sur l'autre Globalement en revanche, l homogeneite dans la repartition mensuelle des agnelages entre troupeaux a permis de mettre en lumiere l'heterogeneite inherente a ce processus Les mises bas de septembre-mars correspondent a des conceptions ayant eu lieu en fin de saison seche et pendant la saison des pluies En zone sahelienne la transition saison seche-saison des pluies semble favorable a la conception des brebis (Traore 1987) En outre c'est pendant la saison des pluies que la qualite de la semence des beliers Djallonke semble meilleure (Chiboka 1981) Un effet benefique majeur de la saison des pluies est l'abondance et la meilleure qualite du fourrage De ce fait, l alimentation ne constitue pas un facteur limitant et explique le fort taux de conception

Taille de la portée

La taille relativement faible de la portee de ces brebis est comparable a celles obtenues ailleurs (Charray *et al*, 1980, Wilson *et al* 1983 Charray 1986 Wilson 1986 Armbruster *et al* 1991a) Ce resultat confirme celui deja observe dans la même zone a travers des enquêtes ponctuelles (Niare *et al*, 1991) Même chez des croises Djallonke x type sahelien la taille moyenne de la portee reste faible (Kabuga et Akowuah, 1991) Elle est plus faible que celle des Djallonke du nord de la Côte d Ivoire (Filius *et al* 1985), des brebis du sud tchadien (Charray *et al* 1980) et des brebis du Macina (Wilson *et al* 1983) Malgre leur bonne fertilite, les brebis etudiees ici sont peu prolifiques etant donne la faible proportion de naissances gemellaires Toutefois celle-ci augmente de plus de 20 points entre les 3eme et 6eme agnelages Cette chance accrue des femelles pluripares semble constituer un phenomene assez general peut-être lie à l'atteinte de la maturite physiologique L energie emmagasinee serait alors vrai semblablement utilisee preferentiellement pour la fonction de reproduction chez ces brebis

Viabilité des agneaux

Le taux tres eleve de viabilite perinatale des agneaux suggere que les problemes d avortements de mortinatalites ou de mortalites perinatales (1-6 jours) sont minimes, voire negligeables Dans le sud-est de la Côte d'Ivoire, la mortalite perinatale (0-5 jours) des agneaux est egalement plus faible qu'apres 30 jours (Armbruster *et al* 1991b) Ces resultats semblent imputables au bon comportement maternel des brebis

De la naissance a l'âge de 6 mois la mortalite des agneaux est de 15%, et independante de l'intervalle entre agnelages contrairement aux conclusions d'etudes rapportees par Wilson *et al* (1983) En outre, elle ne semble pas dependre significativement du sexe de l agneau, les mâles et les femelles presentant les mêmes risques de deces Les causes de la mortalite jusqu'au sevrage sont essentiellement d origine pathologique Il n'est pas exclu qu en milieu villageois, les conditions alimentaires precaires, ajoutees aux aleas climatiques, aient un impact sur l'etat de morbidite et vraisemblablement donc sur les chances de survie des agneaux

Stratégies d'exploitation et conséquences de l'accroissement des effectifs

De même que dans les troupeaux senegalais (Faugere *et al*, 1990), les ventes subissent d'importantes variations interannuelles liees au besoin des familles Mais au niveau du troupeau II la logique de commercialisation semble predominer compte tenu de la moindre importance des activites agricoles du proprietaire Neanmoins dans un cas comme dans l autre cette vente repond à un souci de satisfaction des besoins vitaux On retrouve la egalement le rôle d epargne facilement mobilisable que jouent les petits ruminants d une maniere generale et plus particulierement les ovins Cette epargne est surtout mobilisee quand les proprietaires en eprouvent le besoin Les troupeaux ovins semblent constituer donc un moyen de recours pour la gestion du "risque (risque de famine par exemple) mais aussi, aspect tout aussi important, une forme de consolidation des rapports sociaux

A cette fonction primaire du troupeau doit se substituer progressivement une nouvelle dynamique d exploitation du cheptel qui se traduirait par un destockage Celui-ci, conçu dans le cadre d un objectif de production precis assurera, outre la satisfaction des besoins vitaux de l eleveur a travers les revenus monetaires generes, une fonction de regulation de la charge des parcours

Dans le troupeau I on observe un phenomene d accumulation du cheptel en raison des faibles taux d exploitation et de mortalite En revanche, le croît du second troupeau presente une grande variabilite interannuelle pour des raisons evidentes de satisfaction des besoins vitaux Globalement cependant, l augmentation des effectifs est réelle Elle traduit alors la bonne performance de reproduction observee dans ces troupeaux et, dans une moindre mesure, l'acquisition de nouveaux animaux

A l'echelle du terroir ce phenomene peut, a terme, vite degrader les pacages par surpâturage En outre, la vegetation de cette zone soudano-sahelienne soumise a des prelevements de plus en plus importants verra son potentiel de regeneration diminuer Il y a donc lieu de craindre, ce qui pour l'agro-pastoraliste Peyre de Fabregues cite par Dumont (1985), pourrait être une degradation irreversible du fait d'une destruction anarchique et abusive de la strate arbustive

Face a cette expansion demographique du cheptel (recherchee parce qu'elle autorise la reconstitution des troupeaux de pasteurs et d'agro-eleveurs apres les annees de secheresse) aux consequences nefastes, les cultures fourrageres constituent un moyen qui assurerait a la fois le maintien de l elevage, son integration a l agriculture tout en garantissant, grâce au fumier le maintien de la fertilite des sols Cette solution ne saurait cependant être imposee Elle aurait toutefois l'avantage de reduire la divagation des animaux laquelle oblige les paysans a clôturer a grands frais les parcelles de culture de saison seche Elle doit aussi s'inscrire dans une autre conception du troupeau integrant une nouvelle dynamique d'exploitation qui optimiserait la gestion de l'espace pastoral par le betail en general et les ovins en particulier

Conclusion

Cette etude, realisee en zone soudano-sahelienne, une region caracterisee par un contraste saisonnier des disponibilites fourrageres tres marque entre la saison seche et la saison des pluies, n a ete effectuee que sur deux noyaux d'elevage traditionnel ovin Sa representativite a l'echelle de la zone agro-ecologique est par consequent discutable Des etudes complementaires sur un nombre de troupeaux plus important s'averent necessaires avant de degager, puis de generaliser, des conclusions pertinentes Toutefois, la methodologie de suivi individuel des performances des animaux rend credible et fiable les valeurs indicatrices des criteres evalues Les reproductrices des deux noyaux paraissent precoces tres fertiles mais peu prolifiques Ces caracteristiques de reproduction sont fortement tributaires des conditions nutritionnelles des animaux Un apport de complement au cours de la periode de soudure est indispensable Par ailleurs l'organisation de la lutte afin de faire coincider les periodes de besoins eleves avec celle de production fourragere peut être une alternative interessante En complement aux etudes realisees dans la zone semi-aride (Wilson *et al* 1983), celle-ci autorise une extension des connaissances des ovins a d autres zones agro-ecologiques du Mali

Remerciements

Cette etude a ete realisee grâce au soutien financier de la Fondation internationale pour la science (FIS) (bourse B/1416-1)

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Reproductive performance and numerical increase in two traditional sheep nucleus systems in the subhumid zone in Mali

Abstract

Small ruminants are found in all agro-ecological zones in Mali Due to the limited number of studies carried out on these species in the country, little is known about the major constraints to their development This study has been carried out to partially solve this problem and is based on monitoring of individual production performance In the study females matured early with an age at first parturition of 16±1 4 months their fertility rate was very high at 132%, but they were not very prolific (litter size = 1 08±0 03) This high fertility may be due to a low lambing interval of 243±16 1 days Survival rate from birth to weaning was 85% Herd, year of birth, season of previous parturition and number of litters influenced all the major components of numerical productivity However, feed parameters seemed to be the major factors that determined the expression of these components The need for feed supplementation between two consecutive growing seasons was discussed and the organisation of the breeding season was seen as a very interesting alternative Management strategies seemed to vary with different owners However, sheep were used as a resource for 'risk' management and for strengthening social links at various levels through different forms of utilisation Given the low turnover rate and with the use of preventive health measures, the high reproductive performance recorded should result in a 58% increase in herd size The implications of this increase are discussed as well as the measures (destocking forage crops etc) to be implemented to promote livestock development

The induction of puberty in female Boer goat kids

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Abstract

The effects of season, nutrition and presence of a ram at the onset of puberty in female Boer goat kids were studied Permanent presence of a vasectomised ram with the female goat kids induced puberty earlier (P<0 05) than when the teaser ram was introduced to the female goat kids twice daily Exposure of female goat kids to a higher energy diet tended to also induce puberty earlier but this influence did not differ much (P>0 05) from female goat kids put on a low energy diet Female Boer goat kids born in summer and weaned in autumn attained puberty earlier (P<0 05) than those born in spring and weaned in summer The results of this study suggest that the reproductive functions, such as puberty, in female Boer goat kids can be manipulated through management techniques such as permanent exposure to the ram, good nutrition and strategic weaning and breeding

Introduction

In general, breeding is delayed until the animal has attained 60–75% of its mature body weight (Shelton 1978) Most goat breeds are pubertal between 5 and 10 months of age and this occurs during the season of shortening days, whereas the termination thereof occurs during lengthening days (Riera 1982) It is generally accepted that the breeding season centres around the period of short daylight length

There is evidence that the presence of the ram may modify the age of puberty in the goat (Shelton 1977) and influence oestrous behaviour in does, with some degree of synchronisation of oestrus (Ott et al 1980) Two physiological actions are triggered by the presence of the rams viz a neurohumoral action which advances the pre-ovulatory luteinising hormone (LH) peak and an entirely neural action which gives rise to the ram-effect It is postulated that the ram-effect is sufficient to both synchronise and produce oestrus in the doe and that exogenous hormones are unnecessary

The onset of puberty is related to body weight which in turn depends on the level of nutrition, age type of birth and season of birth (Shelton 1978 Smith 1978) Thus this study was initiated to investigate factors (season, nutrition and ram-effect) which may play a role in the induction of puberty in the female Boer goat kid

Materials and methods

Female Boer goat kids (n=65) born in spring and weaned December and kids (n=45) born in summer and weaned April were used following weaning in the first and second trials respectively and for observation periods of 144 and 190 days, respectively In each trial all kids were randomly allocated and maintained on two nutrition regimes, viz high (HE) and a low (LE) energy diets (Table 1) All kids were randomly subdivided into the following treatment groups for each trial

Treatment 1 Permanent ram group (PR) — a vasectomised ram was run permanently with the kids to act as stimulus and detect oestrus

Treatment 2 Teaser ram group (TR) — a vasectomised ram was introduced to the kids twice daily to act as stimulus and detect oestrus

Treatment 3 Control group (NR) — kids completely isolated from males for the duration of the trial

Table 1 *Composition of the high and low energy diets (pelleted) fed during the trials*

Ingredients	High energy (HE)	Low energy (LE)
Lucernene (%)	50 0	93 4
Maize meal (%)	38 0	–
Fishmeal (%)	10 0	–
Molasses (%)	–	5 0
Monosodium phosphate (%)	1 0	1 0
Agricultural lime (%)	0 5	–
Salt (%)	0 5	0 5
Trace element mixture (%)	0 1	0 1
Energy content (MJ/kg DM)	9 613	7 688

The live mass of each animal was monitored weekly and the average daily weight gain calculated Blood samples were taken weekly from five animals/group serum was extracted and stored at 20 C for subsequent determination of serum LH concentrations (Niswender et al 1969) and serum progesterone concentrations (Youssefnajadian et al 1972) Oestrous observations were performed together with serum LH and progesterone values evaluation twice daily in the PR and TR groups to monitor the onset of cyclic activity in the female kid Data were statistically analysed by analysis of variance, the smallest significant difference was calculated to

determine which groups performed best and the chi-square test was implemented to compare the oestrous response between groups (Snedecor and Cochran 1980)

Results

Oestrus

The oestrous responses (indicative of puberty) for the goat kids during the respective observation periods are set out in Table 2 There was a significant difference (P<0 05) in the number of does exhibiting oestrus between the PR and TR groups during both seasons The former group demonstrated oestrus earlier than the latter Regarding the level of nutrition, no significant difference in the occurrence of oestrus (puberty) was noted for both groups of animals born during the different seasons

The age to first oestrus (puberty) is set out in Table 3 For the purpose of comparison, distribution of the time interval of occurrence of first oestrus is indicated The mean age-at-first oestrus was significantly (P<0 05) earlier for all kids weaned in the April breeding season than for those weaned during December (157 2 vs 191 1 days, respectively)

Body weight

Significant (P<0 01 and P<0 05) differences in the mean percentage gain in body weight between high and low energy diets were found for kids weaned in December and April, respectively There was no significant difference between treatment groups within the two levels of nutrition regarding the percentage body weight gained ADG did not differ significantly between the different ram treatment groups

No significant difference was found for the body weight at which puberty was reached for the two energy diets and treatments though body weight at first oestrus tended to be higher for females weaned in April than for those weaned in December (31 1 vs 27 4 kg) (Table 3) No significant correlation was found between body weight and age-at-first oestrus

Serum luteinising hormone levels

From Table 4 it is evident that LH levels between and within treatment groups and observation periods varied greatly Seasonal differences (December vs April weaning) for the mean concentrations of serum LH in the peri-pubertal goat (Figures 1 to 4) were present The PR (P<0 01) and TR (P<0 05) April weaned groups had a higher LH level than the December-weaned PR and

Table 2 *Percentage Boer goat does exhibiting oestrus during the respective observation periods*

	Weaning season				
	December		April		
	HE	LE	HE	LE	Overall (%)
Permanent ram group (%)	100 0[a]	75 0[a]	100 0[a]	100 0[a]	93 3[a]
Teaser ram group	37 5[b]	50 0[b]	50 0[b]	57 1[b]	48 3[b]
Overall %	70 6[a]	62 5[a]	75 0[a]	78 6[a]	–

HE = high energy LE = low energy

Values with the same superscripts do not differ significantly from each other

Table 3 *Mean age and body weight (±SD) of Boer goat does at the demonstration of their first visual oestrous period*

	Weaning season			
	December		April	
	HE	LE	HE	LE
Permanent ram group				
Age at first oestrus(days)	197 9±29 6[a]	203 5±40 3[a]	155 8±54 8[a]	153 3±33 3[a]
Distribution (days)	147–234	164–268	124–268	115–202
Body weight at first oestrus (kg)	29 0±5 6[b]	23 4±2 3[b]	31 3±10 1[b]	28 3±5 4[b]
Teaser ram group				
Age at first oestrus(days)	184 5±50 2[a]	178 5±24 5[a]	168 7±53 2[a]	171 0±56 8[a]
Distribution (days)	149–220	149–209	136–230	110–235
Body weight at first oestrus (kg)	29 6±5 2[b]	26 0±2 6[b]	32 6±7 7[b]	32 2±6 8[b]

HE = high energy LE = low energy

Values with the same superscripts do not differ significantly from each other

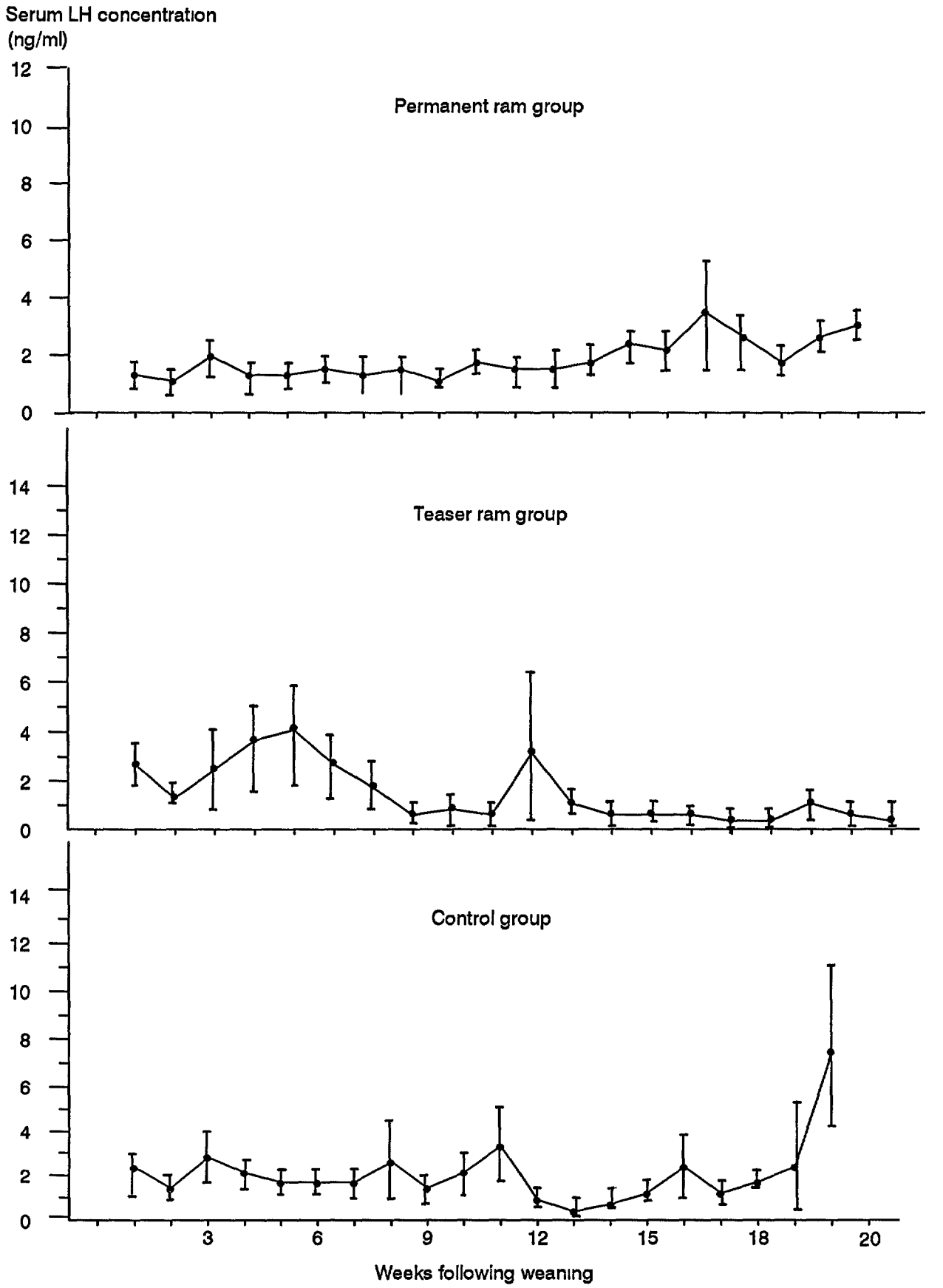

Figure 1 *Serum LH concentration (±SE) of Boer goat kids subjected to different male treatments (weaned December) on a high energy diet*

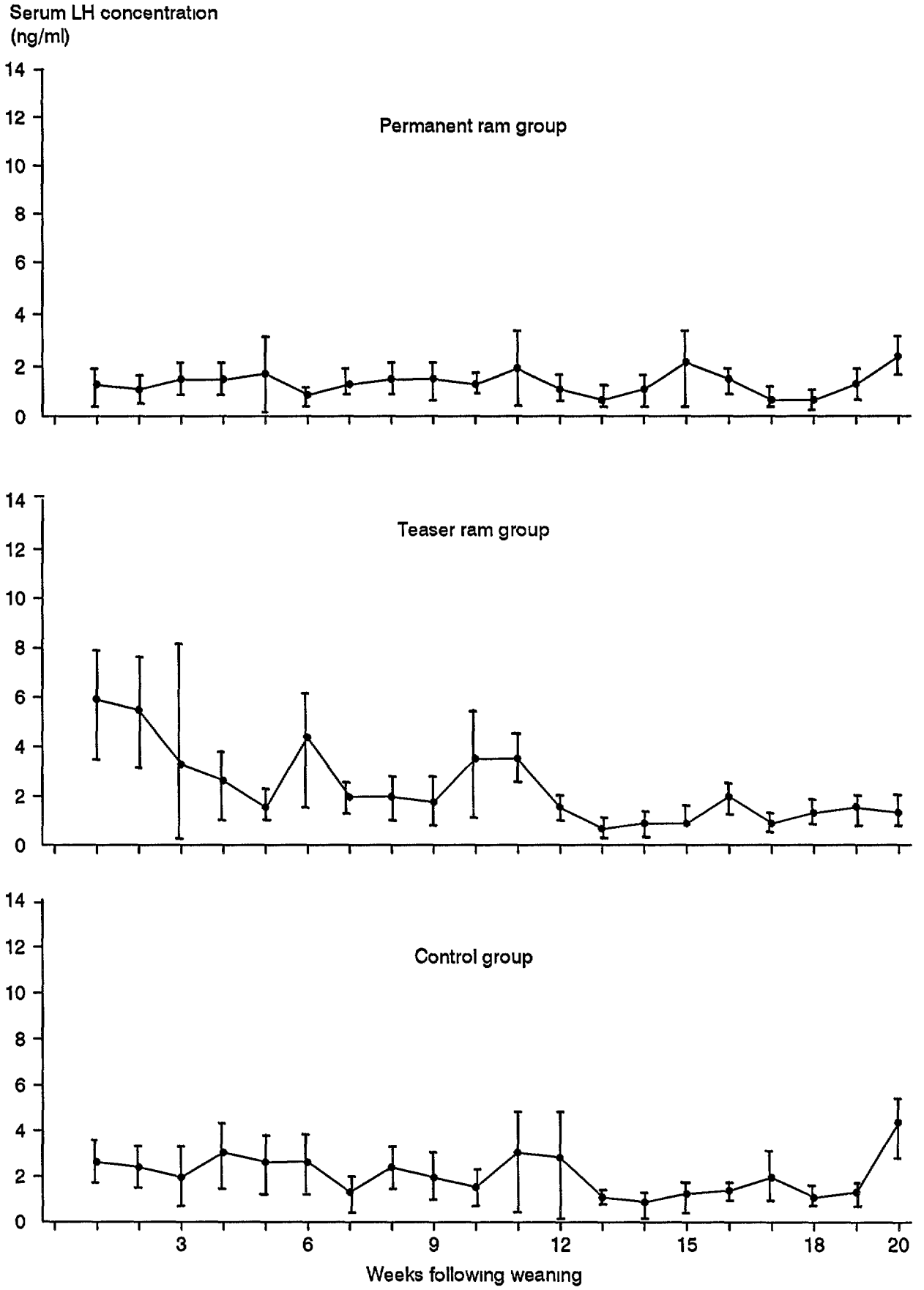

Figure 2 *Serum LH concentrations (±SE) of Boer goat kids subjected to different male treatments (weaned December) on a low energy diet*

Table 4 *Mean (±SD) weekly LH concentrations (ng/ml) during the respective observation periods for pre pubertal female Boer goat kids bred in specific seasons*

	Weaning season			
	December		April	
Treatment	HE	LE	HE	LE
Permanent ram group	1 78±1 36[a]	1 36±1 41[a]	3 89±3 04[c]	4 3 ±3 60[c]
Teaser ram group	1 42±1 96[b]	2 32±2 72[a]	1 98±1 78 [a]	3 69±2 03[c]
Control group	1 97±1 91[a]	2 03±1 89[a]	1 16±0 70[b]	1 75±1 52[a]

HE = high energy LE = low energy

Values with the same superscript do not differ significantly from each other

TR groups, while the December-weaned control group was found to show higher (P<0 01) LH level than the April weaned control group

Significant differences in the mean serum LH concentration were found in the PR (P<0 01) and TR (P<0 05) groups weaned in December (Figures 1 and 2) for the two levels of nutrition Significant differences (P<0 01) in the mean LH concentration were recorded in the TR and control groups weaned in April (Figures 3 and 4)

The ram-effect did not result in significantly different mean LH levels for the December-weaned PR and TR groups on the high-energy diet The control group, however had a significantly (P<0 05) higher mean LH level than the PR and TR groups (Figure 1) In the low-energy groups (Figure 2), higher (P<0 01) LH levels were recorded in the TR and control groups than in the PR group The kids weaned in April however, showed higher (P<0 01) mean LH level (HE diet) in the PR group compared to the TR and control groups The mean LH level of the TR group was also higher (P<0 05) than that of the control group (Figure 3) In the low energy (LE) groups, the mean serum LH of the PR and TR groups were not significantly different, although significantly higher than that of the control group (Figure 4)

Serum progesterone levels

Most of the kids weaned in December which did not show any external signs of oestrus did show periodically elevated progesterone levels (>1 ng/ml) during the observation period In some animals, the progesterone concentration remained low throughout the observation period, similar to values found in anoestrous females Kids weaned in April showed the same progesterone pattern as those weaned in December The occurrence of phenomena like silent heats was however less frequent possibly due to the higher incidence of oestrus in animals weaned in April than in those weaned in December

Within the December weaning season, the PR group on a high-energy diet and TR group on a low-energy diet showed significant (P<0 05) differences in their mean progesterone levels for the observation period (0 87 vs 0 65 ng/ml, respectively) Similar significant (P<0 05) differences were found between the control (HE) and the TR groups (HE) (1 01 vs 0 75 ng/ml respectively) and also between the control (HE) and TR (LE) groups (P<0 01) (1 01 vs 0 65 ng/ml, respectively) The control group (HE) of kids weaned in April maintained a significantly (P<0 01) higher mean progesterone level than the TR groups (0 98 vs 0 66 ng/ml and 0 98 vs 0 7 ng/ml for HE and LE groups, respectively) Similarly the control group (HE) had a higher (P<0 05) mean serum progesterone level (0 98 vs 0 76 ng/ml) for the entire observation period when compared to the permanent ram group (LE)

The progesterone levels maintained by the PR and control groups (HE) weaned in December, were significantly higher (P<0 05, P<0 01) than the mean progesterone levels in the TR group (HE) weaned in April – 0 87 vs 0 66 ng/ml and 1 01 vs 0 66 ng/ml respectively The control group (HE) of the December weaned kids also maintained a significantly higher mean progesterone level than either the PR group (LE) (P<0 05) the TR group (LE) (P<0 01) or the control group (LE) (P<0 05) weaned in April However the mean progesterone levels of both TR groups weaned in December were lower than those of the control (HE) group weaned in April (P<0 05 and P<0 01 for the HE and LE diets, respectively)

Only 50% of the male stimulated kids (both levels of nutrition) weaned in December demonstrated at least one oestrous period, compared to 83 3% of the females weaned in April

Discussion

It would seem that the age at onset of puberty in Boer goat does compares well with and in fact is somewhat earlier than in most goat breeds such as the Saanen (217 9 days) Angora (240 days) Black Bengal (196 5 days) and Barbari nannies (213 days) (Riera 1982 Amoah and Bryant 1984b Bhattacharyya et al 1984)

Values for mean body weight and age of the Boer goat doe at first oestrus recorded are in agreement with results obtained elsewhere on goats (Riera 1982) The mean body weights at first oestrus for Boer goat kids born in January and August were 31 1 kg and 27 4 kg, respectively, compared to 30 0 kg for Saanen kids born

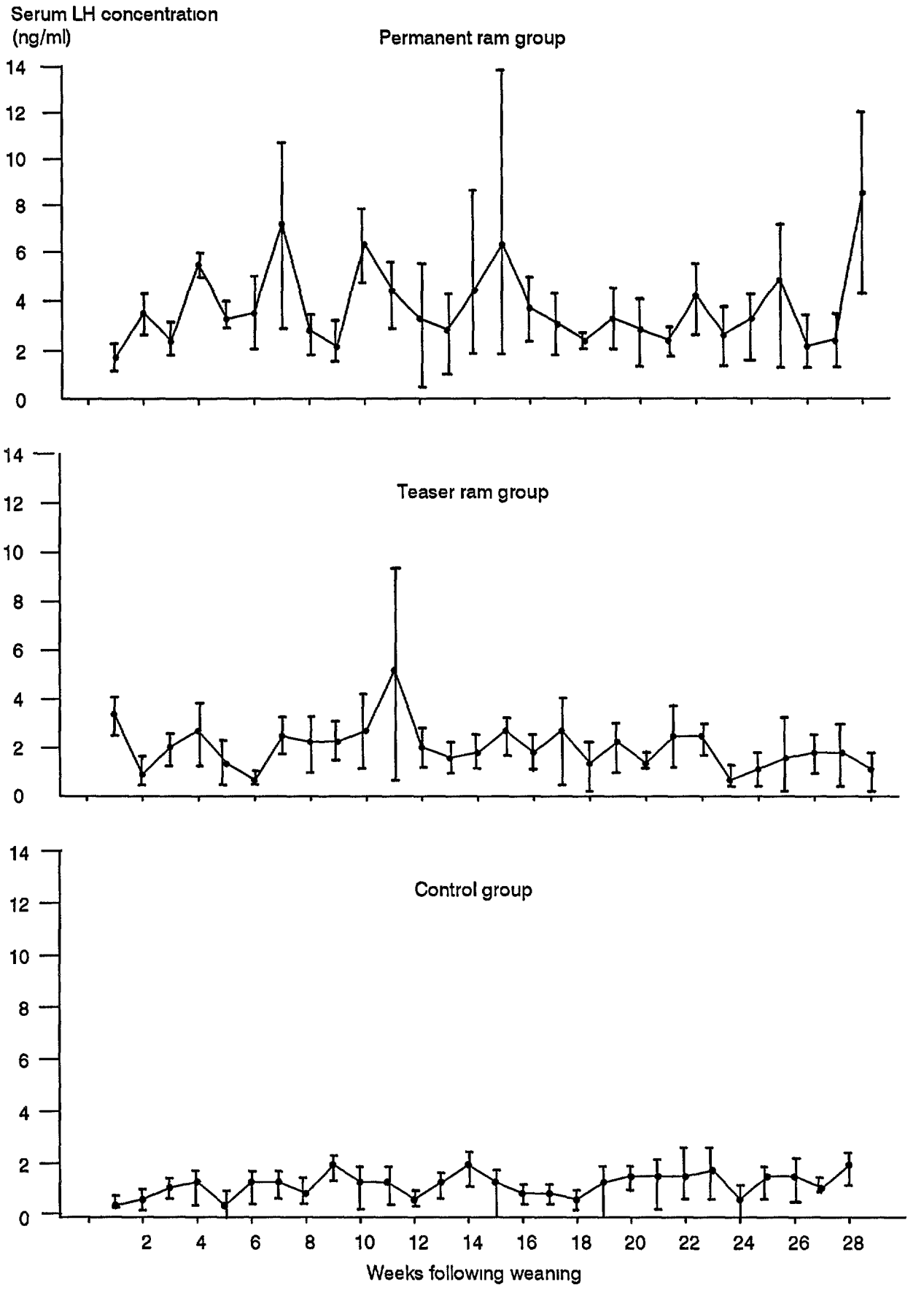

Figure 3 *Serum LH concentrations (±SE) of Boer goat kids subjected to different male treatments (weaned April) on a high energy diet*

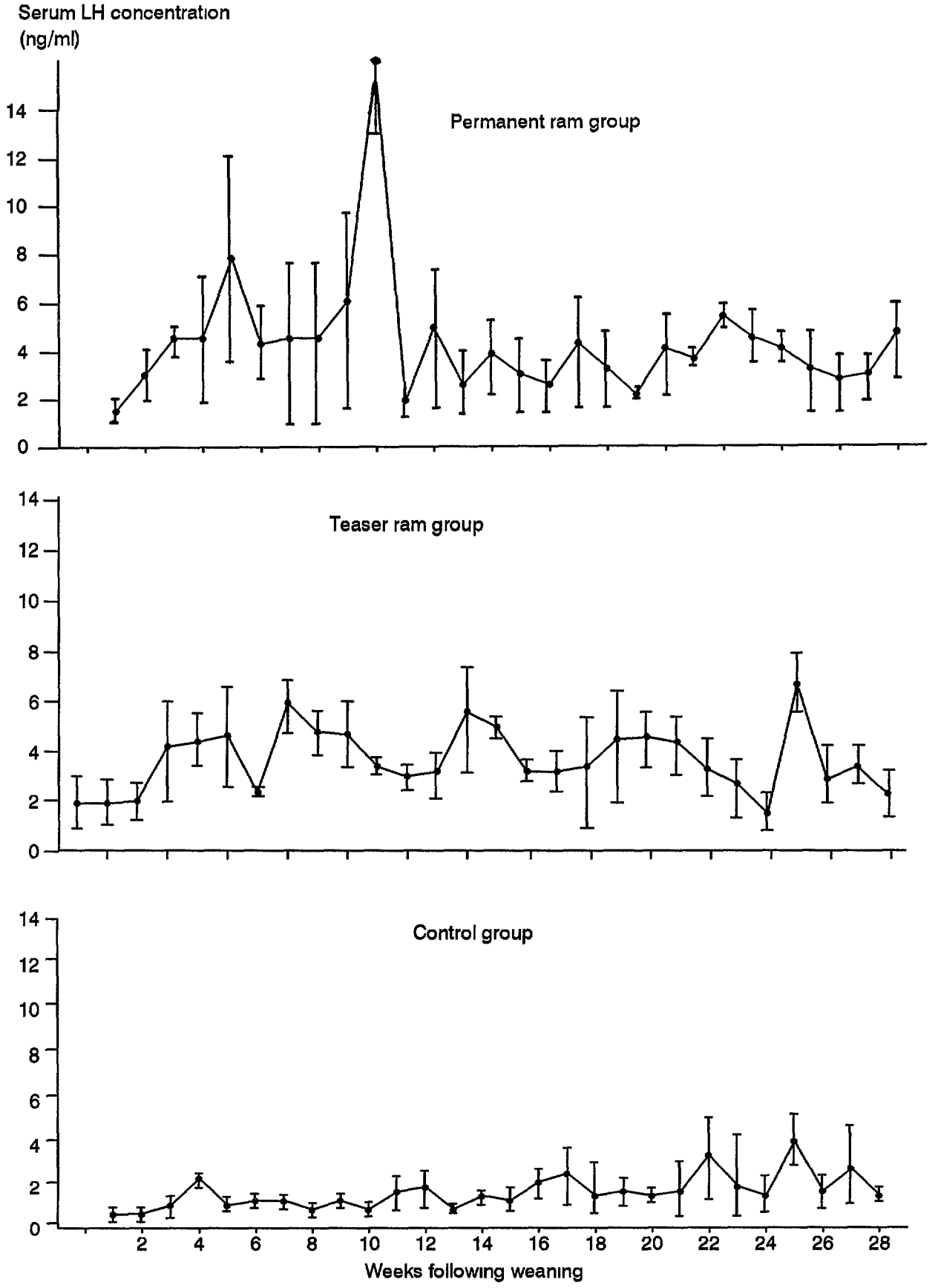

Figure 4 *Serum LH concentrations (±SE) of Boer goat kids subjected to different male treatments (weaned April) on a low energy diet*

in March/April (Amoah and Bryant 1984a) In the present study, kids weaned in April (during the normal breeding season) exhibited oestrus significantly (P<0 05) earlier than those weaned in December This phenomenon cannot be ascribed to a higher mean live weight within the respective kidding seasons the level of nutrition or the ram-effect It would seem as if season of birth is the main cue for the onset of puberty According to Quirke (1979), once ewe lambs have attained a critical body weight necessary for attainment of puberty, differences in live body weight have little influence on the time of onset of puberty There is however, good evidence that inadequate nutrition may adversely affect pituitary function (Lamming 1969)

Emanating from the oestrous response, it is evident that the permanent presence of a male did have a marked (P<0 05) beneficial effect on the number of animals exhibiting oestrus, in both seasons Amoah and Bryant (1984a) suggested that contact with the male goat does have an effect on the timing of puberty and is associated with rapid and highly synchrous attainment of puberty in the majority of kids

The long inter-sampling period (weekly), as well as the variation in serum LH levels obtained between individuals within groups, tend to complicate the interpretation of these hormone levels recorded The LH pattern in the pre-pubertal female goat is characterised by pulsatile or episodic LH releases In the ewe lamb, these rhythmic LH elevations first appear between 4 and 11 weeks of age The transition of the adult ewe from anoestrus into the breeding season, is associated with a marked reduction in response to oestradiol much the same as in the lamb during puberty (Foster and Ryan 1979) From serum LH concentrations recorded in the Boer goat, it is evident that the pituitary is active from 13 weeks of age (weaning) irrespective of season, ram-effect or level of nutrition, although the time interval between blood sampling was too long to obtain reliable pre-ovulatory peak LH values The fact that animals weaned in April maintained a significant (P<0 05) higher mean LH level than animals weaned in December, may indicate greater pituitary activity during the breeding season (April)

The possible high occurrence of silent heats or oestruses without ovulation is emphasised by individual serum progesterone profiles recorded during the respective observation periods Several kids have been found to show elevated progesterone levels (>1 0 ng/ml) for one or more consecutive weeks, without any overt signs of oestrus This occurrence of silent heats or oestrus without ovulation is a phenomenon which also frequently occurs in ewe lambs at, and following puberty (Edey et al 1978) From the serum progesterone values obtained, it seems that ovarian activity started in the high and low-energy diet groups at approximately 7 6±3 5 and 9 1±4 3 weeks following weaning for kids weaned in December and at 7 6±3 5 and 12 7±6 8 weeks after weaning for the kids weaned in April These values correspond well to the mean age at which first oestrus was recorded in the Boer goat The mean progesterone values obtained at first oestrus in the present study are in agreement with those recorded in pre-pubertal sheep viz 0 3 ng/ml (Berardinelli et al 1980) and with those recorded in goats viz 0 2–0 4 ng/ml (Amoah and Bryant 1984a) and 0 29–0 53 ng/ml (Bhattacharyya et al 1984)

Conclusions

Contact with male goats did have a beneficial effect on synchronisation and timing of puberty, entrained by photoperiodic stimulation, while nutrition, as applied in this experiment, played a minor role The effect of the interaction between these factors on puberty is however, difficult to assess It would appear that during the pre-and post pubertal period, cyclic activity of the young animal is rather erratic and irregular and breeding at such an age is impractical and not advisable Further research is needed to elucidate the relative importance of male stimulation on the initiation of puberty especially in relation to other environmental (season and nutrition) cues

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Induction de la puberté chez des chevreaux femelles de race Boer

Résumé

L effet de la saison, de la nutrition et de la presence d un belier au debut de la puberte a ete etudie sur des chevreaux femelles de race Boer La presence permanente d'un mâle vasectomise declenchait la puberte plus tôt (P<0,05) que si le mâle etait introduit aux femelles deux fois par jour La ration a niveau eleve d'energie declenchait egalement la puberte plus tôt mais cet effet n'etait pas tres different (P>0 05) de celui de la ration a faible niveau d'energie Les chevres femelles Boer nees en ete et sevrees en automne atteignaient la puberte plus tôt (P<0 05) que celles nees au printemps et sevrees en ete Les resultats de cette etude montrent qu on peut manipuler les fonctions de la reproduction comme la puberte chez les jeunes chèvres femelles Boer grâce a des techniques d'elevage telles que la presence permanente du mâle une bonne alimentation et un sevrage et une gestion strategiques

Milk production from the indigenous Malawi goat

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Abstract

In a 2x2 factorial trial involving 80 does kept under traditional management, the milking potential of the indigenous Malawi goat was determined and the effects of supplementary feeding examined Feeding was based on grazed indigenous pasture, largely *Hyparrhenia* spp only and with supplementation of 250±10 g maize bran daily Does were separated from their kids each evening at housing and hand milked before turn out Kiddings occurred between July 1991 and April 1992 Milk yields from 25±3 days post-partum varied between 1 5 and 61 litres per lactation and lactation length between 13 and 252 days Lactation patterns were similar, with peaks of 270±99 ml on day 26 for supplemented animals and 259±99 ml on day 19 for controls but a significant interaction between date of kidding and supplementation was noted Does kidding in August had higher yields (31 6±17 5 vs 21 2±13 66 litres for supplemented and unsupplemented does, respectively) than those of does kidding in March (17 7±7 5 vs 9 1±5 7 litres, P<0 05) Mean daily yields for supplemented does were 191 ml over weeks 1–10 and 139 ml over weeks 1–20 For control animals the equivalent figures were 158 and 104 ml Reproductive performance was not affected by milking, with kidding to first oestrus intervals of 110±57 days for the milked does and 80±52 days for unmilked does Anoestrus period was not affected by supplementation Most kid mortality occurred in the first 30 days and was not influenced by milking or level of supplementation There was no effect of doe treatment upon kid growth to 28 weeks, when live weights were 7 25±0 87 kg, 7 63±0 75 kg, 6 75±0 66 kg and 7 33±0 6 kg for the unmilked and unsupplemented unmilked and supplemented, milked and unsupplemented, and milked supplemented animals, respectively It is concluded that with minimal modification of traditional husbandry methods the indigenous Malawi goat may be milked daily without detriment to her or her offspring

Rationale

It has been estimated that in some areas of Malawi the incidence of malnutrition in children under the age of five years may be as high as 70% The problem is particularly severe in those children who have been weaned off breast milk and who are now required to rely largely on 'phala' (maize meal gruel) In many areas of the world milk is seen as being of special benefit to such children, providing high quality protein and high levels of minerals especially calcium and vitamins, in a very palatable form For some, the most usual source of that milk is the cow but for many, it is the goat In excess of 60 million goats are currently being milked world-wide producing nine million tonnes of milk annually (FAO 1990) Many of these milking goats are to be found in Africa especially in the Arabic-speaking countries to the north while, despite the presence of large numbers of goats in sub-Saharan Africa, the practice of milking them is uncommon in the area Malawi is a good example of this situation

Estimates of the number of goats in Malawi vary between one million (Zerfas, personal communication) and 1 6 million (Government of Malawi 1988) and yet, with the exception of a few areas, these goats are not milked There does not appear to be any custom or taboo prohibiting the drinking of goat milk (Chimwaza 1982) and in a recent survey Banda (1992a) showed that goat milk was acceptable to many people and was, indeed, preferred to that of the cow or the sheep

The aim of the project reported here was therefore to examine the potential of the indigenous Malawi goat as a milk producer when managed under a system as similar as possible to that practised in the villages and in particular to answer the following questions

1 How much milk, per day and per lactation is one doe capable of producing when milked once a day?
2 What effect does the removal of this milk have on the survival and growth rate of the goat kids?
3 Is it possible by supplementing ' bush" grazing with maize bran, to increase milk yields economically?

Materials and methods

This trial was undertaken at Bunda College of Agriculture, University of Malawi, during 1991–92 In order to mimic traditional management as far as possible animals grazed unimproved grassland as their main forage source but during the dry season they had access to maize stover in fields and to tobacco gardens Animals were brought in from grazing before dusk and turned out immediately after milking each morning Housing was constructed of blue-gum poles and chain-link fencing under galvanised iron roofing

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Individual pens were approximately 4x4 m and each housed 10–14 does and their kids Water was available in the pens overnight Half of the animals involved (n = 40) were offered a supplementary feed of 250±10 g of maize bran daily fed in the pen each morning before turnout Half of the animals in each group were milked once daily in the morning These animals were removed from their kids each evening at housing and penned separately The following morning each doe was hand-milked before being rejoined with her kid(s) for the day's grazing Milking began 25±3 days after kidding and usually continued until yield fell below 50 ml/day for three consecutive days Does which lost their kid(s) were removed from the trial Thus the effective trial design was a 2x2 factorial with two levels of supplementation and two levels of milking

Animals were blocked by week of kidding, beginning on 1 July 1991 and allocated to treatment within block, according to litter size Milking continued until September 1992 and a total of 50 lactations were recorded Milk yield for each doe was measured daily and all oestruses and matings recorded Does were weighed regularly and all mortalities were noted

Results

Reproduction

Data for the period July 1991 to June 1992 are given in Table 1 Kiddings took place in most months of the year Overall kidding rate was 142 live births/100 does kidding There was no relationship between doe live weight and number of kids born (the overall correlation being 0 1)

Overall kid mortality averaged 33 5% of live births Few triplets were born but mortality was high at 58 3% For single and twins mortality was 30 4% and 35%, respectively

The majority of deaths took place within the first 30 days after birth, that is, before hand milking had begun, and were spread throughout the year with no significant time-of-year effect Treatment of dam had no effect on kid mortality Numbers dead were 33 from milked does vs 43 from the unmilked and 33 from supplemented does vs 42 for the unsupplemented

In the does post-partum anoestrus was very variable, ranging from 22 to 214 days There was a trend for longer anoestrus in milked goats (110±57 days) than in the unmilked (80±52 days) but the differences were not significant There was also a tendency for does kidding in the dry season to have longer anoestrus than those kidding in the rains Level of supplementation had no effect on anoestrus period

Milk production

Milk production per doe was extremely variable with yields ranging from 1 5 to 61 litres per lactation Does that had very low yields often did not reach the bottom limit of 50 ml per day and the decision was taken to stop milking them Lactation length was thus extremely variable, ranging from 13 days for the very low yielders to 252 days for the better animals

Total lactation yields were not significantly affected by supplementation Data, broken down by month of kidding and by lactation period, are given in Table 2, with weekly yield totals shown in Table 3 Overall patterns of lactation were not different between treatments with peak daily yield from supplemented animals reaching 290±99 ml at 26 days from commencement of milking (range 140–500 ml) while equivalent figures for unsupplemented does were 259±99 ml at 19 days (range 80–450 ml) Supplemented does milked for longer than controls (147±54 days vs 117±47 days) There was an interaction between level of supplementation and month of kidding (Figure 1) For does kidding in August supplementation had no effect on yield or persistency For does kidding in February/March, with much of their lactation after the end of the rainy season, supplementation led to longer lactations and significantly higher yields (17 7±0 7 vs 9 1±1 5 litres P<0 05) There was no relationship between doe live weight at kidding and subsequent milk yield The correlation coefficients were 0 42 for supplemented animals and 0 33 for controls The overall linear regression equation was y = –18 +57w (where w = doe live weight in kg)

Kid growth

The live weights of kids, by age and treatment are given in Table 4 The kids from supplemented does were consistently heavier than those of unsupplemented animals while those from unmilked animals were heavier than those from milked ones from the 8th to the

Table 1 *Kidding performance of Malawi does July 1991–June 1992*

	Month of kidding												
Variable	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Type of kidding (number)													
Single	9	9	14	4	2	11	2	8	13	9	–	–	
Twin	4	10	13	1	4	4	1	6	3	3	–	–	
Triplet	–	1	–	–	–	1	–	1	–	–	–	1	
Does kidding (number)	13	20	27	5	6	16	3	15	16	12	–	1	134
Kids born alive (number)	17	32	40	6	10	22	4	23	19	15	–	3	191

Table 2 *Lactation performance (means±SE) of Malawi does*

Variable	Period	Dietary treatment: Supplement (n=20)	Control (n=20)
Yield by month of kidding (litres)	August	31 6 ± 17 5	21 2 ± 13 6
	September	17 7 ± 12 0	15 6 ± 10 9
	February/March	17 7 ± 7 5	9 1 ± 5 7
Yield by lactation period (litres)	Weeks 1–10	13 4 ± 5 0	11 1 ±5 7
	Weeks 1–20	19 4 ± 9 4	14 5 ± 9 6
	Overall	21 2 ± 13 2	15 0 ± 11 0
Mean lactation length (days to <50ml/day)		119 ± 54	90 ± 47

Table 3 *Mean weekly performance (ml±SE) of Malawian does by dietary treatment and month*

Week	Supplemented: August	September	February/March	Unsupplemented: August	September	February/March
1	1406±246	1564±539	1502±497	1586±562	1393±562	1312±581
2	1148±162	1619±528	1276±483	1394±484	1158±381	1298±484
3	1250±111	1727±629	1538±390	1472±484	1109±361	1251±580
4	1338±155	1572±511	1526±401	1551±618	1200±519	1192±620
5	1274±54	1543±587	1491±415	1417±361	1313±719	1118±680
6	1397±267	1465±566	1500±462	1309±584	1360±619	996±432
7	1407±470	1474±654	1157±378	1735±645	1213±486	867±601
8	1377±459	1387±752	1065±300	1643±516	1144±422	782±431
9	1425±487	1351±573	1137±362	1376±468	1189±540	698±540
10	1425±487	1466±684	1122±338	1548±642	1108±497	533±179
11	1387±502	1307±650	1066±329	1418±642	895±350	411±276
12	1262±588	1302±707	1135±284	1550±731	849±441	–
13	1227±581	1226±781	950±225	1213±559	896±375	–
14	1252±616	1176±807	876±249	1152±618	829±320	–
15	1189±617	1123±847	944±146	1111±667	690±173	–
16	980±546	1177±863	805±157	1244±461	549±225	–
17	832±501	1010±720	–	985±523	499±265	–
18	760±302	1045±764	–	951±315	546±195	–
19	601±193	932±588	–	775±293	688±140	–
20	664±201	542±573	–	739±285	517±24	–

28th week of age but none of these differences were significant Mortality rates were not affected by treatment

Discussion

The performance of goats in this trial was similar in all respects to that reported elsewhere In terms of reproduction overall kidding rate was higher than the 109% reported by Reynolds (1979) and the 103% of Karua (1988) Kid growth rates thought somewhat disappointing were in line with the 42 g/day reported by Zerfas and Stotz (1987) and the 47 g/day of Karua, despite the amounts of milk removed The quality of milk from the Malawi goat is high Banda (1992b) reports an analytic composition of 5 3% protein, 6 7% butterfat and 4 7% lactose, figures similar to those found in the West African Dwarf goat (Akinsonyu et al 1977) and the South African Boer goats (Raats et al 1983) but significantly higher than those of exotic' milking goats Two hundred millilitres of this milk would thus provide 10 5 g high quality protein, 13 5 g fat and 250 mg calcium Such amounts would go a long way towards improving the diet of children drinking this milk and the nutritive value would not be impaired by the boiling which would be necessary before its use It should however be noted that the overall mineral composition of goat milk is such that it is unsuitable for children below one year of age

Conclusions

It is concluded that while yields vary considerably it is possible with minor modifications to traditional husbandry practices and at a small cost, to produce usable amounts of milk from the indigenous Malawi

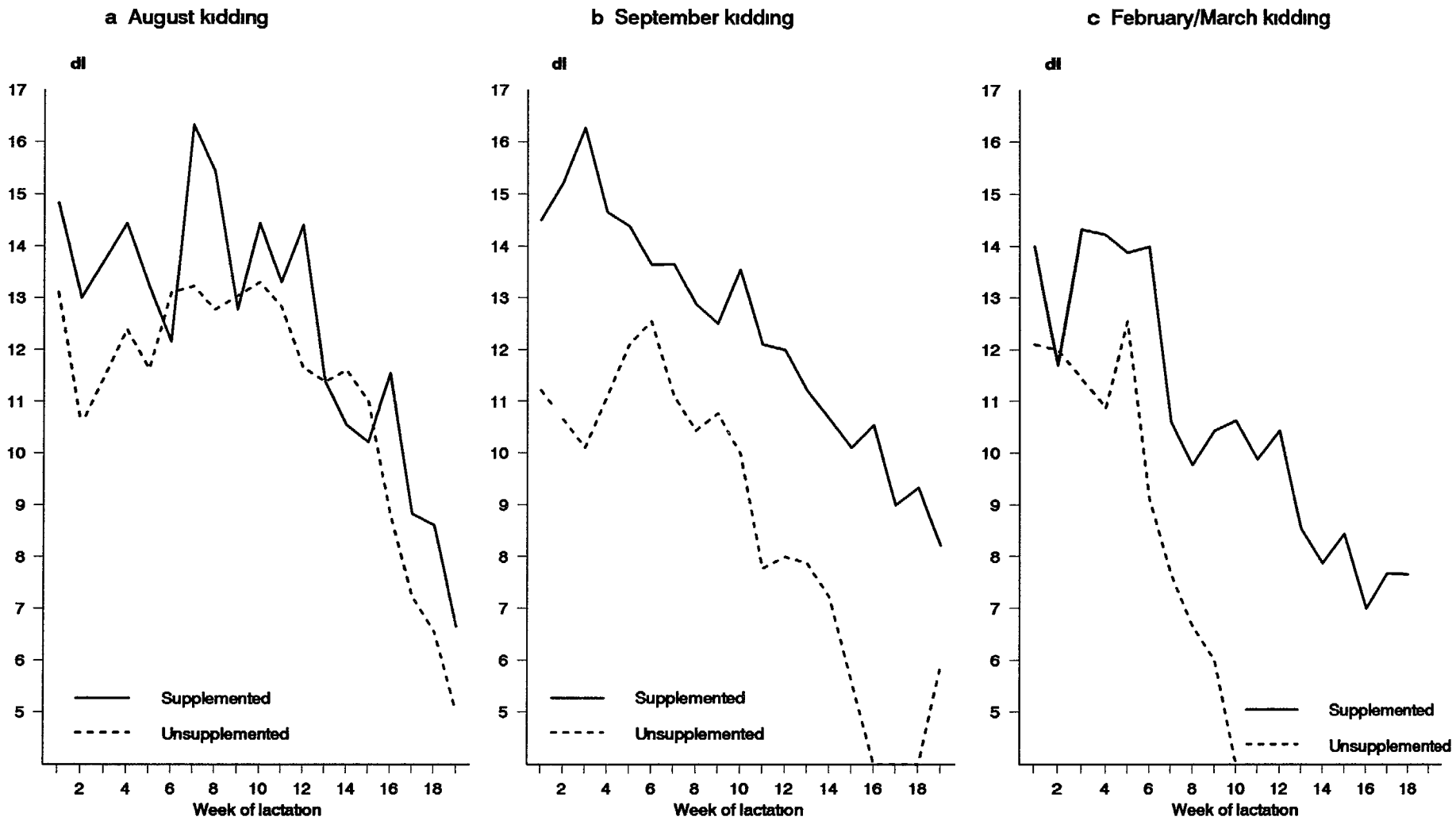

Figure 1 *Mean milk yield per week by month of kidding (dl)*

Table 4 *Weights (mean ± SE kg) of kids born in year 1991–92 by age and treatment group*

	Treatment			
	Non milked		Milked	
Age (wks)	Non supplemented	Supplemented	Non supplemented	Supplemented
Birth	1 88±0 125	1 88±0 08	1 78±0 07	2 00±0 11
4	3 00±0 102	3 14±0 09	3 06±0 03	3 18±0 24
8	3 42±0 46	3 60±0 19	3 17±0 11	3 59±0 20
12	4 17±0 36	4 50±0 79	3 96±0 18	4 32±0 29
16	4 83±0 22	5 19±0 65	4 55±0 27	5 05±0 29
20	5 58±0 46	5 88±0 59	5 25±0 37	5 73±0 36
24	6 25±0 76	6 56±0 58	5 88±0 52	6 39±0 42
28	7 25±0 87	7 63±0 55	6 75±0 66	7 33±0 60
52	14 00±1 73	13 67±3 76	13 25±1 03	15 67±0 88

goat, removing this milk does not have any adverse effects on the doe or her offspring and the milk so obtained is capable of contributing significantly to the diets of children aged between one and five years in the households in which the goats are kept

Acknowledgements

The help and encouragement of the Principal and all the staff at Bunda College is gratefully acknowledged This work was funded by the Natural Resources Institute of the UK Overseas Development Administration

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Production laitière des chèvres locales du Malawi

Résumé

Une experience factorielle 2 x 2 a ete effectuee pour determiner les potentialites laitieres et l effet de la complementation alimentaire sur 80 chevres locales du Malawi elevees en systeme traditionnel L alimentation etait a base de pâturages locaux constitues principalement d *Hypparrhenia* spp uniquement ou complementes avec 250±10 g de son de mais par jour Les meres etaient separees des petits et logees le soir au coucher puis traites a la main le matin avant de partir pour les pâturages Les mises bas ont eu lieu entre juillet 1991 et avril 1992 La production de lait a partir de 25 ± 3 jours apres la parturition variait de 1 5 a 61 litres par lactation pour une duree de lactation comprise entre 13 et 252 jours Les caracteristiques de la lactation des sujets recevant une complementation etait similaires a celles des autres animaux, avec un maximum de 270±99 ml au 26eme jour chez les premiers et de 259±99 ml au 19eme jour chez les seconds Toutefois, il existait une

interaction significative entre la date de chevrotement et la complémentation Les femelles qui mettaient bas en août produisaient plus de lait (31,6±17,5 contre 21,2±13,66 l respectivement pour les animaux a ration complementee et les autres) que celles qui chevrotaient en mars (17,7±7,5 contre 9,1±5,7 litres, P<0,05) Avec la complémentation, la production moyenne de lait etait de 191 ml/jour entre la 1ere et la 10eme semaines et de 139 ml/jour entre la 1ere et la 20ème semaines La traite n'avait pas d'effet sur les performances de reproduction, et l'intervalle entre la mise bas et l'oestrus suivant etait de 110±57 jours chez les animaux traits contre 80±52 jours chez les autres La complementation n'avait pas d'effet sur la duree de l'anoestrus Les cas de mortalite de chevreaux etaient essentiellement concentres sur les 30 premiers jours Ni la traite ni le niveau de complementation n'avaient d effet sur le taux de mortalite des jeunes Le traitement de la mere n avait par ailleurs aucun effet sur la croissance des jeunes jusqu'a 28 semaines, les poids vifs a cet âge etant de 7,25±0,87 kg (sans traite ni complementation) 7,63±0,75 kg (sans traite mais avec complementation) 6,75±0,66 kg (traite mais sans complementation) et 7,33±0 6 kg (traite et comple mentation) On peut conclure qu avec de legeres modifications des methodes d'elevage traditionnel, il est possible de traire les chevres locales du Malawi chaque jour sans consequence ni pour elles-mêmes, ni pour leurs petits

Synchronisation des chaleurs et gestion de lutte chez le mouton Djallonké

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Résumé

Cet essai est une contribution a la maîtrise du cycle sexuel et a l etude de la fertilite du mouton Djallonke Il a porte sur l'etude de la reponse de la brebis Djallonke a la synchronisation des chaleurs a l'aide de l'acetate de fluorogestone ainsi que sur le comportement sexuel et la fertilite du belier Djallonke soumis a differents regimes de saillies Les resultats de cet essai revelent que les brebis Djallonke repondent de façon satisfaisante a la synchronisation des chaleurs par l'acetate de fluorogestone suivie de l'injection d'un ovulatoire, la gonadotrophine serique de jument gravide (PMSG) Par ailleurs, on peut utiliser les beliers Djallonke dans le cadre d'un regime de 6 saillies par jour pendant 6 jours successifs sans affecter leur fertilite Des etudes supplementaires sont necessaires afin de connaître d'une part le seuil optimal des saillies exigibles par belier, et d'autre part la dose optimale de PMSG en rapport avec un taux de prolificite raisonnable

Introduction

Devant l'envergure desormais nationale de son programme d'amelioration genetique ovine, le Centre d appui technique de Kolocope envisage la mise en oeuvre d un programme plus dynamique, base sur une strategie de selection a noyau ouvert faisant appel a une large base de selection couvrant l'ensemble du pays (Traore 1991) Ce programme prevoit a moyen terme le testage des beliers destines a la lutte en lignee sur la descendance Ce test, pour être efficace, devrait se derouler dans un delai bref et permettre la comparaison d un nombre suffisant de descendants par belier Aussi etait-il interessant d'etudier les voies et moyens d une optimisation de la methode de reproduction en cours au Centre La presente communication porte sur la reponse de la brebis Djallonke a une synchronisation des chaleurs a l aide de l'acetate de fluorogestone et sur le comportement des beliers Djallonke soumis a des regimes de saillies plus ou moins intensifs L'incidence de l'intervalle mise bas/pose d'eponge ainsi que l'influence de la dose de PMSG sur le delai d'apparition et la duree des chaleurs feront l objet d une communication ulterieure

Matériels et méthode

Le Centre d appui technique de Kolocope (CATK) cree en 1980 dans le cadre du Projet de developpement de l'elevage des petits ruminants au Togo (PNPR) est situe dans la region des plateaux a environ 45 km au nord-est d'Atakpame Il avait pour rôle essentiel de servir de centre de demonstration des techniques d'elevage ameliorees des petits ruminants, de produire des animaux selectionnes a diffuser dans les fermes ovines ameliorees encadrees par le projet, de former des bergers et des eleveurs ainsi que des techniciens et des etudiants aux techniques d'elevage des petits ruminants, et de servir de cadre a la recherche d'accompagnement en vue de l'amelioration constante de messages techniques diffuses par le projet

Matériel animal

Les animaux utilises pour l essai sont des moutons de race Djallonke dont 144 femelles âgees de 12 a 34 mois vides de 25,64±3,1 kg de poids moyen, 6 geniteurs de poids moyen 47,33 kg âges de 41 mois, et quelques mâles porteurs de tablier utilises comme des beliers detecteurs de chaleurs

Conduite de l'élevage

Le cheptel ovin du centre d un effectif moyen de 1700 têtes est compose de 750 brebis Djallonke reparties en 5 troupeaux de 150 têtes d'une quarantaine de geniteurs repartis en 5 lignees et d'un troupeau d antenais et d antenaises d effectif variable Le mode de reproduction est la lutte contrôlee en cycle de 8 mois Il necessite l utilisation des beliers par lignees (les beliers de chaque lignee effectuant 2 luttes consecutives dans un même troupeau de brebis) En matiere d alimentation, les animaux exploitent les parcours

naturels et les parcelles fourrageres de *Panicum* de *Leucaena* et de *Cajanus* et reçoivent en complement toute l annee environ 350 g de graines de coton par tête et par jour Les sels mineraux leur sont fournis *ad libitum*

Matériel et technique de synchronisation

Materiel

Le materiel de synchronisation utilise comprenait un "freinateur' ou agent anovulatoire l'acetate de fluorogestone sous forme d'eponge vaginale dosee a 40 mg (eponges pour agnelles), un ovulaire la gonatrophine serique de jument gravide (PMSG) sous forme d'injection intramusculaire, et un ensemble d'instruments et de produits necessaires a la pose et au retrait des eponges

Synchronisation

Les brebis ont ete graduellement soumises aux operations de synchronisation de chaleur sur la base des previsions journalieres de saillies Chaque brebis reçoit une eponge vaginale dosee a 40 mg d'acetate de fluorogestone, retiree apres 14 jours Ce retrait est suivi d une injection intramusculaire de 400 mg de PMSG

Saillies

Chaque belier s est vu affecte une trentaine de brebis synchronisees a differentes dates en prevision des regimes de saillies Apres detection des chaleurs a l'aide de beliers portant des tabliers le matin a 7h et l'apres-midi a 15h, les brebis reconnues en chaleurs sont presentees a 12h d'intervalle a la saillie par un belier choisi selon le regime

Retour en chaleurs

Des contrôles ont eu lieu a partir du 15eme jour apres la saillie pour confirmer la reussite de celle ci Les femelles retournees en chaleurs sont presentees a nouveau a la saillie (2 sauts a 12 h d'intervalle)

Analyses statistiques

Les calculs et les analyses statistiques des donnees sont realises a l'aide du logiciel STAT-ITCF Des analyses de variance et des tests de khi-deux ont ete effectues pour etudier l'effet du regime de saillie sur les taux de retour en chaleurs, de fertilite, de fecondite et de prolificite

Résultats et discussions

Compte tenu des variations dans la disponibilite de femelles en chaleurs, les regimes de saillies ont ete de 3 saillies par jour et par belier au lieu de 4 pour le 1er regime Le taux de synchronisation observe au cours de cette etude (n = 144) a ete de 97,22% L'etude comparee des deux regimes de saillies dont les resultats sont presentes au tableau 1 donne des taux de 137 78% et 120 61% de fecondite totale et 186 41% et 183 20% de prolificite respectivement pour les regimes de 3 saillies et 6 saillies quotidiennes par belier

Le tableau 2 donne les moyennes des differentes performances par regime avec ou sans le belier N 89179 qui a manifeste des signes evidents de faible fertilite Les analyses de variance des differents taux de reproduction n ont pas permis de mettre en evidence des differences statistiquement significatives

Le taux de synchronisation observe au cours de cet essai est du même ordre de grandeur que les chiffres de 100 et 91% rapportes par Lahlou-Kassi et Boukhilq (1989) respectivement pour les races D'man et Timahdite synchronisees avec de l acetate de fluorogestone et une dose de 400 UI de PMSG On ne dispose que de tres peu d'informations sur la reponse de la brebis Djallonke a une synchronisation des chaleurs En Côte d Ivoire il a ete rapporte un taux de 87% de femelles en chaleurs apres une synchronisation a base de 40 mg d acetate de fluorogestone suivie d'une injection de 300 UI de PMSG (Toure et Meeusen 1980) Lors d'un essai anterieur mene au CATK, les brebis synchronisees ont toutes ete inseminees entre 56h et 57h en moyenne apres le retrait des eponges sans detection prealable des chaleurs (Rouleau, 1988), bien que des variations des parametres de reproduction enregistres aient ete notees dans les deux regimes de saillies (tableau 2), les tests statistiques indiquent qu ils ne presentent pas de difference significative (Tableau 1)

Par consequent, on pourrait envisager d utiliser sans prejudice a leur fertilite les beliers pour un regime de 6 saillies par jour pendant 6 jours Cela poserait d autant moins de problemes que ces geniteurs sortiraient d'une periode de repos sexuel Cependant, les differences observees entre differents beliers d'un même regime montrent l'interêt du suivi de la fertilite des geniteurs Dans la presente etude le belier N 89179 a donne des performances inferieures a celles des autres (tableau 2) Son exclusion ameliore les resultats du regime a 6 saillies (tableau 3)

Les examens macroscopiques et microscopiques de son sperme bien qu'effectues 8 semaines apres son utilisation ont permis d'en attester la mauvaise qualite (presence de sang, faible motilite etc)

Le taux de fertilite de cet essai est tres proche de celui rapporte par Rouleau (1988) et ou les brebis avaient ete inseminees apres synchronisation sans detection prealable des chaleurs (69,77% contre 69%) Ceci denote la tres bonne reponse de la brebis Djallonke a la synchronisation des chaleurs La prolificite moyenne de 184 80% est plus elevee que celle indiquee par Amegee (1978), Armbruster (1987) et Dettmers (1976) Malgre la presence du belier N 89179, l ecart peu prononce entre les taux de prolificite des deux regimes montre que ce parametre zootechnique depend beaucoup plus de la femelle que du mâle Le taux tres eleve enregistre est probablement dû a la forte dose de PMSG utilisee (400 UI) Mais il convient de signaler que Rouleau (1988) obtenait egalement un taux de prolificite

Tableau 1 *Principaux parametres de reproduction chez les brebis selon les regimes de saillies et les beliers*

	Regime					
	3 saillies/Bélier No			6 saillies/Belier No		
Parametre	89113 (n=21)	2474 (n=23)	915 (n=29)	89190 (n=23)	004 (n=19)	89179 (n=25)
TRC (%)	14 2	21 7	20 7	13 4	21 1	44
TFr (%)	68 2	68	86 2	78 3	70	48
TFc (%)	118 2	140	155 2	147 8	130	84
TP (%)	173 3	205 9	180	188 9	185 9	175

n = nombre de brebis synchronisees

TRC taux de retour en chaleur

TFr taux de fertilite (brebis gestantes par rapport aux brebis synchronisees)

TFc taux de fécondite (nombre d agneaux nés par rapport aux brebis synchronisees)

TP taux de prolificite (nombre d agneaux par rapport aux brebis ayant mis bas)

Tableau 2 *Moyennes des parametres de reproduction chez les brebis dans les deux regimes de saillies avec ou sans le belier n 89179*

		6 saillies	
Parametres*	3 saillies 2 = 73	avec le No 89179 n = 67	sans le No 89179 n=42
TRC (%)	18 48	27 48	19 22
TFr (%)	74 13	65 42	74 13
TFc (%)	137 78	120 61	138 91
TP (%)	186 4	183 20	187 3

eleve avec des doses de 250 a 275 UI de PMSG Pour le mouton Djallonke qui n'est pas une bonne laitiere, cette situation n est pas souhaitable car elle entraîne un fort taux de mortalite Dans la presente etude, le taux de mortalite a ete de 16,02% contre 1,76% au CATK en 1990 (Hadzi, 1990) L'incidence de la dose de PMSG sur les caracteristiques des chaleurs et les taux de prolificite doivent donc faire l'objet de travaux plus pousses

Conclusion

Les resultats de l etude de la maîtrise de la reproduction du mouton Djallonke ont conduit aux conclusions preliminaires suivantes les brebis Djallonke repondent de façon satisfaisante aux techniques de synchronisation par l'acetate de fluorogestone suivie d'injection de PMSG les beliers Djallonke peuvent être utilises dans le cadre d'un regime de 6 saillies par jour pendant 6 jours successifs sans une baisse sensible de fertilite la poursuite de l essai sur les regimes de saillies est necessaire afin d approcher le seuil optimal de saillies pouvant être effectuees par le mâle sans porter prejudice a sa fertilite, et il serait souhaitable de mener des essais destines a etudier l influence de differentes doses de PMSG et l incidence de l'intervalle de temps entre l'agnelage et la synchronisation sur differents parametres de reproduction Cela permettra de mieux cerner les problemes relatifs a l adaptation des doses de PMSG aux races locales

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Oestrous synchronisation and mating management in West African Dwarf sheep

Abstract

This trial is a contribution to better control over the sexual cycle of Djallonke sheep and better knowledge of their fertility characteristics The trial studied the response of Djallonke ewes to the use of fluorogestone acetate for oestrus synchronisation and the sexual behaviour and fertility of Djallonke rams used for various service schemes Results indicated that Djallonke ewes responded satisfactorily to oestrus synchronisation using fluorogestone acetate followed by an injection of Pregnant Mare Serum Gonadotrophin (PMSG), an ovulation-inducing substance Djallonke rams can be used in a six times a day service scheme for six consecutive days without affecting their fertility

Reproductive performance of Tswana ewes and Boer does in south-eastern Botswana

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Abstract

The reproductive performance over a five year period (1989–93) of Tswana ewes and Boer does kept under semi intensive management at Estate Management Unit farm of the College at Sebele-Gaborone Botswana was analysed A total of 70 lambings and 152 kiddings involving 202 lambs and 288 kids were subjected to statistical analysis The parameters studied were age at first parturition (AFP), parturition intervals (PI), annual parturition rate (APR), birth weight (BW) and correlation between dam weight (DW) and young birth weight The results showed that for Tswana ewes AFP PI, APR and BW were 18 00±1 39 months, 365±28 50 days, 1 00 and 3 30±0 89 kg respectively, while for Boer goats they were 18 00±0 69 months 350±2 4 days 1 00 and 3 23± 0 76 kg, respectively Tswana ewes are seasonal breeders, they lamb in late spring and early summer (October–December) Male to female sex ratio was 49 0% for the 202 lambs and 52 78% for the 288 kids recorded The rate of single and twin lambings were 80 59% and 19 41% respectively, while the rate of single, twin triplet and quadruplet kiddings were 28 29%, 53 28% 16 45% and 1 32% respectively Mortality and stillbirths were 3 43% and 0 5% respectively, for sheep while mortality stillbirths and abortions for goats were 10 42%, 2 78% and 0 66%, respectively The analyses show that Tswana ewes and Boer does are early maturing breeders There was a poor correlation (r^2 = 0 02 for sheep r^2 = 0 04 for goats) between the dam's body weight and the young s birth weight

Introduction

Tswana sheep are indigenous to Botswana while Boer goats are imported from South Africa The Tswana sheep is fat-tailed with some coarse negligible wool on the coat The coat colour is predominantly black and white and is mainly kept for mutton The Boer goat is white with a reddish brown head and neck The goat has broad droopy ears horns and is used for meat milk and skin

In 1990 there were 2 096 000 goats and 317 000 sheep (MoA 1990) 267 000 sheep were under traditional management and about 50 000 were on commercial farms while about two million goats were under traditional management and 62,000 were on commercial farms The average flock sizes were 17 5 sheep and 30 2 goats per farm Mannathoko (1993) reported that the total number of sheep slaughtered at the Botswana Meat Commission (BMC) abattoirs were 5963 and 3573 head for 1992 and 1993, respectively, while the goats slaughtered were 6685 and 3456 for the same years respectively The offtake of both sheep and goats was 11 0% (MoA 1990) Small stock play an important role in the socio-economic life of the Botswana Small ruminant ratio to cattle is about 44%

This study examines the reproductive performance of Tswana ewes and Boer does which are the predominant breeds of small stock in Botswana

Materials and methods

The data for this study were collected from a flock of Tswana ewes and Boer does kept under a semi-intensive system of management at the Estate Management Unit (EMU) Sebele-Gaborone in south-eastern Botswana The flock grazed daily for eight hours on natural pasture and was housed at night in kraals with corrugated roofing Sheep and goats were fed lucerne or groundnut hay as supplementary feeds in winter and drought periods They were also provided with bonemeal and salt or dicalcium phosphate and salt mixture mixed in a 2 1 ratio as mineral lick The flock was treated against ectoparasites e g ticks once a week in summer and every other week in winter and endoparasites three times a year, i e every four months routinely Flushing of the ewes and does was practised just before mating for two weeks Mating occurred on pasture using two Tswana rams and two Boer bucks in May–June every year Veterinary care was provided whenever necessary

The parturition period was October–December every year parturition records included sex birth weight and type of birth The analyses covered a five-year period (1989–93) and involved 170 lambings of 202 lambs and 152 kiddings of 288 kids The parameters evaluated were age at first parturition (AFP) parturition interval (PI), birth weight (BW) and type of birth (TB) Data were analysed using descriptive analysis for means and t-test used to test significant differences between means at P<0 05 (Steel and Torrie 1980)

Results

BW, frequency of TB, stillbirth and preweaning mortality values are shown in Table 1 Sex was not a significant source of variation in lamb survival There was a high incidence of multiple births in both species Abortions and stillbirth incidences were very low in both species The average birth weights of singles were higher (P<0 05) than those of twins In most years the males were heavier (P<0 05) at birth than the females There was poor correlation (r^2 = 0 02 sheep and r^2 = 0 04 goats) between dam's body weight and the young's birth weight in the flock

Table 1 *Mean and standard deviations of some reproductive parameters of Tswana ewes and Boer does*

Parameters	Tswana sheep	Boer goats
Number of mature breeding females	170	152
Gestation period (days)	150 00±0 23	150 00±0 19
Age at first parturition (months)	18 00±1 39	18 00±0 69
Parturition interval (days)	365±28 50	350±2 4
Live weight of dam (kg)	42 82±8 51	47 68±7 73
Birth weight (kg)		
Young	3 31±0 87	3 23±0 76
Males	3 33±1 04	3 35±0 77
Females	3 13±0 99	3 10±0 71
Singles	3 45±0 96	3 23±0 62
Twins	2 91±1 07	3 38±0 70
Triplets	–	2 73±0 50
Quadruplets	–	2 60±0 18
Frequency (%)		
Singles	80 45	27 97
Twins	19 55	54 57
Triplets	–	16 04
Quadruplets	–	1 43
Stillbirths	0 61	5 29
Abortions	–	0 61
Pre-weaning mortality (%) (1–3 months)	3 36	10 43
Prolificacy rate (%)	119 9	193 42
Productivity to weaning/ewe doe (%)	115 2	167 32

Discussion

Tswana sheep can be improved genetically by careful selection, improved nutrition and management with a lambing interval of 365±28 50 days (Table 1) This study showed a gestation period of 150±0 23 days for sheep Capote and Vazquez (1986) reported that the gestation length and lambing interval in Suffolk x Criollo ewes averaged 148 7 days and 318 2 days, respectively They stated that 54% of the lambs born were females and 58% of the lambings occurred during the dry season They concluded that neither sex of lamb, nor season of lambing had a significant effect on gestation length but there was a significant interaction of type of lambing (single or twin) and sex of lamb Adu et al (1985) studied the reproductive performance of Balami and Desert Sudanese sheep in a dry hot environment They observed that lambing interval was significantly shorter in Desert Sudanese ewes than in Balami ewes (254 vs 279 days) but the number of lambs born per ewe per annum in both breeds was similar (1 6) This study showed age at first lambing of 18 00±1 39 months Kabuga and Akovuah (1991) reported that age at first lambing averaged 506 2 days in Djallonke x Sahelian crossbred ewes They found that the interval between parturitions averaged 279 days, and litter size and number of lambs produced per year averaged 1 1 and 1 5, respectively

Age at first kidding of 18 00±0 67 months shows a short generation interval for the Boer goats This is in line with 11 33–18 47 months reported by Husain et al (1990) for Bengal goats in Bangladesh The kidding interval observed in this study averaged 350 00±2 4 days which is lower than the 451±16 6 days reported by Lawar et al (1991) for Angora goats in India and higher than the 274 2 and 293 6 days reported by Dickson et al (1990) for Anglo-Nubian and French Alpine goats, respectively

Mean birth weight of 3 31±0 87 kg for Tswana lambs is higher than the 2 44 kg reported for Djallonke x Sahelian crossbred lambs by Kabuga and Akowuah (1991) The Boer kids recorded 3 23±0 76 kg for birth weight which is higher than the 1 47 kg reported for Bengal kids by Verma et al (1991) Boer goats are classified as medium sized breed by Devendra and McLeroy (1987) There was low abortion rate and preweaning mortality in both lambs and kids which could be due to the adequate management practices and the good veterinary care received on the farm

Verma et al (1991) reported that litter size was not affected by parity in Black Bengal goats They also found that the percentages of single twin and triplet births were 74 7, 24 0 and 1 3, respectively, in a herd of 20 female Bengal goats Mellado et al (1991) reported the reproductive performance of 40 Anglo-Nubian female goats They observed that the interval between kiddings averaged 301 days and prolificacy averaged 1 77 Multiple birth was very frequent in the herd over a five-year period Maternal size in Tswana sheep and Boer goats did not influence young birth weight significantly Milne (1987) reported that maternal size appears to become a less important determinant of energetic efficiency during gestation as litter size increases Prolificacy rate of Boer goats in this study was 193 42% This is higher than the 1 77 (177%) reported for Nubian goats in northern Mexico (Mellado et al 1991) where fecundity rate was found to be correlated with rainfall in the month preceeding mating

Values obtained in this study are indications that Tswana sheep and Boer goats are highly productive under good management and productivity can be improved upon by planned breeding programmes This will obviously increase the level of goat and sheep meat production for local consumption and export in Botswana

Acknowledgement

The authors would like to express their gratitude to the management of Estate Management Unit (E M U) at Sebele-Gaborone for permission to publish the data

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Performances de reproduction des brebis Tswana et des chèvres femelles Boer dans le sud-est du Botswana

Résumé

Les performances de reproduction de brebis Tswana et de chevres Boer elevees en systeme semi-intensif pendant cinq ans (1989–1993) a la ferme du Botswana College of Agriculture a Sebele Gaborone ont ete analysees Un total de 70 agnelages et de 152 chevrotements portant respectivement sur 202 agneaux et 288 chevreaux ont fait l'objet d analyses statistiques Les parametres etudies etaient l âge a la premiere parturition l intervale entre mises bas le taux annuel de parturition le poids a la naissance et la correlation entre le poids de la mere et celui du jeune a la naissance Les brebis Tswana avaient un âge a la premiere parturition de 18 00±1 39 mois un intervalle entre mises bas de 365 ± 28,50 jours, un taux annuel de parturition de 1,00 et le poids a la naissance de leurs agneaux etait de 3 30± 0,89 kg Pour les chevres Boer les chiffres correspondants etaient repectivement de 18 00±0 69 kg de 350±2,4 jours de 1 00 et de 3 23±0 76 kg Les brebis Tswana sont des reproductrices saisonnieres qui mettent bas vers la fin du printemps et le debut de l ete (octobre-decembre) Le sex ratio etait de 49,0% pour les 202 agneaux et de 52 78% pour les 288 chevreaux Les taux des naissances simples et gemellaires etaient respectivement de 80 59% et de 19,41% chez les brebis, les naissances de produits simples, de jumeaux, de triplets et de quadruplets representant respectivement 28 29% 53 28% 16,45% et 1,32% des naissances totales chez les chevres Les taux de mortalite et de mortinatalite etaient respectivement de 3 43% et de 0 5% chez les ovins alors que ceux de mortalite de mortinatalite et d avortement etaient respectivement de 10 42% 2 78% et 0 66% chez les caprins Les analyses ont montre que les brebis Tswana et les chevres Boer sont des races precoces Enfin il y avait une faible correlation (r^2 = 0 02 pour les ovins et r^2 = 0 04 pour les caprins) entre le poids de la mere et celui du jeune a la naissance

Quelques données sur le sperme de béliers peul blancs et touareg du Niger

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Les volumes de sperme, la motilite massale des spermatozoides, la concentration en spermatozoides, la production totale de spermatozoides par recolte les taux de spermatozoides anormaux ou morts ont ete etudies chez onze beliers adultes de race peul et touareg Avec une et deux ejaculations successives respectivement chez les beliers peul le volume moyen est de 0 895± 0 31 ml et 0,93±0 53ml la motilite massale de 3±1 3 et 3,2±1,2 la concentration moyenne en spermatozoides de 3777 10^6±1245 10^6 spz/ml et 3694 10^6±1345 10^6 spz/ml et le nombre total de spermatozoides par recolte de 3614 10^6±1758 10^6 et 3723 10^6±2854 10^6 spz/ml Chez les beliers touareg pour une et deux ejaculations le volume moyen est respectivement de 1 13±0 31 ml et 1 78±0,48 ml la motilite massale moyenne de 3 4±0 9 et 3,1±0 1 la concentration moyenne en spermatozoides de 4156 10^6±791 10^6 ml et 3580 10^6±406 10^6 et le nombre total de spermatozoides par recolte de 4805 10^6 ±1631 10^6 et 6414 10^6±2119 10^6

Introduction

Le Niger abrite une population totale de 7 793 millions de têtes de petits ruminants dont 3 045 millions d'ovins et 4 748 millions de caprins On distingue, parmi les ovins, des moutons a laine et des moutons a poils, ces derniers sont numeriquement les plus importants et se composent de deux races la peul et la touareg L amelioration des performances de reproduction des animaux necessite la connaissance des parametres de reproduction des femelles et des mâles Jusqu ici, les parametres de reproduction des animaux connus en milieu sahelien et particulierement au Niger sont limites a l etude de la femelle, notamment en ce qui concerne la productivite numerique en milieu traditionnel, les parametres de reproduction des brebis en station et en milieu traditionnel et les facteurs influant sur ces parametres Chez le mâle peu d etudes ont ete effectuees sur le comportement du belier en station (Gaillard 1979 Harouna 1987) La connaissance des performances de reproduction du mâle et des facteurs qui l affectent peuvent aider a ameliorer genetiquement les races par la selection des meilleurs geniteurs et a augmenter la productivite numerique du troupeau en agissant sur la fecondation, la viabilite de l'oeuf et la frequence des saillies fecondantes C'est pour toutes ces raisons que la presente etude sur la connaissance des parametres de reproduction chez le mâle a ete entreprise Les resultats presentes se rapportent a des etudes preliminaires au cours desquelles les animaux ont ete testes grâce a des techniques connues mais tout a fait originales pour ces animaux notamment l'utilisation du vagin artificiel et la determination de la concentration en spermatozoides par la densite optique Les resultats de cette mise au point technique serviront de point de depart pour les etudes ulterieures portant sur l'influence de differents facteurs (climat, alimentation, conditions d'elevage, etc) et sur la fertilite du mâle

Matériel et méthodes

Les animaux

L experience a ete realisee au parc de la Faculte d agronomie de l'Universite Abdou Moumouni a Niamey (longitude 2 08 latitude 13 30, altitude 216 m) Elle a porte sur onze beliers repartis en deux lots, le 1er de six beliers peul blancs, le 2eme de cinq beliers touareg Le 1er groupe est compose d animaux âges de 1 a 2 ans et pesant entre 35 5 kg et 43,5 kg Ceux du 2eme groupe etaient âges de 2 a 4 ans et pesaient entre 37,5 et 55 kg Ces animaux ont ete deparasites et vaccines contre la peste, la pasteurellose et les deux types de charbons Ils vivent en stabulation libre et leur alimentation est a base de bourgou (*Echinochloa stagnina*), de son de riz, de tiges de mil, de mais de sorgho de fanes de niebe d'oligo-elements sous forme de pierre a lecher et d eau *ad libitum*

Collecte et analyse du sperme

Le sperme a ete collecte au vagin artificiel en presence d une brebis en chaleur ou non Une ou deux ejaculations sont effectuees par recolte

Examens immédiats

Aussitôt apres la recolte le volume et la couleur de l ejaculat sont releves a travers le tube collecteur La motilite massale est notee (de 0 a 5) par observation au microscope photonique d'une goutte de sperme pur deposee sur une lame

Détermination de la concentration en spermatozoides

Le sperme est dilue par melange de 20 ml de solution de dilution (NaCl a 9% + formol a 1%) et de 0 05 ml de sperme pur ce qui correspond a une dilution au 1/401 La densite optique du sperme dilue est lue au spectrocolorimetre regle sur une longueur d onde de 520 mm Le comptage des spermatozoides est effectue au microscope photonique a l aide d une cellule de Malassez Chaque prelevement de sperme dilue est compte quatre fois puis la moyenne est calculee

Détermination des taux de spermatozoides anormaux ou morts

La semence est diluee par melange d'un volume de sperme frais et de quatre volumes de lait frais La preparation de la lame se fait en y deposant trois gouttes de colorant (eosine/nigrosine) puis une goutte de sperme dilue, le tout est melange pendant 10 secondes et laisse au repos pendant 50 secondes Le melange est ensuite etale a l aide d une lamelle en un film fin et regulier

Pour le comptage des differentes classes de spermatozoides la lame est placee sur la platine du microscope et differents champs sont examines a la lumiere directe jusqu a un total de 150 spermatozoides Tout spermatozoide colore en partie ou en totalite en rouge ou en rose, est considere comme mort au moment de la coloration

Tests statistiques

L analyse de la variance a deux criteres de classification a ete utilisee pour comparer les effets race le nombre d'ejaculations et leur interaction sur les parametres mesures Des tests relatifs a la regression et a la correlation entre les concentrations en sperma tozoides et les densites optiques ont ete effectues Des comparaisons inter-raciales de ces coefficients de regression ont ete effectuees et la signification des coefficients de correlation correspondants a ete recherchee (Dagnelie 1975)

Résultats

Volume de l'éjaculat

Le volume moyen de l ejaculat est de 0 895±0 31 ml chez les beliers peul blancs contre 0 93±0 53 ml chez les touareg Il existe des variations individuelles du volume de l ejaculat chez les deux races De même l interaction race x nombre d ejaculations modifie de façon significative (P<0 05) le volume Ainsi lorsqu on augmente le rythme de collecte le volume de l ejaculat du belier touareg est superieur a celui du belier peul blanc

Motilité massale

La motilite masale varie en moyenne entre 3 et 3,4 selon la race et le rythme de collecte Toutefois ces deux facteurs de même que leur interaction n ont aucune influence significative (P>0 05) sur la motilite massale

Concentration et nombre total de spermatozoides

La concentration moyenne en spermatozoides (spz) par ejaculat est de 3771 21 (±1758 25) 10^6spz/ml et 4156 49 (±791 75) 10^6spz/ml respectivement pour la race peul et la touareg

De tres importantes variations individuelles ont ete enregistrees chez les beliers peul blancs (figure 1) alors que les variations sont beaucoup moins marquees chez les touareg Ni la race ni la frequence de collecte ni l interaction entre ces deux facteurs n influencent de maniere significative (P>0 05) la concentration en spermatozoides

Le nombre total de spermatozoides par recolte est influence par l interaction race x nombre d ejaculations les valeurs etant plus elevees chez les touareg lorsque la frequence de collecte passe de 1 a 2 (tableau 1)

Taux de spermatozoides anormaux

Deux beliers peul blancs et trois beliers touareg ont servi a la determination de ce parametre Le pourcentage de spermatozoides anormaux varie de 1 9 a 13 pour les beliers peul blancs (tableau 2) contre 4 a 11 5 pour les beliers touareg (tableau 3)

Tableau 1 *Caracteristiques morphologiques du sperme de beliers peul blancs et touareg*

Nb d ejaculations par recolte	Races	Nb d animaux	Volume de sperme (ml)	Motilite Massale	Concentration en spz ($x10^6$/ml)	Nb total de spz/recolte ($x10^6$/ml)
1	Peul	6	0 895 (±0 31)	3 0 (±1 3)	3777 (±1245)	3614 (± 1758)
	Touareg	5	1 13 (± 0 31)	3 4 (± 0 9)	4156 (± 791)	4805 (± 1631)
2	Peul	6	0 93 (± 0 53)	3 2 (± 1 2)	3694 (±1345)	3723 (± 2854)
	Touareg	5	1 78 (± 0 48)	3 1 (± 1 0)	3580 (± 406)	6414 (± 2119)

Tableau 2 *Taux de spermatozoides anormaux et morts chez les beliers peul blancs*

Belier	Volume (ml)	Couleur	Motilite massale	Concentration en spz (x10^6/ml)	Taux de spz anormaux	Taux de spz morts
P1	1 22 (±0 19)	Blanchâtre	4 12 (±0 21)	3660 (±41)	4 5 (±2 6)	18 5 (±4 15)
P2	1 5	Blanchâtre	3 5 (±0 5)	/	9 (± 4)	29 (± 4)

Tableau 3 *Taux de spermatozoides anormaux et morts chez les beliers touareg*

Belier	Volume (ml)	Couleur	Motilite massale	Concentration en spz (x10^6/ml)	Taux de spz anormaux	Taux de spz morts
T2	1 35 (±0 21)	Blanchatre	2 75 (±0 423)	4064 (± 341)	11 (± 0 43)	41 25 (±4 8)
T4	1 35 (±0 15)	Blanchatre	3 25 (±0 25)	4405 71	4 5 ± 0 5)	36 5 (± 1 5)
T6	0 6	Blanchatre	4	/	11	22

Taux de spermatozoides morts

Les mêmes animaux qui ci dessus ont servi a la determination de ce parametre Le pourcentage de spermatozoides morts varie de 14 5 a 33 chez les beliers peul blancs (tableau 2) contre 22 a 46 05 chez les beliers touareg (tableau 3)

Relation entre la concentration en spermatozoides et la densité optique

La relation entre la concentration en spermatozoides dans un milieu biologique et la densite optique du milieu mesuree au spectrocolorimetre a ete utilisee pour etablir une courbe d etalonnage en vue de determiner la concentration en spermatozoides

Trente ejaculats de chaque race ont ete utilises pour etablir les courbes d etalonnage Avec la semence de beliers peul blancs (figure 1) on observe une grande dispersion des concentrations en spermatozoides le long de la courbe ce qui traduit une grande variation individuelle

L equation de la droite ainsi obtenue est

Y = 8225 2 x D O + 18 2 (Y etant la concentration en spermatozoides)

Le coefficient de correlation r de 0 97 est hautement significatif (P<0 01) (figure 1) Avec la semence de beliers touareg (figure 2) le regroupement des points traduit des variations plus faibles entre les individus en ce qui concerne la concentration en spermatozoides L equation de la droite est

Y = 7590 6 x D O + 316 7

(Y etant la concentration en spermatozoides) Le coefficient de correlation r de 0 86 est hautement significatif (P<0 001) (figure 2) Il n y a pas de difference significative entre les coefficients de regression des deux droites (P<0 05)

Discussion

L'aspect visqueux et blanchâtre (cremeux laiteux) du sperme des beliers peul blancs et touareg est semblable a celui du belier peul bicolore (Harouna 1987) et des moutons djallonke et peul du Cameroun (Nielsen *et al* 1985) Le volume moyen de sperme collecte lors d'une ejaculation chez les deux races de beliers (0 895 a 0 930 ml) est voisin de celui du belier peul bicolore (0 72 a 1 50 ml) (Harouna 1987) ou des races europeennes (0 8 a 1 2 ml) [Colas *et al*, 1975] Toutefois des differences raciales importantes de volume apparaissent lorsque le nombre d ejaculations est double par recolte le belier touareg ayant tendance a produire plus de sperme que le belier peul blanc

(1 78 ± 0 48 et 0 93±0 53 ml respectivement)

Il a egalement ete montre que le volume de la semence chez le belier est fonction de l âge et de la croissance corporelle (Colas *et al* 1975) Les deux lots d animaux utilises ici sont d'âge et de poids differents les beliers peul blancs etant plus jeunes (1 a 2 ans) et moins lourds (35 5 a 43 5 kg) que les touareg (2 a 4 ans et 37 5 a 55 kg)

La motilite massale varie au cours des differentes collectes chez les deux races une variation de ce parametre au cours de collectes successives a ete notee chez le belier peul bicolore (Harouna 1987) chez les races camerounaises Djallonke et Fulani (Nielsen *et al*, 1985) et chez le belier Ile-de-France (Colas 1980) Cette donnee subjective et imprecise peut constituer en l etat actuel des connaissances un critere de tri des animaux dans la mesure ou il traduit tout de même une plus ou moins forte proportion de cellules vivantes (Colas 1980)

Les concentrations moyennes en spermatozoides sont comparables entre les races peul blanche et touareg et comparables a celles des beliers peul bicolores (Harouna 1987) Djallonke et Fulani du Cameroun (Nielsen *et al* 1985) et Romanov (Colas, 1975) A la difference du volume de sperme, la concentration en

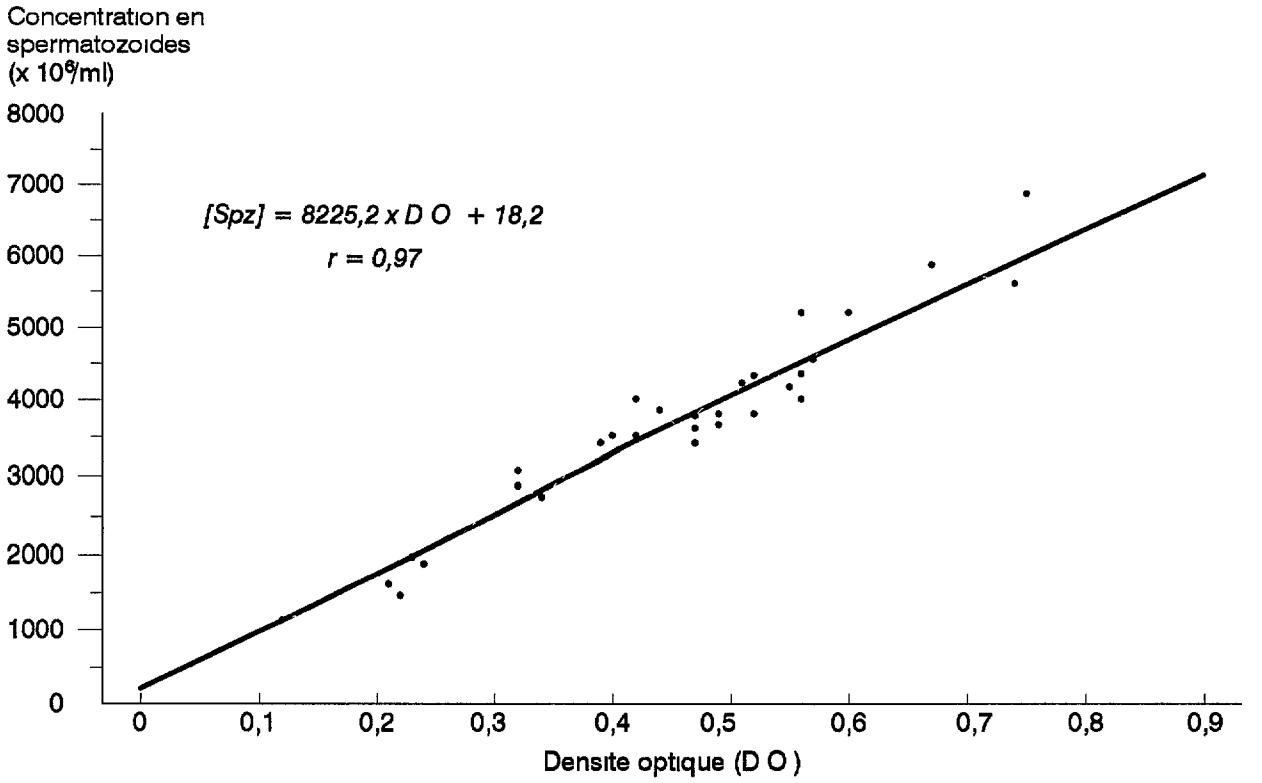

Figure 1 *Correlation entre la densite optique et la concentration en spermatozoides de la semence de belier peul*

spermatozoides des ejaculats est etroitement liee a la frequence de collecte (Colas *et al*, 1975) Ainsi, une faible frequence de recolte analogue a celle utilisee ici ne permet pas de recuperer toute la production spermatique, une proportion du sperme s eliminant de façon permanente par l'urine chez le belier (Colas, 1980) Il est donc probable que les concentrations rapportees dans cette etude soient sous-estimees par rapport a la production testiculaire

Des variations individuelles de la concentration en spermatozoides ont ete notees surtout chez le belier peul blanc Ces variations raciales peuvent être rapprochees des facteurs environnementaux et des conditions d'elevage tres differentes qui caracterisent les deux niches ecologiques ou vivent les deux races de moutons (Ibrahim, 1974) La tres grande variation de la concentration en spermatozoides constatee chez le belier peul blanc offre des possibilites de selection de cette race

La production totale de spermatozoides est variable selon la race, le belier touareg ayant une production plus importante que le belier peul blanc (6414,24 10^6 spz et 3723 10^6 spz respectivement) Il est par consequent probable que la multiplication des cellules spermatiques soit plus importante chez le belier touareg que chez le belier peul blanc Les travaux de Banoin (1993 resultats non publies) qui montrent que l index mitotique des follicules ovariens est plus grand chez la race touareg que chez la race peul blanche corroborent cette hypothese Toutefois des etudes ulterieures s averent necessaires sur la production spermatique par unite de temps chez ces deux races de mouton en vue de confirmer cette hypothese

Les taux de spermatozoides anormaux se situent entre 4 5 et 11% Colas (1981) dans une etude effectuee sur des ovins de race Ile-de-France, a rapporte les taux de fertilite de 50 a 60% pour un taux de spermatozoides anormaux compris entre 10 et 20% puis entre 40 et 50% pour des taux de fertilite de moins de 50% Ainsi, pour les spermes analyses ici, ce parametre se situe dans des limites acceptables pour la fertilite

Les taux de spermatozoides morts determines dans cette etude se situent entre 18 5 et 45% et sont donc relativement eleves par rapport aux limites de 20 a 30% consideres comme acceptables pour un bon geniteur Cependant il est etabli que ce parametre varie en fonction de la temperature Le fait que la collecte ait ete effectuee en condition de temperatures elevees explique peut-être les chiffres eleves obtenus Par ailleurs ce parametre connaît des variations individuelles que l on ne saurait ignorer Enfin on sait que le taux de spermatozoides morts diminue avec le nombre d ejaculations Etant donne qu'on n'a travaille ici qu avec une ejaculation par recolte il est possible d ameliorer ces taux avec un nombre plus eleve d'ejaculations par prelevement

Conclusion

Les parametres etudies se rapprochent globalement des chiffres enregistres chez d autres races africaines et europeennes Ces parametres temoignant ensemble de la qualite du sperme l etude de l effet des

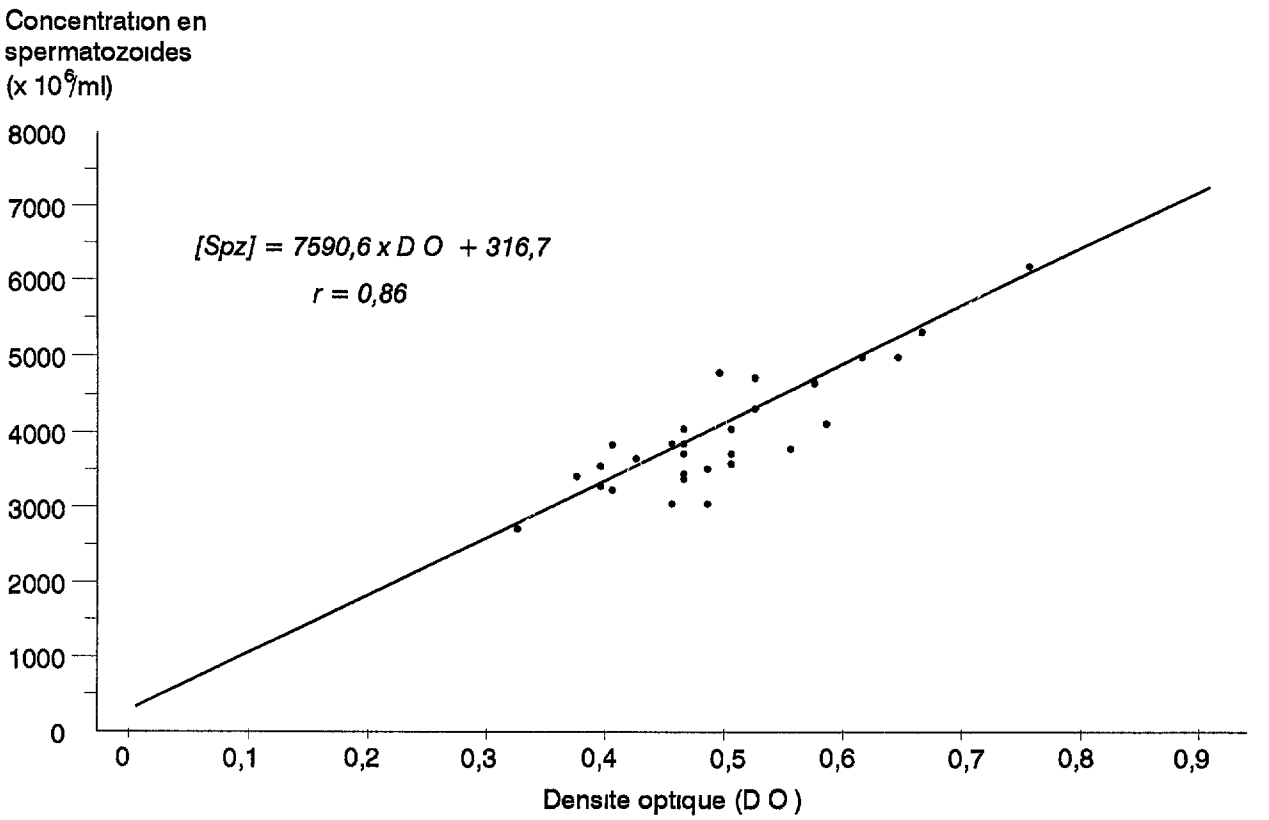

Figure 2 *Correlation entre la densite optique et la concentration en spermatozoides de la semence de belier touareg*

differents facteurs de l environnement est envisageable en relation avec la saison

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Some data on the semen of White Fulani and Tuareg rams in Niger

Semen yield, mass motility of spermatozoa semen spermatozoa concentration, total number of spermatozoa per ejaculation and percentage of abnormal and dead spermatozoa were studied in 11 Fulani and Tuareg adult rams With one and two successive emissions in Fulani rams, average sperm volume was 0 895±0 31 ml and 0 93±0 53 ml respectively, mass motility was 3±1 3 and 3 2±1 2 units spermatozoa mean concentration was 3777 x 10^6±1245 x 10^6 per ml and 3694 x 10^6±1345 x 10^6 while total number of spermatozoa per emission was 3614 x 10^6± 1758 x 10^6 and 3723 x 10^6±2854 x 10^6 In Tuareg rams, for one and two emissions, average sperm volume was 1 13±0 31 ml and 1 78±0 48, respectively, mean mass motility was 3 4±0 09 and 3 1±0 1 ml, mean spermatozoa concentration was 4156 x 10^6±791 x 10^6 and 3580 x 10^6±406 x 10^6 while total number of spermatozoa per emission was 4805 x 10^6±1631 x 10^6 and 6414 x 10^6±2119 x 10^6 Breed x number of emissions had a significant effect (P<0 05) on volume of sperm and total number of spermatozoa in semen but not on mass motility and spermatozoa concentration (P>0 05) Depending on the breed it is therefore better to use two emissions per "yield" to determine sperm volume and total number of spermatozoa Percentage of abnormal spermatozoa was similar in both breeds It varied from 4 5 (±0 5) to 11 (±0 43) and was within normal limits for fertility Percentage of dead spermatozoa varied from 18 5 (±4 15) to 41 25 (±4 8)% for both breeds, which is rather high However this should be related to other environmental and individual factors including temperature, individual biological parameters number of emissions etc Regression between semen spermatozoa concentration and optical density was studied using a spectrocolorimeter For Fulani rams, the equation of the regression line was Y = 8225 2 X + 18 2 (where Y is the spermatozoa concentration and X is the optical density) The highly significant (P<0 01) correlation coefficient (r = 0 97) indicated a strong relationship between the two variables For Tuareg sperm the equation of the regression line was Y = 7590 6 X + 317 7 and the correlation coefficient (r = 0 86) was also highly significant (P<0 05) These results suggest that morphological characteristics of the sperm of Tuareg rams are different from those of Fulani rams semen when collection frequency is greater than 1 Taken together these parameters indicate the quality of sperm It is concluded that studies of various environmental factors should be carried out in relation with seasons

Performances laitières et état nutritionnel des chèvres du Sahel conduites sur parcours naturels: relations avec la croissance des chevreaux

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Résumé

La production laitiere de 22 chevres du Sahel âgees de 2 ans et demi en moyenne elevees sur parcours naturels, a ete etudiee par la methode de la double pesee avant et après la tetee Son influence sur la croissance des chevreaux a egalement ete examinee Les quantites de lait consommees par les chevreaux ont represente 56 a 65% de la production totale La production laitiere a ete plus élevée chez les chevres ayant mis bas pendant la saison des pluies et a portee multiple La glycemie a connu un pic dans les 24–48 heures apres la parturition (1,25 et 0,78g/l dans les lots ayant mis bas respectivement en saison des pluies et en saison sèche) puis a progres- sivement diminue La même tendance a ete observee pour l'uremie avec un pic decale se situant vers les 4-6emes semaines de lactation Il existe une correlation etroite entre la consommation de lait des chevreaux (r = 0 55) et leur croissance pendant les soixante premiers jours L'indice de consommation a ete de 6 24 pour les chevreaux

Introduction

Dans les pays de la zone sahelienne, ou la malnutrition proteino-energetique est l'une des principales causes de mortalite et de morbidite surtout chez les jeunes, le lait et la viande de chevre s averent souvent être les seules ou l'une des rares sources de proteines de qualite disponibles De plus, etant une espece a cycle court pouvant vivre dans les conditions assez difficiles de la zone sahelienne ou le disponible fourrager depasse rarement huit mois dans l annee, la chèvre regagne un intêret incontestable Au Senegal en particulier la chevre du Sahel est traditionnellement exploitee pour la production laitiere par les femmes en milieu rural et dans les zones periurbaines Malgre ce regain d intêret pour les chevres les connaissances sur leurs performances laitieres et sur leurs metabolismes demeurent assez limitees Par ailleurs pendant la periode qui va de la naissance au sevrage la croissance des chevreaux dépend etroitement des performances laitieres de leurs meres (Amegee, 1984)

Cette etude avait pour objectif d evaluer les potentialités laitieres des chèvres du Sahel conduites sur parcours naturels par des mesures directes et de caracteriser leur etat nutritionnel par le dosage de certains metabolites Les relations entre leur niveau de production laitiere et la croissance des chevreaux ont ete egalement etablies

Matériel et méthodes

Animaux et schéma de l'expérience

Vingt deux chèvres âgees de 2 ans et demi en moyenne et ayant mis bas entre juillet et octobre ont ete utilisees dans cette etude Elles ont ete conduites de manière identique, avec 8 heures de pâture/jour (8–17 heures), interrompues par une heure d'abreuvement (entre 13 et 14 heures) a la ferme de Sangalcam, dans la zone periurbaine (region de Niayes), a 40 km au nord-est de Dakar La composante vegétale du parcours et le comportement alimentaire des chevres ont ete rapportes dans une etude precedente (Cisse *et al* ,1993)

A partir du 14eme jour post-partum, les chevres ont ete alternativement reparties en 2 lots un lot non complemente (lot 1) et un lot complemente (lot 2) recevant le soir , au retour du pâturage 500 g/animal/j de concentre (66% de mais, 30% de tourteau d'arachide et 4% de CMV), de valeur nutritive calculee en energie et en azote de 1,12 UF et 190g MAD/kg de MS respectivement

Prélèvements et mesures

Quantités de lait produites et composition du lait

Les quantites de lait produites ont ete mesurees par la methode de la double pesee du chevreau avant et apres la tetee (Cisse *et al* , 1993) Un contrôle laitier individuel s effectuait trois fois par semaine au cours des deux premieres semaines post-partum, puis une fois par semaine pendant le reste de la lactation Les tetées avaient lieu a 8 13 18 et 22 heures Les mesures s'effectuaient ainsi quatre fois par jour par pesee de la traite du matin des quantites bues par le/les chevreaux et de la traite a fond de la mere apres la tetee Les petits

etaient separes des meres la veille du contrôle laitier au soir La pesee des petits et des quantites de lait traites s'effectuaient a l'aide d'une balance Sartorius de 0 1 g de precision et de 16kg de portee Un echantillon de 100ml de lait auquel on ajoutait 1ml de formol etait constitue a partir des traites du matin et de 18 heures en vue de l analyse de composition chimique Les teneurs en matieres grasses, en proteines et en lactose du lait ont ete determinees

Notation de l'etat corporel

L'etat corporel a ete apprecie selon une echelle de notation de 6 points (0= condamne, 1= tres maigre 2= maigre, 3= moyen, 4= gras, 5= tres gras) par observation et palpation des regions sternale et lombaire (Cisse *et al* , 1994) une fois par mois, sur chaque chevre

Prelevements sanguins

Des prises de sang ont ete individuellement effectuees sur toutes les chevres en fin de gestation, dans les 24–48 heures apres la parturition puis tous les 14 jours, a compter de la date de mise bas Le sang a ete immediatement centrifuge et le plasma recupere puis reparti dans plusieurs cupules et congele a -20 C jusqu a l analyse Les kits commerciaux ont ete utilises pour le dosage du glucose et de l uree Le glucose a ete dose selon la methode a la glucose-oxydase de Trinder (1969) (kit Sera-Pak Miles Italiana) et l uree par la methode de Gutmanni et Bergmeyer (1974) (kit uree enzymatique UV H P Biotrol) (Cisse *et al* 1991)

Croissance des chevreaux

Le contrôle de croissance a ete hebdomadaire En fait, le poids des chevreaux etait regulierement enregistre au moment du contrôle laitier

Résultats

Quantités de lait produites

L'apport de complement a eu un effet positif (mais non significatif) sur la production laitiere moyenne (tableau 1) Les quantites de lait consommees par les chevreaux ont represente 56 a 65% de la production totale

La production laitiere a ete plus importante chez les chevres qui ont mis bas pendant la saison des pluies (figure 1) L'effet de la taille de la portee a ete significatif sur la production totale de lait et sur les quantites de lait consommees (tableau 1), le volume de la tetee etant positivement lie au nombre de chevreaux

Tableau 1 *Quantites de lait produites par les chevres (en g/j/animal de lait brut) et composition du lait (g/kg)*

		Sources de variation[2]				
	Moyenne[1]	Apport de concentre	Saison de mise bas	Taille portee	Covariable	RSD[3]
Semaines 3 a 6++						
Lait total	1019 4	23 7 ns	151 4 ns	242 4+	**	192 2
Lait consomme	641 9	22 5 ns	19 8 ns	237 2 **	**	111 6
Lait trait	416 7	31 8 ns	52 0 ns	211 6 ns	ns	204 6
Taux butyreux	36 4		4 2 ns	2 0 ns	ns	7 3
Taux proteique	43 8	5 6 ns	4 6 ns	ns	8 7	
Taux de lactose	41 0	0 2 ns		8 8 ns	ns	8 9
Semaines 3 a 10++						
Lait total	970 4	25 3 ns	178 6 ns	259 4+	*	216 6
Lait consomme	615 5	15 0 ns	3 2 ns	243 3*	*	135 5
Lait trait	384 1	24 6 ns	44 5 ns	157 0 ns	ns	178 0
Taux butyreux	37 5	3 2 ns	3 5 ns	ns	7 1	
Taux proteique	48 7	5 1 ns	2 1 ns	ns	5 5	
Taux de lactose	40 5	2 6 ns	6 8+	ns	6 2	
Semaines 3 a 14++						
Lait total	841 0	4 0 ns	202 6 ns	186 8 ns		226 4
Lait consomme	552 4	23 0 ns	3 2 ns	224 9**	*	114 5
Lait trait	323 5	14 9 ns	83 8 ns	101 9 ns	ns	149 9
Taux butyreux	37 0	2 8 ns		3 6 ns	ns	7 1
Taux proteique	49 2	4 2 ns		1 8 ns	ns	5 2
Taux de lactose	38 8	0 3 ns	7 8 *	ns	5 7	

[1] Moyenne ajustee

[2] Sources de variation l effet des facteurs respectifs constitue la difference (complemente non complementé) (saison des pluies saison seche) (portee multiple portee simple) Il est significatif a 1%** 5% * 10% + ou non significatif (ns)

[3] Ecart type residuel

++Periode de complementation 1er mois (semaines 3 a 6 de lactation) 2 premiers mois (semaines 3 a 10) et periode totale (semaines 3 a 14)

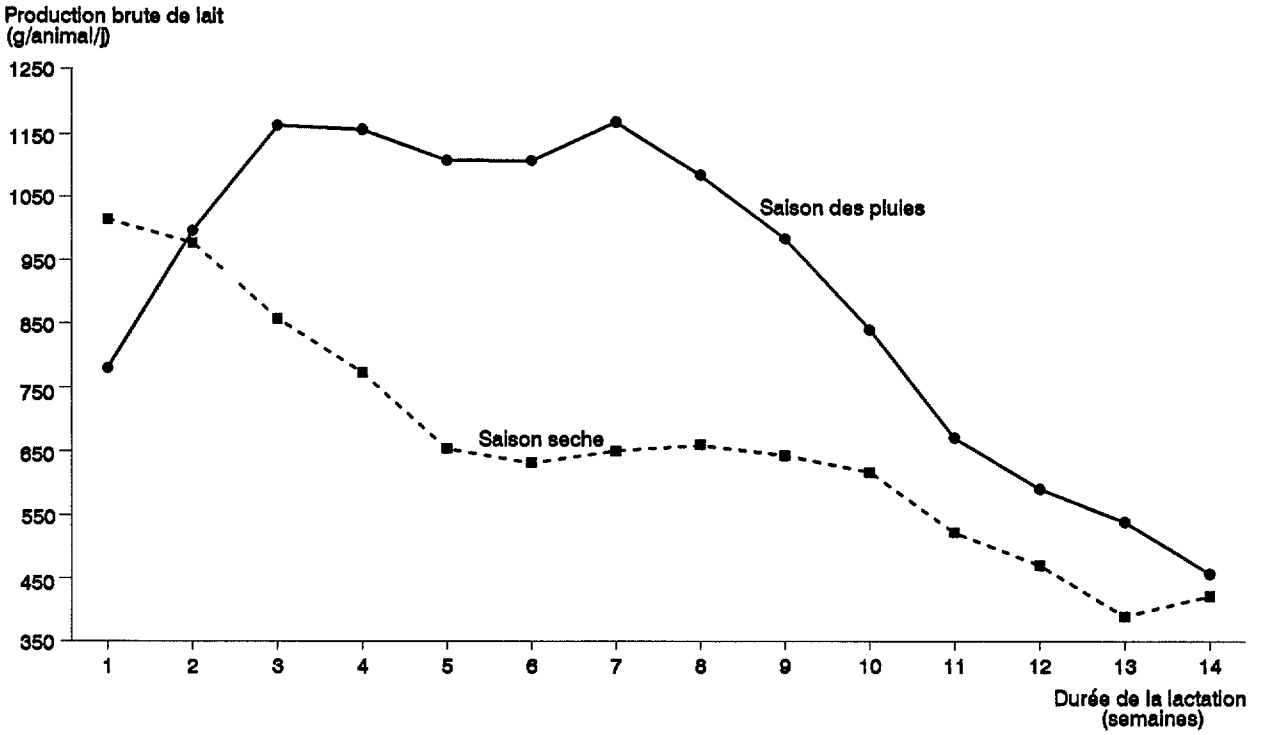

Figure 1 *Evolution de la production laitiere des chevres en fonction de la saison de mise bas*

Variations de la note d'état corporel

La complementation n'a pas eu d'effet significatif sur la note d etat corporel des chevres Sur la periode totale (semaines 1 a 14 de lactation), la note d etat moyenne a ete de 2,7±0,4 et 2,6±0,5 points Les chevres qui ont mis bas en saison des pluies ont eu un meilleur etat corporel que celles qui ont chevrote en saison seche (figure 2)

Glycémie et urémie

La glycemie a ete relativement faible en fin de gestation (figure 3) Elle a connu un pic dans les 24-48 heures post-partum Les valeurs les plus elevees ont ete enregistrees a cette periode 1 25 et 0 78g/l dans les lots ayant mis bas en saison des pluies et en saison seche respectivement Pendant les deux premiers mois de lactation la glycemie a ete relativement stable puis a progressivement diminue au cours du 3eme mois, dans tous les lots La saison de mise bas ou l apport de complement n a pas eu d effet significatif sur la glycemie Par contre l effet de la taille de la portee a ete significatif sur la glycemie enregistree en fin de gestation les chevres a portee multiple ayant eu une glycemie plus faible que celles a portee simple

L uremie a ete faible en fin de gestation dans tous les lots (0 43±0 07g/l) Elle a par la suite progressivement augmente pour atteindre un pic vers les semaines 4 et 6 de lactation (figure 4) L uremie mesuree en fin de gestation a ete significativement plus elevee chez les chevres ayant mis bas en saison des pluies (0 46 vs 0 39g/l p<0 05)

Croissance des chevreaux

La croissance des chevreaux a ete suivie jusqu a l âge de 8 semaines Le poids a la naissance a ete plus faible (tableau 2) chez les chevreaux du lot non complemente (lot 1) car le nombre de naissances doubles etait plus eleve dans ce lot (6/11) que dans le lot 2 (3/9)

Tableau 2 *Poids a la naissance et vitesse de croissance des chevreaux (en g) tous sexes confondus*

	Lot 1	Lot 2	RSD
Poids a la naissance	1551 3a	1839 0b	392 7
GMQ 1ere semaine (S2 S1)	104 6a	116 6b	40 1
GMQ 1er mois (S1 a S4)	95 3a	100 3a	23 4
GMQ 2eme mois (S5 a S8)	75 0a	63 3a	54 9

Sur la meme ligne les moyennes suivies de lettres differentes sont significativement differentes (P<0 05)

Le potentiel de production laitiere de la mere a eu un effet significatif sur le gain de poids vif au cours du 1er mois de lactation (tableau 3) Les chevreaux nes doubles ou triples ont gagne moins de poids (–1 6 kg p<0 01) pendant la même periode que ceux nes simples

La relation entre la quantite de lait consommee (y) et la vitesse de croissance ou GMQ (x) calculee sur 20 chevreaux tous sexes confondus et sur les donnees cumulees des 8 semaines de mesure (figure 3) est la suivante

$$y = 3\ 09x + 398\ 5 \qquad r = 0{,}55,\ p<0\ 01 \qquad rsd = 126\ 6$$

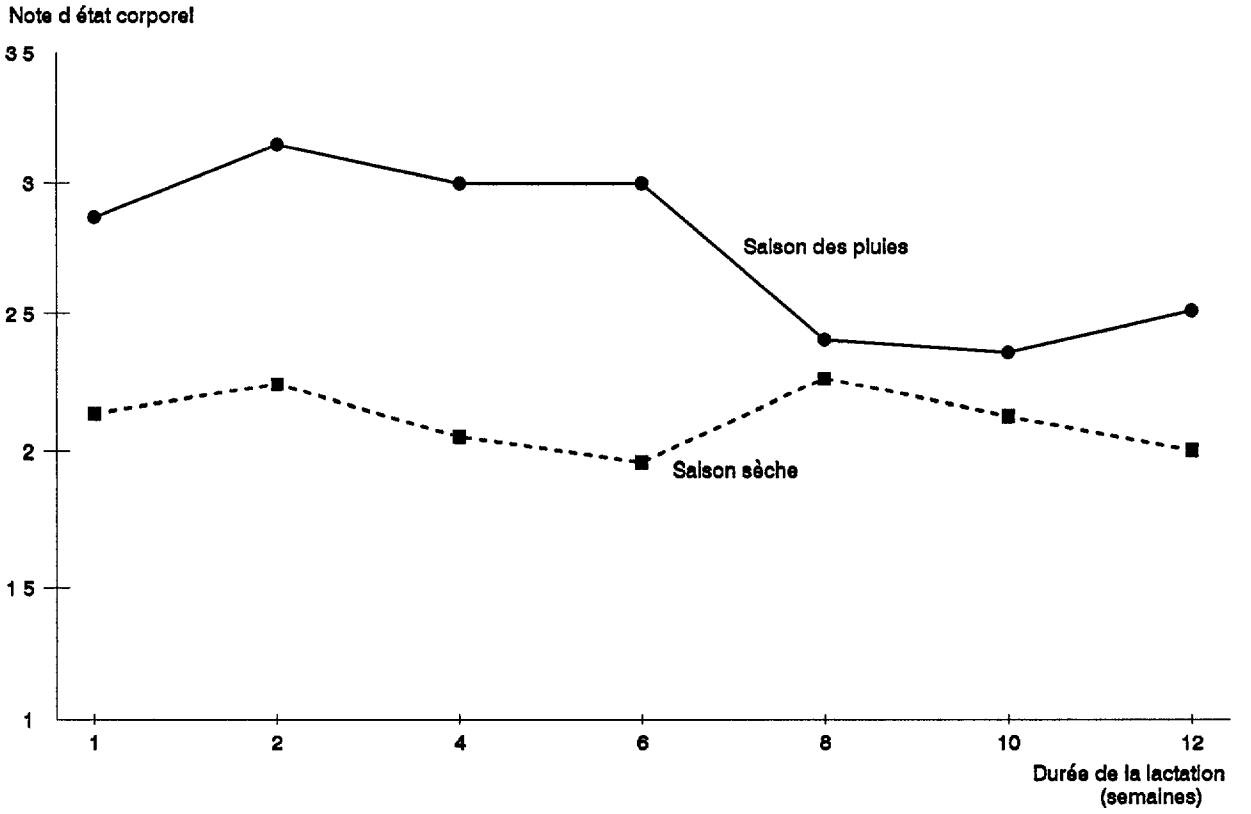

Figure 2 *Variations de la note d etat corporel des chevres en fonction de la saison de mise bas*

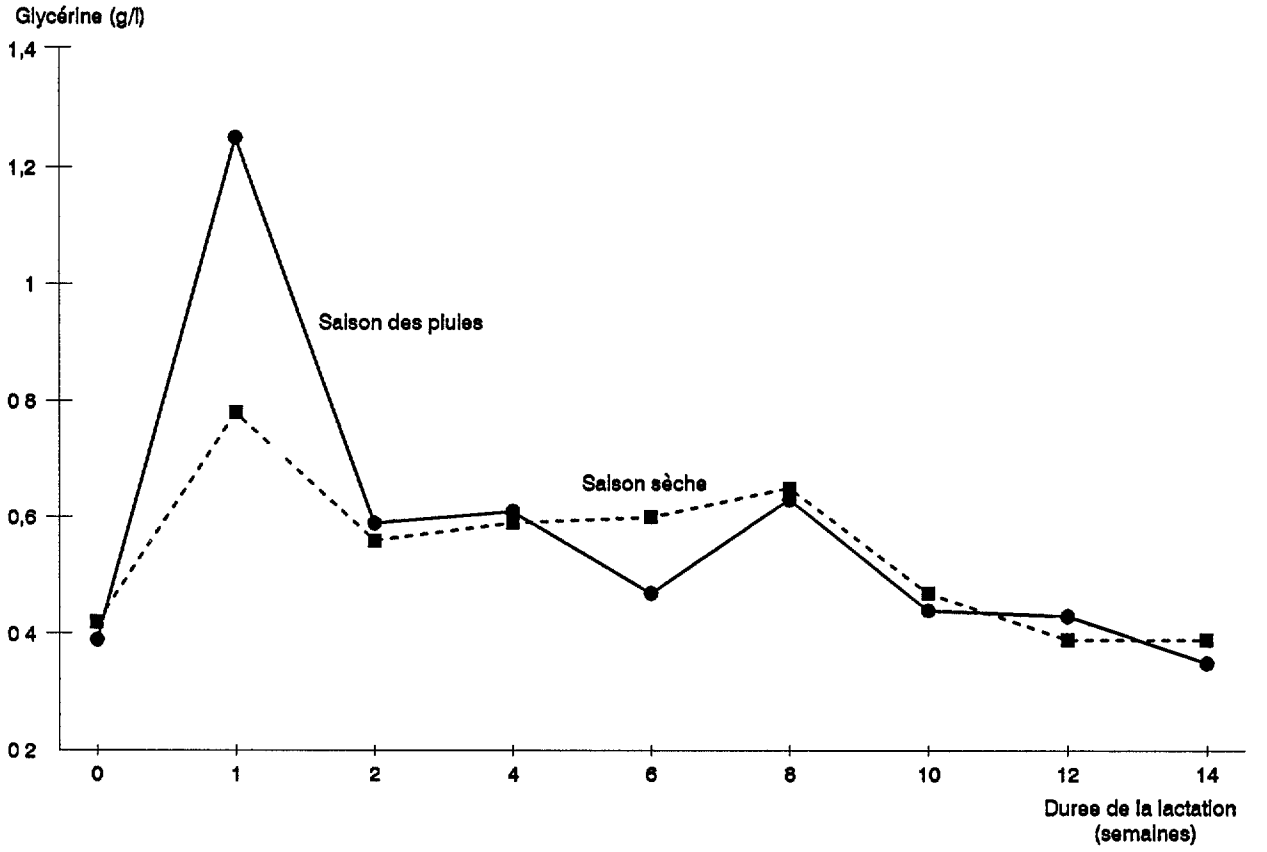

Figure 3 *Evolution de la glycemie des chevres en fonction de la saison de mise bas*

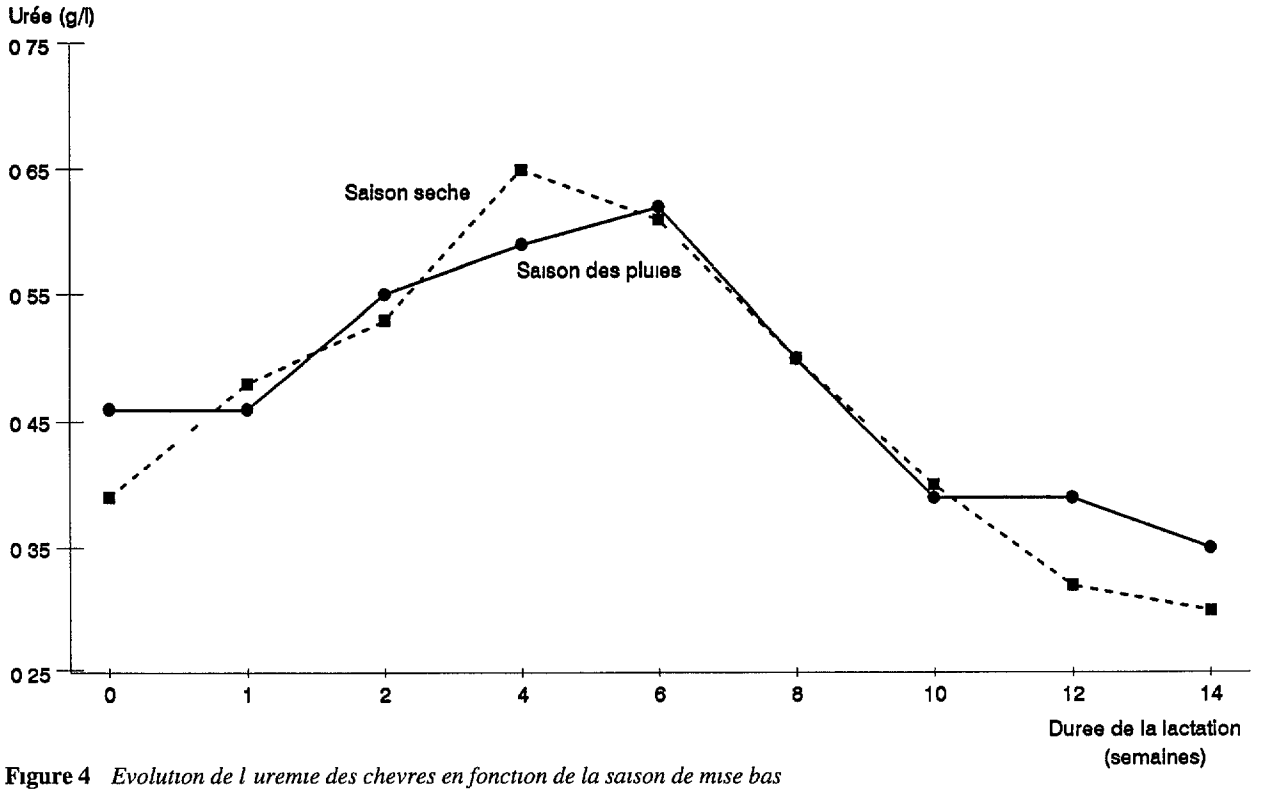

Figure 4 *Evolution de l uremie des chevres en fonction de la saison de mise bas*

Tableau 3 *Poids des chevreaux tous lots confondus*

	Sources de variation					
	Moyenne	Taille portee	Sexe	Saison	Covariable	RSD
Poids vif moyen (g) (S1–S2)	2093 1	577 4*	81 4 ns	291 2 ns	ns	172 1
Gain de poids vif (g) (S4–S1)	2905 9	1620 4 **	469 7 ns	663 4 ns	*	1099 1

S = semaine de lactation

Covariable = potentiel de production laitiere de la mere

Effet sexe = difference male femelle

L'indice de consommation c est a dire la quantite de lait necessaire par unite de gain de poids a ete de 6,24±0 9

Discussion

La reponse de production laitiere suite a l apport de complement de valeur nutritive 1 12 UF et 190g MAD/kg de MS a ete relativement faible si on tient compte du fait que les besoins de production laitiere de la chevre s elevent a 0 4 UF et 50g MAD/kg de lait a 4% de matiere grasse (Riviere 1977 cite par Cisse *et al* 1993) Parmi les facteurs pouvant expliquer cette faible reponse il y a de maniere vraisemblable l âge relativement jeune des chevres qui devaient en plus satisfaire des besoins de croissance et le disponible alimentaire de la saison seche qui devait se situer en dessous d'un seuil critique (Cisse *et al*, 1993) En revanche la production plus importante de lait pendant la saison des pluies est a lier a la disponibilite et a la bonne valeur nutritive de l herbe consommee

Par ailleurs les chevres ayant mis bas en saison des pluies ont eu les meilleures notes d etat corporel (figure 2) En effet les reserves corporelles des chevres ayant chevrote pendant la saison seche etaient certainement plus sollicitees pour couvrir les besoins d entretien et de production laitiere On peut aussi s attendre a des repercussions sur les performances de reproduction (Cisse *et al* 1992)

Le profil biochimique ne peut en aucun cas se substituer a un bilan complet de rationnement qui seul permet de verifier si les besoins nutritionnels sont couverts Il peut cependant completer et etayer le bilan nutritionnel Le glucose est le parametre le plus souvent mesure dans les profils biochimiques des ruminants

bien que son rôle chez ces animaux ait une moindre signification que chez les monogastriques Une hyperglycemie a ete constatee dans les 24–48 heures apres la mise bas Elle a deja ete signalee par certains auteurs et serait probablement due au stress de la parturition qui entraîne des decharges de gluco-corticoides (Gueorguiev *et al* 1995) La baisse de la glycemie constatee par contre avec l avancee de la saison seche peut être le reflet d'un deficit energetique L'uremie a progressivement augmente apres la mise bas On peut l attribuer a la reprise de l appetit ou a un hypercatabolisme qui resulterait de l involution uterine pendant le premier mois post-partum (Remond et Journet, 1978)

Le GMQ enregistre au cours des 7 premiers jours est tout a fait comparable a celui rapporte sur les chevreaux saheliens de Louga (Faugere *et al*, 1989) Sur la periode totale de l'etude la vitesse de croissance a ete neanmoins plus importante en station qu'en milieu eleveur ou des GMQ de l ordre de 60g/j sont rapportes L'indice de consommation obtenu au cours de cet essai (6,24) est tout a fait comparable a celui obtenu par Amegee (1984) chez l agneau Vogan Ces resultats peuvent trouver une application pratique dans la determination indirecte de la production laitiere des chevres par la vitesse de croissance de leurs chevreaux

Remerciements

Ce travail a pu être realise grâce a l appui financier du Reseau africain de recherches sur les petits ruminants (SRNET), ILRI Addis-Abeba Ethiopie

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Milk production and nutritional status of Sahel goats on natural pastures: Relationship with kid growth

Milk production from 22 goats aged 2 5 years on average and raised on natural pastures was studied using the weight measurement by difference method before and after sucking its effect on kid growth was also studied Milk consumption of the kids was 56 to 65% of total milk production This production was higher in goats kidding during the rainy season and in those with multiple births Glycaemia was highest 24–48 hours after kidding (1 25 and 0 78 g/l in animals giving birth in the rainy and dry seasons, respectively) and then decreased gradually The same trend was observed for uraemia with a shifted peak at between 4th and 6th week of lactation There was a strong correlation (r = 0 55) between milk consumption of the kids and their growth during the first 60 days Kids' consumption index was 6 24

Posters – Abstracts

Studies on kid mortality during the first four months of life in Nigerian Red Sokoto goat

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Studies were carried out on some possible factors influencing kid mortality rate in the Nigerian Red Sokoto goat during the first four months of life The factors considered included birth weight seasonal birth birth year parity, birth type, and sex of kid Necropsy and microbiological examinations were also done on the dead kids Birth year parity and season of birth significantly (P) affected the mortality rate while birth type and sex of kid had no marked effect Kid mortality was found to be 32% (P) up to four months of life Necropsy examination revealed pneumonia 36 84% starvation 15 80%, haemonchosis 12 40% and ectoparasitism 9 40% as the main causes of kid mortality

Housing small ruminants in Botswana. A case study of the Kweneng and Kgatleng districts

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This study as part of an on going Botswana Small Ruminant Research Network (BSRRN) project was an attempt to identify and characterise the various traditional housing systems used for small ruminants in rural Botswana Data for the analysis were collected from 93 randomly selected farms in a pilot questionnaire survey conducted in the Kweneng and Kgatleng districts between February and April 1993 The results show that varying proportions of the farmers keep small ruminants for meat (97 62%) cash income (88 32%) social obligations (70 85%) milk production (24 39%) and for the skin (6 44%) The commonest structure found in both districts was the acacia bush kraal (45 16%), followed by the bush pole kraal (31 18%), and the gum pole and wire kraal (16 13%) However, the brick/block shelter (4 30%) the diamond mesh wire kraal (2 15%) and the diamond wire shelter (1 08%) were only found in the Kgatleng District indicating perhaps greater awareness of innovations and potential adoption of new technology The acacia bush kraals were generally circular or oval in shape while the rest were rectangular The mean age of the kraals in the Kweneng District was 4 93 years (SD=90) while that in the Kgatleng District was 3 54 years (SD=1 94) The mean area of the kraal in the Kweneng District was 144 95 m (SD=29 65) with a stocking density of 1 97 m/animal (SD=0 58) In the Kgatleng District the mean area was 125 13 m (SD=45 74) while the stocking density was 1 24 m/animal (SD=0 52) Suggestions are made that could improve the design and overall efficiency of the traditional kraals found in the study area

A study of village sheep production in the western region of Ghana

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A 12-month retrospective survey of management system productivity and health care of 26 village flocks of sheep was undertaken in the western region of Ghana All the flocks were owned by adults with the majority belonging to men Cash to meet urgent needs of the family was the main reason for keeping sheep Most of the sheep were held in simple pens at night and left out to graze on roadside vegetation and fallow fields during part of the day Supplementary feed of household wastes were often provided during confinement The stock population showed an increase of 15% over the 12-month period Adult and young-stock mortalities were 17 8 and 32 4% respectively and higher in the flocks that were not vaccinated against pestes des petits ruminant (PPR) Half of the flocks were subjected to ectoparasite control in the form of hand dressing and endoparasite control was undertaken in 46% of the flocks Foot rot occurred in 27% of the holdings

Endoparasites of goats in Gaborone, Botswana

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About 24% of 585 goats sampled had a significant worm egg count This low infestation rate could be due to the fact that sampling was performed during the rainy season and the infective larvae were washed into the soil Some degree of innate resistance and acquired immunity could also play a role *Chabertia* and *Haemonchus* were the commonest worm eggs encountered

Dry matter herbage productivity and aspects of chemical composition in four forage shrub legumes at a subhumid site in Ghana

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Four forage shrubs *Leucaena leucocephala Gliricidia sepium Flemingia macrophylla* and *Cajanus cajan* were evaluated for herbage productivity in two years after they had been established in hedgerows 4 m apart and within-row spacing of 15 cm Herbage dry-matter yields were assessed after harvesting at 1 and 2 years of primary growth During the third year regrowth yields at cutting intervals of 6 weeks (3 cuts), 12 weeks (1 cut) and 18 weeks were assessed for the four species Crude protein, calcium and phosphorus contents were assessed for the entries during the regrowth yield assessments *Gliricidia sepium* consistently outyielded the three other species in primary growth and regrowth after cutting with yields exceeding two tonnes per hectare in the regrowth assessments In CP% Ca% and P% analysis *Leucaena leucocephala* was outstanding with highest values being 29 0% 1 74% and 0 36% for the three analysed items respectively

Enquête sur l'élevage ovin dans la région forestière de l'Est-cameroun

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Une enquête a ete menee en 1990 a l aide d'un questionnaire et d interviews aupres de 202 elevages traditionnels de la region forestiere de l'Est-Cameroun L'analyse des donnees montrent que la majorite des eleveurs de moutons de la region (79%) ont moins de 45 ans d âge et les ovins appartiennent surtout aux hommes (92%) Le taux d alphabetisation des eleveurs (35%) est relativement bas La taille moyenne du troupeau est generalement de 2–5 animaux (52%) et la majorite des animaux (70%) sont herites des parents Les animaux sont laisses en divagation permanente toute l'annee et l'herbe est assez abondante pour assurer une alimentation convenable Des mises bas precoces (18–20 mois) sont signalees par 66% des eleveurs Les naissances doubles sont les plus frequentes et la fecondation est observee toute l annee Les principaux symptômes pathologiques enregistres sont les diarrhees (34%) la toux (6%) et les gales (5%) Les maladies sont exclusivement traitees avec des moyens locaux dont l efficacite n est pas toujours garantie Les principales contraintes a l elevage des ovins sont le comportement social la sante et la commercialisation

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