Goat production in the humid tropics

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The Organizing Committee

FOREWORD

The goat, perhaps the first animal to be domesticated, occupies an important place in the rural economy of the humid tropics as a source of meat. In the humid tropical environment of West Africa, the West African Dwarf is the adapted goat breed. Among the rural dwellers, who form the vast majority of people in the humid tropics, livestock keeping around the homestead is usually practised. Such livestock subsist on household/ kitchen wastes, scavenging and bush grazing. Given this situation, productivity is low, disease incidence is high, parasite burden is heavy and the contribution of livestock to household earnings is small. Also in this zone, animal protein consumption is very low resulting in high infantile mortality and morbidity, low adult productivity and short live expectancy.

Research Institutions have exerted efforts in the improvement of animal productivity through research in cattle, pig, poultry and sheep production with very little attention being paid to the goat until recently. Goats have been despised by crop farmers because of the destruction that they can cause to crops on the field, during processing and in storage. Besides the innate mischievousness and destructive capacity of goats, they are difficult to confine. This is moreso for the West African Dwarf goat with its compact body and short legs. However, these hardy animals are adapted to the humid tropical environment and research has to be developed to modify the traditional husbandry system to exploit the potential of the humid tropical environment for herbage productivity, the adaptability and high reproductive efficiency of the West African Dwarf breed of goat, the tendency of the farmer to devote greater attention and resources to crop production and the role of women and children in the productive process.

This has engaged the attention of a team of scientists made up of nutritionists, veterinarians, reproductive physiologists, agronomists, economists and extension specialists in the last six year. These scientists drawn from the Obafemi Awolowo University, Ile-Ife, Nigeria and the National Agricultural University, Wageningen, The Netherlands have been engaged on a project on the "Management of the West African Dwarf goat in the Humid Tropics" in the former institution. The International Livestock Centre for Africa has co-operated in the project. In addition to developing a management package for the West African Dwarf goat, another objective of the project has been the dissemination of research findings. This was done in an "International Workshop on Goat Production in the Humid Tropics" held at Ile-Ife, Nigeria, in July 1987. Although the Workshop was planned for about 50 participants, the enthusiasm with which the announcement was greeted was overwhelming. 158 participants attended the Workshop - 88 from Obafemi Awolowo University, 49 from elsewhere in Nigeria and 21 from other countries namely: Benin, Mozambique, Belgium, India, Sri Lanka, Indonesia, Ethiopia, Gambia, Togo, Kenya, United Kingdom and The Netherlands. This is a reflection of the pride of place which the small West African Dwarf goat currently enjoys. It is our hope that this volume will provide useful information on the present state of knowledge on the management of the West African Dwarf goat for animal scientists, college students, socio-economists, livestock farmers, extension workers and policy makers.

This project would not have been possible but for the encouragement, support and substantial financial inputs of the government of The Netherlands through the Ministry for Development Co-operation and the National Agricultural University, Wageningen and the government of Nigeria through the Obafemi Awolowo University Research Committee. This support is gratefully acknowledged. We also acknowledge the initial approval given to this co-operative project by the Ministry of Economic Development (now Ministry of National Planning), Lagos, the National Universities Commission, Lagos and the Federal Livestock Department of the Federal Ministry of Agriculture, Lagos. We wish to thank the staff of the Humid Zone Programme of the International Livestock entre for Africa for their co-operation at all times.

We are indebted to the Royal Netherlands Embassy, Lagos for the sustained interest, support and encouragement that it continues to give to the Dutch personnel on the project and to His Excellency Mr. L.P.J. Mazairac, The Netherlands Ambassador to Nigeria for finding time off his busy schedule to attend the Workshop and deliver an Address at the Opening Session. We also acknowledge the continued support of Prof. Wande Abimbola, Vice-Chancellor, Obafemi Awolowo University and Dr. K. David-West, Director, Federal Livestock Department.

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Finally, I am very grateful to all those who assisted in the arrangements for a successful Workshop. It is our hope that this book will provide useful information to those who want to know something about the Management of the West African Dwarf goat.

Prof. A.A. Ademosun
Team leader

KEYNOTE ADDRESS: "GOAT PRODUCTION IN THE HUMID TROPICS - ACTUAL AND POTENTIAL CONTRIBUTION TO AGRICULTURAL DEVELOPMENT"

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Abstract

Goats are important numerically in the humid zone of West Africa with approximately 0.5 goats per head of rural, human population. Goat meat is a major item of animal protein in human diets, although the consumption per head is low in the humid zone. Much of the meat consumed is produced in the northern, more arid zone, with consequent high transport costs, while some is imported. As population grows and incomes rise, demand for goat meat is expected to rise by 8% annually. There is a real need and challenge to expand production of small ruminants in the humid zone.

The "traditional" production system is based on free-roaming village flocks, with, on average, 3 or 4 breeding females per household. Managerial and labour inputs are minimal. Nonetheless a rate of return on capital of over 30% may be earned on average. A breeding goat is a relatively small investment within the means of most individuals, but caretaking allows those without capital to keep breeding does and receive half the offspring.

Possible innovations include measures to improve health, nutrition, management, breeding and marketing but an integrated, systems approach is needed. Health measures like vaccination against PPR may increase numbers surviving and ultimately lead to the need for forage production, thus changing the system significantly. However cutting of browse and alley farming may provide fodder without competing with food crops. Intensified production systems require improved management to attain their potential. Government support services and appropriate pricing policies are also necessary for success of new intensive production systems.

PRODUCTION CAPRINE EN ZONE TROPICALE HUMIDE : CONTRIBUTION REELLE ET POTENTIELLE AU DEVELOPPEMENT AGRICOLE

Résumé

Les caprins sont nombreux en zone humide d'Afrique de l'Ouest où on compte approximativement 0,5 chèvre par habitant dans la population rurale. La viande de chèvre représente une source de protéines importante du régime alimentaire de l'homme dans cette zone, même si le taux de consommation par habitant en est faible. La viande consommée provient, à des coûts de transport élevés, du nord plus aride qui en produit une grande partie tandis que le reste est importé. On prévoit une augmentation de la demande de cette viande de 8% par an en rapport avec la croissance démographique et la hausse des revenus. Il est donc indispensable de relever le défi en développant la production des petits ruminants en zone humide.

Le système de production "traditionnel" consiste à laisser les troupeaux divaguer librement dans les villages en gardant en moyenne 3 ou 4 chèvres

reproductrices par ménage. L'apport de main d'oeuvre et de gestion est minime mais le taux de rentabilité du capital est de plus de 30% en moyenne. Une chèvre reproductrice représente en effet un investissement relativement faible à la portée de plus grand nombre et un système de métayage permet à ceux qui n'ont pas le capital nécessaire de garder les chèvres reproductrices et de recevoir, en contrepartie des soins donnés, la moitié de leurs descendants.

Des mesures visant à améliorer la santé, la nutrition, la conduite, la reproduction et la commercialisation font partie des innovations possibles mais il faudra aussi adopter une approche intégrée par systèmes. Des mesures vétérinaires, comme des campagnes de vaccination contre la PPR, peuvent augmenter les taux de survie (et, par conséquent, les effectifs), conduire à la nécessité de produire des fourrages et modifier en fin de compte le système de façon significative. Les ligneux et les cultures en couloirs peuvent être source de fourrages sans concurrencer les cultures vivrières. L'intensification des systèmes de production doit s'accompagner d'une gestion améliorée pour permettre d'en tirer le meilleur parti possible. La réussite de ces nouveaux systèmes sera aussi conditionnée par l'appui des services gouvernementaux et l'application de politiques appropriées en matière de fixation des prix.

The importance of goats in the humid tropics

The aim of this paper is to demonstrate the actual and potential importance of goats to agricultural development in the humid tropics, with special reference to West Africa. What I have to say falls conveniently into three sections. The first deals with the economic and dietary importance of the goat to the whole region; the second outlines the strengths and weaknesses of the existing system of production, while the third considers some possible options for improvement.

Goats are found in many different continents and climatic zones, although it is estimated that 94% of the world total live in the developing countries (FAO, 1984). In Africa, although the majority are found in the semi-arid and arid regions, there are more than 11.5 million goats in the humid zone (Jahnke, 1982). Thus there are approximately 0.5 goats per head of the rural element of the rural economy of humid West Africa. Indeed surveys in South Western Nigeria indicate that over 70% of rural households in some villages keep goats or sheep (ILCA, 1980).

The economic importance of goats, in this zone, stems from their contribution to human diets. Although rice is the staple food in Sierra Leone, and maize is widely grown, much of the humid zone of West and Central Africa is dependent on root crops such as cassava and yam. Root crop based diets are liable to be deficient in protein, so that supplementation with animal protein is particularly necessary. Livestock production in the humid zone is limited to species and breeds which tolerate trypanosomiasis, as the entire region is infested at varying levels with the tsetse flies which carry the disease. Thus locally produced animal protein is largely restricted to poultry meat and eggs together with the meat of dwarf goats and sheep. Although these small ruminants may be slaughtered ceremonially on special occasions, the meat nonetheless forms a part of household diet. Some pigs are kept, but ruminants have a distinct advantage over animals with simple stomachs in being able to convert cellulose and other materials unsuitable for human consumption into products of high nutritional value. This is particularly true of goats. Experiments at Reading University have shown that untreated straw can form a large proportion of goats' diets, if sufficient feed is

provided to allow refusal rates of 50% (Wahed & Owen, 1986). Trypanotolerant cattle are far less numerous, while supplies of bush-meat are limited where human population is concentrated.

Traditionally, the humid zone of West Africa has depended on more arid areas to the north for the supply of livestock. This is illustrated by Nigeria where 70% of her total livestock production comes from the northern part of the country (Nigeria, Federal Office of Statistics, 1981). Substantial costs are involved in marketing and transporting cattle, sheep and goats over long distances, and this is reflected in price differentials. Prices of meat in Abidjan, Accra, Lagos, Ibadan and Port Harcourt may be twice as high as the prices paid in the northern markets. Increasing quantities of livestock products are imported from overseas (Mittendorf & Wilson, 1961; Josserand & Sullivan, 1979).

Although northern breeds are larger than the southern dwarf goats, the meat is a close substitute. As a result of market forces the price per kilogramme live weight of northern and southern goats is similar at between $3 and $4 in 1982-83 (Okali & Upton, 1985). These relatively favourable prices provide an incentive for farmers to sell local goats. Increased sales of southern animals, to substitute for purchases from the north, are beneficial from a national viewpoint in that transport costs are saved. Substitution of locally produced livestock for imports saves scarce foreign exchange.

As might be expected, in view of the higher prices, per capita consumption of livestock products is much lower in the humid east and west of Nigeria, at about 6 g and 8 g per day respectively, than in the drier north where it is about 60 g per day (Ojo, M.O. personal communication). Any increase in local production, especially at reduced cost, would be beneficial in increasing the rather low intakes of the humid zones, besides substituting for imports. Thus there are market opportunities for increased livestock production within the humid zone.

Furthermore the market opportunities are increasing. It must not be forgotten that the demand for livestock products is growing all the time. The human population of Sub-Saharan Africa is estimated to be expanding at about 3% annually. Thus to keep pace with this growth, and maintain current levels of animal protein intakes would require a comparable expansion in livestock production. In addition the market for these products expands even faster as a result of urbanization and increasing incomes. As people migrate from rural areas to the towns, those remaining must produce an increasing marketed surplus of livestock products to supply urban markets. At the same time livestock products are comparative luxuries with a high income elasticity of demand. This means that as incomes increase, spending on meat, milk and eggs increases more rapidly. The result of all these influences is an estimated annual growth rate of 8% in the demand for goat meat in Nigeria (Olayide, 1982).

Clearly there is a very real need and challenge to expand the production and increase productivity of these small ruminants in the humid zone of West Africa.

Production systems

Goats, in the humid tropics, are generally kept as a low-cost adjunct to arable and tree-crop production. Much of the household's food needs are met from cereals and root crops generally grown in a bush-fallow rotation, while cash income is earned from tree crops such as cocoa, oil palm, rubber or various fruits. Goats and other livestock generally absorb only a small proportion of the total household resources and make a comparatively minor contribution to total household income. (Typically a

household goat flock is made up of three or four animals). However, they make a significant and valuable contribution.

Under the so-called "traditional system", common in humid West Africa, goats scavenge in free-roaming village flocks with no special provision of forage or housing and with minimal management. No forage crops are grown and manure is not returned to the cultivated crops, so links with crop production are slight. The entire village stock can be considered as a single, interbreeding flock, and usually there are no attempts to control mating. Since very few males are required for breeding, most families can sell or consume all the male offspring. Animals receive virtually no veterinary care, and mortality rates are relatively high, though variable. In general these animals received little attention and as a consequence labour costs are negligible.

There are instances, particularly in densely populated eastern Nigeria and in the People's Republic of Benin, where more intensive methods are adopted. Goats are commonly tethered or permanently housed, feed is cut and brought to them and their manure is collected and spread on the fields to maintain fertility (Mecha, 1975; Lagemann, 1977; Mack et al., 1985). Clearly labour costs are increased under such systems, but there is still no competition with cultivated crops for land since cut and carried fodder and browse are obtained from fallow land or crop by-products.

Under either system, goats are kept both for home consumption, often associated with ceremonial slaughter at special festivities, and for sale. Some kids are slaughtered at about weaning age, but most sales appear to be adult goats of 12 months or more. Although some animals are consumed within the household, the main objective of keeping goats, reported in a survey by Matthewman (1977) was financial gain. Of the South-Western Nigerian households studied, 91% said that this was their reason for keeping small livestock. It seems appropriate, therefore, to assess productive performance in terms of the financial return.

A breeding goat is, of course, an item of capital. In economic terms, capital is something that was produced in the past and will add to production in the future. Breeding livestock fit this definition exactly. The young that are produced may be slaughtered and consumed or saved and invested. In the latter case they join the breeding flock, and contribute to future production. Alternatively breeding animals may be purchased. Thus capital investment in goats should be seen as an alternative to other forms of on and off-farm investment such as tree crops, storage of produce, petty trading or cooked food selling. These alternatives may be compared in terms of the rate of return on capital.

The West African Dwarf doe is a veritable engine of production, kidding every eight or nine months on average and bearing one and a half kids per parturition. Thus she produces more than two young every year from the age of about 18 months under traditional village systems (Mack, 1983). Some production statistics from South-Western Nigeria are given in Table 1. Given that at weaning body weights average 5 kg, while that of the average doe is about 16 kg, she must produce two-thirds of her own body weight or a 67% yield each year. Unfortunately, much of this potential is lost as a result of high mortality, particularly at the pre-weaning stage. Typically about one-third of all kids are lost before weaning while nearly half die in their first year.

These parameters may be used to estimate overall measures of productivity. For instance the weight of weaners produced per doe per year (net of mortalities) amounts to 5.8 kg. The weight of weaners produced per kg of doe weight is .385 grammes or 38.5%. However such measures do not take account of the capital costs of carrying breeding bucks and growing kids, of live weight gains between weaning and sale or slaughter, or re-

Table 1. Production parameters for West African Dwarf Goats under traditional management (Mack, 1983).

	Mean	Coefficient of variation (%)
A. Parturition interval (days)	259	41
B. Kids per litter	1.49	37
C. Annual kid drop = $\frac{365B}{A}$	2.1	
D. Age at first parturition (years)	1.50	46
E. Weight at 90 days (kg)	5.3	34
F. Daily gain (grammes)	40	50
H. Kid mortality to 90 days (%)	33	
I. Mortality 3 to 12 months (%)	23	

placement costs for does and the market values of the animals.

Using market price data collected in village markets in 1982-83, estimates were made of the financial rate of return on capital invested in dwarf goats in South-Western Nigeria (Upton, 1985a, 1985b and 1986). Net output per doe per year was estimated to be US $25.38 (N17.27) and the rate of return on capital 34%.

Several simplifying assumptions were made in reaching this estimate, which might inflate the figure. All costs of labour, feed and veterinary treatment were ignored on the grounds that they are likely to be small. Also it was assumed that animals are disposed of at 12 months although some are slaughtered or sold earlier. On the other hand, all mortalities were assumed to be valueless even though some may be consumed. In any case a return of over 30% on average, makes traditional goat production an attractive investment option.

There are other advantages associated with goats as a form of investment. First, a goat is a conveniently small unit of investment. Even an adult dwarf goat could be consumed by one family over a few days, whereas a cow is too bulky to be eaten by one family. Similarly the price of a goat falls within the means of most rural households. A flock of 3 or 4 does is not a huge investment.

Second, the fact that goats do not compete with crops for land is an advantage especially in areas of increasing population density where there is pressure on land. In parts of eastern Nigeria, evidence suggests that reduction in the length of fallows is resulting in falling crop yields (Lagemann, 1977; Anthonio & Ijere, 1973). Given these circumstances small ruminants are an important means of raising farm incomes and family food supplies, without increasing pressure on the land. However, the dangers of livestock straying and damaging growing crops may be so severe as to require confinement of the animals.

A third advantage of investment in goats is for landless people, particularly the women in some areas. Since goats may be fed on household scraps, crop residues and rough grazing or browse, access to land is not a necessary precondition. Commonly goat keeping is associated with food processing. The cassava peels and other crop products of small-scale commercial food processing provide the basis for feeding a small flock of breeding does (Carew, 1982).

Finally, it seems that in traditional goat keeping there are no significant economies of scale. This is an advantage in that everyone can

partake in this activity and there is no strong tendency for the development of large individually owned flocks with consequent large inequalities within the village society. This egalitarian feature of goat keeping is reinforced by the widespread practice of "caretaking". In South-Western Nigeria 54% of households surveyed were caring for "borrowed" animals (Okali, 1979). Women in particular acquire stock in this way. Social norms are such that a livestock owner cannot refuse a request for a loan of breeding stock. The offspring are usually shared equally between the borrower and the lender, although risk of mortality of the doe is borne largely by the owner (Sempeho, 1981). The borrower thus receives income from rearing his or her share of the offspring in return for caretaking, at little or no capital cost. In this way breeding stock are shared and redistributed among individuals and households. Large individually owned and managed flocks are exceptional.

Caretaking not only redistributes livestock and income but also reduces risk to the individual. On the one hand risk of kid loss is shared between the owner and the caretaker, similar to the way in which risks are shared between landlord and tenant under sharecropping arrangements. On the other hand, an individual who suffers severe disease losses of breeding stock, knows that the flock can be rebuilt by caretaking borrowed stock. This means that risks are effectively pooled within villages and kinship groups. At the same time the individual goat keeper may treat his other stock as a risk reserve to be sold or slaughtered in case of emergency or on other occasions when there is pressing need for cash.

Options for improvement

A rather obvious question is why, given the relatively high average returns from goat keeping and the other advantages already mentioned, so few goats are kept; why is the typical household flock limited to 3 or 4 breeding females? Farmers have themselves given the following list of limitations: feed, need for fencing, time, cash and disease (Okali, 1979; 1983).

Of these five possible constraints on the expansion of traditional goat production, feed is clearly important. So long as small ruminants are fed mainly on household scraps their numbers must be limited by the amount available. Experience has, no doubt, shown that the average household produces only enough food by-products to support 3 or 4 breeding animals. Incidentally this may help to explain the early disposal of some young stock soon after weaning. A larger return would be obtained by carrying them through to maturity - but feed shortage may preclude this. Any increase in small ruminant numbers would then require increased reliance on purchased feeds such as maize bran (eri), cut and carried fodder or pasture/browse production. This last alternative would require the fencing of pastures, which involves a substantial cost, and probably explains the farmers' emphasis of this item.

If an increase in goat numbers necessitate changing to a new, more intensive system, labour and cash costs per goat must rise. This is presumably why farmers list labour and cash as limitations on further expansion. Improved systems will only be accepted if they raise farmers' incomes; that is if the extra benefits from increased production exceed the extra costs.

Disease is the last of the limitations mentioned. Obviously morbidity results in loss of production, while mortality reduces livestock numbers. In this sense disease is a direct constraint on production. However, there are no grounds for assuming the proportionate losses will be any higher in a large flock than in a small one. Indeed the risks of major losses may be

lower in a large flock (Upton, 1985b). If increasing flock size requires the confinement of animals and introduction of cut and carry feeding, disease incidence and mortality may increase unless the standard of management is improved. A preliminary analysis of data collected from eastern Nigerian goat flocks restricted to small stockades, suggests substantially higher mortality rates than for free roaming flocks (see Mack et al., 1985). In effect, management may be a constraint on expansion and intensification of goat production.

In considering options for improvement of productivity and returns, from small ruminants, five main areas may be identified, (1) nutrition, (2) health, (3) management, (4) breeding and (5) marketing (Devendra & McLeroy, 1982). Such a list emphasises the range of different scientific disciplines which might contribute, but cannot provide a basis for establishing priorities for improvement. For this purpose an inter-disciplinary approach is needed in considering alternative production systems.

A possible development sequence, proposed by ILCA scientists in the early stages of the humid-zone small-ruminant programme is shown in Figure 1 (ILCA, 1980). Although some changes might be appropriate in the light of more recent research, this diagram will serve to emphasise the main issues and options.

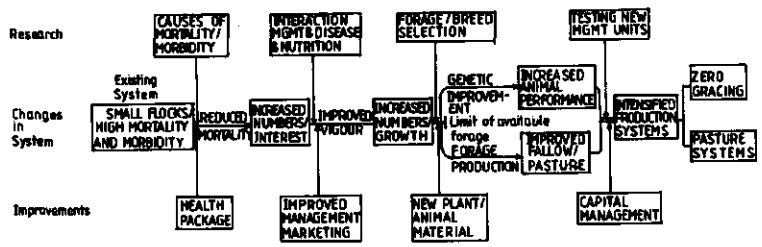

Fig. 1. A possible development process proposed in the early stages of the ILCA Small Ruminant Programme (ILCA, 1980).

Probably the first and most readily feasible option is the introduction of health measures to reduce mortality. Annual vaccination with tissue culture rinderpest vaccine (TCRV) as a means of controlling peste des petits ruminants (PPR) falls into this category. This disease appears to be the major cause of mortality among goats in the humid zone of West Africa, and TCRV appears to give a large measure of control (Adeoye, 1985; Opasina, 1985). Rough calculations suggest that the benefits of such a programme would exceed the costs. It should also be noted that a reduction in mortality, not only increases production and offtake on average, but also reduces the risk of disastrous losses (Upton, 1985b). Although disease control measures should have a significant impact on offtake and returns they do not necessarily change the management practices of the farmer. The existing traditional production system can continue unchanged. Other health measures which have been considered, such as monthly dipping against sarcoptic mange, would require some changes in the system, if only a somewhat higher level of management and control.

In the light of farmers' attitudes to expansion, it appears that any increase in numbers would necessitate increased provision of forage. This, in turn, would mean a major change in the farming system. The purchase of feed supplements and the cutting and carrying of browse must increase cash and labour costs. When the limit of available forage is reached, then forage production must be introduced to the system. This need not compete with food and cash-crop production for the use of land if fodder or browse production substitutes for the bush fallow phase of crop rotations. Alley farming, which involves growing rows of leguminous trees such as Leucaena leucocephala and Gliricidia sepium with arable crops between the rows, provides mulch to maintain soil fertility and browse which may be fed to goats. Provided an appropriate balance is maintained between the number of goats and the area of alley farming there is no competition between arable crop output and goat production; the two activities are complementary. This low-cost system appears to benefit both crop and livestock production (Sumberg, 1985).

On-farm trials of alley farming combined with goat production were launched in 1984 by the Nigerian National Livestock Projects Unit on the basis of research by ILCA and IITA. Spontaneous adoption occurred in neighbouring villages and more than 100 producers have established trees on their farms. Alley farming has now been included in Nigeria's Fourth National Livestock Development Plan aimed at reaching over 15,000 farmers during the next five years.

Developments of this nature, or other approaches to forage production, require the adoption of either a grazing/browsing system or a cut-and-carry zero-grazing system or possibly a combination of these. During the course of this conference we shall learn much more about these alternatives and the improvements in productivity. Our theme is the "Management of the West African Dwarf Goat in the humid tropics", so there is some justification for ending this paper on the subject of management.

Intensified production systems not only raise productivity they also incur costs of growing fodder, fencing grazing land, housing livestock and the extra labour involved. With a high level of management, production should increase substantially more than costs, to yield significant improvements in net returns. However with inadequate management greater losses may be incurred than under the traditional system. Thus performance is very dependent on the level of management and control of (i) animal nutrition and provision of balanced rations, (ii) health and use of appropriate disease control measures, (iii) the selection of breeding animals and (iv) marketing, the identification of where and when the best prices may be obtained.

Some of these skills may be developed by farmers during the on-farm testing and introductory phase of the farming systems development as mentioned above in relation to alley farming. Experience gained from the village level testing of the intensive system developed at Ife, in Isoya, will be very useful in this respect. A continuing input of agricultural extension advice may be needed to maintain the necessary management standards.

Governments too can assist in creating a favourable economic environment and the right incentives for increased production. Foreign exchange and pricing policies are important in this respect. Thus, devaluation of overvalued currency raises the costs of imported animal protein, and thereby encourages a switch to the consumption of home-produced livestock, to the benefit of local producers.

Apart from extension and management advice, other support services may be provided by the government. Of particular relevance are disease control campaigns, provision of improved breeding stock, improved marketing

facilities (though existing markets and trading arrangements for goats are quite effective, (see Okali & Upton, 1985) and credit for investment in intensive livestock. Careful appraisal is needed to assess whether increased government spending in these areas is justified. However, in some circumstances, improvement in these support services may be critical for the success of new intensive production systems.

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Appropriate Management Systems for the West African Dwarf Goat in the Humid Tropics

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Abstract

Goats constitute a major potential resource in the humid tropical environment where they are more numerous than sheep and cattle. The West African Dwarf goat is adapted to the hot and humid environment where it is used as a source of meat. Unfortunately, under the traditional management system the animals depend mostly on household wastes and bush grazing which do not provide adequate levels of nutrition for optimum production. Lack of veterinary care also raises problems of diseases and parasitic infestation. Thus the animals suffer heavy mortality and the level of productivity of surviving ones is very low indeed.

Any management innovations must recognize the peculiar characteristics of the traditional production system and provide for improvement in feeding, health and shelter. At the Obafemi Awolowo University, a package that is simple, adaptable and based on locally available materials has been developed. The use of this new management system has resulted in improved animal performance.

SYSTEMS DE GESTION APPROPRIES POUR LA CHEVRE NAINE OUEST-AFRICAINE EN ZONE TROPICALE HUMIDE

Résumé

Les caprins constituent une importante resource potentielle des zone tropicale humide où il sont plus nombreux que les ovins et les bovins. La chèvre naine de l'Afrique de l'Ouest, adaptée au climat chaud et humide, est consommée dans ces régions mais les déchets ménagers et ligneux de brausse dont elle se nourrit dans le système d'élevage traditionnel ne suffisent pas à lui assurer un régime alimentaire permettant une production optimale. L'absence de soins vétérinaires favorise, en outre, maladis et infestations parasitairs. Par conséquent, les taux de mortalité des troupeaux sont très élevés et les niveaux de productivité des survivants très faibles.

Toute innovation en matière de gestion doit tenir compte des caractéristiques particulièrs du système de production traditionnel et inclure des mesures pour améliorer l'alimentation, la sorté et les abris des caprins. A l'Université Obafemi Awolowo, l'introduction d'un nouveau système d'exploitation simple et adaptable, basé sur du matériel localement disponible, a permis une amélioration de la production caprine.

Introduction

The humid tropical environment in Africa covers most of the west coastal areas and the central region of the continent. This zone is characterized by high temperatures and rainfall in excess of 1500 mm, which is

distributed on a bimodal basis, and high relative humidity (80-90%). The vegetation is typical tropical rainforest in the coastal areas becoming derived savanna in the northern parts. The zone is associated with high incidence of animal diseases and parasitism. Trypanosomiasis has limited adapted breeds of livestock to largely trypano-tolerant breeds which are usually of small frames and low productivity. Although the zone is suitable for abundant herbage productivity, this is of low feeding quality because adapted legume forages are limited to a few species while the grass species are the tall, stemmy and rapidly lignified types. The farmers are predominantly food and cash crop growers who practise shifting cultivation and have not integrated livestock production into the farming systems. For instance, crop residues and other agricultural by-products are not utilized for livestock feeding while animal wastes have not been useful in improving soil fertility largely because farmsteads are separated from homesteads around which livestock are kept. Thus the zone has not been an important one as far as livestock production is concerned and has depended on the more arid northern regions for the supply of meat and animal products.

With increasing urbanisation and pressures on the land, the length of the bush fallow is decreasing. In addition, increasing sophistication and incomes have led to changes in the consumption patterns of the people. The demand for meat and animal products is increasing and greater attention is being devoted to livestock production. The adapted goat breed in the humid tropical environment of Africa is the West African Dwarf which is widely distributed throughout the region, with concentrations in Nigeria, Ghana, Cote d'Ivoire and Liberia. The population of goats in the region has been estimated at about 8 million and goats are more numerous than sheep and cattle (Table 1) (Jahnke, 1982). About 70% of the goats are located in Nigeria. Goats are raised for meat, as a status symbol, an insurance against crop failure and to provide ready cash as occasions demand.

Table 1. Ruminant livestock population in the humid zone of West Africa.

('000s)

Country	Goats	Sheep	Cattle
Nigeria	5,621	3,476	857
Togo	45	102	225
Ghana	1,200	990	558
Cote d'Ivoire	816	874	65
Liberia	190	190	38
Sierra Leone	59	20	92
Guinea	79	86	1,530
	8,010	5,738	3,365

Source: Jahnke (1982)

One characteristic of goats under the traditional production system is the high mortality resulting from high incidence of diseases and parasitism, poor feeding and poor management. Investigations were initiated in the 1960's at this University in an attempt to find solutions to these problems. It soon became obvious that the magnitude of the problems was such that it needed assistance from, and collaboration with,

outside bodies. Contacts made with the newly established Humid Zone Programme of the International Livestock Centre for Africa (ILCA) in Ibadan in the late 1970's led to the tripartite talks between ILCA, the University of Ife and the National Agricultural University, Wageningen, and the collaborative research on "Management of the West African Dwarf Goat in the Humid Tropics" which is jointly funded by the governments of The Netherlands and Nigeria and the National Agricultural University, Wageningen, The Netherlands. The International Livestock Centre for Africa has a sustained interest in the project.

The objectives of the project are:

a. to study the management and economics of the production of the West African Dwarf Goat in the Humid Tropics,
b. to develop research facilities,
c. to disseminate research findings,
d. to train scientists, young graduates and students.

The project which started in September 1981 was for an initial period of four years but an extension of three years was obtained early in 1985 to ensure the development of a package that can be extended to and adopted by farmers. This Workshop is aimed at providing an opportunity to disseminate results to and to share experiences with scientists interested in West African Dwarf Goat production in Nigeria and other parts of West Africa as well as The Netherlands, other EEC countries and the International Livestock Centre for Africa.

Traditional Management Systems

The keeping of small ruminants, particularly goats is widely practised in the zone although flock sizes are small. Sellers et al. (1976) in a survey in South-Western Nigeria found that the average number of goats per household in the town was 3.5 while the number in the village was five. ILCA (1979) reported average number of goats per household in central, south east and south west of Cote d'Ivoire as 4.5, 4.6 and 4.1, respectively. Although goat numbers per households are small, large numbers of households keep goats. For instance, a survey showed that 41.7% and 33.3% of households surveyed in Western and Eastern Nigeria, respectively kept goats (ILCA, 1980).

Under the traditional system of management little attention is paid to adequate feeding and health of the animals. Goats are usually provided with household and kitchen wastes which could include yam, cassava and plantain peelings, the bran of maize and other grains and pods of beans. The animals supplement this with bush grazing. However, in some places where animals are kept near the farmsteads and there is danger of crop destruction or where, because of increasing human population and pressure on land, free ranging is no longer practical, animals are kept on tethers or in enclosures. In certain localities, the keeping of goats is prohibited to safeguard crops. Thus where the animals are kept on the tethers or any type of confinement the use of household wastes is also supplemented with the hand-feeding of natural forages. The effect of these systems of management is high mortality and morbidity caused by external and internal parasites, infectious diseases and nutrient deficiencies. The most vulnerable age groups are the young, the pregnant and the lactating animals. The most common disease in the zone is peste de petits ruminants (PPR) which is responsible for heavy mortality especially among kids. The incidence of the disease is highest during the rainy season and early dry season. Another important disease is mange due to Sarcoptes scabei. ILCA (1984), in health interventions involving yearly vaccination with tissue culture rinderpest vaccine to control PPR and dipping against mange,

reported a two-fold increase in the population of village goats over a 24-month period. Opasina (1985) reported a 75% reduction in mortality in the animals vaccinated against PPR over a 12-month period. In contrast, dipping against mange alone had no effect.

Under village management conditions, helminthiasis can constitute a serious problem, although the magnitude of the problem is often underestimated. This is particularly true of free ranging animals. Assoku (1980) in a survey carried out in the Accra plains of Ghana found that 88.3% of goats kept under the traditional system were infected with parasitic helminths. The most common were the nematodes. ILCA (1982) reported the presence of Stroglylus, Strongyloides and Noniezia among village flocks. A few Coccidia ova were also seen. ILCA (1982) also noted that helminthiasis accounted for 13% of all diseases encountered at village level. Smith et al. (1986), in a survey carried out in the dry season in South-Western Nigeria, identified similar parasites although the burden was generally low, due probably to the seasonal effect. Blood parasites such as Trypanosome vivax, Babesia sp. and Anaplasma sp. have been detected. These have not constituted serious problems although ILCA (1982) reported that 17% of all diseases recorded in villages in the derived savanna zone in Nigeria was due to trypanosomiasis. Thus under the traditional system, diseases and parasites have constituted the major problems.

The disease situation has however been aggravated by poor nutrition. Household wastes are of low nutritive value particularly with regards to crude protein content (Table 2).

Table 2. Proximate composition of some household wastes commonly fed to goats.

		Composition Dry Matter (%)				
Name	% dry matter	crude protein	ether extract	crude fibre	nitrogen free extract	ash
Cassava peels	27.9	5.3	1.2	21.0	66.6	5.9
Cocoyam peels	33.2	9.4	0.8	5.7	75.3	8.8
Sweet potato peels	11.7	6.3	1.3	0.3	87.4	5.0
Yam (water) peels	25.9	11.7	1.0	6.6	71.2	9.5
Yam (white) peels	17.7	11.2	1.2	9.5	68.4	9.8
Yam (yellow) peels	21.7	7.4	0.7	7.6	76.8	7.5
Rice bran (with little husk)	89.0	7.6	7.6	36.6	36.9	11.3
Cowpea husk	92.6	13.0	0.7	33.4	45.7	7.2
Rice husk	92.8	4.9	1.7	42.3	39.0	12.3
Maize husk	92.6	2.6	0.8	31.6	61.0	4.0
Banana peels (ripe)	14.1	7.9	11.6	7.7	59.4	13.4
Plantain peels (unripe)	17.2	10.6	9.6	5.8	61.1	12.8
Pawpaw leaves	24.6	32.6	0.8	7.3	48.3	11.0

Source: Oyenuga (1968)

However, the more serious problem is that the level at which the by-products are available is usually inadequate for most of the year and therefore cannot satisfy the nutrient needs of the animals (Table 3). The bush grazing and browsing used to supplement the household wastes contain higher levels of crude protein (Table 4). However, their chemical composition varies markedly depending on the season, soil type, associated plants, stage of growth and the parts that are eaten. Mecha and Adegbola (1980) showed that while the shrubs and herbs provide higher levels of protein, the trees and grasses are more fibrous and thus less nutritious.

Table 3. Proportions (%) of goats fed household wastes at different seasons.

Ecological zone	Early wet season	Late wet season	Early dry season	Late dry season
Forest	6.3	91.3	38.1	27.8
Derived savanna	42.9	87.5	42.1	50.0

Source: ILCA (1980a)

Table 4. Proximate composition of some browse in the humid tropics.

Name	% dry matter	Dry Matter Composition (%) crude protein	ether extract	crude fibre	nitrogen free extract	ash
Acacia spp	29.9	11.2	0.8	23.8	57.2	7.0
Citrus (leaves of orange)	55.2	20.1	1.9	26.8	42.2	9.0
Oil palm leaves	50.1	12.5	6.6	29.8	44.2	7.0
Mango leaves	19.2	10.1	1.3	30.5	63.1	5.0
Plantain leaves	35.7	19.9	1.0	24.1	44.5	10.5
Guava leaves	36.0	10.5	1.0	20.0	67.5	1.0
Pigeon pea	36.7	29.8	6.8	24.9	34.5	4.0
Cassava leaves	41.8	31.5	7.7	17.4	39.8	3.5
Aspilia africana	36.1	19.9	2.0	11.4	62.8	3.9
Calopogonium mucunoides	25.4	24.1	3.1	21.6	41.4	9.8
Eupatorium odoratum	44.5	20.6	3.8	9.3	58.7	7.6
Sida spp	33.0	13.6	3.6	14.2	56.6	12.0
Pennisetum purpureum	26.8	13.1	2.0	34.4	43.7	6.8
Andropogon tectorum	32.1	11.8	2.5	29.3	50.4	6.0
Bamboo leaves	46.7	19.5	1.8	28.2	39.5	11.0
Maize leaves	31.4	15.3	2.8	23.2	50.7	8.0

Source: Mecha and Adegbola (1980)

Another characteristic of bush grazing is that it hardly provides enough feeding materials year round for the browsing animals. ILCA (1982) in an analysis of 343 samples of forage and browse commonly consumed by village small ruminants showed that the mean crude protein and magnesium content of 18.19% and 0.45%, respectively, was adequate for the animals but the phosphorus content may have been inadequate. High potassium content may affect efficient utilization of sodium while high iron content may depress uptake of copper and manganese. Thus inadequate nutrition characterises the traditional systems. The quality of available browse is low, household wastes are insufficient and of low nutritive quality and nutrient imbalance is likely to be a feature of feeding under this system. This low level of nutrition coupled with the poor health situation has resulted in heavy mortality of goats often reaching 40% up to 12 months of age.

The high mortality resulting from poor management has increased the need for importation of slaughter animals, often of other breeds, into the region although in some places preference is still for the local dwarf breed which commands very high prices at certain times of the year. Interventions in health, nutrition and provision of shelter to protect the animals against inclement weather conditions can result in marked improvement in the performance of the dwarf goat in the humid tropics. The potential of the goat has been virtually unexploited. Its high reproductive performance as a result of high fertility, year round breeding, high prolificacy of about 160% and fecundity of up to 250%, early sexual maturity, adaptation to the environment, hardiness and compact size are attributes of the goat which make it an interesting animal for the development of appropriate management systems in this environment.

Appropriate Management Systems

Any management intervention must take cognizance of the small size of flocks owned per household, the fact that the farmers are primarily crop farmers and even sometimes delegate the care of livestock to women and children as well as the need for improvement in health and nutrition which must be simple, adaptable and depend on locally available resources. At the Obafemi Awolowo University (formerly University of Ife) the emphasis, in the early days, was on an assessment of locally available fodder resources. Feeding trials based on Pennisetum purpureum, Panicum maximum, Stylosanthes guyanensis and Cynodon nlemfuensis among others showed that these forages alone were unlikely to provide adequate nutrients to permit the animals to express their optimum genetic potential in terms of productivity. Thus it was normal practice to provide supplementary concentrates of 200-500 g per animal per day, depending on level of productivity, for all animals. The management method at this time was to keep the animals on pasture mainly Cynodon nlemfuensis for part of the day and supplement them with concentrate when they were brought into confinement for the rest of the day. Despite this feeding regime, the performance of the animals was still not satisfactory, PPR was a major problem and ecto- and endo-parasitic infestations were expensive to control.

This management practice continued at the start of the project in 1981 but because of disease problems and poor performance of the animals it was decided at the end of 1982 to confine all animals and zero-graze them on available forages - Panicum maximum, Gliricidia sepium and Leucaena leucocephala. The use of the browse, Gliricidia and Leucaena, resulted in improved feed intake although it was still necessary to supplement with concentrate feed (Ademosun et al., 1985). In addition, the problem of

ecto-parasitic infestation was contained. However, the problems of endo-parasites particularly helminths and coccidiosis still remained. The use of split bamboo slatted floor as a means of improving the general hygienic conditions in the house, elimination of daily removal of faecal material from the pens and the use of faecal material which has accumulated over time as farm yard manure was embarked upon. This had the added advantage that bamboo slats can be cheaply provided by farmers. This method greatly reduced labour requirement for cleaning and improved the health condition for the animals. For instance, within a year of the introduction of zero-grazing and slatted floors cases of helminthiasis were reduced from 100 to nil, mange from 80 to 6, tick-borne diseases from 41 to 1 and lice infestation from 10 to nil. All in all, the incidence of diseases decreased from 293 cases in 1982 to 68 a year later, following the introduction of the new management system. This was despite an increase in goat population from 57 in December 1982 to 112 a year later. Mortality decreased from 46 (56.8%) in 1982 to 23 (17%) in 1983. During the year, vaccination against PPR was initiated.

The basic characteristics of the new management system were:

- Complete confinement of the animals.
- Improved nutrition through the use of browse - Leucaena and Gliricidia-supplemented with salt lick.
- Provision of shelter.
- Vaccination against PPR and ecthyma and dipping against mange and lice.
- Control of occasional health problems such as diarrhoea, Caseous lymphadenitis and pneumonia.

The next stage was the development of a model that would be adaptable under the village system while at the same time incorporating the above characteristics. A bamboo hut with approximately 30 m^2 floor area was developed with hard wood frame work, split bamboo slatted floor raised about 1 m from the ground, and corrugated iron sheet roof. This was meant to house up to 12 breeding does, one buck and their offspring. The rationale was that with improved management the average flock size was likely to increase and it was better to plan for a bigger flock size than the present average of about 4 animals per household. Later, the bamboo floor had to be replaced with wood for the adult animals as this is more durable. More information on the design and the testing of the new model will be given later at this Workshop (Bosman et al.,1987).

A component of the new package was the provision of browse legumes-Gliricidia and Leucaena - to ensure a steady source of feed for the animals. Since the local farmers are principally crop farmers, this package can be integrated into food crop production. Once the bamboo huts are provided and stocked the provision of feed on a cut-and-carry basis can be accomplished with little demand on the farmer's time. Indeed he can depend on his children's labour for feeding the animals. The system is quite flexible. Browse legumes can be grown in feed gardens close to the bamboo huts in order to cut down on costs of cut-and-carry feeding. On the other hand, the use of browse legumes can be integrated with crop production in alley farms as described by ILCA (1984a). This has advantages for the animals and the crops but larger areas of land are required.

Conclusion

Efforts at Ife have been aimed at developing a management package for the West African Dwarf goat that will meet the peculiar circumstances of the crop farmer in the humid tropical environment. In doing this, a team of researchers in different disciplines has tackled various aspects

including nutrition, health, reproduction, economics, management and extension. This interdisciplinary approach to adaptive research has been quite rewarding and papers at this Workshop will focus on the various aspects leading to the present stage where the package is being tested on a limited number of farms around Ife.

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A STRATEGY FOR IMPROVING GOAT PRODUCTIVITY UNDER VILLAGE PRODUCTION SYSTEMS IN THE HUMID TROPICS

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Abstract

The paper outlines a strategy for the improvement of the productivity of goats under village conditions. Particular emphasis is laid on the need to take production constraints and resource availability at village level into account in the design of improved technologies. The main constraints to increased goat production are discussed. Alley farming and intensive feed gardens with leguminous fodder trees are presented as potential solutions to the existing nutritional constraint. Foliage from the trees is not only protein-rich animal feed but may also be used as a high nitrogen mulch for the maintenance of soil fertility. The system thus integrates crop and livestock production to their mutual benefit. The alley farming research of the Humid Zone Programme of ILCA, which includes agronomic and nutritional trials both on-station and on-farm, is outlined.

DESCRIPTION D'UNE METHODE VISANT A AMELIORER LA PRODUCTIVITE DES CAPRINS DANS LES SYSTEMES DE PRODUCTION VILLAGEOIS DES REGIONS TROPICALES HUMIDES

Résumé

Cette communication décrit une stratégie utilisée pour améliorer la productivité des caprins en milieu villageois. L'accent est mis en particulier sur la nécessité de tenir compte des contraintes à la production et des ressources disponibles dans le village même, lors de toute élaboration d'une technologie améliorée. L'étude porte sur les principales contraintes freinant une augmentation de la productivité des caprins et indique comme solutions potentielles aux carences nutritives, la culture en couloirs et la production intensive de légumineuses fourragères arbustives. Le feuillage des arbres n'est pas seulement une source de fourrages riches en proteines mais peut également servir de paillis azoté de très grande qualité pour préserver la fertilité du sol. C'est donc un système qui intègre production animale et production agricole et profite à l'une comme à l'autre. Une brève description, enfin, fait état des recherches menées par le programme du CIPEA en zone humide sur les cultures en couloirs qui comportent des essais agronomiques et sur la nutrition, en station et à la ferme.

Introduction

The key word in the title to this paper is village, and all subsequent remarks relate to village goat production as the focal point.

What is meant by strategy? Strategy is the art of employing plans to work towards a goal. The goal here is improving village goat production. The ILCA (my) strategy is built around a triumvirate of research, training

and information, each one supporting the others. Research provides answers to the problems, but training and information are necessary to take solutions to the village farmers. Training and information are outside the scope of this workshop and this paper will concentrate on research.

Research workers in many parts of the world have shown that animal productivity can be increased by: (i) better feeding, (ii) better breeding, (iii) better health care, (iv) better financial incentives. Before any improved method can be recommended for the village it must first be tested and be shown to work. Feeding trials with concentrates, breeding with exotic bucks or imported semen, regular monthly deworming and dipping can all be performed in on-station trials - and indeed many such research projects are carried out each year. Economists can produce abstract computer models. However if the goal is improved village goat production, for the foreseeable future the types of schemes mentioned above are irrelevant. They may serve a useful function as training exercises for students but, in the context of village goat production, for experienced researchers they are of academic interest only. They will do nothing to improve the lot of the village goat producer.

To be effective a strategy to improve village goat production must be firmly based on the reality of the village itself, take account of prevailing conditions, and, just as important, likely conditions after the end of the project period. Any project with a chance of short-term success in the village ensures that all required inputs are available, but the long-term need for inputs cannot be ignored. Who will provide a regular supply of cotton seed cake, imported semen or veterinary drugs to small farmers after the externally funded project has ceased operation?

The realities of village goat production in the humid tropics which must be taken into account are: (i) small herd size, (ii) low priority from farmers and, often governments, (iii) no purchased feed, (iv) no veterinary care, (v) weak extension services. It is on these realities that strategies to improve village goat production must be based. Small farmers and goats are an integral part of African agriculture but habits and attitudes, developed over generations, are hard to break. A great leap forward is fraught with danger, but small steps taken one at a time will eventually reach the same goal, and allow the avoidance of unforeseen pitfalls along the way.

The general approach outlined above has been formalised as farming systems research (FSR), of which livestock systems research (LSR) is a subbranch. Details of FSR and LSR can be found in numerous papers (e.g., Norblom et al., 1985; Kearl, 1986; Butler-Flora & Tomecek, 1986). Over an 8 year period the ILCA Humid Zone Programme based at Ibadan, Nigeria, has developed an integrated system that appears to meet all the criteria to improve village small ruminant production. The approach taken by ILCA, and the results of the study are presented below.

Problems and constraints to village small ruminant production

(a) Land

Soil fertility and crop yields decline with cropping. The traditional farming system uses a bush fallow period to restore soil fertility, so that for 2 ha under crops, 6-10 ha will be left under fallow. In the bush fallow system organic matter and nutrient levels in the soil are gradually restored over a number of years when grasses and leaves from trees and bushes fall to the ground and slowly decompose. In some areas there is now insufficient land because of increasing population density and hence fallow periods are being shortened. The regeneration of soil fertility is

therefore limited and crop yields decline. In the derived savannah less land is available for grazing as the number of arable farms increases.

(b) Livestock

The primary constraint to livestock production is disease with 40-50% of small ruminants failing to survive to 12 months. In West Africa periodic outbreaks of peste des petits ruminants (PPR), or kata, can decimate village livestock populations. It is therefore risky for farmers to build large herds of sheep or goats in the absence of veterinary care or medication.

The secondary constraint is nutrition, particularly for confined animals. The growth rates of confined village animals are only half those of free-roaming animals. Free-roaming animals can select the most nutritious parts of grass and browse, but confined animals are limited in choice to what the farmer provides from the bush and from fallow land. Purchased feed is very rarely offered to small ruminants.

A potential solution - alley farming

Few smallholder farmers are willing to devote much time or money solely to livestock while it remains a minor farm enterprise. Thus any innovation to improve livestock production should also benefit other farm activities. Alley farming offers a means of achieving this and allowing the integration of crop and livestock enterprises. It involves the planting of leguminous multipurpose trees in rows (hedge-rows) on arable land with food crops planted between the tree rows (i.e., in the alleys). On sloping land, when planted along the contours, the trees limit soil erosion. Foliage cut from the trees (prunings) can be placed on the soil as mulch and fertiliser for food crops, and/or be used for animal feed. Cropping and fallow periods, separated under traditional farming systems, have been combined in alley farming so that tree foliage is used to maintain and improve soil fertility while cropping is in progress, thus making for an enhanced land-use efficiency.

Alley cropping research in Africa was initiated in the late 1970's by the International Institute of Tropical Agriculture (IITA) as an alternative to shifting cultivation (Kang et al., 1981). Tree foliage was used to improve soil fertility and crop production and reduce the requirement for a fallow period. Alley cropping involves food crop production between hedge-rows of leguminous trees or shrubs, with pruned foliage from the trees used solely as mulch. ILCA extended the concept to benefit livestock by using a portion of the tree foliage for animal feed under cut-and-carry management. The resultant package, with potential benefit for both crops and animals, is called alley farming.

The tree species chosen must therefore be capable of maintaining and improving soil fertility, remain productive under regular pruning, allow improved crop production, and provide nutritious and palatable livestock feed to supplement the existing diet. Leucaena leucocephala and Gliricidia sepium have been shown to meet these requirements, and other species, including Cajanus cajan are being investigated.

For those farmers who wish to give greater attention to livestock it is possible to concentrate on trees for forage production. Feed gardens where tree rows are planted either solely or in combination with grasses, excluding arable crops, are one solution. Another possibility is to plant trees in hedges to demarcate boundaries of the compound farm or other fields.

A booklet entitled "Guidelines for alley farming (Reynolds et al., 1987)

has been produced
The guide ...

The effects of mixed Leucaena and Gliricidia browse (1:1 by weight) offered as a supplement to West African dwarf sheep has also been studied. Figure 1 shows the effect on productivity index of varying levels of browse offered to adult females during the final 8 weeks of pregnancy through to weaning at 12 weeks post partum. Productivity index is measured

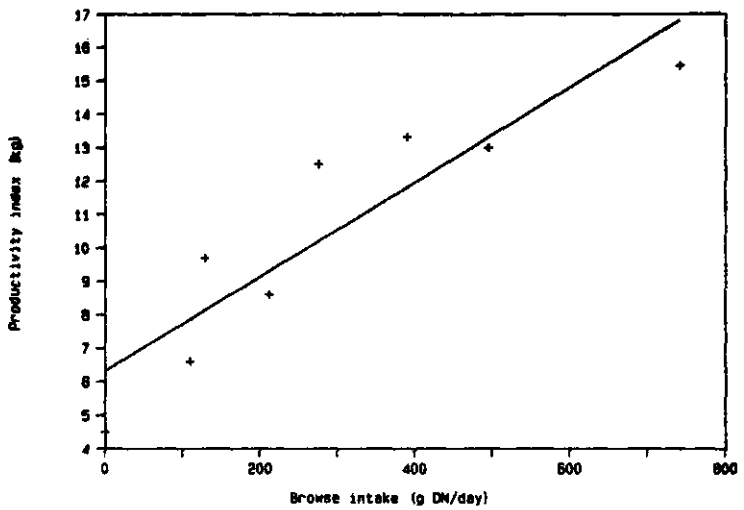

Fig. 1. Browse supplementation to WAD sheep (effect on productivity index)

as kg of lamb weaned/ewe/year, and depends upon parturition interval, litter size, survival rate to weaning and weaning weight. All of these component factors, with the possible exception of litter size, improved as increased levels of browse were added to a basal grass and cassava peel diet. From the regression line it can be shown that supplementation to dams with 100 g browse DM daily for the last 2 months of pregnancy and 3 months of lactation using a total of 14 kg browse DM, raises the productivity index by 1.4 kg.

A brief study of prices for meat and grain shows that use of browse as animal feed is advantageous compared to its use for mulch. Using the method of calculation shown earlier 14 kg of browse used as mulch would produce 2.0 kg incremental maize grain. Assuming a maize price of N1000/tonne and sheep price of N4/kg live weight, values of the alternative products are N5.65 for meat, and N2.03 for grain. The return to animal feed is therefore 278% of the return to mulch.

On-farm Research

On-farm research with alley farming began in South-Western Nigeria in 1981. In the first three years of on-farm work, sixteen alley farms were established on farmers' fields. The early trials addressed basic questions about the design, establishment methods, and appropriate size of alley farms, and their viability under farm conditions.

As time went on, farmers took increasing responsibility for the management of the alley farms. At the end of 1983, a pilot project was

initiated in two communities in South-Western Nigeria (Atta-Krah, 1986).

The target clients were farmers with access to land who preferably keep small ruminants.

Farmers did not need additional finance to establish alley farms, and credit facilities were not available. ILCA provided seeds for the trees, and advice, but allowed farmers to modify the interventions to suit their own circumstances. Trees were established under many combinations of food crops, and by observation it was learnt that planting with first season maize or with a pepper crop produced the strongest trees. Mature cassava gave too much shade, and yam vines could smother the tree seedlings (Atta-Krah & Francis, 1987).

The purpose of this phase of research was to assess the relevance, workability and acceptability of the system to farmers and to allow its further development by them under a range of management and environmental conditions. An extension worker seconded from the Ministry of Agriculture and trained by ILCA was stationed at the site and given special responsibility for advising farmers on the management and utilisation of alley farms. The establishment and management of the farms are monitored closely, and data are collected on the socio-economic characteristics of participators. Farmers mainly use the trees for mulch, fodder and yam stakes.

The rate and success of adoption of alley farming at the pilot project site are shown on Table 2. Of the 68 farmers who had viable alley farms at

Table 2. Adoption and establishment of alley farms in a pilot study area in South-Western Nigeria.

Year of planting	Number of farmers planting	Number well established 12 months after planting	Total viable
1984	86	68	68
1985	72	33	101
1986	39	39	140
1987	(40*)	-	-

*As at May 1987.

the end of 1984, 60 farms are still in good condition as of May 1987. In 1985 among those planting were 2 farmers who had attempted to establish trees the previous year on exhausted soils. Some farms were planted with seeds obtained from neighbours, and only discovered by ILCA at a later date. During 1985 and 1986 groups from neighboring villages approached ILCA for seeds to establish trees. These developments more than anything else indicate the acceptability of the alley farming system in the zone.

Developments elsewhere

Alley farming is not a new concept. It has been employed by farmers in parts of Asia and the Pacific for many years to improve soil fertility, reduce soil erosion and provide animal feed (Parera, 1986). In Australia cattle ranchers have established Leucaena in natural and planted pasture to improve the carrying capacity and to increase the growth rates and fertility of beef cattle, and milk yield of dairy animals (Partridge &

Adams, 1985).

Within Africa 20 countries have work in progress on multipurpose trees suitable for alley farming systems. Tree species being studied include Cassia siamea, Flemingia congesta, Cajanus cajan, Acioa barterii and Sesbania grandiflora, in a variety of environments. For the past three years ILCA and IITA have jointly organised alley farming training courses which have attracted 120 participants from 27 African, 4 Asian, 1 Caribbean, and 2 European countries (Table 3). In many of these countries national research organisations are already working on alley farming or on ways of modifying the basic concept to suit their own particular environment, some times in collaboration with ILCA, while for others participation in the training course is a first step towards an alley farming project.

Table 3. Countries participating in alley farming training courses at Ibadan, Nigeria between 1985-1987.

West Africa	Sahel	East Africa	Asia
Senegal	Mali	Ethiopia	India
Gambia	Chad	Somalia	Sri Lanka
Guinea	Sudan	Tanzania	Nepal
Guinea Bissau		Zambia	Indonesia
Liberia		Malawi	
Sierra Leone		Zimbabwe	Caribbean
Ivory Coast	Central Africa	Uganda	Haiti
Ghana	Zaire	Madagascar	
Togo	Gabon		Europe
Benin	Angola		Germany
Nigeria	Burundi		The Netherlands
Cameroon			

A network is planned to promote discussion and research on alley farming and similar improved methodologies, to test the technology and use of the concept across diverse environments in tropical Africa, and to encourage inter and intra country co-operation to support this concept. Network activities will be responsive to the needs of participating countries. Research of regional interest will be co-ordinated by a network steering committee and different countries will play leading roles in tackling the various problems to be studied. Topics of more local interest will be undertaken by National Research groups themselves with the network being available for advice as required.

Conclusions

Improvement in agricultural production in Africa depends on the development of relevant technologies and an effective mechanism for the transfer of such technology from the research station to the farmer. Alley farming is a technology with a sound technological base. Its emphasis on soil fertility maintenance and improved land use is appropriate for the humid and sub-humid areas of tropical Africa where soils are generally highly weathered with inherent low fertility and low structural stability. Furthermore, the possibility of integrating a livestock component into the general farming system through alley farming opens a new area of crop-

livestock interactions. Most farmers in the zone have both crop and livestock interests, but these interests are pursued independently. Alley farming has the potential to encourage the interaction between crops and livestock to the benefit of both components.

On-station trials, have shown that crop yields can be maintained and improved using mulch from trees in alley farms. The inclusion of a fallow period in alley farming provides an addition boost to crop yields, and to tree production. The use of tree foliage as supplementary feed for livestock increases productivity, providing additional dietary protein which is particularly valuable in the dry season for animals in confinement.

On-farm work in southern Nigeria has demonstrated that alley farming is appropriate and acceptable under village conditions. This intervention is of potential benefit to other areas of Africa, but it may be necessary to investigate adaptations and modifications of the alley farming system in other countries to allow for particular local requirements.

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PRODUCTIVITY OF THE WEST AFRICAN DWARF GOAT IN A TEMPERATE ENVIRONMENT: SMALL IS BEAUTIFUL

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Abstract

A brief description is given of a co-operative research project between the Universities of Wageningen, The Netherlands and Ife, Nigeria. It is explained why in this project major emphasis has been placed on environmental factors like health and nutrition rather than on the genetic improvement of dwarf goats.

Data are shown with regard to the productivity of dwarf goats under high levels of management and nutrition in The Netherlands. On average 21 kg of weaned kid per doe per year was produced, but the variation was very high, ranging from 2 to 62 kg over a period of nine years. A comparison of present data with data of the first years indicate that these results have hardly changed, suggesting that the combination of animal-environment has been kept constant.

Finally a number of advantages and disadvantages of a small ruminant like this dwarf goat are discussed. It is concluded that this small goat is a beautiful link in our chain of domestic animals.

PRODUCTIVITE DE LA CHEVRE NAINE DE L'AFRIQUE DE L'OUEST EN CLIMAT TEMPERE : "SMALL IS BEAUTIFUL""

Résumé

Cette communication donne une brève description d'un projet de recherche conjoint entre l'Université de Wageningen, Pays-Bas, et l'Université d'Ife, Nigéria. Elle indique les raisons du choix favorisant l'étude des facteurs du milieu ambiant comme la santé et la nutrition plutot que celle de l'amélioration génétique des chèvres naines.

Des données recueillies sur la productivité des chèvres naines soumises à des régimes de gestion et de nutrition intensifs aux Pays-Bas, il ressort que la production moyenne est de 21 kg de chevreau sevré par femelle par an mais que les écarts sont très amples et varient de 2 à 62 kg sur une période de neuf ans. En comparant les données actuelles à celles des premières années, on observe que les résultats n'ont guère changé, ce qui laisse entendre que le rapport animal-milieu est resté constant.

Certains avantages et inconvénients de l'élevage de ce type de petit ruminant sont ensuite énumérés et analysés pour aboutir à la conclusion que la petite chèvre naine est un très beau maillon de notre chaine d'animaux domestiques.

Why this project?

I would like to explain briefly why the Agricultural University of

Wageningen is interested in dwarf goats and has taken part in this project. A major reason is that in our university approximately 20% of the activities are tropics-oriented. Between 15 and 20% of the students take a tropics-oriented course of study, like Tropical Crop Production, Development Economics, Tropical Animal Production. This means that teaching and research must have a strong relationship with the tropics and sub-tropics.

The second reason to choose dwarf goats for research and teaching is that of all tropical domestic ruminants only dwarf goats are available in The Netherlands in large numbers, because they are kept as pets.

The third reason is that goats, and meat goats in particular, offered up till recently a little explored field of investigation. In addition, most work on goats originates in arid and semi-arid areas and not in the humid tropics.

Finally, the study of dwarf goats offered a possibility to co-operate with research institutions in the tropics. This indeed materialized into a firm co-operation with the University of Ife, where Prof. Ademosun proved to be a very enthusiastic and equally capable project leader. Because of this it took little time to reach agreement on the project between him, me and Mr. de Haan from International Livestock Centre for Africa (ILCA). But it took the bureaucratic powers more than two years to produce the final signature and thus the project became effective in the summer of 1981 when two young Dutch scientists arrived in Ife to study West African Dwarf (WAD) goats, together with the project team of Ife University. The objectives of the project are: (i) to study the management and the economics of production of the WADG in the humid tropics, (ii) to develop research facilities, (iii) to disseminate research results, (iv) to train scientist, young graduates and undergraduates (memo 1980). The project aimed at mutually beneficial two-way transmission of knowledge and technology. To date, for instance, four students from the University of Ife have done or are doing all or part of their MSc research work in Wageningen, whereas eight students from The Netherlands did part of their research work in Ife.

I gratefully acknowledge the financial contribution of the Dutch Ministry for Development Co-operation, which made it possible to realise the project, as well as the substantial contributions of the University of Ife and the Agricultural University of Wageningen.

Animal or environment?

Now I would like to touch on a few topics with regard to the substance of the project. If one looks around in the world of animal production projects in developing countries, one very often finds that projects put more emphasis on efforts to improve the animal material than on efforts to improve the environment. What are the reasons for this? Some of the reasons may be: (i) the example of the green revolution, (ii) the lack of communication between farmers and scientists, (iii) the availability of genetic progress achieved elsewhere, (iv) the high yields per animal in developed countries.

If we look into the history of animal production in Europe, we pretty soon come across the name of Robert Bakewell, sometimes called the founding father of animal breeding. Although we should hold the pioneering work of Robert Bakewell in high esteem, we might ask the question: why was it Robert Bakewell who started this work, why not his grandfather or his grandson? I believe the chances for Robert Bakewell himself were better because in his time both the need for better animals and the possibilities to make use of better animals became manifest. In other words: he lived in

a period when man created an environment in which animals were able to express their genetic potential better than before. Moreover, the time of Bakewell was an era of great changes in society; the industrial revolution, causing higher labour costs but also higher incomes; a switch from the "commons" to private land ownership; the use of turnips, to mention a few. Under those conditions of a ready market and availability of improved inputs the need was for a better animal, that is an animal that would respond to an improved but also more expensive set of inputs. As an illustration Table 1 lists some data on slaughter weights of animals

Table 1. Live weights of slaughter animals at Smithfield market in 1710 and 1795.

	1710	1795	Increase
	kg	kg	%
Cattle	170	360	116
Calves	23	67	196
Sheep	13	36	186
Lambs	8	23	178

Source: Rice et al., 1967.

sold at Smithfield market in Britain. These data suggest that before some genetic improvement had taken place before Bakewell started his breeding work. But it is clear that the improved environment played a very important role. Another characteristic of animal improvement in Europe is that it took place on the farm, that is under the prevailing environment. In this way the equilibrium between animal and environment was maintained and probably maintained better than when the breeding work had taken place on research stations or university farms (Montsma, 1976).

Let me give another example. Only a few years ago I attended a conference where a young scientist, of European background, presented a paper on his study of goat production in a dry and very remote area of Africa. He found that production per animal was very low and that the owners sold their best bucks for slaughter and kept the last scrubby animal for reproduction. His explanation for this phenomenon was more or less that these farmers lived far away from university and research and were therefore not aware of genetic possibilities to improve their animals. Fortunately, opposition arose from the audience and I think the best question asked was: "How do you explain that these farmers produced good slaughter animals by using a scrubby buck?" Presumably, if the environment is harsh enough, the phenotypic expression of genetic potential becomes so low, that selection, if possible at all, has a very low priority. It is certainly not my intention to belittle the work on genetic improvement of animals. What I would like to stress is the importance of equilibrium between animal and environment.

When we started to work on dwarf goats in Wageningen we were surprised about the large variation in our flock (e.g. pre-weaning gains of 10-140 g d^{-1}). This led to the idea that since the genetic potential was available, we should direct our efforts first to environmental factors and, for the time being, leave the breeding work to others. We are aware of a disadvantage of this decision, namely that in experiments one has to use a somewhat larger number of animals per treatment because of this large

variation. But we also think that it is not easy to develop a well-considered set of aims to be pursued in selective breeding. In addition, the study of environmental constraints may lead to results with a wider application.

Dwarf goats at Wageningen University

Returning to the title of this paper, the organizing committee of this workshop asked me to contribute some information on the flock of West African Dwarf goats at our department in Wageningen. A fair amount of information has been supplied at previous occasions already. Some of this information was based on analyses of routine observations of the flock, like birth weight, weaning weight, litter size. The latest analysis is at this moment in progress, but I can cite some of the results here (Table 2). From these results we see that they vary very little with time, in so far that the results from the analyses of five years ago are practically the same as those of the present analysis. This suggests that both the animals and the environment have changed very little, since the values for both the animal and the environment dependent parameters are very similar at both times. Also, the variation within the various parameters has not declined and leaves ample scope for selection.

Table 2. Values of some major reproductive and growth parameters of WADG under a high level of feeding and management.

	N	Present estimate[1]	N	Previous estimate[2]
	-	(x±sd)	-	(x±sd)
Litters				
size at birth	384	1.9 ± 0.6	174	1.8 ± 0.6
size at weaning	384	1.7 ± 0.6	168	1.7 ± 0.6
weight at birth, kg	379	2.9 ± 1.0	168	3.0 ± 0.9
weight at weaning, kg	325	14.2 ± 5.4	139	13.7 ± 5.2
preweaning gain, g d^{-1}	324	141 ± 54	139	139 ± 50
gestation length, d	352	145.5 ± 1.9	120	146.4 ± 2.3
kidding interval, d	36	193 ± 21	36	193 ± 21
Individual kids				
weight at birth, kg	887	1.5 ± 0.3	308	1.6 ± 0.4
weight at weaning, kg	692	8.4 ± 2.0	238	8.2 ± 2.5
preweaning gain, g d^{-1}	690	84 ± 18	238	83 ± 19
age at weaning, d	701	81.5 ± 14.3	147	80.2 ± 21.1

[1] Animals in previous estimate are also included.
[2] Hofs et al. (1985)

Small is beautiful

When Schumacher (1973) wrote his book: "Small is beautiful", he most likely had no inkling that this title would be used in animal production, where "more and bigger" is often a better fitting characteristic.

Small ruminants, let us say of the size of the WADG, have advantages and disadvantages. In comparison with for instance cattle, some of the

advantages are: small investment and labour cost per animal, a lower mortality risk per unit body weight, a suitable size of the slaughter animal for family use, a shorter period to reach maturity. Disadvantages are: higher investment and labour cost per kg animal, possibly a lower carcass weight per kg animal.

Although small ruminants require more maintenance feed per kg live weight, this is only of importance in an absolute sense and not when considered in relation to production under ad libitum feed supply, as was shown already by Max Kleiber (1961) in his book: The Fire of Life (Table 3). Expressed as a percentage of mature weight, a daily gain of 50 g in dwarf goats is about 50% higher than a daily gain of 1 kg in a Holstein Friesian cow.

Table 3. Feed utilization and body size.[1]

	Steer	WADG
Number of animals	1	25
Total body weight, kg	500	500
Available feed, kg	1000	1000
Feed consumption, $kg.d^{-1}$	7,5	17,5
Heat production, $MJ.d^{-1}$	70	157
Days on feed	133	57
Gain in weight, $kg.d^{-1}$	0.75	1.75
Total gain, kg	100	100

[1] Adapted from M. Kleiber: The Fire of Life, p. 320.

Weaning weight at 13 weeks, expressed as percentage of birth weight was approximately 400% in the Wageningen flock, compared with approximately 270% in calves of three West African cattle breeds (West African Shorthorn, N'Dama and Sokoto Gudali), whose dams were fed on roughage, supplemented with concentrates (Montsma, 1962).

Growth intensity, i.e., number of days required to double birth weight, showed a similar ratio, namely, 42 days for the three West African cattle breeds (Montsma, 1963) and 27 days for WAD kids in the Ife flock (Bosman, 1986). As an approximation we can say that relative growth was 50% faster in WADG than in the three West African cattle breeds under reasonable conditions.

A consequence is then that we also need 50% more total feed. Likewise, if we are interested in getting the same total gain per day, we should not compare one 500 kg cow with 25 goats of 20 kg each, but with 11 goats only. These figures are approximations and would need more precision. I assumed for instance the mature weight of WADG to be 25 kg. The data on West African cattle are based on a total of approximately 80 animals per breed only.

Even less data are available on reproduction. It is, however, tempting to compare WADG with the three cattle breeds mentioned. If we express litter weight at birth as a percentage of mature weight we get: 5.7, 6.2 and 5.0% for the West African Shorthorn , the N'Dama and the Sokoto Gudali respectively (Montsma, 1962, 1963), compared with 9.2% in WADG in Ife and even 12% in WADG in Wageningen. Within the West African context we see again a 50% higher value for WAD goats. The value of 12% obtained with WADG in Wageningen is also about 50% higher than in Holstein-Friesian

cattle in the Netherlands.

Finally, if we express total productivity as: kg weaned kid per kg dam per year, we find for the three cattle breeds 0.25, 0.31 and 0.26 resp. (Montsma, 1962, 1963) and for WADG at Ife 0.38. As in the data for cattle no mortality figures could be included, we see also here that the value for WADG is approximately 50% higher. Of course more could be said about these problems of scaling. Research in this field requires large numbers of animals, for instance for serial slaughtering.

This year we have started more research on this subject and this was financially possible because we use relatively cheap dwarf goats for it, in combination with D_2O techniques.

For the time being we can tentatively conclude that a hypothetical dwarf goat with a mature weight of 50 kg will not use its energy more efficiently than a dwarf goat of 25 kg mature weight. Unless of course we slaughter the 50 kg animal at 25 kg already. Advantages and disadvantages of dwarf goats must therefore be sought elsewhere, for instance in a specific value of goat meat or in the advantage that goats will eat bark from bushy legumes, thus increasing the percentage of dry matter used from these forages by approximately 15% compared with cattle (Bosman et al., 1987).

The small dwarf goat is a beautiful link in our chain of domestic animals.

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RESEARCH RELEVANCY IN SMALL RUMINANT SYSTEMS IN AFRICA

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Abstract

The paper highlights the many husbandry techniques available that are not applied in small ruminant systems in Africa because of socio-economic interactions and constraints. It is argued therefore that traditional production research that produced these techniques is no longer relevant given the scavenging, low priority nature of small ruminant keeping in the majority of farming systems.

The nature and evolution of production research are discussed in seeking to understand why small ruminant systems have benefitted so little from past research. It is suggested that in the present circumstances of small ruminant systems the farmer has a major research role.

Attention is drawn to the optimum nature of existing small ruminant systems. It is suggested that any immediate improvements are most likely to come through extension activities possibly involving women and/or community services. The relevance of a problem-solving education is stressed as an important non specific way of improving small ruminant output. Any technical research it is suggested should be of a basic nature aimed for example at simplifying drug and vaccine use and production and improving the feeding value of fodder trees.

It is concluded that there is wasted research effort which could be beneficially redirected.

PERTINENCE DE LA RECHERCHE SUR LES SYSTEMES DE PRODUCTION DES PETITS RUMINANTS EN AFRIQUE

Résumé

Cette communication décrit les nombreuses techniques d'élevage existantes qui ne sont pas appliquées aux systèmes de production des petits ruminants en Afrique en raison d'interactions et contraintes socio-économiques. L'auteur avance l'opinion que les recherches traditionnelles sur la production qui ont été à l'origine de ces techniques, ne peuvent désormais plus s'appliquer à la majorité des systèmes de production qui se caractérisent désormais par une faible priorité accordée à l'élevage des petits ruminants dont la nourriture se compose essentiellement de déchets.

La question est ensuite posée de la nature et de l'évolution de ce type de recherche afin de comprendre pourquoi les systèmes de production de petits ruminants en ont si peu tiré parti dans le passé. Dans les conditions actuelles, il est suggéré de donner la primauté au paysan dans toute recherche portant sur les systèmes de production des petits ruminants qui ont atteint leur stade de développement optimal et ne sont susceptibles d'être améliorés dans l'immédiat que par des activités de vulgarisation impliquant si possible des femmes et/ou des services de développement communautaire. L'accent est mis sur le rôle de la formation pratique dans l'amélioration de la production des petits ruminants. Toute recherche technique devrait être de caractère fondamental et viser par exemple à

simplifier l'utilisation et la production des médicaments et des vaccins et à améliorer la valeur nutritive des arbres fourragers. En conclusion, de nombreux efforts ont été gaspillés et il conviendrait de donner une nouvelle orientation aux recherches.

Introduction

The objective of this paper is to question the relevancy of much traditional small ruminant research and to try and suggest a better approach for the future.

With the considerable benefit of hindsight it is possible to argue that small ruminant research in the past has been too technically specific and too repetitive. It has been demonstrated repeatedly that giving animals more and/or better quality food results in better performance; that animals with internal parasites respond to treatment with anthelmintics; and that some animals perform better than others in given circumstances and that if these are encouraged to breed improvements in the average genotype can be achieved.

When these specific and now long established research findings are taken to the field there are a variety of socio-economic-environmental interactions which usually result in the specific potential benefits being unrealised. This may be because there is a lack of available grazing land, or overgrazing, or no opportunity to practice cut and carry methods. Anthelmintics may be unavailable or too costly. There may be no routine use of castration and therefore no means of controlling mating, especially in communal grazing systems.

As there seems to be no lack of potentially useful production techniques, cynics have posed the question "Would it matter if all research on small ruminants stopped tomorrow; would it make any difference to African sheep and goat-keepers?". It obviously wouldn't matter in the short-term. Would it matter in the medium to long-term, i.e. 1987-2000? The answer to this question is not so obvious. It depends on a number of factors such as the nature and research receptivity of small ruminant systems, the rate of uptake of previous research findings and what we mean by "research".

The nature and research receptivity of small ruminant systems

Throughout the tropics the majority of small ruminants are found in part-time low input, low output, scavenging systems in flocks of 5-10 animals. Despite this, they are nevertheless very important as a source of meat for both nutritional and religious purposes and as a means of accumulating modest savings. They are also important as a means of generating capital as and when required and for maintaining an acceptable cash flow throughout the year. However, because of their relative unimportance, they are not a priority enterprise for monetary investment or innovation. As such they have a low receptivity for research findings which is further reduced by the rural remoteness of small ruminant systems and their management by junior family members.

Uptake of previous research findings

Table 1 illustrates known techniques that research (and/or experience) has produced and that could be applied in small ruminant systems. No-one would claim that the application of these techniques is widespread. Indeed in many cases virtually no application has been achieved. If the techniques in Table 1, which are very basic and widely agreed as being

Table 1. Animal production techniques of known effect available for application in small ruminant systems when circumstances are appropriate.

Nutrition	Husbandry and health maintenance
flushing	adoption of a breeding season
pregnancy feeding	culling
lactation feeding	kidding care
creep feeding	kid care
finishing	fostering
mineral/salt/vitamin supplementation	castration
constant water provision	dehorning
pasture improvement	identification/records
legume supplementation	planned weaning
forage and feed conservation	drenching
rotational grazing	dipping
control of stocking rate	foot care
use of by-products for feeding	vaccination
growth stimulants/additives	first aid
Housing	**Breeding**
house design to minimise heat stress	selection of "the best"
shade provision - trees	performance testing
slatted or concrete floored pens	planned matings, "best to best"
sick pens	crossbreedings c.f. inbreeding
troughs	grading-up
roofed housing	

technically correct are not being applied is there any point in further research investment? The answer to this depends on what is meant by research.

A definition of research

A typical dictionary definition of research is "a systematic investigation towards increasing the sum of knowledge". In the case of small ruminants this definition implies that research can be done by anyone on any component of the production system including, and importantly, the small ruminant keeper. Traditionally however research has usually been perceived as something done by high status researchers on special farms or in laboratories. This high status of research arises from the fact that it is commonly seen by laymen and bureaucrats as the source of new knowledge and the means of problem solution. Politicians and senior civil servants, who are rarely technicians, often show an almost unquestioning belief in research to produce "breakthroughs" and "major advances". Politicians and administrators often appear to believe that every subject will eventually benefit from a "research breakthrough". Hybrid maize is the classic tropical example of a "breakthrough" and optimists now await a similar innovation in animal production, including goats and sheep. The chance that research will be dramatically beneficial in small ruminant systems cannot be denied. But in the author's view it is a hope that at present sustains much otherwise irrelevant and repetitive work.

Evolution of tropical livestock research

Toulmin (1984) has described the evolution of tropical livestock research as having occurred in three phases: (i) veterinary; (ii) scientific; (iii) farming systems. This historical sequence of research phases is actually the history of pressure groups. Early colonisers tended to be innovators and much "research" they carried out for themselves by trial and error and careful observation and recording. However, what they could not do was to investigate those problems requiring a pure science input, e.g., disease control through drug development and vaccine production and hence the veterinary phase which was stimulated by the fear of major killing diseases such as rinderpest and by the desire of colonisers to import exotic animals requiring drug therapy.

The successful development of drugs and vaccines gave the scientists enhanced status, confidence and power. Consequently they became a pressure group in themselves increasingly selecting their own research priorities upon which to work. Science was seen as the answer to every problem and hence the next and appropriately named scientific phase.

It was soon realised, however, that science alone did not hold all the answers and there then developed the social science pressure group which stressed the importance of the integrated holistic approach which has contributed to the development of farming systems research. This phase has led to the introduction of many social scientists into research organisations although usually at international rather than national level and often as expatriates rather than as local professionals.

It is obvious that small ruminant keepers are not a pressure group. On the basis of the above discussion it is therefore unlikely that they will get the research they need. The veterinary and scientific phases of research have produced the general techniques in Table 1 but the nature of small ruminant systems seems to limit their relevance and applicability.

In considering the current farming systems phase it should be recognised that farming systems research is carried out by more or less traditional, if enlightened, researchers. Irrespective of the quality of diagnostic surveys it is always going to be impossible to quantify and therefore understand the farmer's actual perceptions, fears, jealousies and aspirations which ultimately will have a major influence on his/her decisions. Furthermore farming systems research can be very costly and tends to produce a recommendation for the average farmer of which there are very few. By the time the average solution is produced, tested and disseminated, it may also be out-of-date and overtaken by changing circumstances. Perhaps the wrong people are practising systems research. Should it be done by farmers?

Farmers as researchers

In reality pure farming systems research and on-farm trials have been practised by small ruminant keepers for generations. Could they have produced optimum systems for their specific circumstances? What would be expected of such systems? They should have a high output per unit of input, they should be stable and yet flexible and complement the more important crop production systems. They should have an output increasing at a faster rate than comparable products. Notwithstanding the limitations of national and international statistics Table 2 demonstrates that over the period 1974/76 to 1985 the numbers and meat output of sheep and goats in Africa increased at a greater rate than for cattle. This line of argument can be continued with the conclusion that the small ruminant systems of Africa are apparently highly suitable for the varied and situ-

Table 2. Increases in numbers and indigenous meat output of cattle and buffalo and sheep and goats in Africa, 974/76 to 1985.

Numbers (1000 hd)	1974/76	1985	% Increase
cattle and buffalo	157982	179013	13.3
sheep and goats	300495	348010	15.8
Indigenous meat (1000 mt)			
beef and buffalo meat	3000	3239	8.0
mutton and goat meat	1277	1401	9.7

Source: Adapted from FAO, 1986.

ation specific circumstances in which they are found.

However, it might be argued that there is a high level of mortality in lambs and kids which could be avoided. ILCA (1985) has demonstrated dramatic responses in goats to prophylactic parasitic control in South-West Nigeria. But, can these measures be applied by farmers on a guaranteed long-term basis? If not, the goats' tolerance of internal parasites may be lost through only sporadic dosing and it may be inadvisable to consider such initiatives until such time that they can be sustained and integrated into the routine management.

Reynolds (1986) has clearly summarised the needs of small ruminant systems and stressed the importance of system modification rather than change. Low cost interventions suggested by Reynolds (1986) include provision of water in pens, maximum use of crop residues and reserved grazing. All of these depend on individual farmer and/or community decisions requiring research, if any, into individual and group behaviour of people rather than a further demonstration that for example use of crop residues can reduce weight loss during the dry season. Unfortunately research into individual human and group behaviour tends to be descriptive of the past rather than predictive or determinative for the future.

Joserand (1984) suggested that the following topics could be investigated in the context of small ruminant research:

- forage and feed use and their effect on the local environment,
- the use of crop stubble and agricultural by-products,
- use of manure on fields and gardens,
- individual and communal herding practices,
- existence of cut and carry feeding or grazing areas,
- impact of basic health care,
- effect of controlled breeding and selection.

These topics could be tackled using traditional researchers and methods and produce acceptable papers. But if they are to be investigated in the reality of small ruminant systems they are so locally specific that the research must not only be on farm but by farmer.

Future circumstances

Many African countries have struggling economies (World Bank, 1984). Infrastructural components such as the veterinary and livestock services are therefore deteriorating rather than improving (Brocklesby, 1985). This implies that research is required on zero or low input systems possibly in the absence of any government support or livestock services. Has traditional research anything to offer in these circumstances?

Slade (1983) has interestingly suggested ways of coping when a veterinarian is not available and emphasized the following:

- prevention is better than cure,
- provision of fresh food, water and air,
- avoidance of stress e.g., excessive movement,
- good herding practices,
- "horses for courses" - avoidance of "exotics",
- avoidance of disease by non-mixing of different herds,
- culling,
- recording,
- avoidance of overstocking,
- provision of minerals.

Slade's (1983) suggestions are the basic wisdom of animal husbandry in line with the practices outlined in Table 1. Yet for various reasons the vast majority of small ruminant keepers, except for avoiding exotics, are unable or unwilling to apply them. Perversely, government initiatives in small ruminants have usually focussed on trying to promote exotics. Few of these initiatives have been fully evaluated and experience suggests that the majority have had little impact.

If livestock services are indeed deteriorating and farmers are being forced back to more subsistence systems then it is difficult to see what traditional research has to offer.

The way forward

The above discussion argues that traditional livestock research moved beyond the ability of small ruminant systems to absorb its output and that any improvements in production will be determined by agricultural and country evolution as interpreted by small ruminant keepers. In these circumstances the way forward must be investment in extension and extension research and in ways of helping farmers to find the solutions to their own specific problems. This means attention to some type of management recording, farmers' groups and on a broader front basic education-provided that it has a problem solving approach. Small ruminants are often family systems and extension directed through women and community activities may be more appropriate than traditional activities involving men and the Ministry of Agriculture. In the technical field only research that can cheapen and simplify veterinary inputs to the point of making them virtually free and on improved fodder tree species would appear justified. Neither of these areas are production based but science based in drug and vaccine chemistry and tree genetics respectively.

Conclusions

It is the author's view that the cessation of much current small ruminant research would be sound economy. Particularly if the savings so made could be re-directed towards extension and inter farmer communication so as to identify, and if appropriate, to overcome the real constraints.

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NUTRITIONAL STUDIES WITH WEST AFRICAN DWARF GOATS IN THE HUMID TROPICS

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Abstract

At Ife a nutrition concept for dwarf goats is being developed as part of a management package for intensive goat rearing, designed to be easily adaptable under village conditions. This means that the nutritional research in the first instance has been focussed on the evaluation of locally available feed resources. Grasses like Panicum maximum and Cynodon sp. were among the first feeds to be investigated, followed by the legumes Gliricidia sepium and Leucaena leucocephala. Concentrate was only used to determine the potential production levels of West African Dwarf goats under humid tropical conditions, in order to obtain a guideline for the evaluation of roughage and agro-by-products.

This paper reviews the results of the experiments carried out so far. It is concluded that West African Dwarf goats are unable to maintain themselves on poor quality tropical grasses. On the other hand, legumes like Gliricidia sepium and Leucaena leucocephala can satisfactorily constitute the basic diets of dwarf goats producing weight gains of up to 35-40 grams a day. Cassava and Brewers' Dried Grains hold promise as energy and protein-rich supplements respectively. Further research is required to determine the optimal feeding level and, in the case of cassava, feeding frequency.

ETUDES SUR LA NUTRITION DES CHEVRES NAINES D'AFRIQUE DE L'OUEST DANS LES ZONES TROPICALES HUMIDES

Résumé

Des recherches sont en cours à Ife pour mettre au point une stratégie de nutrition qui s'insère dans un programme global de gestion pour l'élevage intensif de caprins et qui sont facilement adaptable aux conditions villageoises. L'accent a donc été mis d'abord sur l'évaluation des ressources fourragères localement disponibles. Les premières ressources étudiées pour leurs qualités fourragères ont été les herbes Panicum maximum et Cynodon sp. suivies des légumineuses Gliricidia sepium et Leucaena leucocephala. Les concentrés n'ont été utilisés que pour déterminer les niveau de production potentiels des chèvres naines de l'Afrique de l'Ouest en milieu tropical humide et faciliter ainsi l'évaluation de la production de fourrages grossiers et de sous-produits agricoles.

Cette communication rapporte les résultats obtenus jusqu'ici et les conclusions pouvant en être tirées, comme l'impossibilité pour les chèvres naines ouest-africaines d'avoir une ration d'entretien suffisante en se nourrissant d'herbes vertes tropicales de médiocre qualité. Les légumineuses comme Gliricidia sepium et Leucaena leucocephala peuvent constituer des régimes de base satisfaisants pour les chèvres naines auxquelles ils confèrent des gains de poids atteignant jusqu'à 35-40 g par jour. Le manioc et les drêches de brasserie déshydratées offrent des

perspectives intéressantes en tant que complément énergétique pour le premier et protéique pour les secondes. D'autres recherches sont requises pour déterminer le niveau optimal de nutrition et, dans le cas du manioc, les intervalles entre les repas.

Introduction

Apart from health, nutrition is probably the most important factor limiting the productivity of the West African Dwarf goat in the Humid Zone of Nigeria (Sumberg, 1985). When the number of animals increases as a consequence of successful health interventions like PPR control the demand for feed increases accordingly. In places where the increased pressure on arable land led to laws dictating the total confinement of small ruminants the animals depend for feed solely on what is being brought to them.

The nutritional studies carried out at the project site at Ife can roughly be grouped into three categories: feeding trials, feeding/growth trials and growth trials. Experiments in the first two categories were carried out with animals housed in metabolism units throughout the whole experimental period, while studies in the last category were conducted with animals housed in ground pens. Feeding trials were mainly conducted with adult animals and lasted for 3-6 weeks, while feeding/growth trials were only carried out with young animals over prolonged periods (above 20 weeks).

Table 1 reviews the nutritional studies conducted since the start of the project in the middle of 1981. Although it will not be possible to present and discuss all the results of these experiments in detail we will try to summarize the most important parameters in such a way that a clear overall picture develops.

Feeding trials

The selective ability of West African Dwarf (WAD) goats was clearly shown in a trial with Cynodon hay offered at different levels (Fig. 1). As the dry matter intake (DMI) rose from 32 to 40 g DM $kg^{-0.75}$ d^{-1} the leaf intake increased from around 18 to 32 g DM $kg^{-0.75}$ d^{-1}, or expressed as % of the DMI from 55 to 80%. The total digestible dry matter intake (DDMI), even at the highest level offered (130 g DM $kg^{-0.75}$ d^{-1}), did not meet the maintenance requirements (27 g DOMI $kg^{-0.75}$ d^{-1}, NRC, 1981), indicating clearly that pen-fed West African Dwarf goats may not be able to maintain themselves on star grass hay only.

Also in other trials it was shown that WAD goats do not perform well when fed on hay of tropical grasses alone (Table 2). They thrive well only when the grass is well fertilized and harvested at an early stage of regrowth attaining DDMI of up to 40 g $kg^{-0.75}$ d^{-1}. To produce such a type of feed requires not only the appropriate climatological conditions but also a high level of input in terms of fertilizer and management.

Once it was clear that tropical grasses alone could not provide stall-fed WAD goats with the nutrients required for reasonable production levels, studies were aimed at the evaluation of other high quality feed resources, which will be easily available to the local farmer for the major part of the year.

Thus feed resources such as Gliricidia sepium and Leucaena leucocephala were included in the studies. Both legumes, of which only the leaves and petioles were fed, proved to be very valuable supplements for goats fed on a basic diet of Panicum maximum hay (Fig. 2, Table 2). In the case of Gliricidia the DMI increased linearly with level of supplementation up to

Table 1. Review of the nutritional studies carried by the goat research project.

Exp no	Basic ration	Supplement	Substitute	Description
1	Cynodon nlemfluensis (hay)			Feeding trial, selective consumption
2	P. maximum, (young well fertilized)	concentrate		Feeding trial
3	Panicum maximum (hay)	Leucaena Leucocephala		Feeding trial
4	Panicum maximum (hay)	Gliricidia sepium		Feeding trial
5	Panicum maximum (hay)	L. leucocephala or concentrate		Feeding/ growth trial
6	Gliricidia sepium	P. maximum (young) cassava L. leucocephala		Feeding/ growth trial
7	Gliricidia sepium		Leucaena leucocephala	Feeding/ growth trial
8	G. sepium L. leucocephala	cassava		Feeding/ growth trial
9	P. maximum (hay)	Brewers' Dried Grain or concentrate		Growth trial
10	G. sepium L. leucocephala			Feeding/ growth trial DHP inocul.

the highest level (0.8 g/g Glir.) thereby only slightly depressing hay intake. It improved digestibility and hence the total intake of digestible nutrients (38 g $kg^{-0.75}$ d^{-1} at the highest supplement level). Leucaena leucocephala produced similar results with DDMI of 34 g $kg^{-0.75}$ d^{-1} when offered at 21 g DM $kg^{-0.75}$ d^{-1}.

Feeding/Growth Trials

In a long term feeding/growth trial, comparing Leucaena (B) with concentrate (A), when fed ad libitum in addition to Panicum maximum hay mean DDMI amounted to 35 g $kg^{-0.75}$ d^{-1} for the Leucaena treatment and 55 g $kg^{-0.75}$ d^{-1} for the concentrate group. In both treatments the DMI consisted only for a minor part of hay (A: 21%; B: 37%). Growth rates obtained in the concentrate group (60 g d^{-1}) are comparable to those found by Zemmelink et al. (1985) feeding ad lib good quality hay plus 60 g $kg^{-0.75}$ d^{-1} concentrates (68.5 g d^{-1}) and by Adebowale & Ademosun (1981)

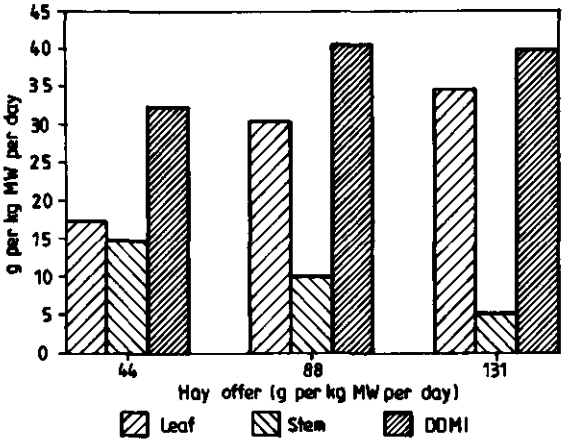

Figure 1. The effect of level of offer of Cynodon hay on the leaf, stem and total digestible dry matter intake (DDMI).

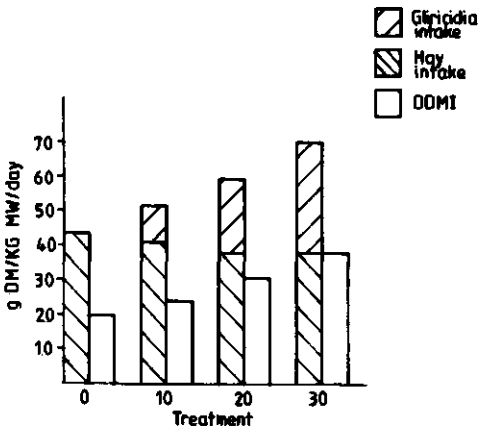

Figure 2. The effect of Gliricidia supplementation on the total dry and digestible dry matter of West African Dwarf goats fed on Panicum maximum hay.

including 15% brewers' dried grains in a Stylosanthes based diet (56.1 g d^{-1}). Weight gains observed offering ad lib Panicum maximum and Leucaena leucocephala (35 g d^{-1}) compare quite well with those obtained by Zemmelink et al. (1985) feeding ad lib good quality hay plus 30 g $kg^{-0.75}$ d^{-1} concentrates (35 g d^{-1}). This shows clearly the potential of this browse species. No harmful effects of Leucaena were observed, although it

Table 2. Some results of the feeding trial carried by the Goat Research Project

Exp no	Feed	Offer g $kg^{-0.75}$ d^{-1}	Intake g $kg^{-0.75}$ d^{-1}	Digestibility %	DDMI g $kg^{-0.75}$ d^{-1}
2	P. maximum (well fertilized, 6 weeks)	75	54.9±2.2	75.8±2.6	40.6±2.5
4	P. maximum (hay)	77.1	43.1±6.4	45.0±6.1	19.5±4.1
1	C. nlemfluensis (hay)	87.5	40.6	43.2	17.5
1	C. nlemfluensis (hay)	131.5	39.9	46.6	18.5
4	P. maximum (hay) G. sepium	74.9 31.9	37.2±2.5 31.9±0.2	55.1±2.9	37.9±3.1
3	P. maximum (hay) L. leucocephala	73.4 31.6	36.8±5.1 31.6±1.2	47.7±3.1	32.6±2.3

amounted to 63% of the total DMI. As expected growth rates were higher in the concentrate group (60.0 vs 35 g d^{-1}) indicating the potential of the dwarf goat under Ife conditions.

As Gliricidia and Leucaena had proven to be good supplements to low quality feeds, it was considered useful to investigate how those browse species would affect animal performance when fed as the sole or major part of the diet.

In the first experiment of this kind Gliricidia sepium was fed as the basic diet supplemented with either Panicum maximum grass, cassava or Leucaena leucocephala. On the sole Gliricidia diet DDMI amounted to 23.3 $kg^{-0.75}$ d^{-1} with a growth rate of 23.3 g d^{-1}, which is similar to the estimated daily gain between 90 and 150 days at village level (20 g d^{-1}) (Mack, 1983). All the supplements raised the DDMI significantly but only in the case of Leucaena was a significant increase in weight gain observed (36.0 g d^{-1}). The response to the cassava supplement was inconsistent and rather striking. Although it had the highest DDMI (45.7 $kg^{-0.75}$ d^{-1}) this was not reflected in the growth rate (14.3 $kg^{-0.75}$ d^{-1}) which was significantly lower than rates obtained on the grass or Leucaena supplement. This might be related to a rapid release of readily available carbohydrates, which in turn might have led to a sudden increase in volatile fatty acid (VFA) production in the rumen. In this respect it is perhaps useful to mention that the supplements were fed in the morning before the rest of the ration. As further research was considered necessary to clarify the effect of cassava supplementation another experiment was set up with Gliricidia sepium (75%) and Leucaena leucocephala (25%) as basic ration and three levels of cassava supplement (0, 15 and 30 g $kg^{-0.75}$ d^{-1}). The supplements were administered about 1.5 hours after the first half of the basic diet was offered. The results were more consistent than in the previous experiment (Table 3). Although the cassava supplement improved the digestibility and the DDMI (48-50 vs 40 g.$kg^{-0.75}$ d^{-1}) significantly this positive effect was not fully reflected in the growth rates (42-43 vs 37 g d^{-1}). Also no difference was found

Table 3. Some results of the feeding/growth studies carried out at the project site.

Exp no	Feed	Offer	Intake	DDMI	Growth rate
		g $kg^{-0.75}$ d^{-1}			g/day
6	G. sepium	94.0	66.7±6.2	37.9±3.2	23.3±3.7
5	L. leucocephala	49.6	40.8±2.7	35.0±2.6	34.8±5.3
	P. maximum (hay)	85.8	23.5±4.6		
6	G. sepium	93.7	56.8±6.6	40.6±3.2	28.7±4.9
	P. maximum (young)	32.4	13.8±5.1		
6	G. sepium	93.0	45.3±9.4	42.3±3.5	36.0±10.6
	L. leucocephala	32.4	25.6±4.4		
5	P. maximum	84.4	16.3±2.6	55.1±4.2	60.0±12.8
	concentrate	90.3	61.7±6.8		
8	G. sepium	74.9	35.6±4.8	48.0+4.0	41.8+11.1
	L. leucocephala	24.2	22.0±2.9		
	cassava	14.8	14.1±1.0		
8	G. sepium	74.6	25.3±6.9	49.6±3.9	43.5±5.5
	L. leucocephala	24.2	21.6±3.0		
	cassava	29.6	23.2±3.9		
8	G. sepium	75.1	44.1±8.9	39.5±5.8	37.4±8.9
	L. leucocephala	24.3	22.8±2.7		
	cassava	-			
6	G. sepium	94.2	42.5±22.9	45.7±10.1	14.3±11.3
	cassava	30.1	23.0±7.0		
7	G. sepium	105.7	53.8±7.0	37.2±3.5	13.4±11.5
	L. leucocephala	-	-		
	bark	16.2	9.0±3.8		
7	G. sepium	78.8	35.2±5.8	42.3±4.9	30.4±8.8
	L. leucocephala	27.2	23.4±2.2		
	bark	13.5	9.4±2.2		
7	G. sepium	52.6	25.8±8.7	42.2±5.5	25.7±4.9
	L. leucocephala	54.4	32.1±7.6		
	bark	12.8	5.6±2.6		
10	G. sepium	50.9	26.2±7.9	42.0±6.6	16.6±12.2
	L. leucocephala	48.2	37.4±6.6		
10	G. sepium	26.0	17.5±4.1	42.6±5.7	20.8±5.8
	L. leucocephala	71.4	47.0±9.9		

between the two supplementation levels. This might be due to the fact that the amount of readily available carbohydrates released at one time was still too high leading to a reduction in the activity of the cellulotic bacteria and to a disharmony with the microbial protein synthesis. Further research is now being carried out to investigate if offering the cassava supplement several times a day will enhance the performance of the animals. It is interesting to note that the cassava replaced the Gliricidia and did not affect the Leucaena intake resulting in about equal intake levels of the three components at the highest supplement level.

Other studies have shown that WAD goats like to eat Leucaena in larger quantities than Gliricidia. A substitution trial, where Gliricidia and Leucaena were fed at respectively 100%, 75-25% and 50-50%, revealed that inclusion of Leucaena into a sole Gliricidia ration clearly improved DDMI (42 g vs 37 g $kg^{-0.75}$ d^{-1}). Following observations that goats relish the bark of especially Gliricidia the intake of this plant component was also studied in this experiment. A comparison of the intake data with those from other trials does not suggest that the bark really increased the total DMI but rather that it substituted for part of the leafy fraction of the legumes. Growth rates stayed slightly below expectation based on the DDMI, due to a subclinical pneumonia infestation, traces of which were discovered during the carcass evaluation performed at the end of the experiment.

Although Leucaena has proven to be a useful feed, its mimosine content, which in ruminants is normally degraded to the toxic 2,4 Dihydroxy Piridine (DHP), makes feeding diets containing more than 1% mimosine on DM-basis over prolonged periods prohibitive (Jones & Hegarty, 1984). Jones (1981) however observed that goats in Hawaii were able to thrive on rations mainly composed of Leucaena for extended periods, without signs of DHP toxicity. Further research showed that this was thanks to the presence of a bacteria in the rumen, which can metabolize the DHP, and, when kept under certain conditions can be transferred to other animals (Jones & Megarrity, 1983; 1986). Once this inoculum became available the International Livestock Centre for Africa (ILCA) and the West African Dwarf Goat Project prepared a joint project to determine whether this bacteria would be present in West African Dwarf goats and sheep fed on high levels of Leucaena, and if not, whether those animals could be effectively inoculated. As results from the first phase revealed high levels of DHP in the urine, proving the absence of the bacteria, the second phase was started. Some preliminary results are presented in Table 3. On the highest Leucaena level (75% Leucaena leucocephala and 25% Gliricidia sepium) Leucaena accounted for about 73% of the total DMI. DDMI amounted to 42-43 g $kg^{-0.75}$ d^{-1}), which is quite similar to that obtained in previous experiments. Growth rates, however, were poor due to a severe pneumonia outbreak, which proved to be difficult to eradicate. More research has therefore been planned to reinvestigate the effect of inoculation, especially on growth.

The previous experiments have shown that the WAD goat can, when fed on very high quality feed i.e. concentrates, grow at a rate of 60 g d^{-1} over prolonged periods. As this figure can be considered the potential maximum under Ife conditions it can be used as a guideline for the evaluation of other feed resources. Animals fed on sole Gliricidia attain only 39% of this level. However in combination with Leucaena it achieved considerably better growth rates, up to 62% of the maximum growth rate. Adding an energy source like cassava to this combination further improved this rate by another 10% (Fig. 3).

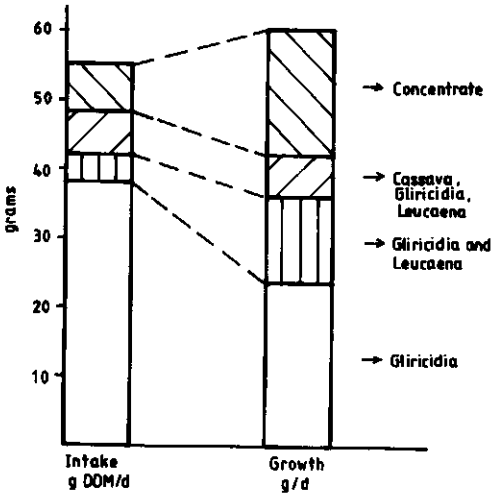

Figure 3. The relationship between DDMI and daily weight gain.

Growth trials

Two trials were conducted specifically to measure weight gain. One was carried out as part a Gliricidia-Leucaena substitution trial, which was partly executed in metabolism units, partly with animals housed in ground pens with slatted floors, which are assumed to be closer to the "practical" situation than metabolism cages. Growth rates were comparatively higher in the ground pens, at least partly due to the earlier mentioned disease problem. The results show the better weight gains on the composed diets (37-40 vs 25 g d^{-1}) (Table 4). No significant difference, however, was found between the 25 and 50% substitution level.

Table 4. Some results of growth trials carried out at Ife.

Exp no	Feed	Feed offer g DM $kg^{-0.75}$ d^{-1}	Growth rate g/day
7	G. sepium	±100 (leaf)	24.8±7.3
7	G. sepium (75%) L. leucocephala (25%)	±100 (leaf)	37.2±11.7
7	G. sepium (50%) L. leucocephala (50%)	±100 (leaf)	40.3±2.1
9	P. maximum Brewers' dried grain	ad libitum 25	9.2±7.7
9	P. maximum Brewers' dried grain	 50	29.2±10.5

Another source of cheap protein i.e. Brewers' Dried Grains was evaluated in the other study. As a supplement to poor quality Panicum hay it proved to be quite promising producing growth rates of 29 g d^{-1} when fed at 50 g $kg^{-0.75}$ d^{-1}. When supplemented at 25 g $kg^{-0.75}$ d^{-1} the weight increase was only 9 g d^{-1}, which seems relatively poor. One has to consider, however, that the goats cannot maintain themselves on Panicum hay alone. So part of the supplement is needed to meet the maintenance requirements. Further research is under way to study the usefulness of this industrial by-product in more detail.

Slaughter characteristics

An integral part of some experiments was to assess the effect of the different diets on the slaughter characteristics of the WAD goat. Some of the results have been summarized in Tables 5 and 6.

Table 5. A review of some slaughter characteristics.

Exp no	Description		Age (days)	Live weight (kg)	Dressed carcass (kg)	Dressing out[1] 1 (%)	2 (%)	3 (%)
7	100% Glir		337	9.1	3.1	34.0	46.0	66.0
		s.d.	35	0.9	0.2	1.4	1.5	2.1
7	75% Glir.+		380	13.5	5.6	41.2	52.5	72.1
	25% Leuc.	s.d.	58	1.4	0.9	2.4	2.2	2.8
7	50% Glir.+		357	12.8	5.3	41.6	52.1	73.3
	50% Leuc.	s.d.	65	1.1	0.3	1.7	0.6	3.4
8	75% Glir.+		244	9.4	3.4	36.4	48.5	71.1
	25% Leuc.	s.d.	28	0.6	0.3	1.6	1.6	2.3
8	75% Glir.+		278	10.1	4.0	39.9	48.7	75.3
	25% Leuc.	s.d.	34	1.0	0.3	2.1	5.7	4.0
	15 g cassava							
8	75% Glir.		286	9.7	4.2	43.3	52.9	82.0
	25% Leuc.	s.d.	44	0.7	0.5	2.7	2.9	4.1
	30 g cassava							

[1]: 1=(dressed carcass/live weight)*100
2=(dressed carcass/empty body weight)*100
3=((dressed carcass+abdominal fat+organs+intestine+head+skin)/live weight)*100

Glir. = Gliricidia sepium; Leuc. = Leucaena leucocephala

The animals evaluated so far were not yet fully mature as shown by their live weight (9-13 kg) and age (244-380 days). The fact that the goats were not starved before slaughtering explains the rather low dressing out percentages calculated in the conventional way (rate 1) ranging from 34 to 43%. Calculated on the basis of empty body weight (rate 2, range 46-56%)

Table 6: Some results of carcass evaluations.

Exp no	Description		Age (days)	Carcass weight	Lean %	Intermusc. fat %	Bone %
7	100% Glir.		337	3.1	69.2	6.8	25.0
		s.d.	35	0.2	3.1	1.7	4.0
7	75% Glir.+		380	5.6	70.0	8.2	21.9
	25% Leuc.	s.d.	58	0.9	4.9	1.4	4.0
7	50% Glir.		357	5.3	74.6	6.6	18.8
	50% Leuc.	s.d.	65	0.3	2.3	1.6	1.3
8	75% Glir.+		244	3.4	64.2	10.1	25.7
	25% Leuc.	s.d.	28	0.3	3.9	3.0	0.9
8	75% Glir.+		278	4.0	69.6	10.9	19.5
	25% Leuc.+ 15 g cassava	s.d.	34	0.3	1.4	2.2	1.0
8	75% Glir.+		286	4.2	67.3	11.6	21.2
	25% Leuc.+ 30 g cassava	s.d.	44	0.5	2.4	0.4	6.3

Glir. = Gliricidia sepium; Leuc. = Leucaena leucocephala

it compares quite well with the 50-51% dressing out percentage reported by Akinsoyinu et al. (1975) for approximately one and a half year old dwarf goats, starved for twelve hours which recalculated on empty body weight equals to 57%. As in many countries not only the carcass but also other body components like head, organs, intestine and skin, are highly appreciated, a dressing rate has been calculated which takes into account those parts (rate 3) as well. This percentage shows that a major part of the goat (66 to 82%) consists of valuable products.

Carcass evaluation data, based on the dissection of the left half of the carcass indicate fat contents of 6 to 15% (Table 6). The relatively low values from the Gliricidia-Leucaena substitution trial are probably related to the suboptimal physical condition of those animals, as discussed earlier. The results show that cassava supplementation did not lead to significantly fatter carcasses.

Folkertsma (1980) studied the carcass composition of very well-fed WAD goats in The Netherlands at different live weights (i.e. 14, 20 and 28 kg), which they attained between the ages of eight and thirteen months. He found fat contents (subcutaneous + intermuscular) ranging from 19 to 33% (expressed as percentage of carcass weight), which increased exponentially with the carcass weight. The share of bone and lean diminished at the same time from 16 to 12% and from 61 to 53% respectively. Although one has to be very careful making comparisons because of the environmental and possible genetical differences, it seems valid to conclude that the goats in the experiments reported here had not yet reached a stage, where fat deposition became the major growth factor, notwithstanding the fact that the animals in Ife were of about the same age as those in The Netherlands. This is probably a good example of what an important key role nutrition

may play in an intensive goat production system.

Conclusions

On the basis of the nutritional studies carried out by the West African Dwarf Goat Research Project the following conclusions can be drawn:

- WAD goats cannot be maintained on poor quality tropical grasses.
- The combination of the legumes Gliricidia sepium and Leucaena leucocephala can constitute an adequate basic diet for WAD goats producing weight gain of up to 35-40 grams a day.
- Cassava and Brewers' Dried Grains hold promises as energy and protein rich supplements respectively. Further research is required to determine the optimal feeding level and, in the case of cassava, feeding frequency.

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STUDIES ON UNTREATED CROP RESIDUE UTILIZATION IN RED SOKOTO(MARADI) GOATS

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Abstract

The utilization of cereal and legume based crop residues was studied in Red Sokoto (Maradi) goats aged 1 to 1.5 years and varying in body weights from 14.6 to 18.5 kg. The cereal crop residues evaluated were sorghum stover, millet stover, maize stover, sorghum leaves, sorghum threshed panicle and maize husk whereas legume crop residues were cowpea vine, cowpea leaves, cowpea shells and groundnut haulms. Mean dry matter intake for cereal crop residues ranged from 0.7% body weight (BW) for maize stover to 2% for sorghum leaves (5.5% Crude Protein). As for legume crop residues dry matter intake were slightly higher ranging from 0.8% BW for cowpea vines (5.9% CP) to 3.4% BW for groundnut haulms (16.7% CP). Medium level supplementation with 128-208 g Cottonseed cake per head per day permitted the goats to maintain body weight, while additional supplementation with 25% molasses further improved performance.

ETUDE DE L'UTILISATION DE RESIDUES NON TRAITES DE CULTURES PAR LES CHEVRES ROUSSES DE SOKOTO (MARADI)

Résumé

L'utilisation des résidus de cultures de céréales et de légumineuses a été étudiée sur un groupe de chèvres rousses de Sokoto (Maradi) de 1 an à 1,5 an dont les poids variaient de 14,6 à 18,5 kg. Dans le cas des résidus des cultures céréalières l'évaluation a porté sur les pailles de sorgho, mil et maïs, les feuilles de sorgho, les panicules de sorgho après battage et les fanes de maïs. Dans celui des résidus de culture de légumineuses elle a porté sur les fanes, feuilles, casses de niébé et fanes d'arachides. L'ingestion moyenne de matièrs sèches pour les résidues à base de céréales variait de 0,7% du poids corporel pour les pailles de maïs à 2% pour les feuilles de sorgho (5,5% de protéines brutes). Les taux d'ingestion étaient légèrement plus élevés pour les résidus de légumineuses, variant de 0,8% de poids corporel pour les fanes de niébé (5,9% de protéines brutes) à 3,4% du poids corporel pour les fanes d'arachide (16,7% de protéines brutes). Lorsqu'on a complété le régime alimentaire par un apport de tourteaux de graines de coton on a constaté que des doses moyennes (128 à 208 g par jour) permettaient d'assurer la ration d'entretien des caprins alors qu'un supplément de mélasse à 25% a encore augmenté la performance des chèvres.

Introduction

With the advocated increase in the production levels of various food crops (especially those based on cereals and legumes) in Nigeria, there will be more residues (straws, haulms, chaffs, etc.) left after crop

harvest. It appears that in Nigeria, the biggest concentration of goats is in the northern Sudan-Sahel hills (Green Revolution, 1981) where the largest amount of these crop residues is produced also. Studies on the nutritive value of crop residues, even in the more humid areas of the country where green feed is available for a considerably longer period of the year, should enable more judicious supplementation and increased output from ruminant animals. Since goats are considered superior to other ruminants in the utilization of poor quality, high fibre forages (Brown & Johnson, 1984) an exploitation of this potential through improved utilization of crop residues should increase the productivity of these animals.

This brief presentation forms part of a series of crop residue utilization studies involving cattle, sheep and goats.

Materials and Methods

A number of crop residues gathered from the experimental plots of the Institute for Agricultural Research (IAR), Samaru, Zaria, were evaluated for chemical composition, nutritive value and effects of supplementation on Red Sokoto (Maradi) goats in confinement. The goats were 1 to 1.5 years old and weighed 14.6 to 18.5 kg.

The cereal crops (maize, millet and sorghum) had previously been fertilized with 62 kg N ha^{-1} and 32 kg P_2O_2 ha^{-1}. For legumes (cowpea, groundnuts) 32 kg P_2O_2 ha^{-1} was applied. Prior to feeding, cereal crop residues were chopped into 32 - 60 mm pieces with a forage harvester. Legume crop residues were, however, fed whole. All crop residues were offered *ad libitum* In supplementation studies, measured amounts of the supplement were offered. For cottonseed cake (CSC) supplementation, graded levels were offered to produce various concentrations of CP in the total diet (straw + cottonseed cake) ingested. For the molasses supplementation studies three levels (0, 25, 33% straw) were fed to goats on a fixed level of cottonseed cake. This level was established from the previous trials on cottonseed cake supplementation of various stovers.

Details of the studies reported here are presented elsewhere (Alhassan *et al.*, 1983, 1984 and 1986).

Results

For cereal based crop residues, CP ranged from 2.6% in maize stover to 5.5% in sorghum leaves. Lignin and neutral detergent fibre (NDF) values were high. Intake as percentage of body weight ranged from 0.7 in maize stover to 2.0 in sorghum leave (Table 1). Legume based residues ranged in CP from 5.9% in cowpea vines (without leaves) to 16.7% in well-cured, leafy groundnut haulms. Intake ranged from a low of 0.8% body weight in cowpea vine to 3.4% body weight in groundnut haulms (Table 2).

Maximum straw intake was at the low level of cottonseed cake supplementation (40 to 48 g d^{-1}) for sorghum and millet stovers. In very poor quality maize stover as used in the present trial, stover intake decreased linearly with increasing levels of CSC supplementation (Table 3). Over all the stovers, high nitrogen retention values were on the medium to high (128 to 344 g d^{-1}) levels of cottonseed cake supplementation. In millet stover with adequate CP supplementation from cottonseed cake, molasses addition improved goat performance. However, no improvement in response was observed beyond 25% molasses addition (Table 4).

Table 1. Chemical composition and nutritive value of cereal crop residues for goats of various body weights.

Crop residue	Goat mean body weight kg	Dry Matter Intake % body weight	Dry Matter Intake g $kg^{-0.75}$ d^{-1}	DM dig coeff. %	Chemical composition % DM CP	NDF	lignin
Sorghum stover	15.8	1.1	22.0	51.6	5.0	72.6	7.8
Millet stover	18.5	1.5	31.2	56.9	4.0	69.2	9.7
Maize stover	14.8	0.7	13.8	52.9	2.6	74.6	8.6
Sorghum leaves	17.2	2.0	41.0	57.3	5.5	66.5	8.3
Sorghum threshed panicle	16.4	1.9	38.5	45.7	3.2	76.7	8.5
Maize husk	17.0	1.3	26.3	50.6	2.6	86.0	7.6

Source: Alhassan et al., 1983, 1984.

Table 2. Chemical composition and nutritive value of legume crop residues for goats of various body weights.

Crop residue	Goat mean body weight kg	Dry Matter Intake % body weight	Dry Matter Intake g $kg^{-0.75}$ d^{-1}	DM dig coeff. %	Chemical composition % DM CP	NDF	lignin
Cowpea vine (no leaves)	15.8	0.8	16.0	47.1	5.9	74.9	5.6
Cowpea leaves	14.6	2.1	40.9	56.3	12.0	50.3	10.5
Cowpea shells	17.6	3.2	65.5	65.6	9.0	57.3	10.5
Groundnut haulms	16.8	3.4	68.8	67.6	16.7	42.2	8.7

Source: Alhassan et al., 1983, 1984.

Discussion

The dry matter intake for sorghum leaves of 41 g $kg^{-0.75}$ d^{-1} is close to the value of 42.9 g $kg^{-0.75}$ d^{-1} reported for goats on sorghum stover (Olayiwole, 1976). The intake of 22.0 g $kg^{-0.75}$ d^{-1} for sorghum stover (leaf + stem) is about half the value reported by Olayiwole (1976) but close to the value for Damascus goats on barley straw of an equivalent CP content (Louca et al., 1982). The mean dry matter intake for cereal crop residues was 28.8 g $kg^{-0.75}$ d^{-1}. The dry matter digestibility for sorghum stover (51.6%) was close to the value of 52.4% reported by Olayiwole (1976). The highest dry matter digestibility among cereal crop residues was for sorghum leaves. In general, the leaf portions of crop residues are more nutritious than the more stemmy portions (Powell & Butterworth, 1984) the only exception being in rice straw where the reverse is usually the case (Verma & Johnson, 1984). The legume residues, as expected, were more nutritious than the cereal ones as evidenced by their higher digestibility and voluntary intake levels.

In general, stover intake response by goats to cottonseed cake supplementation appeared curvilinear except in maize stover where there

Table 3. Responses of goats on various stovers to cottonseed cake supplementation.

Crop residue	Level of cottonseed cake				
	None	Low	Medium	High	S.E.
Sorghum stover					
CSC intake, g d^{-1}	0	48	128	288	-
stover intake, g d^{-1}	171.0	173.5	143.8	134.9	9.1 N.S.
DM digestibility coefficient, %	51.6	46.5	44.1	49.1	3.8 N.S.
nitrogen retention, g d^{-1}	0.1	1.2	2.8	8.0	0.3
Millet stover					
CSC intake g d^{-1}	0	48	184	328	-
stover intake g d^{-1}	242.6	265.0	212.2	166.4	12.9*
DM digestibility coefficient, %	58.1	48.9	46.1	45.8	2.7 N.S.
nitrogen retention, g d^{-1}	-0.9	-0.4	4.1	8.1	0.6*
Maize stover					
CSC intake g d^{-1}	0	72	208	344	-
stover intake, g d^{-1}	95.7	90.3	83.0	64.0	20.5
DM digestibility coefficient, %	64.1	36.5	56.2	78.8	16.4
nitrogen retention, g d^{-1}	-0.1	1.8	5.0	9.3	0.3

CSC = Cottonseed cake
* Significant at $P<0.05$

Source: Alhassan et al. 1986.

Table 4. Influence of molasses addition to millet stover in goats.

Criteria	% Molasses in stover			
	0	25	33	S.E.
No. of animals	5	5	5	-
Cottonseed cake intake, g d^{-1}	160	160	160	-
Straw DM intake, g d^{-1}	176.3	181.4	181.8	7.6
Initial body weight, kg	16.1	15.6	14.8	0.7
Average daily gain, g	-1.7	5.0	5.7	9.3
Average daily DCP intake, g	33.0	32.9	34.9	0.8
Average daily ME intake, Mcals	0.7^{c}	1.1^{a}	0.8^{b}	0.0

Means in a row with different superscripts are significantly different ($P<0.05$).

Source: Alhassan et al. 1986.

was a linear decrease (Table 3). The stover intake responses were, however, significant ($P<0.05$) only in the case of millet stover. Although cottonseed cake supplementation at high levels depressed straw intake

total dry matter intake was increased up to the highest level. Similar responses to supplementation of straw have been noted elsewhere (William, 1984). It would appear that medium (128 to 208 g d^{-1}) to high levels (288 to 344 g d^{-1}) of cottonseed cake would be required for satisfactory nitrogen retention in goats fed on cereal straws. It would also appear cheaper to supplement at the medium levels for maintenance to low body weight gains if nitrogen retention is used as an approximate index for weight gain.

In millet straw supplemented with cottonseed cake, there is not much improvement in straw intake and rate of gain beyond 25% molasses addition to the straw. This level would appear to be the recommended level of inclusion in protein supplemented millet stover.

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FEED INTAKE REGULATION AND SMALL RUMINANTS

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Abstract

Feed intake in relation to maintenance requirements is one of the most important factors determining productivity in ruminant production systems. Especially in the tropics, where feed intake is generally low in relation to maintenance requirements, a relatively small increase in feed intake can result in considerable increases in productivity.

There are a number of factors influencing intake that may be grouped under animal effects (species, breed, physiological state, etc.), feed effects (protein content, digestibility, physical form, etc.) and "environmental" effects (climate, housing, disease, etc.). In this paper a number of animal and feed factors that seem to influence intake will be discussed, starting with a short description of the dominant hypothesis on the mechanisms of feed intake regulation and its consequences for small ruminants. Then an analyse is made to establish whether this hypothesis is consistent with available information regarding intake in large and small ruminants. The hypothesis is evaluated and a plea is made for more attention to alternative intake regulation mechanisms.

REGULATION DE L'INGESTION ALIMENTAIRE CHEZ LES PETITS RUMINANTS

Résumé

Le rapport entre ingestion alimentaire et besoins d'entretien est l'un des facteurs les plus importants qui régissent la productivité dans les systèmes de production des ruminants. Dans les régions tropicales en particulier, où l'ingestion est généralement faible comparée aux besoins d'entretien, il suffit souvent d'une très petite augmentation de l'ingestion pour entraîner des hausses considérables de la productivité.

L'ingestion est influencée par toute une série de facteurs qui peuvent être regroupés en : effets dûs aux animaux (espèces, races, conditions physiologiques, etc.), effets dûs aux aliments (teneur en protéines, digestibilité, forme physique, etc.), effets du "milieu" (climat, abris, maladies, etc.). Dans cette communication, on étudie un certain nombre de facteurs (espéces animales et fouragères) qui semblent influencer l'ingestion. Après une brève description, il est procédé à l'analyse de l'hypothèse dominante sur les mécanismes de régulation de l'ingestion alimentaire et ses conséquences pour les petits ruminants pour voir si elle est conforme aux données existantes relatives à l'ingestion des petits et des grands ruminants. L'auteur propose ensuite une évaluation de cette hypothèse pour conclure en demandant d'accorder davantage d'attention à d'autres mécanismes de régulation de l'ingestion alimentaire.

The concept of physical limitations to roughage intake

Despite the considerable number of references on feed intake regulation that have been published recently (e.g. Freer, 1981; van Soest, 1982; Minson, 1982; Waldo, 1986; Forbes, 1986) the mechanisms that regulate feed intake in ruminants are still poorly understood. There seems to be general agreement, however, that on the one hand metabolic factors influence feed intake and that on the other hand intake may be limited by physical factors. This view is generally expressed in a model like the one presented in Figure 1, which shows that the animal can adjust the organic

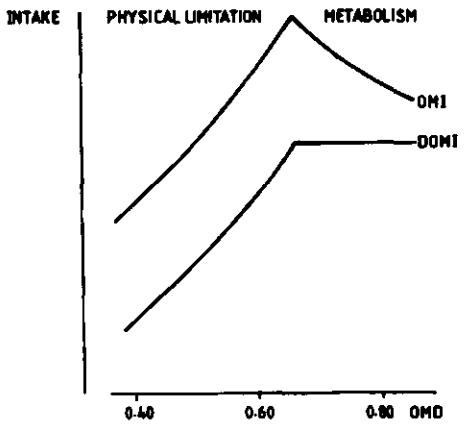

Figure 1. Model representing the effect of organic matter digestibility (OMD) and digestible organic matter intake (DOMI): metabolic regulation of intake of good quality diets, physical limitation to intake of poor diets.

matter intake of food quality diets to achieve a constant digestible organic matter intake (DOMI). The metabolism of the animal (its requirements for energy) determines intake for these type of diets. If lower quality rations (generally roughages with organic matter digestibilities below 0.7 or 0.6) are offered, the animal can not compensate for the lower digestibility by increasing its intake because of the limited capacity of the gastrointestinal tract to handle digesta. Hence feed particles (by the combined action of rumination and microbial breakdown) have to be diminished to a size small enough to be removed from the reticulo-rumen. If a large part of the feed is indigestible and/or microbial breakdown is slow, more space in the rumen will be occupied by each gram of dry matter consumed compared to a diet with a higher digestibility. For these rations the intake is then not determined by the energy requirements of the animal but by the maximum capacity of the reticulo-rumen of the animal on the one hand and the feed characteristics (digestibility, fermentation rate, physical structure, etc.) on the other.

Van Soest (1982) analysed the relationship between body weight and fermentation contents in a large number of ruminant species and concluded that fermentation contents are approximately proportional to body weight across ruminant species. In his view this implies that the intake of roughage across species offered the same ration is also proportional to body weight.

Consequences of this concept for small ruminant species

It is generally accepted that maintenance requirements across species are not related to body weight but are rather proportional to metabolic size. If maintenance requirements are proportional to metabolic size (weight raised to the power 0.75) but feed intake is proportional to the simple body weight the consequences for small ruminants may be serious, as is illustrated in a small model calculation in Table 1 (for this calculation it has been assumed that hay is offered with 9% ash and organic matter digestibility 0.60; maximum intake is 2% of body weight; maintenance requirements are 30 g of DOM $kg^{-0.75}$). This model calculation shows that if feed intake is proportional to animal weight small ruminant species need a better feed quality than the larger species. Van Soest (1982) reaches the same conclusion and estimates that ruminants with body weights lower than 21 or 105 kg (at rumen turnover times of 24 and 36 hours respectively) need rations with a digestibility of more than 0.70 in order to maintain their weights.

Table 1. Model calculation of feed intake relative to maintenance in three ruminant species (for explanation see text).

Species	Weight (kg)	DM required for maintenance (g)	DM intake (2% of W)	DM intake relative to maintenance requirements
Dwarf goats	10	309	200	0.7
Texel sheep	30	705	600	0.9
Cattle	300	3965	6000	1.5

If the hypothesis that gastrointestinal capacity of ruminants (a) limits feed intake and (b) is proportional to body weight are both valid, the consequences for small ruminant production systems are very serious. In the following paragraph a number of observations on feed intake relative to maintenance requirements in some ruminant species will be discussed.

Intake in relation to maintenance requirements in ruminant species

At the Department of Tropical Animal Production, Wageningen Agricultural University, an experiment was carried out with 24 dwarf goats and 6 Texel sheep of the same age. Individual feed intake was recorded for group-housed animals for two years. The fasting heat production (FHP), a measure of the basal metabolic rate or the net energy requirements was determined in respiration chambers for 12 goats and 6 sheep eight times during the two years. In parallel experiments the digestibility of the rations used was determined with dwarf goats and Texel sheep. A detailed report of these experiments will be published later. A preliminary analysis of part of the collected data show that the organic matter intake across species is approximately proportional to metabolic size (Table 2). Organic matter digestibility did not differ significantly between species which indicates that energy intake was also approximately proportional to metabolic size. A first analyses of a part of the FHP-data collected is presented in Figure 2. The regression equation shows that FHP across species is approximately proportional to metabolic size. These data show that feed intake for dwarf goats and Texel sheep is definitively not proportional to

Table 2. Regression of organic matter intake (OMI) on body weight in two ruminant species (dwarf goats and Texel sheep) for three diets.

Feed:	Hay OMD : 0.60 CP : 12%	Grass straw pellets OMD : 0.40 CP : 10%	Lucerne pellets OMD : 0.52 CP : 17%
Mean live weight			
goats (kg)	12	15	22
sheep (kg)	45	55	80
Regression equation	$OMI=54.9*W^{0.752}$	$OMI=81.9*W^{0.785}$	$OMI=90.5*W^{0.723}$

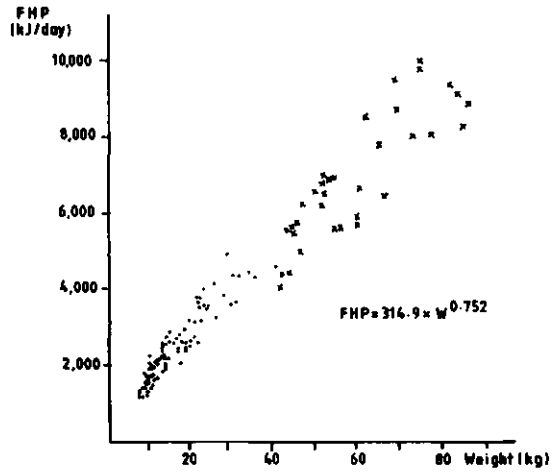

Figure 2. Relation between weight and fasting heat production (KJ d^{-1}) in dwarf goats (.) and Texel sheep (x).

body weight but rather to the basal metabolic rate of the species involved. This suggests that intake in relation to maintenance requirements is constant across these two species when animals of the same age are offered equal diets.

In the literature a number of suggestions may be found that the same is true when other ruminant species are compared. Blaxter et al. (1966a) found that between sheep and cattle feed intake was proportional to the energy maintenance requirements and Vercoe & Frisch (1980) showed feed intake between cattle (Bos taurus), swamp buffalo (Bubalus bubalis) and Banteng (Bos banteng) to be proportional to the fasting metabolic rate of the species involved. Thus there seems to be little doubt that between ruminant species feed intake is not related to body weight but is approximately proportional to the basal metabolic rate.

Also within species, between breeds, feed intake capacity does not seem to be related to body weight but to basal metabolic rate, both in sheep (Blaxter et al., 1966b) and in cattle (Rogerson et al., 1968; Frisch & Vercoe, 1977). Figure 3 shows the effect of genotype on relative appetite and relative maintenance requirements as recorded by Frisch and Vercoe. There are suggestions that also within breeds individual differences in

feed intake may be proportional to differences in basal metabolic rate (Blaxter et al., 1966b). A further analysis of FHP- and feed intake data of dwarf goats and Texel sheep recorded in Wageningen may give more information on this point.

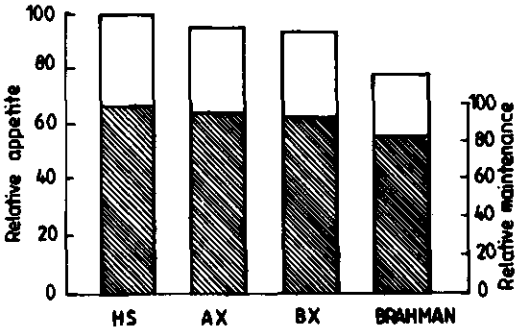

Figure 3. Relative appetite and maintenance requirements of four genotypes (HS: Hereford x Shorthorn; AX: HS x Africander; BX: HS x Brahman) From: Frisch & Vercoe, 1977.

These observations suggest that between ruminant species, between breeds within ruminant species and possibly between individuals within ruminant breeds, feed intake is not proportional to weight but rather to basal metabolic rate. This seems to contradict van Soest's (1982) observation that gastrointestinal capacity limits feed intake and that gastrointestinal capacity is proportional to weight.

Gutfill in relation to maintenance requirements in ruminant species

The ARC (1980) reviewed experimental data regarding gutfill in sheep and cattle. Figure 4 shows gutfill as a percentage of empty body weight (EBW) in sheep and cattle according to ARC's regression lines for all roughage diets. It is evident that at approximately the same percentage of mature weight sheep show a larger gutfill than cattle. This means that the concept that gutfill is proportional to body weight does not hold true for the two most important domesticated ruminant species. In Figure 5 the amount of gutfill is scaled by the estimated maintenance requirements of the two species (estimated at 360 and 450 KJ $kg^{-0.75}$ d^{-1} for sheep and cattle resp.). This calculation shows that differences in relative gutfill almost disappear if gutfill is scaled by maintenance requirements. This means that not only feed intake is proportional to the basal metabolic rate but also the gastrointestinal capacity. This raises the question whether gastrointestinal capacity is limiting or is merely a result of feed intake while feed intake in its turn is regulated by the metabolism of the animal. In the following paragraph some of the evidence for physical limitation of feed intake in ruminants will be discussed.

More on the concept of physical limitations of roughage intake

The model presented in Figure 1 is derived mainly from the work of Conrad et al. (1964), which is referred to in most recent publications on feed intake regulations (e.g. van Soest, 1982; Forbes, 1986; Waldo, 1986).

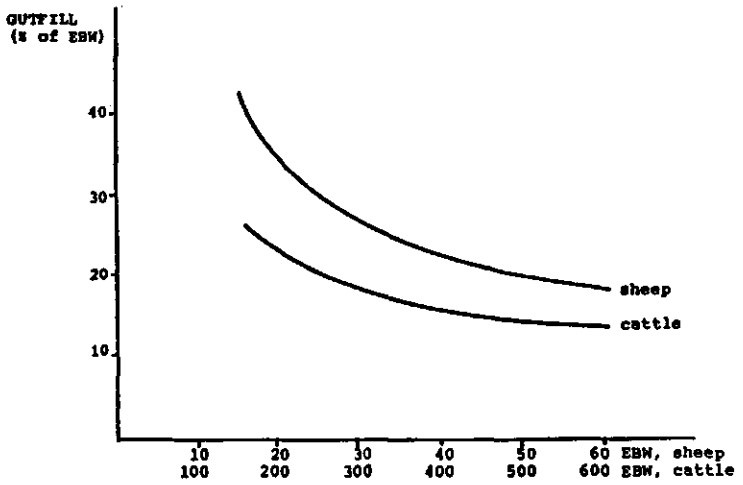

Figure 4: Gutfill relative to empty body weight (EBW) on all roughage diets according to ARC (1980) estimates.

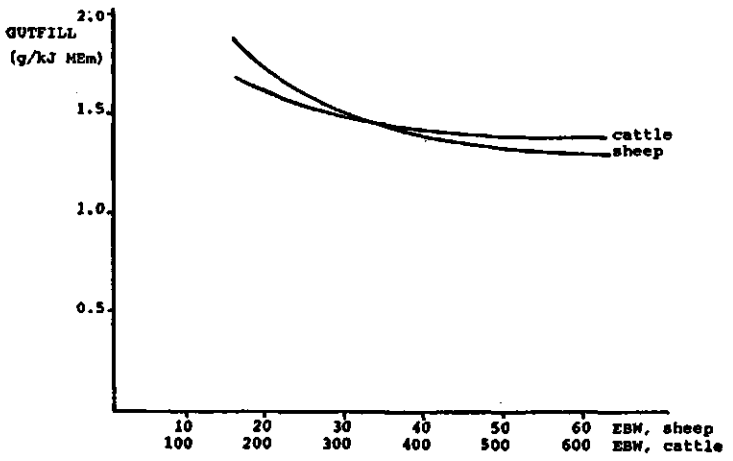

Figure 5: Gutfill relative to ME requirements for maintenance (MEm).

Conrad et al. analysed intake data of dairy cattle and found that the following model fitted their data very well up to a dry matter digestibility coefficient of 0.67:

$DMI = c \times W^{0.99} \times (F/W)^{1.01} \times D^{1.53}$, with

DMI: dry matter intake, c: constant, W: animal weight, F: faecal dry matter produced, D: dry matter digestibility. Although not explicitly stated by the authors this model has been interpreted to indicate that feed intake of diets up to D-values of about 0.67 is proportional to weight and is limited by the capacity of the gastrointestinal tract to handle undigested residues.

Conrad et al. used three variables (W, F and D) to explain DMI. Two of these variables however determine, by definition, DMI in the model DMI = F/(1-D). This means that they used the wrong model to analyse their data

and it can be shown that the authors could never have arrived at exponents of W and F/W other than approximately 1.0. No significance therefore may be attached to these exponents in relation to the mechanisms of feed intake regulation. There are also quite a number of observations that do not show feed intake to reach a maximum level, even at digestibilities of more than 0.80 (see e.g. Freer, 1981). Also data recorded in Wageningen do not support the concept of physical limits to feed intake (Figure 6, from Zemmelink et al., 1985 and unpublished results). Four groups of dwarf goats were offered ad lib hay and either none or one of three levels of concentrate. Feed intake and digestibility were recorded and gutfill was determined after slaughtering. The results show that in groups B and C animals did not reach their maximum energy intake level while gutfill was certainly not limiting intake. Apparently factors other than gastrointestinal capacity determined intake in these groups.

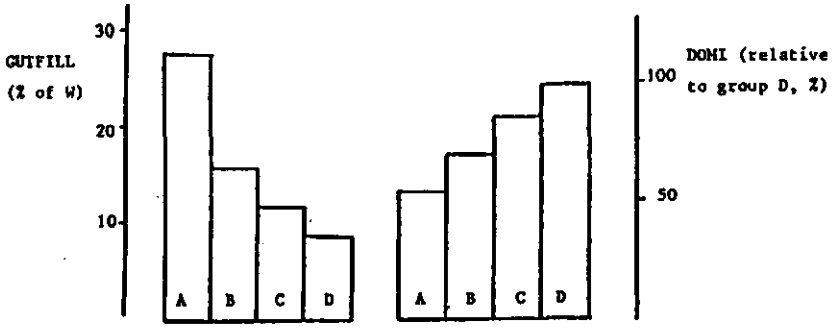

Figure 6: Gutfill and DOMI of dwarf goats, all fed ad lib hay and either no (group A), increasing amounts of (groups B and C) or ad lib concentrates (group D).

The most direct evidence for physical limitations to roughage intake is the effect of placing inert material in the rumen on feed intake. Campling & Balch (1961) placed water filled bladders in the rumen of cattle and recorded a decrease in feed intake, an experiment often referred to as evidence for a physical limitation to roughage intake. The authors themselves however conclude that the effects were surprisingly small; they had to fill up almost half of the rumen volume with water bladders to force hay consumption down by 25%. This decrease may well have been caused by a disturbance of normal rumen functioning rather than by the filling effect itself. Carr & Jacobson (1962) carried out a similar experiment but with smaller bladders and concluded that additional mass placed in the rumen did not reduce voluntary feed intake in all roughage diets. Welch (1967) placed 150 g of 30 cm long poly-propylene fibre in the rumen of sheep; this caused a decrease in hay consumption from approximately 65 to 20 g $kg^{-0.75}$. This experiment is often referred to as evidence to support the hypothesis of physical limitation to roughage intake (e.g. van Soest, 1982; Forbes, 1986). It seems however highly unlikely that the filling effect of these fibers (even when it is assumed that the volume of the fibers plus associated water would be 20 times the volume of the fibers alone) in a rumen with a capacity of probably more than 7 liters could have decreased intake by more than 65%. Possibly intake decreased as a result of the disturbing effect of these long fibers (too long to be ruminated) on normal rumen functioning.

These examples show that the direct evidence for physical limitations to feed intake often referred to in review articles is not always convincing. Of course, generally some relationship is found when feed intake is regressed on a feed quality parameter like digestibility, cell wall content, in-vitro degradation rate, etc. These are, however, statistical relationships and do not necessarily indicate a causal relationship and thus are not direct evidence that roughage intake is limited by the physical ability of the gastrointestinal tract to handle digesta.

Conclusion

The concept that roughage intake is limited by the capacity of the gastrointestinal tract and that this capacity is proportional to body weight does not seem to be true for the most important domesticated ruminant species.

Experimental results often referred to as direct evidence for the concept that roughage intake is limited by the gastrointestinal capacity of ruminants to handle digesta is not always convincing.

It seems worthwhile to direct more research effort towards the identification of metabolical mechanisms that might influence roughage intake in ruminants.

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EFFET D'APPORTS COMPLEMENTAIRES DE LEGUMINEUSES FOURRAGERES OU DE SOUS-PRODUIT AGRO-INDUSTRIEL SUR LES PERFORMANCES ZOOTECHNIQUES DE CHEVREAUX NAINS D'AFRIQUE DE L'OUEST ENTRETENUS SUR PATURAGE NATUREL

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Resumé

Une essai a été conduit sur la performance des chevreaux nains d'Afrique de l'Ouest nourris sur pâturages naturels et de complements alimentaires: (I) sans compléments (témoins, Pn) (II) avec Leucaena leucocephala (PnL) (III) avec Gliricidia sepium (PnG) (IV) avec drêches de brasserie (PnD).

Les quantités de matières sèches consommées ont été de 69,1 ± 4,3, 8,7 ± 0,4 et 163,5 ± 0,9 g/jour/animal pour les compléments alimentaires Leucaena leucocephala, Gliricidia sepium, drêches de brasserie. Les animaux ont généralement perdu du poids avant d'en reprendre progressivement. Les gains moyens quotidiens (GMQ) enregistrés ont été de 8,0 ± 0,0 ; 20,0 ± 1,3 ; 12,4 ± 0,5 ; 24,4 ± 1,5 g/animal respectivement pour les animaux des régimes alimentaires Pn, PnL, PnG et PnD.

Les variations du périmètre thoracique du début à la fin de l'essai ont été de 1,8 ± 0,0, 5,1 ± 0,2, 3,8 ± 0,2 et 5,7 ± 0,3 cm respectivement pour les animaux des régimes alimentaires Pn, PnL, PnG et PnD.

Les variations de la hauteur au garrot ont été de 1,6 ± 0,0, 2,9 ± 0,5, 2,1 ± 0,1 et 2,5 ± 0,4 cm respectivement pour les animaux des régimes alimentaires Pn, PnL, PnG et PnD.

Le pâturage naturel ne suffit donc pas pour assurer une croissance suffisante des chevreaux. La drêche de brasserie est le complément qui peut être conseillé aux éleveurs proches des centres industriels. Leucaena leucocephala paraît plus adapté au milieu rural. Gliricidia sepium semble moins intéressant.

EFFECTS OF FEEDING A LEGUME FODDER OR AGRO-INDUSTRIAL SUPPLEMENT ON THE GROWTH AND DEVELOPMENT OF WEST AFRICAN DWARF GOATS RAISED ON NATURAL PASTURES.

Abstract

The performance of the West African dwarf goats fed on natural pastures, with or without supplements (I) (control group, Pn), or (II) with Leucaena leucocephala (PnL), (III) with Gliricidia sepium (PnG), or (IV) with brewers' dried grain (PnD) supplement was studied.

The daily dry matter intake in grams was: 69.1±4.3, 8.7± 0.4 and 163.5±0.9 for the supplements Leucaena leucocephala, Gliricidia sepium and brewer's grain respectively. The animals generally started by losing weight and then gradually gained. The average daily weight gains were 8.0±0.0, 20.0 ±1.3, 12.4±0.5 and 24.4±1,5 g for Pn, PnL, PnG and PnD respectively. Changes in the thoracic girth were 1.8±0.0, 5.1±0.2, 3.8±0.2 and 5.7±0.3 cm respectively for animals in Pn, PnL, PnG and PnD. In the same order, changes in height at withers were: 1.6±0.0, 2.9±0.5, 2.1±0.1

and 2.5±0.4 cm.

The conclusion is that natural pasture alone does not ensure adequate growth in goats. Brewer's grain was the most effective supplement and is to be recommended to goat keepers living near industrial centres. L. leucocephala seems usable in the rural areas; G. sepium seems less worthwhile.

Introduction

L'intérêt de l'élevage des petits ruminants dans les pays en voie de développement, notamment en Afrique, a été souligné par beaucoup d'auteurs. Ce sont des animaux rustiques, à cycle relativement court et surtout ne concurrençant pas l'homme sur le plan alimentaire. De tous les petits ruminants, la caprin est celui dont l'élevage est le plus répandu dans les zones tropicales et subtropicales.

Au Sud du Bénin, la race caprine la plus rencontrée est la race "naine d'Afrique de l'Ouest". Un mode typique d'élevage caprin dans cette région consiste, pendant les saisons humides, à maintenir les animaux à un pieu ou un arbuste, par une corde sur un terrain en jachère. Ceci pour éviter la divagation des animaux et la destruction des cultures en végétation aux environs immédiats des habitations. Cet élevage traditionnel est peu performant, les animaux ne peuvent extérioriser toutes leurs potentialités zootechniques du fait surtout d'une alimentation défectueuse basée essentiellement sur le pâturage naturel souvent de composition floristique essentiellement graminéenne et déficiente, par conséquent, en certains nutriments essentiels tels que matières azotées et phosphore.

La présente étude est un essai d'alimentation au cours duquel des chèvres élevées sur pâturage naturel, ont reçu comme aliments complémentaires, des légumineuses fourragères (Leucaena leucocephala ou Gliricidia sepium) ou un sous-produit agro-industriel (drêches de brasserie).

Matériels et méthodes

L'essai s'est déroulé pendant la période de grande saison pluvieuse (avril-juillet) correspondant à la période de végétation active du pâturage naturel et d'installation des cultures. Au mois d'avril 1986, 12 chevreaux nains (8 mâles et 4 femelles) de poids moyen 6.9 ± 0.3 kg ont été achetés dans un village dans la région côtière du Bénin. Les animaux ont subi une quarantaine de 15 jours et pendant cette quarantaine ainsi que tous les 30 et 45 jours respectivement un déparasitage externe et interne. Les animaux ont été vaccinés contre la peste des petits ruminants pendant la quarantaine. Ensuite les 12 chevreaux furent répartis en 4 lots. Chaque lot comprenait 2 sujets mâles et un sujet femelle. Les 4 lots d'animaux étaient assignés de manière aléatoire aux 4 régimes alimentaires différents suivants : Lot 1 - pâturage naturel : Pn; Lot 2 - pâturage naturel + Leucaena leucocephala : PnL; Lot 3 - pâturage naturel + Gliricidia sepium PnG; Lot 4 - pâturage naturel + drêches de brasserie : PnD.

La composition floristique du pâturage naturel est essentiellement graminéenne et les graminées dominantes : Andropogon gayanus. Leucaena leucocephala et Gliricidia sepium ont été prélevées quotidiennement dans la plantation fourragère de la ferme de la Faculté des Sciences Agronomiques. Seulement les feuilles et rameaux verts ont été servis aux animaux. Les drêches de brasserie ont été achetées dans la brasserie "La Béninoise" de Cotonou. La composition des compléments est donnée dans le Tableau 1. L'essai d'alimentation a duré 16 semaines après deux semaines

d'accoutumance. Il consistait a conduire les animaux au pâturage à partir de 10 h et à les reconduire à la chèvrerie vers 17 h. Au pâturage, les animaux restent attachés à des arbrisseaux ou pieux avec des cordes de 2,1 m de longueur. L'emplacement d'un animal est changé tous les matins et tous les après-midi. Les compléments alimentaires Leucaena leucocephala, Gliricidia sepium, drêches de brasserie sont servis ad libitum tous les matins à 8 h. Les refus sont pesés le lendemain avant la nouvelle distribution. L'eau est distribuée à volonté. Chaque animal dispose d'un bloc de pierre à lécher comme complément minéral.

Tableau 1. Composition chimique des compléments alimentaires (% de la matière sèche).

	Drêches de brasserie	Leucaena leucocephala	Gliricidia sepium
Matière sèche	91,1	24,9	26,1
Matière organique	97,0	93,4	93,0
Cellulose brute	18,5	15,9	15,1
Protéines brutes (N x 6,25)	25,4	19,0	18,5
Cendres	3,0	6,6	7,0
Calcium	0,6	0,9	1,0
Phosphore	0,8	0,2	0,2
Ca/P	0,8	4,5	4,1

Les animaux ont été pesés au début de l'essai et ensuite toutes les deux semaines. La pesée a lieu le matin avant la distribution des compléments. La hauteur au garrot et le périmètre thoracique ont été mesurés au début de l'essai et, ensuite, toutes les 8 semaines ce qui correspondait au début, au milieu et à la fin de l'essai. Concomitante de la fréquence de pesée des animaux, l'ingestion journalière moyenne des compléments alimentaires a été calculée pour chaque période de deux semaines et pour toute la durée de l'essai. Les valeurs calculées ont été rapportées au kg de poids vif et au kg de poids vif métabolique ($P.M.^{0,75}$). Les gains moyens quotidiens (GMQ) ont été calculés pour chaque periode de deux semaines et pendant toute la durée de l'essai. Les données recueillies ont été analysées statistiquement suivant la méthode d'analyse des blocs aléatoires complets.

Résultats

L'état général des animaux était dans l'ensemble satisfaisant. Cependant, des cas de diarrhées intermittentes furent enregistrés entre la 6ème et la 8ème semaine d'alimentation chez les animaux recevant Gliricidia sepium. Deux semaines furent nécessaires pour habituer les animaux au système d'attache. Une estimation sur la base de la productivité instantanée du pâturage exploité (2,5 tonnes de matières sèches/ha), de la longueur de la corde (2,1 m) et du changement de lieu de pâturage une fois par jour tous les après-midi, permit de mettre aussi théoriquement à la disposition de chaque animal et par jour, 7,12 kg de matières sèches de fourrage, suivant la formule :

$$2 \text{ fois/jour} \times 1000 \text{ kg} \times \frac{2,5 \times 14,25}{10\,000} = 7,12 \text{ kg de matières sèches.}$$

Le Tableau 2 présente les résultats d'ingestion journalière de complément frais, matières sèches, matières azotées digestibles et énergie par les animaux.

Tableau 2. Ingestion de compléments alimentaires et de nutriments par les chevreaux (valeur moyenne ± écart type).

	Compléments alimentaires		
	Leucaena leucocephala	Gliricidia sepium	Drêches de brasserie
Poids vif moyen au début de l'essai (kg)	6,5 ± 0,9	6,5 ± 0,3	6,5 ± 0,9
Poids vif moyen à la fin de l'essai (kg)	8,1 ± 1,1	7,9 ± 1,7	9,2 ± 0,8
Poids métabolique moyen au cours de l'essai (kg)	4,3 ± 1,1	4,2 ± 0,1	4,4 ± 0,3
Ingestion de matières fraîches (g/jour/kg de poids métabolique)	$64,2^{a}$ ± 4,5	$8,2^{c}$ ± 2,5	$40,5^{b}$ ± 2,9
Ingestion de matière sèche g/jour/animal	$69,1^{b}$ ± 4,3	$8,7^{c}$ ± 0,4	$163,6^{a}$ ± 0,9
Ingestion de matières sèches (g/jour/kg de métabolique)	$16,9^{b}$ ± 1,1	$2,1^{c}$ ± 0,4	$38,9^{a}$ ± 4,1
Ingestion de matières azotées digestibles (g/jour/animal)	$10,2^{b}$ ± 0,6	-	$21,4^{a}$ ± 0,1
Ingestion de matières azotées digestibles (g/jour/kg/PM)	$2,5^{b}$ ± 0,1	-	$4,8^{a}$ ± 0,3
Ingestion d'énergie UF/jour/kg/PM)	$0,015^{b}$ ±0,01	-	$0,026^{a}$ ±0,002

Les differences entre les moyennes affectés d'esposants distincts sur la même ligne sont statistiquement significatives ($P<0,05$).

Pour les compléments, servis à l'état frais, Leucaena leucocephala a été en g par kg de poids vif, le complément le plus consommé : 40 ± 4,5 contre 4,8 ± 1,5 et 23,2 ± 2.2 respectivement pour Gliricidia sepium et les drêches de brasserie. Par contre, en termes de quantités de matières sèches ingérées exprimées en g par kg de poids vif, la drêche de brasserie a été le complément le plus ingéré : 22,3 ± 2,8 g par rapport à Leucaena leucocephala : 10,0 ± 1,1 et Gliricidia sepium 1,2 ± 0,4. Les valeurs des quantités de compléments ingérés par les animaux conservent la même tendance pour la matière fraîche et la matière sèche pour les expressions en g/jour/animal et en g/jour/kg de poids métabolique. Compte tenu de la très faible consommation de Gliricidia sepium les apports en matières azotées digestibles (MAD) ont été pratiquement nuls pour les animaux nourris avec ce complément. En g de MAD/kg de poids vif et par jour, Leucaena leucecephala et les drêches de brasserie ont apporté respectivement 1,4 ± 0,1 et 2,7 ± 0,2 aux animaux nourris respectivement avec ces compléments. En g de MAD/g de poids métabolique et par jour, la drêche de brasserie a apporté 4,8 ± 0,3 contre 2,5 ± 0,1 pour Leucaena leucocephala.

Dans les deux cas les valeurs sont significativement différentes ($P<0,05$) l'une de l'autre. Exprimée en UF (Unité fourragère) par jour et par kg de poids métabolique, les animaux ayant reçu la drêche de brasserie ont ingéré plus d'énergie : avec ce complément: 0,026 ± 0,020, que ceux ayant reçu Leucaena leucocephala : 0,015 ± 0,001 ($P<0,05$).

La Figure 1 représente l'évolution des poids vifs des animaux sous les différents régimes alimentaires. Le Tableau 3 présente les poids et gains de poids, variation de hauteur au garrot et du périmètre thoracique des animaux aut terme de l'essai.

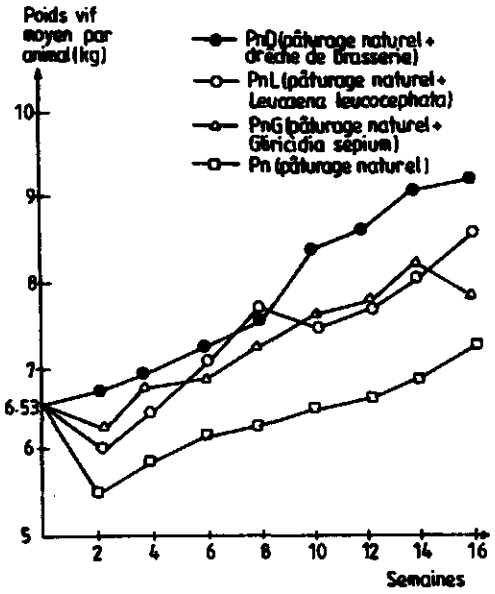

Fig. 1. Evolution des poids vifs moyens des animaux.

Tableau 3. Croissance pondérale des chevreaux (valeurs moyennes ± écart type).

	Régimes alimentaires			
	Pn	PnL	PnG	PnD
Poids vif moyen au début de l'essai (kg)	6,5 ± 0,5	6,5 ± 0,9	6,5 ± 0,3	6,5 ± 0,9
Poids vif moyen à la fin de l'essai (kg)	7,4 ± 0,0	8,7 ± 1,1	7,9 ± 1,7	9,2 ± 0,8
Gain moyen quotidien (g/animal)	8,0 ± 0,0	20,0 ± 1,3	12,4 ± 0,5	24,4 ± 1,5
Variation de la hauteur au garrot (cm)	$1,6^{b}$ ± 0,0	$2,9^{a}$ ± 0,5	$2,1^{b}$ ± 0,1	$2,5^{a}$ ± 0,4
Variation du périmètre thoracique (cm)	1,8 ± 0,0	5,1 ± 0,2	3,8 ± 0,2	5,7 ± 0,3

Les differences entre les moyennes affectés d'esposants distincts sur la même ligne sont statistiquement significatives ($P<0,05$).

A ce stade de l'essai, les animaux des régimes alimentaires PnG, PnL et PnD avaient pris respectivement 20%, et 31% plus de poids que les animaux du régime alimentaire Pn. Bien qu'il n'y ait pas eu de différence significative (P>0,05) entre les valeurs du GMQ, les régimes alimentaires PnD et PnL avec les valeurs respectives de 24,4 ± 1,5 g et 20,0 ± 1,3 g ont donné de meilleurs gains moyens quotidiens par animal que les régimes alimentaires PnG : 12,4 ± 0,5 et Pn 8,0 ± 0,0 g.

Les animaux des régimes alimentaires PnD et PnL ont connu des variations positives de hauteur au garrot (respectivement 2,5 ± 0,4 cm et 2,9 ± 0,9 cm) qui s'averait supérieure à celles de leurs homologues des régimes alimentaires PnG (2,1 ± 0,1 cm) et Pn (1,6 ± 0,0 cm). Cependant il n'y a de différence significative (P>0,05) ni entre ces valeurs (Tableau 3) ni entre celles donnant les variations du périmètre thoracique. Les valeurs les plus élevées ont été constatées pour les animaux sous régime alimentaire PnD (5,7 ± 0,3 cm), PnL (5,1 ± 0,2 cm) contre 3,8 ± 0,2 cm et 1,8 ± 0,0 cm pour les animaux respectivement soumis aux régimes alimentaires PnG et Pn.

Discussion

Ce système d'attache exerce certainement des effets néfastes sur les performances zootechniques des animaux mais son amélioration en milieu paysan peut déboucher sur une forme d'exploitation rationnelle des pâturages.

Les drêches de brasserie ont donné le meilleur résultat pour ce qui est du gain de poids moyen quotidien. Elles ont été en effet le complément le plus consommé, exprimé en matières sèches et a apporté aux animaux le plus de MAD et d'énergie.

Le gain de poids moyen quotidien des animaux recevant Leucaena leucocephala (20,0 ± 1,3 g/animal) est comparable au résultat (20,7 g/animal) de Arinto & Abilay (1981) obtenu sur des chèvres nourries avec des rations contenant 19% de Leucaena leucocephala.

Le GMQ des animaux recevant un apport complémentaire de Gliricidia sepium (12,4 ± 0,5 g/animal) est légèrement inférieur aux 14.4 g obtenus par Carew (1983) et supérieur aux 6.6 g obtenus par Manigui (1982) sur des chèvres naines d'Afrique de l'Ouest nourries sur la base de rations constituées à 100% de Gliricidia sepium. Le faible niveau de consommation de ce complément explique certainement la faible croissance enregistrée.

Les variations de périmètre thoracique enregistrées pour les animaux recevant des compléments alimentaires sont relativement plus élevées que celles des animaux du lot témoin.

Au total, le pâturage naturel, même en période de végétation active, ne peut supporter une forte croissance élevée des chèvres. Lorsque les drêches de brasserie sont disponibles, il est préférable de les utiliser en complément alimentaire du pâturage naturel. En milieu rural où les difficultés d'approvisionnement et le coût financier de la drêche de brasserie peuvent constituer des facteurs limitants, Leucaena leucocephala apparaît plus indiqué comme aliment à distribuer en complément du pâturage naturel.

Remerciements

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THE EFFECTS OF BROWSE SUPPLEMENTATION ON THE PRODUCTIVITY OF WEST AFRICAN DWARF SHEEP OVER TWO REPRODUCTIVE CYCLES

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Abstract

Supplementation of a basal diet of Panicum maximum and cassava peel with Leucaena leucocephala and Gliricidia sepium (1:1, w/w) increased lamb growth rates to weaning and to 24 weeks of age, and improved lamb survival rates. Total feed intake of dams increased with level of supplementation, although intake of the basal diet tended to decrease.

Lambs born in the middle of the dry season grew more slowly to weaning than those born at the end of the dry season. Lambs weaned in the middle of the dry season grew more slowly from 12-24 weeks, than those weaned at the start of the rains.

EFFETS D'UNE APPART COMPLIMENTAIRE LIGNEUX SUR LA PRODUCTIVITE DES PETITS RUMINANTS AU COURS DE DEUX CYCLES DE REPRODUCTION

Résumé

Un régime alimentaire de base (Panicum maximum et épluchures de manioc) complété par Leucaena leucocephala et Gliricidia sepium (rapport 1/1 sur la base du poids corporel) a permis d'augmenter les taux de croissance des agneaux au sevrage et à 24 semaines et d'améliorer le taux de survie. L'ingestion alimentaire totale des mères devenait plus importante à mesure qu'augmentaient les apports complémentaires de nourriture tout en étant associée à une tendance à la baisse de l'ingestion des aliments de base.

La croissance des agneaux nés en milieu de saison sèche était plus lente que celle des agneaux nés à la fin cette même saison et les agneaux sevrés en milieu de saison sèche se développaient plus lentement entre la 12ème et la 24ème semaine que les agneaux sevrés en début de saison des pluies.

Introduction

The use of multipurpose leguminous trees to maintain soil fertility and crop production, and also provide forage in a cut-and-carry system, has been advocated by ILCA for small-holder farmers in the humid zone. A typical small farm household comprises 6-8 persons, cultivating 2-4 ha of land and owning 2-4 small ruminants. In southern Nigeria, where most of the ILCA Humid Zone Programme studies have been carried out, the ratio of goats to sheep is 6:1.

The crude protein content of tropical grasses is adequate for moderate levels of animal production for only a few months of the year when the grass is young. Protein supplementation of grass diets when the crude protein content of the grass is less than 7% will increase food intake and animal performance (Minson & Milford, 1967). Supplementation with the foliage of tree legumes has been shown to improve the growth rate of goats

between the ages of 4-10 months (van Eys et al., 1986).

The objective of the present study was to compare the productivity of West African Dwarf sheep receiving different levels of mixed Leucaena leucocephala and Gliricidia sepium supplementation over two reproductive cycles.

Materials and methods

Forty female West African Dwarf sheep, aged between 2 and 5 years were housed with rams for a 6 week breeding period. Six weeks after the end of the breeding period the females were randomly allocated to one of dietary treatment groups 1-4, and placed in individual pens, remaining on trial until lambs were weaned at 12 weeks post partum. After weaning dams were rebred for a 6 week period and then randomly reallocated to one of the treatment groups 2-5 six weeks later. In all, five dietary treatment groups were studied. In the first reproductive cycle a basal treatment of ad libitum chopped Panicum maximum plus 50 g d^{-1} of sun-dried cassava peel daily was used, with 3 levels of supplementation with a 1:1 (w/w) mixture of Leucaena leucocephala and Gliricidia sepium. In the second reproductive cycle the unsupplemented treatment was dropped in favour of an additional level of supplementation (Table 1).

Table 1. Supplements offered (g d^{-1}) to West African Dwarf sheep receiving chopped Panicum maximum ad libitum.

	Sun dried cassava peel	Browse supplementation*, fresh weight				
	all groups	group 1	2	3	4	5
Adults	50	0	550	1100	2200	3300
Lambs:						
12-16 weeks	12	0	137	275	550	825
16-20 weeks	16	0	172	344	688	1040
20-24 weeks	20	0	206	412	825	1240

* Leucaena leucocephala and Gliricidia sepium (1:1, w/w).

Lambs at weaning remained in individual pens, receiving the same dietary treatment as their dams but with quantities adjusted to allow for lower body weights. Data collection ceased when lambs reached 24 weeks of age.

Water was available ad libitum and all animals had access to a mineral block. Animals were treated with Systamex (Oxfendazole, Wellcome Foundation, U.K.) against internal parasites, and were dipped with Gamatox (gamma benzene hexachloride, Cooper MacDonald and Robertson, U.K.) against external parasites. Treatments were given monthly during the rainy season (May - October), and bimonthly during the dry period (November - April).

The trial started in July 1985 and was concluded in April 1987 after two complete reproductive cycles. In the first cycle dams were lactating during the dry season; in the second cycle parturition was 3 months earlier and lambs were in the post-weaning stage during the dry season (Table 2).

Table 2. Month and season of stages in the reproductive cycles of sheep on a browse supplementation trial.

Stage	First cycle 1985/1986		Second cycle 1986/87	
	month	season	month	season
Breeding	July/Aug.	rains	April/May	early rains
Lambing	Dec./Jan.	dry	Sept./Oct.	late rains
Weaning	March/April	end of dry	Dec./Jan.	dry
End of trial for lambs	June/July	rains	March/April	end of dry

Results

Feed dry matter (DM) content is shown in Table 3. During the dry season (November - April) the mean DM level was 3.6% units higher than during the rains.

Table 3. Monthly changes in the DM content (%) of Panicum, Leucaena and Gliricidia.

Season	Month	Panicum	Leucaena	Gliricidia
dry	November	32.3	33.4	34.0
	December	32.5	34.3	33.5
	January	34.5	33.5	32.5
	February	33.5	35.3	34.0
	March	34.1	36.6	35.7
	April	35.0	35.7	34.8
wet	May	28.4	31.8	31.0
	June	29.6	32.6	31.6
	July	28.7	30.1	29.1
	August	31.2	32.7	29.8
	September	28.0	31.1	29.2
	October	31.0	32.2	32.2
Mean				
dry		33.7	34.8	34.1
wet		29.5	31.8	30.5

Food DM intake for dams is shown in Figure 1 for the first reproductive cycle and in Figure 2 for the second cycle. In the first reproductive cycle grass intake for dams was significantly higher for the unsupplemented group at all stages of the trial ($P<0.01$). In the second reproductive cycle there was little difference in grass intake between groups 2 and 3, although groups 4 and 5 ate less grass overall ($P<0.001$). Intake of browse rose significantly from groups 2 to 5 reflecting the quantities offered. For dams the total DM intake over the 20 week trial period in the first reproductive cycle was highest in group 4 (171 kg) and lowest in group 2 (136 kg) and the unsupplemented animals consumed 158 kg.

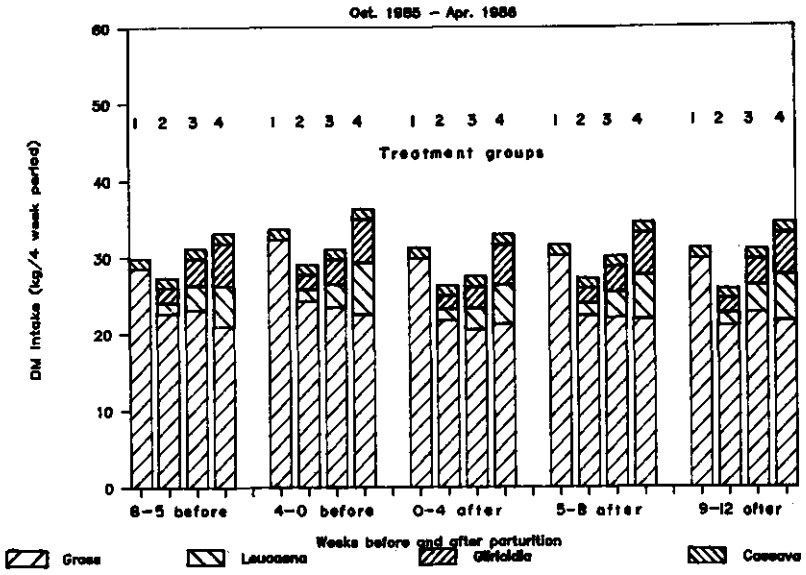

Fig. 1. Dry matter intake before and after parturition of adult sheep offered different levels of supplementary browse (Leucaena and Gliricidia) in 1985/86.

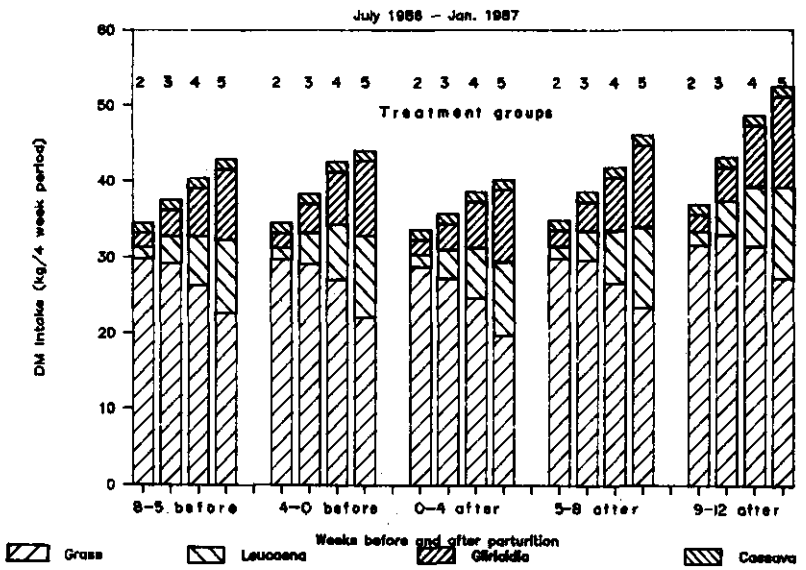

Fig. 2. Dry matter intake before and after parturition of adult sheep offered different levels of supplementary browse (Leucaena and Gliricidia) in 1986/87.

During the second reproductive cycle total food intake increased steadily from 175 kg to 226 kg as the level of supplementation rose. Total food intake over the complete trial, comparing dams in groups 2, 3 and 4 was 26% higher in the second reproductive cycle than in the first ($P<0.001$).

Food intake for lambs post weaning is shown in Figure 3 for the first reproductive cycle and Figure 4 for the second. There was little difference in grass intake between groups of lambs in the first reproductive cycle. Intake of browse again reflected quantities offered.

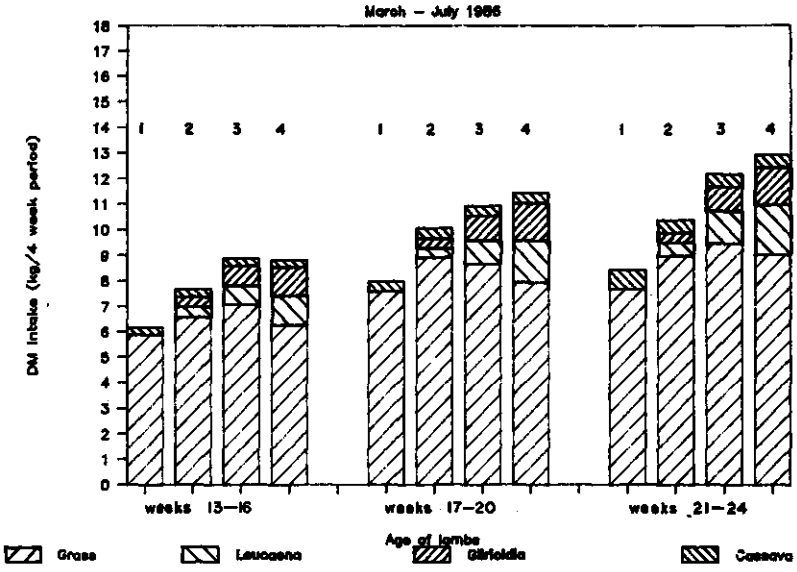

Fig. 3. Dry matter intake of lambs, after weaning, offered different levels of supplementary browse (Leucaena and Gliricidia) in 1985/86.

Total DM intake over the 12 week period was significantly higher for groups 3 and 4 (32.4 and 33.8 kg), than for groups 1 and 2 (22.6 and 28.6 kg), with the differences increasing as the trial progressed ($P<0.001$). During the second cycle grass intake was again similar across groups, but the differences between groups 2 and 3 in total intake were less marked, 24.1 and 25.4 kg respectively for the 12 week period, while for group 4 and 5 intakes were 32.7 and 39.9 kg ($P<0.001$). Food intake over the 12 week period was therefore 19% and 28% higher for groups 2 and 3 respectively in the first reproductive cycle compared to the second. Intake for group 4 was similar in the two cycles.

The effects of supplementation on lamb growth rates are shown in Table 4 for the first reproductive cycle and Table 5 for the second. Birth weight was not affected by treatment in either reproductive cycle. In the first cycle, when lambs were born in the middle of the dry season unsupplemented lambs grew at a rate of 39 g d^{-1} from birth to weaning, and 12 g d^{-1} from weaning to 24 weeks, compared to 58 g d^{-1} and 25 g d^{-1} for group 4 lambs. Significant effects of supplementation on growth rate were obtained in the post-weaning period, and from birth to 24 weeks, but significant levels during lactation were only reached between groups 1 and 3. In the second

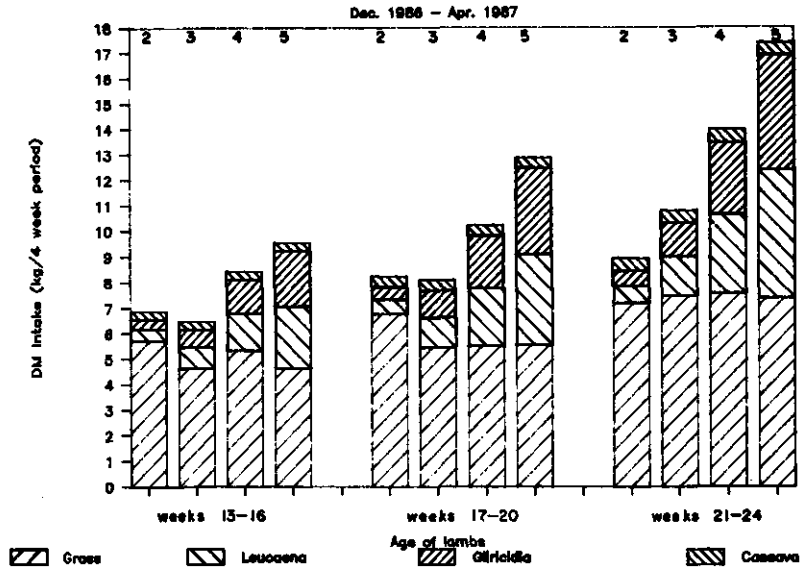

Fig. 4. Dry matter intake of lambs, after weaning, offered different levels of supplementary browse (Leucaena and Gliricidia) in 1986/87.

Table 4. The effects of browse supplementation on growth rates of lambs during 1985/1986.

Treatment group	Browse intake g DM d^{-1}		Growth rate g d^{-1}		
	dam*	lamb+	birth-12 week	12-24 week	birth-24 week
1	0	0	39.0a	11.9bc	25.5ef
2	110	27	43.5	17.9d	33.2g
3	212	71	58.7a	21.4b	38.3e
4	390	111	57.9	25.5cd	44.3fg

Within a column values with the same letter are significantly different
P<0.05 a b d e
P<0.01 c f g
* From 8 weeks prepartum to 12 weeks post partum.
+ From weaning at 12 weeks to 24 weeks post partum.

reproductive cycle growth rates from birth to weaning were higher than in the first cycle, ranging from 49 g d^{-1} for group 2 to 84 g d^{-1} for group 5. Post-weaning performances were much lower than from the previous lambing cycle, (1 g d^{-1} for group 2 and 16 g d^{-1} for group 5). Thus overall growth rates from birth to 24 weeks were little changed between the first and second reproductive cycle.

The overall conception rate in the first reproductive cycle was 0.7, rising to 0.9 in the second cycle. No adult mortalities occurred during the trial.

Survival rates of lambs to weaning and to 24 weeks are shown in Table 6. In both reproductive cycles survival rates improved as the level of browse

Table 5. The effects of browse supplementation on growth rates of lambs (during 1986/87).

Treatment group	Browse intake g DM d^{-1}		Growth rate g d^{-1}		
	dam*	lamb+	birth-12 week	12-24 week	birth-24 week
2	129	38	49.1ab	1.1de	28.2hi
3	275	79	56.4c	0.6fg	31.4jk
4	495	155	73.1a	12.6df	44.6hj
5	741	250	84.0bc	16.5eg	50.3ik

Within a column values with the same letter are significantly different.
P<0.05 cd
P<0.01 abfhj
P<0.001 egik
From 8 weeks prepartum to 12 weeks post partum.
From weaning at 12 weeks to 24 weeks post partum.

Table 6. The effect of browse supplementation on the survival rates to weaning and 24 weeks of lambs.

Treatment group	1985/86				1986/87			
	Number born	Litter size	Survival		Number born	Litter size	Survival	
			weaning	24 week			weaning	24 week
1	8	1.33	0.50	0.50	-	-	-	-
2	8	1.00	0.75	0.62	8	1.00	1.00	0.62
3	11	1.37	0.55	0.55	12	1.20	1.00	0.83
4	8	1.33	1.00	0.87	10	1.00	1.00	0.90
5	-	-	-	-	9	1.12	1.00	1.00

supplementation increased. In the second cycle when lambs were born during the late rains, no mortalities occurred before weaning. Over-all survivability ranged from 0.50 for unsupplemented lambs to 1.00 for those in group 5.

Discussion

The benefits of supplementary browse on the reproductivity of group fed sheep with free breeding has been reported previously (Reynolds & Adeoye, 1985). Effects were noticed on parturition interval, litter size, survival rates and weaning weights. The present study employed individual feeding, so that intake of dietary components could be monitored.

In the first reproductive cycle animals were in late pregnancy and lactation during the dry season when the nutritive value of the basal diet was low. Post-weaning, with the onset of the rainy season young grass was available to the lambs. In the second reproductive cycle parturition occurred in the early dry season, and lambs reached 24 weeks of age around the onset of the rains. Post-weaning, therefore, the nutritive value of the basal diet would remain low.

Although positive responses to supplementary browse were observed in

both reproductive cycles the effects were modified by season as can be seen in a comparison of food intake and growth rates in the two reproductive cycles. In the first reproductive cycle overall food intake for the dams (1.39 kg DM d^{-1}) was lower than in the second cycle (1.95 kg DM d^{-1}), reflecting the poor digestibility of the basal diet in October-April as compared to July - January. Food intake of lambs post-weaning can be directly compared for groups 2, 3 and 4. Mean food intake through the 12 week post-weaning period for these lambs in the first reproductive cycle was 361 g d^{-1}, compared to 325 g d^{-1} in the second cycle, despite the weights of the two groups at weaning being 6.4 kg and 6.9 kg respectively, and browse intake being 72 g d^{-1} in the first cycle and 91 g d^{-1} in the second cycle. The depression in total food intake is accounted for by grass intake which dropped from 290 g d^{-1} for the first group of lambs to 221 g d^{-1} for the second group.

Lamb growth rate to weaning reflects the milk producing ability of the dam, which in turn is affected by the quantity and quality of feed consumed. Lambs from the second reproductive cycle, born in the late rainy season tended to grow faster than those born in the dry season. Mean growth rate to weaning from groups 2, 3 and 4 for the first cycle was 53.4 g d^{-1}, compared to 59.4 g d^{-1} for the second cycle. The positions were reversed for post-weaning growth rates; lambs in groups 2, 3 and 4 from the first reproductive cycle, weaned at the start of the rains, grew at 21.6 g d^{-1}, compared to only 4.8 g d^{-1} for lambs from the second reproductive cycle, weaned in the middle of the dry season. Post-weaning growth rates observed in the second reproductive cycle at all levels of nutrition are surprisingly low, compared to results for the first reproductive cycle and earlier trials (Reynolds & Adeoye, 1985). A sub-clinical infection in the herd might have been a factor, but as signs of ill-health were not observed, the hypothesis must remain unsubstantiated.

In a similar trial with growing goats van Eys et al. (1986) found that the intake of Napier grass (Pennisetum purpureum) when supplemented with Leucaena and Gliricidia at 15% of DM intake, was lower than that of controls receiving no legume supplement, although, unlike the present trial, total DM intake was unchanged. Daily weight gain of supplemented animals was 21 g d^{-1} as compared with -1 g d^{-1} for control animals. Studies on the rate and extent of protein digestion showed that the yield and efficiency of microbial protein production in the rumen may be higher with supplemented diets, owing to release of larger quantities of rumen degradable nitrogen in the form of amino acids, rather than ammonia-nitrogen and a higher ruminal turnover rate of legumes. Digestibility of dry matter and crude protein was unaffected by legume supplementation, suggesting possibly an enhanced urine-nitrogen loss on the grass diet.

A combination of Panicum maximum and Gliricidia sepium has been shown to have a higher DM digestibility than grass alone (J. Ifut, personal communication). Readily fermentable carbohydrate, in the form of cassava, increased the DM digestibility of both Gliricidia and Leucaena (Goat Research Project, University of Ife, 1986). Thus the combination of Panicum, cassava peel and the Leucaena/Gliricidia mixture used in the present trial should have been more digestible than the basal diet alone. The benefits of legume supplementation would have been manifest in both an increased DM intake and higher DM digestibility.

At the highest level of supplementation dams consumed 23% of total DM intake as Leucaena. No signs of toxicity were observed, and no adverse effects on lamb growth rates were apparent. This would confirm earlier literature reports that for ruminants Leucaena, up to 30% of the daily ration, will have no harmful effects (NAS, 1977; Jones & Bray, 1983).

Conclusion

Supplementation of a basal diet of Panicum maximum and cassava peel with Leucaena leucocephala and Gliricidia sepium (1:1, w/w) increased lamb growth rates to weaning and to 24 weeks of age, and improved lamb survival rates. Total feed intake of dams increased with level of supplementation, although intake of the basal diet tended to decrease.

Lambs born in the middle of the dry season grew more slowly to weaning than those born at the end of the dry season. Lambs weaned in the middle of the dry season grew more slowly from 12-24 weeks than those weaned at the start of the rains.

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COMPOSITION DE LA CARCASSE DE LA CHEVRE DJALLONKE EN PERIODE TERMINALE

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Résumé

Trente-deux caprins mâles de la race Djallonké ont été suivis de la naissance jusqu'à l'âge de 24 - 30 mois. Ils sont castrés dès l'âge de 5 mois. Parmi eux, 25 ayant atteint l'âge adulte ont été abattus pour l'étude de la carcasse.

Le poids adulte (20 kg) est atteint à 2 ans. Les rendements à l'abattage sont de 52,9% (sur la base du poids vif) et de 58,4% (sur la base du poids vif vide). Malgré une réduction des proportions des membres postérieurs en comparaison avec ceux des jeunes animaux, la carcasse est bien conformée.

Au point de vue composition tissulaire, la carcasse est caractérisée par un rapport muscle/os assez élevé mais avec une tendance à l'excès de gras.

CARCASS COMPOSITION OF THE MATURE DJALLONKE GOAT

Abstract

Thirty-two Djallonké (West African Dwarf) male goats were studied from birth to 24 - 30 months. They were castrated at five months. Twenty-five that reached maturity were slaughtered for carcass studies. The animals reached their adult weight (20 kg) at 24 months. Dressing percentages were 52.9 (live weight) and 58.4 (empty live weight). Although the hind-quarters, in comparison with young animals, were proportionately smaller, the carcass configuration was good. In terms of tissue composition the muscle/bone ratio in the carcass was quite high, but there tended to be too much fat.

Introduction

La chèvre Djallonké ou chèvre de l'Afrique de l'Ouest ou du Fouta Djallon ou du Sud (CIPEA, 1979; IEMVT, 1980) est une race élevée pour la viande. Jusqu'à ces dernières années peu de travaux ont été consacrés à l'étude de ses qualités bouchères. Les rares données dont on dispose actuellement concernent les jeunes caprins (Akinsoyinu et al., 1975; Amegee, 1986). Devendra & Burns (1983) classe la viande de chèvre en trois catégories, à savoir : (1) Viande de chevreaux : 8-12 semaines d'âge, (2) Viande de jeunes chèvres : 1-2 ans, (3) Viande de chèvres adultes : 2-6 ans. Il faut reconnaître qu'au Togo et dans les pays voisins on ne connaît pas la viande de la première catégorie parce qu'à cet âge le chevreau Djallonké est d'un poids trop faible. Une telle pratique serait considérée comme un gaspillage. De surcroît, le consommateur recherche une viande ferme, provenant d'animaux âgés. L'objectif du présent travail est de connaître à quel âge les boucs atteignent leur poids adulte qui est de 18-20 kg (CIPEA, 1979) et quelle est la composition de la carcasse.

Matériel et Méthode

Treinte-deux caprins mâles ont été suivis de la naissance jusqu'à l'âge de 24 - 30 mois. Tous ont été castrés vers l'âge de 5 mois. Conduits sur parcours naturel dans la journée, ils recevaient le soir un complément alimentaire composé de graines de coton (25%), Leucaena (20%), drêches de brasserie (20%), remoulage de blé (20%) et son de blé (15%). Ce concentré titrant 18,5% matières azotées totales (MAT) et 0,85 UF. La distribution était ad libitum, mais la consommation estimée à environ 350 g par animal adulte. Les animaux disposaient également du complément minéral et d'eau. Ils étaient protégés sur le plan sanitaire.

A l'âge de 24 à 30 mois, 25 animaux ont été abattus, après 24 heures de jeûne. Les demi-carcasses droites ont été découpées et disséquées selon la méthode décrite pour les ovins par Boccard & Dumont (1955) et Boccard et al. (1976). Le poids de la carcasse comprend le rognon et son gras.

Résultats

Les poids en fonction des âges sont résumés au Tableau 1.

Tableau 1. Poids par classe d'âge de référence.

Naissance	:	1,1 ± 0,2 kg
5 mois	:	5,9 ± 1,2 kg
12 mois	:	11,6 ± 2,0 kg
15 mois	:	13,3 ± 1,8 kg
24 mois	:	20,1 ± 2,9 kg

Les caractéristiques des animaux adultes (24 - 30 mois) sont les suivantes: Hauteur au garrot 43,0 ± 3,0 cm, périmètre thoracique 65,3 ± 4,2 cm, longueur du corps 59,0 ± 4,0 cm, poids vif 21,0 ± 3,0 kg.

Le poids de carcasse est de 10,3 ± 2,0 kg avec un rendement brut de 52,9 ± 2,4% (sur la base du poids vif à jeûn) et un rendement vrai de 58,4% (sur la base du poids vif vide). Toutefois si l'on tient compte des abats, les rendements passent respectivement à 72,0 et 79,5%. Mais en fait, toutes les parties de l'animal sont consommées, à savoir la tête, les pieds et la peau (l'animal n'étant pas dépouillé mais les poils sont brûlés et grattés). Il faut ajouter que le sang est utilisé également dans une préparation culinaire avec le cinquième quartier. C'est dire que la chèvre a une valeur commerciale considérable. Les carcasses paraissent excessivement grasses avec une accumulation de graisse autour des viscères, dans les espaces inter-musculaires et sous-cutanés. La graisse sous-cutanée a une épaisseur moyenne de 3,0 ± 1,4 mm. La graisse de rognon a un poids de 373 ± 128 g et la graisse intestinale pèse 788 ± 290 g.

Les dimensions de la carcasse sont présentées dans le Tableau 2. L'indice de compacité (rapport poids de carcasse sur longueur) est assez bonne : 0,2 ; l'indice de gras (rapport du gras de rognon sur poids de carcasse en %) très élevé : 3,6. Le rebondi (rapport G/F) vaut 0,8. Le baron (gigot + selle + filet) a une valeur de 42,6% de la carcasse. Ainsi, malgré une faible proportion de l'arrière, la carcasse de la chèvre adulte est assez bien conformée pour la boucherie.

La carcasse est caractérisée par une faible proportion du gigot (Tableau 3) et d'une manière générale par une réduction des proportions des membres

postérieurs. La répartition des diverses catégories de morceaux se présente comme suit: 1ère catégorie : 51,4%, 2ème catégorie : 27,3% et 3ème catégorie : 21,3%. Cette répartition est en faveur des morceaux nobles.

Tableau 2. Mensurations de la carcasse.

	cm
Longueur de la base de la queue à la base du cou	45,2 ± 1,5
Plus grande largeur au niveau des côtes	19,1 ± 1,4
Distance la plus courte entre le périnée et le bord inférieur de la surface articulaire tarso-métatarsienne (F)	24,9 ± 0,6
Plus grande largeur au niveau des trochanters (G)	20,6 ± 0,9

Tableau 3. Proportions relatives des différents morceaux de la carcasse.

	Poids (g)	% de la carcasse
Gigot	1099	22,6 ± 1,0
Selle	466	9,2 ± 0,8
Filet	527	10,8 ± 1,0
Carré couvert	435	8,8 ± 0,9
Carré découvert	287	6,2 ± 0,6
Epaule	998	21,1 ± 0,7
Poitrine	641	12,8 ± 0,1
Collier	399	8,6 ± 0,6

Le Tableu 4 donne la répartition des différents tissus dans les morceaux. Les carcasses sont excessivement grasses. Cependant le taux de muscles reste satisfaisant et le rapport muscles sur os, élevé : 3,37. Les

Tableau 4. Composition organique des différents morceaux.

	%			
	Muscles	Os	Graisses	Déchets
Gigot	69,3	14,4	10,5	5,9
Selle	59,0	20,2	14,9	6,0
Filet	59,9	11,2	22,2	6,7
Carré couvert	49,2	7,0	18,8	5,1
Carré découvert	58,4	26,9	7,2	7,5
Epaule	64,0	17,5	3,0	5,6
Poitrine	52,4	17,5	25,6	4,5
Collier	62,8	23,8	5,8	7,7
Carcasse	61,6	18,2	14,3	6,0
	±2,3	±1,5	±3,4	±0,9

morceaux les plus maigres sont le gigot, le carré découvert, l'épaule et le collier, tandis que la poitrine, le filet et le carré sont les plus gras. La composition tissulaire de la carcasse fait de la chèvre Djallonké un excellent animal de boucherie, ce qui en fait constitue sa seule vocation.

Discussion et conclusion

Les résultats obtenus dans cette expérience montrent que la chèvre naine de l'Afrique de l'Ouest atteint sa pleine maturité vers l'âge de 24 - 30 mois. Son rendement est alors maximal. En effet dans un essai antérieur avec de jeunes mâles castrés (9 - 15 mois), les rendements obtenus étaient plus faibles (48,1 et 54,6%). Les rendements du présent essai sont aussi supérieurs à ceux obtenus avec des adultes mâles castrés du Botswana par Owen et al. (1977) (48,3 et 55,8%). Nos résultats se classent parmi les meilleurs en zone tropicale (Devendra & Owen, 1977). En ce qui concerne la composition tissulaire, on note un accroissement du tissu gras au détriment de la musculature et de l'os chez les animaux adultes en comparaison avec les jeunes avec toutefois un meilleur rapport muscles sur os (3,4 contre 3,2). Contrairement aux jeunes mâles, la carcasse des adultes est couverte de graisse. La carcasse de la chèvre du Botswana est aussi grasse (14,8% de gras) mais avec un plus faible taux de muscles : 57,8% (Owen et al., 1977).

En conclusion on peut dire que la chèvre Djallonké bien nourrie atteint sa pleine maturité vers deux ans. Elle donne alors de bons rendements à l'abattage, une composition tissulaire satisfaisante, avec toutefois un certain excès de graisses qui est d'ailleurs apprécié par la population locale.

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NUTRITIVE EVALUATION OF ECHINOCHLOA PYRAMIDALIS USING WEST AFRICAN DWARF GOATS

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Abstract

The nutritive value of Echinochloa pyramidalis, a floating macrophyte growing on lake Kainji, was evaluated using four batches of six West African Dwarf goats fed exclusively on the plant harvested at 4 stages of regrowth - 3, 6, 9, and 12 weeks to determine voluntary intake, nutrient digestibilities and nitrogen balance. Samples of the plant taken at the various stages of regrowth were analysed for proximate contents as well as acid detergent fibre and gross energy.

The crude protein (98.2 g kg^{-1} DM) and carbohydrate fraction - both structural (442.8 g kg^{-1} DM) and non-structural (512.3 g kg^{-1} DM) - were fairly high at 6 weeks of age with the sugar content being higher than in most forages. Voluntary intake, digestibility of dry matter, organic matter, lignin and energy fractions decreased with increasing maturity beyond 6 weeks of age.

The nutritive value index of the forage ranged from 23.4 at 12 weeks to 35.8 at 3 weeks of age. Digestible dry matter intake at 6 weeks was 30 $MJ/kg^{-0.75}$ d^{-1}, digestible energy intake 0.60 MJ $^{k}g^{-0.75}$ d^{-1} and N retention of 0.1 g N g $kg^{-0.75}$ d^{-1} showed that the goats could be maintained on six weeks old E. pyramidalis.

EVALUATION DES CARACTERISTIQUES NUTRITIVES D'ECHINOCHLOA PYRAMIDALIS POUR LES CHEVRES NAINES DE L'AFRIQUE DE L'OUEST

Résumé

Quatre groupes de 6 chèvres naines ouest-africaines ont été utilisés pour évaluer la valeur nutritive d'Echinochloa pyramidalis, un macrophyte flottant à la surface des eaux du lac Kainji. Les animaux ont été nourris exclusivement de cette plante, récoltée a 4 stades de regain (à 3, 6, 9 et 12 semaines) afin de mesurer l'ingestion volontaire, la digestibilté et le bilan azoté. Des échantillons végétaux ont été prélevés à différents stades de regain et analysés pour leurs teneurs approximatives ainsi que pour leurs ADF et énergie brute.

Les fractions protéiques brutes (98,2 g/kg MS) les hydrates de carbone structurels (442 g kg^{-1} MS) et non-structurels (512 g kg^{-1} MS) étaient assez importantes lorsque la maturité était de 6 semaines et la teneur en sucres était plus éevée que celle de la plupart des autres fourrages. Par contre, on a pu observé une diminution progressive de l'ingestion volontaire, de la digestibilité des matières sèches et de la lignine et de la valeur du fourrage en tant que source énergétique, à dès maturités supéieures à six semaines.

L'indice de valeur nutritive s'étageait de 23,4 pour les fourrages vieux de 12 semaines à 35,8 pour les fourrages de 3 semaines. Les valeurs observées à 6 semaines pour l'ingestion des matières sèches digestibles

(30 g $kg^{-0.75}$ j^{-1}), et de l'énergie digestible (0.6 MJ $kg^{-0.75}$ j^{-1}) et pour le bilan azoté (0,1 g N $kg^{-0.75}$ j^{-1}) ont montré que la ration d'entretien des caprins pouvait être assurée par l'ingestion d'E. pyramidalis ayant une maturité de 6 semaines.

Introduction

Echinochloa pyramidalis as well as E. Colonum (L) Link and E. stagnina (Retz). Beauv. are known to be particularly rich fodder for livestock both as green fodder and as hay (Adebowale, 1987). The grains are also edible. E. pyramidalis is very common in swampy areas and also in periodically flooded sandy river beds found in many parts of Northern Nigeria and along the Southern Lagos Lagoon coast.

Ruminants may lose weight during the dry season because of scarcity of suitable fodder. Many farmers settled around Lake Kainji in Kwara State, Nigeria, have recognised the dry season fodder potential of the plant and thus harvest large quantities of the grass to feed their stock during the dry season. An evaluation of the nutritive value of the E. pyramidalis is presented in this paper.

Materials and Methods

The grass was cut back just above the water level in October and the cleared area was divided into four plots. Regrowths were thereafter harvested at 3, 6, 9 and 12 weeks from the four plots respectively by hand clipping. The samples were wilted for 48 hours, hand crimped and chopped into 2 cm lengths. They were bagged and later oven dried at 50°C for 48 hrs. Subsamples taken before bagging were dried at 100°C for 24 hrs to determine dry matter content.

Twenty-four West African Dwarf goats weighing between 14 and 17 kg were randomly divided into four groups of six animals each. Animals were weighed at the beginning and at the end of the experiment. The average of the two live weights was used to calculate mean metabolic body weights. Animals were confined in individual metabolism cages during the entire period of the experiment. They were fed twice daily and allowed free access to water in a ten-day period followed by a ten-day collection period during which the animals were fed at 90% of ad libitum intake. Procedures for sampling feed, faeces and urine were as described by Adebowale (1983). Proximate contents of these samples were determined using standard AOAC (1975) methods while forage fibre was analysed as described by Goering & Van Soest (1970). Gross energy of feed and faeces were determined in a Gallenkamp ballistic bomb calorimeter using benzoic acid as the standard. Data were analysed by analysis of variance for a completely randomized design as described by Steel & Torrie (1960).

Results and Discussion

Acid detergent fibre and gross energy values increased, while crude protein and digestible energy values decreased with forage age (Table 1). Oyenuga (1958), Ademosun & Baumgardt (1967) and Ademosun (1968) reported a similar trend. Despite the increase in gross energy, digestible energy declined with maturity due to the fact that as the plant matured lignification increased. Dry matter intake as shown on Table 2 decreased from 47.5 g $kg^{-0.75}$ d^{-1} at 6 weeks to 36.5 g $kg^{-0.75}$ d^{-1} at 12 weeks of age. This intake is lower than 51.3 g $kg^{-0.75}$ d^{-1} recorded by Adebowale (1987) for WAD goats fed on Echinochloa stagnina. Both structural and non-

structural carbohydrate contents were fairly high with the sugar content substantially higher than in most other forages. The high sugar content probably accounted for its high palatability.

Table 1. Chemical composition of Echinochloa pyramidalis at different stages of growth.

Age (wks)	Ash	Crude protein	Acid detergent fibre	Nitrogen-free extractives	Gross Energy (MJ/kg DM)	Digestible Energy MJ/kg DM)
	g DM kg^{-1}					
3	89.3	93.5	414.1	532.6	19.5	12.3
6	91.2	98.2	442.8	512.3	20.1	11.9
9	86.2	87.4	495.2	462.1	21.7	11.7
12	90.4	72.5	508.4	448.0	21.6	11.1

Table 2. Voluntary intake by WAD goats of E. pyramidalis.

Age (wks)	3	6	9	12	SEM
No of animals	6	6	6	6	
Average wt (kg)	15.2	14.8	16.7	15.5	
Dry matter intake					
- g/day	348.4	356.2	364.5	285.0	18.1
- g $kg^{-0.75}$ d^{-1}	45.2	47.5	43.9	36.5	2.4
Digestible dry matter intake (g $kg^{-0.75}$ d^{-1})	30.0	30.0	26.7	18.7	2.6
Digestible energy intake (MJ $kg^{-0.75}$ d^{-1})	0.6	0.6	0.6	0.4	0.1

Apparent digestibility of dry matter (DM),organic matter(OM), acid detergent fibre (ADF) and gross energy (GE) increased up to 6 weeks of age, then decreased progressively thereafter (Table 3). However, with the

Table 3. Apparent digestibility (%) of E. pyramidalis by WAD goats.

Age (wks)	3	6	9	12	SEM
Apparent digestibility (%)					
dry matter	66.4	63.2	60.9	51.2	3.3
organic matter	70.1	68.2	59.1	55.6	3.5
acid detergent fibre	56.2	57.1	41.2	42.3	1.4
energy	63.2	59.1	53.9	51.4	2.5
Nutritive value,					
relative intake	56.6	59.0	55.2	45.6	2.9
nutritive value index	35.8	34.9	32.7	23.4	2.8

exception of GE digestibility, values were not statistically (P>0.05) better for the six week than the three week old plants. In all cases, the 12 week old forage was the least digested. Increased lignification with maturity of forage partly accounted for this decline in digestibility. The relative intake and nutritive value index were calculated according to the formula of Crampton et al. (1960). Except for the 12 week old forage values were higher than those obtained by Ademosun (1968) for P. purpureum.

Digestible dry matter intake (DDMI) ranged between 18.7 g $kg^{-0.75}$ d^{-1} for the 12-week to 30 for the 3 and 6 week old forages (Table 2). Zemmelink et al. (1985) estimated the energy requirements for maintenance and growth of WAD goats at 26.0 g DOM $kg^{-0.75}$ d^{-1} and 2.4 g DOM/g live weight gain respectively. With an ash content of nearly 10%, it will require 28.9 g DDMI $kg^{-0.75}$ d^{-1} of E. pyramidalis for maintenance only. This shows that only the three week and six week old forages could maintain the animals. Goats on the nine and 12 week old forages actually lost weight throughout the experimental period. Ademosun et al. (1985) obtained a DDMI of 45.3 g $kg^{-0.75}$ d^{-1} when WAD goats were fed a combination of Leucaena leucocephala and Gliricidia sepium. When the investigators fed a combination of Panicum maximum and Leucaena leucocephala, a DDMI of 35.0 was obtained. This was slightly better than feeding E. pyramidalis alone.

The nitrogen retention of goats fed on the 3 and 6 week old forages was very low, 0.1 g N $kg^{-0.75}$ d^{-1}. Other groups were in negative balance (Table 4). Since N data showed the goats to be in positive balance for the 3 and 6 week old forages, it could be assumed that their N requirements for maintenance were being met.

Table 4. Nitrogen balance of WAD goats fed on E. pyramidalis.

Age at harvest (wks)	3	6	9	12	SEM
	g $kg^{-0.75}$ d^{-1}				
Nitrogen intake	0.70	0.74	0.62	0.51	0.05
Nitrogen excretion,					
faecal	0.30	0.32	0.30	0.28	0.01
urinary	0.32	0.37	0.32	0.26	0.02
total	0.62	0.64	0.62	0.54	0.02
Nitrogen retention	0.08	0.10	0.00	-0.03	0.03

This study shows that E. pyramidalis at six weeks of age could best maintain WAD goats. Beyond that, nitrogen retention might be negative while intake becomes poor. Since seasonal effects do not affect its growth adversely, E. pyramidalis appears to be a potential source of nutrients for small ruminant livestock throughout the year.

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THE NUTRITIVE VALUE OF GRASS ENSILED WITH CASSAVA PEEL AND POULTRY EXCRETA FOR GOATS

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Abstract

In an effort to provide dry season feed for ruminants, a crop of Panicum maximum and Pueraria phaseoloides was ensiled with cassava peel and poultry excreta in the ratio of 60:20:20 respectively. A digestibility trial with eight animals was conducted to evaluate the nutritive value of the grass silage for goats. Maize silage served as control diet. Rumen fluid and blood samples were taken at 0, 1, 2, 4, 8 hr after feeding and were analysed respectively for pH, NH_3-N, volatile fatty acids (VFA), osmolality and blood Urea-N, blood glucose and thiocyanate concentrations. The grass silage was well consumed by the goats (grass silage 427.8 g DM d^{-1}, maize silage 431 g DM d^{-1}). The digestibility of organic matter, crude protein, ether extract and nitrogen-free extract did not differ ($P>0.05$) for the two diets but the maize silage resulted in higher ($P<0.05$) digestibility of dry matter and crude fiber. Blood urea nitrogen and blood glucose levels were not affected ($P>0.05$) by dietary treatment. Blood thiocyanate levels were higher ($P<0.05$) with the grass silage diet. Rumen fluid ammonia nitrogen, pH and total VFA were similar ($P<0.05$) for the two diets, except at 4 hr when total VFA was higher for the maize silage diet. Rumen fluid osmolality was higher ($P<0.05$) immediately after feeding for the grass silage.

Parameters determined indicated a normal rumen function. It is concluded that grass ensiled with cassava peel and poultry excreta can sustain ruminant animals during the dry season.

VALEUR NUTRITIVE D'UN ENSILAGE D'HERBES MELANGEES A DES EPLUCHURES DE MANIOC ET DES FIENTES DE VOLAILLES, DESTINE A L'ALIMENTATION DES CAPRINS

Résumé

Une récolte de Panicum maximum et Pueraria phaseoloides a été mélangée et ensilée avec des épluchures de manioc et des fientes de volaille dans des proportions de 60, 20 et 20 respectivement en vue de constituer un fourrage de saison sèche pour les ruminants. Un essai de digestibilité a été conduit sur huit animaux afin d'évaluer la valeur nutritive de l'ensilage herbacé pour les caprins. Un ensilage de maïs a servi de régime alimentaire témoin. Du jus de rumen et des échantillons de sang ont été prélevés à des intervalles de 0, 1, 2, 4 et 8 heures après les repas et analysés pour en déterminer le pH, les teneurs en ammoniaque, azote et acides gras volatiles, l'osmalalité et les concentrations sanguines en urée, azote, glucose et thiocyanate.

L'ensilage herbacé a été bien consommé par les chèvres (ensilage herbacé 427,8 g MS/j ; ensilage de maïs 431 g MS/j). La digestibilité des matières organiques des protéines brutes, des extraits d'éther et des extraits non azotés ne différait pas d'un ensilage à l'autre ($P>0,05$) mais la

digestibilité des matières sèches et des fibres brutes était plus élevée (P<0,05) dans le cas du maïs. Le régime alimentaire n'a pas modifié les teneurs en urée, azote et glucose du sang (P>0,05) mais les niveaux de thiocyanate étaient plus élevés (P<0,05) avec l'ensilage herbacé. Les teneurs en ammoniaque, azote, acides gras volatiles et le pH du jus de rumen étaient similaires (P<0,05) pour les deux régimes sauf à 4 h où la concentration d'acides gras volatiles était plus forte dans le cas de l'ensilage de maïs. L'osmolalité du jus de rumen était plus élevée (P<0,05) immédiatement après les repas pour l'ensilage herbacé.

Les paramètres mesurés ont indiqué un fonctionnement normal du rumen et permettent de conclure qu'un ensilage d'herbes mélangées à des épluchures de manioc et des fientes de volaille peut assurer une ration d'entretien au ruminant en saison sèche.

Introduction

One of the major constraints to the production of small ruminants in the humid tropics is the problem of insufficient feed to sustain their growth during the dry season. In some instances, the problem is alleviated by feeding preserved forages in the form of hay or silage. Good quality hay is difficult to make, particularly in the tropical rain forest zone due to inclement weather. The best and most popular silage is made from maize crop. Unfortunately, the ever increasing human population is making higher demands on the maize crop. This is in addition to the massive requirements for the monogastric animals, and, more recently, local industries have started to use maize for the production of alcoholic beverages and flour.

The necessity to reserve any available maize for the above priorities calls for investigations into alternative dry season feeds. This trial was, therefore, set up to investigate the feasibility of making a good quality silage with grass, cassava peels and poultry excreta, and also to evaluate its nutritive value for goats.

Materials and methods

A crop of Panicum maximum interspersed with Pueraria phaseoloides was ensiled with cassava peel and poultry excreta in an experimental silo (2 x 3 x 2 m). Poultry excreta from caged layers was partially dried to reduce the moisture content. Cassava peel was gathered from the Orie Oba (Nsukka) market area. The three feeds were ensiled in the ratio of 60:20:20 respectively, on wet weight basis. In filling the silo, an effort was made to mix the three feeds as uniformly as possible. The silo was covered with polythene sheets on which cement blocks were piled for tight packing. The silo was then left undisturbed for 90 days before the trial commenced.

Eight West African dwarf bucks with an average initial weight of 15 kg were used. The eight animals were individually housed in metabolism crates. Four animals were fed the grass/cassava peel/poultry excreta silage while the remaining four animals were fed a control maize silage diet supplemented with wet brewers' grain. Both diets were iso-nitrogenous (14% crude protein). Feed and water were available continuously and the trial lasted for 28 days.

Blood and rumen samples were taken on days 18 and 20. Blood samples were obtained before the morning feeding (0 hr) and at intervals of 1, 2, 4 and 8 hours after feeding. Half the samples from each animal were transferred into vials containing some anticoagulant (EDTA) The other half was clotted and centrifuged to collect the serum. Samples were stored at -10°C until analysed. Rumen fluid was collected by stomach tubing aided by a vacuum

pump. Rumen fluid samples were filtered through four layers of cheese cloth and dipped into an ice bath until frozen. A fraction of the rumen fluid was used to measure pH and osmolality. During the last seven days of the trial faeces were collected daily before the morning feeding and dried in the oven at 105°C for 24 hours. Faecal collections from each goat were bulked and stored in polythene bags.

Chemical analyses of the feed and faecal components were by standard AOAC (1975) procedures. Rumen ammonia and plasma urea nitrogen concentrations were determined by the method of Fawcett & Scott (1960) as modified by Chaney & Marbach (1962). The pH of the rumen fluid was measured with a crison pH meter. The thiocyanate content of blood serum was determined by the method of Bowler (1944) while the HCN content of the feed was estimated by the method of AOAC (1975). Rumen fluid osmolality was measured with an "OSMETTE A" automatic osmometer (Precision Systems Inc., Sudbury, Mass.). The results were subjected to analysis of variance according to Steel & Torrie (1980).

Results

The chemical characteristics of the two silages are shown in Table 1. The pH (4.6) of the forage silage is an indication that the silage was of good quality. Animals were initially reluctant to consume the silages, particularly the forage silage. However, after the 10th day of feeding, they increased their consumption and reached their peak intake about the

Table 1. Chemical characteristics of grass and maize silages.

	Grass silage	Maize silage*
Dry matter	30.5	29.8
Crude protein	13.8	8.5
Crude fiber	35.2	29.7
Ether extract	3.0	3.3
Ash	8.4	5.8
Nitrogen free extract	39.7	52.7
Gross energy MJ kg^{-1}	17.6	18.2
pH	4.6	4.8
Osmolality mOsm kg^{-1}	657	628
HCN mg kg^{-1}	52.5	4.6

* To present isonitrogenous diets (15% CP) the maize silage was supplemented at feeding with wet brewers' grain.

16th day. The data for dry matter intake and digestibility are shown in Table 2. There was no significant difference ($P>0.05$) in the dry matter intake of the two diets. The digestibility of organic matter, crude protein, ether extract and nitrogen free extract did not differ ($P>0.05$) for the two diets. Dry matter and crude fibre digestibility coefficients were however, higher ($P<0.05$) for the maize silage diet.

Changes in the concentration of rumen metabolites with time after feeding are shown in Table 3. Rumen fluid pH declined with time after feeding, reaching low levels at 2-4 hrs. There was no difference ($P>0.05$) in rumen fluid pH for the two diets although there was the tendency for lower pH with the grass silage diets. Rumen ammonia concentration did not

Table 2. Average dry matter intake and apparent nutrient digestibility coefficient.

	Grass silage	Maize silage
Dry matter g d^{-1}	427.8	431.0
Nutrient digestibility (%)*		
dry matter	65.2[a]	70.1[b]
organic matter	73.8	75.1
crude protein	70.4	68.9
crude fibre	57.6[a]	63.3[b]
ether extract	68.8	71.3
nitrogen free extract	81.4	82.1

* Means bearing different superscript differ significantly ($p<0.05$).

Table 3. Effect of diet and time after feeding on rumen fluid metabolites.

Metabolite*	Diet	Post-feeding time (hr) 0	1	2	4	8
pH	grass silage	6.2	5.7	5.4	5.8	5.5
	maize silage	6.4	5.9	5.6	5.5	5.5
NH_3-N	grass silage	10.5	15.8	21.9	18.9	15.4
mg/100 ml	maize silage	12.6	18.1	23.5	20.9	18.2
VFA	grass silage	1.3	3.2	5.1	6.8[a]	6.4
mg/100 ml	maize silage	1.2	3.6	5.8	7.2[b]	6.8
Osmolality	grass silage	292	344[a]	368[a]	332	319
mg kg^{-1}	maize silage	285	308[b]	341[b]	325	304

* Means bearing different superscript differ significantly ($p<0.05$).

vary ($P>0.05$) between the two diets but it was affected by time after feeding. Total volatile fatty acid (VFA) concentration was similar ($P>0.05$) for the two diets except at 4 hrs after feeding when there was a higher build up of VFA for the maize silage diet. Rumen osmolality increased with post-feeding time. Higher values ($P<0.05$) were observed with the grass silage diet in the first two hours after feeding. The concentrations of blood plasma urea nitrogen, blood glucose and thiocyanate are shown in Table 4. The concentrations of plasma urea nitrogen and blood glucose increased postprandially and did not differ ($P>0.05$) for the two diets. Blood thiocyanate levels were higher ($P<0.05$) for the forage silage diet with the highest level recorded at 8 hours after feeding.

Discussion

In spite of the initial reluctance to eat, the goats finally increased their feed intake to levels that compare with 403-493 g d^{-1} reported for goats averaging 15 kg live weight (Ash & Norton, 1984). The intake values amounting to 2.9% of the body weight are in agreement with the value of 2.8% of the body weight reported by Akinsoyinu (1985) and the value of 440 g dry matter intake d^{-1} for goats averaging 14 kg (Mba *et al.*, 1974). It has been stated that voluntary feed intake is an important factor in

Table 4. Effect of diet and time after feeding on blood levels of urea-N, glucose and thiocyanate.

Metabolite*	Diet	Post-feeding time (hr) 0	1	2	4	8
Blood urea-N	grass silage	27.4	29.8	31.8	38.2	38.0
mg/100 ml	maize silage	28.5	31.3	33.1	37.9	40.1
Blood gluc.	grass silage	19.1	28.5	32.5	41.3	41.8
mg/100 ml	maize silage	21.1	27.4	33.4	38.8	41.4
Blood thiocyanate	grass silage	2.6[a]	2.8[a]	3.7[a]	4.0[a]	4.8[a]
mg/100 ml	maize silage	0.5[b]	0.7[b]	1.4[b]	1.4[b]	2.1[b]

* Means bearing different superscript differ significantly ($p<0.05$).

determining the quality of feeds (Milford & Minson, 1966). The level of dry matter of the grass silage consumed is an indication of its quality. Why of the dry matter and crude fiber of the maize silage is highly digestible is not very clear. It is speculated that the supplemental brewers' grain may have stimulated the rumen function, thus resulting in better digestibility of the two nutrients. The similar pH of the rumen fluid in the two groups of goats suggests a similar fermentation pattern.

Rumen ammonia nitrogen concentration was not different for the two diets. This was expected since both diets were isonitrogenous. The concentration of ammonia-N was consistently within the range 5-25 mg/100 ml required for rumen microbial growth (Satter & Slyter, 1974; Mehrez & Ørskov, 1976). The lack of any difference in the concentration of total VFA indicates some common pattern of fermentation. There is also a strong indication that the grass silage is as efficient as the maize silage in the supply of VFA.

Higher rumen fluid osmolality observed for the grass silage may be due to higher concentration of silage acids as reflected in the lower silage pH. The highest level of rumen osmolality (368 mOsm kg^{-1}) observed at 2 hrs for the grass silage diet, is below the critical level of 400 mOsm kg^{-1} which may limit rumen function (Bergen, 1972).

It has been reported that a linear relationship exists between ruminal ammonia and blood urea (Lewis, 1957; Abou Akkada & Osman, 1967). The relatively low levels of blood urea nitrogen observed in this trial are a good indicator of the intake level and solubility of the nitrogen-containing compounds fed (Lee et al., 1978). The postprandial rise in blood glucose may be attributed to early increase in the proportion of propionic acid at the expense of acetic acid, due to the availability of readily fermentable carbohydrates in the two silages.

Higher blood thiocyanate concentrations for the grass silage diet were expected, since it contained cassava peel. These thiocyanate levels were considered low and they indicate a light load of HCN in the rumen.

Conclusion

Ensiling of Panicum maximum and Pueraria phaseoloides with cassava peel and poultry excreta gave a good quality silage which was consumed in equal amount as the maize silage. Although the dry matter and crude fibre digestibility was lower for the grass silage diet, the overall indication is that the diet was well utilized by goats. It is recommended, therefore, that, in anticipation of dry season feeding, grasses or grass/legume

forages be ensiled supplemented with cassava peel for energy and poultry excreta for crude protein.

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HERD-HEALTH PROBLEMS IN WEST AFRICAN DWARF GOATS RAISED IN CONFINEMENT IN THE HUMID TROPICS

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Abstract

Recorded cases of diseases and deaths, and their causes in a herd of West African Dwarf goats raised in complete confinement in the humid forest zone of Nigeria were analysed in order to identify the more prevalent diseases associated with a management system not commonly used to raise goats in Nigeria. The herd comprised a foundation stock of 78 does and 5 bucks plus their 434 descendants born during the 6-year period (1982 to 1987) when herd health was monitored.

Analyses of the herd health records showed that infectious conditions accounted for about 70% of all recorded disease conditions. Parasitism (internal and external), reproductive problems and injuries each had a proportional morbidity rate of 6%, while nutritional disorders and miscellaneous conditions had 3 and 8% respectively.

Proportional morbidity and mortality rates of the more prevalent specific diseases grouped under the six headings above were: enteritis 19 and 8%; contagious ecthyma, 19 and 0%; caseous lymphadenitis, 11 and 0%; broncho-pneumonia, 8 and 10%; trauma, 6 and 9%; rickets, 3 and 9%; mange 3 and 0%; coccidiosis 3 and 1% respectively. Peste des petits ruminants which had a proportional morbidity rate of less than 1%, nevertheless had a high case fatality rate of 71%, underlining the deadly nature of the disease. Other entities with high case fatality rates were rickets 77%, trauma 35%, broncho-pneumonia 29% and enteritis 9%.

Prophylactic health packages must be targeted towards these entities with high mortality rates. Other conditions with low mortality rates but high incidence should not be neglected because of their subtle detrimental effects on productivity and economic returns.

PATHOLOGIE DES TROUPEAUX DE CHEVRES NAINES DE L'AFRIQUE DE L'OUEST ELEVEES EN ENCLOS DANS LES REGIONS TROPICALES HUMIDES

Résumé

Les cas signalés de maladie et de mortalité ont été analysés et leurs causes etudiés sur un troupeau de chèvres naines ouest-africaines maintenu strictement en claustration en zone forestière humide au Nigéria afin d'identifier les principales maladies associées à cette méthode de conduite qui n'est pas traditionnelle au Nigéria. Le troupeau était composé de géniteurs (78 chèvres et 5 boucs) et de leurs 434 descendants nés entre 1982 et 1987 pendant la période de suivi de la santé des animaux.

L'analyse des fiches de santé a montré que les maladies infectieuses etaient dominantes et représentaient environ 70% de tous les cas de morbidité signalés. Les taux de morbidité pour le parasitisme interne et externe, les problèmes de reproduction et les blessures résultant d'accidents étaient de 6% dans les trois cas tandis que les désordres

nutritionels et autres conditions pathologiques représentaient 3 et 8% respectivement des cas de morbidité.

On a observé les taux de morbidité et de mortalité suivants pour les principales maladies spécifiques regroupées dans les six grandes catégories précitées: entérite, 19 et 8%; ecthyma contagieux, 19 et 0%; lymphadénite caséeuse, 11 et 0%; broncho-pneumonies, 8 et 10%; traumatismes, 6 et 9%; rachitisme, 3 et 9%; gale, 3 et 0%; coccidiose, 3 et 1%. La peste des petits ruminants dont le taux de morbidité était inférieur à 1% était affectée, néanmoins, d'un taux de mortalité très élevé (71%), témoignant bien de l'issue, le plus souvent fatale, de cette maladie. On a aussi trouvé un taux de mortalité élevé dans les cas suivants: rachitisme (77%), traumatismes (35%), broncho-pneumonies (29%) et entérites (9%).

Tout ensemble de mesures prophylactiques doit viser les catégories de maladies dont les taux de mortalité sont élevés. Cependant il convient de ne pas négliger les états pathologiques dont les taux de mortalité sont faibles mais dont l'incidence est élevée car ils sont souvent préjudiciables à la productivité et à la rentabilité économique.

Introduction

According to recent estimates (FAO, 1981), 96% of the 469 million goats in the world are found in developing countries. In terms of productivity per animal however, goat meat yield in developing countries is only 62% of what is produced in developed countries (World bank, 1983). Nigeria alone, with her 26 million head of goats holds 6% of the world goat population and yet cannot meet her demands or needs for animal protein from all livestock sources. The problem is clearly not one of inadequate numbers but of low productivity.

Goat rearing in Nigeria is a low input, minor farm activity concentrated mainly in the rural areas. According to Sumberg & Cassaday (1985), up to 75% of the rural village population keep small ruminants with an average herd size of 2-5 animals per house hold, goats being more commonly kept than sheep. These animals which constitute the bulk of the Nigerian goat population are managed under the extensive, low-input, traditional husbandry system, which allows the animals to roam about in search of food. Housing, regular and specialised feeding, and veterinary care are not provided. Understandably, disease morbidity and mortality are high among these village goats, and productivity is low, never reaching the animal's potential.

Major changes in the management system are therefore required to improve goat productivity in Nigeria. A shift from the traditional extensive system to a more intensive system is already apparent in South-Eastern Nigeria, where, because of increasing human population density and decreasing agricultural land, goats and sheep are being increasingly restricted in small stockades or by tethering (Mack et al., 1985).

In South-West Nigeria where the subsistence, low-input system is still common, recent studies (Mack, 1983; Adeoye, 1985) have demonstrated that simple veterinary interventions such as vaccination against peste des petits ruminants (PPR) and mange treatment may improve productivity and reduce mortality. Reduced mortality means larger herds. In other words, if these veterinary interventions continue for much longer, the free roaming goats will eventually need to be confined, if only to protect valuable crops. Confined rearing of goats either from a desire to improve productivity and make goat rearing a profitable venture, or because of diminishing agricultural land appears inevitable.

Confined rearing demands a high level of management in terms of specialised feeding, housing, routine and veterinary care. Appropriate feeding, housing and management needs of confined goats have been discussed by others at this workshop (Ademosun, 1987; Bosman et al., 1987). Disease prevalence, incidence and severity have been shown to vary with management system (Smith & van Houtert, 1984). These authors reported that while infections accounted for over half of all disease conditions observed in a group of intensively managed goats, they were of negligible prevalence in a control group raised semi-intensively. In this latter group, parasitic gastro-enteritis was the most prevalent disease condition.

It is important therefore to identify the more prevalent diseases in goats reared in confinement, a hitherto uncommon management system for goats in this environment, so that appropriate prophylactic measures can be formulated for potential entrepreneurs. Towards this end, we present a summary of observations made over a 6-year period (1982-1987), on the disease spectrum, morbidity and mortality rates, and seasonality within a herd of West African Dwarf goats raised in confinement in the humid forest zone of Nigeria.

Materials and Methods

The goat herd under study was maintained on the research farm of the Obafemi Awolowo University. Situated at an altitude of 240 mm above sea level, 7°28¹N and 4°23¹E, Ile-Ife ecologically typifies the hot humid tropical forest. The rainfall pattern is bimodal averaging about 1290 mm yearly. It is dry (36 mm/month) and hot (32°C) from November to March, but wet (165 mm/ month) and slightly cooler (28.9°C) from April to October.

The goat herd consisted of 83 foundation stock animals (5 bucks, 78 does) purchased over a period of 3 years, and their 434 descendants born over the 6 year period from 1982 to 1987. The foundation goats were quarantined for 28 days immediately after purchase and managed as detailed in Table 1. All the goats were kept in complete confinement within two types of housing units: a low cost half roofed bamboo unit and a more elaborate completely roofed barn. The pen floors in each type of unit were slatted except for a few solid experimental pen floors in the barn.

Table 1. Reception treatment of quarantined goats.

Period		Treatment
day 0	-	newly purchased goats tagged and transferred to isolation unit
day 1	-	prophylactic treatment with hyperimmune PPR antiserum
	-	prophylactic antibiotherapy for 3 days
day 4	-	broad-spectrum anthelmintic and coccidiostat treatment
day 7	-	washing with acaricide
day 10	-	TCRV vaccination
day 28	-	repeat acaricide and anthelmintic treatment

The daily routine management and feeding of the goats are well described by Ademosun (1987) and Bosman et al. (1987). Suffice it to note that the

goats were fed a basal roughage diet of Panicum maximum (Guinea-grass), Gliricidia sepium and Leucaena leucocephala, plus a concentrate supplement. Salt licks and water were provided continuously. In terms of health management, only Tissue Culture Rinderpest Vaccine (TCRV) was administered on a yearly basis to all goats older than 3 months. Deworming and acaricide treatments were only practised curatively as and when necessary.

A complete record of all illnesses, deaths and diagnosed causes was maintained on all the goats. The record was analysed to evaluate the relative importance of observed disease conditions in terms of morbidity and mortality rates, and seasonality. First, all diagnosed causes of illnesses and deaths were grouped under six headings: infection, parasitism, injuries, nutritional/metabolic disorders, reproductive problems and miscellaneous. The proportional morbidity rates of each group were then calculated by expressing the number of cases for a particular group as a percentage of all recorded cases of diseases or deaths.

Disease seasonality was determined for the more important disease conditions by expressing the number of cases of a particular disease observed during the wet (April-October) or dry (November-March) months, as a percentage of the total (wet plus dry season).

Disease morbidity rates within the herd was estimated as: (a) incidence rate, i.e., the number of observed cases of a particular disease expressed as a percentage of the total number of susceptible animals, and (b) proportional morbidity rate, i.e., the number of observed cases of a particular disease as a percentage of all disease conditions. Apart from estimating pre-weaning and post-weaning mortality rates, proportional mortality (number of animals that died of a particular disease as a percentage of the total number of deaths) and case fatality rates (number of animals that died of a particular disease, as a percentage of the total number of cases of the disease) were also calculated.

Results

A summary of disease morbidity according to the grouping described earlier is shown in Table 2. Infections were most prevalent accounting for over 70% of all disease conditions. At the other extreme were nutritional/metabolic disorders with a proportional morbidity of less than 3%. The other 4 groups of diseases each accounted for about 6% of observed disease conditions. The specific diseases categorised together under the six groups are shown in Table 3.

Table 2. Proportional morbidity rates of observed disease conditions.

Disease group	Observed no. of cases	Proportional morbidity (%)
Infections	608	71.8
Injuries	54	6.4
Parasitism	50	5.9
Nutritional/metabolic disorders	23	2.7
Reproductive problems	47	5.5
Miscellaneous	65	7.7
Total	847	100.0

Table 3. Common diseases of confined goats.

Infections	Injuries	Parasitism	Nutritional/ metabolic disorders
enteritis	broken horns	coccidiosis	rickets
broncho-pneumonia	abdominal hernias	helminthiasis	
contagious ecthyma	haematomaasis	mange	
caseous lymphadenitis	laceratrons		
PPR	fractures		

Reproductive problems	Miscellaneous
abortions	congenital limb malformation
still births	intestinal occlusion
agalactia	duodenal intussusception
mastitis	low birth weight
metritis	

Some of these diseases demonstrated a definite seasonality. Diseases that appeared more prevalent during the rainy season were: broncho-pneumonia (83% of cases occurred during the rains), enteritis (76%), PPR (85.7%) and mange (65%). Only rickets was more prevalent during the dry season (73%), while contagious ecthyma and caseous lymphadenitis were more or less evenly distributed. These trends are depicted in Figure 1.

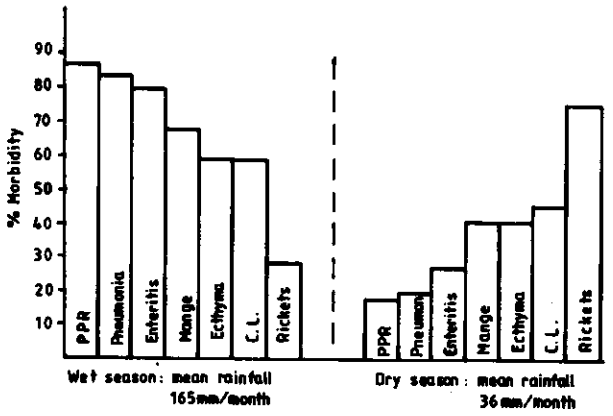

Fig. 1. Seasonal distribution of goat diseases.

Morbidity rates in terms of incidence and proportional morbidity of the more important diseases are summarised in Table 4, while their proportional mortality and case fatality rates are shown in Table 5. The data suggests that enteritis, contagious ecthyma, caseous lymphadenitis and broncho-pneumonia were of major concern in the confined goats. Together they accounted for over 50% of all disease conditions observed.

Table 4. Morbidity rates of common diseases of confined goats.

Disease	Incidence rate (%)	Proportional morbidity rate (%)
Enteritis	31.7	19.4
Contagious ecthyma	30.4	18.5
Caseous lymphadenitis	17.8	10.9
Broncho-pneumonia	12.6	7.7
Injuries	9.5	5.8
Rickets	5.1	2.6
Mange	5.0	3.1
Coccidiosis	4.1	2.5
PPR	1.4	0.01

Table 5. Mortality rates of common diseases of confined goats.

Diseases	Proportional mortality rate (%)	Case fatality rate (%)
Rickets	9.2	77.3
Broncho-pneumonia	10.3	29.2
Injuries	9.3	34.7
Enteritis	7.6	8.5
PPR	2.7	71.4
Coccidiosis	1.1	9.5

Caseous lymphadenitis and contagious ecthyma, while quite prevalent in the herd, caused no deaths. On the other hand, rickets and peste des petits ruminants (PPR) which were of very low incidence were extremely deadly, with over 70% of affected goats dying in each case. Losses from broncho-pneumonia were also fairly important (29% case fatality rate, CFR). The pre-weaning and post-weaning mortality rates were 27 and 20.9% respectively.

Discussion

The main objective of the study was to identify diseases that may be of major concern to confined goats. The more prevalent and serious diseases observed in this study (Table 3) have been reported by others working with free-roaming (Adeoye, 1985; Opasina, 1985; Adenowo et al., 1985) or confined (Akerejola, 1982; Otesile et al., 1983) goats. A few peculiarities of the present study directly related to the management system are worth highlighting.

The very low incidence of PPR, a disease reported by several authors (Nduaka & Ihemelandu, 1973; Ojo, 1976; Adekeye, 1984; Ezeokoli et al., 1984; Majiyagbe, 1985) as the most important viral disease of goats, seems strange.

Peste des petits ruminants lived up to its reputation of being a highly prevalent and deadly disease at the beginning of the project in 1981 when the herd was being assembled, and nearly completely wiped out the first batches of goats purchased during that year. Subsequently, the reception

treatment shown in Table 1, was routinely employed, and the incidence of PPR was drastically reduced.

Data on disease morbidity and mortality in 1981 were not included in the present report because the goats were then not raised in confinement until 1982, from which time they were vaccinated yearly against PPR using TCRV. By 1984, the herd became closed, as no new purchases were made from then on. In other words, the apparently low incidence of PPR could be attributed to the twin-factor of yearly vaccination and the absence of new entries.

A second peculiarity of the present report, is the unusually high incidence of rickets in the herd. As indicated earlier, the goats were fed mainly on roughage (Panicum maximum and Gliricidia) and concentrate supplements. During the dry season the diet consisted essentially of Panicum maximum hay, Gliricidia and concentrates. This browse has a disproportionately wide calcium-phosphorus ratio that could be as wide as 10 or 12:1 (Le Houerou, 1980; Kabaija, 1985). According to Underwood (1981) a liberal supply of vitamin D would be required for a proper utilisation of dietary calcium and phosphorus particularly when the ratio of the two elements is above the optimum of 2:1.

The goats housed in the completely roofed barn apparently did not receive an adequate supply of sunlight for vitamin D production to alleviate the effects of the adverse dietary calcium:phosphorus ratio. It was only in this group of goats that rickets was observed in kids aged 4-7 months. No cases of rickets were observed in the half-roofed bamboo units, which allowed a liberal absorption of ultra-violet rays for the conversion of skin 7-dehydrocholesterol to vitamin D.

The case fatality rate for rickets was high (77%) because once affected, the kids were reluctant to move (to feed troughs) and could not chew properly because the jaw articulation was affected. This led to a rapid weight loss and death. The problem of rickets was tackled by (a) replacing some of the asbestos roofing material with transparent material through which sunlight could pass, (b) building uncovered runs attached to kid pens to ensure an adequate daily dose of sunlight and (c) supplementing with a vitamin-mineral mix.

Goats are known to be highly susceptible to respiratory problems (Ojo, 1976), which may be exacerbated under confinement, owing to cold air drafts and high population density. Broncho-pneumonia was not only fairly prevalent, but also had a high case fatality rate (30%). Most of the observed cases were associated with the cool wet months. The few cases observed during the dry season occurred during the cold harmattan months.

Enteritis which had a high incidence rate was less fatal than broncho-pneumonia. Since the majority of cases occurred during the wet season when the animals were fed green lush herbages, we concluded that the high moisture content of the feed as well as the environmental temperature changes were to a large extent the causative factors. This conclusion was borne out by the fact that a large number of cases responded to simple intestinal astringents like kaolin.

In a previous study comparing disease incidence in goats reared intensively or semi-intensively, Smith & van Houtert (1984) reported that the incidence of injuries was 10 times higher in total confinement. Injuries also took a heavy toll in the present study accounting for 9% of all deaths in the herd, with 35% of all injured goats dying. Injuries caused by horn butting during feeding or after returning weaned does to the dry doe pens were fairly common. Dehorning, provision of adequate numbers of feed troughs and movement of a group rather than single weaned does to the dry doe pens were the management techniques used to alleviate this problem. Another important cause of injuries was the limbs getting

caught between the slats. This was particularly deadly for new born kids for whom the slats were too wide apart to negotiate. The provision of a "nesting box" in which the kids stayed during the first few days until they were strong enough to avoid the spaces between the slats appeared effective against the problem.

Contagious ecthyma (orf) was observed only in kids aged 1 to 2 months on the average, with a range of 2 weeks to 5 months. This is in contrast to reports by Odeniyi & Afolabi (1985) that mild cases were observed in adult goats. We observed that once cured, an animal seemed to acquire a life-long immunity, and no case of recurrence was recorded. A simple home made vaccine prepared from a 10% emulsion of crusts from the lesions in glycerine-gentian violet and applied by scarification to the inner lateral side of the thigh substantially reduced not only the morbidity, but also the severity in affected kids. The shelf-life of the vaccine stored at room temperature is under investigation. Daily swabbing of the lesions with gentian violet led to rapid recovery. In contrast to orf, caseous lymphadenitis occurred in both kids and adults with a high recurrent rate of about 40%, confirming reports that the natural disease does not stimulate a strong immunity in goats (Nairn et al., 1982).

Although the goats were not routinely dewormed on a regular basis, parasitic gastro-enteritis was negligible and clinically unimportant. This was due mainly to the goats being kept on slatted floors. An outbreak of coccidiosis occurred in a group of kids kept on solid rather than slatted floors, thus underlining the effectiveness of slatted floors in minimising parasitic gastro-enteritis.

Other conditions of low prevalence, but which may be of economic significance given their adverse effects on productivity, include: mange and reproductive problems such as still birth, agalactia and abortions. Low birth weight contributed significantly to preweaning mortality. The mean birth weight of all kids was 1.3 kg, compared to 846 g for kids that died within the first few days after birth, without any symptoms except for a general weakness. Proper feeding of pregnant does particularly during the last stages of pregnancy may reduce the incidence of low birth weight with the accompanying high mortality.

The various diseases discussed above could be classified into three categories: (a) high morbidity-high mortality diseases such as enteritis, broncho-pneumonia and injuries; (b) high morbidity-low mortality diseases such as contagious ecthyma and caseous lymphadenitis; (c) low morbidity-high mortality diseases such as PPR and coccidiosis. Prophylactic health packages must necessarily be targeted towards diseases with high morbidity and mortality rates, but others with low mortality but high or even low morbidity rates should not be neglected because of their insidious detrimental effects on productivity and economic returns.

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THE INJECTION SITE REACTION AND ANTIBODY RESPONSE IN SHEEP AND GOATS FOLLOWING THE USE OF MULTIVALENT CLOSTRIDIAL VACCINES

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Abstract

The injection site reaction and antibody response in a group of 40 goats was compared with 40 sheep following clostridial vaccination.

The vaccines used were Covexin 8, Heptavac and Tasvax 8. In all animals swellings averaging 2.5 cm diameter were present at the injection site 7 days after vaccination, and were still apparent 28 days post vaccination. They did not occur in a control group injected with sterile water. By 14 days the reactions were significantly larger in sheep than in goats and by 28 days the reactions to Covexin 8 were larger than those to the other vaccines in sheep and goats.

Serum antibody was present in all groups prior to vaccination and with the exception of the goats vaccinated with Heptavac, increased 14 days after vaccination. The increase was greater in sheep than in goats. By 28 days, antibody levels had declined in all but the sheep vaccinated with Heptavac in which a further increase occurred. At that time, the antibody levels in vaccinated sheep were still higher than the unvaccinated group whereas the antibody levels in vaccinated goats were no longer different from the control group.

These results suggest a real difference between the vaccines used and between the two species and support the clinical observation that the protection afforded goats by multivalent Clostridial vaccines is poorer than that in sheep.

REACTIONS LOCALES AU POINT DE VACCINATION ET PRODUCTION D'ANTICORPS CHEZ LES OVINS ET LES CAPRINS APRES UTILISATION DE VACCINS ANTI-CLOSTRIDIEN POLYVALENTS

Résumé

Cette communication porte sur une étude comparative entre un groupe de 40 caprins et un groupe de 40 ovins vaccinés contre les clostridies afin de déterminer les réactions locales au point de vaccination et la résponse en anticorps.

Covexin 8, Heptavac et Tasvax 8 ont été les vaccins utilisés. On a constaté des boursouflures de 2,5 cm de diamètre en moyenne chez tous les animaux à l'endroit où le vaccin avait été injecté, 7 jours après la vaccination, et elles étaient encore visibles 28 jours plus tard. Elles n'ont pas été observées sur un groupe témoin auquel on avait injecté de l'eau stérile. Après 14 jours, l'importance des réactions était plus significative chez les ovins que chez les caprins et après 28 jours les effets déclenchés par Covexin 8 étaient plus importants que ceux résultant de tous les autres vaccins injectés aux caprins comme aux ovins.

Les anticorps sériques étaient présents dans tous les groupes avant la vaccination. Quatorze jours plus tard, ils étaient en augmentation partout

sauf dans le groupe des caprins vaccinés avec Heptavac, et en plus fortes proportions pour les ovins que pour les caprins. Au bout de 28 jours, les titres en anticorps avaient diminué dans tous les groupes à l'exception du groupe des ovins vaccinés avec Heptavac chez lequel on a constaté une nouvelle élévation du nombre d'anticorps. Les niveaux d'anticorps continuaient à être plus élevés pour les ovins vaccinés que pour ceux qui ne l'étaient pas alors que, dans le même temps, on n'observait plus aucune différence de titrage entre le groupe vacciné et le groupe témoin des caprins.

Ces résultats suggèrent des différences significatives entre les vaccins utilisés et leurs effets sur l'espèce vaccinée et corroborent l'observation clinique, à savoir que le vaccin polyvalent anti-clostridien confère aux caprins une moindre protection qu'aux ovins.

Introduction

Clostridial diseases pose a constant threat to the health and productivity of sheep and goats. Effective vaccines have been developed for use in sheep (Jansen, 1967a) and, although not manufactured specifically, for goats use of these vaccines is claimed to reduce the incidence and severity of disease in this species (Shanks, 1949; Smith, 1957). However, reports of unsightly reactions at the vaccination site (Smith & Klose, 1980) and poor efficacy (Shanks, 1949) have led to much confusion amongst goat owners as to their choice of vaccine. In a recent study, local tissue reactions at vaccination site persisted for up to six months in 53% of goats regardless of the vaccine used and dose administered (Blackwell et al., 1983).

Vaccination site reactions are not commonly reported by sheep farmers, however, the frequent reports from abattoirs of subcutaneous abscesses and the recent attempts to improve multidose syringes suggest that they are also a problem in sheep.

This study was designed to investigate the local reaction and antibody response in sheep and goats using three commercially available vaccines. The vaccines chosen were those commonly used in sheep and dairy goats.

Materials and Methods

Forty goats, comprising thirty 18-month old and ten 12-month old goatlings, from a commercial zero grazed dairy herd of 160 were used in this study. The older animals were all in the last month of pregnancy and the younger ones were not yet in kid. They were a variety of breeds, including British Alpines, Saanens and Toggenburgs. The goats were all previously vaccinated with an initial 2-dose course of vaccine (Tasvax) at 3 months of age. The sheep comprised 18-month old Clun Forest shearlings and were selected from a flock of 220 sheep. They were all in the second month of pregnancy and had been previously vaccinated with an initial course of Covexin 8 at one month of age with a subsequent booster at 10 months of age. The constituents of the vaccines used (Covexin 8, Tasvax and Heptavac) are listed in Table 1.

The sheep and goats were each divided into four groups of 10 animals, A, B,C and D. Group A was vaccinated with Tasvax, group B with Covexin 8, group C with Heptavac and group D with sterile water as a control. The day of vaccination was taken as day 0. Assessment of local tissue reactions was carried out on days 0, 1, 7, 14 and 28 and blood samples were taken on days 0, 14 and 28. Subcutaneous injections of 2 ml were administered in the fold of loose skin over the thorax behind the elbow. The vaccines were

taken from new bottles by swabbing with 70% alcohol, inserting a sterile needle and withdrawing all ten doses required for each group. A sterile needle was used for each injection.

Table 1. The constituents of the multivalent Clostridial vaccines.

Clostridial species	Tasvax[1]	Heptavac[2]	Covexin[1]
Cl. perfringens (type B)	-	toxoid	formal culture
Cl. perfringens (type C)	toxoid	toxoid	toxoid
Cl. perfringens (type D)	toxoid	toxoid	toxoid
Cl. tetani	toxoid	toxoid	toxoid
Cl. septicum	toxoid	toxoid	toxoid + lysed cells
Cl. novyi (type B)	toxoid	toxoid	formal culture
Cl. haemolyticum	toxoid	-	formal culture
Cl. chauveoi	formal culture	formal culture	formal culture

[1] Coopers Animal Health
[2] Hoechst U.K. Ltd.

Hyperimmune serum used as a positive control in the enzyme linked immunosorbant assay (ELISA) for the detection of Epsilon toxin was prepared by vaccinating a 6-month old Clun Forest wether three times in a 6-week period using Tasvax. Blood was collected from the jugular vein into 7 ml plain glass vacutainer tubes and incubated at 37°C for 2 hours and at 4°C overnight. The tubes were then centrifuged and the serum collected, frozen and stored at -20°C. Local tissue reactions following vaccination was assessed by palpation and measurement of the smallest diameter of any swelling in centimetres using calipers. The measurement of antibody to Epsilon toxin was made using an ELISA (Engvall & Perlman, 1972). Microtitre plates were coated with test dilutions of Epsilon toxin (Wellcome Biotechnology). The positive control serum was used to determine optimum antigen coating concentration (10 mg ml^{-1}) and serum dilutions (1/25, 1/50, 1/100, 1/200).

Enzyme conjugated, porcine, anti-bovine IgG, which crossreacted with ovine and caprine IgG, was used to detect the antitoxin (Voller et al., 1976). Dilutions of the positive control serum were included in each plate and a standard curve of optical density against serum dilutions was drawn. The antitoxin levels in the test sera were then expressed as a percentage of the positive control.

A further control was set up to ensure that the porcine anti-bovine IgG crossreacted to the same degree with sheep and goat IgG. Gamma globulin precipitates of normal sheep and goat sera were prepared by precipitation with 40% ammonium sulphate. The precipitate was separated and redissolved in PBS. The immunoglobulin concentration was determined spectroscopically measuring the optical density at 280 nm. The samples were then adjusted until all were of the same concentration, coated on a microtitre plate and the ELISA carried out in the normal way.

The experimental design was a block structure with individual animals as a blocking factor and vaccine type, time and their interaction as

experimental treatments. All data were subjected to an analysis of variance after logarithmic transformation of the antibody titres to ensure a normal distribution of values. A Pearson correlation was carried out on the paired values of antibody titres and size of local tissue reaction.

Results

In sheep the control group showed no tissue reactions throughout the experiment and all vaccinated groups formed tissue reactions at the site of vaccination (Fig. 1). These reactions were detectable in 56% of sheep the day after vaccination and in all other cases by 7 days post-vaccination. The reactions were roughly spherical with least diameters ranging from 1 to 5 cm. The mean reaction size reached a maximum in the Tasvax and Heptavac groups at 7 days post-vaccination and at 14 days post-vaccination in the Covexin group. At day 1 the Heptavac group showed significantly larger tissue reactions than the Covexin group ($P<0.05$). By day 7 all the vaccinated groups had produced a significant increase in reaction size ($P<0.01$). Between days 7 and 14 the reactions in the Covexin group had increased in size and were significantly ($P<0.05$) larger than those in the Heptavac and Tasvax groups, which had decreased in size since day 7. By day 28 the reaction size had decreased significantly ($P<0.01$) in all groups but reactions in the Covexin group were still significantly larger than those of the other two groups ($P<0.01$).

In goats the control group showed no tissue reactions throughout the experiment whereas the vaccinated groups all gave reactions (Fig. 2) which were detectable in 70% of goats the day after vaccination and in all cases by 7 days post-vaccination. The reactions were roughly spherical with least diameters ranging from 1 to 5 cm. The mean reaction size was maximum at 7 days post-vaccination in all groups.

There was no significant difference in the tissue reactions between the vaccinated groups ($P>0.05$) the day after vaccination. There was a significant increase in size by day 7 ($P<0.05$) in all cases. There was no significant change ($P>0.05$) in reaction size between days 7 and 14 but there was a significant reduction in reaction size by day 28 in the Tasvax ($P<0.05$) and Heptavac ($P<0.05$) groups. On day 28 the reaction size in the Covexin group was significantly larger than those in the Heptavac ($P<0.01$) and Tasvax ($P<0.05$) groups.

There was no significant difference between the tissue reaction size in sheep and goats on day 1 ($P>0.05$). By days 7 and 14, however, there was a significantly larger reaction in sheep than in goats ($P<0.05$). By day 28 there was no longer a significant difference ($P>0.05$) (Figs. 1 and 2).

Antibody levels to Epsilon toxin in sheep were in the range 0.70 to 1.73 (log of percentage standard) before vaccination (Fig. 3). Levels in the control group did not change significantly during the experiment ($P>0.05$) but significant rises occurred in the vaccinated groups by day 14 ($P<0.05$). Heptavac, however, produced antibody levels which were significantly lower than those produced by Covexin and Tasvax at this time ($P<0.05$). By day 28 the antibody levels in the Tasvax and Covexin groups had decreased while those in the Heptavac group had increased, but these changes were not significant ($P>0.05$). This meant that there were no longer any significant differences between the vaccinated groups ($P>0.05$). All three groups had antibody levels which were still significantly higher than the control group at day 28 ($P<0.05$). Throughout the 28-day period, vaccination with Covexin produced the highest antibody levels; however, this improved result over Tasvax was not significant ($P>0.05$). In the goats, on the other hand, antibody levels to Epsilon toxin ranged from 0.30 to 1.74 (log of percentage standard) before vaccination (Fig. 4). The

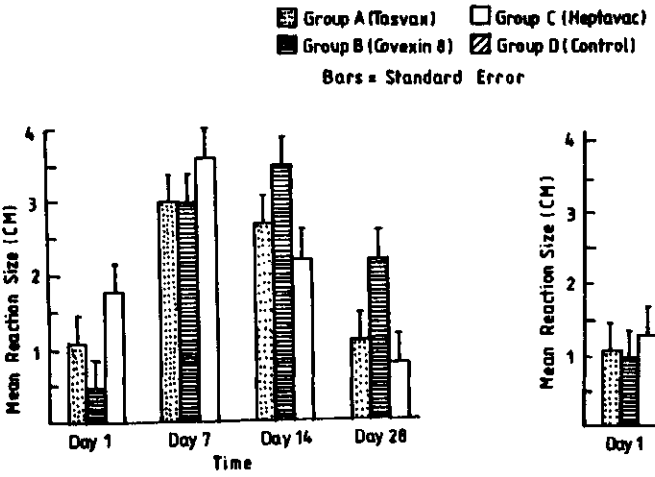

Fig. 1. Mean tissue reactions occurring in three groups of sheep at different times after vaccination (at day 0) with Tasvax, Covexin 8 and Heptavac.

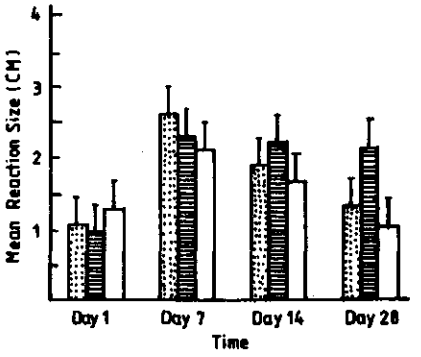

Fig. 2. Mean tissue reactions occurring in three groups of goats at different times after vaccination (at day 0) with Tasvax, Covexin 8 and Heptavac.

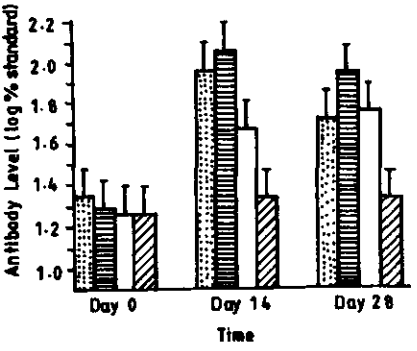

Fig. 3. Mean antibody levels occurring in four groups of sheep before and after subcutaneous injection (at day 0) of Tasvax, Covexin 8, Heptavac and sterile water.

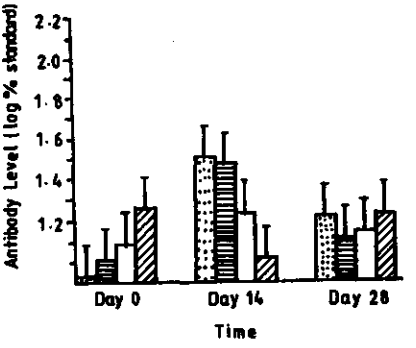

Fig. 4. Mean antibody levels occurring in four groups of goats before and after subcutaneous injection (at day 0) of Tasvax, Covexin 8, Heptavac and sterile water.

control group had a significantly higher antibody level than the group treated with Tasvax at this time ($p < 0.05$). The antibody levels of the control group did not change significantly throughout the experiment ($P>0.05$). Vaccination of the goats produced a rise in antibody level by day 14 which was significant in the Tasvax and Covexin groups only ($P<0.05$). The antibody levels in these two groups were significantly higher than the control group at day 14. There was no significant increase in antibody levels in the Heptavac group at day 14, either from its levels at day 0 or from the control group levels at day 14 ($P>0.05$). At day 28 there was no significant difference in antibody levels between any of the four groups ($P>0.05$). At day 28 there was no significant difference in antibody levels between any of the four groups ($P>0.05$). Vaccination with Tasvax produced the highest antibody levels; however, this improved result over Covexin was not significant ($P>0.05$).

Prior to vaccination, the antibody level was 17% higher in the sheep than the goats. The mean rise in antibody levels by day 14 was 30% more in sheep than goats. There was considerable variation in the antibody levels produced in response to any one vaccine by individual sheep and goats. This is shown by the "least significant difference" bars in Figs. 3 and 4, and was slightly greater in sheep. There was no significant correlation between the local tissue reactions and antibody response in either sheep ($R = 0.2461$) or goats ($R = 0.0978$), and there was no significant difference between the strength of binding of conjugated anti-bovine IgG to ovine and caprine immunoglobulins ($P>0.01$).

Discussion

This study demonstrates that subcutaneous swellings, 2-5 cm in diameter, represent a normal reaction to the multivalent Clostridial vaccines, Tasvax, Covexin and Heptavac, commonly used in sheep and goats. The manufacturers state in their data sheets that such reactions are an occasional occurrence (APBI, 1985) and the frequency with which goat owners report such swellings is attributed to unhygienic vaccination techniques.

The swellings which occur in sheep are seldom reported by farmers but the subcutaneous abscesses seen at slaughter have caused concern to the industry and resulted in the development of "sterimatic" multidose syringes in an attempt to sterilise the needle between injections. No biopsy samples were taken in this study and so we are unable to say whether the observed swellings were abscesses. The absence of any reaction following injection with sterile water demonstrates that these reactions are not the result of infection at the time of vaccination.

A feature of this study was that between days 7 and 14 the swellings seen in sheep (3 cm) were larger than those seen in goats (2.25 cm). This difference is unlikely to be of any clinical significance but is nevertheless interesting. It may represent an inherent difference in the response of sheep and goats; alternatively it may be a reflection of the frequency of vaccination. The sheep used in this study had been vaccinated three times, whereas the goats had been vaccinated twice. However, the variation in individual animals with a similar vaccination history suggests that this represents a true species difference.

At day 28 the reactions caused by Covexin in both sheep and goats were significantly larger than those caused by Heptavac and Tasvax. It seems likely that this represents a difference in vaccine presentation. Tasvax and Heptavac are prepared from purified toxoids adsorbed onto an aluminium hydroxide adjuvant along with a cell culture of *Clostridium chauvoei*. Heptavac also lacks *C. haemolyticum* toxoid. Covexin is prepared from whole

bacterial cell cultures and uses potassium aluminium hydroxide as an adjuvant. The manufacturers of Covexin recommend the use of 5 ml of vaccine in goats and 2 ml in sheep, while those of Tasvax recommend 2 ml in both sheep and goats. In this study 2 ml of vaccine was used in all cases in order that direct comparison between species and between vaccines could be made.

The vaccination site chosen in this study is that preferred by goat owners. The loose skin in the axilla facilitates subcutaneous vaccination and any local reaction is hidden by the elbow. This is particularly important in show goats. It has been suggested that swellings at this site cause lameness but this was not seen in the present study. This site is also recommended for Covexin in sheep but in practice the neck is the favoured site. Vaccination reactions are camouflaged by the fleece in sheep and are of less concern to sheep farmers. The present study shows that subcutaneous swellings should be expected in all sheep following vaccination and in view of this potential to cause damage to the carcass we endorse the use of a site high in the neck as close to the ear as possible.

The immune response to vaccination was assessed by measuring the IgG antibody to the Epsilon toxin. Antibody was present in all animals prior to vaccination. This was not surprising as all had been previously vaccinated. The levels were higher in sheep and the control group of goats. This probably represents differences in vaccination history and environmental exposure in the case of the sheep and a more recent booster vaccination given to the control group of goats.

All three vaccines elicited an antibody response in sheep. Wide ranges in antibody levels similar to those reported by Jansen (1967b) were observed, but there were significant differences in the kinetics and magnitude of the response to different vaccines. The difference in response to Covexin and Heptavac at 14 days was similar to that reported by Kerry & Craig (1979), but by 21 days the response to both vaccines was similar. The present study gives no indication of the level of antibody necessary for protection against clostridial diseases but the results suggest that although persisting for at least 4 weeks after vaccination, the optimum antibody levels occur 2 weeks after vaccination with Tasvax and Covexin and 4 weeks after vaccination with Heptavac.

The response in goats was more variable. The results obtained at 14 days were repeated in view of the apparent reduction of antibody in the control group at this time, but the outcome was the same. Tasvax and Covexin stimulated an antibody response but it was only 70% of that seen in sheep. This was not a reflection of a difference in the strength of binding of anti-bovine IgG to ovine and caprine IgG or a difference between primary and secondary response. It may have occurred because of the difference in vaccination history of the sheep and goats or may represent a true species difference. There is a clinical impression that protection against clostridial diseases is poorer in goats than in sheep (Dunn, 1982). Double doses of vaccine are often used in practice and in some cases vaccination every 6 months is advised (Smith & Klose, 1980). This needs further clarification. Heptavac failed to produce a significant response in goats; 6 of the 10 goats vaccinated failed to respond. We are unable to explain this surprising result. It is possible that it is peculiar to the Epsilon toxin and that the response to all other components is normal.

The kinetics of the antibody response in goats was particularly interesting. The maximum response was seen 14 days after immunisation. However, by 28 days there was no significant benefit from vaccination of the goats.

These results indicate that subcutaneous reactions are a normal reaction

to clostridial vaccination in sheep and goats and support the clinical impression that the protection afforded goats is poorer than that in sheep.

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REPRODUCTION OF WEST AFRICAN DWARF GOATS - A SUMMARY OF RESEARCH WORK AT ILE-IFE, NIGERIA.

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Abstract

Experiments carried out on the West African Dwarf goat at Obafemi Awolowo University indicated that growth rate for the first 40 weeks of life ranged from 28.2 (12 weeks) to 31.5 g d^{-1} (9 weeks) and that weaning weight is a better graduator for weaning "maturity" than age. In a feeding/weaning trial, the lowest parturition interval (239 days) was recorded when weaning was at 12 weeks with high feeding level (concentrate supplement: 500 g d^{-1} for lactating does and 250 g d^{-1} for non-lactating does). Over a four year period, it was noticed that multiple births was strongly related to parity. Similarly, weaning weights seemed to increase with increasing age of the does. Average litter size at weaning was 1.5 in the dry season and 0.9 in the rainy season. More births seemed to have occurred during the dry season than during the rainy season suggesting more conceptions in the rainy season. A highly significant relationship was observed between birth weight and gain in dam body weight during pregnancy. In libido and semen work, reaction time ranged between 45 $\pm$ 33.3 and 162 $\pm$ 68.2 seconds. Colour of semen was white, creamy or lemon juice. Semen volume ranged from 0.5 to 0.8 ml. Raw motility ranged from 3 to 4. Total abnormality was between 8 and 10% while live sperm was between 70 and 85%. Total sperm count ranged from 1.8 to 2.5 x 10^9. Semen work in Wageningen showed the same trend. In the does, estrous cycle length lasted between 19 and 34 days while the duration of heat was between 26 and 46 hours.

RECHERCHES EFFECTUEES A ILE-IFE, NIGERIA, SUR LA REPRODUCTION DE LA CHEVRE NAINE DE L'AFRIQUE DE L'OUEST

Résumé

Les recherches effectuées à l'unité caprine (chèvre naine de l'Afrique de l'Ouest) de l'Université Obafemi Awolowo ont montré que les taux de croissance des chèvres naines pendant leurs premières quarante semaines de vie avaient varié de 28,2 (à 12 semaines) à 31,5 g par jour (à 9 semaines) et que le poids est un meilleur critère que l'âge pour déterminer le moment du sevrage. L'essai sur la nutrition au sevrage a permis d'observer un intervalle minimum entre mises bas (239 jours) lorsque le sevrage était effectué à 12 semaines, les chèvres recevant alors un fort complément de nourriture sous forme de concentrés de 500 g par jour lorsqu'elles étaient allaitantes et de 250 g par jour autrement.

Une période de suivi du troupeau pendant quatre ans a montré qu'il y avait un rapport très étroit entre les naissances multiples le nombre de

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mises bas. Il est également apparu que les poids au sevrage tendaient à augmenter avec l'âge des mères. La taille moyenne de la portée était de 1,5 en saison sèche et de 0,9 en saison des pluies. Il semble aussi qu'il y ait davantage de naissances en saison sèche qu'en saison humide, ce qui laisserait supposer un plus grand nombre de fécondations pendant la saison des pluies.

On a observé un rapport significatif très élevé entre le poids à la naissance et le gain de poids de la mère pendant la gestation ($P<0.01$).

Dans les travaux portant sur la libido et la semence, on a observé que le temps de réaction (en secondes) variait de 45 $\pm$ 33,3 à 162 $\pm$ 68,2. La semence était de couleur blanche, blanc crémeux ou jaune citron, le volume en variant de 0,5 à 0,8 ml. On a observé une motilité brute de 3 à 4, 8 à 10% d'anomalies pour la totalité des cellules et mesuré de 70 à 85% de sperme vivant. Le décompte total a donné de 1,8 à 2,5 x 10^9 spermatozoides. Des travaux semblables menés à Wageningen ont montré des tendances similaires. Le cycle de l'oestrus, chez les chèvres, variait de 19 à 34 jours tandis que la période de chaleur durait de 26 à 46 heures.

Introduction

An understanding of the reproductive characteristics of the West African Dwarf goat as affected by various genetic and environmental factors is a fundamental component in enhancing the productivity potential of the animal. Season is a environmental factor that has apparently influences performance of the individual animal (Ampy & Rottensten, 1968; Kirkpatrick & Akindele, 1974; Oppong & Yebuah, 1981; Ngere & Mbag, 1982). McDonald (1975) and Younis et al. (1979) recommended that pregnant animals should gain weight so as to be able to produce and maintain viable fetus throughout the gestation period. Failure to gain enough weight may result in delayed milk initiation coupled with insufficient milk production, increased mortality rates in the offspring and poor reproductive performance during the next season.

Sheep and goats in the southern parts of Nigeria are not usually reared under an intensive system of management unlike the sheep and goats in the temperate countries of the world (Chiboka, 1983). Traditionally the native dwarf sheep and goats of Nigeria (West African dwarf sheep and goats) roam about streets and bushes scavenging garbage and local forage. Although, in the native setting the animals are allowed to move freely, they still return to their respective homes or owners at the end of the day. The Goat Research Project at Ife is the first of its kind dwarf goats are reared in large numbers under an intensive management system. Under this management system, the objective of the series of trials conducted in the area of reproduction is to maximise the productivity of the goat breeding flock. The trials to date focussed on:

1. Effect of age at weaning on the performance of West African Dwarf kids.
2. Effect of age at weaning and different levels of nutrition on reproductivity of dwarf goats.
3. Effect of season and parity of the doe on the litter size, birth and weaning weights and number of kids weaned.
4. Effects of year of birth, season, litter size at birth, litter composition and birth weight on body weight gain over pregnancy.
5. Libido and semen characteristics.
6. Length of estrous cycle and duration of estrus.

Materials and Methods

Trial 1. Effect of age and weaning on the performance of West African Dwarf kids.

Three weaning age groups (9, 12 and 15 weeks) were chosen on the basis of general experience thus far. Goats used in this study were confined in a large barn with a slatted floor and with a roof of asbestos sheets. The barn was partitioned into small pens. There was a service corridor between every row of pens. Each pen was provided with a forage rack, concentrate bowl and water troughs.

Goats were fed twice a day (morning and evening) on forage consisting of *Panicum maximum*, *Leucaena leucocephala*, *Gliricidia sepium* and a concentrate supplement. Salt licks and clean water were always available to the animals. Concentrate supplement was given at different levels depending on the physiological state of the animals; suckling kids and growers were given 100 g and 150 g respectively, while each lactating female was given 500 g. The animals were routinely treated once every three months against ectoparasites like lice. The goats were vaccinated against brucellosis once in the animal's life and annually vaccinated against *peste des petits ruminants* (PPR). Prompt veterinary attention was given to the animals when necessary.

Data were extracted from records routinely kept at the Teaching and Research Farm of Obafemi Awolowo University at Ife. The variables analysed included: weaning age, litter size, growth rate (g d^{-1} every 10th week up to 40 weeks *post partum*) and weaning weight (kg).

Trial 2. Effect of age at weaning and different levels of nutrition on reproductive performance of dwarf goats.

In order to better understand how the age at weaning (in Trial 1) in combination with different levels of nutrition affects the productivity of dwarf goats, 56 polyparous does were assigned randomly in successive replicates to a 2 x 2 factorial design in a feeding/weaning trial in which the first factor (A) was two levels of age at weaning -(a) 12 weeks post partum or 5.5 kg body weight (whichever came first) with no exposure to puberal buck before weaning and (b) weaning at 16 weeks with daily exposure to buck soon after delivery (zero weaning). The second factor (B) was two levels of feeding - (a) high feeding level of concentrate supplement of 500 g d^{-1} for lactating does, 250 g d^{-1} for non-lactating does and (b) low feeding level of concentrate supplement of 360 g d^{-1} for lactating does, 180 g d^{-1} for non-lactating does. The basic diet of the does consisted of Guinea grass (*Panicum maximum*) *ad libitum*, and when available small amounts of browse (*Leucaena leucocephala* and *Gliricidia sepium*). Other management routines were as indicated in trial 1. In gravid does the level of aggressiveness increases with the stage of gestation and diminishes gradually after parturition. Therefore the does in the delivery pens were tethered and then fed concentrate individually. About two weeks before the expected parturition date, gravid does were transferred to a delivery pen (2 does per pen). During breeding does were taken to a breeding pen where they were exposed to a buck every day till pregnancy had been ascertained. Does in breeding pens were supplemented on group basis. All kids have free access to a creep feed area where they were supplemented with concentrate and browse (mainly *Gliricidia sepium*).

Trial 3. Effect of season and parity on reproductive characteristics of West African Dwarf does.

Reproductive data were extracted from records routinely kept in the goat unit of the Teaching and Research Farm. The records covered a period of four year (1982-1985). The variables measured consisted of litter size, birth weights, weaning weights and number of kids weaned. Management was as described in Trial 2. Data were then analysed for the effects of season (rainy or dry) and parity (1 to 3) in a 2 x 3 factorial design and the effects of year of birth and parity in a 4 x 3 factorial design. The sub-programme ANOVA in the statistical package for social sciences (SPSS) (Nie et al., 1975) was used. Significant differences between means were determined using Duncan's New Multiple Range Test (Steel & Torrie, 1960).

Trial 4: Effect of year of birth, season, litter size, litter composition and birth weight on body weight gain during pregnancy.

Reproductive data for this study came from the same source as in Trial 3 and covered the same four-years period. Gain during pregnancy was measured as the difference between the dam's weight just before parturition and at mating. The data were analysed as a 4 x 2 factorial for the effects of year of kidding (1982-85) and season (dry or rainy). As 4 x 2 x 3 factorial for the effects of year, season and litter size (single, twin or triplets); 4 x 2 x 7 factorial for the effects of year, season and litter composition. Classification on the basis of litter composition depended on the sex of the kids and in what ratios they appeared in the twin or triplet sets. The effects of year of kidding were also analysed in one-way ANOVA after adjusting for birth weight which was used as a covariate. All procedures of statistical analysis were by SPSS (Nie et al., 1975) and means compared by Duncan's New Multiple Range Test (Steel & Torrie, 1960).

Trial 5: Libido and semen characteristics.

Four West African Dwarf bucks were used to determine libido and semen characteristics. Libido was determined by measuring the following coital cues.

1. Time to sniff the estrous doe's perineum or genital region.
2. Time spent on abortive mounts.
3. Total number of abortive mounts.
4. Time spent by the male on intromission.
5. Time spent on ejaculation.
6. Ejaculation latency - interval of time between two successive ejaculations or matings.
7. Reaction time which consists of the following coital cues, 1, 2, 4 and 5.

Each time the libido of a male was to be determined, the male in question was put in a testing pen and an estrous doe taken to him. Other protocols were as described by Chiboka (1973). Semen was collected by artificial vagina and the following variable determined volume (ml), motility (%), total abnormality (%) live sperm (%), sperm concentration (x 10^9/ml) and total sperm count (x 10^9 ml^{-1}). This is still an on-going experiment.

In another completed experiment under the goat project, three trials were carried out to determine the effect of frequent ejaculation of West African Dwarf goats on semen characteristics (Okere et al., 1986) using 4 bucks. In the first trial semen was collected from the bucks twice a week (Tuesdays and Thursdays) for five months. In a second trial semen was

collected from five bucks in a Latin square design one to five times a week for five weeks and in a third trial semen was collected three times a day at 5.5 hr intervals for 21 days from four bucks. This work was done at the Agricultural University of Wageningen, The Netherlands.

Trial 6: Length of estrous cycle and duration of heat.

Each of eight sexually mature does was checked daily for estrus using vasectomized sexually mature bucks. During testing a buck was put in a testing pen and a doe introduced to it. Each doe was allowed about ten minutes with a buck after which time the doe was removed whether or not heat was detected. Heat was checked at 8.00 a.m. and 3.00 p.m. If a doe proved receptive during any test, she was subsequently checked for heat every two hours until she failed to accept the male. The time when sexual receptivity disappeared was the end of estrus; the time between initial detection and the end of heat is the duration of heat. While the period between the end of one estrus and the beginning of another estrus represented the length of one estrus cycle.

Results

Table 1 (Trial 1) shows the results of the weaning experiment carried out in 1984-85 in the main goat unit. The result showed weight gains and their standard deviations every 10-week period up to 40 weeks, and weaning weights. Growth rates of the first 40 weeks of life ranged from 28.2 (12 weeks) to 31.5 g d^{-1} (9 weeks) and were not significantly ($P>0.05$)

Table 1. Results of the weaning experiment carried out in 1984-85 in the main goat unit.

Litter size at birth	growth rates (g d^{-1}) Week 1-10	n	Week 11-20	n	Week 21-30	n	Week 31-40	n	Week 1-40	n	Weaning weight (kg)	n
	weaning at 9 weeks											
1	63.5±13.6	5	18.9± 6.3	5	16.2±10.7	4	30.8±13.5	5	31.0±4.7	4	5.3±0.6	5
2	54.0±13.7	9	19.1±15.2	9	20.3±14.7	8	23.8± 8.7	8	30.1±5.0	8	4.9±2.0	9
3	43.1±16.7	7	11.5±21.4	4	36.1± 5.6	2	30.6± 8.6	2	38.1±5.1	2	3.9±1.5	7
X	52.6±16.1	21	17.3±14.5	18	21.4±13.7	14	27.0±10.4	15	31.5±5.4	14	4.7±1.2	21
	weaning at 12 weeks											
1	54.8±15.3	6	20.6±12.3	6	21.5± 5.5	6	20.9±11.7	6	29.4±5.2	6	5.6±1.0	6
2	40.2± 7.0	8	35.5±10.7	8	11.1±13.4	7	16.7±17.6	7	26.0±5.8	7	4.9±0.0	8
3	45.0±16.5	4	21.4± 9.0	4	33.9±19.5	4	21.5±10.9	4	30.4±8.9	4	5.4±0.4	5
X	46.1±13.4	18	27.4±12.7	18	20.2±15.2	17	19.4±13.6	17	28.2±6.3	17	5.3±0.8	19
	weaning at 15 weeks											
1	53.1± 0.4	2	22.9±30.3	2	24.6±22.5	2	34.4± 4.0	2	33.7±1.0	2	6.2±1.5	2
2	48.2±19.0	22	32.8±10.3	22	16.6±10.7	22	20.9±14.3	22	29.6±7.2	22	6.1±1.5	22
3												
X	48.6±17.2	24	31.9±12.0	24	17.3±11.5	24	22.0±14.2	24	30.0±7.0	24	6.1±1.5	24

influenced by treatment. The highest gains were observed during the first ten weeks post partum, the lowest in the period after weaning at 12 weeks. Five of 9 kids born in triplets in the 9 weeks treatment died between weaning and 40 weeks of age while four out of six in the 12 weeks treatment survived during that period. Table 2 shows the results of the feeding/weaning trial. From the table, the lowest parturition interval (239 days) was recorded when weaning was at 12 weeks with the high feeding level. Results of Trial 3 (as shown in Tables 3 to 6) show the effect of season and parity on kidding characteristics of West African Dwarf goats.

Table 2. Results of the feeding/weaning trial.

Treatment	H/12 weeks	H/16 weeks	L/12 weeks	L/16 weeks
n	8	10	10	10
Parturition interval (days)	239±43	267±30	264±44	278±34
n	9	11	9	10
Reproduction index (kg weaned kid/doe/year)	9.8±3.8	10.0±5.0	8.0±3.2	7.7±3.6
n	21	23	21	21
Litter size at birth	1.9±0.4	1.6±0.6	1.7±0.6	1.6±0.6
n	14	17	13	15
Litter size at weaning	1.6±0.5	1.5±0.5	1.5±0.5	1.3±0.6
n	20	23	20	19
Litter birth weight (g)	2239±421	2131±675	2070±615	1866±67.3
n	14	17	13	15
Litter weaning weight (kg)	9.8±3.0	10.6±3.6	9.2±3.5	8.3±2.8
n	14	17	13	14
Litter weight gain birth-weaning (g d^{-1})	80.1±34.0	77.7±25.8	65.5±24.1	60.4±19.9
Mortality (preweaning)%	23%	11%	18%	27%

H: high concentrate level L: low concentrate level
12 weeks: weaning at + 5.5 kg (+ 12 weeks) no preweaning breeding
16 weeks: weaning at 16 weeks: preweaning breeding.

Table 3 shows no major effect of season and parity on mean values of reproductive variables measured. But analysis of variance showed significant ($P<0.01$) effect of parity on litter size, birth weight, weaning weight and number of kids weaned (Table 4). The effect of parity and year of birth on the reproductive variables (Table 5) followed the same trend as Table 3. Table 6 (analysis of variance of the effect of year of birth and parity on reproductive traits) showed significant ($P<0.05$) effect of parity on liter size at birth, birth weight, weaning weight and litter size at weaning, indicating improvement in these traits with parity. Tables 7 to 12 (Trial 4) show the effect of year of birth, season, litter size at birth, litter composition and birth weight on body weight gain during pregnancy in the dwarf goat. Table 7 shows the analysis of variance of the effect of year of birth and season on weight gain during pregnancy. There was no significant ($P>0.05$) treatment effect on body weight gain during pregnancy. But Table 8 indicates that mean body weight gain over pregnancy seemed to improve with subsequent years of kidding.

Table 3. Mean values for effects of season and parity on the reproductive characteristics of West African Dwarf goats on yearly basis.

Season	Parity	Litter size (No.)	Birth weights (kg)	Weaning weights (kg)	Number weaned (No.)
S1	P1	1.3±0.5^{a}	1.5±0.5^{a}	3.8±3.6^{a}	0.7±0.6^{a}
	P2	1.5±0.5^{a}	1.9±0.6^{a}	6.1±3.9^{b}	1.2±0.6^{a}
	P3	1.6±0.9^{a}	2.2±0.5^{ab}	5.1±3.5^{b}	1.0±0.6^{a}
S2	P1	1.0±0.1^{a}	1.4±0.2^{a}	5.1±1.2^{b}	0.9±0.2^{a}
	P2	1.7±0.8^{a}	2.0±1.0^{a}	7.0±6.6^{bc}	1.4±1.1^{ab}
	P3	-	-	-	-

Means with the same superscript in the same column are not significantly different (P>0.05).

Table 4. Analysis of variance for the effects of season and parity on the reproductive characteristics of West African Dwarf goats.

Source of variation	Degree of freedom	Mean Squares: Litter size	Birth weights	Weaning weights	Number weaned
Season 'S'	1	0.0	73646.5	5612261.5	0.3
Parity 'P'	2	3.2**	4405251.2**	51272412.0**	2.9**
SxP	2	0.6	254615.9	4974758.2	9.4
Residual	65	0.2	392161.3	18358116.6	0.5

** = P<0.01

Table 5: Mean values for effects of parity and year of birth on the reproductive characteristics of West African Dwarf goats.

Year of birth	Parity	Litter size	Birth weights (kg)	Weaning weights (kg)	Number weaned
Y1	P1	1.3	1.0	2.0	0.3
	P2	0.0	0.0	0.0	0.0
	P3	0.0	0.0	0.0	0.0
Y2	P1	1.2^{a}	1.4^{ab}	4.9^{b}	0.8^{b}
	P2	1.7^{b}	2.1^{b}	6.1^{c}	1.4^{c}
	P3	1.0^{a}	1.6^{b}	0.0	0.0
Y3	P1	1.2^{a}	1.5^{b}	6.0^{c}	1.2^{c}
	P2	1.6^{a}	2.0^{b}	8.7^{c}	1.6^{c}
	P3	2.0^{b}	2.4^{c}	7.4^{d}	1.8^{d}
Y4	P1	1.2^{a}	1.6^{c}	5.6^{b}	1.0^{b}
	P2	1.4^{b}	1.8^{c}	7.1^{d}	1.1^{c}
	P3	2.2^{b}	2.5^{dc}	9.2^{e}	1.5^{c}

Y1 - 4 = Years 1 - 4, P = Parity
Means with the same superscript in the same row are not significantly different (P>0.05).

Table 6. Analysis of variance for the effects of year of birth and parity on the reproductive characteristics of West African Dwarf goats.

Source of variation	Degree of freedom	Mean Squares: Litter size	Birth weights	Weaning weights	Number weaned
Year of birth	3	0.0	453.7	31114.4	1.1
Parity	2	2.2**	2818.3**	60198.8*	1.4*
Residual	69	0.3	382.6	17579.6	0.5

* = P<0.05, ** = P<0.01

Table 7. The effect of year of birth and season on weight gain during pregnancy.

Source of variation	D.F.	Mean square
Year of kidding	3	702.4
Season	1	0.8
Year x season	3	530.0
Residual	140	316.3

Table 8. Mean values of the effect of year of birth, season and litter size at birth on weight gain during pregnancy in (kg).

Year	1		2		3		4	
	Season							
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Litter Size								
single	4.9^{a}	-	5.0^{a}	5.0^{a}	4.9^{a}	4.5^{a}	5.6^{ab}	6.5^{b}
twin	4.8^{a}	3.5^{a}	6.3^{c}	5.3^{a}	6.4^{c}	6.8^{c}	6.4^{c}	7.3^{cd}
triplet	-	-	4.8^{a}	-	5.7^{a}	-	5.4^{a}	9.8^{b}

Means with the same superscript in the same row are not significantly different (P>0.05).

Table 9. The effect of the year of birth, season and litter size at birth on weight gain over pregnancy.

Source of variation	D.F.	Mean square
Year of birth	3	818.6
Season	1	0.3
Litter size at birth	2	715.6
Residual	139	311.9

Tables 9-11 indicate that the factors under test had no effect on body weight gain over pregnancy but Table 12 indicates significant (P<0.01) effect of year of kidding on gain over pregnancy before and after adjusting for birth weight as covariate.

Table 10. Mean values of the effect of the year of birth, season and litter composition on weight gain during pregnancy (kg).

Year	1		2		3		4	
Season	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Litter composition								
1	2.8^{a}	-	3.5^{a}	5.1^{b}	6.1^{c}	-	5.0^{b}	6.4^{c}
2	5.8^{a}	-	6.8^{a}	$7.2^{a b}$	4.4^{a}	5.1^{a}	4.9^{a}	$6.8^{a b}$
3	4.9^{b}	2.6^{a}	5.2^{b}	5.4^{b}	$6.3^{b c}$	5.8^{b}	5.8^{b}	6.4^{b}
4	5.9	3.1	6.0	6.1	5.6	6.5	7.6	7.7
5	4.8^{a}	-	6.9^{b}	-	6.7^{b}	-	6.5^{b}	-
6	-	-	4.8^{a}	-	6.6^{b}	-	-	9.7^{c}
7	-	-	-	-	-	-	6.1^{a}	9.2^{b}

Means with the same superscript in the same row are not significantly different (P>0.05).

Table 11.The effect of year of birth, season and litter composition on weight gain during pregnancy.

Source of variation	D.F.	Mean square
Year of birth	3	563.1 ns
Season	1	177.2 ns
Litter composition	6	304.3 ns
Residual	118	288.9

ns = P>0.05

Table 12.The effect of year of kidding on gain over pregnancy before and after adjusting for birth weight.

Source of variation	D.F.	Mean squares before adjustment	Mean squares after adjustment
Year of kidding	3	934.0 ns	558.4 ns
Birth weight (covariate)	1	3691.2 **	3691.2 **
Residual	4	274.8	274.8

ns = P> 0.05 ** = P<0.01

Trial 5 results show that the four bucks (996, 207, 999 and 1000) used in this trial had mean reaction times of 162.0±68.2, 45.5±26.3, 45.0±33.3 and 72.0±59.0 seconds respectively (Table 13). Semen was white creamy or

Table 13. Summary of reproductive traits in male and female dwarf goats in two locations.

	Ife	Wageningen
Volume	0.5-0.8 ml	0.4-0.8 ml
Progressive mortality %	75 - 85	76 - 80
Total abnormality %	8.5 - 10.1	8.7 - 10.1
Live sperm %	78 - 85	75 - 80.2
Total sperm count	1.8 - 2.5 x 10^9	2.1 - 2.5 x 10^9
Semen colour	white, creamy or lemon juice coloured	white, creamy or lemon juice coloured
Libido - reaction time (seconds)	ranged between 45±33.4 and 62±68.2	NA
Duration of estrus	33.0±5.9 hr	NA
Length of estrus cycle	20.4±2.2 days	NA

NA = Not applicable.

lemon juice coloured, and the volume ranged between 0.5 and 0.8 ml. Raw (mass) motility ranged between 3 and 4. Total abnormal sperm ranged between 8 and 10%. Live sperm ranged between 75 and 85%. Total sperm count ranged between 1.8 to 2.5 x 10^9. The semen work by Okere et al. (1986) at the Agricultural University of Wageningen, The Netherlands, showed similar semen characteristics.

Trial 6 results on length of estrus and duration of heat show the mean duration of one estrous cycle to be 20.4±2.2 days and mean duration of heat to be 33.0±5.9 hours. There were 5 cases of estrous cycle lengths ranging between 42 and 88 days; these figures were not used in the computation of estrous cycle length. The figures used in the computation ranged between 19 and 34 days.

Discussion

As shown in Table 1, the results of the weaning experiment did not reveal any effect of weaning age on animal performance as far as single and twin kids were concerned. The weaning weights of the kids on the 9 weeks treatment were in fact relatively high. For triplets nine weeks seems to be too short a period for a satisfactory performance resulting in low weaning weights and high mortality. The small numbers of animals and genetic heterogeneity of the population however makes it rather difficult to draw clear conclusions. Still, the results seem to confirm earlier observations indicating that weaning weight is a more useful indicator or graduator for weaning "maturity" than age. Table 2 on feeding weaning experiment indicate lowest parturition interval of 239 days at 12 weeks with high feeding level of concentrate supplement. This parturition interval can lead to three kiddings in two years as was achieved by Chiboka (1986). Other parturition intervals in this feeding/weaning trial are so high that three kiddings in two years are impossible. It is to be noted that unfortunately the poor quality of the concentrate in the middle of the trial had a negative effect on the variables measured. As a consequence mortality among the kids increased drastically, raising the overall preweaning mortality (including the periods of good concentrate supply) in some treatments above 20%, a figure which must be considered

moderate for an intensive well managed system. Taking into account the aforementioned constraints, the attained productivity levels are considered reasonable. The trial is continuing with improved concentrate supplementation in order to collect more reliable and consistent data for a long period of time to be able to reduce the parturition interval thus making three kiddings in two years more likely. The improved quality of concentrate supply will also help reduce the mortality of the kids.

On the effect of season and parity on reproductive characteristics, both Tables 1 and 3 indicate that in general, litter size increased with parity. Similar observations have also been made by Prasad et al. (1971) in Barbari goats and by Singh & Singh (1974) and Peaker (1978). The effects of season and year of kidding on multiple births, when present, are indirect effects of nutrition through the availability and quality of pasture. Good nutrition is known to favour a high ovulation rate which in effect establishes whether there will be multiple birth or not. Similar observations were made by Oppong & Yebuah (1981) and Ngere & Mbap (1982). Like in the present study, these authors also noted the absence of a definite kidding season. Since all the animals were being managed intensively and fed on a cut-and-carry system with concentrate supplementation differences in nutrition due to season and year of kidding were minimal.

The effects of parity on birth weights, weaning weights and number of kids weaned are also interrelated with the effect of this factor on litter size and the age and physiological condition of the animals. Primiparous does are usually younger and still growing hence will give birth to smaller kids than the polyparous does. Since they produce less milk than the older does their kids have lower survival rates and for those that survive, lower weaning weights. However, the older does have a higher incidence of multiple births and it is very well known that single kids are larger and heavier at birth and usually also at weaning than twins or triplets. The latter also have lower survival rates.

On the effect of year of birth, season, litter size, litter composition and birth weight or body weight gain during pregnancy most grazing animals in the tropics are known to lose weight during the dry season for which they compensate during the rainy season, because of the state of pastures on which they depend for their nutrition (Tizikara et al., 1985). This is even more so in gravid animals that cannot easily meet their nutritional requirements and will thus mobilize their tissues to ensure normal growth of the conceptus. The animals in this experiment were under zero-grazing, being fed on either fresh grass or hay, Gliricidia and Leucaena legumes and concentrate all year round. This implies that, since nutrition was adequate, year and season effects would not be expected and indeed they did not significantly affect weight gain during pregnancy.

Litter size, and composition (sex effect) are known to affect birth weights but not dam body weight (Misra, 1981). It is therefore not surprising that in this study they did not affect the weight gain especially considering the fact that the does had a good nutritional status. The effects of these factors related more to higher nutritional requirements of twins and males than the singles and females. The significant effect of birth weight observed in this study is also related to this nutritional requirement.

Semen data collected from the dwarf goat at University of Wageningen, The Netherlands revealed high epididymal sperm reserve since semen could be harvested frequently even three times a day for twenty one days without depleting the semen reserve (Okere et al., 1986). Also the West African Dwarf goat responded to semen collection by artificial vagina very readily. These qualities of the dwarf goat can be advantageous for estrus

synchronization and artificial insemination programmes which can lead to easy multiplication. The work done here in Ife indicates that the dwarf goat has high libido characterised by short reaction time which means that for large scale production, after synchronization of estrus, potent bucks can be used recourse to artificial insemination. The dwarf goat breeds all year round thus facilitating multiplication. The results on duration of heat and estrous cycle make it easy to know when to expect a doe in heat after estrus manifestation.

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PERFORMANCES DE REPRODUCTION DE LA CHEVRE DJALLONKE AU TOGO

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Résumé

Le bilan de six années d'études sur la reproduction de la chèvre naine au Togo a donné les résultats suivants: âge à la première mise bas : 15 ± 2,7 mois, intervalle entre les mises bas : 7 mois, taille de la portée: 1,83. Par ailleurs, la race n'est pas saisonnée.

REPRODUCTIVE PERFORMANCE OF THE DJALLONKE GOAT IN TOGO

Abstract

A six-year survey on the reproductive performance of dwarf goats in Togo gave the following results: age at first kidding 15 ± 2.7 months, parturition interval 7 months, litter size at birth 1.83. Kidding was not seasonal.

Introduction

Le type de caprin le plus répandu au Togo fait partie de la race naine de la sous région et il est en tous points comparable à celui des pays voisins. Aucun projet de développement de l'élevage ne l'a intégrée dans ses programmes jusqu'à ce jour. C'est pour cette raison que l'Ecole Supérieure d'Agronomie a constitué un troupeau en vue d'étudier les potentialités zootechniques. Le caractère le plus important pour le développement d'une race est son aptitude à se reproduire et à donner une descendance nombreuse. Cet article expose le bilan de six années d'observation sur la reproduction de la race.

Matériel et Méthode

Un troupeau de 30 reproductrices a été constitué en 1980-81 à la ferme Agro-Pédagogique de l'Ecole Supérieure d'Agronomie, Université du Bénin, à Lomé. Les chèvres ont été achetées dans les villages du Sud du Togo. Le troupeau compte à ce jour une cinquantaine de reproductrices avec deux boucs en permanence. Chaque animal est identifié par tatouage à l'oreille et enregistré sur un fichier individuel. Tous les caractères de reproduction sont soigneusement notés. L'alimentation du troupeau est constitué par un pâturage naturel complété par des graines de coton pendant les saisons sèches.

Résultats

Pour 47 chevrettes nées à la station, l'âge à la première mise bas est de 450 ± 83 jours soit 15 ± 2,7 mois. L'intervalle entre les mises bas est de 208 ± 38 jours (moyenne de 201 intervalles) soit un intervalle moyen de

7 mois. L'intervalle était de 5-6 mois pour 23,4% de ces femelles qui peuvent donc, autrement dit, mettre bas deux fois dans l'année. Contrairement aux races européennes, la chèvre Djallonké n'est pas saisonnée. Sur 344 mises bas enregistrées on note une répartition qui varie de 4,3% en octobre à 13,7% en août (Tableau 1).

Tableau 1. Rythme saisonnier de la reproduction chez la chèvre Djallonké.

Janvier	: 9,7%	Mai	: 7,7%	Septembre	: 8,0%
Février	: 9,7%	Juin	: 7,4%	Octobre	: 4,3%
Mars	: 8,0%	Juillet	: 8,0%	Novembre	: 7,7%
Avril	: 8,0%	Août	: 13,7%	Décembre	: 10,4%

On peut observer cependant dans cette répartition un léger pic au mois d'août suivi d'une chute en septembre et octobre. Le pic correspond à des fécondations du début de la grande saison pluvieuse en mars et avril avec une influence favorable de la repousse de l'herbe sur la reproduction. Par contre, les grandes pluies de mai-juin sont défavorables aux fécondations. Ces observations peuvent servir de base pour une gestion de la reproduction.

Le nombre de chevreaux nés pour 100 mères est de 183,7% avec la répartition suivante: naissances simples : 32,7%; naissances doubles : 54,0%; naissances triples : 12,8%; naissances quadruples: 0,6%. Les naissances multiples représentent donc 67,2%. L'étude de la prolificité en fonction du rang de mise bas montre que les naissances gémellaires s'installent dès la deuxième mise bas. La prolificité se présente comme suit de la première à la huitième mise bas: 118, 175, 185, 205, 225, 200, 223, 207. A partir de la quatrième mise bas les naissances doubles sont de règle. Sur 732 chevreaux nés, le sex ratio est de 50,9% pour les mâles contre 49,2% pour les femelles.

Le poids moyen de naissance est de 1,1 kg. Il varie peu avec le mode de naissance. Pour les naissances simples ce poids est 1,2 $\pm$ 0,2 kg pour les mâles et 1,1 $\pm$ 0,2 kg pour les femelles. En ce qui concerne les naissances multiples ce poids est de 1,0 $\pm$ 0,2 kg. Cette absence de différence peut s'expliquer par la faible taille des portées des primipares.

La mortalité des jeunes avec le sevrage a été exceptionnellement élevée à cause d'une pathologie des jeunes chevreaux qui s'est installée dès la création du troupeau. Il s'agit d'une diarrhée qui apparaît régulièrement chez les jeunes vers la troisième semaine sans que l'on ait pu diagnostiquer la cause. Mais on suspecte une origine microbienne car certains cas cèdent après un traitement antibiotique par voie orale. A partir de 1984, une infestation par les puces de chien (Ctenocephalides canis) devait aggraver les mortalités. Les mesures prises nous ont permis de la réduire sensiblement. Une autre cause de mortalité non négligeable dans les premiers jours est le faible poids de naissance surtout parmi les naissances multiples. Les taux de mortalité enregistrés chez les jeunes de moins de 5 mois sont les suivants y compris la morti-natalité: 1980-83 : 27,4%, 1984 : 54,7%, 1985 : 51,7%, 1986 : 15,7%.

Discussion et conclusion

L'âge à la première mise bas est plus élevé que celui trouvé par Vohradsky & Sâda (1973) au Ghana mais reste inférieur à celui de la chèvre naine d'Ibadan, Nigéria (Ngere & Mbap, 1980). Par contre l'intervalle

entre les mises bas successives est plus faible que celui de la race dans la région (Vohradsky & Sâda, 1973 ; Otchere & Nimo, 1976 ; Buadu, 1972). En ce qui concerne la prolificité nos résultats concordent avec ceux des pays voisins. Pour le Ghana, les chiffres varient entre 170 et 186% (Vohradsky & Sâda, 1973 ; Otchere & Nimo, 1976 ; Oppong & Yebuah, 1981 ; Buadu, 1972) et, pour le Nigéria, la prolificité est d'environ 170% (Ngere & Mbap, 1982).

Il se dégage de cette étude que la chèvre naine de l'Afrique de l'Ouest est très prolifique.

Toutefois lorsqu'elle est rassemblée en troupeau il peut se déclencher une pathologie de groupe.

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PRODUCTION CHARACTERISTICS OF A HERD OF WEST AFRICAN DWARF GOATS AT UBIAJA, BENDEL STATE OF NIGERIA

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Abstract

Analyses were conducted on some aspects of performance and productivity of West African Dwarf goats kept at Ubiaja in Bendel State of Nigeria. The analysis covered 129 kids from 76 kidding records of 44 does over a two-year period, 1984-1986.

The mean litter size at birth (1.7) was significantly influenced by season. The parturition interval was 265.7 days. Prolificacy increased with increasing parity, the mean kidding percentage being 169.7. For the 104 kids for which weight records were available, the mean birth and weaning weights were 1.3 and 4.1 kg respectively. Kid mortality to 3 months of age was 39.4%. The annual kidding rate was 2.34 per breeding doe. Productivity index based on kg offspring weaned at 90 days per dam per year gave a value of 5.9 kg. Multiple births considerably reduced the productivity of does.

CARACTERISTIQUES DE PRODUCTION D'UN TROUPEAU DE CHEVRES NAINES DE L'AFRIQUE DE L'OUEST A UBIAJA, BENDEL STATE, NIGERIA

Résumé

Des analyses ont été effectuées de 1984 à 1986 sur certaines caractéristiques de production et de productivité de chèvres naines ouest-africaines dans l'Etat de Bendel, Nigéria, à Ubiaja, pour 44 chèvres et 76 mises bas (129 chevreaux).

On a observé que la saison avait un effet significatif ($P<0,05$) sur la taille moyenne de la portée et que l'intervalle entre mises bas était de 265,7 jours. La prolificité augmentait avec le nombre de mises bas, le pourcentage moyen de chevrotage atteignant 169,7. Les poids moyens à la naissance et au sevrage des 104 chevreaux pour lesquels on disposait de feuilles de pesées étaient respectivement de 1,3 et 4,1 kg. Le taux de mortalité des chevreaux avant 3 mois était de 39,4% et le taux annuel de chevrotage par chèvre reproductrice de 2,3. L'indice de productivité calculé en fonction du poids en kg de descendants sevrés à 90 jours par femelle et par an a donné le chiffre de 5,9 kg. Enfin on a constaté que les naissances multiples avaient considérablement abaissé la productivité des chèvres.

Introduction

The small ruminant research programmes of the National Animal Production Research Institute (NAPRI), Zaria, Nigeria, are directed at improving the productivity of sheep and goats in two contrasting environments, namely the savanna and humid zones. The humid zone station at Ubiaja, Bendel State was established to improve the productivity of West African Dwarf

sheep and goats - the predominant species in that zone - by developing breeding and management strategies applicable to small-scale farmers under the humid zone situation.

No selection has been done yet because of small herd size and lack of adequate records. Crossbreeding the West African Dwarf goat common in this area with the larger long-legged northern breeds has also been discouraged because the larger long-legged offspring may be at a disadvantage under the village husbandry system where no ranching is practised. The only breed improvement strategy so far practised has been the supply of 'improved' males to the farmers. Thus the Ubiaja farm is intended to be a nucleus or source of animals with superior genetic merit.

The Ubiaja ranch, owned by the Government of Bendel State, covers about 60 ha out of which 50 ha were given to NAPRI. Developmental activities started in 1983. Although the farm was expected to stock 200 breeding females each of sheep and goats, NAPRI was only able to stock the farm with 56 breeding West African Dwarf goats in 1984 due to funding problems. The main objective of this paper is therefore to report some aspects of performance and productivity of these goats during the period 1984-86.

Materials and Methods

The study was conducted at Ubiaja sheep and goat farm in Bendel State. Ubiaja is situated within the humid low-land forest zone on latitude 6.75°N and longitude 6.25°E. The rainfall pattern is bimodal with peaks in June and September. Mean annual precipitation is about 1200 mm while maximum temperature varies from 21°C in December/January to 32°C in February/March. Relative humidities are normally high.

The animals were maintained on improved mixed Stylosanthes species. Supplementary concentrates were offered in small amounts during the dry season. All animals were vaccinated against peste des petits ruminants (PPR), dewormed and dipped regularly. Mating occurred throughout the year with a buck to doe ratio of 1:12. Kids were weaned at 3 months of age.

Data collected during the period May 1984 to September 1986 are presented in this paper. A productivity index based on the weight of kid weaned per doe per year was calculated from the formula 365*l*s*w/k where l is the litter size at birth, s is the survival rate to weaning, w is the weaning weight of kid and k is the parturition interval. The data were used to estimate some aspects of reproduction and associated traits and to analyse the effects of some environmental variables on preweaning performance of kids (Steel & Torrie, 1960).

Results and Discussion

Weight records were only available for 104 kids from 44 does of which 22 had kidded only once, 13 twice, 8 thrice and 1 four times. The reproductive efficiency of tropical breeds of animals are particularly influenced by litter size and parturition interval. The mean litter size at birth for does in this study was 1.70. The season in which the animals were born had significant effect on litter size at birth (Table 1), goats kidding during the dry season having the higher litter size. This is probably a reflection of nutritional status at the time of conception and during pregnancy. The litter size obtained in this study is similar to the 1.65 average litter size for PPR-vaccinated goats in South-Western Nigeria (Reynolds & Adeoye, 1986), 1.70 for Beetal goats in India and 1.76 for Damascus goat in Israel (Garcia & Gall, 1981). The figure is higher than the 1.5 and 1.3 reported for village goats in South-Western and South-Eastern Nigeria respectively (Adeoye, 1985).

Table 1. Mean Square (MS) Values for factors affecting litter size at birth in the West African Dwarf goat.

Source of variation	df	MS
Season	1	0.784*
Parity	3	0.579*
Error	99	0.147

* (P<0.05)

Table 2. Prolificacy of does at different parities and seasons.

	No of does	Kidding %	% of type of birth of kids			
			Single	Twin	Triplet	Quadruplet
Parity						
1	22	150.0	33.3	66.6	-	-
2	13	157.7	22.0	39.0	29.3	9.8
3	8	187.5	13.3	66.6	20.0	-
4	1	250.0	-	40.0	60.0	-
Season						
wet (Apr.-Oct.)	44	156.8	20.3	58.0	21.7	-
dry (Nov.-Mar.)	32	187.5	26.7	46.7	20.0	6.7
Overall	76	169.7	20.2	55.8	20.9	3.1

Table 2 shows the prolificacy of the does at different parities. Among the kids from first parity does, two-thirds were twins, while the proportion of kids from multiple births increased to 69.1 and 86.6% in the 2nd and 3rd parities respectively. The average kidding percentage over all kidding was 169.7. With this performance, the dwarf goat can be described as a prolific breed. The sex ratio showed a greater tendency towards female (50.96:49.04). The average kidding interval was 265.7 days. Neither season of kidding nor parity had significant on the effects on parturition interval. The annual kidding rate, the total number of young born per breeding female per year, is a useful indication of an animal's rate of reproduction. The figure of 2.3 obtained in this study is similar to those obtained for goats elsewhere (Wilson, 1982; Wilson et al., 1984).

Environmental effects on preweaning growth and survival rate till three months are presented in Table 3. The average birth weight of 1.3 kg obtained in this study is lower than figures of 1.5, 1.6 and 1.6 kg reported for goats under improved management in South-Western Nigeria (Ngere et al., 1984; Reynolds & Adeoye, 1986). At birth, male kids were significantly (P<0.05) heavier than female kids. However, that initial advantage did not persist until weaning as female kids were significantly (P<0.05) heavier at this stage. There were no significant differences between the weights of single and twin kids both at birth and weaning. Season of birth also had no significant effect on both the birth and weaning weights of kids.

Mortality to weaning was high (39.4%) when compared to the values of 32.5 and 33% reported by Ngere et al. (1984) and Adeoye (1985) respectively. Nevertheless, the figure still falls within the range of kid mortality figures (25 to 55%) reported in the literature (Minett, 1950; Reynolds, 1986). As was expected, mortality was lower (P<0.05) for single

Table 3. Effect of season, sex and type of birth on preweaning growth and survival of West African Dwarf goats.

	Birth weight kg		Weaning weight kg		Preweaning live weight gain g	Survival % months	
	n	X	n	X	X	0-1	0-3
Overall	104	1.3±0.0	63	4.1±0.1	34.6±3.4	76.0	60.6
Season							
wet (Apr-Oct)	57	1.3±0.1	33	4.1±0.0	35.1±2.9	75.4	57.9
dry (Nov-Mar)	47	1.4±0.1	30	4.2±0.0	37.6±4.1	76.6	63.8
Sex							
male	51	1.4[a]±0.0	31	4.0[a]±0.0	34.3±3.6	74.5	60.9
female	53	1.2[b]±0.0	32	4.3[a]±0.1	38.1±3.9	77.4	60.4
Type of birth							
single	33	1.3[a]±0.0	29	4.3[a]±0.0	38.4±2.4	93.9	87.9
twin	55	1.3[a]±0.0	30	4.1[a]±0.0	32.2±3.4	60.0	54.5
triplet	12	1.1[b]±0.0	3	3.8[b]±0.1	33.7±5.1	33.3	25.0
quadruplet	4	1.0[c]±0.0	1	3.0[c] -	22.1 -	25.0	25.0

X = Mean Standard deviation.
(within variable means in the same column bearing different superscript differ significantly (P<0.05).

Table 4. Causes of mortality in West African Dwarf goats at Ubiaja.

Post-mortem finding/ Causes of death	% frequency kids	adults
Snake bite	3.0	4.8
Orf	6.0	-
Scouring/diarrhoea	24.0	-
Pneumonia	12.0	33.3
Enteritis	25.5	-
Starvation/malnutrition	4.5	-
Pediculosis	3.0	-
Bloat	3.0	9.5
Anaemia	1.5	-
Muscle paralysis	1.5	9.5
Mange infection	1.5	28.6
Injury/wound	3.0	9.5
Sudden death (unknown)	12.0	-
Missing	-	4.8
Total number of deaths recorded	66	21

than for multiple births and was not significantly influenced by season.

The causes of deaths for goats at Ubiaja are presented in Table 4. For kids, enteritis, scouring and pneumonia appear to be the major causes of death, while pneumonia and mange caused more deaths in the adults. From these recorded disease syndromes and signs, the indication that the Pneumo-gastro-enteritis complex and mange are the major health problems in

the dwarf goats is in line with ILCA (1979) findings. The productivity index obtained for goats in this study (5.9 kg) is lower than 6.6 kg obtained for goats under improved management in South-Western Nigeria, but higher than 5.7 kg for free-roaming village goats in South-Eastern Nigeria (Reynolds & Adeoye, 1986). From the results of this study, there seems to be considerable scope for improving the dwarf goat through genetic, nutrition and health interventions. Future NAPRI research will focus on these areas.

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IS THERE SCOPE FOR INTENSIVE DWARF GOAT PRODUCTION IN THE HUMID TROPICS? THE IFE EXPERIENCE

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Abstract

The West African Dwarf Goat Project has aimed its research at obtaining the basic knowledge required for a proper understanding of the existing management practices and the possible development of a suitable management package for the West African Dwarf goats in the humid tropics. This paper describes prototype designs and tests at station level and the first experiences with pilot farmers at village level; it also highlights some zootechnical and economical parameters. It is concluded that the new intensive management system developed by the project holds promise for improvement of the productivity of the West African Dwarf goats at the village level. Although the first reactions of the pilot farmers are encouraging, still more research is required to confirm the farmers' reactions on a larger scale.

PERSPECTIVES D'UNE PRODUCTION INTENSIVE DE LA CHEVRE NAINE EN ZONE TROPICALE HUMIDE : LE PROJET D'IFE

Résumé

Le projet sur la chèvre naine d'Afrique de l'Ouest vise à acquérir les données fondamentales nécessaires à la compréhension des pratiques existantes et à mettre éventuellement au point un ensemble de méthodes permettant la conduite d'un élevage de chèvres naines ouest-africaines en zone tropicale humide. Cette communication décrit l'élaboration et la mise à l'essai de prototypes en station ainsi que les premiers essais réalisés avec les fermiers-pilote en milieu villageois et relève l'importance de certains paramètres zootechniques et économiques. En conclusion, les perspectives du système de conduite intensive expérimenté dans le cadre du projet apparaissent réellement prometteuses pour améliorer la productivité des chèvres naines d'Afrique de l'Ouest en milieu villageois. Les premières réactions des fermiers-pilote sont certes encourageantes mais de plus amples recherches sont indispensables pour que etayer les reactions des paysans à plus grande échelle.

Introduction

Since the start of the project in 1981 management has always received major attention. Since management refers to the whole of activities involved in the rearing of livestock it determines the zootechnical environment of any animal production system. Therefore it is not surprising that the "study of the management" was included as one of the project's main objectives.

All the basic research carried out so far in the areas of nutrition, health and reproduction was in fact aimed at obtaining the knowledge

required for a proper understanding of the existing management practices and the possible development of a suitable management package for the West African Dwarf goat in the humid tropics. This development process can roughly be divided in three stages:
- determining and resolving of basic management problems,
- designing and testing new packages at station level,
- testing prototypes at village level.

The first phase has been discussed by Ademosun (1987). So this paper will describe the consecutive phases and discuss some productivity indices in relation to specific economical parameters.

Designing and testing prototypes at station level

Once the basic management problems were resolved early prototypes were designed and tested at the station. So far three animal huts have been erected successively, at the end of 1983 and 1984 and in the middle of 1986. Table 1 and Figure 1 review their major characteristics. Several construction materials and methods have been and are being evaluated. Of major importance has been the testing of different floor types e.g. split bamboo slats, whole bamboo and wooden slats. The wooden slats are the strongest and most durable, however, they are also the most expensive. The

Table 1. Some characteristics of the three prototype goat huts erected at the station site.

Characteristic		Hut 1	Hut 2	Hut 3
basic framework		hard wood	local wood	local wood
floor	adults + kids	wooden slats	whole bamboo	-
	growers	split bamboo	whole bamboo	split bamboo
roof material		iron sheets	raffia palm	raffia palm
pens	number	3	4	4
	size	2*5 m	3.5*2.5 m	3.5*2.5 m
animals	adults[1] (F)	12 (2*6)	12 (3*4)	-
	(M)	1	1	-
	growers	7-10	7-10	± 28 (4*(6-8))
approx. costs[2] (N)		700,=	320,=	350,=

1. at optimum stocking rate
2. adjusted to 1987 prices (1 USD = 3-4 N)

split bamboo type, which is the cheapest holds a major risk for the newborn, which during their first few days of life when they are still unsteady on their legs, get easily trapped in the irregular openings between the bamboo slats. They can be severely injured when they panic and try to pull out their limbs. If well constructed and maintained, however, split bamboo seems reasonably adequate for the older animals. The whole bamboo type is in between; it is more expensive than the split bamboo but

less hazardous and less expensive than the wooden slats but more hazardous. Because of the curves in the whole bamboo there is a risk that newborn kids, when still wet, can slip in between the bamboo's or fall through, in rare cases with a fatal end.

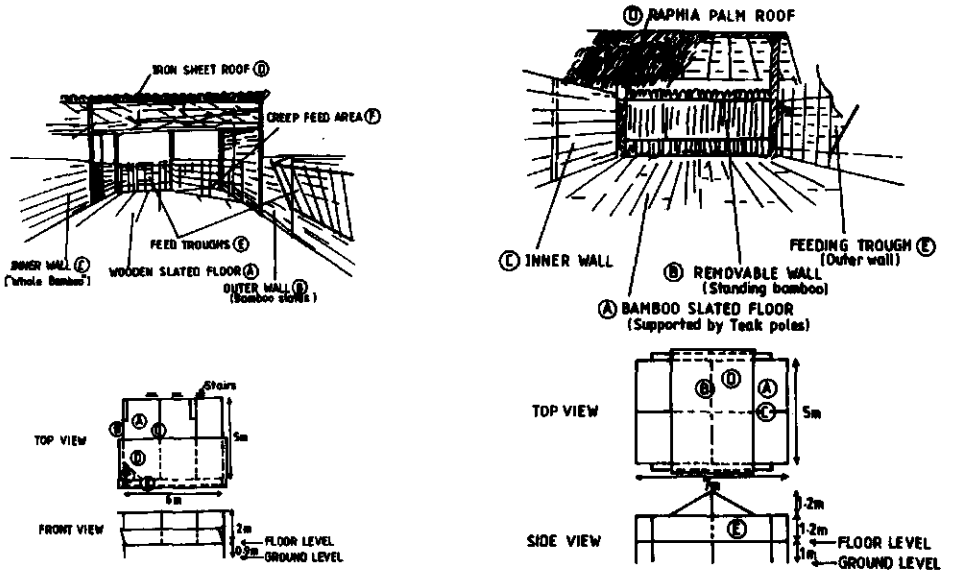

Figure 1. Animal hut I and II.

A lot of attention has been paid to the roof, not only because an adequate shelter is indispensable for goats but also because it turned out to be one of the most expensive parts. The first hut was partly covered with iron sheets, whereas in the second and third huts raffia palm leaves were used. After three years the iron sheets are still in good condition, while the raffia palm leaf roofs had to be repaired yearly because of wind and insect damage. Unfortunately the major part of the roof had to be replaced during that exercise. Attempts are being made to improve the attachment of the leaves to the roof and to modify the slope of the roof to make the roof more durable. As it looks now (1987) the iron sheets might in the long run be the cheapest as they are only about three times more expensive than the raffia palm leaves, when only the cost of material is being taken into account, thus excluding labour.

The results of the first nutritional studies have shown that goats can not thrive well on grass alone, as its quality falls below the minimum level required for reasonable production during the major part of the year. In combination, however, with nutritious browse species like Gliricidia sepium and Leucaena leucocephala it proved to be useful. At the same time it was clear that the use of a composite concentrate would not be economically justifiable. In more recent studies it was also found that Brewers' Dried Grains, which are locally available at reasonable prices, can, as a major constituent of the diet, produce quite satisfactory weight

gains. The nutrition in the pilot units is therefore based on grass (Panicum maximum) and browse (mainly Gliricidia sepium as the availability of Leucaena leucocephala was limited). Brewer's Dried Grains are used as a supplement in the most critical period of the dry season. Feed gardens of both legumes were established around the animal huts.

In the beginning, the first hut contained three pens, one (3*5 m) for the 12 adult females + buck and two (1.5*5 m) for the growers. Soon it became clear, however, that 12 were to many to attain satisfactory production levels. This was due largely to the highly individualistic character of the goat (which is not a "flock" animal) and the heterogeneity within the group of does as far as aggressiveness and social ranking is concerned. The second hut, which was erected about a year later was therefore provided with four pens (3.5*2.5 m each), two for adults, two for growers. As it was observed that also two pens could not conveniently accommodate 12 adult females + buck it was decided to designate one of the growers pens for the housing of adults. In the older hut a similar modification was performed. The existing adult pen and one growers pen were transformed into two adult pens of equal size (2*5 m). The use of more pens for the reproductive flock enabled the grouping of animals according aggressiveness and social ranking. The buck is rotated daily between the pens to ensure adequate breeding.

Another year of observation showed that general performance of the flock in both huts had attained satisfactory levels (Table 2). As the productivity improved thanks to the modifications made in favour of the adults the growers pen tended to get overstocked. So the result was that some animals had to be sold at a rather low weight (8-10 kgs). Sine this weight is not the optimum market weight at village level it was considered useful to study the animal performance up to a weight which indeed meets the local market preference. Since a continued evaluation of both pilot units was considered indispensable to assess their suitability it was decided to put up a third pilot unit which would serve as a kind of extension to the existing huts. The new unit is in fact a modified version of the second unit. The same materials were used only the construction techniques for the basic construction, roof and feed troughs were altered slightly. Since only growers were to be housed the floor was made of split bamboo.

The health aspects do not receive much attention in this paper as those are dealt with by Smith et al. (1987). In general one can state that the overall health situation is quite satisfactory as partly shown by the mortality figures in Table 2. For this paper it will suffice therefore to mention only the routine health care practised at the pilot huts. These include:

- daily checking of all animals and adminstration of appropriate treatments,
- vaccination against ecthyma immediately after birth,
- yearly vaccination against peste de petits ruminants (PPR) with tissue cultured rinderpest vaccine (TCRV),
- dipping or washing every three months (against lice, mange).

Productivity

Table 2 shows that the performance in the second hut compares favourably with the first hut, for the major part due to the longer "adjustment" period of the first pilot unit. Birth weights in the range of 1.1 to 1.4 kg are quite reasonable and match those obtained in the main flock (GRP, 1987). During the first half year of life kids grew at a rate of about 37 g a day which means that at an age of six months they weighed about eight

Table 2. Some zootechnical parameters of the pilot huts.

	Hut I	Hut II
Period	1983-87	1985-87
Birth weights (g)	1132±222	1345±264
n	77	46
Growth birth weaning (g/d)	46.6±15.4	50.7±13.7
n	56	39
Growth rate 0-210 days (g/d)	36.8±16.1	37.2±6.8
n	53	27
Live weight 180 days (kg)	7.7±1.6	8.0±1.3
n	54	29
Litter size at birth	1.76±0.52	1.71±0.60
n	50	29
Litter size at weaning	1.5±0.5	1.5±0.6
n	40	26
Parturition interval (days)	261±51	272±55
n	36	22
Preweaning mortality (%)	29.6	20.8
Mortality weaning to 1 year(%)	2.0	1.5
Reproduction Index (Kg weaned kid/doe/year)[1]	7.6±3.8	9.1±5.4
n	13	12
Productivity Index (kg weaned kid/kidding doe /year)[2]	11.1	12.0

1. calculated on individual basis
2. calculated on basis of the means of each parameter

kilos. Pre-weaning mortality ranging from 20 to 30% must be considered as quite acceptable and compares favourably with data found under the traditional system at village level (33%, Mack 1983). The relatively low survival rate till weaning in the first pilot unit (70.4%) is due to the above mentioned problems faced during the initial stages of adjustment and implementation of the first version of the management package. The mortality between weaning and one year of age is extremely low (1-2%),which shows clearly the impact of this management system. The productivity index, calculated as the total kilograms weaned offspring per litter per year, amounts to 11.1 and 12.0 for the pilot units versus 6.6 kg for the unimproved traditional system (Mack, 1983). One should be aware, however, that these indices were computed on the basis of mean values of the different parameters and only refer to the weaned litters and not, for instance, to the reproductive females. This explains why

these values compare so favourable with the reproduction indices which have been calculated on an individual basis. These values show that up to now 7 to 9 kilogrammes weaned kid have been produced per breeding doe per year. The relatively high standard deviations (cv pilot hut I:50%; pilot hut II:59%) clearly indicate the considerable individual variation.

Preliminary economic analysis

To get an idea of the economic prospects of the intensive goat production system a small scale intensively managed goat unit, based on data obtained at the pilot units, is being compared with the traditional unimproved system, as described by Mack (1983). Table 3 sumarises the results. It shows the substantial increase in productivity when animals are kept under the high intensity system. The live weight production per doe per year more than doubles, from 10.9 kg for the traditional system to 24.2 kg for the high intensity model. This increase is due to a higher survival rate (especially after weaning), a higher growth rate of the offspring and a higher litter size at birth, the first two reasons being the most important.

The second part of Table 3 presents the cost-benefit analysis of the two systems. Additional costs for the high intensity system include veterinary care, labour for feeding (cut and carry) and cleaning of the hut (total labour for 6 does with offspring estimated at 1 hour per day), salt lick, water bowls, a drum for dipping, ropes for tying the browse, and the cost of housing. Based on the construction cost of pilot huts in the village, the capital investment for one hut comprising 6 does and their offspring is estimated to be in the order of N400.00 with replacement after 4 years. The labour and land invested in establishing the feed garden is not costed.

When labour is costed at an imputed wage labour rate of N0.75, net output per doe per year increases only slightly, from N35.50 for the low traditional system to N37.50 for the high intensity model. Net output above labour cost (i.e. with no costing of labour) more than doubles, from N35.00 per doe for the low intensity system to N82.50 for the high intensity model. The annual rate of return on capital is substantially lower for the high intensity model when labour is costed, but is higher for the high intensity model with zero labour cost and reaches 36%.

Under conditions of scarce family labour resources, the incremental return to an additional labour investment provides an important indicator of the economic attractiveness of such an investment. Table 4 shows the incremental returns per labour hour with and without an interest charge for capital (assuming 15%). By moving from the low to the high intensity model, the extra labour required (60 hours per doe) may earn a revenue of about N0.78 per hour, which is slightly above the earlier assumed wage rate. It is, however, very difficult to obtain an estimate of rural wage rates as most labour is hired on a piece-contract basis and time studies for such piece-contracts are not available.

Cashman (1986) has calculated the returns to labour for a number of female activities such as food processing and marketing. They range from N0.15 per hour for wayside food sales, N0.33/hr for maize processing to N0.93/hr for cassava flour making. These figures are solely indicative as they are usually based upon single cases.

From the above analysis it is tentatively concluded that the high intensity goat production system may have development potential. Although the returns to labour are only slightly above the assumed rural wage rate, in contrast to wage labour activities family labour used in goat production can be employed at such rate permanently. The daily time

Table 3. Preliminary economic analysis of the intensive system.

	Model	
	traditional[1]	intensive
Average litter size (kids/litter)	1.50	1.74
Parturition interval (days)	259	267
Annual reproductive rate (kids/doe/year)	2.1	2.4
Survival rate to weaning (%)	67	75
Survival rate 3-12 months (%)	77	95
Effective kidding rate (kids surviving to 12 months)	1.09	1.69
Live weight at 12 months (kg)	10.0	14.3
Productivity (live weight production per doe per year (kg)	10.9	24.2
Number of does per buck	16	6
Mortality of breeding stock(%)	20	10
Mean price per kg (N)	5.00	5.00
Price adult doe (18 kg) (N)	90.00	90.00
Price adult buck (N)	80.00	80.00
Gross output per doe (N)	54.50	121.00
Doe depreciation (N)	18.00	9.00
Buck depreciation (N)	1.00	1.33
Veterinary cost (N)		5.00
Feed cost (60 hrs*N0.75)		45.00
Other annual input costs[2]		6.50
Housing (N400/(6*4)		16.67
Total cost (N)	19.00	83.50
Net output per doe per year (N)	35.50	37.50
Net output above labour cost (N)	35.50	82.50
Capital investment per doe (N)	122.25	230.50
Annual rate of return 1) (labour costed)	29%	16%
2) (labour not cost.)	29%	36%

1. Mack, 1983
2. These include salt lick, ropes, bowls, etc

Table 4. Incremental rate of return to labour from the intensive system.

	Interest	
	without	with
A. Gross output (N)	66.5 *	66.5
B. Non-labour costs (N)	19.5	13.0
C. Interest cost housing (15%)	-	12.3
D. Total costs (N)	19.5	31.8
E. Net output above labour cost (N)	47.0	34.7
F. Incremental rate of return per labour hour (E/60)	0.78	0.58

* Figures indicate the differences in costs and output between the high intensity and low intensity production model.

investment of one hour for feeding the animals and cleaning the hut may provide the households with an additional family labour income per year of ₦280 for the unit size of 6 does.

Testing of prototypes at village level

As soon as a management package, in principle adaptable under village conditions was ready the final and decisive phase of the development process, e.g. testing at the farmers level, was started. In cooperation with the Isoya Rural Development Project[1] three farmers were selected in the neighborhood of Ife on the basis of their interest in goat rearing and their general performance as farmers. At the beginning of the rainy season they established their feed gardens (Gliricidia sepium and Leucaena leucocephala) and during the following dry season they designed and constructed their animal hut. About one year after the establishment of the feed gardens the huts were stocked with goats from the Project flock to ensure a healthy take off. The farmers received seeds and one buck free of charge, while the female animals were provided in exchange for their own goats.

The pilot units are visited fortnightly to monitor their performance and to advice them when necessary. At this occasion all animals are weighed and their general condition is checked. Newborn kids are eartagged and vaccinated against ecthyma with an autovaccine, produced at the University. The project assists with the yearly PPR vaccination and the quartely dipping against ectoparasites (mainly mange). Table 5 describes some of the characteristics of the huts they have erected in their backyard. Pilot farmer one, who is a local chief, put up an expensive but durable hut, while the other two, who dispose of less means constructed smaller huts of cheaper material. So the approximate construction costs per breeding female at optimum stock density, varies from ₦175,= (pilot 1) to ₦52,= (pilot 2) and ₦69,= (pilot 3).

Although it is far too early to draw conclusions one can state that the first experiences are quite promising. The farmers are very interested and really participate actively. Of course their knowledge of intensive goat rearing is still limited, especially on feed requirements, but on the other side they are very eager to learn. Also the animal performance answers expectations so far.

Hopefully this small scale testing will give some indication of the suitability of the intensive goat production system as developed at the project site. Far more extensive testing will be required to get a concise view of the economic benefits of this system. Such an evaluation should not limit its self to the comparison of the intensive system versus the traditional system but also look at intermediate systems, which incorporate some aspects of the intensive model like veterinary treatments and supplementary feeding. In this way it would be possible to assess the benefits of the different components of the intensive system.

Conclusions

Early findings indicate that the new management system developed by the project can improve of the productivity of the West African Dwarf goat at

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Table 5. Some characteristics of the goat huts erected by the pilot farmers.

Characteristic		Pilot 1	Pilot 2	Pilot 3
Basic framework		hard wood	local wood	local wood
Floor		wooden slats	whole bamboo	half bamboo
Roof material		used iron sheets	used iron sheets	used iron sheets
Pens	number	4	2	2
	size	3.5*2.5 m	3.8*2.5 m	3.0*2.5 m
Animals adults[1]	(F)	8 (2*4)	6 (1*6)	4 (1*4)
	(M)	1	1	1
growers		14-16	10	8
Approx. costs[2] (N)		1400,=	312,=	276,=
Cost per doe (N)		175,=	52,=	69,=

1. at optimal stocking rate
2. adjusted to 1987 prices (1 USD=3-4 N)

the village level. Also, economically there are prospects. Although the first reactions are encouraging, still more research will be required to sense the farmers reactions on a broader scale and to respond to the farmers feedback.

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THE PROSPECT OF LARGE SCALE COMMERCIAL DWARF GOAT PRODUCTION IN SOUTH-WESTERN NIGERIA

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Abstract

The analysis shows that it can be possible to produce goats commercially. The investment cost to establish a modest, profitable goat farm of the size referred to in this paper is about N22,000. An average annual return on investment of about 5.8% could be earned. The payback period is 5 years which is long for the average Nigerian farmer because of his poor financial position. The net present value (NPV) is positive and the internal rate of return (IRR) is slightly higher than the cost of capital (interest rate).

The enterprise could be operated as a sole-owner under a sole business organisation and could be combined effectively with other farm enterprises because it does not compete extensively with them for farm resources.

PERSPECTIVES D'UNE PRODUCTION CAPRINE COMMERCIALISEE A GRANDE ECHELLE

Résumé

Cette étude montre ou'il est possible de commercialiser et rentabiliser la production caprine. Il faut investir environ N22.000 pour mettre en place un élevage de chèvres comparable à celui décrit ici, si l'on veut qu'il soit rentable. On peut en tire benéfice annual d'environ 5.8%. La période de remboursement est de 5 ans et relativement longue puor le paysan nigerian dont la situation financière est médiocre. La valeur nette actuelle est positive et le taux de rentabilité interne est plus élevé que le taux d'intérêt sur le capital.

L'entreprise peut être de type individuel privé et combinée effectivement à d'autres exploitations agricoles puisqu'elle n'entre pas en vive concurrence avec celles-ci pour utiliser les ressources disponibles.

Introduction

Goat is a source of meat which provides animal proteins that are indispensable to a balanced human diet. Its meat is acceptable to all Nigerians. Goat rearing is not new in Nigeria, nearly every rural household keeps a few goats.

The increasing demand for goat meat and the increasing awareness by farmers make it necessary to study the profitability of commercial goat production.

Materials and Methods

The physical production data were obtained from a prototype bamboo unit of the Goat Research Project at the Obafemi Awolowo University, Ile-Ife,

Nigeria. Resources and revenues were adequately costed at market prices. The profitability, liquidity and solvency for a 5-year period was examined for an enterprise with a foundation stock of 48 does and four bucks. The production, trading, profit and loss accounts (Woods, 1979) were prepared to show the profitability of the enterprise. Also prepared were the sources and uses of cash to show the amount of cash needed by the enterprise to take off (capital and loans), receipt and disbursement of cash and cash liquidity in each year. Various project evaluation techniques (the return on investment, the payback period, the net present value (NPV), and the internal rate of return) (Horngren, 1980) were used to examine the economic worthiness of the enterprise.

Results and discussion

The factors of production can be grouped into land, labour, capital and management. The enterprise under study could be located on land which cannot be used for the production of other crops because of low soil fertility. The main capital of the business is the building (goat house) whose construction and maintenance costs could be kept to the barest minimum by using local farm materials and unused family labour.

The main labour required is for feeding of the animals and cleaning of the pens. A project of this size requires 540 man-days a year. Except for an occasional need for specific skills (e.g. veterinary services) mostly unskilled labour is required.

Goat management is not new to the farmers, the only difference in the present scheme is that the goats are in confinement which facilitates management.

There are three main forms of business organisation: the sole-proprietorship, partnership and joint-stock company or corporation (Kotler, 1980). Considering the advantages and disadvantages of each commercial structure and the modest requirements of this enterprise in terms of land, labour, capital and management sole-proprietorship seems most appropriate.

It is not sufficient for an enterprise to be profitable, it must also be solvent and liquid to stay in operation. Table 1 on the sources and uses of cash points to the fact that with an initial investment of N22,000.00 the farm should not run into cash problems. Since the enterprise should have sufficient assets to offset its liabilities which is proof of solvency.

The project costs are estimated as follows:

Items	Amount (N)
Purchases (48 does + 4 bucks)	3,300.00
Goat houses (4)	2,400.00
Inventory	153.00
Paddock establishment	450.00
Well (water)	300.00
Miscellaneous	200.00
Working capital (Table 2)	15,197.00
	22,000.00

The investment could be financed by both owner's equity and loans. If the owner can provide part of the funds needed interest will be lower, thus increasing net profit and improving the owner's risk bearing ability and credibility.

The budget showing a sales revenue analysis is based on the assumption that sales will start in year three. The initial three years period is allowed for the doe development after purchase, conception, gestation,

three kiddings, nursing and full growth of kids born in the first year (20 kg live weight.

Table 1. Sources and uses of cash for the first five years of operation.

Items	Year					
	0	1	2	3	4	5
Uses	₦	₦	₦	₦	₦	₦
Purchases (goats)	3,300					
Buildings (huts)	2,400			1,200	2,400	
Inventory	153				153	
Browse establishment	450					
Well (water)	300					
Feeding (labour)		2,060	2,060	2,625	2,625	2,625
Medication		100	100	150	150	150
Interest charges (15%)		1,463	975	975	488	-
Maintenance building		400	400	500	500	500
Browse maintenance		50	50	50	50	50
Miscellaneous		200	200	200	200	200
Total expenses	6,603	4,273	3,785	5,700	6,566	3,525
Loans repayment	-	-	-	5,000	2,500	-
Total cash uses	6,603	4,273	3,785	10,700	9,066	3,525
Sources	-	-	-	-	-	-
Capital	14,500	-	-	-	-	-
Loans	7,500	-	-	-	-	-
Sales (100% cash)	-	-	-	6,710	6,710	19,624
Total cash sources	22,000					
Opening cash balance	22,000	15,397	11,124	7,339	3,349	993
Closing cash balance	15,397	11,124	7,339	3,349	993	17,092

After the first three years there will be on the average three kiddings every two years with an average litter size of 1.7. The mortality rate is 25%. Sales price is at ₦5.50 per kg live weight. There will be no credit sales. The project is assumed to end after the fifth year, when all the animals will be sold. Figures on animals and sales revenue for each year are shown in Table 2.

The main objective of going into business most especially in a private enterprise economy is to make profit. The ability to make profit is the justification for entering and the continued existence in that particular enterprise. For the size of the enterprise under study loss was made in year three with profit building up gradually starting in the fourth year. The payback period (5 years) is long considering liquidity level of an average Nigerian farmer (Table 3).

The net present value of the enterprise is positive and the profitability index is slightly greater than one, which shows that the project is profitable but the level of profitability is very low and therefor it may not be able to compete effectively with other profitable farm enterprises. The internal rate of return of the project is slightly higher than

the cost of capital (interest rate) thus confirming the viability of the enterprise (Table 3) in the absence of other more profitable projects.

Table 2. Physical Quantity of Animals (closing stock x sales) and of sales Revenue.

Type of animals	Year				
	1	2	3	4	5
Foundation stock					
does	48	48	48	48	48
bucks	4	4	4	4	4
Kids (closing stock)	61(6kg)	61(6kg)	61(6kg)	92(6kg)	
		61(13kg)	61(13kg)	61(13kg)	
Sales		61(20kg)	61(20kg)	92(6kg)	
				92(13kg)	
				61(20kg)	
Sales revenue (N)			6710.00	6710.00	16324.00

Table 3. Production, trading, profit and loss accounts for the first five years of operation.

Items	Year	1-3	4	5
		N	N	N
Sales		6,710	6,710	16,324
Opening stock		3,500	3,500	3,500
Purchases		-	-	-
Closing stock		3,500	3,500	3,500
Cost of goods sold		-	-	-
Gross profit		6,710	6,710	16,324
Expenses				
Feeding		6,745	2,625	2,625
Repairs x maintenance (goat houses)		1,300	500	500
Medication		350	150	150
Paddock maintenance		150	50	50
Depreciation		2,978	1,200	1,200
Interest charges		3,413	488	-
Miscellaneous		600	200	200
Total expenses		15,536	5,213	4,725
Net profit/loss		-8,826	1,497	11,599
Return on investment (N22,000)		40.1%	6.8%	62.4% (AROI 3.9%)
Return on owner's capital (N14,500)		60.9%	10.3%	80.0%

Payback period = 5 years
Net present value = N1.120.00
Profitability index = 1.05
Internal rate of return = 15.3%

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LIVESTOCK AND FARMING SYSTEMS IN SOUTH-EAST NIGERIA

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Abstract

The paper presents the results of a survey of small ruminant owners in four states of South-East Nigeria (Bendel, Anambra, Imo and Rivers). Sheep were found in 28% of households and goats in 92%. The mean flock size for sheep was 3.2 for all households, and 11.4 for owners only. The corresponding figures for goats were 6.9 and 7.5. However, the distribution of animals was skewed with most households owning only a few animals. The main problems mentioned by farmers in keeping livestock were related to feed, disease and housing. Three modes of management were distinguished according to degree of animal confinement. Management was related to climatic zone, human population density, farming system, animal disease incidence and mortality. Confinement was found to be associated with a higher incidence of disease and higher mortality.

ELEVAGE ET SYSTEME DE PRODUCTION DANS LE NIGERIA DU SUD-EST

Résumé

Cette communication expose les résultats d'une étude portant sur l'exploitation des petits ruminants dans quatre Etats du Nigéria du sud-est (Bendel, Anambra, Imo et Rivers). Il en est ressorti que 28% des ménages possédaient des ovins et 92%, des caprins. Le nombre moyen de moutons par famille était de 3,2 pour l'ensemble des ménages et de 11,4 par propriétaire effectif, les chiffres correspondants pour les chèvres étant respectivement 6,9 et 7,5. La répartition des animaux se trouvait toutefois biaisée du fait que la plupart des ménages ne possédaient qu'un petit nombre d'animaux. Les problèmes principaux mentionnés par les paysans élevant des animaux avaient trait à l'alimentation, aux maladies et aux abris qu'il convenait de prévoir. Trois modes de gestion ont pu être distingués selon le degré de liberté laissé à l'animal. Le système de conduite a été étudié en fonction de la zone climatique, de la densité démographique, du système de production, de l'incidence de la morbidité et de la mortalité animales. On a pu observer que la claustration était associée à une plus forte incidence de la morbidité et de la mortalité animales.

Introduction

South-East Nigeria is one of the most densely populated parts of Africa. Rural population densities in some areas exceed a thousand persons per km^2. Pressure on land resulting from the increasing population and the expansion of cash cropping (in particular the production of oil palm) has led to the intensification of land use. However, with the exception of Lagemann's (1977) study of three communities in present-day Imo State,

little information is available on the consequences of this process of intensification. In particular, little data exist on the distribution or management of livestock in South-Eastern Nigeria.

This paper presents the results of a survey of small ruminant owners in four South-Eastern states of Nigeria. It attempts to relate livestock management systems to their socio-economic and ecological environment, and to relate these in turn to management practices and to characteristic problems and hazards facing small ruminant producers in the areas surveyed.

Although more extreme in South-East Nigeria, the circumstance of increasing population pressure on land is general to the humid zone of West Africa. The survey thus not only provides information on South-East Nigeria, but also suggests the implications of rising population densities and agricultural intensification for smallholder livestock production systems throughout the zone.

Background

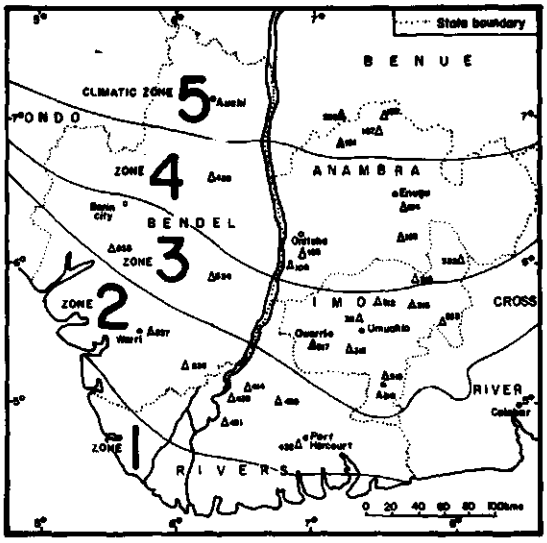
South-Eastern Nigeria is a diverse area, although tropical forest and derived savanna ecologies predominate. Annual rainfall ranges from less than 1500 mm in the north of Anambra State to over 4000 mm in the South-Western extremity of the area. The most common soils are ultisols, which are acidic, with pH ranging from 4 in the highest rainfall areas to around 5.5 further north. These soils are of low natural fertility, but are intensively farmed. In many areas, pressure on land has led to shortening fallow periods and declining soil fertility. Cassava and yam are the main crops. Other crops of importance are maize, cocoyam and plantain, and, in some areas, rice. Oil palm has historically been an important cash crop in the zone. Land holdings are small (generally less than 1 ha), and often fragmented. Frequently these include different types of land which are managed in different ways. Around the compound may be a continuously cultivated area, the 'compound farm', within which are found a complex variety of trees and food crops, and which benefits from animal manure and household waste. Outlying plots, of which there may be a number of types, are cultivated less intensively. Farms are worked by hand. Men are generally responsible for clearing and the cultivation of yams, while women are responsible for most other operations and crops.

Trypanosomiasis restricts livestock production in South-East Nigeria, and the local trypanotolerant dwarf breeds of sheep and goats are the most important livestock species, both economically and, after poultry, numerically. They are valued as a source of meat (though they are usually slaughtered only on the occasion of festivals or ceremonies), of cash, and of manure. Nevertheless, livestock remains a minor farm enterprise. Upton's (1966) figures indicate that livestock contributed less than 4% of farm income, while according to Lagemann (1977), the contribution of livestock was between 10 and 20% of gross farm income (about two-thirds of the livestock produced being consumed within the household).

Management and other inputs are minimal. While small ruminants may be confined, special housing is the exception rather than the rule. Animals are fed household scraps, tree foliage (commonly palm fronds), and the by-products of food processing. Veterinary inputs are minimal or nil.

Methods

The study was undertaken in four states in the South-East of Nigeria-Bendel, Anambra, Imo and Rivers (see Map 1). Twenty-seven local government areas (LGAs) were selected in these states by applying randomly generated



Map 1. South-Eastern Nigeria showing sate boundaries, climatic zones and sample points.

coordinates to a grid imposed on a set of 1:250,000 maps of the area. Sampled LGAs are shown in Map 1. Within each of these LGAs, two communities were selected which appeared from the map to be of a contrasting character with regard to their proximity to main roads and urban centres. A random sample of about 30 households was selected at each sample point. Only members of households in which sheep or goats were owned were interviewed. On the basis of agricultural census figures, small ruminant owning households (i.e. the population represented by this survey) are estimated to comprise approximately one half of all rural households in the area (see Federal Office of Statistics, 1972). The data were collected between January and March 1983.

For the purpose of analysis, the area was divided into five climatic zones on the basis of the annual pattern of rainfall. As Map 1 indicates, movement from climatic zone 1 to 5 represents movement north from the coast. In zone 1, the driest month records 60 mm of rain (this zone is not represented in this study). In the second zone, one to two months are dry (i.e. with less than 60 mm of rainfall). The third region has three dry months in which total rainfall is less than 60 mm while the annual total ranges between 1875 mm and over 2500 mm. The fourth region has four months in which precipitation is less than 60 mm with the driest month having less than 30 mm. Most parts of this zone have a total annual rainfall in excess of 1750 mm, but the overall range is from 1600 to more than 2000 mm. The fifth and last climatic zone has four dry months in which rainfall totals less than 48.5 mm. Annual total rainfall in this region ranges from 1500 to 1830 mm (Ofomata, 1975).

Findings

Household and farming system

The mean household size was 10 persons, consisting of 1.8 adult males, 2.1 adult females and 6.1 children. Dissagregation of these data by state

and by climatic zone shows that households in the Southern, higher rainfall, states and zones tended to be larger than those in the more northerly areas. In addition, the ratio of resident adult males to adult females was greater in climatic zone 2 (1:1) than in other zones (0.84:1). This reflects a higher level of male out migration in the drier zones. Farming was the predominant occupation for adults in all zones, and was given by 72% of males and 81% of females as their primary occupation.

As already indicated, in many parts of South-Eastern Nigeria, the zoning of land is a characteristic feature of the farming system. Around the homesteads are often found "compound farms", where both tree and arable crops are cultivated intensively and manure and household waste is applied. Outside this area 'near' and 'distant' farmland are distinguished, each with its own crop rotation practices and tenure rules. Compound farms were seen in almost a half (47%) of the sample. As Table 1 indicates, they were markedly more common in Anambra, Imo and Rivers States than in Bendel, and in the northern, drier, climatic zones. Compound farms were also associated with higher levels of human population

Table 1. Presence of compound farm by state and by climatic zone.

State	n	Households with compound farm (%)	Climatic zone	n	Households with compound farm (%)
Rivers	242	43	2	277	39
Bendel	235	18	3	406	39
Imo	321	47	4	174	50
Anambra	281	75	5	162	77
All	1079	47			

density. The rank correlation coefficient between population density and proportion of households with compound farms in the 27 LGAs in the survey was 0.50 ($P<0.01$).

Cassava and yam were the most important crops, cassava predominating in the Southern zones 2 and 3, and yam in the northerly zones. However, a wide variety of other annual and tree crops was also found.

Small ruminant ownership

Goats were more widely owned than sheep. Sheep were found in 28% of households and goats in 92%. Mixed flocks of sheep and goats were found in only 20% of households. The frequency distribution of the numbers of animals of both species, especially that of sheep, was highly skewed. Table 2 therefore provides modes and medians as well as means as measures of central tendency and also ranges and interquartile ranges. The mean number of sheep owned across all households was 3.2 head, as compared with 6.9 goats. However, where present, the average flock size of sheep (11.4 head) was larger than that of goats (7.5 head). Ownership of the two species was associated. The correlation coefficient between the number of sheep and the number of goats owned in any household was 0.38 ($P<0.001$).

Flock size was also related to household size. The correlation coefficients between total household size on the one hand and the number

Table 2. Small ruminant ownership: all households.

	Sheep	Goats	Small ruminants
Mean flock size, all households	3.2 (10.2)	6.9 (11.0)	10.1 (17.6)
Number of households in sample	1079	1079	1079
Number of owning households	300	996	1079
Percentage of owning households	28	92	100
Mean flock size, owners only	11.4 (16.7)	7.5 (11.3)	10.1 (17.6)
Mode, owners only	1	3	2
Median, owners only	6	5	5
Range, owners only	1-120	1-183	1-244
Interquartile range, owners only	3-12	3-8	3-10
Percent households with:-			
None	72	8	-
1 - 5	14	54	52
5 - 10	6	11	24
10 - 20	4	2	15
More than 20	4	5	9

(Standard deviations in brackets)

of sheep, goats, and total small ruminant holdings were 0.35, 0.35, and 0.42 respectively (all significant at the 0.1% level). This is a reflection both of household labour supply and household consumption requirements.

Tables 3 and 4 give ownership and flock sizes for sheep and goats respectively by state and climatic zone. For sheep, both the proportion of owning households and the mean flock size were strikingly higher in Rivers than in the other three states. The mean herd size of goats was also higher in Rivers than in other states, although the goat ownership level, at 84% of households, was somewhat lower (Table 4). Both ownership and flock size of sheep were highest in climatic zone 2. Goat herd size was also highest in this zone.

The majority of animals (79% of sheep and 71% of goats) were born from stock whilst 17% of sheep and 20% of goats had been purchased. The remaining 4% of sheep and 7% of goats were from other sources (for example, gifts and loans).

Small ruminant management

Three types of livestock management were distinguished on the basis of animal confinement as follows: free roaming all year round; confined or tethered during the cropping season only; and confined all year round. Goats were more likely to be confined than sheep (in 36% vs. 24% of owning households).

Tables 5 and 6 show the distribution of livestock management systems for sheep and goat owning households by state and by climatic zone. It is clear the confinement of both sheep and goats is more common in the more densely populated states of Imo and Anambra and in the drier climatic zones. The seasonal confinement of both sheep and goats is particularly associated with Anambra State and with climatic zone 4. This is related to the practice of compound farming in these areas. Year-round confinement of goats was noted in 57% of households where compound farms were found,

Table 3. Sheep ownership by state and climatic zone.

	Owing households (%)	Mean flock size (owners)	Median flock size
State			
Rivers	52	15.2 (19.1)	8
Bendel	21	9.7 (14.1)	5
Imo	18	10.1 (17.9)	4
Anambra	23	6.7 (9.1)	4
Climatic zone			
2	49	15.0 (18.9)	8
3	16	7.8 (16.6)	4
4	30	10.7 (13.8)	5
5	18	5.1 (4.5)	4
All households	28	11.4 (16.7)	6

(Standard deviations in brackets)

Table 4. Goat ownership by state and climatic zone.

	Owing households (%)	Mean flock size (owners)	Median flock size
State			
Rivers	84	12.3 (15.4)	8
Bendel	96	7.2 (9.0)	5
Imo	94	6.3 (11.7)	4
Anambra	95	5.4 (6.9)	4
Climatic zone			
2	84	11.9 (15.9)	8
3	97	5.9 (10.3)	4
4	91	7.3 (9.7)	4
5	96	5.3 (4.9)	4
All households	92	7.5 (11.3)	5

(Standard deviations in brackets)

as compared to 18% where they were not (the corresponding figures for sheep-owning households were 32% and 14%). The rank correlation coefficient between the proportion of households where goats were confined and the proportion where compound farms were observed in each of the 27 LGAs was 0.69 ($p = 0.001$). The equivalent coefficient for sheep was -0.36 ($p = 0.06$).

Goat confinement was more closely associated with higher population densities than was that of sheep. The rank correlation coefficient between the population densities and the proportion of households confining their goats in the 27 LGAs was 0.64 ($p < 0.001$). The corresponding statistics for sheep management were $r = -0.16$, $P = 0.47$. (LGA population densities used were those given in Idachaba (1985)).

The size of small ruminant holdings was also related to management

Table 5. Management of sheep and goats by state (percent, owners only).

State	n	Management system: free roaming	seasonally confined	confined all year	total
Sheep					
Rivers	127	84	0	16	100
Bendel	49	82	0	18	100
Imo	59	73	2	25	100
Anambra	65	32	25	43	100
All states	300	70	6	24	100
Goats					
Rivers	204	89	0	11	100
Bendel	225	88	0	12	100
Imo	301	51	3	46	100
Anambra	266	20	15	65	100
All states	996	59	5	36	100

Table 6. Management of sheep and goats by climatic zone (percent, owners only).

Climatic zone	n	Management system: free roaming	seasonally confined	confined all year	total
Sheep					
2	135	85	0	15	100
3	66	71	2	27	100
4	69	48	22	30	100
5	30	54	3	43	100
All zones	300	70	6	24	100
Goats					
2	234	88	0	12	100
3	395	60	1	39	100
4	212	51	15	34	100
5	155	23	6	71	100
All zones	996	59	5	36	100

system in that the necessity for confinement appeared to limit flock size. Where animals were free roaming, the mean flock size was 13.2 for sheep and 8.4 for goats, whereas for confined animals the mean flock sizes were 7.4 and 6.2 goats (owners only). Labour for the collection and carrying of feed and the availability of housing would seem to be the main constraints on animal numbers.

A separate construction or enclosure for the animals was observed in only 27% of cases where the year-round confinement of goats was practiced. This was usually constructed of wood (48%), corrugated iron sheeting (21%) or mud (18%). Otherwise the animals were simply confined in the house or compound. Where the confinement of goats was seasonal, special constructions for the animals were observed only rarely (4% of cases). Where sheep were confined, however, they were more likely to be provided with special purpose housing, which was noted in 60% of cases of year-round and 12% of seasonal confinement.

Feed was seen to be offered to animals in 58% of households in the sample. Its presence was related to the animal management system. Where confinement was permanent, feed was observed in almost all cases. However, collected feed had also been provided in many cases where animals were free roaming (49% for sheep, 32% for goats).

Browse was the most commonly observed feed type, seen either alone or in combination with other feeds in 81% of cases where feed was offered. Household refuse was offered by 48% of households and farm products or food processing by-products (for example, cassava or yam peelings) in 15% of the households where feed was offered. Browse was particularly important in climatic zone 4, where it was observed in 98% of cases where feed was offered as compared with an average of 74% in the other zones.

Perceived problems

Feed, disease and housing were given by farmers as the main problems encountered in keeping livestock, together accounting for 54% of responses. Lack of veterinary care, crop destruction and theft were the next most frequently cited problems.

There was some variation between climatic zones in the types of problem cited. Feed was apparently seen as a less serious problem in climatic zone 2 than in the drier zones, while housing, surprisingly, was less often cited as a problem in zone 5, where confinement is most widespread. Disease was rather considered the major problem in this zone. Problems cited were also related to the mode of management. As might be expected, farmers whose animals were confined saw the provision of feed as their greatest problem. Interestingly, this appears particularly so where confinement was seasonal. Seasonal confinement was also associated with the citing of housing as a problem. Where animals were free roaming, concern over health predominated.

Specific reasons for not keeping sheep were given by 62% of informants (72% were non-owners). The difficulty of controlling sheep was the most common reason cited (although a lower proportion of households in fact confined sheep than did goats). This is clearly related to two other reasons cited -- problems of crop destruction and housing. As we have seen, relatively few farmers provided special purpose housing for sheep, so presumably the citing of this reason is also related to the difficulty of providing feed for the confined animals, which was cited as the major problem in households where animals were confined. Traditional ritual prohibitions against sheep were given in four local government areas in which they appeared to affect a substantial proportion of the population. Only 5% of informants gave reasons for not keeping goats (8% were non-owners). Crop destruction and susceptibility to disease were the most important of these.

Diseases observed

Pneumo-gastro-enteritis complex (PGEC), probably most often found due to

the viral infection peste de petits ruminants, was considered overwhelmingly the major health problem. Of the farmers citing specific diseases, PGEC symptoms were mentioned by 96%. Other health problems referred to include footrot, abortion, mange and tick infestation, although only 5% of sheep and 10% of goat owners mentioned such other problems.

Thirty percent of informants reported that they had a PGEC outbreak in their flocks within the last twelve months. Sixty six percent reported never having observed symptoms of the disease in their flocks, while the remaining 4% recalled an outbreak between two and six years prior to the time of the interview.

Table 7 and 8 give the reported incidence of PGEC within the last year by climatic zone and management system respectively. A higher proportion of sheep than of goat owners reported outbreaks. Table 7 shows an increasing incidence of PGEC among both sheep and goats passing from the higher to the lower rainfall zones. Table 8 indicates that disease levels are also related to animal management system. Chi-squared tests showed that the differences in PGEC incidence between regions were significant at the 5% level for both species and differences in incidence between management systems were significant at the 5% level for goats.

Mortality

Mortality indices for each species were calculated from farmers' recollection of the number of deaths over the preceding year. The mean mortality index for goats, at 24%, was somewhat higher than that for sheep (21%). However, 35 households had lost all of their sheep and 12 households all of their goats in the course of the preceding year. If mortality indices for such households no longer owning the particular species are included in the respective sub-samples, the indices rise to 29% for sheep and 25% for goats. This suggests that epidemics resulting in the death of all animals of a species in a household are more common among sheep than among goats.

Tables 7 and 8 also give the mortality indices by climatic zone and management system for both sheep and goats. The lower rainfall environments and the seasonal confinement of animals are associated with higher mortalities. These findings are consistent with those relating to the incidence of PPR. Data reported by Mack et al. (1985) similarly shows a higher mortality among confined goats in two sites in Imo and Anambra

Table 7. Disease and mortality of sheep and goats by climatic zone.

Climatic zone	Sheep			Goats		
	n	PPR observed in last 12 months	mortality index (%)	n	PPR observed in last 12 months	mortality index (%)
2	135	33	17	234	25	21
3	66	27	19	395	23	21
4	69	39	26	212	36	28
5	30	53	24	155	43	32
All	300	35	21	996	29	24

Table 8. Disease and mortality of sheep and goats by management system.

Management system	Sheep			Goats		
	n	PPR observed in last 12 months	mortality index (%)	n	PPR observed in last 12 months	mortality index (%)
Free roaming	211	34	21	585	29	23
Seasonally confined	17	53	32	47	34	28
Confined all year	72	33	17	364	29	24
All	300	35	21	996	29	24

States than among free-roaming goats in South-Western Nigeria (4.5 vs. 2.7% per month).

Conclusions

The distribution of animals was skewed with most households in the sample owning only a few animals. The modal values were one sheep and three goats per household, while only 14% of households contained more than five sheep and only 38% more than five goats. However, substantial flocks were found in a minority of households, with 9% owning more than 20 small ruminants. Ownership patterns differed between states and between climatic zones. The mean flock sizes of both species were highest in Rivers State and climatic zone 2.

Management practices differ by state, climatic zone and farming system. The confinement of animals was most common in the drier climatic zones and in Anambra State. Higher population densities and agricultural intensification (of which compound farming was taken as an indicator), were associated with the confinement of livestock, in particular of goats.

In general, mortalities were high, and PPR was reported overwhelmingly as the most important disease. There was evidence that disease problems were greater in the lower rainfall areas. PPR was observed in sheep and goats both more commonly and more recently in climatic zones 5 and 4 than in zones 3 and 2. Higher levels of mortality for both species were also observed in these zones.

Patterns of disease and mortality were also related to management systems. Seasonally confined animals seem especially vulnerable to disease. This may be a reflection of a failure to adjust management to this transitional phase of confinement. Where confinement is seasonal, it would appear that management strategies to accompany the confinement of animals (of housing, feeding, watering, breeding), are not fully developed. Furthermore, the period of confinement being during the growing season, the requirement to provide feed for the animals coincides with the peak period of labour demand for cropping.

Increasing population densities and agricultural intensification are likely to lead to increasing animal confinement both in South-Eastern Nigeria and throughout the humid zone. New strategies of management, in

particular relating to feed and disease, will be required under these circumstances.

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WOULD JAVAN GOAT AND SHEEP HOUSES BE USEFUL IN NIGERIA?

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Abstract

In Java, goats and sheep are confined in houses with raised slatted floors. These houses provide a cool dry environment for the animals, and are relatively cheap. This paper describes their design. The floor area is between 5 and 8 m^2, and the average number of animals in each house is eight. The floor is about 0.6 m above the ground. It is made from bamboo slats which are 40-45 mm wide and the space between them is 15 mm. Dung and urine fall through the slats into a pit beneath the house. The walls are made of wooden or bamboo bars, and about half the wall area is open space. The sloping roof is made of tiles, thatch or other material. Usually the animals enter the house up a ramp to a door at one end. The food trough is outside one of the long walls.

LA CONSTRUCTION D'ABRIS POUR LES OVINS ET CAPRINS COMME A JAVA SERAIT-ELLE UTILE AU NIGERIA?

Résumé

A Java, ovins et caprins sont maintenus en claustration dans des constructions dont les planchers surélevés sont constitués de lattes. Ces abris mettent les animaux au sec et au frais et leur construction, relativement bon marché, est conforme au modèle décrit dans la communication. La surface du plancher couvre 5 à 8 m^2 et le nombre moyen d'animaux est de huit par chévrerie. Le plancher, à 60 cm au dessus du sol, est fabriqué en lattes de bambou de 4 à 4,5 cm de large, espacées de 1,5 cm. Crottes et urine tombent à travers les fentes entre les lattes dans un fossé creusé sous la chévrerie. Les parois latérales consistent en planchettes de bois ou tiges de bambou, la moitié de la surface murale étant à claire-voie. Le toit en pente est recouvert de tuiles, de chaume ou d'un autre matériau. Les animaux pénètrent habituellement dans la chèvrerie en empruntant une rampe d'accès à une porte située sur l'un des côtés, et la mangeoire est fixée à l'extérieur de l'une des plus longues faces latérales.

Introduction

Java has a hot humid climate, a very high population density and small intensively-cropped farms. Sheep and goats are kept in animal houses partly to prevent them from eating crops, and partly because the houses provide a good physical environment.

The Southern half of Nigeria has a climate similar to that of Java. In

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both areas the average herd size for sheep and goats is small, typically fewer than 10 animals. If the present scavenging system of sheep and goat production in Nigeria were to be improved and intensified, housing would be necessary, and the Javan style of house would appear to be suitable.

The design of houses in Java

Traditional houses for sheep and goats in Java are small with a floor area between 5 and 8 m^2. A detailed description of these houses was given by Gatenby et al. (1985). A sketch of a house is given in Figure 1, and a floor plan in Figure 2.

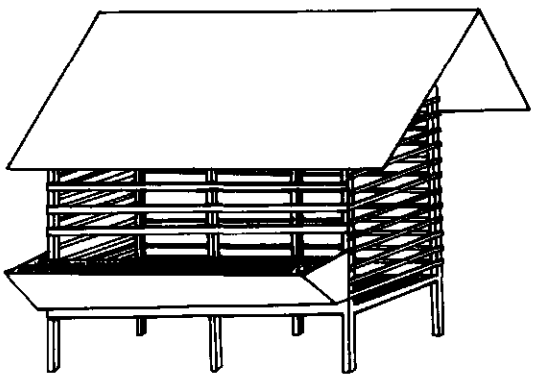

Fig. 1. Javan goat house.

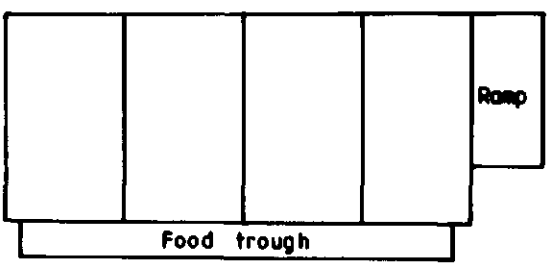

Fig. 2. Javan goat house; floor plan.

The average number of animals (including lambs and kids) in each house is eight. The width of all houses is almost constant at 1.7 m, but the length varies according to the number of animals. Most houses are divided internally into a number of pens (usually 3 or 4).

Animal houses in Java have a raised floor made of bamboo slats. This floor or platform is about 0.6 m above the ground. The slats allow dung to fall down to the ground below. Bamboo slats are particularly well-suited as their upper surface is convex which helps the dung to roll off and fall through the spaces. The dung pellets of sheep and goats are typically 7 mm

in diameter and 12 mm in length. Clusters of pellets are usually 20 to 30 mm in diameter. The width of slats is 40 to 45 mm and the space between them is 15 mm. The separation of the slats is critical - if they are too close together the dung cannot fall through, but if they are too far apart the legs of the animals (particularly lambs and kids) pass through and are trapped.

The dung is collected in a pit beneath house. Any food which has fallen out of the food trough is also swept into this pit, and urine adds to the mixture. The pit is emptied at regular intervals and the manure is spread on the crops.

The walls of Javan animal houses are usually made of wooden or bamboo bars, placed either horizontally or vertically. The width of these bars is about 90 mm and the spaces between them are about 80 mm, so that about half the wall area is open. Open walls, together with the slatted floor, are beneficial because they encourage air circulation through the house. During certain seasons of the year the animals can be given more protection by covering one or more walls with sacking or board.

The roofs of Javan animal houses are made from whatever materials are available in the villages: clay tiles, thatch of palm leaves and occasionally zinc sheeting (either proprietary corrugated roofing or old oil cans). The roof of the house has two main functions. Firstly, it shades the house, and to do this well it should be thick and have a substantial overhang. Secondly, it gives protection against rain which in the humid and sub-humid tropics is often torrential; it should not leak and it should have good overhang to prevent rain entering sideways into the house.

Most of the roofs in Java are double-pitched with the apex along the long axis of the house. The slope of the roof (i.e. the angle of elevation) is about 30° and the overhang on each side is about 0.8 m. The construction of the roof must be strong enough to withstand strong winds even if these occur only occasionally. The most desirable type of roof material is thick, impermeable to water and not easily damaged by fungi or vermin. Thatch in good condition makes an excellent roof, and it is cheap. However, palm and grass thatch rots in a humid climate and must be replaced frequently.

There is usually a door at one end of the house, although for the herds which are not grazed this door is rarely used. Animals walk between the ground and the door on a bamboo ramp which may be removed after use. The food trough runs along the outside of one of the long walls of the house, and the animals eat by putting their heads out between wooden bars.

Benefits and problems of Javan houses

The houses for sheep and goats in Java are well-designed to provide a good physical environment for the animals. The animals are well-shaded, air movement in the house is good and faeces and urine are immediately removed from the animals. The ways in which the houses modify the environment are discussed by Gatenby *et al.* (1987). On average in Java, the air temperature inside the house is only 0.3°C higher and the absolute humidity only 0.03 g m^{-3} higher than outside the house. With a more enclosed style of house the temperature and humidity would be substantially higher inside than outside. If the animals were kept outside in the sun they would be severely heat stressed.

Because the houses are constructed entirely from materials produced in the villages, they are relatively cheap. The price of a house in Java is about US$ 50, or roughly the cost of two ewes or does.

Problems do occur with the animal houses. The house must be inspected

every day, and any food and faeces on the slatted floor should be scraped off. Holes in the floor must be mended immediately to prevent the possibility of the animals' legs being broken. Displaced roof tiles and leaking thatch roofs must be repaired. In Java most farmers were relatively unconcerned about the state of their roofs during the dry season, but repaired them at the beginning of the rainy season.

The durability of the house depends on the material used and the method of construction. In general, wooden frames last longer than bamboo, and tile roofs last longer than thatch. A house with a bamboo frame lasts about 6 years. If the carpenter is not skilled, the house tends to fall sideways so that the cross-section becomes diamond-shaped instead of rectangular, and eventually the structure collapses.

General discussion

Animal houses of the type built in Java would seem to be very suitable for Nigeria, but the only people who at present are skilled at making them are Javan sheep and goat farmers and village carpenters. The broad aspects of the design of these houses can be gained from diagrams and descriptions, but the finer points can only be appreciated by watching the craftsmen at work. This leads us to suggest that the best way to transfer this technology from Java to Nigeria would be for one or more Nigerian craftsmen with a knowledge of animal production to go to Java and watch the construction of animal houses in several locations in Java. The alternative would be for one or more Javan craftsmen to visit Nigeria and pass on their skills to interested people. I think the former approach would be better as the Nigerian craftsmen would be able to look at many houses and decide exactly which methods of construction would be best for their home country, whereas the other method would transfer a smaller amount of knowledge.

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ROLE ET PRODUCTIVITE DE LA CHEVRE AU TOGO

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Résumé

Le Togo possède un important cheptel caprin de type Djallonké qui est estimé à plus de 750 000 têtes. L'élevage de la chèvre naine guinéenne est extrêmement répandu aussi bien à la campagne que dans les centres urbains. Depuis 1981, l'amélioration de l'élevage des ovins et des caprins est confié au Projet petits ruminants (PROPR) qui organise des campagnes annuelles de vaccination (PPR) et de déparasitage interne. Les activités d'encadrement du projet sont plus intensifiées sur les ovins que sur les caprins.

La chèvre Djallonké est élevée pour sa chair et pour l'épargne. Elle est un moyen de consolidation des liens familiaux et fait l'objet de l'élevage de rente. Elle n'est pas encore totalement intégrée dans les systèmes de production agricole.

ROLE AND PRODUCTIVITY OF GOATS IN TOGO

Abstract

Togo has about 750,000 West African dwarf goats which are commonly reared both in rural and urban areas. Since 1981 sheep and goat improvement work has been carried out by the Project Petits Ruminants (PROPR) which conducts annual campaigns to vaccinate against PPR and control internal parasites. The project focusses more heavily on sheep than on goats.

The West African dwarf goat is raised for its meat and as a source of savings and cash because of its social significance in the family. Goat rearing is not yet fully integrated into the agricultural production system.

Introduction

Le Togo est l'un des pays de la sous-région ouest-africaine dans lesquels la chèvre ne bénéficie pas jusqu'à présent d'une situation confortable dans les programmes de développement de l'élevage, notamment l'élevage des petits ruminants. Par contre le mouton susoite un intérêt de plus en plus grand et soutenu. L'exemple de la Côte d'Ivoire illustre cet état de fait: en effet, dans ce pays, un important programme national ovin a vu le jour en 1977 et depuis dix ans, on peux constater que, la chèvre est toujours écartée. Dans certains pays, elle a été accusée d'être responsable de la désertification et son élimination a failli être mise en oeuvre. Dans les conditions de l'élevage non rationnel, caractérisé par la privation et le manque de soins appropriés (soins vétérinaires, habitat et alimentation inéfficaces) la chèvre se présente comme un animal particulièrement vulnérable. Pourtant ses aptitudes à la reproduction et sa rusticité sont des qualités qui devraient déclencher une série

d'observations et d'expérimentations systématiques. Enfin, elle est capable d'aller trouver de l'herbe et des feuilles d'arbres là où le mouton échoue et peut, en conséquence, subsister là où les autres ruminants disparaîtraient.

Situation de l'élevage des caprins au Togo

Le cheptel ovin et caprin est estimé à 1 598 400 têtes, dont plus de 750.000 chèvres. La race de chèvre la plus répandue au Togo est la chèvre naine guinéenne, encore appelée chèvre Djallonké. La taille au garrot des femelles primipares et multipares varie de 36 à 44 cm, celle des mâles adultes ne dépasse pas 50 cm. Le poids des mâles et des femelles primipares et multipares se situe entre 12 et 29 kg. Les caractères biométriques sont indiqués dans les Tableaux 1 et 2. Les mensurations ont été réalisées sur 21 femelles et 5 mâles.

Tableau 1. Caractères biométriques des femelles primipares et multipares.

	Longueur (cm)	Hauteur au garrot (cm)	Périmètre thoracique (cm)	Poids (kg)
Moyenne	59,8	40	62	17,2
Variation	55-72	37-45	57-73	12,2-29,5

Tableau 2. Caractères biométriques des mâles adultes.

	Longueur (cm)	Hauteur au garrot (cm)	Périmètre thoracique (cm)	Poids (kg)
Moyenne	60,5	48,5	63	19
Variation	58-63	45-50	59-66	15-22

Certaines races caprines des régions sahéliennes et la chèvre rousse de Maradi sont également présentes au Togo. En raison de leur grande taille, ces animaux intéressent quelques éleveurs. L'élevage de la chèvre Djallonké est extrêmement répandu dans les fermes (habitat dispersé) et dans les villages aussi bien que dans les centres urbains. Dans les villes, les chèvres sont élevées en claustration stricte ou en semi-stabulation. Ce mode d'élevage entraîne des frais occasionnés par l'alimentation (achat de fourrages, de concentrés) et par quelques soins vétérinaires. A la campagne, la divagation est la règle et pendant les périodes d'activités agricoles, elles sont en claustration ou attachées. Les mâles castrés font l'objet d'embouche dite traditionnelle.

Depuis 1981, un changement est intervenu. En effet, dans le cadre du programme d'encadrement et d'action sanitaire du Projet de Développement de l'Elevage des Petits Ruminants, plus de 120 000 bêtes (ovins et caprins confondus) sont atteintes chaque année par les campagnes d'immunisation et de déparasitage interne. En 1986, l'effectif ovins et caprins encadré par le Projet était de 120 000 têtes. Les résultats obtenus sont mentionnés au Tableau 3.

Toujours dans le cadre des activités du Projet, certains élevages semi-intensifs de la chèvre naine dont les effectifs vont de 15 à 40 têtes,

Tableau 3: Les interventions en faveur des petits ruminants.

Interventions	Année	Effectifs (ovins/caprins)
Vaccinations Projet petits ruminants	1981/82	149 658
	1982/83	121 974
	1983/84	101 108
	1984/85	56 706
	1985/86	3 989
	1986/87	16 943
Déparasitage interne	1981/82	139 978
	1982/83	253 965
	1983/84	148 233
	1984/85	114 607
	1985/86	84 544
	1986/87	pas d'intervention
Déparasitage externe	1981/82	-
	1982/83	89 323
	1983/84	88 842
	1984/85	136 458
	1985/86	pas d'intervention
	1986/87	pas d'intervention

Source: Rapport d'activités du Projet petits ruminants, 1985-1986.

bénéficient d'encadrement technique régulier. Les thèmes techniques sont les mêmes pour les ovins et les caprins, à savoir : l'amélioration et l'hygiène de l'habitat, l'amélioration de l'alimentation, abreuvement hygiénique et suffisant, vaccination, déparasitage interne et externe, amélioration génétique (choix des mâles, castration). Les résultats obtenus sont reportés dans le Tableau 4. L'examen du Tableau 3 montre que de grands efforts d'interventions sanitaires sont à déployer pour atteindre des effectifs très importants de petits ruminants. Les données du Tableau 4 illustrent bien le peu d'intérêt accordé à la chèvre.

Tableau 4. Effectifs des ovins et caprins des élevages semi-intensifs encadrés par le Projet.

	1985		1986	
	Ovins	Caprins	Ovins	Caprins
Nombre d'éleveurs	49	9	166	11
Nombre de mères	1 794	160	4 865	150
Effectif total	3 115	389	9 408	254

Source: Rapport d'activités du Projet petits ruminants, 1986.

Le rôle de la chèvre

Dans nos milieux, le rôle de la chèvre est multiple. La chèvre naine est élevée pour sa chair (la peau aussi est consommée). Elle est l'un des animaux domestiques le plus abattus dans des communautés non islamisées

pour diverses raisons: autoconsommation, fêtes, baptême, sacrifices aux ancestres, aux dieux. La viande de chèvre est la plus demandée dans les restaurants populaires dans les villes et dans les villages, surtout de la partie méridionale du pays. A ce titre, la chèvre Djallonké assurerait un apport en protéines animales à une importante fraction de la population du Togo.

Dans le milieu rural, le troupeau de chèvres représente aussi un capital, une épargne qui vient en complément des ressources financières provenant de la vente des produits de récoltes. Les ventes sont effectuées pendant les périodes de soudure ou à tout moment suivant les besoins pécuniaires. La chèvre est souvent offerte à des personnalités ou à des amis. L'élevage de la femelle est fréquemment confié à des tiers (parents, amis) qui inspirent une certaine confiance. A ce titre, la chèvre serait un moyen de consolidation des liens de parenté et d'amitié.

L'élevage de rente est un type d'élevage visant à favoriser l'implantation progressive du profit monétaire, mais son développement est sérieusement compromis car la gestion d'importants troupeaux de chèvres guinéennes pose d'énormes problèmes à tel point que certains éleveurs réduisent l'effectif des caprins au profit des ovins.

L'intégration de la chèvre dans le système de production agricole consiste à lui donner les résidus des récoltes, les sous-produits de transformation (les sons, les épluchures) ou les produits impropres à la consommation humaine. Les ressources fourragères des jachères sont également disponsibles. En général, l'utilisation des poudrettes de petits ruminants pour la fertilisation des sols n'est presque pas pratiquée par les paysans-éleveurs qu'il faudrait s'efforcer de sensibiliser à cette technique.

Productivité de la chèvre naine guinéenne au Togo

Si l'élevage de la chèvre Djallonké doit être stimulé par l'exécution d'un programme de développement, il serait logique de consevoir une série d'observations systématiques qui permettent de faire la lumière sur les performances de reproduction, sur la croissance pondérale, sur la mortalité et le régime alimentaire des animaux. Les données ayant une signification statistique ne sont pas disponibles, seuls les résultats de quelques observations et enquêtes ponctuelles et sommaires sont présentés ici. Dans les conditions de l'élevage traditionnel de la chèvre naine,- l'âge à la première mise bas va de 12 à plus de 24 mois. Le poids après la première parturition varie de 12,2 à 13,9 kg (6 observations). L'intervalle entre mises bas est de 6 à 12 mois. Il n'est pas rare qu'une primipare mette bas des jumeaux. Il existe des lignées de femelles qui mettent bas des chevreaux doubles ou triples durant toute leur carrière reproductrice. Dans un troupeau, sur 15 chevreaux nés de 8 mères, il y a eu deux naissances simples, cinq naissances doubles et une naissance triple. La taille de la portée est de 1,9.

Pour 15 chevrotages, le poids moyen à la naissance (type, rang de naissance et sexe confondus) est de 1,5 kg, la variation de 1,2 à 2,3 kg. A 2 mois, le poids est de 3 à 4,5 kg et de 3 à 4 mois il atteint les 5 à 7 kg (observations faites sur 27 chevreaux). Pour évaluer la croissance de la chèvre Djallonké, les poids de 18 femelles et de 7 mâles ont été relevés et classés par tranche d'âge. Pour la détermination de l'âge, la lecture de la dentition a été pratiquée. Les résultats sont présentés dans le Tableau 5.

Il est difficile de chiffrer les taux de mortalité et d'avortement en l'absence d'études specifiques. Se suffira de signaler que la mortalité moyenne est très élevée, des taux de 15 à 20% étant souvent mentionnés

Tableau 5. Dentition - poids des femelles et des mâles.

Dentition	Femelles	Mâles
0 paire	8,7	8,5
1 paire	8,5	14,6
2 paires	11,7	-
3 paires	13,8	-
4 paires	17,4	21,0

Source: Rapport d'activités du Projet petits ruminants, 1986.

pour la tranche d'âge comprise entre la naissance et 5 mois dans les zones tropicales humides ou sèches. Les syndromes pneumo-pathiques, les parasitoses et les carences nutritionnelles sont les causes fréquentes de mortalité. Les épizooties de la peste des petits ruminants viennent périodiquement aggraver la situation, en augmentant les taux jusqu'à 40 à 60%.

Conclusion

Le cheptel caprin du type Djallonké représente environ 47% de l'effectif des chèvres au Togo. (Wilson & Bourzat, 1987). La chèvre guinéenne est présente partout et tient une place importante dans la vie sociale et économique des populations rurales en particulier. Sa contribution en apport en protéines animales est très appréciable sur la plan national. Son potentiel de reproduction et sa capacité d'adaptation au milieu devraient nous amener à adapter une politique de développement favorable visant à améliorer et à rentabiliser sa productivité. La diffusion de modèles éprouvés de gestion rationnelle de grands troupeaux pourrait susciter l'intérêt des agriculteurs pour cette spéculation.

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