J. TURK

CAPRINOS E OVINOS NO NORDESTE DO BRASIL

Anais da 1ª Reunião Técnico-Científica
do Programa de Apoio à Pesquisa Colaborativa
de Pequenos Ruminantes

GOATS AND SHEEP IN NORTHEAST BRAZIL

Proceedings of the First Workshop
of the Small Ruminant
Collaborative Research Support Program

CENTRO NACIONAL DE PESQUISA DE CAPRINOS
Sobral, Ceará, Brasil
14-18 abril, 1986

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EMPRESA BRASILEIRA DE
PESQUISA AGROPECUARIA -
EMBRAPA

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INTRODUÇÃO

Francisco A. V. Arruda

Chefe, EMBRAPA/Centro Nacional de Pesquisa de Caprinos

A Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) através do Centro Nacional de Pesquisa de Caprinos (CNPC) iniciou em 1980 o convênio com o "Small Ruminant Collaborative Research Support Program" (SR-CRSP). O programa multi-institucional e multidisciplinar contemplou a aplicação da ciência e tecnologia para melhorar e produção de pequenos ruminantes em condições adversas do semi-árido do Nordeste Brasileiro, presentemente com uma população superior a 35 milhões de habitantes.

O programa teve como objetivos prioritários: 1 - treinamento de estudantes brasileiros e americanos, 2 - fortalecimento institucional e 3 - condução a longo prazo de projetos de pesquisa básica e aplicada, visando o melhoramento da agricultura no Nordeste, principalmente para pequenos produtores que habitam a região. Desde o estabelecimento do programa, a maior parte da agenda tem sido cumprida:

1 - Treinamento de estudantes brasileiros e americanos

Dez técnicos americanos foram ou estão sendo treinados a nível de PhD: Helaine Burstein, Corrie Brown, Amanuel Gobena, Nestor Gutierrez, Linda Hardesty, Robert Kirmse, Scott Kronberg, James Pfister, João Queiroz e Walter Schacht. Por outro lado dezesseis pesquisadores brasileiros concluiram ou estão cursando o programa de pós-graduação em universidades americanas e brasileiras: Selmo Alves, Ubiraci Alves, Angela Eloi, Oriá Fernandes, Elsio Figueiredo, Enéas Leite, Roberto Mesquita, Jaimundo Neto, Marisa Neumaier, Ederlon Oliveira, Djair Pena, Lucia dos Santos, Aurino Simplicio, Pedro de Sousa, Wandrick Souza e Maria Auxiliadora Vasconcelos. Além disso, o SR-CRSP tem mantido cientistas a nível de PhD, lotados em Sobral, os quais têm ajudado no treinamento de técnicos de laboratórios e de campo, que podem exercer, agora diversas funções dessas áreas.

2 - Fortalecimento institucional

Neste respeito tanto a EMBRAPA como o SR-CRSP têm visualizados sólidos benefícios. Os suprimentos e equipamentos para laboratório e pesquisas de campo adquiridos, tem sido de grande importância na manutenção do alto nível de produtividade até agora alcançados por nossos cientistas nos Estados Unidos e no Brasil.

3 - Condução da pesquisa

Os resultados de pesquisa apresentados nos Anais desta Reunião, tem contribuido para modelar futuros esforços de

pesquisa e ajudarão na eleaboração de pacotes tecnológicos a serem aplicados a nível de fazenda.

Estes Anais representam seis anos de esforços integrados e estreita colaboração entre nossas instituições. Em nome da EMBRAPA, eu gostaria de agradecer os participantes representando a USAID e outras instituições americanas e brasileiras pelo tempo e esforço dedicados a este importante evento.

Outrossim, nós brasileiros somos muito gratos a uma pessoa em particular, o ex-diretor da SR-CRSP, Dr. David Robinson que conduziu com sucesso um esforço e uma busca complexa para uma participação bem sucedida e equitativa neste projeto ambicioso.

INTRODUCTION

Francisco A. V. Arruda

Director, National Goat Research Center(EMBRAPA)

The Brazilian National Goat Research Center (CNPC), representing EMBRAPA (Brazilian Enterprise for Agricultural Research) first established working ties with the SR-CRSP in 1980. The multi-institutional, multi-disciplinary program contemplated the application of science and technology to improve small ruminant production in the adverse conditions of the semi-arid Northeast Brazil, presently inhabited by more than 35 million people.

The program had as priority three main goals: (1) training of American and Brazilian students; (2) forage institution building; and (3) conducting basic and applied long-term research projects to improve the agriculture capabilities of the Northeast, primarily of smallholders who live for subsistence. Since the establishment of the program, most of the agenda has been accomplished as follows:

(1) Training of American and Brazilian students

Ten American postgraduate scientists were or are being trained: Helaine Burstein, Corrie Brown, Amanuel Gobena, Nestor Gutierrez, Linda Hardesty, Robert Kirmse, Scott Kronberg, Jim Pfister, João Queiroz and Walter Schacht. On the Brazilian side, the following colleagues have been involved in the training program: Selmo Alves, Ubiraci Alves, Angela Eloi, Oriá Fernandes, Elsio Figueiredo, Enéas Leite, Roberto Mesquita, Jaimundo Neto, Marisa Neumier, Ederlon Oliveira, Djair Pena, Lucia dos Santos, Aurino Simplicio, Pedro de Sousa, Wandrick Souza and Maria Auxiliadora Vasconcelos. In addition, the SR-CRSP has maintained PhD scientists on site who have helped train laboratory technicians and field workers which can now handle diverse field and laboratory functions.

(2) Institution building

In this respect, both EMBRAPA and SR-CRSP institutions have seen a benefit. Laboratory and field research supplies and equipment purchased have been of paramount importance in maintaining the high level of productivity until now accomplished by our scientists in the United States and Brazil.

(3) Conducting of research

Research findings presented in this workshop proceedings have contributed to mold future research efforts and will help design a technological package to be applied at the farm level.

These proceedings represent six years of integrative efforts and close collaboration among our institutions. In the name of EMBRAPA, I would like to thank the participants representing US-AID and other American and Brazilian institutions, for the time and effort dedicated to this important event. Nevertheless, we Brazilians are grateful to one man in particular, the late director of the SR-CRSP, Dr. David Robinson, who successfully carried forward a complex endeavour and a quest for a successful equal partnership in an ambitious project.

INTRODUCTION

W. C. Weir
Acting Program Director, Small Ruminant CRSP

University of California-Davis

This workshop provides an opportunity for scientists of the Centro Nacional de Pesquisa de Caprinos (CNPC) and state research agencies affiliated with the EMBRAPA system (notably EPACE, Ceará, and EMEPA, Paraîba) and their guests, provided through the Small Ruminant Collaborative Research Support Program (SR-CRSP), to demonstrate the true collaboration which has developed since 1979, when the designated principal investigators from the several U.S. institutions made their first working visits to Sobral. Both the CNPC and the SR-CRSP have evolved tremendously since that first year, as has been documented in annual reports. We are all cognizant of the role of the United States Agency for International Development (AID), through its Title XII programs that are overseen by the Board for International Food and Agricultural Development, in providing the grant funds which have facilitated this unique experiment in long term scientific collaboration.

The accomplishments have been many. Principal constraints to goat and hair sheep production in Northeast Brazil, and, by extrapolation, in similar areas throughout the semi-arid tropics, have been identified. Through experimentation much data has been accumulated showing ways to surmount these constraints.

Now we are ready to communicate these findings to a variety of audiences. Hopefully the Proceedings of this Workshop will be used by researchers, extension specialists, rural development leaders, and students.

The IV International Conference on Goats, to be held in Brasilia in March 1987, will provide an opportunity to share the results of our collaboration with a world audience. Scientists from the several Brazilian and U.S. collaborating institutions will collectively play a prominent role at that gathering.

One important aspect of the EMBRAPA/SR-CRSP collaboration has been the training of young scientists. As the funding levels for the SR-CRSP diminish, more and more of the responsibility for research and outreach leadership at the CNPC will pass to newly-trained Brazilian scientists. As the CNPC continues to grow and develop, the interest and best wishes of all members of the SR-CRSP family will be with you.

I am personally very pleased to have been a participant in this Workshop, and commend the papers presented as valuable contributions toward the solution of practical problems in

Northeast Brazil and other similar regions, as well as to the world scientific literature on goats and hair sheep in the tropics.

I. PESQUISA PARA DESCREVER O SISTEMA DE PRODUÇÃO ATUAL NO NORDESTE DO BRASIL

I. RESEARCH TO DESCRIBE THE PRESENT PRODUCTION SYSTEM IN NORTHEAST BRAZIL

FARM-LEVEL RESOURCES FOR SMALL RUMINANT PRODUCTION

A. John De Boer, Nestor Gutierrez A., and José de Souza Neto

Winrock International Institute for Agricultural Development
and National Goat Research Center (EMBRAPA)

ABSTRACT - Survey work is synthesized from collaborative projects dealing with farming systems in Northeast Brazil. Information includes descriptions of farming systems, farm resource productivity, characterization of small ruminant productivity, and resource adjustments during periods of severe climatic fluctuations. Sheep and goats are important components of farming systems in the semi-arid tropics of Brazil. In the higher rainfall areas, small ruminants are usually grazed with cattle on mixed crop/livestock farms that typically produce maize, beans, and tree cotton. As rainfall amounts in the area decrease, goats become relatively more important than hair sheep and cattle and cropping activities decrease. During droughts, goats are of even greater importance. Lambing and kidding seasons follow rainfall patterns, as do stocking rates.

Land management reflects minimal levels of capital inputs resulting in little control over grazing or animal management. Crop residues and forage crops are used primarily for cattle, with sheep and then goats accorded lower priority. Offtake rates for sheep exceeded that for goats only in good years, but overall small ruminant offtake levels were low reflecting high mortality rates, low fecundity, and herd reductions that occurred during the study period.

Current management systems and resource constraints make it difficult to genetically upgrade current herds/flocks or to target specific range/forage improvement strategies for small ruminants. Climatic fluctuations are likely to have larger technical and economic impact upon farm resource productivity than will improved technology generated by CNPC/SR-CRSP programs. Climatic variability also will make it difficult to carry out sound on-farm validations of potential technologies.

Index terms: Sheep, Goats, Northeast Brazil, Farming systems, Farm-level resources.

RECURSOS PARA A PRODUÇÃO DE PEQUENOS RUMINANTES A NÍVEL DE FAZENDAS

RESUMO - O trabalho de pesquisa foi sintetizado do projeto colaborativo que trata do sistema das fazendas no Nordeste do Brasil. As informações incluem descrições do sistema pecuário, recursos de produtividade da fazenda, caracterização do produtividade de pequenos ruminantes, e mudanças na utilização de recursos durante o período de severas flutuações climáticas. Ovelhas e cabras são importantes componentes do sistema pecuário

no clima tropical semi-árido do Brasil. Em áreas de alta precipitação pluviométrica, pequenos ruminantes pastam normalmente com o gado bovino, em fazendas mistas (agropecuários) que produzem tìpicamente milho, feijão e algodão. A medida que a índice de precipitação na área diminue, as cabras tornam-se mais importantes do que as ovelhas lanadas, e o gado, e o plantio diminue. Durante a sêca, cabras são de ainda maior importância. A época de parto amamentação se guia pelas chuvas, assim como também o número de animais por hectare de terra.

A administração da terra reflete níveis mínimos de investimentos de capital, resultando em pouco controle de partejo e dos animais em geral. Residuos de colheitas e plantações de forragem são primariamente para o gado, depois para a ovelha e por último para a cabra. A taixa de comercialização para ovelhas excedeu a das cabras somente em anos bons, mas no geral a comercialização de pequenos ruminantes foi baixa, refletindo alta taixa de mortalidade, baixos nìveis de fecundidade, e reduções no rebanho que ocorreram durante o perìodo de estudo.

Atuais sistemas de manejamento e restrições de recursos fazem com que seja difìcil melhorar geneticamente os rebanhos, ou mesmo determinar uma estratégia de melhoramento das forragens para pequenos ruminantes. Flutuações climáticas possivelmente tem maior impacto técnico e econômico sobre os recursos de produtividade da fazenda do que melhoram a tecnologia gerada pelo programa do CNPC/SR-CRSP. Variações climáticas também tornam difìcil validar as tecnologias potenciais.

Termos para indexação: Ovelhas, Cabras, Nordeste do Brasil, Sistêmas agropecuários, Recursos da fazenda.

Introduction

This paper synthesizes a baseline survey by the economics project and later collaborative work with the animal breeding project covering a group of farms monitored from 1980 to 1982. Supplementary information was provided by a collaborative range management project that proivded detailed data on stocking rates, soil types, vegetation types, and range conditions (Queiroz et al., 1986). Therefore, most of these results cover only a limited number of microregions in Ceará state and must be interpreted with caution when dealing with Northeast Brazil in general or with the sertão (semi-arid) region in particular. Primov (1983) found substantial differences in farm characteristics between the groups of farms reported upon in this paper and groups of farmers interviewed in more arid regions of Western Bahia state. Additional baseline surveys are under way in other states of Northeast Brazil and progress on this work will be reported upon elsewhere in the workshop.

Despite the limited sample of farmers, the selection process was designed so that the ecological characteristics of the microregions selected would be similar to those of most of the

agro-climatological zones found in Northeast Brazil. Sheep and goats tend to be concentrated within specific microregions in the sertão and the sample covered most of these main microregions.

The following description of farming systems systhesizes information from both the baseline survey and the periodical survey that included a subsample of farms from the baseline survey. Information covers farming systems, resource productivity, characteristics of small ruminant performance, and characteristics of the farms during periods of severe climatic fluctuations.

Description of the Farming Systems

Sampling for the 127 farms included in the baseline survey was based on microregions defined by geographic similarities. Each of the five microregions selected was composed of several counties and had high concentrations of sheep and goats, with the five representing over 50% of the total population of sheep and goats in Ceará. Two counties were sampled in each microregion as shown in Table 1, with enumeration during April-June 1980. Figure 1 shows the location of the sample sites within the sertão.

TABLE 1. Baseline survey structure 1980.

Microregions	County	No. of Farms
Sertão de Sobral	Granja	15
	Sobral	16
Sertão de Crateús	Crateús	13
	Independência	14
Sertão de Inhamuns	Tauá	16
	Parambú	14
Sertão de Quixeramobim	Quixadá	5
	Quixeramobim	9
Baixo Jaguaribe	Morada Nova	15
	Russas	-
Total		127

Analysis of the baseline survey of 127 farms provided a static description of the production system and an estimation of the percentage of producers engaged in sheep and goat production in the eight major producer counties. Based on these data, a subsample of four farms per county were included, composed of a random selection of two farms above the median value and two below. Thus, a total of 32 farms from the initial sample were selected for surveys made 4 times each year, from September 1980 to January 1982. The objective of this survey was to evaluate

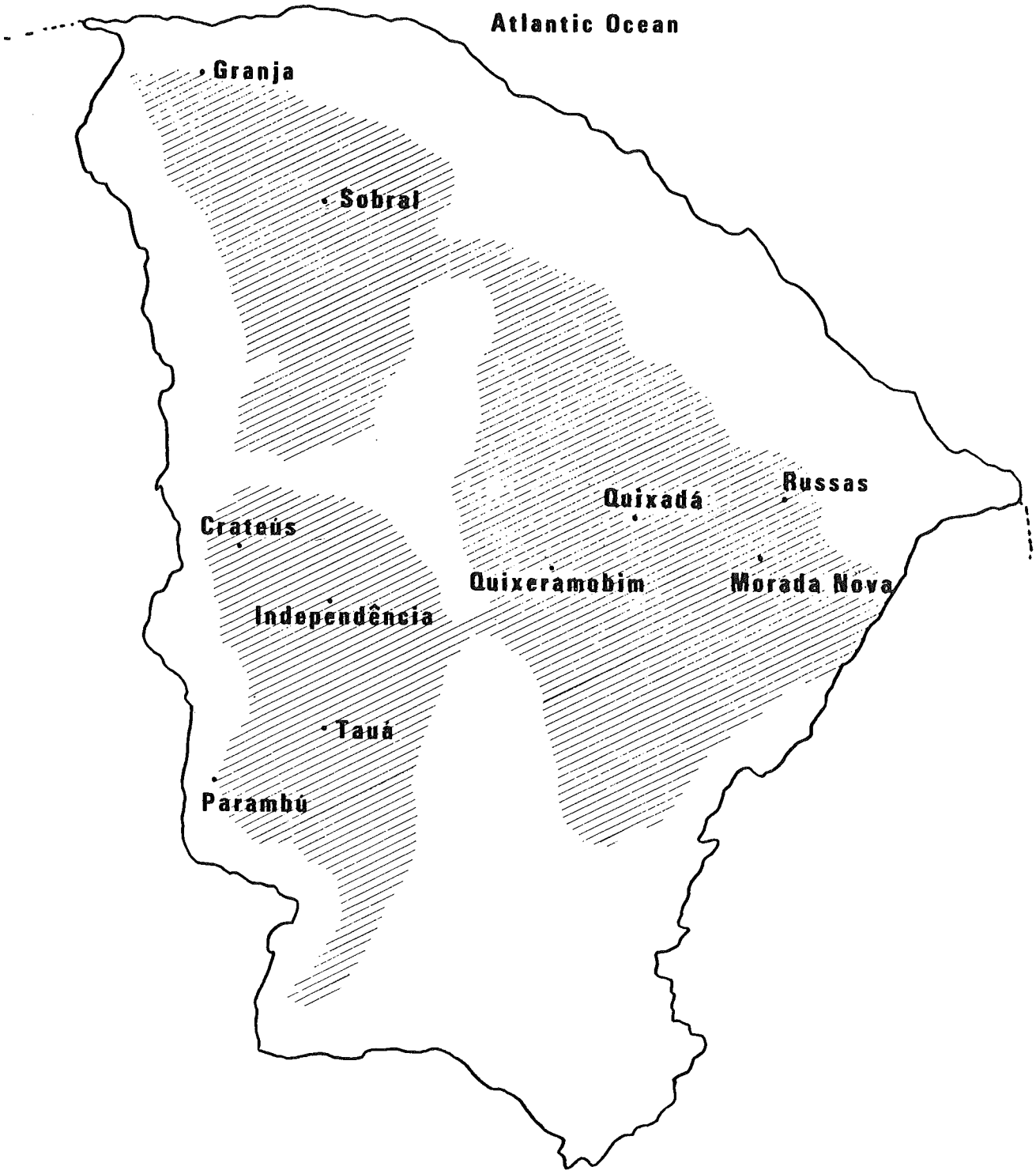

Figure 1. The Sertao (shaded area) in Ceara state (adapted from Ministerio da Agricultura, 1979).

the dynamics of the productive system (Gutierrez & Ponce de Leon, 1986a,b) and obtain interyear and interseasonal variations in animal performance. In late 1983 (September-October), a limited survey was made of land use by 27 farms in the above subsample. The following sections are based heavily upon the paper by Queiroz et al. (1986), reflecting analysis of data from the subsample of farms surveyed over the 1980-82 and 1983 periods.

Climate

Climate is the overriding variable in forage and animal production in the sertão. Temperatures do not vary widely in the state of Ceará; however, extreme variations in rainfall play an important role.

The overall average rainfall for the survey area over a 34-year span was 684mm, with a wide variation among counties.

A relatively short rainy season of 5 months (January through May) comprised 93% of the total annual rainfall. February, March, and April accounted for 67% of the total. Because of these rainfall patterns, the sertão climate can be classified as tropical semi-arid.

Agriculturally significant droughts may result from a deficiency in total amount of annual precipitation or from unfavorable distribution of monthly precipitation. The surveyed counties were classified in two groups, by isohyets (400mm to 600mm; 600mm to 800mm), the average annual rainfall from 1978 to 1983 was diagrammed to show the rainfall pattern. The 1978 to 1983 period was considered a drought period because of the sequence of years with below-average rainfall. In the two groups of counties the amount of rainfall was much the same, with each reflecting a decrease in rainfall between 1980 and 1983.

Soils

The production systems surveyed include a wide range of soil types. To cope with this variability, the local agriculturalists have developed an informal soil classification scheme.

Two major types of land are recognized: 1) those suitable for cultivation and 2) those unsuitable. This stratification is based primarily on drainage, location, fertility, and to a lesser extent on depth and surface texture. Because of their greater economic importance, the soils suitable for cultivation are classified in more detail than are noncutivatable soils.

The preferred soil types are the deep, dark-colored alluvial deposits adjacent to streams on topographic lowlands. They are locally known as "coroas" or "baixios" and are subdivided into sandy ("ariscado") or clay ("liguento, massape"). Within the broad class, the sandy type is preferred due to better drainage conditions and ease of cultivation on a yearly basis.

Less preferred are soil types collectively known as "barro vermelho" (red clays). These occur on undulating, rolling terrain and are characterized by a relatively sticky and reddish subsurface. Surface textures are highly variable and include clay loams as well as very gravelly loamy sands. Surface characteristics are used to subdivide the "barro vermelho" class. In general, the subtypes with relatively fine-textured and stone-free surfaces are preferred. Subtypes with stony surfaces are less desirable as they make the use of hand-held tools more difficult. Within the "barro vermelho" class, soil depth is usually less than 100cm. Slash and burn cultivation of perennial cotton and grain crops is common on these soils. Rest periods usually exceed 10 years.

Vegetation

The vegetation types covering the semi-arid portion of the northeast of Brazil are known collectively as "caatinga." Most plant species present in "caatinga" vegetation are deciduous. Their dry leaf litter is an important component of livestock diets throughout the dry season. During the rainy season (January-July), most of the livestock were grazed on "caatinga," but its use was largely restricted to goats during the remainder of the year.

Because there is no detailed and systematic subdivision of the "caatinga" type, the name "caatinga" in international literature encompasses all the vegetation types that are present in the sertão area of the Northeast. In fact, even at the physiognomic level, a variety of vegetation types may be identified.

For the purpose of this discussion, the vegetation in the area surveyed may be grouped into four distinct physiognomic types. These are 1) an arboreal "caatinga;" 2) a shrubby "caatinga" that typifies the concept; 3) an open woodland; and 4) palm stands.

Livestock Management

The integration of livestock and crop production is a common characteristic of the small ruminant production systems observed, which had combinations of cattle, sheep, and goats or of cattle and sheep. The combination of cattle and goats is infrequent and was not considered.

Grazing Systems

By considering only major features of the grazing systems used, 16 different management strategies were identified. The term, "grazing system" is defined as the controlled movement of livestock within the farm, usually between areas of native vegetation and cultivated fields during the year.

The 16 grazing systems were subdivided into four major groups:

- Group 1 (Figure 2) represents the grazing systems in which the dry season movement of the cattle (C), sheep (S), and goat (G) herds is simultaneous.
- Group 2 (Figure 3) is characterized by the goats remaining in the "caatinga" throughout the year.
- Group 3 (Figure 4) represents farms that do not have goats.
- Group 4 (Figure 5) represents situations in which structural features of the farms, such as fencing, influence the grazing system.

The grazing of cultivated fields in the dry season is a common occurrence in each of the four groups. Fields of corn and beans, or corn, beans, and immature perennial cotton, become available to livestock grazing in late June to early July after the grain is harvested. Generally, fields that include annual or mature perennial cotton are not grazed until the August-September period after harvest has been completed.

Group 1

Grazing system GS3 is the most widely used in Group 1. In this system, cattle, sheep, and goats graze in the native "caatinga" until September when the cotton harvest is completed, and all three animal species are transferred to the cotton fields. A portion of the cattle herd, usually pregnant and "weak" animals, receive supplemental feed. The farms (11.5%) using this system intercrop cotton with corn and beans. In contrast, farms using grazing system GS1 include in their system fields without cotton which may be grazed in July. Grazing system GS2 is used by a farm with over one-half of its total land area cleared and cropped. An interesting aspect of this complex grazing system is grazing of perennial cotton fields by cattle in the first half of the rainy season. Since cattle prefer the weedy annual growth, the practice serves to reduce weed competition with the cotton. The implementor of grazing system GS4 is an absentee landlord with a large area cleared for grazing.

Group 2

Group 2 farms are characterized by minimum input given to goat production. The goat herds have to rely on the native vegetation for sustenance throughout the year. This strategy is used by 42% of the farms in the sample. They range in size from 18ha to 450ha. More than one-third of the farms in the sample use grazing system GS5 or GS6. The main difference between these two systems is the treatment given to sheep. In GS5, sheep and goats are treated in the same manner, whereas in GS6 the sheep are treated similar to the cattle. In grazing system GS7, cattle graze the perennial cotton fields in the first half of the wet season. Grazing system GS8 is used by a farm that raises

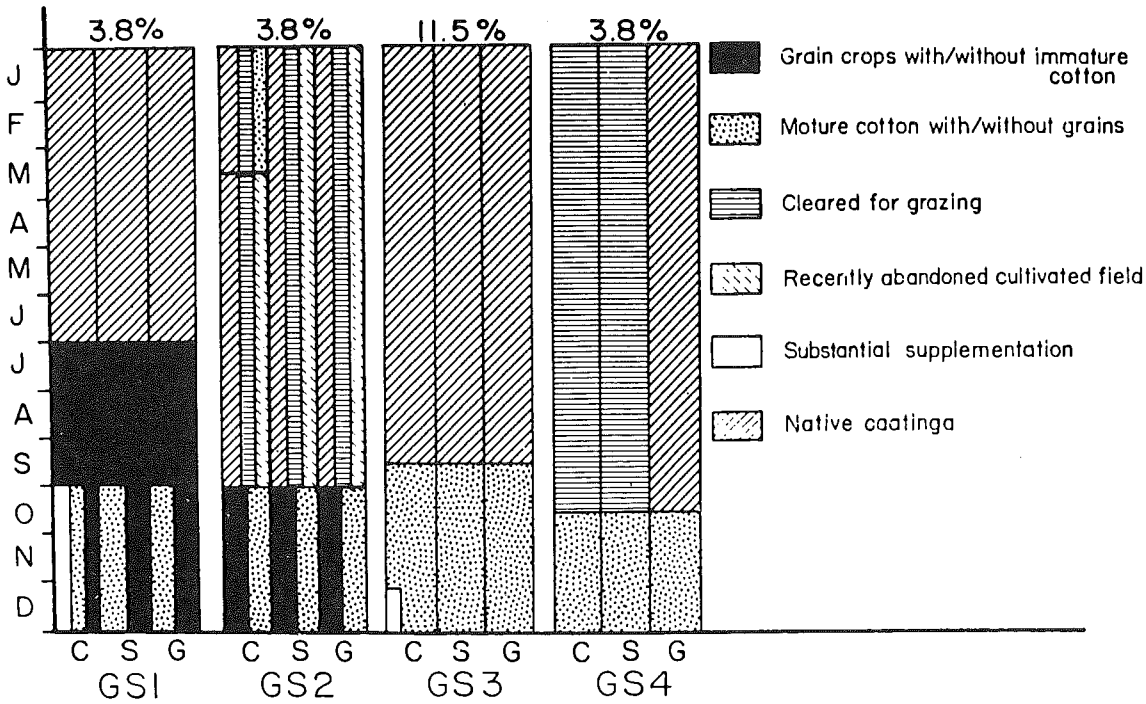

Figure 2. Diagrammatic representation of the grazing systems (GS) in which cattle (C), sheep (S), and goats (G) are moved in unison during the dry season.

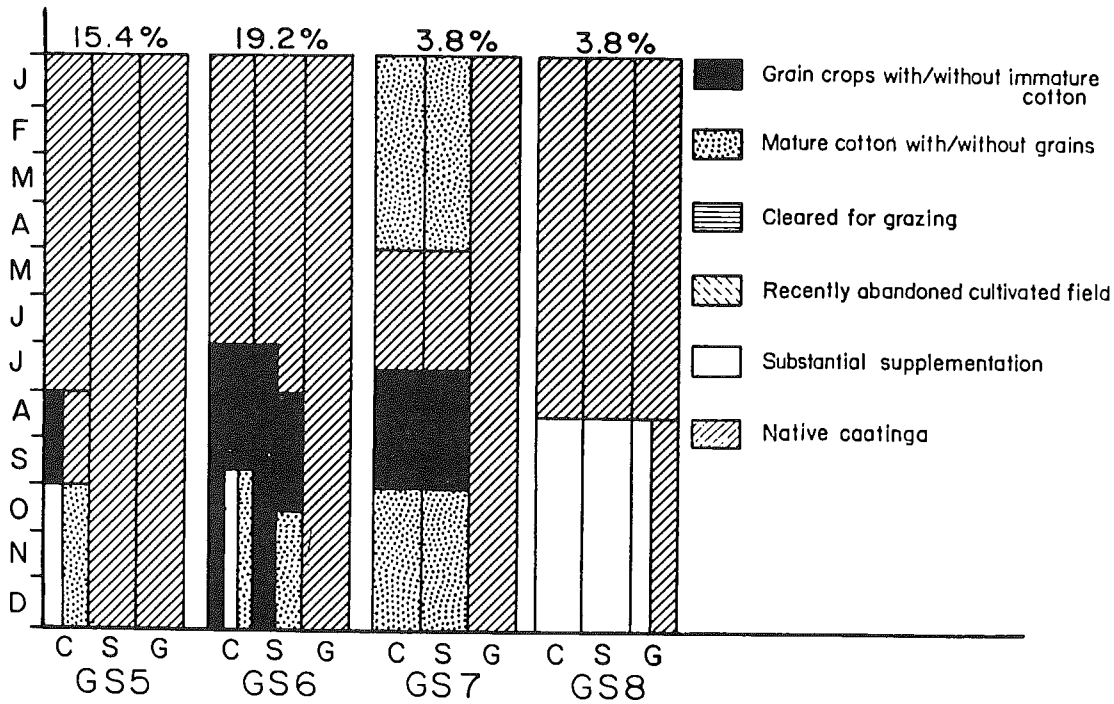

Figure 3. Diagrammatic representation of grazing systems (GS) in which goats remain in the native vegetation throughout the year--cattle (C), sheep (S), and goats (G).

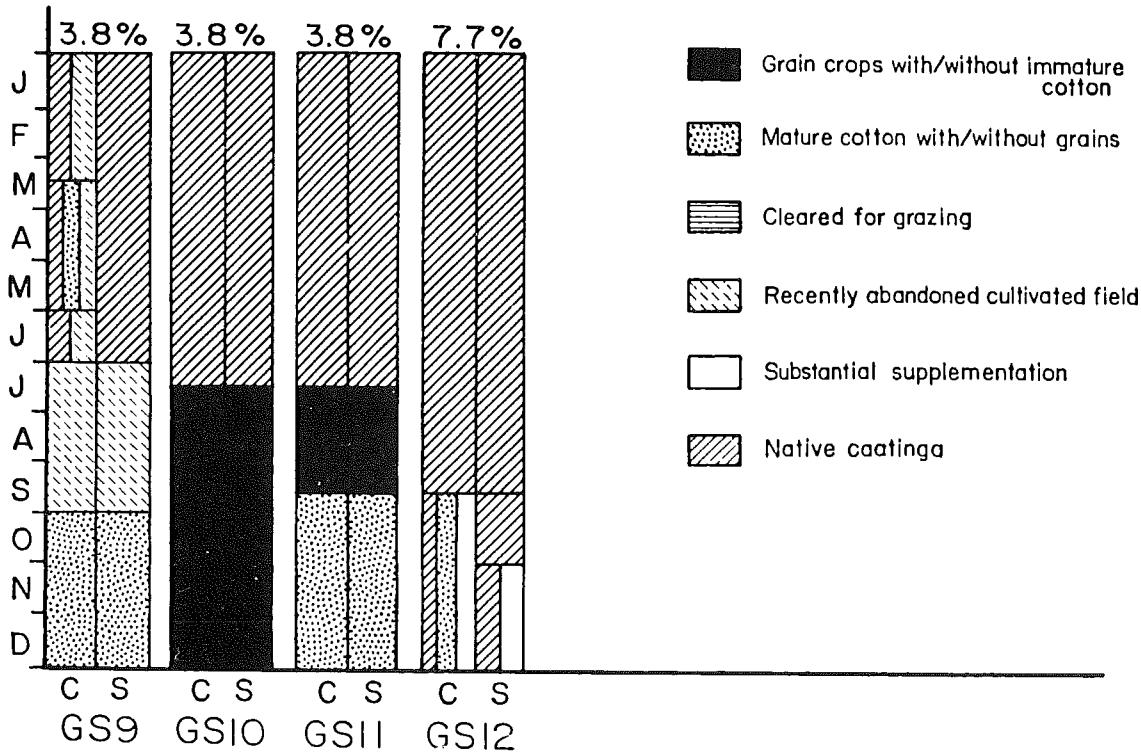

Figure 4. Diagrammatic representation of grazing systems (GS) used in farms without goats--cattle (C) and sheep (S).

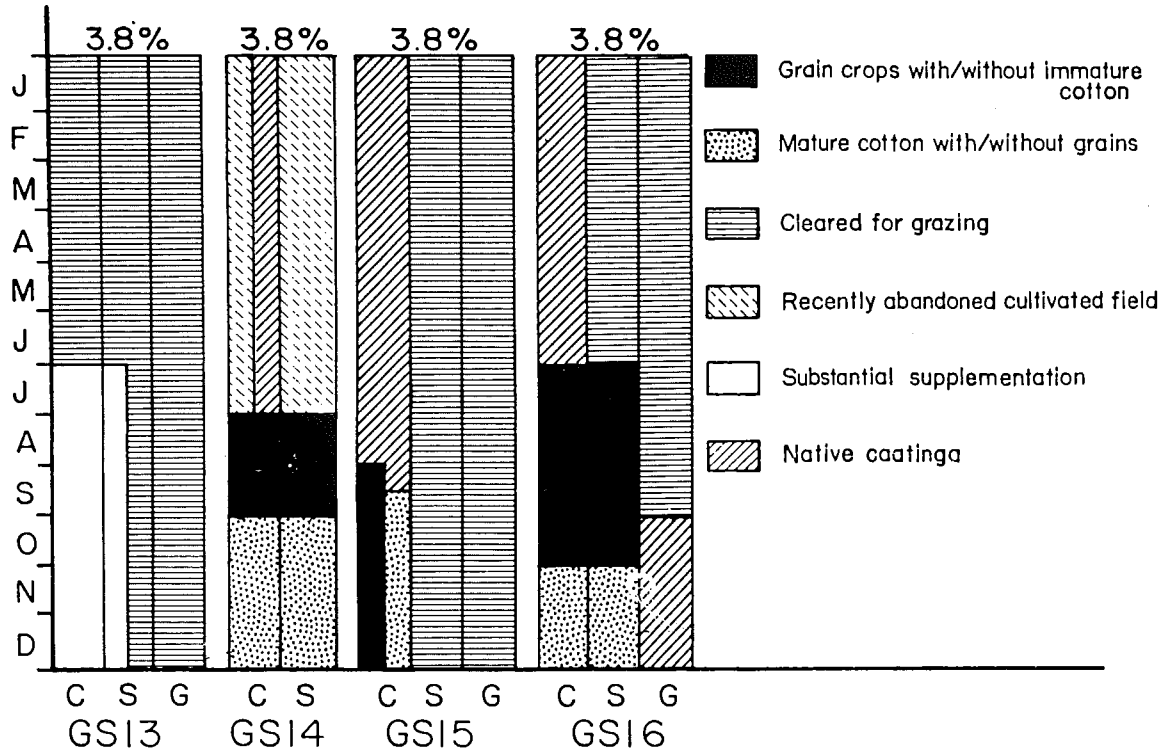

Figure 5. Diagrammatic representation of grazing systems (GS) shaped by structural features of the farm--cattle (C), sheep (S) , and goats (G).

virtually no crops. The relatively large amount of feed supplement used requires input from outside the farm.

Group 3

Group 3 farms do not produce goats. In grazing systems GS9, GS10, and GS11, cattle and sheep remain together through the dry season. In grazing system GS12, sheep are not allowed to graze cotton fields.

Group 4

On Group 4 farms, the grazing systems are imposed by infrastructure deficiencies such as poor fencing. For example, the farm using grazing system GS15, grazes small ruminants in cleared areas throughout the year. The exclusion of cattle from these cleared patches in favor of small ruminants is peculiar and contrary to local wisdom. The reason for this abnormality is the lack of goat- and sheep-proof fences in the area under native vegetation. The same rationale applies to grazing systems GS14 and GS16. Grazing system GS13 is a product of complete clearing and irrigated crops, which are not grazed.

Dry-Season Livestock Management

During the dry season in the Northeast there is a scarcity of livestock feed; this constraint causes most of the farmers to depend on the use of supplement and the grazing of cultivated fields to sustain a significant portion of their livestock. A wide range of products is used to supplement livestock in the sertão region of Ceará (Table 2).

Generally, the producer determines which livestock will receive supplemental feed; first priority is given to cattle, particularly dairy cows; then sheep, and finally goats. It is traditional to supplement only those sheep and goats that are in poor condition. The amount of supplement needed depends on the length of the rainy season, the quantity of native forage and crop residues produced on the farm, and the producer's ability to buy it.

On the surveyed farms, 85% of the cattle are given supplement feed, 50% of the sheep, and only 30% of the goats. Sixty-one percent of the farms use balanced rations, such as cottonseed meal and grain. Of these, 59% use balanced rations only for cattle, 23% for cattle and sheep, and 18% for cattle, sheep, and goats. These results reflect the priorities given by the farmer. Cattle (in particular) are the species culled to adjust the stocking rate during the dry season. Farmers usually keep lactating females in order to sell their milk as a source of cash to buy supplement. In some cases, small ruminants are marketed for the same purpose.

Sufficient information was collected on 21 of the 27 farms to estimate the stocking rates in cultivated fields for the last

TABLE 2. Percentage of farms using supplementation by source and species, 1983.

Type of supplement	Cattle	Sheep	Goats
Balanced ration	37	15	11
Cottonseed meal	33	11	4
Elephantgrass	33	7	-
Cactus (Palma)	18	4	4
Mandacarú	15	7	7
Corn grain	-	11	7
Crop residues	7	11	-
Cassava	4	4	-
Canarana	4	4	-
Canafístula	4	4	4
Corn, cotton meal, corn cob	4	-	-
Cunhã	4	4	-
Juazeiro	4	-	-
Fava do Piaui	-	4	4

five months of the dry season. Dry-season stocking rates are presented in Table 3. Estimates range from .3ha to 7.6ha per animal unit. Reasons for this wide range include supplementation, soil quality, type of crop, animal species, and precipitation. Of the farms in the study, 35% cultivate between 1.1ha and 1.5ha to support one animal unit for the last 5 months of the dry season. This narrow range of .4 ha/animal unit representing only 5.5% of the total range (7.3 ha/animal unit) suggests that management strategies have contributed to the relationship between area cultivated and herd size.

Large variations were found during the dry season between the amount of supplements fed to species and by animal unit as well as the frequency; most farms supplement animals on a daily basis. In the dry season, cattle are kept in semiconfinement whenever possible.

The forage value of fields with mature perennial cotton differ markedly from those with annual cotton. This difference stems from the fact that the former is not weeded and the bulk of available forage consists of the annual weedy growth. In the latter case, crop residue is the principal forage component.

Water Supply Infrastructure

The rainfall patterns in the counties surveyed vary considerably from year to year and month to month. As a result of irregular and unpredictable rainfall, producers have developed ways to conserve water to use during the dry season. Two aspects of water conservation were studied on the surveyed farms: 1) the type and permanence of the water facilities used; 2) the degree to which the availability of water limited livestock production.

TABLE 3. Distribution of estimated stocking rates used in cultivated fields for the last 5 months of the dry season.

Ha/animal unit	No. of farms	Percentage of farms
.3 to .5	1	5
.6 to 1.0	3	14
1.1 to 1.5	8	38
1.6 to 2.0	2	9
2.1 to 2.5	0	0
2.6 to 3.0	1	5
3.1 to 3.5	1	5
3.6 to 7.6	5	24
Total	21	100

In general, a high financial investment in water reservoirs ("acudes") were formed by dams positioned across natural drainages. Two types of reservoirs were considered, based on their capacity to hold water during the drought: permanent reservoirs, characterized by a relatively large holding capacity and low levels of soil permeability; and temporary reservoirs, which are less efficient in terms of water retention. Within this latter type, another relatively common water source is the natural or artificial land depression that fills with water during the rainy season. These reservoirs could be defined as small ponds ("barreiro"). Artesian wells and dug wells ("cacimbas") with bricks were also compared for their ability to store water.

The type of water facility and the percentage of the farms in the survey that have this type are presented in Table 4.

General Animal Management Aspects

The sections which follow are based primarily upon data from the baseline survey of 127 producers in 1980. The presentation follows closely that of Gutierrez & Ponce de Leon (1986a).

The general management strategy for sheep and goat production can be classified as an extensive grazing system. Generally animals were released in the morning and remained in the fields from 6a.m. until they were penned in the evening, usually between 5 and 6p.m. Corralling the animals every night was common in the region, but there was some variation by species and season.

The person who was in charge of the sheep and goat management and usually the daily labor, was often a family member or a hired worker. This worker normally did not receive cash

TABLE 4. Percentage of farms with water storage facilities.

Facilities	Percentage of farms
Artesian wells	7
Reservoirs	
Permanent	37
Temporary	31
Permanent & temporary	9
Dug wells	
Permanent	70
Temporary	7
Ponds	30

wages but rather was remunerated in "species form." This system was called "sorte" and consisted of a fourth or fifth of the total animals or some increment of the offspring.

Housing

Most of the producers located their corrals and any other type of animal housing near the farm house to avoid predator (human and/or animal) losses.

There was considerable variation in the housing facilities for small ruminants in the sertão. Six housing systems were defined, ranging from a simple corral to a sophisticated roofed pen raised about 1.5m above the ground. A total of 96% of all the farms in the baseline survey had some kind of housing facility. The largest proportion (48%) had only a simple type of corral fenced with native wood sticks. Another 19% had corrals plus divisions and a covered shed. The roofs of these sheds were usually made with tiles. Another 24% of the farms had a corral plus the raised pen, which was easy to clean because the manure and urine were collected on the ground beneath the slotted, raised floor. Most of the materials used in these buildings were native to the region. EMATERCE was the local institution that gave recommendations and advice about the construction of these pens. Other forms of animal facilities, such as corrals with divisions or very sophisticated pen systems, were not widely encountered in the sertão region.

Fencing

Fencing, which plays an important role in animal management, becomes even more vital when the farm system includes crop activities. Data from the baseline survey show that 79% of the farms had full perimeter fencing. In most cases, perimeter fences were the type used for cattle and consisted of seven or eight barbed wire strands and wooden sticks. When the fences were used to keep livestock away from crops, the number of wires

was increased and additional wood was positioned at the base of the fence to keep small ruminants out.

More detailed data collected during the first periodic survey showed that 75% of the farms had full perimeter fences, 12% had between 70% and 90% of their perimeter fenced and 13% had only 60% to 69% fenced. Internal fencing data showed that 49% of the farms had one or two lots fenced, 33% had three or four fences for divisions, 12% had five or six divisions, and 6% had more than six fenced lots.

Greater numbers of fenced lots provided opportunities for applying more intensive management regimens and should result in higher levels of productivity.

Health Management

Mortality rates were based on the periodic surveys during 1980 and 1981 (Table 5).

TABLE 5. Sheep and goat mortality by age, species, and season, 1980-1981.

Class	Species	Season		Annual
		Dry	Rainy	
		Percentage		
Kids	Sheep	12.3	3.9	
	Goats	14.9	10.9	
Adults	Sheep	15.5	2.4	
	Goats	13.3	1.9	
Total	Sheep	14.8	2.9	17.7
	Goats	14.2	5.7	19.9

Source: Periodic survey.

Causes of mortality could not be determined since veterinary services and diagnostic laboratories were usually not available.

No apparent endemic infectious diseases were observed, nor could producers specify one single cause of mortality as the most important. However, parasitic infection appeared to exist subclinically.

Preventive health care of animals can influence mortality rates. The periodic survey showed that about 18% of the farmers did not deworm sheep and goats; 67% dewormed only once or twice per year; and the remaining producers drenched animals three or four times per year. Most deworming was done during the rainy

season. Seventy percent of the farms treated the umbilical cords of the newborn with a solution of 10% iodine. Ectoprasite controls were not common; the survey indicated that only 30% of the farmers carried out control measures at least once a year.

Human predators accounted for 2% and 1.5% of the sheep and goat losses, respectively. Animal predators (foxes, eagles, etc.) caused 1% and 2.7% of losses in sheep and goats, respectively, with newborn animals particularly vulnerable.

Breeding Management and Reproduction

The baseline survey showed that 96% of the farms did not have a planned breeding season. Animals of both sexes were maintained together and females were bred throughout the year. Undesirable parent-to-offspring and half- and full-sib matings occurred, and inbreeding levels appear to be medium to high. However, to reduce potential inbreeding effects, 80% of the farms surveyed would not use breeding males produced on the farm. Males brought in from other farms were kept as breeding animals for as long as 4 or 5 years.

Separation of sexes did not occur at weaning time; nor was systematic weaning practiced. Young females (10-133 months old) were exposed, by default, to males at all times. Those that conceived gave birth at 15 to 18 months of age.

Lambing and kidding peaks were associated with previous breeding period influenced by a rainy period. September rains, called "cashew rains," appear to have prompted birth peaks the following February-March in 1980 and in February of 1981.

The concentration of lambings occurred during the same periods as those observed for goats; 75% and 76%, respectively, of all births occurred within the periods March-September 1980 and April-October 1981.

Kidding peaked in alternate months from March 1980 through September 1980, with 73% of the kiddings in a 7-month period. In 1981, 80% of the kiddings occurred between April and October, again a concentration in a 7-month period. The peak kidding periods differed by one month in 1981 and 1980, which might be attributed to a one month difference in the onset of rainfall in 1980 and 1981.

Most lambings and kiddings were at the end of the rainy season and the first half of the dry season.

The data for both species strongly suggest a positive correlation between monthly rainfall and the number of births 5 months later. The monthly distribution of goat births was more constant within the kidding period than was that of the lambing curve for sheep, which was almost a mirror image of the rainfall curve.

An important measure of productivity is the net yield of offspring produced per breeding female (11 months or older) maintained in the herd (Table 6). The net productivity of sheep was higher than that of goats in 1980 but lower in 1981. These figures suggest that sheep productivity might have been directly proportional to the amount of annual rainfall (629mm in 1980 and 562mm in 1981), while net productivity of goats may have been less adversely affected by the decrease in precipitation.

TABLE 6. Net yields (lambs or kids weaned) per breeding female maintained, 1980-1981.

Year	Sheep	Goats
1980	1.10	0.92
1981	0.84	1.15

Source: Periodic survey.

Average sizes of farm sheep flocks and goat herds in this state were 142 and 116 head, respectively, as reported previously by Gutierrez et al. (1982). The periodic surveys showed that small-ruminant herds were composed primarily of animals of native breeding. Among the sheep flocks, 28%, 56%, 75%, and 6% of the farms had some animals belonging to the Morada Nova, Bergamacia, Santa Inês, and Somalis Brasileira breeds, respectively. For the goat herds, 25% and 28% of the farms had Bhuj and Anglo-Nubian breeds, respectively. These figures show that producers were trying to upgrade the native animal with available breeds of hair sheep and exotic goats. On the average, producers used about one breeding male for 18 breeding females.

Herd/Flock Offtake

The average sheep flock offtake was 46%, consisting of 15% on-farm consumption and 31% sales. For goats the offtake rate was 35%, of which 11% was used for home consumption and 24% was sold.

The higher offtake rate associated with sheep demonstrates their larger contribution to net income in comparison to that of goats. No differences in market price for sheep and goat meat were observed in this region (Gutierrez & De Boer, 1982). Sales accounted for about the same proportion of the total offtake in both species -- 67% and 68% for sheep and goats, respectively. Most of the animals sold were surplus yearling rams between 15 and 18 months old (average live weight 25kg), surplus yearling bucks between 14 and 16 months old (average live weight 20kg), and culled does, 5 or more years old. Commercial sales were made to middlemen at the farm gate or directly to the market center.

Meat and Milk Production

Sheep and goat meat prices were considerably lower than those for beef and pork (Gutierrez & De Boer, 1982). The small carcass size is more important in rural areas since refrigeration is seldom available.

The dressing percentage in the region was 40% for sheep (Bellaver et al., 1983) and 41% for goats (Melo et al., 1985).

Gutierrez et al. (1982) found that in the sertão of Ceará that 0.8% and 20% of the farmers milked sheep or goats, respectively.

Characteristics of Baseline Survey Farms

The survey was not stratified according to farm size, which ranged from 96 to 1,622ha. Land uses included grazing native caatinga (52%), grazing improved caatinga (36%), cultivated pastures (2%), and cropping (10%). Only 31% of the sample farms grew single crops, with tree cotton being the major species grown as a sole crop. Most farms had mixed cropping systems consisting of corn-bean-cotton mixtures or corn-bean mixtures. Of lesser importance were corn-beans-upland rice, corn-beans-sorghum, and corn-beans-cotton-cassava mixtures.

Cattle, sheep, and goats could be considered as complementary activities within a certain level of grazing intensity because of the different varieties of vegetation they consume within the caatinga. In general, however, they are competitive activities, because they compete for the same capital, labor, and improved pasture resources.

Cattle are grazed in the "best" caatinga area throughout the year and in the dry season are supplemented with harvest residues, commercial and farm-produced concentrates, and cultivated pastures.

Of the sampled farms, 88% of the sheep and goat producers had a mixed system: crops, cattle, and small ruminants. This finding implies that 12% of the total sample had either sheep, goats and cattle, or sheep, goats and crops.

Sheep and Goat Production Characteristics

Ownership of Sheep and Goats

Seven basic groups of owners were distinguished: landowners, manager-sharecroppers, sharecroppers, parceiros [farmers settled on land under a Brazilian government land settlement program called the Instituto Nacional de Colonização e Reforma Agraria (INCRA)], renters, communal owners and employees or permanent workers. Sixty-four percent of sheep and goat producers were landowners. In general, this group has large

areas of land which are exploited by the landlords themselves, sharecroppers ("moradores") and permanent or temporary workers.

Sharecropping (19% of the sheep and goat producers) is a very important source of labor in the sertão area and sharecroppers are usually involved in crop production. Basically, the sharecropper is provided with use of a small parcel of land for the production of subsistence crops, a house, and occasionally land for cash crops.

The manager-sharecropper category, which is a mixture of sharecropper and manager, regularly has his own flock running together with that of the landowner. Employees or permanent workers work for a salary without any share of the total production. This group represented 7.1% of the total sheep and goat producers surveyed.

Sheep and Goat Herd/Flock Size

Herd/flock size is an important variable in the mixed production system, especially when there are other animal species competing for the same scarce resources. The average size of mixed sheep and goat populations in the sample was 211 head. There was not much variation between regions (Table 7).

In terms of specialization, producers preferred to produce sheep and goats together than sheep or goats alone.

Livestock Production and Productivity

Detailed information was collected during the periodical survey of 32 farms over a period of 17 months. This was characterized as a period of prolonged drought and provided an opportunity to analyze herd/flock dynamics and stocking rate adjustments to the declining feed base. Most of the sheep (90%) are native, or Crioulo breeds, and most goats are classified as Sem Raça Definada (nondescript, or SRD).

Population Changes

The distribution of the population by species per survey is presented in Table 8. Both species had a relatively static proportion of approximately 70% sheep and 30% goats during the first three survey periods. Drastic reductions in animal numbers occurred between the first and third surveys, but the reduction of sheep was proportionally higher than that of goats.

Breed Distribution

Breed distributions for sheep and goats for the periodical survey farms are shown in Table 9.

TABLE 7. Average sheep and goat population per farm surveyed 1980.

County	Goats[a]	Sheep[a]	Sheep & goats[a,b]
	Head		
Granja	163	149	271
Sobral	60	115	145
Crateús	49	172	194
Independência	213[c]	173	233
Tauá	262	218	448
Parambú	90	49	118
Quixadá	94	165	209
Quixeramobim	57	133	161
Morada Nova	58	108	121
Total	116	142	211

Source: Baseline survey.
[a]Data applies only to farms with specified enterprise.
[b]The average does not equal the average of the two preceding columns since not all farms had both species.
[c]A very small number of farms had goats.

TABLE 8. Percentage change of sample populations between surveys, 1980-1981.

	Survey Number				
Species	1	2	3	4	5
Sheep	2915	2660	2192	2199	2201
Goats	1095	991	860	1145	1138
Total	4010	3651	3052	3344	3339

Age Distribution

In flocks that were managed under a continuous-mating scheme, the age distribution of the flock was nearly constant.

The ewe flock population decreased 27% between surveys one and five, with the largest decrease occurring between surveys one and three. However, the distribution of ewes and does by age remained almost constant between surveys, indicating that culling was practiced in all age groups to an equal degree.

TABLE 9. Percentage distribution of the sheep flocks and goat herds pooled over all surveyed farms by breed and by survey, 1980-1981.

	Survey number				
	1	2	3	4	5
Sheep breeds:					
Crioulo	68	68	66	70	70
Morada Nova	3	3	4	3	3
Bergamacia	11	10	9	7	6
Santa Inês	17	18	20	18	20
Somalis Br.	a	a	a	1	a
Rabada Larga	a	a	a	a	a
Goat breeds:					
SRD	73	79	81	84	88
Bhuj	5	4	4	5	4
Anglo-Nubian	21	16	14	10	7
Marota	a	a	a	0	a
Moxotó	0	a	0	a	a
Caninde	a	0	0	0	0
Repartida	a	a	0	a	a

a = less than 1%.
SRD = Sem Raça Definida (nondescript) breed.

The doe herd, however, decreased 20% between surveys one and three and increased 22% between surveys three and five. The net result was a small increase in the doe herd.

The largest proportion of rams and bucks of both species was found within the first three age classes (birth to 7 months, 7 to 11 months, and 11 to 18 months), with a range of 78 to 88%, depending on the particular survey.

The dynamics of the sheep flock indicated that males were culled between 10 and 18 months of age but females were culled in the same proportions from all age groups. The total offtake was 41.6%. The goat herd dynamics indicated a different pattern. Does were culled from only the older groups and all young females were kept. In addition, it was apparent that some does were purchased to add to the herd. The criteria for culling bucks was the same as for rams. The total goat herd offtake was 24%.

Species Distribution

The state of Ceará in the northeast of Brazil had a population of 1,208,000 sheep and 813,000 goats in 1980 (Gutierrez et al., 1982). These numbers represented 20% of the

sheep and 11% of the goat populations in the northeast of Brazil. The ratio of sheep to goats in Ceará was 1.5:1 but 0.8:1 for the entire northeast region. These ratios demonstrate the relatively greater importance of the sheep subsystem in Ceará than in the other states of the Northeast. The ratio of sheep to goats for the sample of farms used in this study was 2.3:1, which was relatively higher than the general ratio. This finding supports the notion that the sheep subsystem was relatively more important in this state than in the region in general.

Nevertheless, one strategy producers used during long drought periods was to substitute goats--not sheep--for cattle, at an average rate of 2 goats per head of cattle (Queiroz et al., 1986). The sheep-to-goat ratio decreased from 2.7:1 in the first survey to 1.9:1 in the fourth and fifth surveys. This decrease resulted from both a decrease in the number of sheep and an increase in the number of goats (Table 8). This finding of change in the sheep population was confirmed (Queiroz et al., 1986) when data were compared from 1980 and 1983 to determine producers strategies to overcome the effects of the drought. Because of shorter generation intervals, sheep and goat populations adjust in shorter cycles than do cattle, allowing quicker adjustments to weather conditions.

Body Weights and Measurements

This report summarizes the body weight and measurement data gathered from all farms during the fifth survey. The average number of animals per farm was 79 sheep and 41 goats, including at least four breeds of sheep and three breeds of goats of varying ages. Thus for statistical comparisons the study identified farms with a larger number of animals.

Sheep body weights and measurements for the Crioulo, Bergamacia, and Santa Inês breeds by age groups were obtained at the end of the dry season. Bergamacia were generally the largest breed on the sample farms; however the Santa Inês and Crioulo breeds did not differ greatly in body weight and measurement. The large variations in body weights probably were influenced by the effect of animal management differences rather than by breed, sex, and class variations.

Some comparisons of subsamples allowed the following general observations of the performance of small ruminant breeds under traditional farming conditions.

Comparison of mean body weights obtained during the wet and dry seasons between the Bergamacia and Crioulo breeds showed the Bergamacia to be heavier. On the other hand, no difference was observed between Santa Inês and Crioulo mean body weights taken during the wet and dry seasons.

Bergamacias showed more anterior depth and length than did Crioulo animals but did not differ in other body measurements.

Mean body weight differences were not detected between SRD and Anglo-Nubian goats for weight taken at the end of the dry and wet seasons. The farm effect significantly influenced goat body weights at the end of the dry season, but its effect disappeared from the wet-season weights of the same animals. These data indicate that environmental effects are more important during the dry-season period.

Mean body-weight curves for Crioulo sheep and SRD goats were pooled over farms and grouped by age. Minimum and maximum mean weights for Crioulo sheep, ranging from 14 months of age to over 2 years at fifth survey, were 25kg to 28kg, respectively. Minimum and maximum mean weights for the SRD goats of the same ages were 21kg to 26kg.

Sheep weight curves showed that growing animals tend to lower their weight-gain rate during the dry season, with very sharp increase during the wet season; whereas older or more mature animals lose weight during the dry season, with relatively less rapid wet-season weight gains. Goat weight curves showed the same tendencies as sheep weight curves, although goat weight-gain rates were apparently lower than those for sheep. Goats seem to lose less weight during the dry season than did sheep.

Mean live-weight male-female comparisons showed that Crioulo male-sheep are 13% to 37% heavier than females of the same breed. Bergamacia males are 16% to 31% heavier and Santa Inês 16% to 45% heavier than the females of their respective breeds. Turner & Young (1960) suggested that males at least 40% heavier than females are needed for successful breeding programs that select for body weight. It appears that breeding rams are much heavier than the females in the flock, because they receive special care. Nevertheless, the range of weights reported suggests that a selection program using superior animals in these three breeds should be possible. Since the Crioulo breed is a mixture of several breeds (Churra, Merino, Morada Nova, and lately the Bergamacia and Santa Inês), a selection program based on body weight could produce an animal resembling either the Bergmacia or the Santa Inês. For this reason a crossbreeding program with Santa Inês x Crioulo is suggested for simultaneously increasing both body weight and flock uniformity.

Average SRD goat body weights are very similar to those of Crioulo sheep. But the weights of both were taken at the end of the dry season when sheep weights may have been their lowest and goat weights unaffected, since they are better suited to feed themselves during the dry season than are sheep (Queiroz et al., 1986). Male SRD goats were between 9% and 37% heavier than female SRDs. A good selection program based on males weighing 40% more than the females is possible if superior animals can be properly identified.

Under farm conditions, the Bergamacia breed were heavier than the Crioulo breed when weighed at the end of both the wet and dry seasons. However, there was no difference in weights

between the Crioulo and the Santa Inês at the end of either the wet season or dry season.

Under controlled conditions at the CNPC, weight differences between Anglo-Nubian and SRD goat breeds have been reported (Figueiredo et al., 1982; Bellaver et al., 1983). However, under farm conditions, as reported in this study, no differences were found in body weights during either the dry season or the wet season. Failure to detect a difference could be based on management practices that did not allow full genotypic expression of the Anglo-Nubian genotype (or of the animals classified as Anglo-Nubians, which actually were Anglo-Nubian x SRD hybrids). If this explanation is valid, there would be no clear advantage to up-grading the SRD by crossing them to Anglo-Nubians, at least under the management conditions found at the farm level. Anglo-Nubian x SRD cross products evaluated under controlled experimental conditions have not demonstrated superiority over the SRD x SRD products (Andrade, 1982). On the contrary, an evaluation of overall mortality, reproductive ability, and productive traits showed that SRD might benefit from the environmental conditions of Northeast Brazil (Ponce de Leon, 1984).

Environmental influence on yearly growth pattern and weight fluctuation has been previously shown for this region (Melo et al., 1985; Riera et al., 1982). On the average, wet-season weight increases seem to be higher for sheep than for goats.

Pant et al. (1985), in evaluating heat-stress responses, concluded that goats are better adapted than sheep to the hot semi-arid region in the northeast of Brazil.

Under the most difficult environmental conditions, goats appear to have an advantage over sheep. During dry season and drought periods, goats make better use of the dry biomass, which is available in the caatinga (Queiroz et al., 1986).

Producers apparently maintain goats to guarantee maximum use of the land resources during the dry season. If this is the case, then a selection program for superior goats based on body weights would be difficult at the experiment station level because the harsh environmental conditions of Northeast Brazil could not be readily duplicated.

Conclusions

Small ruminant producers engage in a variety of crop and livestock production activities that reflect both the farm resource base and the need for diversification in the face of a highly variable climatic environment. Cattle are managed intensively, as compared to small ruminant management and good soils are managed intensively, as compared to management of poor soils. During the course of a drought, producers readjust their stocking rates by reducing the total animal units carried and by

adjusting the livestock mix on the farms. The net result is a reduction of cattle numbers, partially compensated for by increased goat numbers. Sheep populations appeared to be affected minimally.

A technical approach to reproductive management, being developed by CNPC and the Agricultural Research Center for the Semi-arid Tropics in Petrolina, Pernambuco, Brazil, suggests that reproductive efficiency would be improved by a yearly breeding season during the months of October and November (dry period) with a subsequent parturition in the following March-April period (EMBRAPA/EMBRATER, 1980; Guimares, 1983). This schedule is based on the presumption that breeding females would have sufficient feed for the last third of their gestation period and lambs/kids would have higher birth and weaning weights, which in turn might reduce mortality rates (EMBRAPA/EMBRATER, 1980).

Such a system faces important constraints, including 1) the lack of feed resources during the breeding season when breeding females exhibit their lowest body weights and need some energy supplementation for successful breeding, 2) the concentration of births in one short period during the rainy season increases the demand for labor at a time when most of the available farm labor is dedicated to crops and dairy cattle, and 3) if the rains start late, the resulting feed shortage could be particularly critical because it would occur during late gestation and early lactation, which are the periods of highest nutrient requirements for the breeding females.

Although producers said their aim was to produce a larger number of kids per unit of time, kids or lambs received no special care at the farm level, other than to treat the umbilical cord with iodine. This lack of neonatal management may stem from lack of proper information.

Natural lambing and kidding peaks appeared as a response to a previous rainy season. The largest percentage of births occurred from April through September, and most of the breeding females apparently were bred in November through April. Thus, the breeding-season-management program as proposed by CNPC and Guimaraes (1983) could be used for a portion of the herd, if the above listed constraints could be overcome.

In the evaluation of sheep and goat performance under traditional farming systems, the Bergamacia sheep breed was shown to be larger than the Santa Inês and Crioulo breeds. A cross-breeding program using Santa Inês breeding rams might increase uniformity in the sheep flock. If superior animals could be properly identified, a selection program might be useful in increasing body weights of sheep flocks.

In weight comparisons, the Anglo-Nubian goats were not superior to the Sem Raça Definida (nondescript, SRD). The relative superiority of the former breed under experimental conditions is masked under traditional farm-system management.

Producers apparently use goat herds to make better use of the worst grazing areas on their farms. Thus, goats will always be subject to the worst environmental conditions. As a result, identification of superior animals for genetic improvement will be extremely difficult, making a breeding program based on selection for body weight or crossbreeding impractical under present farming conditions in the surveyed areas.

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SISTEMAS DE MANEJO E PRODUÇÃO PECUÁRIA EM USO NO NORDESTE: O CASO DE CAPRINOS LEITEIROS

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RESUMO - Efetuou-se um levantamento numa amostra de 71 produtores nos estados da Paraíba, Pernambuco e Rio Grande do Norte. Encontrou-se um sistema misto de produção com culturas, bovinos, o vinos e caprinos. Do total de produtores amostrados, 66% produziram as três espécies e apenas 13% produziram somente caprinos. Os rebanhos caprinos nas fazendas amostradas tinham em média 196, 134 e 83 cabeças nos estados da Paraíba, Pernambuco e Rio Grande do Norte, respectivamente. O estado da Paraíba, dentre os demais, detém o maior número de cabras adultas (96) enquanto Pernambuco apresentou o maior período de lactação (150 dias). As médias de produção de leite variaram entre 0,74 e 1,20 litros/dia. Identificou-se dois principais canais de comercialização para os produtos (queijo e leite) da espécie caprina na área estudada: intermediários e mercados locais.

Termos para indexação: Caprinos, Leite, Sistema de manejo, Paraíba, Pernambuco, Rio Grande do Norte.

MANAGEMENT SYSTEMS AND LIVESTOCK PRODUCTION IN THE NORTHEAST: THE CASE OF DAIRY GOATS

ABSTRACT - Seventy-one producers were surveyed in the states of Paraíba, Pernambuco and Rio Grande do Norte. The production systems may be characterized as mixed, consisting of crops, cattle, sheep and goats. Sixty-six percent of all producers raised all three species of animals, while only 13 percent raised only goats. The surveyed farms had an average of 196, 134 and 83 goats per farm in Paraíba, Pernambuco and Rio Grande do Norte, respectively. Producers in Paraíba had the most does (96) while the longest lactation period was found in Pernambuco (150 days). Average milk production ranged from 0.74 to 1.20 liters per day. Two principal market channels for dairy goat products (cheese and milk) were identified: middlemen and local markets.

Index terms: Goats, Milk, Management systems, Paraíba, Pernambuco, Rio Grande do Norte.

Introdução

Dos 8,8 milhões de animais caprinos existentes no Brasil (FUNDAÇÃO INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA- IBGE, 1983), aproximadamente 8,1 milhões são encontrados na região Nordeste. Os estados da Bahia, Pernambuco, Piaui, e Ceará totalizam 85% do efetivo desta região, contribuindo assim com

importante fonte alternativa de proteína animal. Os animais caprinos estão presentes nesta região na proporção de um por cinco habitantes e na densidade de cinco caprinos por quilometro quadrado (IBGE, 1983).

Existe um concenso geral de que os animais ruminantes (bovinos, ovinos e caprinos) compõem a maioria dos sistemas de exploração agropecuária no nordeste do Brasil. No entanto, estatísticas no que diz respeito aos produtores animais, e especialmente de animais caprinos, são quase que totalmente inexistentes.

Muito dos produtos da espécie caprina são consumidos localmente pelas famílias rurais nas propriedades e vilarejos, os quais não são computados estatisticamente. Notadamente que estes fatos substimam a verdadeira importância da espécie caprina no contexto da economia regional.

Observações feitas em mercados locais e regionais confirmaram que existe uma grande demanda por produtos lácticos de origem caprina especialmente o queijo (Neumaier, 1984). Em razão disto, da grande aceitação e fácil comercialização do produto e dos preços comparativamente bons que se obtém pelo leite e queijo é que os produtores de caprinos leiteiros estão procurando incrementar a importância relativa de seus rebanhos. Apesar destas tendências, tem muitos aspectos que permanecem desconhecidos acerca do manejo que os produtores nos mais diversos estados praticam com estas espécies animais.

Finalmente, reconhecendo a importância que estes pequenos animais podem representar junto às camadas mais pobres da região nordeste do Brasil e a falta de dados relevantes sobre a exploração de animais caprinos leiteiros é que o Centro Nacional de Pesquisa de Caprinos (EMBRAPA/CNPC) incluiu nas suas atividades de pesquisa estudos descritivos objetivando caracterizar à nível de fazenda os sistemas de exploração existentes.

Metodologia

Os dados apresentados neste trabalho resultam de um série de levantementos de campo efetuados junto aos produtores de animais caprinos leiteiros em diversos municípios nos estados da Paraíba, Pernambuco e Rio Grande do Norte. A falta de dados sobre produção de caprinos leiteiros por fazenda, impediu a aplicação de um método de amostragem probabilística para o desenvolvimento da pesquisa. Os dados concernentes a fazendas individuais bem como suas localizações do INSTITUTO NACIONAL DE COLONIZAÇÃO E REFORMA AGRÁRIA - INCRA; EMPRESA DE ASSISTENCIA TÉCNICA E EXTENSÃO RURAL EMATER E IBGE. No mais, não existe unidades processadoras de leite de cabra no Nordeste, a níveis empresariais, que pudessem fornecer a relação dos produtores de leite.

Desta forma, a amostra em cada caso não foi probabilística mas foi escolhida após consultas feitas aos presidentes das Associações de Criadores, Extensionistas das Empresas Estaduais de Extensão Rural, Núcleos do Projeto Sertanejo e demais órgãos que de alguma forma estão ligados às atividades agropecuárias nos estados e municípios.

O estudo objetivou caracterizar de forma geral os sistemas de exploracão de caprinos de leite. Para lograr este objetivo, se utilizou a técnica da entrevista pessoal aplicada a uma amostra de 71 produtores nos mais variados municípios dentro dos estados e a única característica predeterminada para que estes produtores constassem da amostra foi a de que produzissem caprinos leiteiros e de alguma forma utilizassem o leite.

Os dados quantitativos que se incluem neste estudo compreendem a distribuição e composição dos rebanhos, produção e comercialização. Dentre as informações qualitativas consideradas importante, se encontram dados sobre manejo animal, sanidade, etc.

O presente trabalho apresenta um resumo dos dados mais importantes obtidos nesta pesquisa.

Resultados e Discussão

Composição do Rebanho

Na Tabela 1, se pode verificar as diferenças existentes entre os produtores de caprinos leiteiros no tocante a quantidade média de animais nas fazendas amostradas nos estados da Paraíba, Pernambuco e Rio Grande do Norte. Os resultados apresentados foram transformados em unidade animal (UA), já que o rebanho total na maioria das fazendas está composto de diferentes espécies (bovina, ovina e caprina). A finalidade deste procedimento foi verificar a importância relativa de cada espécie no rebanho.

Conforme se pode notar, em todos os três estados levantados, há predominância do rebanho bovino (75%) sequindo do rebanho caprino (19%) e finalmente o rebanho ovino com 6,0%. Acredita-se, conforme dados apresentados, na natureza circunstancial da exploração de ovinos junto aos produtores amostrados, especialmente nos estados da Paraíba e Pernambuco. No total de produtores, apenas 13% possuem somente caprinos. Sessenta e seis por cento produzem bovinos, ovinos e caprinos, o que de um mada geral pode estar refletindo a capacidade que os produtores têm em manipular os recursos disponíveis na fazenda visando diminuir o risco da atividade agropecuária.

TABELA 1. Efetivos bovino, ovino e caprino encontrados nas fazendas amostradas nos estados da Paraíba, Pernambuco e Rio Grande do Norte.

Estado	Efetivo (UA)[a]			Total
	Bovino	Ovino	Caprino	
Paraíba	98,26 (71,96)[b]	5,80 (4,26)	32,48 (23,78)	136,54
Pernambuco	138,42 (84,34)	6,57 (4,00)	19,12 (11,66)	164,11
Rio Grande do Norte	87,15 (65,25)	14,23 (10,65)	32,18 (24,10)	133,56
Total	323,83 (74,57)	26,60 (6,12)	68,24 (19,29)	434,21

[a]Bovino= 8 caprinos, 8 ovinos.
[b]Número entre parênteses representam o percentual da espécie em relação ao efetivo total na amostra.
FONTE: Dados de pesquisa.

Rebanho Caprino

Tendo em conta a ampla dispersão existente na amostra e para melhor mostrar a estrutura dos rebanhos em cada estado, se procedeu agrupar as observações da amostra em três categorias de propriedades, baseando-se na área das mesmas e no total de animais caprinos leiteiros, já que esta espécie animal constitui-se no enfoque principal deste trabalho.

Referido procedimento serviu de base para que se pudesse preparar a Tabela 2, onde se apresenta a composição do rebanho caprino leiteiro por estrato, sexo e idade nas fazendas amostradas nos estados.

O rabanho médio de caprinos leiteiros é de 196, 134 e 83 cabeças para os estados da Paraíba, Pernambuco e Rio Grande do Norte, respectivamente. O efetivo de cabras adultas apresenta uma maior importância relativa no estado da Paraíba com uma média de 95 cabeças no total amostrado, no referido Estado, quando comparada com as amostras de Pernambuco e Rio Grande do Norte. Os animais caprinos com menos de um ano (cabritos e cabritas) apresentaram uma proporção relativamente elevada no total dos estados (39%).

TABELA 2. Composição do rebanho caprino leiteiro nas fazendas amostradas nos estados da Paraíba, Pernambuco e Rio Grande do Norte, por estrado, sexo e idade.

Estrato (Nº de cabeças)	Machos Adultos	Cabras Adultas	Cabritas	Cabritos	Total de animais
			Paraíba		
Menos de 50	0,67	2,56	2,22	0,67	6,11
51 a 100	6,50	25,00	24,50	4,00	60,00
Mais de 100	58,17	177,33	77,58	48,25	361,33
Todos	31,17	95,70	43,48	25,78	196,13
			Pernambuco		
Menos de 50	1,60	24,20	12,40	7,80	49,80
51 a 100	6,36	33,45	21,73	9,73	71,27
Mais de 100	17,67	86,60	40,93	33,27	178,47
Todos	15,64	60,79	32,00	26,32	134,75
			Rio Grande do Norte		
Menos de 50	2,00	18,83	4,00	0,50	25,33
51 a 100	3,38	38,13	16,75	7,88	66,13
Mais de 100	6,33	85,33	40,33	33,00	165,00
Todos	3,85	46,50	20,00	13,20	83,55
			Todos os Estados		
Menos de 50	3,33	16,44	9,11	5,00	33,89
51 a 100	10,47	28,59	19,88	13,41	72,35
Mais de 100	22,76	93,31	41,69	29,36	187,11
Todos	17,35	68,07	32,34	22,45	140,21

FONTE: Dados de pesquisa.

Características de Manejo

A produtividade do rebanho está muito relacionada com a rotatividade dos animais reprodutores de modo a evitar problemas de consanquinidade (Anônimo, 1982). Dentre as fazendas levantadas, o tempo de utilização do reprodutor foi estimado em média de 2,5 anos. O tempo de utilização das matrizes foi em média de 6 anos. O descarte dos animais nas fazendas amostradas está, segundo os produtores, relacionado à efetiva necessidade de dinheiro para fazer face às despesas imprevistas na fazenda, já que estes animais são mais fáceis de vender.

No total de fazendas amostradas, aproximadaments 20% dos produtores fazem monta controlada, significando com isto que em 80 das fazendas os machos permanecem junto com as fêmeas durante a maior parte do tempo durante o ano, dificultando desta forma, o controle sobre a época de nascimentos, por parte dos produtores, pois as parições ocorrem durante todo o ano.

Como prática de manejo, o agrupamento de animais é feito por 49,30% dos produtores no total da amostra sendo mais comum, na área estudada, agrupar os animais caprinos por sexo, idade e raça.

Algumas práticas tais como parto em isolamento, desmama, castração e descorna são executadas no total de fazendas amostradas em média por 97%, 94%, 97% e 37%, respectivamente. A desmama e castração são feitas em média aos 3,5 meses de idade.

Como práticas mais comuns de prevenção de doenças a vacinação e vermifugação são os métodos mais usualmente utilizados. Setenta e um por cento dos produtores em todas as amostras nos estados vacinam os animais. O estado de Pernambuco apresentou o menor percentual de fazendas com a prática de vacinação (57%) quando comparado à Paraíba e Rio Grande do Norte. A vermifugação apresentou um percentual de 97% no total de fazendas e é executada em média três vezes ao ano.

A mineralização do rebanho cujos componentes são, nas fazendas amostradas, o sal de cozinha (cloreto de sódio) e sal mineral, é uma prática muito utilizada pelos produtores. Oitenta por cento dos produtores mineralizam seus animais. A distribuição de frequência das práticas de manejo julgadas mais importantes neste trabalho, descritas anteriormente, encontra-se na Tabela 3.

Segundo os produtores amostrados, os maiores problemas de saúde animal no total das fazendas levantadas foram, por ordem de importância, raiva (33%); verminose (30%); linfadenite e mamite (11%) e linfadenite e verminose (8%). Outras enfermidades tais como brocopneumonia, intoxicação (origens diversas), boqueira e bicheira também têm causado prejuízos à exploração de caprinos leiteiros na área amostrada. Ressalte-se que no trabalho a nível de fazenda, não se contou com a presença de um médico veterinário, com o qual se poderia diagnosticar com precisão os problemas relacionados com o estado de saúde dos animais.

As necessidades nutricionais de caprinos leiteiros nas fazendas amostradas são satisfeitas com o uso de recursos forrageiros existentes e pela administração de concentrados.

Produção e Comercialização

Em geral, não existe especialização, a nível de fazenda, na exploração de caprinos leiteiros. Ressalte-se que os sistemas predominantes são mistos onde as mais variadas raças e cruzamento de raças são encontradas.

TABELA 3. Distribuição de frequência das práticas de manejo exercidas pelos caprinocultores de leite nos estados da Paraíba, Pernambuco e Rio Grande do Norte.

Práticas de Manejo	PB	PE	RN	Todos
Parto em isolamento	95,45%	100,00%	95,00%	97,01%
Desmama	100,00%	96,30%	89,47	93,93%
	(3,65)[b]	(3,44)	(3,33)	(3,53)
Castração	91,30%	62,96%	95,00%	97,01%
	(4,86)[b]	(3,00)	(4,06)	(3,77)
Descorna	9,09%	67,86%	15,79%	34,78%
Vacinação	82,61%	57,14%	80,00%	71,83%
Vermifugação	95,65%	96,43%	100,00%	97,18%
	(2,36)[c]	(3,54)	(2,54)	(2,93)
Agrupamento de animal	39,13%	57,14%	50,00%	49,30%
Monta controlada	13,04%	25,00%	20,00%	19,72%
Tempo de uso do reprodutor[a]	2,14	2,95	3,17	2,45
Tempo de uso da matriz	5,10	3,84	7,58	5.97
Identificação dos animais				
Brinco	39,13	51,85	35,00	42,85
Marca (orelha ou queixo)	17,39	11,11	20,00	18,57
Corte na orelha	33,33	11,11	20,00	25,85
Mineralização (sal de cozinha, sal mineral)	69,56	92,85	75,00	80,28

[a]Média em anos.
[b]Idade média em meses.
[c]Número médio de vermifugações.

O percentual médio de cabras em lactação nos rebanhos encontrados foi de 54%, com o estado de Pernambuco apresentando o maior percentual (65%) conforme se pode verificar nos dados constantes na Tabela 4.

TABELA 4. Parâmetros da exploração caprina leiteira, nos estados da Paraíba, Pernambuco e Rio Grande do Norte.

Parâmetros	Estados			Total
	Paraíba N = 23	Pernambuco N = 28	R.G. do Norte N = 20	N = 71
Cabras em lactação (%)	46,02	64,75	55,38	54,42
	(96)	(61)	(47)	(68)
Período de lactação (dia)	120,38	150,80	127,50	134,68
Produção diária (l/cab/dia)	0,74	1,12	0,71	0,80
Produção por lactação	85,36	175,64	121,25	132,58

N = Número de fazendas amostradas.
Números entre parênteses representam os efetivos de cabras adultas.

Combinando-se os dados das Tabelas 2 e 4, tem-se que, em média, 44 cabras produzem leite nas fazendas amostradas no estado da Paraíba, contra médias de 39 e 25 cabras nas fazendas de Pernambuco e Rio Grande do Norte, respectivamente. A diferença existente (5 e 19) entre as fazendas nas amostras é provavelmente o reflexo do manejo produtivo.

Na Tabela 4, encontram-se ainda os períodos médios de lactação, produção diária de leite e produção por período de lactação. No estado de Pernambuco a média do período de lactação (150 dias) é substancialmente mais elevada do que aquelas encontradas para os dois outros estados, entendendo-se assim, que os produtores daquele estado estão mais voltados a manter o fluxo maior de leite por um período mais longo durante o ano.

A média diária de produção de leite varia de 0,74 a 1,2 litros, produzidos pelos mais diferentes tipos nativos e exóticos. No estado do Rio Grande do Norte, nas fazendas amostradas, a produção de leite é na sua maioria (80%) utilizada para consumo na fazenda, sendo o excedente comercializado sob forma de queijo, depois de satisfeitas as necessidades da família e das crias.

Setenta e um por cento dos produtores nos estados de Pernambuco e Paraíba, utilizam o leite in natura e/ou processado, para fins comerciais. Nos 29% restantes, o produto se destina exclusivamente ao uso dos produtores, quer na forma de queijo ou de leite para consumo na fazenda.

A não existência de unidades processadoras de leite de cabra, faz com que muitos produtores no estado de Pernambuco, aqueles que não fabricam queijo, destinem toda a produção para venda no "melhor" mercado de leite (Companhia de Laticínios de Estado de Pernambuco - CILPE), misturando-o com o leite de gado.

A importância que tem as unidades processadoras bem como a distância dos municípios amostrados aos principais centros consumidores pode dar uma idéia, claramente, do destino da produção no total da amostra. Os resultados referente a distribuição percentual do produto a este respeito mostram que 71% dos caprinocultores leiteiros vendem o produto a intermediários, sendo este vendido em outros centros consumidores nas grandes cidades (por exemplo, Natal, Recife, São Paulo, etc.). Vinte e nove por cento aproximadamente, recorrem às feiras livres ou mercados locais oferecendo seus produtos.

Conclusões

O presente trabalho tem permitido comparar algumas características de produção, julgadas importantes na exploração de caprinos leiteiros, nas áreas dos levantamentos efetuados nos estados da Paraíba, Pernambuco e Rio Grande do Norte.

De uma forma geral pode-se afirmar que, a julgar pelos dados obtidos nos levantamentos em cada estado, não existe exploração de caprinos leiteiros onde a atividade principal seja a produção de leite e esteja voltada para o mercado. O que se pode observar foram os sistemas de exploração mistos onde a principal atividade pecuária era a bovinocultura.

A pequena produção de queijo, é destinada para consumo na fazenda e para venda nas áreas urbanas, mercados, feiras ou vendidos a intermediários que transportam o produto para os supermercados nas grandes cidades. Dos contatos mantidos com vendedores de queijo, acredita-se que as maiores restrições à comercialização do produto estejam do lado da oferta e não do lado da demanda.

Finalmente, à exploração de caprinos de leite, estabelecida desta forma, poderiam ser incorporadas técnicas de manejo produtivo, de sanidade, etc., visando melhorar o atual quadro deste tipo de exploração junto aos produtores que de certa forma se interessam pela produção de leite de cabra no Nordeste brasileiro.

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AGROECOLOGY OF SMALL RUMINANT PRODUCTION IN THE NORTHEAST

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ABSTRACT - Environmental variability is a pervasive fact of life to small farmers of northeastern Brazil. Climatic variation, both seasonal and annual, imposes severe nutritional limitations on animal production in native rangeland situations. Information is provided on seasonal dietary protein and energy levels that can serve as a basis for supplemental feeding programs. Manipulation of the native tree and shrub vegetation holds promise for increasing overall forage production on a short-term (1-3 years) basis and for extending the period of available green feed longer into the dry season through manipulation of coppice regrowth from cut trees. Research and technology development should focus on maintaining as much diversity as possible in small farm production enterprises.

Index terms: Rangelands, Caatinga, Agroecology, Sheep, Goats, Animal nutrition.

AGROECOLOGIA DA PRODUÇÃO DE PEQUENOS RUMINANTES NO NORDESTE DO BRASIL

RESUMO - Variação em condições ambientais é um conhecido fator associado à vida dos fazendeiros no nordeste do Brasil. A variação climática quer anual ou estacional, acarreta severas limitações nutricionais sobre a produção animal em condições de pastoreio. Informações sobre os níveis estacionais de proteína e energia na dieta são apresentadas, e podem servir de base para esquemas de suplementação alimentar. A manipulação de árvores e arbustos da caatinga nativa, parece promissora como um meio de aumentar a produção total de forragem durante períodos de um a três anos. Afora isto, esta manipulação pode permitir a extensão do período de disponibilidade de forragem verde durante a estação seca, graças ao rebrote das árvores e arbustos cortadas. Pesquisa e desenvolvimento de tecnologia devem enfatizar a manutenção da maior diversificação possível nas pequenas propriedades.

Termos para indexação: Pastagem nativa, Caatinga, Agroecologia, Ovinos, Caprinos, Nutrição animal.

Introduction

The vast majority of the world's small ruminants are produced on rangelands where few direct controls on the production system are possible. Under these conditions the approach to "management" must be based on ecological principles, rather than reliance upon high-input agronomic approaches (e.g.

growing of forage and grain crops for animals) and sophisticated levels of animal husbandry.

Under this ecological approach, a thorough understanding of the system is essential, because management decisions are made in relation to the environment, rather than from a position of dominance over the environment. This understanding can be gained from decades or even centuries of trial-and-error experience (as by native people) or it can be gained in a shorter term through scientific study. One does not necessarily replace the other, and information from both sources is contributing to our understanding of the caatinga ecosystem of northeastern Brazil.

As a minimum, researchers should have two broad goals when undertaking this kind of research. First, they should have at least a rudimentary understanding of how the production system works, focusing on interactions between climate, soils, vegetation, and livestock. Second, they must gain an understanding of how people perceive their environment (in both economic and ecologic terms) and how they respond to it through management activities.

Once we have insights into these components, we can begin to design and test new manipulations and interventions (i.e. "improved technology") that are not only biologically sound, but that also have some likelihood of being accepted by producers. Finally, promising technology should be tested on an applied management scale, perhaps on carefully chosen cooperating farms, but under control by researchers. While the actual time sequence of these steps can be telescoped or overlapped, it is important to have gone through at least part of the last step before we are ready to broadly extend our findings to producers in general.

There is currently an atmosphere of urgency within the Small Ruminant CRSP to move ahead with extension without having completed all of the above steps. While this may be appropriate for certain program components, it certainly is not for the range project.

By its very nature, range research is long-term in scope. Most interventions involve changes in plant communities, and even in the tropics where successional changes are rapid, we are still having to wait several years to see the net result of a particular practice (e.g. caatinga clearing). Moreover, this whole problem is complicated by year-to-year variation in precipitation which creates an additional set of problems.

My immediate purpose in this paper is to provide an overview of the approach that has been followed by the range project, both independently and in collaboration with the economics project. I also hope to highlight some of our findings and to illustrate the importance of ecological constraints and variability. Details on various component projects are provided by other authors. This analysis of the current state of our research should give us a basis for planning the next step, i.e. management scale testing.

Functional Components of the Agro-ecosystem

Climate

As in most rangeland areas of the world, the climate of northeastern Brazil plays an overriding role in the structure and function of the livestock production system. This influence is exerted in a number of ways.

On a global scale, climate determines the kind of vegetation that is present on a given area and greatly influences the kind of soil that develops there. As can be seen from Figure 1, climatic conditions similar to those of the Northeast exist at a number of places across the world and the vegetation that has developed in response to this climate shares many similarities with caatinga. These are termed "analog areas" and have been reviewed in detail by Linda Hardesty Howell, (1981). The climatic diagrams (after Walter, 1979) relating precipitation and temperature illustrate periods of drought stress (stippled areas) and moisture sufficiency (black areas).

Another obvious influence of climate upon range animal production systems is through annual and seasonal distributions and amounts of precipitation. Figure 2 illustrates the long-term annual precipitation for the town of Forquilha, showing extreme year-to-year variability. More than half of the years can be considered drought years, with extreme droughts occurring on an estimated 26-year cycle (Markham, 1974). The climate of the Northeast, in general, is classified as semiarid tropical according to the Holdridge (1966) scheme that is widely used in Central and South America.

The strong seasonal distribution of rainfall further complicates the picture for sustained animal production. Indeed, the dry season period has been identified as the major limitation to animal production in the Northeast, and much of our research effort has focused on possible ways of mitigating the severity of animal nutritional deficits that occur at that period. Figure 3 illustrates this seasonal distribution pattern for the municipality of Sobral.

Soils

Soils of the Northeast are extremely variable even on a local scale, and this of course influences vegetation and land use patterns. In their survey of production systems in Ceará state, Queiroz et al. (1985) found that local agriculturalists have a surprisingly good practical understanding of soils and land types. Their land classification system is composed of 1) lands suitable for cultivation and 2) those that are not. Criteria used in this classification include drainage properties, location, fertility, depth and surface texture. Within those lands suitable for cultivation, further distinctions are made and these are summarized in Table 1, extracted directly from the

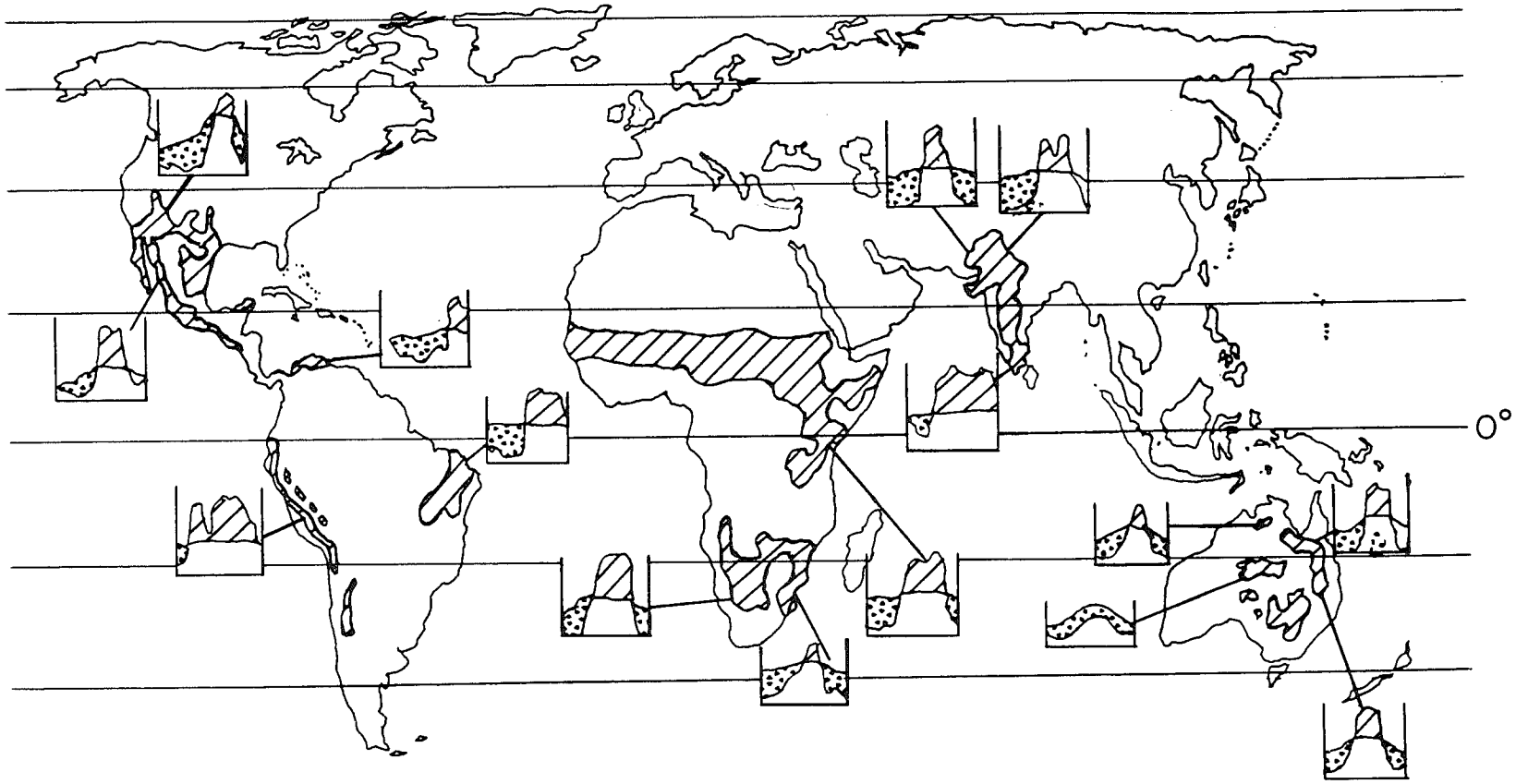

Figure 1. Analog areas and representative climate diagrams. From Hardesty (1981). Areas are depicted to indicate approximate location and scale and not necessarily exact geographic boundaries.

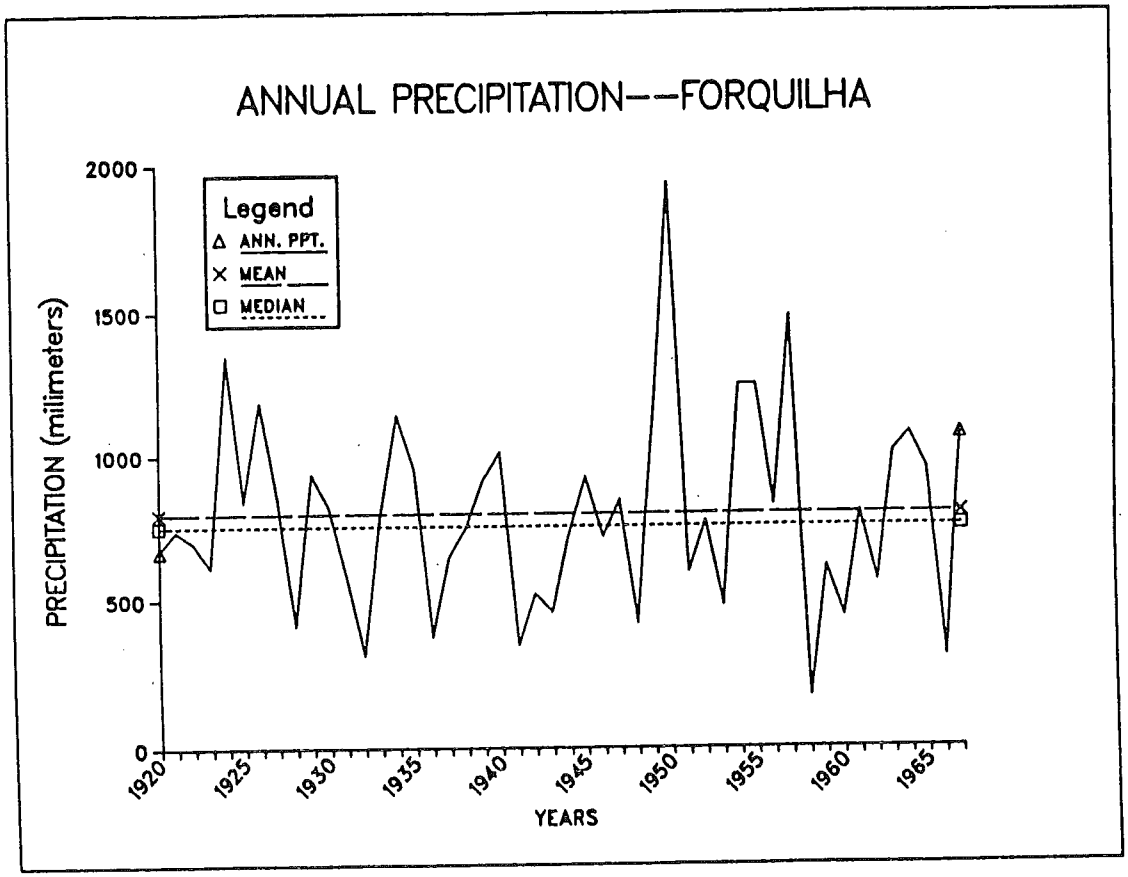

Figure 2. Annual precipitation at the town of Forquilha (1920-1967). From Queiroz (1985).

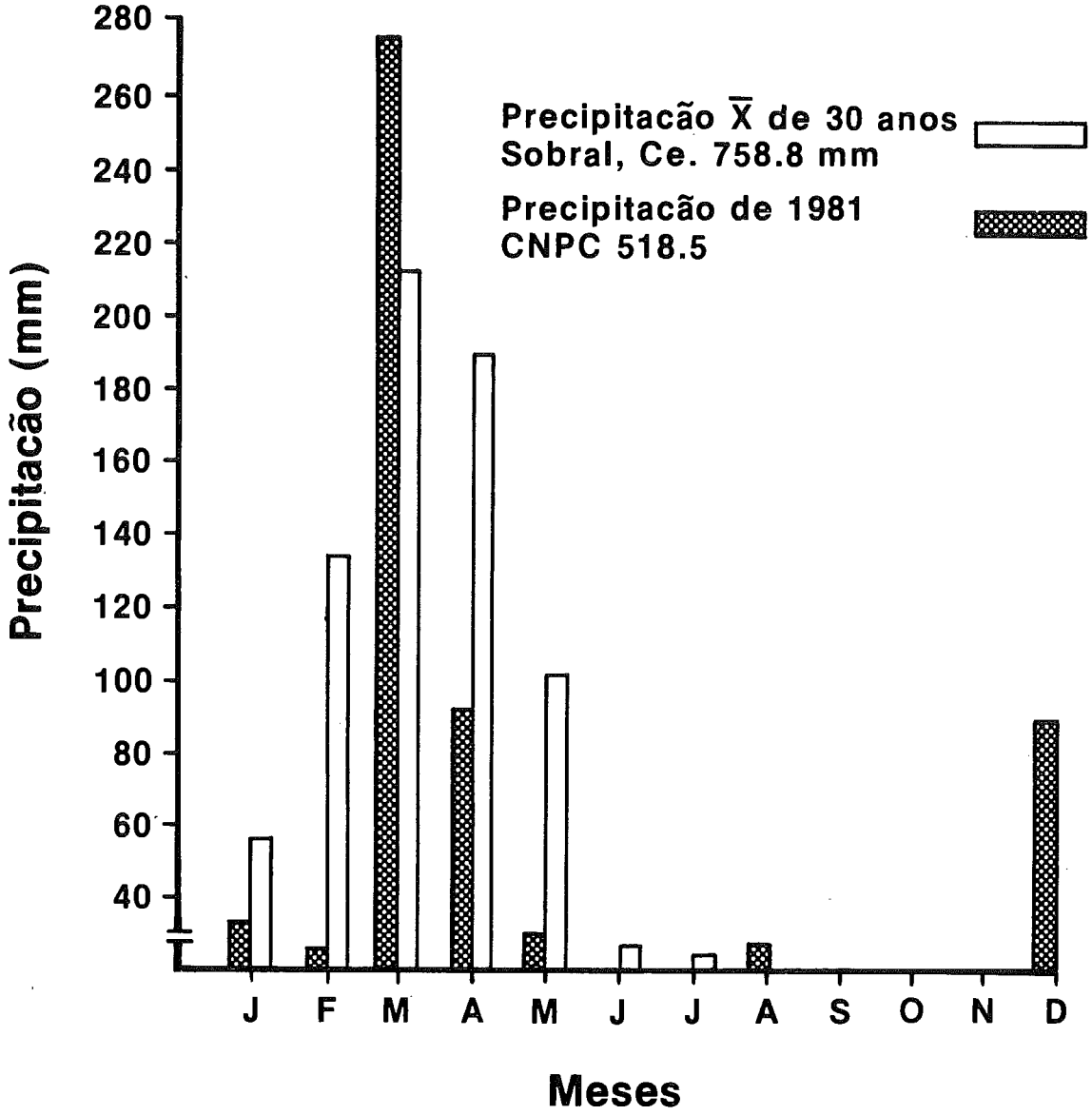

Figure 3. Monthly distribution of precipitation for Sobral municipality (30-year average) and for CNPC during 1981.

Queiroz et al. (1985) paper. Note that this table includes a "suitability" or preference rating based on farmers' perceptions.

TABLE 1. Local terminology, with approximate English equivalent, and suitability ratings for the major soil types encountered in the 28 farms surveyed (Queiroz et al., 1985).

Soil type	Description	Suitability
Barro vermelho (red clay)	Reddish loam/clay-loam subsoil	2-3
Barro vermelho com pedra (stony red clay)	Reddish loam/clay-loam subsoil with stony surface	4
Massapê preto (dark cracking clay)	Poorly drained, dark cracking clays	5
Arisco (sand)	Deep soil with thick (50 cm+) sandy surface and loamy subsoil	3-4
Barro de louça - carrasco (claypan soils, dense shrub layer)	Well-drained soil with a claypan underlying a sandy, often stony, surface	4
Barro de louça - tabuleiro (claypan soils, sparse shrub layer)	Well-drained soil with a claypan underlying a sandy, often stony, nearly level, poorly drained terrain	5
Arisco com pedra - carrasco (stony land, dense shrub layer)	Sandy, stony, and mostly shallow soil	4
Coroa - baixio-liguento (alluvium, fine and medium textured)	Deep, fine, and medium-textured alluvial deposits	1-2
Coroa - baixio-ariscado (alluvium, coarse textured)	Deep and coarse-textured alluvial deposits	1

Soils of the Acaraú Valley are treated in great detail in the recent work by Queiroz (1985). While the technical detail of that study is beyond the scope of this report, it should be noted as a critically important reference for anyone interested in soil-plant relationships and how these affect land use decisions.

Vegetation.

The vegetation of the sertão has been described by several authors including Eiten (1982), Eitern & Goodland (1979), Numata (1970) and others. While all of these people have illustrated the complexity of the vegetation commonly termed caatinga, few have analyzed functional relationships between vegetation and soils, climate, and land use. The recent study of Queiroz (1985) reviews the pertinent published and unpublished work dealing with soils-vegetation relationships and discusses these functional relationships for the Acaraú Valley around Sobral.

Vegetation Community Structure and Soil Relationships. A major distinction between caatinga woodlands and tropical rainforests is that the bulk of woody biomass in caatinga is constituted by relatively few species. For example, in a late-seral stand near Quixada only 32 species occurred in a lha plot; three of these species, pau branco (*Auxema oncocalyx*), sabiá (*Mimosa caesalpinaefolia*) and catingueira (*Caesalpinia pyramidalis*) accounted for 61% of the total wood volume in five stands in the area (Tavares et al., 1969). In a late-seral stand on the CNPC, pau branco was the dominant species by a factor of 2.5 times that of sabiá, the second most abundant species (Kirmse, 1984).

Queiroz s (1985) detailed study pointed out several important features of the local caatinga vegetation. Of the major species present, only jurema preta (*Mimosa acutastipula*) had a well defined tap root; the others had most roots concentrated in the upper 20cm of the soil profile (see Figure 4 showing pau branco as an example). This suggests that most of the important caatinga tree species rely on water stored near the soil surface.

Ordination and cluster analysis studies by Queiroz (1985) revealed two overriding factors determining the kind and amount of caatinga vegetation present on a given site; these are disturbance associated with slash-and-burn agriculture and drainage features of the soil profile. On well-drained clay-pan soils, clearing and burning leads to stands dominated by marmeleiro (*Croton hemiargyreus*), replacing pau branco, sabiá, and catingueira. Repeated disturbances leads to an overall reduction of plant cover.

On moderately deep red clay soils, disturbance contributes to increasing dominance by jurema and marmeleiro and if fallow periods are less than 20 years, marmeleiro tends to dominate the site because late-seral species such as pau branco and sabiá do not have time to re-establish their position from cut stumps (Queiroz, 1985)

Marmeleiro has been singled out as a particularly troublesome species. While it cannot tolerate water-logged conditions on imperfectly-drained sites, it is extremely resistant to both fire and mechanical removal (Queiroz, 1985).

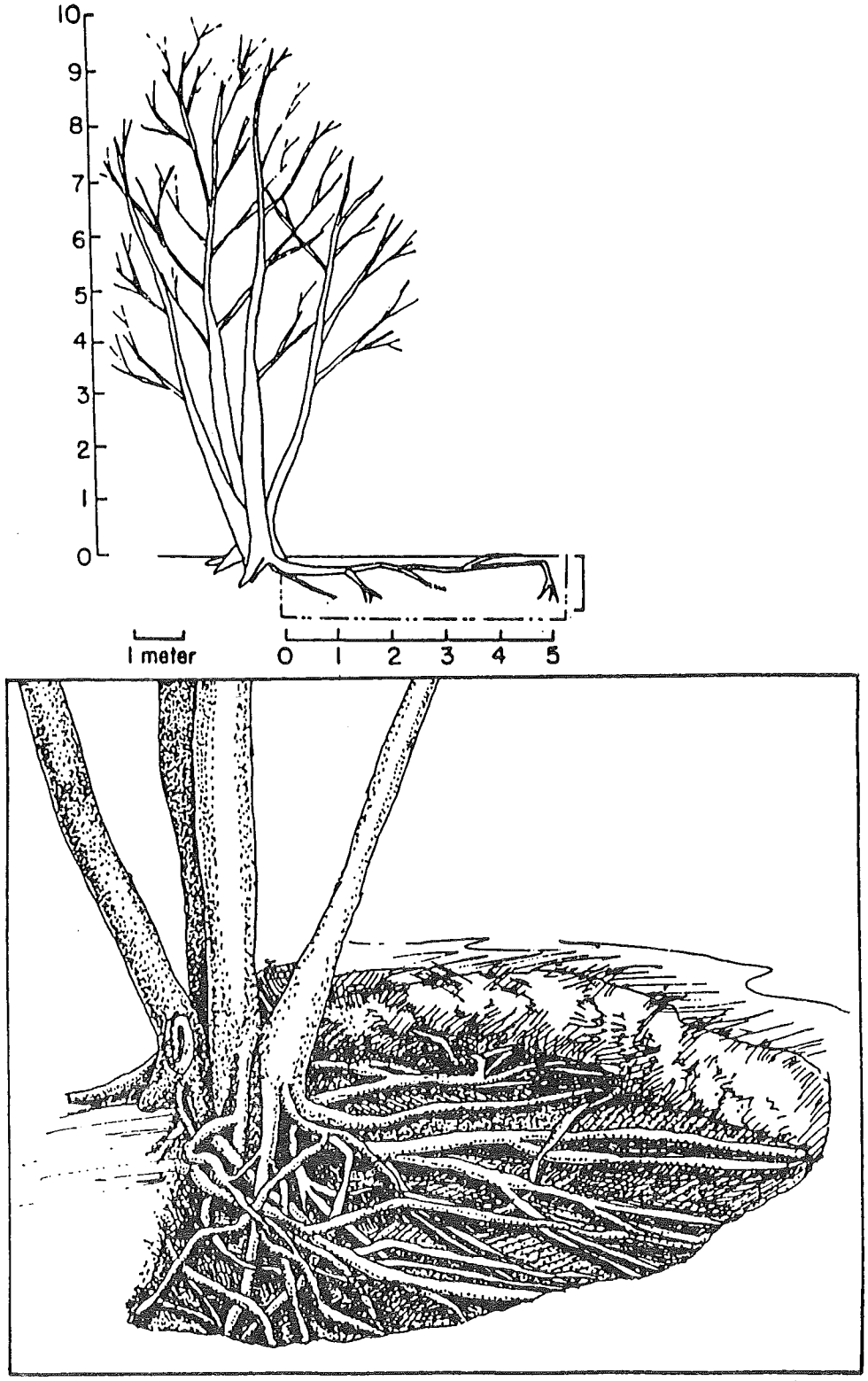

Figure 4. Tree form and root system of pau branco. Excavation radius is 2m. From Queiroz (1985).

This means that with increased disturbance (e.g. shortening of the fallow period as pressures on the land increase for crop production) this species gains virtually permanent dominance of the most productive sites. Considering its low value as a forage and wood species, potential land revenues are sacrificed. As suggested by Queiroz (1985), the potential of chemical control of this ubiquitous species should be investigated.

Vegetation production and forage yields. Several years of data are now available where forage production has been measured over widely different precipitation regimes. These data are summarized in Figure 5 as total forage production, including annual yields of both herbaceous species and fallen leaves from woody species. Measurements were made in a late-seral stand dominated by pau branco. Herbaceous species contributed relatively little to total yields, even in wet years; indeed the exceedingly wet year of 1985 indicated a suppression of herb yields. The main conclusion of this study seems to be that if precipitation is above some critical value, roughly between 500 and 700mm, the site has the capacity to produce around 3,000 $kg.ha^{-1}$ of biomass, irrespective of additional rainfall amounts. In other words, above-average rainfall did not result in above-average plant biomass production.

Cutting and clearing the caatinga stand stimulates major changes in plant production. Kirmse (1984) documented a six-fold increase in production of herbaceous vegetation during the first year after clearing (Figure 6); however, much of this was in the form of stem material of low forage value for sheep and goats. Production of leaves by woody species was, of course, reduced from 3,300 $kg.ha^{-1}$ on uncleared areas to about 1,100 $kg.ha^{-1}$ on the cleared area, with the latter coming from coppice growth. The aggregate yields for the year were 3,450 $kg.ha^{-1}$ for uncleared caatinga versus about 4,600 $kg.ha^{-1}$ for the cleared area. Subsequent work by Schacht (this workshop) has shown that the effects of clearing are transitory and that the tree cover re-establishes dominance in a relatively brief period (<5 yr), because virtually all caatinga tree species coppice profusely and coppice growth rates are rapid.

Livestock

Most of the range project's focus has been on the livestock component, but we have attempted to place our research on livestock in a functional systems context. It is virtually impossible to study the nutrition and production of free-grazing range animals without also considering other system components such as vegetation, soils, climate, and man's management influence.

One of our initial efforts was to establish the seasonal nutrition of animals utilizing native caatinga range year-long. This work has now been summarized in major papers by Pfister (1983) and Pfister & Malechek (1986a and b). These papers emphasize the importance of fallen tree leaves (leaf litter) as

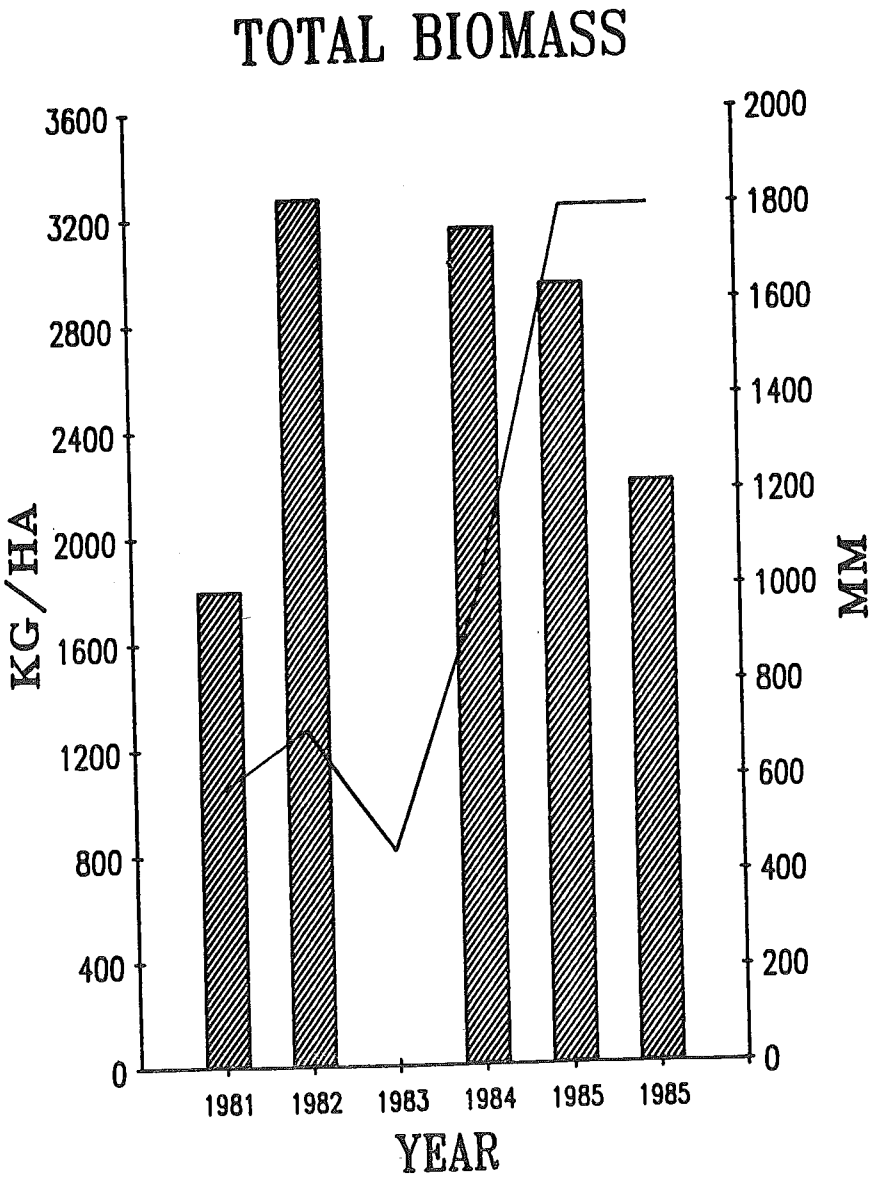

Figure 5. Yearly yields of total forage biomass (herbaceous plants and shed leaves of woody plants) in relation to annual precipitation. The two bars for 1985 represent measurements on two different sites. Data for 1983 are currently unavailable.

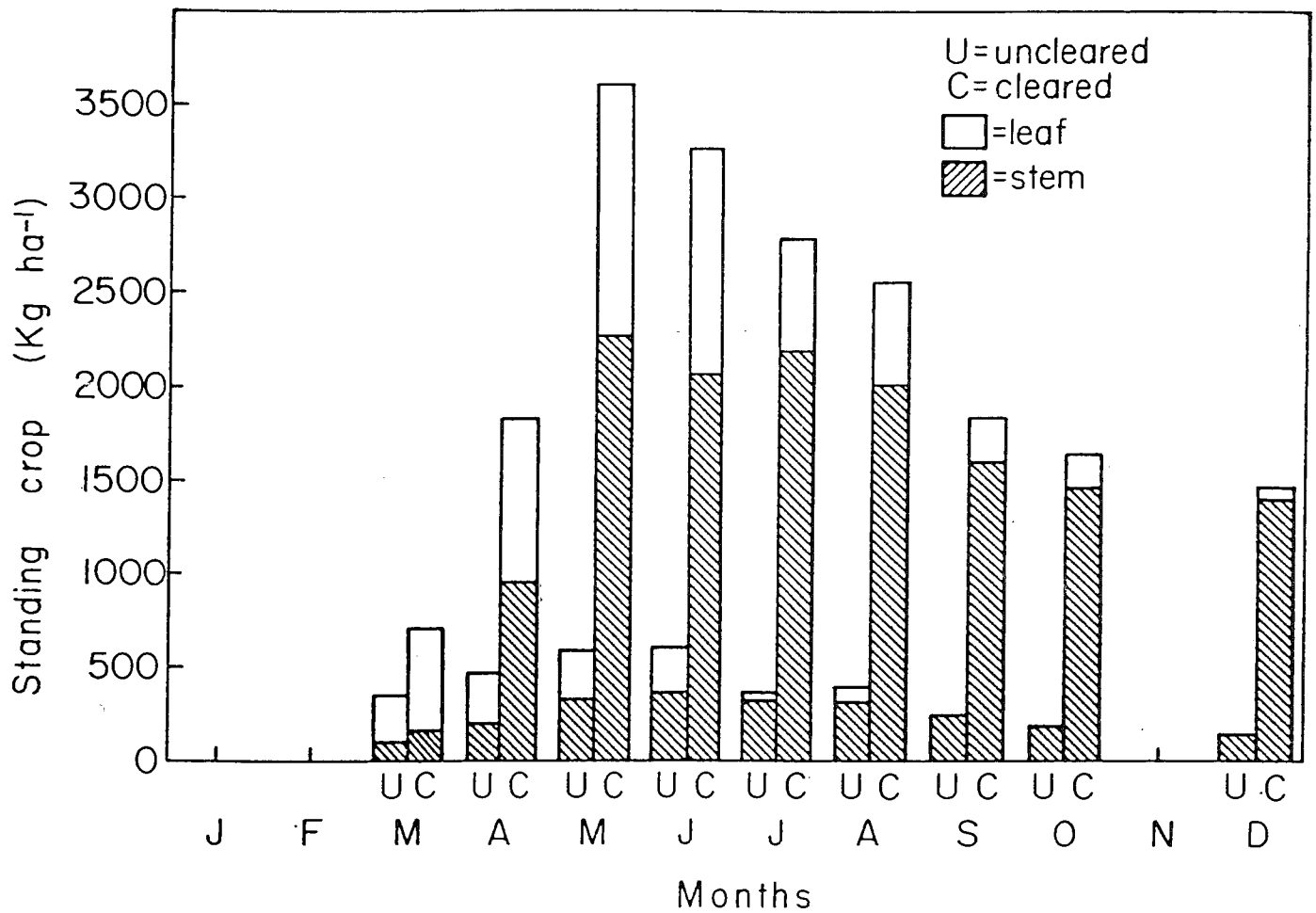

Figure 6. Herbaceous vegetation standing crop on cleared and uncleared caatinga, 1982. From Kirmse (1984).

the key source of dry season forage and point out the key importance of three species, sabiá, catingueira, and mororo (Bauhinia forficata). Interestingly, the usually unpalatable species marmeleiro was briefly important in animal diets in September 1981 when it leafed out in response to a small off-season rainstorm. This is one example of the environmental responsiveness of both vegetation and livestock in the Northeast. While the results from such a single event are generally small, the net effect over time may be quite important in a system where survival is the key demographic factor in animal population (Primov, 1985).

Nutritional work by Pfister & Malechek (1985) indicated that both sheep and goats maintained adequate levels of dietary crude protein (>12%) even at the height of the dry season (December).

In contrast, work the following year by Kirmse (1984) in the same general vicinity but in small (<1ha) paddocks showed that dietary crude protein levels fell below 9% for the entire September - December portion of the dry season. While this difference may be partly attributable to unknown climatic factors associated with different years, certainly an important factor may have been pasture size. Given large (>40ha) areas in which to forage, as in Pfister's study, animals could be expected to better maintain dietary quality through selective grazing. The extremely high spatial variability of caatinga vegetation contributes to such a response.

Pfister & Malechek (1986) reported digestible energy consumption for sheep and goats. Sheep consumed 1,672kcal DE per day, on average, compared to 1,320kcal per day for goats. Seasonally, the lowest DE intake levels were in April with 33.7 kcal/kg body (BW) weight for sheep and 32 kcal/kg for goats. Peak dry season levels (in December) were 50.9 and 44.8 kcal/kg BW for sheep and goats, respectively. Schacht (personal communication) has raised the question of rainy season stress on animals from excessive moisture and insects. This question is worthy of consideration for future research, especially as such stresses affect young growing animals.

People and Caatinga Manipulation. While the major motive for clearing caatinga woodland is for cropping and for harvest of wood products, animals nevertheless are involved in such land use decisions, because virtually all land in the Northeast is grazed at some season of the year. Queiroz (1985) and Queiroz et al. (1985) do a thorough job of describing northeastern production systems and the seasonal calendar of farm activities and animal movements. The strong underlying theme of these studies is that all forms surveyed were complex, mixed-farming, wood-utilizing operations. To view sheep and goat production outside of this context is a serious over-simplification.

In view of the importance of caatinga clearing, Kirmse (1984) studied effects of clearing on animal nutrition as well as forage production (discussed earlier). Overall, clearing did not

result in major changes in dietary quality or intake, but some seasonal differences were important. In a 6-week grazing trial, animals maintained a higher level of dry matter intake on cleared range (Figure 7). Contribution of coppice regrowth to the diet of animals on cleared areas was thought to play a role in this difference.

Hardesty (1984) has extensively studied the coppicing response of cut trees in the caatinga. A finding of potentially major importance from her work is that through strategic timing of cutting, the phenology of coppice regrowth can be shifted greatly. For example, uncut trees in her study shed their leaves in June, while coppice regrowth from cut stumps maintained green leaves until August. Coppicing stumps that were browsed by goats during the late rainy season resprouted leaves in June and held them until September. While the final information is still not in on how coppice contributes to forage production and animal nutrition, the ability to provide a source of green forage well into the dry season offers appealing possibilities for improving animal nutrition. Hardesty discusses coppice ecology elsewhere in these proceedings.

Conclusions

The caatinga ecosystem of northeastern Brazil is an exceedingly complex one. Variability in ecological factors and processes makes agriculture a particularly challenging enterprise. People of the Northeast have a surprisingly good sense of their environment and how to cope with variability. New technology devised by researchers must recognize these factors, else the risk is high that new innovations will either not be accepted, or, worse, poorly designed ones might be accepted and will lead to failure. In ecological systems fraught with extreme variability, people have historically developed a range of strategies for coping. One is to simply move elsewhere for a period of time (nomadism) when drought or other calamities occur. In the sedentary systems of the Northeast where movement is not feasible, having a range of options and alternatives at the local level is essential. As a principle, research and technological development for this region should focus on maintaining or increasing this diversity.

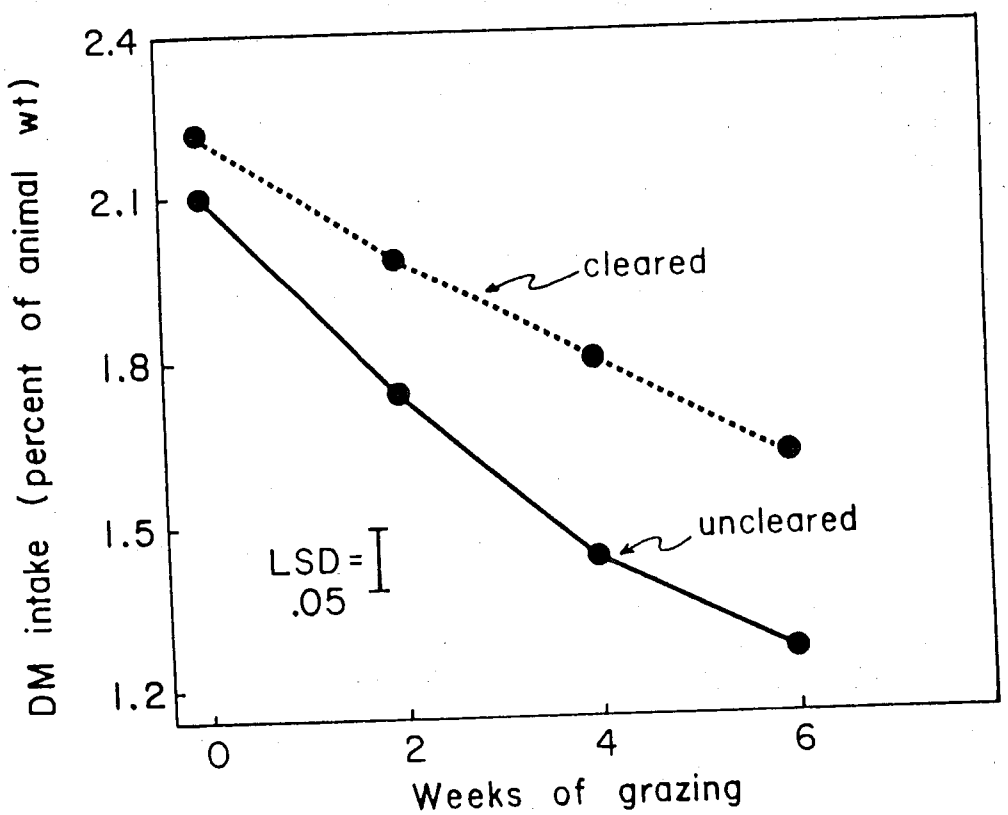

Figure 7. Dry matter intake of goats and sheep grazing on cleared and uncleared caatinga under increasing levels of grazing pressure during the dry season, 1982. From Kirmse (1984).

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AN OVERVIEW OF SHEEP AND GOAT BREEDING RESEARCH

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ABSTRACT - The availability of an adapted productive genotype (species or breed) is a first requirement for a successful animal industry. Choice of species is not usually considered in an animal breeding context, but the appropriate matching of the animal genotypes (between or within species) to the environment and resources available may be one of the most important actions to be taken. It is generally accepted that mixed species grazing of rangelands is advantageous under most conditions. However, under small holder conditions, it may not be desirable to attempt to produce or to implement improvement programs with cattle, sheep and goats. In this case, there may be a need to consider the options in respect to species. In the area where the CNPC and SR-CRSP have been working in Brazil as well as in Texas, goats have generally not been as productive as sheep in respect to meat. It is suggested that goats be favored in the more arid regions of the Northeast, where milk production is the goal or where caatinga is the only feed resource available. Under other conditions, sheep may perform more satisfactorily. More importantly, work to date has identified a number of problem areas with goats which need attention. These are abortion, death loss of kids, poor growth rates and low carcass yields.

It is suggested that all the breeds of sheep and goats found in Brazil have a role to serve and should be preserved. Each of the three recognized breeds of sheep have the potential of serving a unique role and improvement programs should be carried out. It is suggested that in general, the local or native types be preserved and improved as is currently being done with the BNB program. In addition to this, improvement programs need to be established, possibly based on crossbred foundations for meat and milk production.

In respect to mating systems, it is clear that a systematic crossbreeding program will yield good results, but this will be difficult to implement under small holder conditions. Also, there may be problems in respect to available sire breeds.

The genetic parameter estimates necessary for the design of improvement programs for sheep have generally been calculated and will be reported at other points in the proceedings or in subsequent reports. These types of data for goats are not available in Brazil, but data from work in Texas do not lead to much encouragement in respect to rapid progress from selecting within native types.

In respect to exotic genotypes of sheep, it is suggested that consideration be given to introducing new gene stocks of Somali or Blackhead Persian. The Dorper might also be considered to serve the role of a sire breed which would present a problem in a systematic crossbreeding program. In respect to goats, the Nubian has been widely used in Brazil for improvement of both meat and milk production. In addition, the Boer goat must hold interest for improving the meat production potential and a number of dairy type goats should hold interest in respect to milk production. In general, the latter are already present in Brazil.

Index terms: Breeding, Sheep, Goats, Semi-arid tropics.

MELHORAMENTO DE CAPRINOS E OVINOS: UMA VISTA GERAL.

RESUMO - A disponibilidade de genotipos (raças ou espécies) adaptados e productivos e um dos principais requerimentos para uma atividade pecuária de sucesso. A escolha da espécie geralmente não entra no contexto de um programa de melhoramento animal, mas a correta combinação entre animal e ambiente e (ou) recursos disponíveis pode se constituir em uma das mais importantes medidas a serem tomadas. E geralmente aceito que o pastejo combinado de duas ou mais espécies de animais em pastagem nativa de caatinga é vantajoso na maioria das condições; entretanto, nas condições de pequenos produtores pode não ser desejável tentar produzir ou iniciar programas de melhoramento com bovinos, caprinos e ovinos. Neste caso é necessário considerar as opções com respeito a espécie.

Em termos de produção de carne os caprinos não tem sido tão produtivos quanto os ovinos nas áreas em que o CNPC e o SR-CRSP tem trabalhado, tanto no Brasil, como no Texas. Tem sido sugerido que os caprinos são mais favorecidos nas regiões mais áridas do Nordeste, onde a meta é produção de leite ou onde a caatinga é o único recurso alimentar disponível. Sob outras condições, espera-se que os ovinos produzam mais.

Os trabalhos mais importantes até então tem identificado algumas áreas-problemas com caprinos, as quais necessitam alguma atenção, são elas; abôrto, mortalidade de cabritos, lento crescimento e baixa qualidade de carcaça. Em termos de ovinos, todas as raças reconhecidas servem a um propósito diferente e por isso devem ser preservadas e melhoradas. Em termos de caprinos, encoraja-se a ação do BNB na preservação das raças e (ou) tipos nativos e sugere-se o delineamento de um programa de melhoramento para carne e leite, possivelmente baseado em cruzamento.

Em termos de sistemas de acasalamento, os cruzamentos sistemáticos podem dar bom resultados, mas esbarram na dificuldade de implementação em pequenos produtores e na baixa disponibilidade de raças paternas.

Os parâmetros genéticos necessários para os programas de melhoramento já estão disponíveis para ovinos, mas não para caprinos, com excessão de alguns, relatados nos Estados Unidos, porém estes não antecipam um progresso rápido na seleção dos tipos nativos.

Com respeito aos genotipos exóticos encoraja-se a introdução dum novo "gene pool" para a raça Somalis. A raça Dorper merece ser considerada como uma das alternativas como raça paterna. Em termos de caprinos, a raça Anglo-nubiana tem sido largamente utilizada no Brasil para melhorar ambos, a produção de carne e leite. Além desta, a raça Boer parece ser interessante do ponto de vista de produção de carne, e um variado número de raças de caprinos leiteiros são interessantes do ponto de vista de produção de leite e podem ser usadas em cruzamentos.

Termos para indexação: Melhoramento genético, Ovinos, Caprinos, Trópico semi-árido.

Introduction

The presence or utilization of an adapted and productive genotype is a necessity for a successful animal industry. The identification or development of an animal with these attributes is more difficult and also more critical in an adverse environment. The development of highly productive animals in an adverse environment will likely require a very long period of time. Sheep and goats have not been present in the Northeast of Brazil (NE) for the long period of time necessary for this to be fully accomplished with the methods employed in the past. Thus there is a challenge to speed this process utilizing newer approaches. Unfortunately, there are some indications of negative relationships between adaptation to adverse environments and overall productivity of products of value to man such as meat, milk, fiber, etc. These problems and the methods of dealing with them have not been fully explored and should be high priority research for collaborative efforts such as the SR-CRSP. Types of breeding stock available is one of the most critical factors for animal production in unfavorable environments. For instance, the options are to alter the environment or to develop animals which can function under the constraints imposed by the environment. On an overall basis, the choice of these approaches should be obvious. However, as applied to individual environmental constraints, it may be possible to make environmental alterations. Improvement of genetic potential holds a great deal of public interest, and is one of the most frequent interventions in attempts to improve production. These attempts frequently involve introduction of exotic genotypes which is often a questionable practice. The appeal to this approach is that it can be a one-time event and does not require repetition with each season or year. The development of guidelines in this respect should be a high priority goal of collaborative research involving the SR-CRSP.

In terms of improving animal productivity from the standpoint of genetic potential, one might be concerned with choice of species, choice of breeds within species, choice of mating systems, types of selection or improvement programs and the possibility of introducing and utilizing exotic genetic resources. Each of these will be discussed briefly.

Choice of Species

Cattle, sheep and goats are often found intermingled on many rangelands of the world, including that of northeast Brazil. It has been well established that mixed species grazing is advantageous in many resource areas. This is especially true in those areas where multiple types of forages such as browse, forbs and grass are available. It has often been found advantageous to run cattle and sheep together even on pastures dominated by a single species. In the latter case, typical findings are that at comparable stocking rates the total offtake is improved by having the two species present and that the presence of cattle will often improve sheep performance, but not the reverse. It seems a safe assumption that at least under some conditions of the northeast, the resources are best utilized if all species are present. However, under small holder conditions, it may not be practical to implement or conduct improved systems with all three species, in which case it may be desirable to consider which species to exploit or emphasize. In this discussion, we will be concerned primarily with sheep and goats.

The type of product or offtake expected must have a great influence on the species of choice. The writers believe that meeting mankind's food needs, especially that of animal protein, is most efficiently accomplished through milk production. Milk production from small ruminants may be accomplished from either species, but most likely will be derived from goats. Efforts should be made to exploit their use for this purpose. However, this recommendation does not carry with it the prediction that a high percentage of the goats in the NE will be exploited for milk production or that it will be economic to do so on a commercial scale. The use of goats to produce dairy products for domestic consumption is more easily recommended. Marketing of surplus production in the form of cheese is often an available option. Dairy production from goats would appear to require some inputs of feed and dairy breeding.

On the other hand, there is a suggestion that sheep perform in a superior manner, compared to goats, when exploited for meat production. Some data will be presented in support of this viewpoint.

Within the resource areas where the authors are working, an opportunity exists to make a comparison between hair sheep and goats at Sobral and Quixadá in Ceará and at Soledade in Paraíba in Brazil and in Texas, U.S.A. In Texas, meat type (Spanish) goats weaned only 81.4% as much weight as Barbados Blackbelly

sheep although the adult does were approximately 5 kg heavier. They weaned only 59.6% as much weight as Blackbelly x St. Croix ewes. As adapted from annual reports, goats weaned only approximately 47% as much weight as sheep at Sobral. This was based on all the breeds involved in the breed evaluation studies. At the Fazenda Pendencia in Paraíba this figure appeared to be more like 35%, although the comparison at this site involved Santa Inês sheep and Caninde goats, and the former is a much larger animal. Experimental flocks of Morada Nova sheep and SRD (without well defined type) goats are currently maintained at Fazenda Iracema near Quixadá. Performance data relating to sheep have been analyzed (Fernandes, 1985), but overall performance of the goat flock have not been extensively analyzed. A preliminary analysis indicates the goats weaned only 34.5% as much weight as sheep even though adult female weights were approximately equal. In a grazing experiment conducted by EPACE (Fazenda Iracema) the performance of the two species were much more comparable with the goats being superior to sheep under native pasture (caatinga) conditions. In an earlier report (Fernandes et al., 1982a) it was reported that fewer goats gave birth than sheep, and that they had lower weaning weights and slower growth rates. Survival rates of kids were not reported.

In general, these data suggest that, at least in northeast Brazil, goats are not as suitable for meat production as sheep. The reasons for this suggest some areas where improvement is needed with goats. These are: (1) reduce abortion, (2) improve survival of kids, (3) increase growth rate, and (4) increase carcass yields.

Abortions were reported as a problem with most research flocks of goats. For instance, in the breed evaluation study at Sobral, one doe aborted per 3.8 kidded. There appeared to be a tendency for the exotic (introduced) goats to have a higher abortion rate than the native types. In this study, Simplicio et al. (1982) reported that 24.7% of the does aborted and that 68.1% of the kids died before weaning. The latter value is high, but abortion and death losses are reported as a problem with many experimental flocks of goats in the tropics. This is not unique to Brazil, but appears to perhaps be more severe in northeast Brazil than in other areas. For instance, data reported by Oppong & Yebuah (1981) indicate a death loss of greater than 60% for goats up to 6 months of age in West Africa.

Another major factor influencing decisions concerning choice of species would be the type of forage available. It is generally accepted that goats browse more extensively than sheep, although recent studies (Warren et al., 1984) indicate that hair sheep browse more extensively than wool type sheep. Pfister & Malechek (1986) indicate a high degree of similarity between the botanical composition of the diet of sheep and goats at Sobral, but information from other locations in the NE suggest that the two species are foraging in a more traditional manner at those sites. Fernandes et al. (1982b) suggested that goats perform better under caatinga conditions, but that sheep performed better

under cleared or cultivated pasture conditions. The following suggestions appear warranted:

1. Some advantage in forage utilization may be realized from mixed (sheep and goats) species utilization.
2. Resource limitation may indicate a need to concentrate on one species if improvement programs are to be initiated.
3. Goat production would be recommended where milk production is one of the goals.
4. Goats may be preferred where caatinga is the only or primary grazing resource to be utilized.
5. If meat is the primary product to be realized, sheep would appear to provide a better response, especially if forages other than caatinga are available.
6. Major opportunities and needs exist to improve the meat production capability of goats.

In respect to item number 6, immediate improvement can be realized through management, but over the long term genetic change would appear to be of paramount importance. The authors are not aware of any research to determine if abortion and death losses can be reduced through selection. There are indications of breed differences in kid mortality.

Choice of Breeds

Breed evaluation studies have been conducted at CNPC (Figueiredo et al., 1982) and in time will be reported in more detail. The present discussion will consist largely of interpretations of these and other studies.

Sheep - The types of sheep available in the NE are generally listed as: Morada Nova, Santa Inês, Somali, Crioula and Rabo Largo. The latter two were not included in evaluation studies. These two are highly variable and would not have been characterized by small research samples. It is suggested by the authors that each of the three recognized breeds (Morada Nova, Santa Inês and Brazilian Somali) have a role to serve in the NE and that improvement programs should be carried out with each of these. The Brazilian Somali or the parent breed from which they are derived is recognized as being one of the most hardy found in the world. In Brazil, they should serve a role in the more arid interior where multiple births should not be encouraged. Research should be initiated at more arid sites in the NE to evaluate this genotype. The Morada Nova somewhat ideally fits the mold of a dam line being a breed with small size, higher reproductive rates and acceptable adaptability. However, for widespread use in the northeast, it must be treated as a general purpose breed. Due to its larger size and lower lambing rate, the Santa Inês would be classified as a general purpose or as a sire breed. There would appear to be only limited function to be served as a sire breed in this region.

A majority of the sheep in the NE are of the Crioula type.

A majority of the sheep in the NE are of the Crioula type. The most popular breed for use in improvement programs is the Santa Inês. Clearly, the appeal to this breed is its size. It is not unusual to find that selection decisions in many countries are made largely on size, although research often brings into question the desirability of this approach. The use of Santa Inês for this purpose will almost certainly continue regardless of research results. The initial cross would be expected to give a favorable response due to hybrid vigor and to the increased growth potential of the offspring. However, if crossing is continued, the result will be a breed shift to the Santa Inês. There is a very real question of how long this should continue, and research should be conducted to answer this question. Work on producer farms and coordinating by CNPC personnel should provide some answers to this question.

Goats - There are a number of "so-called" native or indigenous breeds. These include the Moxotó, Marota, Canindé and Repartida. In many cases, these can be classified or distinguished largely based on color (Shelton & Figueiredo, 1981). The larger percentage of the goats are generally classified as SRD. Exotic breeds which have been used include the Anglo Nubian and the Bhuj. All of these were included in the breed evaluation studies at Sobral. In addition to these, some of the established dairy breeds, such as the Alpine, have been introduced and are being studied in connection with efforts to improve milk from goats.

Work completed to date suggests that the native breeds are comparable in respect to performance, and that any of these might be used as the producer prefers. The available data suggest caution in using the exotics as purebreds, especially the Bhuj, for meat production under small holder conditions. There is strong indication that kids sired by exotic breed sires may suffer higher mortality rates. Survey data indicate that the Anglo Nubian has been widely used in the region, and that this will likely continue. Increased size in the initial crosses would be expected (Fernandes et al., 1985). However, it is important that research be conducted to determine if this crossing should continue under small holder conditions to the point of a breed shift to Anglo Nubian. Work with the German Alpine (Parda Alemão) breed by EMEPA (Paraíba) suggests that this breed in relatively pure form can be utilized for milk production if a high level of management, including nutrition and disease control, can be supplied. Limited work strongly suggests that this breed, in pure form, should not be expected to perform to advantage under small holder conditions with largely caatinga forage as the feed source. Data on crossbreds between the Alpine and native types under producer conditions is not yet available.

Mating Systems

In respect to mating systems the alternatives are purebreeding vs. crossbreeding. Grading up might also be

considered by many as a breeding system, but when carried to completion would result in breed substitution.

Essentially, no crossbreeding studies involving sheep have been conducted in the regions. In the authors' opinion, crossbreeding among the present breeds would not be strongly indicated. The case of the use of Santa Inês sires on Crioula ewes has previously been mentioned. Initial crosses of these types would be expected to give favorable results, but if continued will result in breed substitution. Systematic crossbreeding programs are difficult to implement or to be carried out under small holder conditions. However, except for this limitation, crossbreeding almost certainly offers a potential for improvement in meat production from sheep in the region, and should be explored for uses by the more advanced producers. The availability of sire breeds presents problems, and research should be initiated with respect to this goal. Crossbreeding studies with goats are underway for both meat and milk production. One report (Fernandes et al., 1985) compares the sires of different breeds when crossed on SRD does. Not surprisingly those sired by Anglo Nubian and Bhuj weigh more at weaning. Although this cross provides a meaningful increae in weight, there remains the problem that continued use of sires of these breeds will result in breed substitution. It is premature to conclude that this is desirable. Preliminary results suggest that the Bhuj should not be used in pure form. Also results from a number of other studies have suggested that small goats may be equally as efficient as the large ones for meat production, and will almost certainly be more efficient if the larger size carries with it reduced reproductive rates or increased death losses. These problems may not be encountered in systematic crossbreeding programs, but may well be the case if the grading up to an introduced breed is the end result. An alternative approach to this is to attempt to establish a new breed based on a crossbred foundation. This approach should be initiated at one or more sites in the Northeast.

Improvement Programs

As a matter of policy, it is important to decide if research institutions such as the CNPC or the state research agencies should attempt to carry out animal improvement programs or if their role is only to provide information, assistance and encouragement to private producers to do this job. The answer to this is not always clear. Geneally, if a large number of breeders are available which can devote a substantial part of their effort to this cause, they will make more progress and frequently more impact than will be made by institutional flocks. A recent or modern innovation in this respect is group breeding scheme or improvement programs which may be affiliated with agencies or institutions. One of the projects currently being conducted by the CNPC and which has been partially supported by the SR-CRPS has the potential of developing into a scheme of this type. If resources are not available at the producer level this

task should be undertaken by institutions themselves. Which course should be undertaken in Brazil is not clear. Breeder organizations are active in the NE and appear to be making a contribution. It is not clear if this is true in the more interior regions of the Sertão.

Assistance in the design of the most appropriate improvement programs is clearly an appropriate responsibility of research agencies. Also, the creation of new breeds and crossbreeding studies is clearly a role of institutions. The design of appropriate improvement programs theoretically requires information or estimates of the appropriate genetic parameters. Although the literature on this subject is extensive, this is not the case with hair sheep or goats in the tropics. Therefore, reseach in this area appears to be indicated. Two studies with sheep have now been completed. These include that of Fernandes (1985) and Figueiredo (1986), and provide a basis for some recommendations in this area. These studies will be reported, in part, in other papers in these proceedings. Similar studies have not been completed in Brazil for goats, but some data are available from Texas (Snowder et al., 1982; Bogui, 1986) and do not lead one to be greatly encouraged about early progress in selection for meat production working with native types.

It is the authors' recommendation that selection flocks with each species and major breed be initiated or continued at one or more sites in the NE. However, as an economy measure, it may be desirable to superimpose management or crossbreeding studies on these flocks as an additional role. This may be particularly critical if the formation of new breeds is being considered. Fortunately, the BNB program can serve the role of preservation and improvement flocks for some breeds such as the indigenous breeds of goats.

Introduction of New of Exotic Genetic Resources

The introduction of breeds of livestock, often from temperate regions, has in the past, been widely practiced in developmental programs. These efforts have not always been successful, and it should be a high priority goal of collaborative research efforts (SR-CRSP) to develop guidelines in respect to this practice.

In respect to sheep in the NE of Brazil, it is difficult to envision candidate breeds for introduction. The authors suggest consideration be given to the introduction of new gene sources of Somali or Blackhead Persian. This would not be a new breed, but merely a new source of genetic material to improve selection within this breed. The most likely source would be Africa, but because of the difficulties of introducing animals from this area it may be significant to note that there is a flock in the Caribbean region (Tobago).

Previous mention has been made of the need for a sire breed in the region. On a world basis, the most recognized breeds to serve this role are the Suffolk, Texel and others of European origin. It would be a serious mistake to attempt to introduce these to the NE of Brazil. As an alternative to these, the Dorper may be a breed which should be considered.

In respect to goats, this subject needs to be addressed in respect to breeding goals. For milk production or the development of a dairy goat industry, there seems to be little alternative to the use of introduced dairy breeds. It should be a legitimate research goal to determine how best to use these. Some of the alterntives are: (a) a systematic crossbreeding program, (b) grading up to exotic types (breed substitution), (c) development of new breeds based on a crossbreed foundation or (d) selection within native types. In an intensified dairy program, the authors' recommendation is the second option, but it remains a legitimate research goal to determine how far this grading up process should continue. For small holder conditions, one of the other options would be preferred, but only crossbreeding would likely yield early results. Selection within native types would be expected to yield slow results. Over a longer period of time, the development of a new breed for use at the farmer level would appear to be indicated.

In respect to meat production, recommendations are not easily made. When decisions are made based on weight alone, as is often the case, the large breeds will be shown to advantage. However, if decisions are made based on efficiency, the small breeds often are equally or more efficient. The latter is often the case if a differential reproductive rate or a lower mortality rate favors the smaller breeds. Potential exotic breeds which might be considered are the Anglo Nubian or the Boer. The authors' recommendations are that indigenous populations be maintained, but also that new populations be created based on a crossbred foundation. The goal of the latter would be to maintain adaptation and reproductive efficiency while selecting for improved gains and carcass yields or value.

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DOENÇAS DE CAPRINOS DIAGNOSTICADAS EM SOBRAL, CEARÁ

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RESUMO - Foram realizadas 726 necrópsias em caprinos de diferentes raças e tipos (Anglo-nubiana, Bhuj, Canindé, Marota, Moxotó, Repartida, Pardo Alemã e do tipo Sem Raça Definida), de diferentes idades e de ambos os sexos. Os estudos macro e microscópicos revelaram que as doenças de maior ocorrência foram: parasitose gastrintestinal (24,93%), broncopneumonia (22,87%) e subnutrição (19,15%). Outras doenças ocorreram em menor frequência, sendo que a criptococose no sistema nervoso, o melanoma e aneurisma da artéria aorta estão sendo relatadas pela primeira vez em caprinos, no Brasil.

Termos para indexação: Caprinos, Doenças, Parasitose Gastrintestinal, Broncopneumonia, Subnutrição.

DISEASES OF GOATS DIAGNOSED IN THE SOBRAL, CE

ABSTRACT - Necropsies were performed on 726 goats of different breeds and types (Anglo-nubian, Bhuj, Caninde, Marota, Moxoto, Repartida, Pardo Alemã and non-descript types), ages and sexes. Macroscopical and microscopical examinations revealed that the most prevalent diseases were gastro-intestinal parasitism (24,93%), bronchopneumonia (22,87%) and malnutrition (19,15%). A variety of other diseases occurred with lesser frequency: cryptococose of the central nervous system, melanomas and aneurisms of the aortic artery being reported for the first time in goats, into Brazil.

Index terms: Goats, Disease, Gastro-intestinal, Parasitism, Bronchopneumonia, Malnutrition.

Introdução

Os caprinos não tem recebido um lugar de destaque entre as demais espécies domésticas, mesmo considerando a sua ultilidade para o homem nas diversas regiões do mundo (French, 1970).

O rebanho caprino no Brasil encontra-se entre os maiores do mundo, com cerca de sete milhões de cabeças representando 92% do rebanho efetivo do país (Anuário Estatístico do Brasil, 1983).

O desenvolvimento da caprinocultura no Nordeste está severamente afetada por inúmeros fatores, entre eles, a alta incidência de enfermidades sem que se conheça todas as causas. A criação de caprinos nas regiões semi-áridas brasileiras é caracterizada por práticas de manejo inadequadas, com relação

principalmente aos aspectos sanitários, o que sobre maneira interfere na produtividade do rebanho (Simplício et al., 1981).

Dentre as doenças que acometem os caprinos o parasitismo por nematódeos gastrintestinais tem relevante importância, sendo destacado como um dos principais fatores limitantes à produção de caprinos no Nordeste. O controle desta parasitose tem sido meta de muitos estudos, porém é necessário se conhecer a epidemiologia dos parasitos, ou seja a sua dinâmica populacional em diferentes períodos do ano e os principais nematódeos prevalentes em caprinos (Torres, 1945; Cavalcante, 1974; Pereira, 1976; Girão et al., 1978). Segundo Costa & Vieira (1984) os nematódeos gastrintestinais de maior importância econômica que ocorrem em caprinos no Ceará são o Haemonchus contortus, Trichostrongylus colubriformis, Oesophagostomus columbianum e Strongyloides papillosus. Outro fator de relevância na epidemiologia dos nematódeos gastrintestinais, é o aumento do número de ovos destes parasitos nas fezes de cabras lactentes, devendo este aumento principalmente a maturação de larvas em hipobiose (Costa, 1983).

As doenças bacterianas também contribuem nas perdas economicas à caprinocultura. Unanian et al. (1985) no estudo sobre abscesso e linfadenite caseosa em cabras encontraram uma incidência de 41,6% de abscessos superficiais palpáveis de um total de 656 animais examinados, e 11,5% de abscessos internos de 486 necrópsias. A incidência geral de abscessos externos e internos foi de 28,8%, deste total 27,7% deviam a Corynebacterium pseudotuberculosis e o restante a C. pyogenes e espécies de Streptococcos e Stphylococos.

No estudo sobre pneumonia em caprinos no Nordeste, Santa Rosa (1984) verificou uma alta prevalência em animais jovens (52,90%) e adultos (11,71%), constatando que as causas predisponentes foram alimentação deficiente, fatores ambientais e práticas de manejo. Johnson & Santa Rosa (1958) verificaram que o principal agente responsável por esta doença é a Pasteurella haemolytica.

Outro grupo de doenças de importância na espécie caprina são as nutricionais e metabólicas, principalmente devido a situação climática no Nordeste, onde temos períodos longos com escassez de alimentos, e regiões de solos deficientes em certos elementos.

Com o objetivo de identificar as principais doenças em caprinos, projetou-se o presente trabalho.

Material e Métodos

A pesquisa foi conduzida no período de janeiro de 1981 a dezembro de 1985, nos laboratórios de anatomia patológica, bacteriologia e parasitologia do Centro Nacional de Pesquisa de Caprinos, Sobral-CE.

Na realização deste trabalho foram efetuadas um total de 726 necrópsias de caprinos, oriundo do rebanho do CNPC, das raças Anglo-nubiana, Bhuj, Canindé, Marota, Repartida, Pardo Alemã e do tipo Sem Raça Definida (SRD) e de ambos os sexos. Os animais foram divididos de acordo com a idade em 5 grupos (0 a 12, 13 a 24, 25 a 36, 37 a 48 e mais de 49 meses).

Nos exames post-mortem foram adotadas as técnicas descritas por Winter (1969) e Jacob (1981) seguidas de algumas modificações. Os fragmentos dos órgãos e tecidos destinados ao estudo histopatológico foram processados de acordo com as técnicas rotineiras de laboratório (Luna, 1968; Lamberg & Rothstein, 1978) e corados em hematoxilina-eosina. Fragmentos de diversos tecidos e órgãos foram enviados para exame bacteriológico e processados de acordo com métodos padrões descritos por Carter, (1984). Os parasitos foram identificados de acordo com a localização e morfologia descritas por Soulsby, (1968) e Levine (1968).

Resultado e Discussão

A Tabela 1 mostra a frequência das doenças diagnosticadas em caprinos, no período de janeiro de 1981 a dezembro de 1985. Do total de animais examinados 637 (87,75%) tiveram diagnósticos concluídos enquanto que nos 89 (12,25%) restantes não foram possíveis obter diagnósticos por não apresentarem lesões ou se encontrarem em adiantado estado de autólise. A maior frequência de morte de caprinos ocorreu em consequência de parasitose gastrintestinal (24,93%) seguida de broncopneumonia 22,87%) e subnutrição (19,15%). As demais doenças foram menos frequente. Melanoma (0,41%), aneurisma da artéria aorta (0,28%) e criptococose (0.14%) ainda não tinham sido relatadas nesta espécie no Brasil.

Parasitose Gastrintestinal

As helmintoses foram diagnosticadas como a principal causa de morte no rebanho estudado, confirmando os relatos de Torres (1945) e Costa & Vieira (1984). Dentre os parasitos observados durante as necrópsias os helmintos mostraram uma frequência de 24,93% e os protozoários de 0,69%.

As lesões macroscópicas observadas nos animais com infecções por nematódeos gastrintestinais foram: severa anemia das mucosas dos orifícios naturais e das vísceras. Em alguns casos foi verificado edema na região submandibular, ascite, hidrotorax e hidropericárdico. O abomaso apresentou edema da parede, hiperemia ou anemia da mucosa e em alguns casos formações ulcerosas, no local de fixação do parasito. O conteúdo abomasal era semi-líquido de coloração avermelhada, contendo inúmeros exemplares de parasitos adultos identificados pela morfologia e localização como Haemonchus spp. Microscopicamente as lesões foram edema da mucosa, submucosa e serosa, descamação de células epiteliais, ulceração e infiltrações de leucócitos com

TABELA 1. Doenças diagnosticadas em 726 caprinos necrosiados durante o período de janeiro de 1981 a dezembro de 1985, Sobral, CE.

Doenças	1981	1982	1983	1984	1985	Total	%
Parasitose gastrintestinal	22	11	13	16	119	181	(24,93)
Broncopneumonia	19	40	40	22	45	166	(22,87)
Subnutrição	42	26	18	13	40	139	(19,15)
Intoxições	-	01	06	03	13	23	(3,17)
Peritonite fibrinosa	02	04	07	03	05	21	(2,90)
Linfadenite caseosa	06	03	02	03	06	20	(2,75)
Abscesso hepático	06	02	04	01	05	18	(2,48)
Urolitíase	-	12	-	-	-	12	(1,65)
Traumatismo	02	01	01	01	03	08	(1,10)
Epididimite	04	02	01	-	-	07	(0,96)
Meningoencefalite	-	-	02	02	03	07	(0,96)
Eimeriose	-	-	-	02	03	05	(0,69)
Artrite supurada	-	-	03	01	-	04	(0,55)
Degeneração testicular	01	01	01	-	01	04	(0,55)
Calcificação testicular	01	01	-	-	01	03	(0,41)
Melanoma	-	-	01	02	-	03	(0,41)
Mastite	01	-	01	-	01	03	(0,41)
Orquite bilateral	01	-	02	-	-	03	(0,41)
Arterite	01	-	01	-	-	02	(0,28)
Encefalite micótica	01	01	-	-	-	02	(0,28)
Onfaloflebite	01	-	-	-	01	02	(0,28)
Aneurisma da artéria aorta	-	01	-	-	01	02	(0,28)
Criptococose cerebral	01	-	-	-	-	01	(0,14)
Deformação esquelética	-	-	-	-	01	01	(0,14)

predominância de eosinófilos. Os achados anátomo-histopatológicos foram semelhantes aos descritos por Smith et al., 1972.

Nos intestinos delgado e grosso as alterações marcantes foram pequenas formações nodulares de colocação creme, amarelado, esverdeado ou acinzentado, de consistência pastosa nas lesões mais recentes e calcificadas nas mais antigas, localizadas na parede do órgão. Na luz intestinal observou-se, misturado ao conteúdo fecal, a presença de parasitos adultos, identificados conforme a morfologia como Oesophagostomum spp. As formações nodulares foram também observadas, com menor frequência, nos linfonodos mesentéricos, omento e fígado. Estes nódulos histologicamente mostram-se encapsulados por fibroblastos, contendo uma massa central de necrose rodeada de grande quantidade de eosinófilos, linfócitos, macrófagos e células gigantes, comprometendo a parte profunda da mucosa e muscular.

Nas infecções por Moniezia spp no intestino delgado, as alterações macroscópicas consistiram na presença de verme adulto na luz, produzindo obstrução parcial ou total e uma enterite catarral. Microscopicamente na mucosa observou-se reação inflamatória aguda constituída por neutrófilos, linfócitos e eosinófilos.

As lesões macro e microscópicas constatadas nas infecções parasitárias foram semelhantes as descritas por Soulsby (1968), Levine (1968), e Smith et al. (1972).

No período de estudo pode-se observar que as mortes em consequência das parasitoses gastrintestinais, ocorreram durante todo o ano, entretanto o maior número de casos foi observado na época chuvosa e início da seca (Fig. 1), confirmando os achados de Costa et al. (1985). Segundo Johnson (1986), neste período os níveis de anticorpos no soro de caprinos são mais baixos do que na época seca. No ano de 1984 as mortes por parsitoses permaneceram baixas e constantes, provavelmente, isto se deve a pouca precipitação pluvial (Fig. 4), ocorrida nos anos anteriores. Por outro lado em 1985 houve maior número de mortes e também um período chuvoso longo e de maior precipitação, confirmando assim as observações de Levine (1968) que considera a precipitação pluvial o fator mais importante na transmissibilidade dos nematódeos. As mortes por parasitose intestinal no período seco, quando as condições ambientais são desfavoráveis para a sobrevivência das larvas na pastagem, devem estar associadas a má nutrição alimentar em consequência da pouca disponibilidade das pastagens neste período, tornando os animais mais suceptíveis a infecção adquirida no final das chuvas e início das secas. O outro fator que contribui para o aparecimento de parasitose no período seco é o estado de prenhez e lactação (Costa, 1983). A faixa etária em que foi verificado maior número de casos de parasitose gastrintestinal, foi de 0 a 12(37,02%) e mais de 49 meses (36,46%) (Tabela 2.)

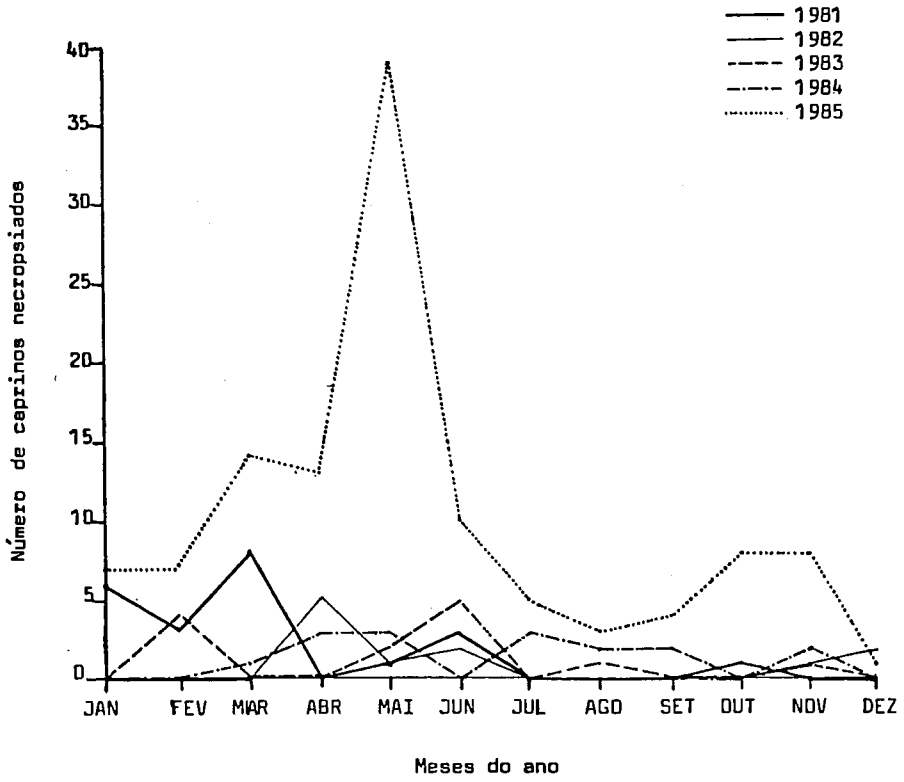

Fig. 1 - Número de caprinos necropsiados com parasitose gastrintestinal, no período de janeiro de 1981 a dezembro de 1985.

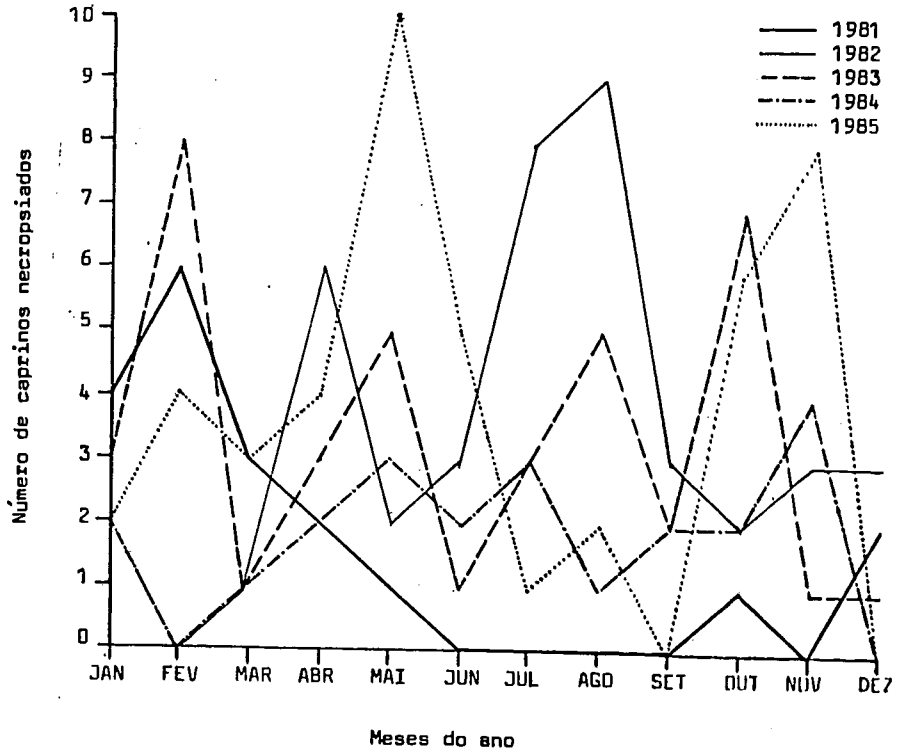

Fig. 2 - Número de caprinos necropsiados com broncopneumonia em caprinos, no período de janeiro de 1981 a dezembro de 1985.

Eimeriose

Nos casos em que foram observados protozoários, as lesões macroscópicas do intestino delgado foram caracterizadas pela formação de hemorragia petequiais, hipertrofia da mucosa e com pequenas formações nodulares de coloração brancacenta. Histologicamente observou-se intensa reação inflamatória constituída por eosinófilos e linfócitos envolvendo a mucosa e submucosa. No epitélio foi observado hiperplasia ou descamação de células e grande número de Eimeria spp em diferentes estágios do ciclo evolutivo.

TABELA 2. Ocorrência de parasitose, broncopneumonia e subnutrição em caprinos de diferentes faixas etárias, no período de janeiro de 1981 a dezembro de 1985, Sobral, CE.

Idade	Necrópsia (%)	Helmintose (%)	Broncopneumonia (%)	Subnutrição (%)
0 - 12 meses	238(48,97)	67(37,02)	77(46,39)	94(67,93)
13 - 24 meses	53(10,90)	26(14,36)	19(11,45)	08(5,76)
25 - 36 meses	46(9,50)	17(9,39)	14(8,43)	15(10,79)
37 - 48 meses	21(4,32)	05(2,76)	09(5,42)	07(5,04)
49 meses	128(26,33)	66(36,46)	47(28,31)	15(10,79)
Total	486	181	166	139

Broncopneumonia

A broncopneumonia foi responsável por 166(22,87%) dos casos de morte nos caprinos do rebanho estudado. A maior percentagem de morte ocorreu no grupo de 0-12 meses (46,39%) e mais de 49 meses de idade (28,31%), confirmando em parte, os achados de Sambyal et al. (1980) e Otesile et al. (1983) que afirmaram ser esta doença mais frequente em animais no primeiro ano de vida. Não foi verificado decréscimo da doença com o aumento da idade, conforme observações de Sambyal et al. (1980). A susceptibiladade dos animais em adquirirem broncopneumonia está associado com o stress do desmame, infecções parasitárias e estado de nutrição.

Na Fig. 2 observa-se que a broncopneumonia ocorreu durante todo o ano, com maior número de casos nos meses de maior precipitação pluvial, ocasionado talvez pelas variações bruscas de temperatura ambiente, exposições a correntes de ar, comumente verificadas neste período. Estas condições são consideradas por Sambyal et al. (1980), Abubarkr et al. (1981) e Lloyd (1982)

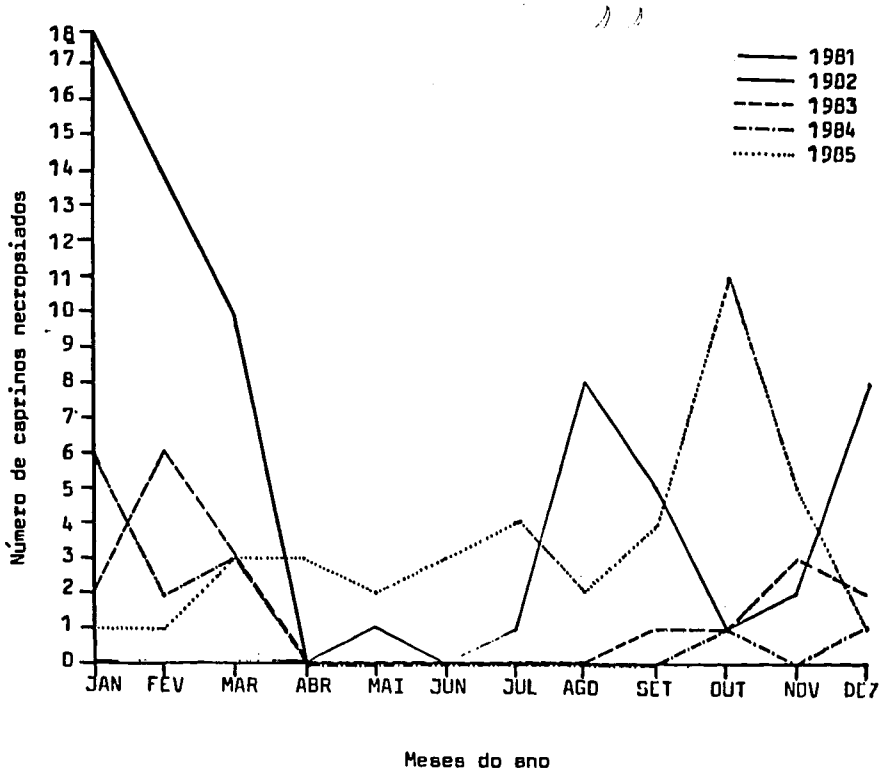

Fig. 3 - Número de caprinos necropsiados com no período de janeiro de 1981 a dezembro de 1985.

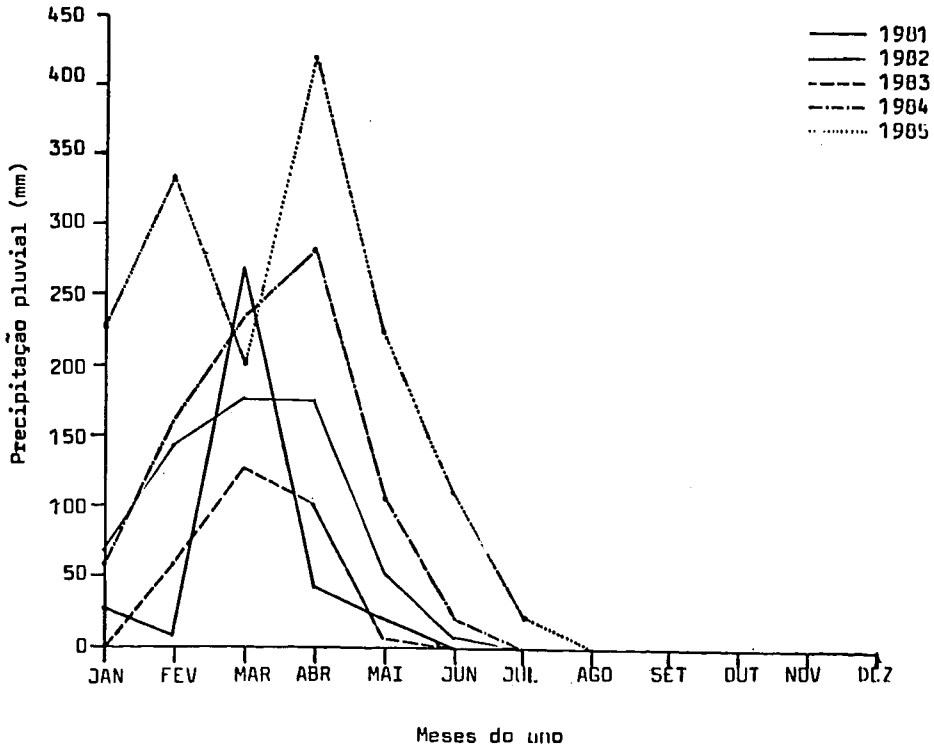

Fig. 4 - Distribuição mensal média de chuvas (mm) no período de janeiro de 1981 a dezembro de 1985.

como causas predisponentes as aparecimento de broncopneumonia na espécie caprina.

As lesões macroscópicas dos pulmões afetados variou desde o aparecimento de áreas de consilodação bem delimitadas, separadas do tecido normal por grupo de alvéolos enfizematosos distribuídos num ou vários lobos pulmonares. Outras vezes as lesões se caracterizaram pela presença de abscessos pequenos e ou grandes, isolados ou múltiplos, distribuídos nos diferentes lobos. Em alguns casos havia, também depósito de fibrina revestindo os lobos afetados e com comprometimento da pleura. Microscopicamente as broncopneumonias foram classificadas de acordo com o exsudato predominante em: supurada (40,28%), catarral (2,54%), fibrinosa (14,71%), fibrinosupurada (5,88%) e por corpo estranho (3,67%).

O resultado do exame bacteriológico de 55 pulmões revelou que a Pasteurella haemolytica (32,60%), Staphilococcos sp (13,42%) foram as bactérias isoladas com maior frequência na broncopneumonia, muito embora outras como Corynebacterium sp (8,90%), Corynebacterium pseudo-tuberculosis (8,69%), Corynebacterium pyogenes (8,69%), Proteus sp (4,35%), Proteus mirabilis (4,33%), Pseudomonas (4,33%), Streptococcos sp (2,17%), Pasteurella sp (2,17%), Moraxela sp (2,17%) e Actinomyces (2,17%), tenham sido cultivados em menor frequência.

Subnutrição

Em nossa região durante os períodos críticos, com escassez de chuvas, faltam alimentos para a sobrevivência dos animais, de maneira que as mortes de caprinos devido a subnutrição é um achado muito comum. No total dos casos estudados, esta contribui em 19,15% sendo considerado a terceira principal causa de morte em caprinos (Tabela 1). As faixas etárias de maior percentagem de morte foram nas de 0 a 12 (67,6%), 25 a 36 (10,79%) e mais de 49 meses de idade (10,79%). Na Fig. 3 observase que as mortes por subnutrição concentraram-se no período de menor precipitação pluvial, onde havia pouca disponibilidade de pastagem. O diagnóstico foi baseado no histórico, no examen clínico nos achado anátomo-histopatológico. Em todos os casos os animais revelaram extrema caquexia, acentuado grau de anemia, ausência do tecido conjuntivo adiposo principalmente nas regiões subcutâneas, sulco das coronárias, mesentéricas e perirenais, além de ascite, hidrotorax e hidroperitôneo. Nos órgãos como fígado, baço e papilas dos pré-estômagos foram constatados hipotrofias. As lesões microscópicas foram caracterizadas por processos degenerativos e regressivos nos diferentes órgãos. As lesões macro e microscópicas foram semelhantes as relatadas por Jubb & Kennedy (1970), Smith et al. (1972) e Santos (1975).

Aneurisma de Artéria Aorta

Aneurisma é a dilatação patológica da artéria em consequência de reação inflamatória, esclerose ou processos degenerativos. Nos equinos é muito frequente o aneurisma verminoso da artéria

mesentérica cranial devido a presença de larva de Strongylus (Smith et al., 1972). Neste trabalho foram diagnosticados dois casos (0,28%) em caprinos adultos da raça SRD, sendo um localizado na aorta caudal e outro na cranial. A necrópsia observou-se acentuada palidez das mucosas naturais, dos órgãos internos e a presença de coágulos nas cavidades. A porção afetada da artéria tinha aproximadamente 10 a 20cm de comprimento, mostrava-se dilatada com formações saculares, tecido necrótico e coágulo. As mortes foram ocasionadas pela perda total do sangue, em consequência da rutura do aneurisma. Microscopicamente havia destruição do tecido epitelial, necrose e infiltração de leucócitos na íntima e muscular da parede do vaso. Esta é a primeira vez que se descreve aneurisma em caprinos no Brasil, embora a etiologia não esteja totalmente elucidada, possivelmente a causa primária tenha sido uma reação inflamatória da artéria.

Melanoma

A ocorrência de neoplasias em caprinos é baixa, quando comparada com as de outras espécies domésticas. A razão disto não se conhece, entretanto acredita-se que deva-se ao fato dos animais serem abatidos muito jovem (Mandal & Singh, 1975). Na Índia a percentagem de neoplasia encontrada em caprinos foi 0,18% enquanto que nos Estados Unidos esta foi de 0,003% (Thomas, 1929; Sastry, 1959; Mandal & Singh, 1975). A percentagem por nós encontrada 0,41% foi mais alta do que as verificadas por estes autores, ocorrendo nos anos de 1983 & 1984. Os tumores descritos no presente trabalho foram classificados anátomo-histopatológicos como melanomas, estando localizados na pálpebra (1), no lábio (1) com metastase no fígado comprometendo 90% do parenquina e na base do chiffe (1). Macroscopicamente a massa neoplásica apresentava-se de aspecto nodular e de coloração negra. Microscopicamente as células tumorais eram arrendondadas ou poliédricas, lembrando células epiteliais, fusiformes e alongadas. O citoplasma era basófilo e contínua na maioria deles grande quantidade de melanina. Os achados anátomo-histopatológicos são semelhantes aos descritos em outras espécies por Jubb & Kennedy (1970) e Smith et al. (1972).

Meningoencefalite

Nas observações realizadas nos 726 caprinos, 9 (1,24%) apresentaram reações inflamatórias no sistema nervoso. Dois destes foram diagnosticados, com base no exame histopatológico, como encefalite micótica. Num dos casos foi detectado no cérebro a presença de Criptococcus sp. Macroscopicamente havia grande formação cística na região frontal direita do hemisfério cerebral. O cisto era constituído internamente por delicadas membranas, limitadas por uma cápsula conjuntiva, contendo no interior uma substância de aspecto gelatinoso. Microscopicamente dentro das cavidades císticas foram observadas estruturas ovoídes, que coradas com hematoxilina e eosina mostraram contornos visíveis, enbora não estivesse presente em todos os microorganismos. Nesta área as circunvoluções cerebrais foram

totalmente destruídas, havendo células endoteliais e linfócitos. O aspecto anátomo-histopatológico foi semelhante ao descrito por Smith et al. (1972). No segundo caso de encefalite micótica o diagnóstico foi confirmado pela presença de hifas na reação inflamatória. Os sete casos restantes, foram histologicamente caracterizados como reação inflamatória supurada com formação de abscessos, localizados no cérebro (2), cerebelo (3) e na fossa hipofisária (1). Somente foi realizado o cultivo bacteriano do abscesso localizado na fossa hipofisária, tendo sido isolado Escherichia coli. Brewer, 1983 descreveu que as bactérias mais frequentes isoladas nestes processos são Staphilococcos, Escherichia coli e Pasteurella.

As inúmeras doenças diagnosticadas neste estudo, indicam a necessidade de projetar-se pesquisa epidemiológica que possibilitem a elaboração de métodos de controle adequado, visando a melhor produtividade do rebanho caprino.

Conclusão

1 - As doenças de maior frequência, diagnosticadas no rebanho estudado foram: parasitose gastrintestinal, broncopneumonia e subnutrição.

2 - Os caprinos jovens (0-12 meses de idade) e os adultos (mais de 49 meses) mostraram-se mais susceptíveis a contrairem parasitose gastrintestinal e broncopneumonia.

3 - Houve uma associação entre o período de maior precipitação pluvial e as ocorrências de parasitose gastrintestinal e broncopneumonia.

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II. PESQUISA PARA MELHORAR O SISTEMA DE PRODUÇÃO ATUAL

II. RESEARCH TO IMPROVE THE PRESENT PRODUCTION SYSTEM

A. MANEJO DE PASTAGENS NATIVAS

A. RANGE MANAGEMENT

RETROSPECTIVA DA PESQUISA EM MANEJO DE PASTAGEM NATIVA NO SEMI-ÁRIDO DO NORDESTE BRASILEIRO

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RESUMO - A pesquisa em manejo de pastagem no nordeste do Brasil teve seu início com o Programa de Colaboração Científica entre a Universidade do Arizona e a Universidade Federal do Ceará em 1964, patrocinado pela USAID. Atualmente a Universidade Federal do Ceará (UFC), Centro Nacional de Pesquisa de Caprinos (CNPC), programa Colaborativo de Apoio à Pesquisa com Pequenos Ruminantes (SR-CRSP), Empresa de Pesquisa Agropecuária do Ceará (EPACE), Departamento Nacional de Obras Contra as Secas (DNOCS), Empresa Pernambucana de Pesquisa Agropecuária (IPA) e Centro de Pesquisa Agropecuária do Trópico Semi-Árido (CPATSA), são as mais importantes instituições que conduzem pesquisa de manejo de pastagem na regiã nordeste. As mais importantes linha de pesquisa incluem: caracterização e identificação de sítio ecológico, métodos de controle de espécies lenhosas indesejáveis, introdução e avaliação de espécies forrageiras, determinação de dietas de animais em pastagem, sistema de pastoreio, pastoreio combinado de bovino, ovino e caprino e determinação de requerimentos nutricionais de pequenos reminantes em caatinga. Provavelmente, a identificação e caracterização de sítio ecológico, como também o seu potencial produtivo e resposta à manipulação de vegetação nativa, é a área de pesquisa que necessita de um esforço mais apurado. De fato, a aplicação dos resultados de pesquisa em pastagem e a validade dos dados dependem de um conhecimento correto das características de sítios e a sua importância para a região.

Termos para indexação: Pastagem nativa, Trópico semi-árido, Manejo.

A SUMMARY OF PAST RESEARCH ON MANAGEMENT OF NATIVE RANGELAND IN THE SEMI-ARID ZONE OF NORTHEAST BRAZIL

ABSTRACT - The research on range management in the northeast of Brazil was started with the scientific collaboration program between the University of Arizona and the Universidade Federal do Ceará in 1964, under the sponsorship of USAID. Presently the Universidade Federal do Ceará (UFC), the Centro Nacional de Pesquisa de Caprinos (CNPC), Small Ruminant Collaborative Research Support Program (SR-CRSP), Empresa de Pesquisa Agropecuária do Ceará (EPACE), Departamento Nacional de Obras Contra as Secas (DNOCS), Empresa Pernambucana de Pesquisa Agropecuária (IPA), and Centro de Pesquisa Agropecuária do Trópico Semi-árido (CPATSA) are the most active institutions conducting range managment research in the northeast region. The most important research lines include: range site identification and characterization, methods of controlling undesirable ligneous

species introduction, and evaluation of forage species, diet determination of range animals, grazing systems, common grazing of cattle, sheep and goat, and determination of nutritional requirements of small ruminants in the caatinga. Probably, range site identification and characterization, as well as their production potencial and response to the native vegetation manipulation, is the research area that needs the strongest effort. In fact, the application of the range research and the validity of the data itself are dependent on the correct knowledge of the site characteristics and its importance for the region.

Index terms: Native rangeland, Semi-arid tropics, Management.

Introdução

O manejo de pastagem nativa tornou-se significante como ciência somente a partir dos últimos 50 anos, primariamente através dos trabalhos do U. S. Forest Service (Bell, 1973). Todavia, seus passos iniciais datam do início do século, com os primeiros trabalhos sobre sucessão vegetal e ecologia de pastagens.

O desenvolvimento e adaptação de técnicas de manejo da caatinga para fins pastoris é muito recente no Nordeste brasileiro. Embora práticas de controle manual da vegetação lenhosa, seguidas da semeadura de forrageiras herbáceas nativas tenham sido testadas extensivamente (Duque, 1973a), foi somente a partir do convênio de colaboração científica entre a Universidade Federal do Ceará (UFC) e a Univesidade do Arizona, firmado em 1964 e financiado pelo USAID, que a vinda de especialista propiciou condições para os primeiros programas em manejo de pastagem nativa, na região Nordeste do Brasil. As primeiras propostas direcionavam a pesquisa para estudos básicos da vegetação da caatinga modificada com o objetivo de favorecer a produção de forragem pelo estrato herbáceo, utilizando-o depois por bovinos.

Neste trabalho, pretende-se apresentar e discutir os programas de pesquisa de manejo da caatinga para finspastorais propostos por diversas instituições, bem como, indicar as áreas em que os trabalhos tem sido conduzido com maior intensidade.

Programas e Prioridades

Com base nas idéias e sugestões dos cientistas da Universidade do Arizona, a UFC, traçou em 1968, seu plano de prioridade de pesquisa em manejo de pastagem nativa, cujas linhas principais se constituem de:

1 - Métodos e técnicas de controle de espécies lenhosas indesejáveis.

2 - Determinaça~o do valor nutrivo e suas variações ao longodo ano da biomassa do estrato herbáceo.

3 - Avaliação do potencial produtivo dos sítios ecológicos mais importantes e das respostas das vegetações às técnicas de manipulação.

4 - Introdução e avaliação de forrageiras exóticas perene em terra seca.

5 - Sistema de pastoreio em pastagem nativa.

Os primeiros trabalhos foram implantados já em 1968, mas foi somente a partir de 1971, que, contando com o apoio financeiro do Banco Nacional de Desenvolvimento Econômico (BNDE) e do Banco do Nordeste do Brasil (BNB), foram estabelecidas quatro áreas de pesquisas em quatro regiões geográficas do sertão cearense, onde foram desenvolvidas pesquisas, segundo as linhas 1, 2, 3 e 4, supracitadas. Posteriormente, em 1975, com o apoio financeiro da SUDENE, o projeto Pastoreio Rotativo-Protelado foi implantado na Fazenda Iracema, em Quixadá. Finalmente, o programa atingiu sua plenitude com o estabelecimento em 1978 do Projeto Pastoreio Combinado Bovino, Ovino e Caprino, na Fazenda Pau-Preto, município de Tauá-Ceará.

Em 1975, o BNB baseado nos resultados preliminares do programa da UFC, iniciou o programa Pró-Pasto com abrangência geográfica no norte e nordeste do Brasil. As linhas de pesquisas contempladas foram:

1 - Introdução e avaliação de forrageiras exóticas para terra seca, com e sem adubação fosforada.

2 - Produção animal e capacidade de suporte com bovinos da vegetaçãoda caatingasob quatro manipulações: nativa, raleada, desmatada e ressemeada-adubada. A semeadura foi feita com capim buffel (Cenchrus ciliarisss) e erva de ovelha (Stylosanthes humilis) e adubação à base de fósforo.

No relatório do Dr. Ray Maxwell Murray, consultor do Instituto Interamericano de Cooperação para a Agricultura (IICA) EMBRAPA em março de 1980, intitulado Necessidade e Prioridade da Pesquisa em Produção de Pastagem e Utilização por Caprinos e Ovinos no Nordeste do Brasil, são propostas linhas de pesquisa para avaliação da caatinga para produção de forragem para pequenos reminantes:

1 - A dieta de caprinos e ovinos pastejando caatinga nativo.

2 - Produção de matéria seca da folhagem de algumas espécies arbustivas palatáveis com base em parâmetros facilmente mensuráveis e época do ano.

3 - O efeito do desmatamento na produção de matériasecado estrato herbáceo e do lenhoso da caatinga.

4 - O efeito da carga animal sobre a produtividade dacaatinga nativa, desmatada e ressemeada.

5 - Estudo do valor nutritivo de algumas espécies arbóreas da caatinga.

6 - Determinação dos requerimentos nutricionais de caprinos para crescimento, prenhês e lactação sob condições de pastoreio nos trópicos.

As linhas de pesquisas ou prioridades enunciadas pelo Dr. Murray coincidem perfeitamente com as contidas no programa de Pesquisa do Centro Nacional de Pesquisa de Caprinos (CNPC), editado em 1981:

1 - Determinação do hábito e preferência alimentar de caprinose ovinos tropicais.

2- Determinaçãoda capacidade de suporte das pastagens utilizadas por caprinos e ovinos.

3- Determinaçãodo valor nutritivo das principais plantas que compõem a dieta animal.

4 - Coleta, identificação, introdução e avaliação de forrageiras nativase exóticas produtivas sob condições ambientais da região.

5- Determinação de métodos de manejo de pastagem adquiridas à criação de caprinos e ovinos.

6- Determinação dos requerimentos nutricionais decaprinos e ovinos na caatinga.

Por fim, o último plano de pesquisa em manejo da caatinga para fins pastoris, foi apontado por pesquisadores do SR-CRSP em 1983, constando das sequintes linhas:

1- Determinação da dieta estacional de pequenos ruminantes na caatinga.

2- Determinação do suprimento anual da forrageme ciclo de decomposição.

3 - Determinação dos sítios ecológicos com base em parâmetros edáficos.

4 - Controle de arbustos e estratégia de manipulação.

Todos os planos e programas de prioridades e linhas de pesquisa expostas têm muitos pontos de coincidência, havendo no entanto, pequenas diferenças, em função, principalmente, do tipo de animal a ser explorado ou de um melhor detalhamento dos conhecimentos procurados. Na realidade, há uma complementariedade entre os diferentes programas resultantes,

provavelmente, do aparecimento dos conhecimentos adquiridos a partir dos resultados das primeiras pesquisas.

Resultados Alcançados

A pouca literatura existente, resultado das pesquisas conduzidas nos últimos 18 anos em pastagem nativa dificulta, de sobremaneira, a montagem de um esboço geral dos resultados obtidos até agora, com a consequente identificação das linhas ou áreas não pesquisadas. Todavia, erá feita uma tentativa de apresentação e discussão dos dados, ressaltando que as informações não mencionadas serão prazeirosamente recebidas e, na certa, enriquecerão este relato.

Zoneamento ao nível do sítio ecológico - Esta constitui, provavelmente, a linha de pesquisa mais importante, pois fornece a base para as demais. A escolha da área para pesquisa na caatinga, sua significância em termos regionais, bem como, a extrapolação dos resultados alcançados só podem ser conduzidas com confiabilidade se fundamentadas na identificação e caracterização dos sítios ecológicos que perfazem o mosaico da paisagem da caatinga nordestina.

A região nordestina e o trópico semi-árido, em particular tem sido objeto de várias tentativas de zoneamento para fins diversos. Em geral o nível hierárquico da unidade de classificação tem sido tão elevado a ponto de não permitir aplicações na adaptação de resultados de pesquisa. Duque (1973b), utilizando-se do índice de aridex (chuva: evapotranspiração) identifica e caracteriza 10 regiões no Nordeste, aqui apresentadas na ordem decrescente de aridez: Seridó, Sertão, Caatinga, Cariris Velhos, Curimataú, Carrasco, Cerrado, Agreste, Serras e Matas. Souza et al. (1979), apresentaram uma compartimentação topográfica do Estado do Ceará, identificando e caracterizando nove unidades: planície litorânea, tabuleiros sublitorâneos, depressão sertaneja, chapada do Apodi, chapada do Araripe, planalto da Ibiapaba, maciços residuais cristalinos, cristais residuais e inselbergs e planíceis fluviais.

Potencial produtivo de sítios do semi-árido - Afora um estudo preliminar conduzido no sertão cearense (Araújo Filho et al., 1982), nenhum outro trabalho foi publicado especificamente sobre o assunto. Foram determinados, ao longo de um período de três anos as flutuações mensais das produções de biomassas, seu teor em proteína, bem como, a resposta da vegetação herbácea a métodos de controle de espécies lenhosas em quatro sítios ecológicos do sertão, isto é, tabuleiro, carrasco, caatinga sucessional, e caatinga virgem.

Manipulação da vegetação lenhosa - Várias pesquisas foram executadas e estão em fase de execução, testando métodos de controle de espécies lenhosas. Métodos químicos (herbicidas), mecânicos, manuais e píricos tem sido utilizados e os resultados

publicados em diversos artigos. Pode-se afirmar que existe informações úteis sobre a resposta de várias espécies lenhosas aos métodos, a eficiência de vários herbicidas localmente disponível, bem como, os efeitos do controle de arbustos e árvores sobre a produtividade do estrato herbáceo. Além disso, técnicas de manipulação da vegetação lenhosa, tais como, o desmatamento, o raleamento e o rebaixamento, foram avaliadas sob pastoreio.

Introdução e avaliação de forrageiras em terra seca - As pesquisas de avaliação de forrageiras especificamente para terra seca, começaram em 1969 na Fazenda Experimental do Vale do Curu da UFC, onde tiveram lugar as primeiras introduções de diversas cultivares de capim buffel no Ceará. Várias instituições executam trabalhos nesta área, destacando-se a UFC, EPACE, ENPC (BAG-Forrageiras), DNOCS, IPA e CPATSA. A difusão e adoção do uso de forrageiras pelos criadores, técnicos, tais como o capim buffel, a leucena e a cunhã, são os resultados mais palpáveis do esforço da pesquisa nesta área.

Determinação da dieta de pequenos ruminantes na caatinga - O pioneirismo da experimentação na composição da dieta dos ruminates no Nordeste com o uso de animais fistulados cabe ao CNPC, que contou com a colaboração decisiva de cientista do convênio SR-CRSP/EMBRAPA. Os trabalhos de Pfister (1983), Kirmse (1984) e Mesquita (1985), forneceram importantes subsídios no aprimoramento da identificação das forrageiras nativas mais importantes da caatinga, bem como, sua participação em bases estacionais na composição das dietas de ovinos e caprinos. Esses resultados contribuirão decisivamente para o aperfeiçoamento das estratégias de manipulação da vegetação lenhosa nativa, objetivando melhorar qualitativa e quantitativamente a oferta de forragem aos animais. Atualmente, o IPA, a UFC e o CPATSA são instituições que desenvolvem, também no Nordeste, pesquisas com determinação de dieta de ruminantes utilizando-se além de animais fistulados, técnicas microhistológicas de análise fecal.

Determinação de capacidade de suporte de caatinga - É, talvez, uma das linhas dos programas que conta com o maior número de projetos. O DNOCS, o Pró-Pasto, a UFC, o IPA e o CPATSA trabalharam principalmente com bovinos na caatinga nativa, manipulada e ressemeada. Já o CNPC e a EPACE, conduziram pesquisas com pequenos ruminantes. Vale ressaltar que os resultados obtidos têm sido idênticos para diversas áreas do semi-árido nordestino e apontam 10-12 ha/cab/ano para bovinos e 1,0-1,5 ha/cab/ano para ovinos e caprinos em caatinga nativa, na rebaixada os valores são 3-4 ha/cab/ano para bovinos, 1,0-1,5 ha/cab/ano para ovinos e 0,3-0,5 ha/cab/ano para caprinos, na raleada, 1,5-2,0 para bovinos, 0,1-0,5 ha/cab/ano para caprinos e ovinos e na ressemeada, 1,0-1,5 ha/cab/ano para bovinos, 0,3-0,5 ha/cab/ano para ovinos e caprinos.

Sistema de Pastoreio - Geralmente o pastoreio contínuo é o sistema mais comumente utilizado na experimentação com animais em área de caatinga. No entanto, a UFC com bovinos e a EPACE com

caprinos e ovinos testaram sistemas de pastoreio rotativo-protelado, utilizando-se de três a quatro divisões por pasto. Os resultados da UFC, após seis anos de trabalhos e a EPACE com iqual período não parecem indicar diferenças, quer no tange a resposta da vagetação, quer com respeito ao desempenho dos animais e da pastagem.

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FACTORS AFFECTING THE SPROUTING OF WOODY CAATINGA SPECIES AND IMPLICATIONS FOR IMPROVED FORAGE PRODUCTION

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ABSTRACT - Since settlement, caatinga vegetation has been subjected to cycles of slash and burn agriculture and wood harvesting with limited understanding of potential forage and wood resource effects. This study was conducted to determine the effects of season of cutting on the coppicing ability of selected tree species in a regenerating stand of caatinga vegetation. A homogeneous stand of mature caatinga was selected in 1982 at Fazenda Iracema and portions were periodically cleared through one dry/wet season cycle. A randomized block design was used with three blocks and four treatments of season of cutting. Production of leaf and stem biomass from coppice shoots of three common trees were estimated using a destructive harvest method. Sabia (Mimosa caesalpiniaefolia) and marmelelro (Croton hemiargyreus) shared a distinctive pattern of response. Significant differences ($P<.05$) occurred between only two of the four treatments. The mid-dry season and early wet season treatments yielded similar results, as did the early dry season and late wet season. Cutting during the mid-dry season or early wet season resulted in greater above ground biomass production than cutting in the early dry season or late wet season. Catingueira (Caesalpinia pyramidalis) showed no significant difference in production regardless of when the tree was cut. These results suggest that season of cutting could be used to affect forage production and relative species composition of the woody flora.

Index terms: Coppice, Mimosa caesalpiniaefolia, Croton hemiargyreus, Caesalpinia pyramidalis.

FATORES AFETANDO A REBROTA DE ESPÉCIES LENHOSAS DA CAATINGA E IMPLICAÇOES PARA O AUMENTO DA PRODUÇÃO DE FORRAGEM

RESUMO: Desde a colonização, a vegetação da caatinga tem sido submetida a ciclos de agricultura itinerante e colheita de madeira, sem que se analize os efeitos sobre o potencial de produção de madeira e forragem da vegetação. Este estudo foi conduzida para determinar os efeitos da estação do corte sobre a capacidade da rebrota de espécies arbóreas selecionadas em um piquete de vegetação da caatinga, em estágio de regeneração. Um piquete homogênio da caatinga foi selecionado em 1982, na fazenda Iracema, e porções deste piquete foram periodicamente raleadas durante um ciclo da estação seca/chuvosa. O desenho esperimental utilizado foi o de blocos completos cazualizados, com tres blocos e quatro tratamentos de estação de corte. A produção de biomassa oriunda de folhas e talos da rebrota de três espécies arbóreas comumente encontradas na caatinga, foi estimada, utilizando um método de coleta destrutivo. Sabiá (Mimosa caesalpiniaefolia) e

marmeleiro (Croton hemiargyreus) apresentaram um padrão de resposta distinto. Diferenças significantes ($P<0,05$) ocorreram somente entre dois dos quatro tratamentos. Os tratamentos de corte na metade da estação seca e começo da estação chuvosa produziram resultados similares, como foram também similares os tratamentos de corte no início da estação seca e ao final da estação chuvosa. O corte durante a metade da estação seca ou no início da estação chuvosa, proporcionou uma maior produção de biomassa do que quando os cortes foram realizados no início da estação seca ou final da estação chuvosa. A catingueira (Caesalpinia pyramidalis) não apresentou diferenças nas produções de biomassa em qualquer dos tratamentos estudados.

Estes resultados sugerem que a época de corte da vegetação da caatinga pode ser usada como uma maneira de afetar a produção de forragem e a composição relativa das espécies arbóreas da caatinga.

Termos para indexação: Rebrota, Mimosa caesalpiniaefolia, Croton hemiargyreus, Caesalpinia pyramidalis.

Introduction

Seasonal fluctuations in forage supply have been recognized as a major constraint to livestock production in Northeast Brazil (Huss, 1976; Ogden, 1980). Among the four technical objectives of the range component of the CRSP when it began was "brush control and manipulation". This emphasis was included on the assumption that control of undesirable woody species would reduce resource competition with desirable forage species.

The desirability of the caatinga vegetation varies with the use one wishes to make of the land. In an undisturbed state, caatinga woodlands stablize the shallow soil, the leaf litter protects the soil surface, and adds some nutrients, and the vegetative cover may moderate the understory microclimate. The caatinga is an important source of fuelwood, construction materials and a variety of other materials used locally (Braga, 1960). However, intact stands produce relatively little for man compared to cultivated plots. Since settlement, the landscape has been subjected to cycles of slash and burn agriculture. In the mixed farming tradition of the Northeast, animal agriculture is combined with production of food and fiber crops. Livestock use whatever native range is available, as well as crop aftermath, by-products, cultivated forages and prepared supplements. Cattle and sheep are the most profitable livestock, but they do not do well on uncleared caatinga ranges. Goats, which are considered hardier under caatinga conditions, are not raised as a major economic product (Primov, 1985). Cleared caatinga which is either regenerating, or maintained as a herbaceous pasture is often considered to be superior to uncleared caatinga for grazing livestock, hence the interest in brush control. (Primov, 1984).

The Northeast is typical of semi-arid areas of the world that are dominated by woody plant species. Attempts by agriculturalists to permanently control woody plants in such regions have generally been unsuccessful, except in parts of India. However, the desirability of traditional brush control in the caatinga is questionable. Diet studies (Pfister, 1983) brought some assumptions into question. Among sheep and goats grazing uncleared caatinga during the dry season, the fallen leaves of some woody species were the primary food item. These leaves appeared to have high enough protein levels to sustain the animals when energy was sufficient. Later studies, looking at dry season diets on cleared and uncleared caatinga (Kirmse, 1984), further emphasized the role of woody species for forage. Clearly, at least some of the woody caatinga species constituted an important dry season forage resource.

As small farmers rarely clear land solely for range improvement, it may be unrealistic to design treatments which have this as the first consideration. However land clearing will continue for agriculture, wood harvest, etc., and it is reasonable to look at how these traditional practices might be modified to improve forage production by the regenerating stand. Manipulation of sprouting stumps is one such modification. If the factors which influence sprouting were understood, then this growth could be manipulated to favor production of those species and growth forms considered most desirable.

Foresters in temperate regions concerned with regenerating trees as efficiently as possible have for centuries manipulated sprouting species to achieve their objectives. This is known as coppicing. A review of brush management techniques used throughout the semi-arid tropics (Howell, 1981) points out that the capacity to sprout following injury is a major obstacle to brush control. In range management we have rarely been concerned with encouraging sprouting and tend to use the word in a negative sense. However, the ability to sprout has obvious survival value for the plant, and properly manipulated, may be a key to more successful management. For this reason, I generally prefer to use the word coppice, with its more positive connotation.

The literature on coppicing of temperate tree species is fairly clear on what factors affect sprouting: the size and age of the tree, the number of times it has sprouted, its species and ecotype, the height of the stump, the season in which it is cut, and any degree of pruning of the regrowth (Hardesty, 1981; Blake, 1983). There is very little information however on coppicing of tropical trees and shrubs, nor is there much in the way of explanation of the actual mechanisms which control sprouting.

Studies were designed to ascertain if the factors known to influence the coppicing of temperate trees also operated in the caatinga. A study of the effect of season of cutting on coppicing ability is described below.

Materials and Methods

The study was conducted at Fazenda Iracema. This area is 4 degrees south of the equator, where day length and temperature are uniform year-round. Rainfall is the only major climatic variable. The average annual rainfall is 800mm in a 4 month period, but during the study, it ranged from 393mm in 7 months, to 769mm in 5 months. Soil moisture is limited by soil depth, usually less than 50cm, and the fact that soils are underlain by crystalline rock (Camargo, 1965). These soils are low in organic matter and highly erodible when exposed or disturbed. The most common soil great groups are alfisols, entisols, and oxisols (Beek & Bramao, 1968).

The caatinga in this region is fairly dense (23,000 stems/ha), and reaches 6-8m high at maturity. The understory, when present, consists mostly of annual forbs and a few annual grasses. The woody flora is dominated by legumes. The species selected for study were among the most common, not only on the Fazenda, but throughout the region. Sabiá (*Mimosa caesalpinaefolia*) and catingueira (*Caesalpinia pyramidalis*) are important forage species, also used for wood products. Marmeleiro (*Croton hemiargyreus*) is a woody invader with limited forage or wood value.

A homogeneous stand of mature caatinga was selected for study. A randomized block design was used, blocking on topographic trend and minor changes in species composition. Each treatment was applied to one plot in each of the 3 blocks.

Six trees of each of the three species studied were selected in a plot. These trees were within the median diameter class for the stand and showed no sign of injury or disease. Selected trees were identified by numbered aluminum tags wired to the base. The height, diameter at breast height, diameter at 30cm, and number of basal sprouts were recorded for each tree prior to cutting. The date of the seasonal treatments was determined by the rainfall pattern. Because trees are normally cut in the mid-dry season, this date was considered the control treatment. The early dry season plots were cut in July, 1982, mid-dry season plots were cut in November, 1982, the early rainy season plots in late January, 1983, and the late wet season plots in May, 1983.

Treatment consisted of traditional land clearing by commercial woodcutters using axes and brushhooks. All woody plants were clearcut, the usable wood removed, and the slash piled away from the stumps being studied. Normally this material would be burned. The trees being studied were cut at a standard 30cm height. Plots were protected from grazing and left undisturbed until one full growing season had passed.

In August of 1984, all coppice growth was harvested. Sprouts were cut from their point of origin on the stump, separated into leaf and stem fractions, oven dried at 65° C for 48 hours, then weighed.

Analysis of variance was used to test for treatment differences in stem, leaf, and total biomass production, as well as leaf/stem biomass ratio.

Results

An analysis of variance using species and treatment as well as blocking and subsampling as factors revealed different patterns of response to the seasonal cutting treatments for different species, and it was decided that separate analyses for each species would provide more information.

The changes in biomass production with season of cutting were consistent between the stem and leaf fractions, but because so much more stem material was produced, this tended to dominate the total production variable. In no case did the leaf/stem biomass ratio of a species vary, regardless of the treatment. Leaf material is more subject to loss or damage during collection, or from storms or insects than stem material, so stem biomass production was selected as the single most reliable variable to examine.

The season of cutting did not affect subsequent biomass production of all species. Catingueira showed no significant difference ($P>.05$) in production leaf, or stem material regardless of when the tree was cut.

Sabiá and Marmeleiro shared a distinctive pattern of response (Table 1). Significant differences occurred between only two of the four treatments. The mid-day season and early wet season treatments yielded similar results, as did the early dry season and late wet season. Cutting during the mid-dry season or early wet season resulted in greater above ground biomass production than cutting in the early dry season or late wet season.

Discussion

This study was designed as a survey to determine which factors, if any, affecting the coppicing of temperate trees also affect the coppicing of tropical species in the caatinga. Although the study was not designed to test hypotheses regarding the cause of any differences or similarities, some cautious speculation may be valuable.

Temperate trees tend to produce the greatest coppice growth when cut during the dormant season, which corresponds to the dry season in the semi-arid tropics. Two of the three species studied in the caatinga produced the greatest coppice growth when cut late in the dry season or early in the rainy season. When a tree is leafless, it still has a continuing demand for energy for respiration and leaf renewal. This is true even if a major

TABLE 1. Mean dry weight stem production (grams) by species and season of treatment.

Season of cut	Sabiá	Marmeliero
Early dry	1024 a b	318 b
Mid-dry	1375 a	532 a
Early wet	1162 a	494 a
Late wet	488 b	233 b

Values within a column followed by the same letter are not significantly different at the .05 probability level as determined by Fisher's LSD test.

portion of its biomass is removed by cutting. Most non-structural carbohydrates in trees are stored in the above ground woody material (Kramer & Kozlowski, 1960). When a tree is cut, the stump is forced to depend on the reserves in the stump and roots. How long the stump must depend on these limited resources before new leaves are produced becomes a critical question. In this study subsequent above ground biomass production declined as the period of dependence lengthened (Table 2).

TABLE 2. Relationship between coppice biomass production and the time between cutting and resumption of growth.

Response	Season of cut	Months until rains
High	Mid-dry	1
High	Early wet	0
Low	Late wet	7
Low	Early dry	5

Desirable trees should be cut late in the dry season, or early enough in the rainy season to allow time for the tree to coppice and accumulate sufficient reserves for the coming dry season. Cutting late in the rainy season does not allow time to replenish the lost carbohydrate store and would be preferred for undesirable species.

Selective cutting in which desirable species were cut late in the dry season or early in the rainy season, and the least desirable species were left until late in the rainy season would

be one way to influence coppice growth. This could be used to affect species composition and forage production in the regenerating stand. However, there may be a conflict when rainy season cutting is preferable because most available laborers are occupied planting and weeding food crops.

In an environment where water is limiting, it might be supposed that the availability of water could be important in explaining the effect of season of cutting on coppice production. Available soil moisture declines throughout the dry season and increases as the rains begin. Cutting late in the dry season affects the tree when available moisture is most limited, yet this is when a greater biomass response can be expected. Cutting late in the rainy season, when moisture is most available results in less total biomass production. The main role of moisture in this seems to be in defining the growing season, or the number of months which a stump must survive on limited reserves.

The fact that catingueira did not show any variation in coppice production with the season of cutting also stimulates some speculation. This species is widely distributed in many different types of caatinga. It is present in all seral stages of a developing stand. It is also one of the first species to produce leaves when the rains begin, and it tends to hollow out with age. Why would this species be less dependent on carbohydrates stored in the stump and roots than the other two? There are several possibilities. The first is that some other factor limits its growth before carbohydrates become limiting. If not this, then perhaps the roots and base of catingueira have more that the usual amount of carbohydrate storage, or perhaps this species is somehow more efficient than the others, such that it is less likely to seriously deplete its reserves even during a long dry season. One other possibility is that catingueira is able to become self-supporting more quickly than the other species once the rains begin. It does leaf out rapidly and might be able to meet all of its metabolic demands with new photosynthate more quickly than other species if they continue to rely on reserves for a period of time after growth has begun. It is possible that this affects leaf production early in the season which then influences total production for that season. Whatever the answer, it appears that catingueira has some unusual strategy for dealing with injury and maintaining itself in the stand.

Leaves are the major browse component although some twigs, fruits and flowers may be eaten (Pfister, 1983). The fact that leaf/stem ratios do not change suggests that the only way to increase total forage production is to increase total growth. Managing for maximum total growth of browse species insures that they will soon (two years) grow out of the reach of browsing sheep and goats. This means that the dry season forage supply is safely out of reach of feeding animals during the rainy season when herbaceous forages, which do not cure well, are abundant. This constitutes a sort of natural storage system. The next step would be to follow biomass production of a regenerating stand to determine at what point production of desirable forage is

maximized and when re-treatment may be needed to insure an adequate supply of quality dry season forage and usable wood products.

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RESPONSE OF CAATINGA VEGETATION TO DECREASING LEVELS OF TREE CANOPY COVER

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ABSTRACT - Although clearing of the caatinga forest is conducted primarily to open areas for crop production and to harvest wood, vegetation manipulation is being promoted as a means of increasing forage availability to livestock. Response of caatinga vegetation to various levels of canopy cover removal is being studied in two experiments at the CNPC, Sobral, Ceará. Complete removal of the tree canopy resulted in a six to eightfold increase in first year production of herbaceous vegetation. This magnitude of increase was also true for canopy covers of 20-30% and 50-60%. Caatinga species coppice readily following cutting and, therefore, canopy cover for the cleared treatment (complete removal) was equal to that of the control (approximately 95%) by the end of the fourth year posttreatment. As a result, herbaceous vegetation and leaf litter yields for the two treatments were similar, too. Sabiá (*Mimosa caesalpiniaefolia*), a tree species which produces palatable browse and valuable wood, responded very favorably to clearing. Not only did many new plants establish, but by the fourth year posttreatment sabiá coppice on the cleared areas produced as much as 10 times more foliar biomass than did the intact trees on the control. The high herbaceous vegetation yields under a thinned canopy and the favorable responses to cutting of such desireable tree species as sabiá, indicate that a multiple use approach involving selectively thinned caatinga could be developed whereby production of the naturally renewable wood and forage resources would be optimized.

Index terms: Caatinga vegetation, Vegetation manipulation, Coppice, *Mimosa caesalpiniaefolia*.

RESPOSTA DA VEGETAÇÃO DA CAATINGA A VÁRIOS NÍVEIS DE RALEAMENTO

RESUMO - Muito embora o desmatamento da caatinga seja conduzido visando principalmente a abertura de novas áreas para produção de alimentos e para utilização da madeira, a manipulação da mesma está sendo indicada como uma maneira de aumentar a disponibilidade de forragem para produção animal. A resposta da vegetação da caatinga a vários níveis de desmatamento está sendo estudada em dois experimentos no Centro Nacional de Pesquisa de Caprinos em Sobral, Ceará. A remoção total da copa das árvores produziu um aumento de seis a oito vezes na produção do estrato herbáceo durante o primeiro ano. Esta mesma intensidade de resposta foi obtido com a manutenção dos níveis da copa das árvores entre 20-30% e 50-60%. O rebrote e regeneração das espécies cortadas foi rápido, e o nível de cobertura da copa para o tratamento com desmatamento total foi praticamente igual (aproximadamente 95%) ao das áreas não desmatadas (controle) quatro anos após o desmatamento. Como resultado dessa

regeneração, a produção de biomassa do estrato herbáceo, bem como a produção de folhas das árvores também foram similares entre os dois tratamentos. A resposta de sabiá (Mimosa caesalpiniaefolia), que produz forragem palatável e madeira de boa qualidade nas condições da caatinga, foi bastante favorável ao desmatamento. O desmatamento não somente favoreceu o estabelecimento de novas plantas, como também a produção de biomassa originando-se do rebrote das áreas desmatadas foi cerca de dez vezes superior à produção das ávores da área contrôle. A alta produção do estrato herbáceo durante o primeiro ano, bem como a resposta de espécies desejáveis como sabiá ao desmatamento, indicam que a utilização de um sistema de raleamento seletivo da caatinga pode ser desenvolvido, onde a produção de recursos naturais renováveis tais como madeira e forragem, poderiam ser maximizados.

Termos para indexação: Vegetação caatinga, Manejo de caatinga, Rebrote, Mimosa caesalpiniaefolia.

Introduction

The heterogeneous caatinga vegetation type of Northeast Brazil is composed of multiple-stemmed, deciduous trees and shrubs with an understory of annual forbs and grasses. In terms of goat and sheep production, the caatinga generally serves as the year-around forage resource. Herbaceous plants supply the bulk of the forage consumed by free ranging goats and sheep during the wet season. As the dry season progresses, herbaceous vegetation availability becomes limiting and the dried leaves of the deciduous trees become an important diet component. By the end of the dry season, these dried tree leaves may compose as much as 70% of a goat's or sheep's diet (Pfister, 1983; Kirmse, 1984).

Dense stands of trees greatly limit herbaceous production (Araujo & Gadelha, 1984; Kirmse, 1984) probably due to low levels of light reaching the forest floor. Most of the system's herbage production, in the form of tree leaves, is out of reach of browsing livestock during the wet season. Nearly all of these leaves, however, become available to livestock during the dry season when the leaves are shed. This material is commonly referred to as leaf litter. Several of the tree species do not produce palatable browse and, therefore, much of a year's leaf production goes unutilized by livestock.

Defining a "typical" stand of caatinga vegetation is not possible, and more than likely is a moot point due to the extreme heterogeneity of edaphic, climatic and cultural factors found in the Northeast. For the purposes of this paper, the focus will be on human induced factors, more specifically, how the commonly used vegetation manipulation practices have influenced the caatinga and possible roles vegetation manipulation may have in caatinga management.

As in many other tropical woodland and forest regions, clearing caatinga is normally conducted for agronomic purposes. Termed slash-and-burn cultivation, field preparation involves hand-clearing of suitable areas of woody plants, stacking and removing marketable wood and burning the slash. This operation is conducted during the dry season with the follow-up burning treatment being a spotty but general fire covering as much of the cleared area as possible. Size of the cleared areas is usually relatively small (less than 5ha) due to intensive labor requirements (Queiroz, 1985).

A less common practice is to clear forest stands for the harvest of marketable wood as well as for grazing management purposes (Primov, 1984; Queiroz, 1985). Clearing for these purposes is generally conducted in mature, relatively dense stands of caatinga. In such cases, offtake of marketable wood is sufficient to cover labor and transport costs. Also elimination or re-reduction of a dense tree canopy greatly increases herbaceous production and, therefore, forage availability during the wet season. Where areas are being cleared for grazing purposes, the slash is burned in order to eliminate its potential effects on livestock movement and herbaceous production. The slash, however, is piled in order to localize the effects of fire.

Selective wood harvesting is also a common practice. When needs for fence posts or construction materials arise, the desired trees are selected and cut. This sporadic and spotty harvest may appear to have little serious effect on the system but it may be substantially modifying relative species composition.

Since caatinga manipulation is an integral part of land use or exploitation in the Northeast, caatinga vegetation responses to various levels of tree canopy removal were studied.

Materials and Methods

Two related studies concerning vegetation responses to manipulation are being conducted at the CNPC, Sobral, Ceará. Generally the soils of the study sites are relatively shallow Red and Yellow Podzols with some Non-Calcic Brown soils. Bedrock is of precambriam origin. Topography is gently undulating with both well drained and poorly drained areas present. Vegetation cover of the area is a mature, dense stand (95% canopy cover) of many of the plant species typical of the caatinga of northern Ceará. Principle tree species on the study area are pau branco (*Auxemma oncocalyx* Taub.), sabiá (*Mimosa caesalpiniaefolia* Benth.), catingueira (*Caesalpinia pyramidalis* Benth.), marmeleiro (*Croton hemiargyreus* Muell. Clrg.), mororó (*Bauhinia forficata* Link) and mofumbo (*Combretum leprosum* Mart.) Important annual herbaceous plants include *Hyptis* spp., *Bainvillea* spp., *Phaseolus* spp. and jitirana (*Ipomoea* spp). Dominant annual grasses are *Paspalum* spp., *Panicum* spp. and *Brachiaria mollis*.

A 6.5ha site was selected during the 1981 dry season with the objective of comparing vegetation responses to clearing. For the remainder of the paper, this study will be referred to as experiment 1. Prior to the rains of 1982, the site was divided into three blocks and half of each block was cleared and fenced. After the marketable wood was removed, the slash was piled and burned. All grazing was excluded from the vegetation sampling areas for the duration of the study.

In the dry season of 1984, another nearby site was located in order to compare vegetation responses to various levels of tree canopy removal. Hereinafter this study will be referred to as experiment 2. Four treatment levels were designated: 1) clearing or 0% tree canopy cover; 2) thinning to a 20-30% tree canopy cover; 3) thinning to a 50-60% tree canopy cover; and 4) control or 95% tree canopy cover. The 8ha study site was divided into two blocks based on vegetation and related soil differences. Within each block, the four 1ha plots were randomly allocated to one of the four treatments. All woody plants were cut on the designated cleared plots. For the 20-30% and 50-60% cover treatments, all woody species which produce nonpalatable foliage (to sheep and goats) were cut. To attain the desired 50-60% cover, very few trees which produce palatable foliage were cut and the final tree density was approximately 670 trees/ha. A significant number of such trees were cut on the 20-30% cover plots as reflected in the final tree density of about 385/ha. For all treatments, marketable wood and large slash material were removed from the site. The remaining slash (10,000 kg/ha) was not burned but left evenly distributed over the sites. Stumps of the cut trees did not receive further treatment.

Vegetation responses measured were:

1. Percent cover of coppicing woody plants on the manipulation, or reduced cover, treatments was estimated using the line intercept method. Cover estimates were made in May 1984 and May 1985 for experiment 1 and in June 1985 for experiment 2.

2. Sampling for peak herbaceous standing crop was conducted at times of flowering of major forb species in May 1982, May 1984 and May 1985 for experiment 1 and May 1985 for experiment 2.

3. Leaf litter biomass and composition were estimated shortly following leaf fall for most of the woody plants in the dry seasons of 1982, 1984 and 1985 for experiment 1 and in 1985 for experiment 2.

4. Coppice production was also estimated for the manipulation treatments in experiment 2 in August 1985. Within eight quadrats (4m x 25m) per treatment all coppice foliage was hand-harvested by species and subsamples were ovendried and weighed.

5. In experiment 1, the increased prevalence of sabiá, during the regeneration of cleared caatinga was studied. In June 1985, the density of sabiá seedlings was estimated using a quadrat method

and a volumetric procedure was used to estimate foliar biomass per seedling. The resulting foliar biomass/ha value was then subtracted from total sabiá leaf litter biomass, obtained from the dry season leaf litter harvest, to yield a figure approximating coppice foliar production.

Results

Year-to-year variation in rainfall was high during the period of these studies (Figure 1). Relative to Sobral's 22 year average of 805mm, annual precipitation measured on the study site ranged from 450mm in 1983 to 1800mm in 1985. In 1985, 1630mm of precipitation was recorded during the growing season, January through May.

First Year Posttreatment Responses to Manipulation

All levels of tree canopy removal responded similarly the first year following manipulation in terms of peak yields of herbaceous vegetation. In experiment 1, removal of the woody canopy resulted in a sixfold increase in standing herbaceous vegetation (Table 1). In experiment 2, all treatment levels resulted in a seven to eightfold increase in herbaceous vegetation yields when compared to the control (Table 2). There were no significant differences in yields between the three manipulation treatments. A major portion of the increased herbaceous vegetation production on the manipulation treatments for both experiments 1 and 2 was in the form of stem biomass. With a common leaf:stem ratio of approximately .5, two-thirds of the herbaceous vegetation production was in the form of stems for all manipulation treatments.

Total leaf litter biomass, including both the dead herbaceous plants and dried leaves of woody plants, was similar for all treatments within experiments 1 and 2 (Tables 1 and 2). Biomass of dried leaves of woody plants, however, was significantly ($P<.05$) higher on the control than on the treated plots for both experiments 1 and 2. It should be noted that in experiment 2, the dominant coppice species retained a portion of their leaves (visual estimate: 10-20% by weight) to the end of the 1985 dry season. Therefore, woody plant leaf litter biomass and total leaf litter biomass determinations for the manipulation treatments in experiment 2 are underestimated.

Total foliar production from coppice was similar for the cleared (1131 kg/ha) and 20-30% cover (1029 kg/ha) treatments but the coppice foliar yield was significantly ($P<.05$) lower for the 50-60% cover treatment (497 kg/ha) than for the other two. The high foliar biomass estimate for the 20-30% cover plots may have been due to some unusually large pau branco coppice shoots that happened to fall within the quadrats.

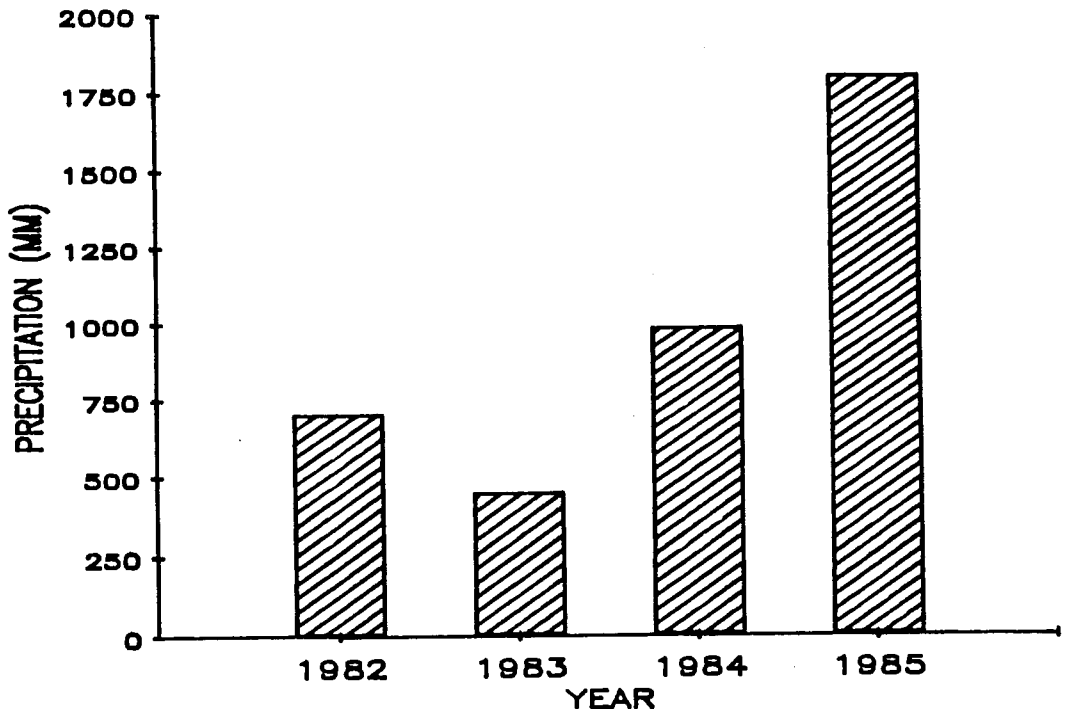

Figure 1. Annual precipitation on the study site for the experimental period, 1982-1985. The 22 year average (1964-1985) in Sobral, Ceara', is 805 mm.

TABLE 1. Peak herbaceous standing crop ($kg.ha^{-1}$) in May 1982, 1984 and 1985 and woody plant leaf litter and total leaf litter biomasses ($kg.ha^{-1}$) in early December 1982, 1984 and 1985 for the cleared and control treatments in Experiment 1.

	May		December			
	Herbaceous		Woody Leaf Litter		Total[1]	
	Cleared	Control	Cleared	Control	Cleared	Control
1982	3412a	564b	1077a	2715b	2532a	2897a
1984	1234a	508b	2660a	2652a	3413a	3113a
1985	202a	141a	3342a	2807a	3428a	2999a

[1]Includes all current year's production of vegetal material found on the forest floor in early December: seeds and leaves of woody plants as well as dead herbaceous plants.

[ab]Means in the same row and in the same vegetation type category, followed by a different letter, are significantly different.

TABLE 2. Peak herbaceous standing crop ($kg.ha^{-1}$) in May 1985 and woody plant leaf litter and total leaf litter biomasses ($kg.ha^{-1}$) in December 1985 for the four treatments in Experiment 2.

	May	December	
	Herbaceous	Woody Leaf Litter	Total[1]
Cleared	1896a	966a	1688a
20-30% Cover	1675a	928a	1712a
50-60% Cover	1767a	1003a	1765a
Control	223b	1891b	2073a

[1]Includes all current year's production of vegetal material found on the forest floor in December: seeds and leaves of woody plants as well as dead herbaceous plants.

[ab]Means in the same column, followed by a different letter, are significantly different ($P<.05$).

Longer Term Responses to Clearing

Caatinga woody plants coppice readily and grow rapidly following cutting. Canopy cover was 30% by the end of the first year posttreatment (1985) for the cleared treatment in experiment 2 (Figure 2). In experiment 1, canopy cover was 78% by the end

of the third year posttreatment (1984) and increased to 96% by the end of the fourth year (1985).

As stated above, peak herbaceous vegetation yield in experiment 1 was six times higher on the cleared areas than the control for the first growing season following treatment. Peak herbaceous standing crop yields were still significantly higher ($P<.05$) on the cleared plots in 1984, third year posttreatment, even though herbaceous plant production had greatly decreased in absolute terms from the first year (Table 1). By 1984, however, total and woody plant leaf litter biomasses were similar for the two treatments. The two treatments were similar by 1985 in terms of both peak herbaceous vegetation production and total leaf litter biomass. In addition, the sum of the peak herbaceous vegetation production and woody plant leaf litter was similar for the two treatments for each of the three years measured.

No long term changes in relative species composition of herbaceous vegetation were noted. The major difference in relative species composition of leaf litter for the two treatments was the dramatic increase in the sabiá leaf component (Figure 3), from only 2% of the total leaf litter biomass on the control in 1984 and 1985 to 20% (652 kg/ha) and 31% (1061 kg/ha) of the total cleared treatment leaf litter biomass in 1984 and 1985, respectively. These increases can be attributed to production by sabiá seedlings and coppice shoots on the cleared treatment. In June 1985, the yield of leaves of sabiá seedlings was estimated to be 267 kg/ha. Subtracting this amount from the total sabiá leaf litter biomass (1061 kg/ha) obtained from the 1985 dry season harvest, an estimate of sabiá leaves from coppice of 794 kg/ha is derived. Therefore, approximately 25% of the total sabiá foliar biomass was from seedlings and 75% from coppice. In addition, a comparison of sabiá leaf litter biomass for the control (76 kg/ha) with the derived coppice production estimate for the cleared treatment, indicates that four-year-old sabiá coppice produced as much as ten times more foliar biomass than did mature, intact trees on the control.

Discussion

One of the major outcomes of these studies is that peak herbaceous vegetation yields were similar for all three manipulation treatments. Therefore, for the caatinga type studied understory herbaceous production does not drop off until some canopy cover level higher than 50-60% is attained. Light is apparently not a limiting factor in terms of herbaceous production for either the 20-30% cover or 50-60% cover levels.

In comparing the first year peak herbaceous vegetation yields for experiments 1 and 2, it should be noted that 1982 was an "average" year in terms of precipitation whereas 1985 was an extremely wet year. The relatively low peak herbaceous vegetation yields in 1985 might be related to waterlogged soils.

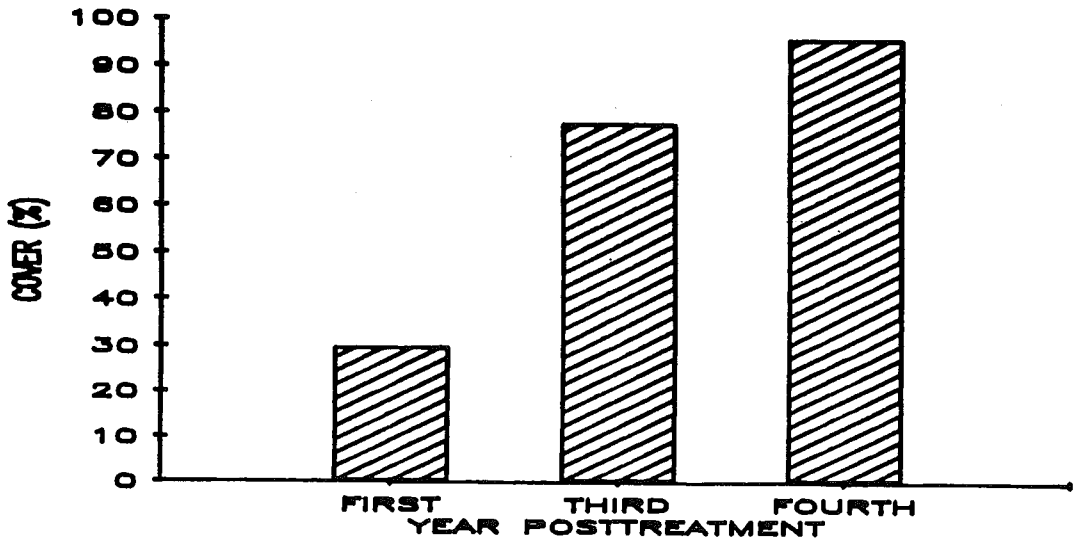

Figure 2. Percent canopy cover of coppice on the regenerating clearfelled caatinga studies. First year posttreatment is from experiment 2 and the third and fourth years posttreatment are from experiment 1.

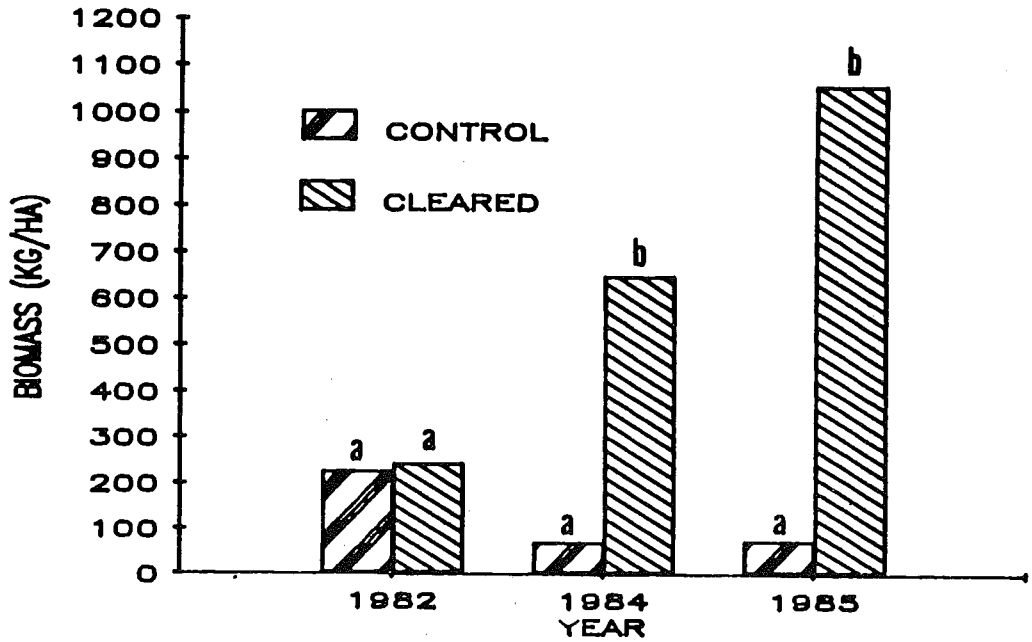

Figure 3. Sabia foliar biomass on the cleared and control treatments of experiment 1 in 1982, 1984 and 1985. Different letters above bars from the same year indicate significant differences ($P < 0.05$).

The only major vegetational component that differentiated the three manipulation treatments was total coppice foliar production. The significantly lower production for the 50-60% cover treatment level was apparently due to the relatively low number of coppice shoots per unit area of land. In terms of total leaf litter biomass produced by woody plants, however, there were no differences by manipulation treatment due to the addition of foliar production by trees on thinned plots. Therefore, these three treatments, as well as the control, are all producing equal amounts of potential forage but making it available to grazing livestock in different forms and at different times of the year.

The 50-60% cover treatment would appear to be the best compromise towards reducing the effects of seasonal fluctuations in forage availability and quality typical of cleared and native caatinga. In fact, the 50-60% cover treatment has the combined advantages of newly cleared caatinga and mature intact caatinga: high herbaceous vegetation production as well as high yields of palatable leaf litter during the dry season. In addition, coppicing woody species which produce palatable foliage are susceptible to overgrazing on cleared areas; whereas when such palatable species remain intact in thinned stands they are not only protected from any grazing damage but they also provide an extremely important dry season reserve of palatable leaf litter.

Aside from the potential forage resource benefits, the 50-60% cover treatment assures a certain level of ecosystem stability that cleared caatinga does not. The most obvious example is that the tree canopy should reduce the impact of early wet season rains in terms of erosion. The canopy of the trees may also provide important shade for grazing livestock during midday.

The regeneration of manipulated caatinga to pretreatment conditions can be rapid. For the dense stand of caatinga studied in experiment 1, the vigorous and rapidly growing coppice on the cleared treatment attained a canopy cover equal to the control by the end of the fourth year. The rapidly increasing canopy cover greatly limited herbaceous vegetation production so that by the fourth year herbaceous production on the cleared areas had been reduced to the control level. Due to the vigorous growth of the coppice shoots, woody plant leaf litter biomass was similar for the two treatments by the third year. There appeared to be only two major differences in vegetation between the cleared treatment and control by the fourth year: 1) physiognomy of the stands as the coppice canopy was very dense and had an average height of 5 to 6m while canopy of the control was about 10m in height, and 2) change in species composition of the woody plant component as sabiá increased in stems/ha and biomass/ha.

The emergence of sabiá seedlings as an important component of the cleared treatment is apparently related to the removal of the tree canopy. Sabiá, acting as an early seral species, was able to take advantage of the cleared situation and greatly

increase its density and importance in the stand. In regard to the response of sabiá coppice, sabiá could be loosely compared to early seral species which root sprout readily under favorable conditions. The aboveground portion of such woody plants lose vigor and degenerate in the development of dense mixed stands, but when such a stand is clearfelled, the below ground portion responds with production of very vigorous coppice.

Until now, research has not dealt with the importance of wood production and how it interrelates with livestock production in the Northeast. Further research needs to be conducted in the area of agroforestry with a possible objective of developing a management scheme which optimizes production of the forage resource as well as production of marketable wood. Some form of thinned caatinga would certainly be the basis of such a system.

According to a possible scheme, woody plant species that do not produce palatable browse are selectively removed from the stand; thereby decreasing canopy cover and increasing herbaceous production without decreasing production of palatable leaf litter. This management would favor sabiá (or other desirable woody plants) which produces palatable forage and valuable wood. Sabiá could be periodically harvested (every 10 years, for example) for wood and subsequently allowed to coppice again in the absence of grazing for at least two wet seasons. This scheme would optimize forage and wood production as well as ecosystem stability.

Conclusions

Reduction of the canopy cover of dense stands of caatinga can greatly increase herbaceous vegetation yields and, in the case of thinned caatinga, this increased production can be realized without seriously affecting production of palatable leaf litter. The first two years following cutting, coppicing woody plants also retain their leaves at least two months further into the dry season than do intact trees. In respect to livestock production, some form of thinned caatinga would appear to be the most consistent and dependable forage resource throughout the year as well as over years.

In terms of future management oriented research, resilience of both individual plant species and the entire ecosystem to periodic harvest needs to be studied. In addition, realistic control methods of the undesirable woody species must be developed. Perhaps the most important item for research, however, is the technical and economic feasibility of proposed management schemes in light of local production and marketing systems.

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MANIPULAÇÃO DA CAATINGA VISANDO O AUMENTO DE PRODUÇÃO DE CARNE CAPRINA

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RESUMO - A disponibilidade de forragem, o comportamento e a dieta animal bem como, o desenvolvimento ponderal de caprinos, foram avaliadas em pastagem nativa, submetida à três níveis de controle de árvores e arbustros e à três taxas de lotação. A remoção seletiva de arvores e arbustros (raleamento) foi o tratamento que proporcionou maior aumento na disponibilidade de biomassa total. Independente dos tipos de manipulação da vegetação e taxas de lotação empregadas, os caprinos despenderam mais tempo na atividade de pastejo durante a estação seca do que na estação chuvosa. O tempo gasto com a ruminação foi maior também na estação seca e menor na estação chuvosa. A qualidade da pastagem parece ter afetado mais diretamente o tempo gasto pelos animais com a ruminação e o pastejo. A chuva e o excesso de umidade reduziram as atividades dos animais. Por outro lado, os caprinos pastejaram em horários de temperatura elevadas, porém, nestas ocasioẽs a umidade relativa do ar era baixa. Talvez o maior desconforto para os animais ocorra somente quando os valores de ambos estes fatores são altos. A análise da composição botânica, revelou uma dieta variada constituida por gramineas, ervas, folhas de arbustros e árvores em diferentes proporçõẽs, dependendo da época do ano e da disponibilidade de forragem. O material herbáceo fenado naturalmente e alguns rebrotos de árvores e arbustros constituiram a forragem disponível durante a estação seca. Durante este período, apesar das folhas secas caídas das árvores terem sido importante na dieta dos caprinos, os animais perderam peso, principalmente nas áreas da caatinga controle. O ganho de peso dos animais foi maior durante a estação chuvosa nas áreas de caatinga desmatadas. Contrariamente, a perda de peso foi maior durante a estação seca, provavelmente devido à baixa quantidade e a má qualidade de forragem disponível neste período.

Termos para indexação: Pastagem nativa, Caprinos, Trópico semi-árido, Produção de carne.

CAATINGA RANGE MANAGEMENT FOR INCREASING GOAT MEAT PRODUCTION

ABSTRACT - The body weight responses, forage preference and seasonal feeding behavior of goats were studied in woodland ("caatinga") areas under three different brush control schemes and under three stocking rates. Removing the shrubs and tree increases yields of herbaceous only on partially-cleared sites. Goats gained body weight (kg BW/ha) during the wet season with the cleared treatment showing the best body weight response per

unit of land. However, during the dry season, animals lost weight probably due to the low quality and quantity of available forage. The botanical composition of goats' diets showed them to be mixed feed, consuming grasses, forbs and browse in various combinations depending on the season and the array of forage species available. During the dry season standing hay from herbaceous species and regrowth of some woody evergreen species were the principal forages. Animals maintained body weight on this forage. However, leaf litter was an important component of goats' diets during the dry season, but inadequate for weight maintenance. Goats in all treatments spent the least time grazing during the wet season and the most time during the beginning of the dry season. They spent the most time ruminating during the dry season and the least time during the wet season. Forage quality was probably a factor limiting animal response during the dry season. Goats exhibited dislike for rain and wet conditions. They grazed when the temperatures were high (35 to 39°C). However, periods of high temperature corresponded to periods of low relative humidity, perhaps moderating the discomfort factor of combined high temperature and high humidity.

Index terms: Native range, Goats, Semi-arid tropics, Meat production.

Introdução

As incertezas das precipitações pluviométricas, suas irregularidades de distribuições aliadas às frequentes limitações do solo: erosão e fertilidade, fazem do semi-árido do Nordeste brasileiro uma das regiões mais difíceis de uso, principalmente no que tange à adocão de um manejo correto da pastagem nativa.

Caprinos, ovinos e bovinos são importantes componentes do sistema tradicional da produção animal nos sertões do Nordeste. Este mesclagem de animais, muito embora, teóricamente proporcione um melhor uso das pastagens, careçe de maiores informações de pesquisas, à despeito da clareza de alguns resultados até então encontrados (Universidade Federal do Ceará, 1985).

Este trabalho teve como principais objetivos avaliar o desempenho, identificar o hábito alimentar e o comportamento dos caprinos, influenciados pelas diferentes práticas de manipulações da caatinga e pela carga animal. Estas informações são relevantes para determinar uma correta taxa de lotação, bem como, fornecer subsídios para um melhor aproveitamento da caatinga através do uso de combinações de ruminantes nas pastagens.

Material e Métodos

O experimento foi conduzido em uma área de 40,5ha, localizada na base física do Centro Nacional de Pesquisa de Caprinos em Sobral - Ce, com as sequintes coordenadas geográficas: 3.42' latitude sul e 40.21' longitude oeste. A

média anual de chuva da região é de 832mm ($\bar{x}$ de 53 anos). A precipitação pluviométrica no ano de condução do trabalho foi de 538mm, considerado baixa (Figura 1).

A área experimental foi dividida em 3 sub-áreas de 18,0; 13,5 e 9,0ha onde foram aplicadas respectivamente, os diferentes tipos de manipulação da caatinga: Caatinga sem manipulação (controle), caatinga raleada e caatinga desmatada. Por sua vez, cada sub-área foi dividida em 3 áreas menores, correspondendo as cargas animais leve, intermediária e pesada, respectivamente, da seguinte forma para cada tipo de caatinga: 3,0; 2,0 e 1,0 ha/animal para caatinga sem manipulação, 2,25; 1,50 e 0,75 ha/animal para caatinga raleada e 1,5; 1,0 e 0,5 ha/animal para caatinga desmatada.

A vegetação arborea nativa dominante incluia, dentre outras: Pau branco (Auxemma oncocalyx), Sabiá (Mimosa caesalpinifolia), Jurema preta (Mimosa actistipula), Juazeiro (Ziziphus joazero), Jucazeiro (Caesalpinia ferrea) e Mofumbo (Combretum leprosum). O estrato herbáceo era dominado principalmente por: Milhã (Paspalum sp e Panicum sp), Bamburral verdadeiro (Hyptia suaveolens), Bamburral Branco (Blainvilhea sphomdadeiro), Ervanço branco (Froelichia humboltiana), Chanana (Turnera guyanensis), Feijão de rola (Phaseolus lathyroides), Mata pasto (Cassia tora) e outros (Tabelas 1 e 2).

A composição botânica e a disponibilidade de matéria seca foram obtidas através do método botanal ("dry-weight-rank method") descrito por Jones & Harqueaves (1979). Usou-se 3 transsetos fixos em cada mancha de solo e, em cada transeto 200 amostras foram coletadas durante dois períodos: Estação chuvosa (ou de crescimento) e estação seca (ou dormência). Durante a estação seca foram avaliadas o material fenado em pé como também o humus (mulch), existente no solo. A densidade e cobertura das árvores e arbustros foram determinadas através da interseção descrito por Hyder & Snevav, 1960).

Nove grupos de 3 caprinos machos castrados do tipo sem raça definida (SRD) balanciados quanto as médias de peso e de idade foram aleatoriamente distribuidos nos níveis de manipulação da caatinga, e taxa de lotação.

Os animais receberam vacinação e vermifugação periódicas para o controle dos parasitas internos e externos. Os animais eram pesados à cada 28 dias após um jejum de 16 horas, sal mineral e água eram oferecidos "ad libitum."

"Scan-sampling" (Altmann, 1974), foi o método usado para determinar as atividades do animal em pastejo cada animal era observado por 5 (cinco) à 10 (dex) segundos, anotando-se a atividade que ele estava engajado. Após os 3 animais terem sido observados era feito um descanso de 5 minutos e novamente reiniciado o ciclo de observação. Os ciclos de observações eram conduzidos o dia todo das 8:00 horas às 17:30. Este procedimento foi executado em cada um dos tratamentos durante um dia em três

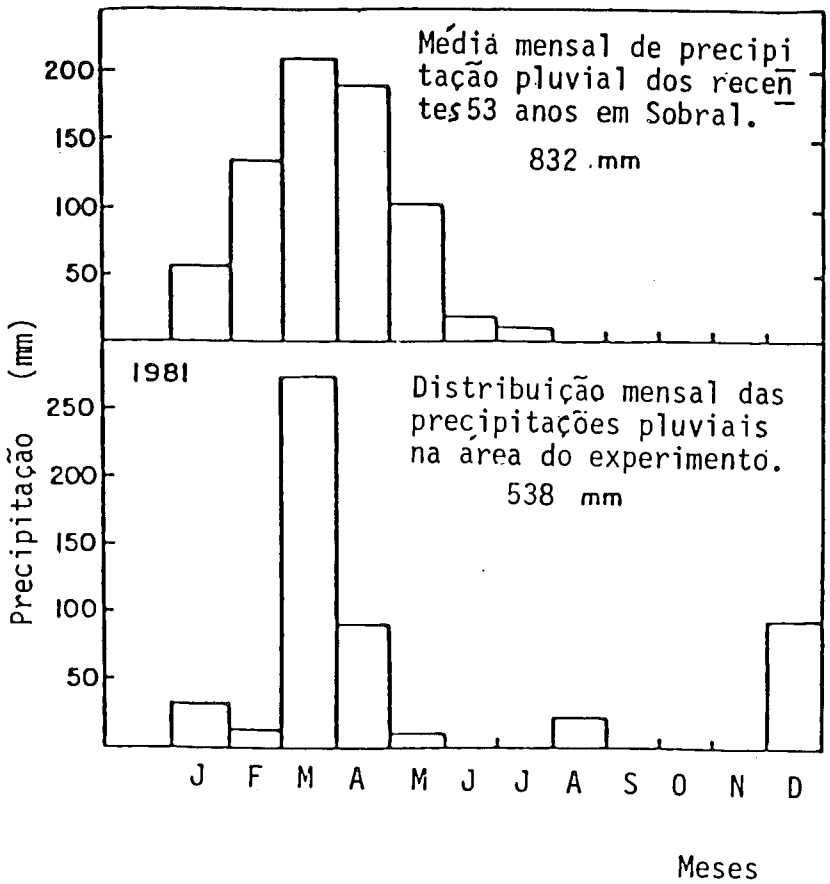

Figura 1. Média mensal dos recentes 53 anos em Sobral e distribuição mensal das precipitações pluviais na área do experimento, em 1981.

TABELA 1. Principais expécies arbóreas e arbustivas dentro das três diferentes densidades da caatinga nas duas estações, chuvosa (C) e seca (S).

Nome comum	Família	Gênero	Controle		Raleada		Desmatada	
			C	S	C	S	C	S
Aroeira	Anacardicea	Astronium	+	-	+	-	-	-
Catingueira	Leguminosae	Caesalpinia	+	+	-	-	-	-
Juazeiro	Ranáceas	Zezyphus	+	+	-	-	-	-
Jucazeiro	Leguminosae	Caesalpinia	+	+	-	-	-	-
Jurema Branca	Leguminosae	Pithecolobium	+	+	+	+	-	-
Jurema Preta	Leguminosae	Mimosa	+	+	+	+	+	+
Marmeleiro	Euforbiácea	Croton	+	-	+	-	+	-
Melosa	Acantácea	Ruellia	-	-	+	-	-	-
Mofumbo	Combretácea	Combratum	+	+	+	+	-	-
Mororo	Leguminosae	Baühinia	+	+	+	+	-	-
Pau branco	Borraginácea	Auxemma	+	-	+	-	+	-
Pereiro	Apocinácea	Arpidosperma	+	-	+	-	-	-
Pinhão bravo	Euforbiácea	Jatrophes	+	-	+	-	-	-
Sabiá	Leguminosae	Mimosa	+	-	+	-	-	-

(+) Presente;
(-) Ausente.

diferentes épocas do ano: maio, agosto e novembro, respectivamente meio da estação chuvosa, início e final da estação seca. As observadas diariamente foram:

1 - Pastejando; 2 - andando; 3 - deitado; 4 - ruminando; 5 - em pé; 6 - bebendo e 7 - lambendo sal.

Quando o animal estava na atividade pastejo era anotado a espécie e parte da planta que estava utilizando. Desta forma, as espécies utilizadas com mais frequência foram consideradas aquelas que tiveram maior percentual de contribuição na dieta dos animais. A percentagem de espécies na dieta e percentagem das espécies presentes no pasto obteve-se a taxa de frequência. O desenho estatístico usado para analisar o comportamento animal foi o delineamento de blocos casualizados com confundimento de 2

TABELA 2. Principais espécies herbáceas encontradas nas três diferentes densidades de caatinga nas estações chuvosa (C) e seca (S), 1981.

Nome comum	Família	Gênero	Controle		Raleada		Desmatada	
			C	S	C	S	C	S
Amendoim bravo	Leguminosae	Arachis	+	-	+	-	+	-
Anil bravo	Leguminosae	Indigofera	-	-	+	-	+	-
Azedinho	Oxalidacea	Oxalis	-	-	+	-	+	-
Bamburral ver.	Compositae	Elainvillea	+	+	+	+	+	+
Bamburral bra.	Labiatae	Labiatae	+	+	+	+	+	+
Can. de lagoa	Leguminosae	Pithicellobium	+	+	+	+	+	-
Capim B. Bode	Gramínea	Andropogon	+	+	+	+	+	+
Car. de agulha	Compositae	Bideus	+	+	-	-	-	-
Chanana	Turneracea	Turnera	+	+	+	+	+	-
Centrosema	Leguminosae	Centrosema	-	-	+	+	-	-
Cidreira Brava	Euphorbiacea	(**)	+	-	+	-	-	-
Erva mijona	Comeliacea	Commelina	+	+	+	+	+	+
Erva de ovelha	Leguminosae	Stylosanthes	-	-	-	-	+	-
Ervanço branco	Rubiaceae	Borrenia	+	+	+	+	+	+
Feijão de rola	Leguminosae	Phaseolus	+	+	+	+	+	+
Jitirana	Concolvulaceae	Ipomoea	+	+	+	+	+	+
Língua de vaca	Compositae	Chaptalia	+	-	+	+	+	+
Malva relógio	Malvaceae	Sides	-	-	+	+	+	+
Maracujá	Passifloraceae	Passiflora	+	+	+	+	+	+
Mar. de cavalo	Leguminosae	Desmodium	+	-	+	-	+	-
Matapasto	Leguminosae	Cassia	-	-	+	+	+	+
Milhã	Gramínea	(*)	+	+	+	+	+	+
Mirassol	Compopsitae	(**)	+	+	+	+	+	+
Paco - paco	Malvacea	Wissadula	+	+	+	+	-	-
Pan. do Ceará	Gramínea	Aristida	+	-	+	+	+	+
Pega - pega	Loasaceae	Mentxelia	+	-	+	+	-	-
Rabo de raposa	Gramínea	Andropogon	+	-	+	+	-	-
Relógio	Sterculiacea	Waltheria	+	-	+	+	+	+
Salsa	Convolvulacea	Ipomea	-	-	-	-	+	+

(*)Dois gêneros (Paspalum e Panicum);
(**)espécies não identificadas;
+ presentes;
- ausentes.

graus de liberdade das interações, de acordo com Cochran & Cox (1957). Para analisar o desempenho dos animais e biomassa disponível foi usado o desenho estatístico de uma repetição com três fatores: vegetativo (V), taxa de lotação (t) e época (E) através de Anova. A redução dos dados e análise estatística foi usado o pacote Minitab (Ryan et al., 1981) e Rummage (Bryce et al., 1980). Para comparação das médias foi usado o teste LSD.

Resultados

a) Performance dos animais

O ganho de peso foi significativamente (P<0,05) maior nos animais da área de caatinga desmatada quando comparado com o peso dos animais na caatinga sem tratamento sendo, respectivamente, 16,9 e 5,4kg. Na pastagem raleada os caprinos mostraram ganhos médios intermediários de 10,3kg. de peso vivo (Tabela 3).

Tabela 3. Ganho de peso (kg.) dos caprinos durante três estações dentro de três diferentes densidades de caatinga, 1981.

Épocas	Controle	Raleada	Desmatada	Média
Chuvosa	$7,6^{cp}$	$10,0p^{bp}$	$16,0^{ap}$	11,2
Transição	$0,7^{am}$	$1,1^{am}$	$1,1^{am}$	1,0
Seca	$(2,9)^{bn}$	$(0,8)^{an}$	$(0,2)^{an}$	(1,3)
Total	5,4	10,3	16,9	

Valores com mesmas letras nas linhas (a, b, c) e colunas (m, n, p) não são significativamente diferentes (P<0,05).

Com relação a taxa de lotação os caprinos ganharam mais peso (P<0,01) dentro dos tratamentos com lotação pesadas. No entanto a taxa de lotação moderada os animais mostraram um melhor desempenho chegando a não perder peso durante o período seco (Tabela 4).

A estação chuvosa proporcionou maior (P<0,01) ganho de peso aos animais do que a estação seca independente do tipo de vegetação e da lotação usada. Contudo todos os animais perderam peso no final da estação seca e início da estação chuvosa.

b) Vegetação

O raleamento da caatinga, proporcionou a maior disponibilidades de biomassa pastável (4,507 kg MS/ha), enquanto o desmatamento resultou menor disponibilidade (3,179 kg MS/ha). A vegetação sem tratamento apresentou valores de disponibilidade de 4,095 kg MS/ha (Tabela 5).

Houve diferença estatística (P<0,05) entre as disponibilidade de forragem existente nas três áreas, recebendo diferentes taxas de lotação. As áreas com lotação intermediária apresentou maiores disponibilidade de biomassa das pastagens nativa natural e raleada, sendo que a maior produção (P<0,01) de

biomassa disponível foi dentro da caatinga desmatada na taxa de lotação leve (Tabela 6).

TABELA 4. Ganho de peso (kg) de caprinos dentro das três diferentes densidades da caatinga durante três épocas, dentro das três taxas de lotação, 1981.

Épocas	Taxa de Lotação		
	Pesada	Intermediária	Leve
		Controle	
Chuvosa	12,83^{ap}	5,48^{bp}	4,50^{bp}
Transição	1,54^{am}	0,55^{am}	0,11^{am}
Seca	(1,47)^{an}	(1,34)^{an}	(0,06)^{am}
Total	12,90	4,69	4,60
		Raleada	
Chuvosa	17,68^{ap}	8,89^{bp}	6,41^{bp}
Transição	1,64^{am}	0,64^{am}	0,68^{am}
Seca	(0,84)^{an}	0,29^{am}	(0,22)^{am}
Total	18,48	9,82	6,87
		Desmatada	
Chuvosa	29,12^{ap}	10,50^{bp}	8,47^{bp}
Transição	1,34^{am}	1,67^{am}	0,13^{am}
Seca	(0,60)^{am}	0,47^{am}	(0,09)^{am}
Total	30,36	12,64	8,69

Valores com mesmas letras nas linhas (a, b, c) e colunas (m, n, p) não são significativamente diferentes ($P<0,05$).

TABELA 5. Produção de biomassa (kg MS/ha) durante o período chuvoso e seco dentro das três diferentes caatingas, 1981.

Épocas	Controle	Raleada	Seca
Chuvosa	2,977^{bp}	3,508^{ap}	2,583^{cp}
Seca	1,118^{am}	1,000^{am}	597^{bm}
Total	4,095	4,507	3,179

Valores com mesmas letras nas linhas (a, b, c) e colunas (m, n, p) não foram estatisticamentes diferentes ($P<0,05$) e ($P<0,01$), respectivamente.

TABELA 6. Produto de biomassa (kg MS/ha) durante a estação chuvosa e seca dentro das três lotações nas três diferentes caatingas, 1981.

Épocas	Taxa de Lotação		
	Pesada	Intermediária	Leve
		Controle	
Chuvosa	2,812^{bp}	3,530^{ap}	2,590^{bp}
Seca	861^{bm}	1,362^{am}	1,135^{abm}
Total	3,673	4,892	3,725
		Raleada	
Chuvosa	3,240^{bp}	4,623^{ap}	2,659^{cp}
Seca	861^{bm}	1,221^{am}	917^{abm}
Total	4,101	5,844	3,575
		Desmatada	
Chuvosa	1,942^{bp}	2,901^{ap}	2,907^{ap}
Seca	511^{am}	563^{am}	717^{am}
Total	2,453	3,464	3,724

Valores com mesmas letras nas linhas (a, b, c) e colunas (m, n, p) não são significativamente diferentes ($P<0,01$), respectivamente.

A biomassa disponível foi avaliada nas estações chuvosa e seca. Houve maior quantidade de forragem disponível durante o período chuvoso, independente do tipo de caatinga e lotação.

Durante o período seco a folhagem caída das árvores foi um importante componente da forragem disponível nas áreas de caatinga natural e raleada. Nas áreas de caatinga desmatada a vegetação herbácea fenada naturalmente foi o principal componente da forragem.

Em todos os tratamentos a quantidade de biomassa foi de modo geral, destacadamente menor durante a estação seca.

c) Dieta animal

Em geral a milhã, o ervanço branco, a jitirana, o bambural verdadeiro e branco tiveram elevados índice de preferência (preferência = percentagem da espécie na dieta, divida pela percentual da mesma espécie na composição botânica da forragem disponível), durante as estações chuvosa e seca. Os rebrotos de jurema tiveram maior frequência de avaliações durante a época seca nos tratamentos raleado e desmatado (Tabela 7). Na mesma

TABELA 7. Relação entre percentagem de espécies disponíveis no pasto e percentagem de espécies encontradas na dieta dos caprinos dentro das três diferentes densidades de caatinga, nas três taxas de lotação durante duas estações, chuvosa (C) e seca (S), 1981.

Espécies	Taxa de Lotação					
	Pesado		Intermediária		Leve	
	C	S	C	S	C	S
			Controle			
Herbáceas						
Bamburral branco	1,4	0,9	-	1,8	0,1	1,6
Bamburral verdadeiro	2,8	0,2	1,1	0,2	1,8	-
Eranço branco	0,4	0,5	-	0,6	0,5	3,1
Jitirana	4,0	-	0,7	-	0,3	3,3
Maracujá	-	-	-	-	19,5	-
Malva relógio	-	-	-	-	0,7	-
Gramíneas	1,1	3,3	2,1	0,6	22,4	7,2
Arbóreas						
Juazeiro	-	163,0	-	-	-	-
Jurema	-	3,2	-	32,5	-	-
Pau branco	-	-	-	0,1	-	-
Sabiá	-	-	-	1,5	-	-
			Raleada			
Herbáceas						
Bamburral branco	1,2	1,8	-	-	1,0	1,8
Bamburrl verdadeiro	-	2,4	3,0	-	6,1	0,7
Ervanço branco	0,1	2,0	1,4	1,9	0,6	0,2
Jitirana	1,4	-	0,9	-	1,3	-
Maracujá	15,0	-	1,9	-	1,6	2,1
Gramíneas	1,3	2,2	4,0	1,5	3,8	12,8
Arbórea						
Jurema	-	-	-	19,0	-	38,7
			Desmatada			
Herbáceas						
Bamburral branco	4,6	6,4	0,2	2,5	0,3	8,0
Bamburral verdadeiro	-	0,1	5,6	1,3	-	0,6
Ervanço branco	1,4	1,5	1,2	1,3	0,3	0,5
Jitirana	5,4	-	0,8	7,8	23,5	-
Malva relógio	-	0,7	3,3	0,2	2,0	8,5
Maracujá	1,6	0,5	2,2	0,5	11,0	1,0
Matapasto	0,5	2,1	0,6	0,4	0,9	1,9
Gramíneas	1,9	1,7	2,1	0,5	0,8	0,5

época, as vagens de jucazeiro foram bastante procuradas pelos caprinos principalmente nos tratamentos das vegetações nativa controle e raleada.

d) Comportamento animal

Pastejando: O pastejo dos animais foi afetado significativamente ($P<0,01$) pela época do ano. Normalmente, os caprinos dispenderam mais tempo pastejando durante o período chuvoso (Tabela 8).

Tabela 8. Percentagem de tempo gasto pelos caprinos em três diferentes atividades, durante o período diurno em três épocas, dentro de três diferentes caatingas, 1981.

Épocas	Caatinga			Média do Período
	Controle	Raleada	Desmatada	
		Pastejando		
Chuvosa	48^{am}	42^{an}	38^{am}	43
Transição	62^{bp}	71^{bp}	61^{bp}	65
Seca	55^{cpm}	60^{cm}	59^{cp}	58
Média Anual	55	58	53	
		Andando		
Chuvosa	26^{ap}	20^{ap}	28^{ap}	25
Transição	14^{bm}	14^{bp}	14^{bm}	14
Seca	21^{cpm}	19^{cp}	18^{cp}	19
Média Anual	20	18	20	
		Deitado		
Chuvosa	16^{bp}	25^{ap}	17^{bp}	19
Transição	12^{am}	4^{bn}	10^{bn}	9
Seca	14^{apm}	10^{bm}	10^{bm}	11
Média Anual	14	13	12	

Valores com mesmas letras nas linhas (a, b, c) e colunas (m, n, p) não são significativamente diferentes ($P<0,05$).

Andando: Os caprinos gastaram mais tempo ($P<0,05$ andando durante a estação chuvosa do que durante a estação de transição (Tabela 9). Os dados mostraram que quando os caprinos gastavam mais tempo andando eles diminuiam seu tempo em pastejo ($r=0,83$).

Deitados: Os caprinos passavam mais tempo deitados ($P<0,01$) durante o período chuvoso e menos tempo durante o período de transição (Tabela 9). Houve uma pequena correlação negativa ($r=0,76$) entre o tempo gasto deitado e o tempo pastejando.

TABELA 9. Percentagem de tempo gasto pelos caprinos em ruminação dentro de três diferentes densidades de caatinga durante três épocas, em três taxas de lotação, 1981.

Estações	Taxa de lotação			Média
	Pesada	Intermediária	Leve	
		Controle		
Chuvosa	$13,2^{am}$	$15,2^{abm}$	$16,4^{bm}$	$14,9^{m}$
Transição	$15,2^{amn}$	$15,2^{am}$	$17,1^{am}$	$15,8^{mn}$
Seca	$17,1^{an}$	$17,1^{am}$	$18,7^{am}$	$17,6^{n}$
		Raleada		
Chuvosa	$13,8^{am}$	$17,1^{bm}$	$17,7^{bm}$	$16,4^{m}$
Transição	$15,9^{amn}$	$15,2^{am}$	$16,4^{am}$	$15,8^{m}$
Seca	$17,1^{an}$	$17,7^{am}$	$17,1^{am}$	$17,3^{m}$
		Desmatada		
Chuvosa	$14,5^{am}$	$13,0^{am}$	$14,5^{am}$	$14,0^{m}$
Transição	$7,0^{an}$	$17,0^{an}$	$18,2^{an}$	$17,4^{n}$
Seca	$18,0^{an}$	$18,7^{an}$	$18,7^{an}$	$18,5^{n}$

Valores com mesmas letras na linha (a, b, c) e colunas (m, n, p) são estatisticamente diferentes ($P<0,01$ e $<P0,05$), respectivamente.

Ruminando: Houve uma diferença estatística entre as taxas de lotação ($P<0,05$) e entre as diferentes épocas do ano ($P<0,01$). Em geral os caprinos dispenderam mais tempo ruminando nas áreas sob lotações leves, principalmente nas pastagens nativa e raleada (Tabela 9). Os caprinos gastaram mais tempo ruminando durante a estação seca e menos tempo durante a estação chuvosa.

Os dados com animal em pé, bebendo água e lambendo sal, não foram discutidos aqui devido ao pequeno percentual (menos de 2% de atividades).

Discussão

a) Vegetação

O corte de espécies arbóreas tem sido um dos métodos utilizados para aumento da produção da forragem herbácea. Este

suposto aumento na produção da matéria seca das espécies herbáceas seria em decorrência da redução da competição dos vegetais lenhosos por nutrientes e água do solo e luminosidade. Esta prática parece ser mais adequada às regiões onde o bovino é o animal mais importante.

No entanto, nas zonas áridas e semi-áridas, onde predomina a exploração de caprinos, remover totalmente árvores e arbustos poderá não ser uma boa opção. Neste estudo as maiores disponibilidades de biomassa foram encontradas nas áreas raleadas durante período chuvoso. Esta mesma disponibilidade deve ser atribuido à remoção parcial das espécies arbóreas e arbustivas no entanto, a remoção total de arbusto e árvores no tratamento da caatinga desmatada, resultou uma menor disponibilidade de biomassa total.

A mais importante diferença entre caatinga nativa natural e releada foi através da produção de espécies herbáceas durante o período chuvoso. No entanto, isto não foi válido para o período seco. Deve-se ressaltar que durante este estudo a produção de matéria seca disponível reflete a produção menos o consumo dos animais que permaneceram na área durante o ano do trabalho.

b) O desenvolvimento ponderal

As melhores respostas em termos de ganho de peso dos caprinos, foram encontrados nas áreas com taxas de lotação moderada, nas duas caatingas, raleadas e desmatadas. Provalvemente tenha sido em decorrência a uma maior disponibilidade de rebrotos de jurema nas duas pastagens.

Este estudo indicou que as taxas de lotação ajustadas é fator importante, que deve ser levado em consideração. Pensando no uso de pastagem nativa desta forma é necessário se conhecer a quantidade de forragem disponível na pastagem em função da precipitação pluvial, para que seja possível estipular uma correta taxa de lotação para o período seco, ou para o ano todo.

Observou-se que durante a estação chuvosa os caprinos não pastajam uniformemente as áreas submetidas às lotações moderada e leve da caatinga controle e raleada. Isto provavelmente resultou em uma maior quantidade de biomassa disponível para a estação seca.

Neste estudo todos os tratamentos de manipulação da caatinga, proporcionavam ganho de peso aos caprinos durante a estação de chuva. Neste período a quantidade e a qualidade da forragem não foram fatores limitados pois mesmo nas taxas de lotações pesadas os caprinos ganhavam peso durante a estação chuvosa.

Apesar da contribuição das folhas caídas, durante a estação seca, de árvores e arbustos na alimentação dos animais, esta fato não foi suficiente para manter aumento contínuo de peso dos animais.

Em concordância com outros pesquisadores (Oliveira et al., 1982; Riera et al., 1982; Melo L. et al., 1983), observou-se uma marcante perda de peso dos animais no final da estação seca e início da estação chuvosa. A perda de peso provocada pelo início da estação chuvosa está mais associada à decomposição da pastagem.

A perda de peso no final da estação seca pode está mais associada às deficiências nutricionais da pastagem (Schacht et al., 1985), enquanto que, a ocorrida no início da chuvosa pode ser atribuida à decomposição da forragem fenado naturalmente.

O deferimento de uma área durante a estação chuvosa poderá minimizar a perda de peso dos animais. Contudo, isto poderá não resolver os problemas de qualidade da pastagem, a menos que esteja presente leguminosas como fonte enriquecedora da pastagem.

c) Dieta dos caprinos

Muito embora os ruminantes sejam considerados "hedyphagic," normalmente selecionando alimentos de acordo com a palatabilidade e não necessariamente, devido à uma superior conteúdo nutricional os caprinos neste trabalho selecionaram partes da planta como folhas novas, flôres e sementes.

As espécies mais consumidas durante a estação chuvosa também foram as preferidas na estação seca (Tabelas 2 e 3).

Em geral os caprinos tendem a consumir a rebrota de espécies reconhecidas como não forrageiras. Tal característica, pode representar um elevado potencial desses animais no controle biológico de especies invasoras nas pastagens. Este fenômeno foi mais acentuado nas taxas de lotação pesadas.

As folhas caídas no solo ("leaf litter") foram importantes componentes na dieta dos caprinos durante a estação seca. No entanto, esta contribuição foi suficiente para evitar a perda de peso dos animais durante esse período.

Em resumo os caprinos mudam rapidamente sua dieta de acordo com a disponiblidade das espécies preferidas. Contudo fatores não identificados podem influenciar marcadamente a frequência de determinadas espécies. Desta forma, baseado em dados encontrados, torna-se difícil classificar os caprinos como um consumidor do estrato herbáceo ou arbóreo, corroborando com as afirmações de Edward (1948), Yocum (1967), Huss (1972), Harrington (1978) e Pfister (1983).

d) Comportamento animal

O pastejo é uma complexa atividade que se inicia com a seleção das espécies mais palatáveis e termina com o processo de formação do bolo alimentar.

Os caprinos despenderam menor tempo pastejando na estação chuvosa uma vez que, a maior disponibilidade e, principalmente a melhor quantidade da forragem compensaram este decréscimo de tempo gasto na alimentação.

Durante o período de transição entre a estação chuvosa e seca os animais tenderam a andar mais. Isto, provavelmente ocorreu devido à menor disponibilidade das espécies preferidas na pastagem, obrigando os animais a se ajustarem à uma nova dieta.

No final da estação seca os animais tenderam a andar menos, consumindo um tempo apreciável na ruminação. É neste período que a qualidade da pastagem torna-se crítica. O teor de fibra e os constituintes da parede celular aumentam. Pfister (1983) trabalhando em um experimento muito próximo à este, encontrou uma correlação entre quantidade de parede celular e tempo gasto na ruminação. Quando o conteúdo da parede celular aumenta, o tempo gasto pelo animal na ruminação também aumentou.

Em resumo, a baixa quantidade e a má qualidade das pastagens são dois importantes fatores que influenciam consideravelmente o tempo gasto na ruminação.

Os caprinos claramente não se adaptam a elevada umidade. Normalmente durante o período chuvoso eles começam a entrar no pasto às 9:00 da manhã, aparentemente, esperando diminuir a unidade na folhagem. A chuva, em qualquer período, interfere no comportamento do animal, fazendo-o paralizar suas atividades até encontrar um abrigo que o proteja.

Observações no campo mostraram que os animais podem pastejar durante altas temperaturas, este fato no entanto, ocorrem porque durante e após o meio dia quando a temperatura chega a atingir o piques máximo e a umidade relativa do ar decrescem provavelmente o desconforto provocado pela elevada umidade seja mais importante que altas temperaturas.

Não foi evidenciado que os animais caprinos modificam seu comportamento alimentar em função do nascer e por do sol. Contudo diferenças de comportamento foram observadas durante o período de escassez de alimento (período seco). Os animais durante este período procura ir ao campo mais cedo, onde provavelmente encontram o pasto, embora seco, um pouco mais tenro devido ao orvalho do norte. Durante a tarde/noite os animais necessitam pastejar mais tempo em virtude de ser necessário período mais longo para ruminação. Fato este, decorrente da baixa qualidade do pasto.

Conclusões e Recomendações

Remover arbustos e árvores tem sido sugerido como uma das maneiras de aumentar a produção de forragem. Contudo neste trabalho somente a prática de raleamento propiciou aumento na produção.

Em todos as densidades de caatinga e dentro as diferentes taxas de lotação chuvosa foi mais produtiva: i) biomassa disponível e ii) ganho de peso dos animais.

Durante a estação seca a pouca quantidade e a baixa qualidade da forragem disponível são provavelmente, as maiores limitações para a produção de caprinos no Nordeste brasileiro.

Este estudo sugere que as espécies Pau branco, Mufumbo e Marmeleiro devem ser retiradas da pastagem. Espécies com potencial madereiro Sabiá, Jurema e Mororo devem ser cortados periodicamente, tornando a rebrota mais acessível aos animais. Trinta a 50% de cobertura talvez seja um bom índice a ser adotado com relação à cobertura vegetal. Espécies forrageiras de crescimento lenta, devem ser preservadas: Juazeiro, Jucazeiro, Catingueira, Aroeira e outras.

Os caprinos não suportam terreno mal drenados, quando chove eles não pastejam. Nestas condições os animais ficam sujeitos à problemas de casco resultando em perda de peso por não procurar o pasto. A qualidade e quantidade de forragem disponível, não são fatores limitantes durante a estação chuvosa. Nesta época, o animal necessita pastejar poucas horas e somente o fazem durante o dia. No entanto, na estação seca quando a quantidade e a qualidade na forragem são drasticamente reduzidas as horas de pastejo devem ser diferenciadas. Durante esta época os animais devem pastejar por um período maior de tempo e de preferência em horários mais cômodos para os mesmo, cedo da manhã e até da noite. É muito importante manejar os caprinos diferentemente durante as duas estações nas regiões de trópico semi-árido.

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EFFECT OF SUPPLEMENTAL NITROGEN AND ENERGY ON DRY SEASON WEIGHT GAINS OF GOATS GRAZING CAATINGA RANGE

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ABSTRACT - It is generally considered that nutritional stress during the dry season is one of the primary factors limiting goat production in Northeast Brazil. This study was conducted to determine if dry season diets of free ranging SRD goats are deficient in nitrogen, energy or both. Forty recently weaned male goats were randomly assigned to one of four treatments: 1) caatinga range; 2) caatinga range + 5g of urea/day; 3) caatinga range + 140g of molasses/day; and 4) caatinga range + molasses (140g/day) and urea (5g/day). Although average daily weight gains for the 12 week growth trial were nearly twice as high for the molasses and urea group as for the other three treatment groups, rates of weight gain were similar for all four treatments during the first half of the growth trial. Botanical and nutritive composition of basal caatinga forage diets remained relatively constant during the first half of the study; however, diet quality decreased and diet botanical composition showed a shift towards lower quality constituents (stems) during the last half of the trial. As the quality of the basal forage diet declined, both molasses and urea were required to sustain weight gains through the entire 12 week trial.

Index terms: Caatinga, Urea, Molasses, Supplementation, Dry season diets.

EFEITO DA SUPLEMENTAÇÃO DE ENERGIA E NITROGÊNIO NO GANHO DE PESO DE CAPRINOS EM PASTAGEM CAATINGA NA EPOCA SECA

RESUMO - O "stress" nutricional de caprinos durante o estação seca é geralmente considerado como um dos fatores limitantes à produção de caprinos no nordeste do Brasil. Este estudo foi conduzido visando determinar se a dieta de caprinos Sem Raça Definida (SRD) em pastoréio é deficiente em nitrogênio, energia ou ambos. Quarenta cabritos recem desmanados foram aleatoriamente distribuidos nos sequintes tratamentos: 1) caatinga nativa; 2) caatinga nativa + 5 g de uréia/dia; 3) caatinga nativa + 140 g de melaço/dia; e 4) caatinga nativa + melaço (140 g/dia) + uréia (5 g/dia). Muito embora o ganho medio diário do grupo recebendo melaço e uréia durante as 12 semanas de duração do experimento, tenha sido cerca de duas vezes maior que o ganho de peso dos outros três grupos, os ganhos de peso dos quatro tratamentos foram similares durante as primeiras seis semanas do experimento. A composição botânica e o valor nutritivo das dietas permaneceram relativamente constantes durante as primeiras seis semanas do estudo. Entretanto, a qualidade das dietas decresceu, e a composição botânica das mesmas apresentou uma maior quantidade de constituintes de valor

nutritivo mais baixo (caule) durante as últimas seis semanas do experimento. A medida que a qualidade da dieta das animais decresceu, melaço e uréia foram necessarios para a manutenção dos ganhos de peso inicialmente obtidos.

Termos para indexação: Caatinga, Uréia, Melaço, Dietas de caprinos na época seca.

Introduction

Goat production in Northeast Brazil is generally considered to be far below its potential due to a wide spectrum of factors, ranging from cultural to purely technical considerations. Viewed as one of the primary factors limiting goat production, nutritional stress on goats during the dry season results in high weight losses and possibly mortality (Pfister et al., 1983). Neither forage quality nor quantity appears to be a major limitation in terms of livestock production during the wet season. It is during the dry season, when plant growth stops, that low forage availability seriously affects animal performance. Therefore, concerns about increasing livestock carrying capacity and performance have been directed towards methods of increasing the quantity and quality of dry season forage reserves in order to minimize the wastage of animal biomass that typically occurs at this time.

The early dry season is normally a favorable period since there is an abundance of good quality dried herbaceous vegetation along with some green browse. By mid dry season, the availability of herbaceous plants diminishes to a very low level due to grazing, trampling and decomposition. At this time, particularly in mature, intact stands of caatinga, leaf litter from the drought deciduous trees is a crucial element in the diets of sheep and goats as it can constitute as much as 70% of their diets. Only a part of the available leaf litter, however, is consumed since several of the tree species do not produce palatable browse.

It is often questioned whether nutrient content of leaf litter is adequate for maintaining goats and sheep under normal dry season conditions (Pfister, 1983). Studies to date (Pfister, 1983; Kirmse, 1984), however, indicate that sheep and goat diets primarily composed of leaf litter are of relatively good quality. These diets contained crude protein (CP) levels of 8 to 12%, *in vitro* organic matter digestibility (IVOMD) of 40 to 50% and sustained organic matter intake levels of 2 to 3% of body weight. Pfister (1983) and Kirmse et al. (1983) have hypothesized, however, that nutrient availability in certain species is affected by anti-quality compounds.

This study was designed with the objective of determining if the dry season diets of free ranging SRD goats are deficient in nitrogen (N), energy or both.

Materials and Methods

Forty male SRD goats about four months old and averaging 15.1kg were used in this experiment. The goats were blocked on basis of liveweight and allocated ten to each treatment in a completely randomized block design. The treatments were as follows: 1) caatinga range (CR); 2) caatinga range + 5g of urea/day (CR + U); 3) caatinga range + 140g of molasses/day (CR + M); and 4) caatinga range + molasses (140 g/day) and urea (5 g/day) (CR + MU). This design was viewed as a means of supplementing N alone (treatment 2), energy alone (treatment 3) and a balanced mixture of N and energy (treatment 4). Quantities of urea and molasses were supplemented to furnish 32% of maintenance crude protein (CP) and digestible energy (DE) requirements for a 15kg goat. The molasses fed in treatments 3 and 4 was presented in dry, powdered form. In diet 4, dry urea was thoroughly mixed with molasses. In diet 2, the urea was dissolved in water and administered orally using a 12cc syringe.

The experiment began on September 19, 1984 and ended on December 31, 1984, with a 20-day adaptation period and a 84-day growth trial. All of the animals grazed the same 18ha pasture of mature, intact caatinga and every night were separated and penned by treatment group. Animals in treatments 2, 3 and 4 received their supplement two times daily (6a.m. and 5p.m.) during both periods of the experiment. A complete mineral mix and water were offered ad libitum. The animals were weighed weekly.

Diet sampling was conducted using seven, 18-month-old esophageally fistulated (EF) SRD goats. The samples were collected during the first week (October 10-12), sixth week (November 14-16) and tenth week (December 17-19) of the growth trial. For each three-day collection period, samples were pooled by animal and used to estimate the botanical and nutritive composition of the diets of the experimental goats. Leaf litter biomass and composition were estimated immediately prior to each collection as well as on two other occasions. Sampling procedures involved collecting all current year's leaf litter (including both dead herbaceous plants and dried tree leaves) from 50 randomly placed quadrats (50 x 60cm) within the experimental pasture. The litter samples were separated by species, ovendried and weighed.

Results

For the 12-week growth trial, average daily weight gain for the CR + MU group was nearly twice as high as the weight gains for the other three (Table 1). There were no significant differences ($p>.05$) between the CR, CR + U and CR + M groups. Although the CR + MU group began deviating from the trend of the other groups during the sixth to eighth week period, it was not until the tenth week that significant differences ($P<.05$) appeared between the CR + MU group and the other three (Fig. 1). From the sixth week to the end of the trial, the CR, CR + U and

CR + M groups maintained weight while the CR + MU group continued to gain weight.

TABLE 1. Mean daily weight gains (g/day) of the nonsupplemented and supplemented treatment groups for the 12-week growth trial, October 8 to December 31, 1984.

Treatment	Daily Weight Gain
CR	24.8a
CR + U	25.3a
CR + M	22.2a
CR + MU	46.4b

[ab]Means in the same column, followed by a different letter, are significantly different ($P<.05$).

Total leaf litter biomass, including dead herbaceous plants and dried tree leaves, decreased significantly ($P<.05$) from 3806 kg/ha to 2888 kg/ha over the course of the study (Fig. 2). Of the total biomass, 21 to 27% was composed of dead herbaceous plants with herbaceous leaves accounting for 3% of the total. Therefore, 73 to 79% of the total biomass was dried tree leaves. In terms of individual species, there were no significant changes in relative species composition over the course of the study.

Chemical analysis of the individual species generally did not indicate significant changes in the quality of the herbage during the experimental period (Table 2). Percent neutral detergent fiber (NDF) and percent crude protein (CP) remained relatively constant for catingueira leaves and herbaceous plant leaves, examples of the higher quality and more palatable components of leaf litter. This was also true for pau branco leaves and stems of herbaceous plants, two of the lower quality and less palatable components.

TABLE 2. NDF (%) and CP (%) of four vegetal components of the leaf litter collected periodically through the growth trial.

Components	NDF			CP		
	Oct 10	Nov 29	Dec 14	Oct 10	Nov 29	Dec 14
Catingueira	41.31	43.04	41.71	10.09	9.82	9.61
Herbaceous leaves	45.99	42.63	46.09	9.76	9.51	11.00
Pau branco	55.31	58.97	58.92	7.50	7.74	7.80
Herbaceous stems	76.77	77.01	73.10	4.94	5.46	5.34

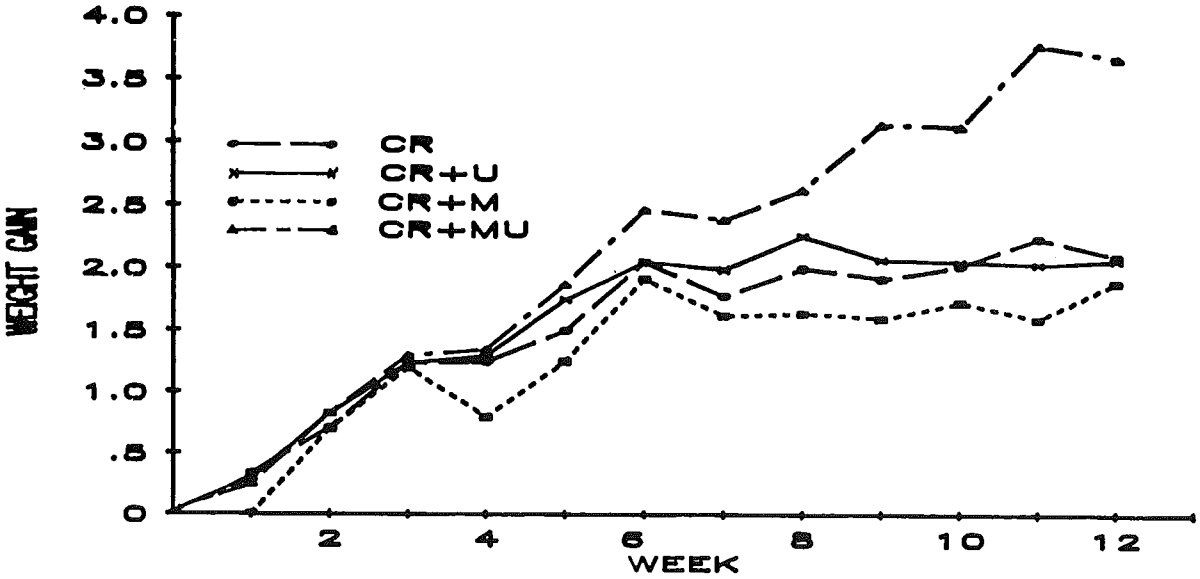

Figure 1. Total weight gain (kg/animal) by treatment group for the 12 week growth trial.

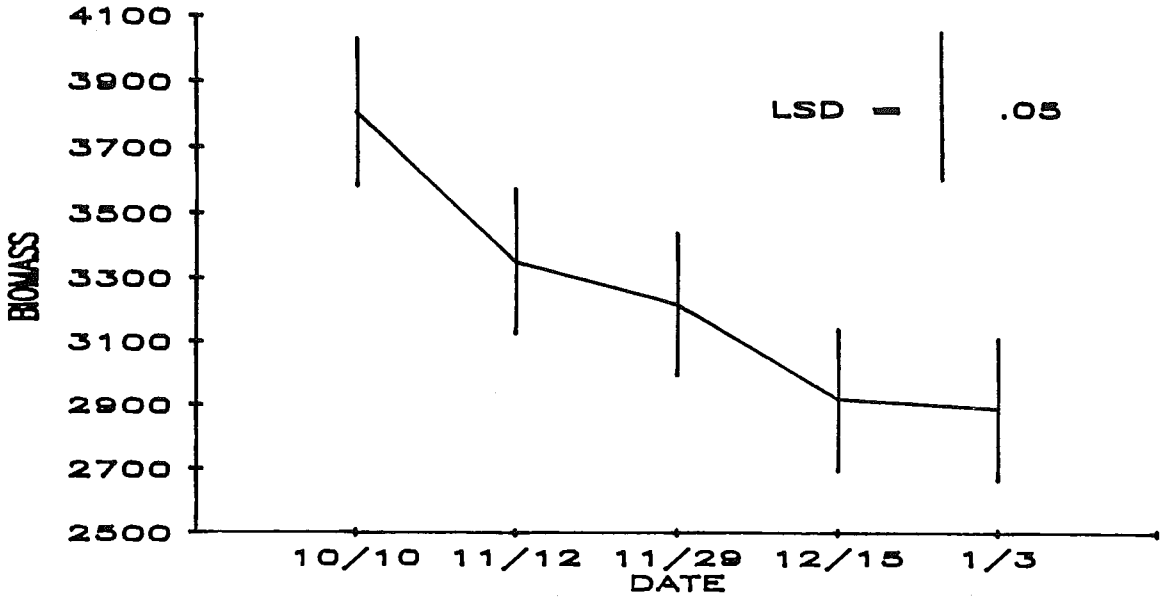

Figure 2. Total leaf litter biomass (kg/ha) at five dates over the course of the growth trial.

Chemical analysis of the diet samples from the EF animals indicated a general decline in quality from October to December (Table 3). NDF remained relatively constant from the first to sixth week; however, it increased significantly ($P<.05$) in the tenth week. Decreases in CP were significant for both the sixth and tenth weeks. IVDMD also remained relatively constant from the first to sixth week and, subsequently, decreased significantly in the tenth week.

TABLE 3. NDF (%), CP (%) and IVDMD (%) of diet samples collected by EF goats in the first, sixth and tenth weeks of the growth trial.

	Week		
	First	Sixth	Tenth
NDF	44.90a	45.06a	52.14b
CP	11.97a	9.64b	8.36c
IVDMD	48.96a	49.34a	45.71b

[ab]Means in the same row, followed by a different letter, are signficantly different ($P<.05$).

Botanical analysis of diet samples indicated that 75 to 80% of the diets of EF animals collected during the first and sixth weeks was composed of leaves (Fig. 3). In the tenth week, only 60% of the diets was identified as leaves and 40% as stems and low quality flower parts. Most of the flower and seed component consisted of the calyx of bamburral branco (*Blainvillea rhombiondea*), a large forb species.

Discussion

The goat weight responses illustrated in Figure 2 can be discussed in terms of two major components: 1) the plant/animal factors that relate to the leveling-off of weight gains for CR, CR + U and CR + M groups during the sixth to eighth week period and 2) the weight responses to supplementation.

In terms of the first point, measured animal related factors indicated that diet quality significantly declined after the sixth week and that botanical composition of the diets increased in low quality constituents (stems of herbaceous plants) during the sixth to tenth week period. These two factors correspond very well with the leveling-off of weight gains in the sixth to eighth week period. Related changes in the plant component, however, are not detectable. A summary of plant related factors are as follows: 1) forage quality of leaf litter components remained constant; 2) leaf litter biomass appeared to be high

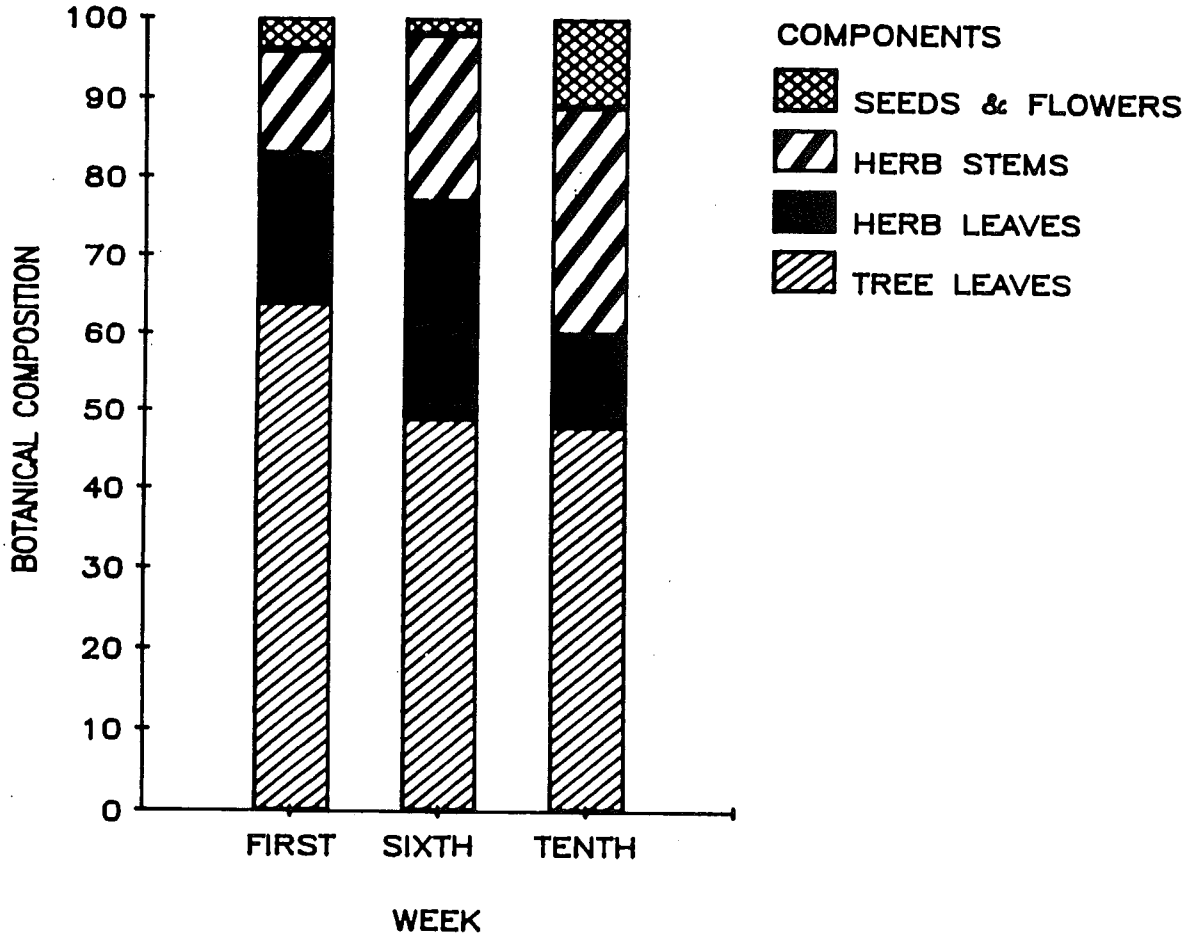

Figure 3. Botanical composition (%) of EF goat diets collected during the first, sixth and tenth week of the growth trial.

even at the end of the study; and 3) relative species composition of the leaf litter did not significantly change during the course of the study. None of these factors indicate that diet composition or weight gains should have changed over the course of the study. However, as the shift in the botanical composition of the tenth week diets (to more stems in the diet) would indicate, the relative species composition of the leaf litter was changing. It could be postulated that by the latter part of the trial, the availability of high quality, palatable forage had decreased to the point that the goats could no longer efficiently select adequate levels of the more desireable forage species and were forced to partially switch to lower quality material (stems). It was not possible to identify any of the real differences in relative species composition of leaf litter as possibly ´seen´ by the animal due to the low precision of the vegetation sampling method used (or of any other practical method).

The lack of weight responses to the urea alone and molasses alone treatments during the latter part of the growth trial indicates that the leaf litter was deficient in both N and energy. A proper balance between the amounts of N and energy available to the rumen microorganisms is needed to realize increased roughage intake and, thereby, increased weight gains (Natural Research Council, 1976). N alone and energy alone supplementation of roughage diets produces variable results, at best, as the level of deficiency of the nonsupplemented nutrient is normally the limiting factor (Loosli & McDonald, 1968; Nolan et al., 1975; Milne et al., 1979; Winks et al., 1979).

The positive weight responses during the latter part of the growth trial for the CR + MU group supports the contention that the leaf litter was deficient in both N and energy. Similar studies (Winks et al., 1979; Mulholland & Coombe, 1979) have also shown that urea and molasses supplemented groups do not gain more weight than nonsupplemented groups during high quality forage periods. These same studies also suggest that when the nonsupplemented animals are able to maintain weight, the urea and molasses supplemented animals will gain weight. Apparently, at times when the roughage supplies only maintenance requirements, the urea and molasses supply the N and energy needed to create the favorable rumen conditions required for increased roughage intake.

Conclusions

Forage quality of dry season leaf litter did not decrease over the course of the study. Goats grazing caatinga range alone were able to select a relatively good quality diet during the first half of the study and make sizeable weight gains. During the middle part of the trial, however, forage availability conditions apparently changed (i.e. limited quantity of palatable, good quality forage) and the goats were no longer able

to select a good quality diet, as indicated by weight responses and diet composition.

Supplementing N alone or energy alone did not improve goat performance (weight gains) in comparison to the nonsupplemented group during the last half of the trial. At this time, where diet quality was decreasing, supplementation of both N and energy was required to sustain the earlier rates of growth.

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HÁBITOS ALIMENTARES E SELETIVIDADE DE CAPRINOS E OVINOS EM PASTOREIO: CONSIDERAÇOES A RESPEITO DOS REQUERIMENTOS NUTRITIVOS DURANTE A ESTAÇÃO SECA

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RESUMO - Os hábitos alimentares e seletividade de caprinos e ovinos em pastoreio na região semi-árida do nordeste do Brasil são discutidos com base nos dados disponíveis para a região. Caprinos e ovinos são espécies bem adaptadas ao ecosistema da caatinga, e se enquadram como animais selecionadores intermediários, variando seus hábitos alimentares de acordo com a estação do ano, a disponibilidade, e a qualidade da forragem. Os dados analisados parecem indicar que a caatinga nativa, por si só, não é suficiente para fornecer os requerimentos energéticos dos animais durante toda a estação seca, e insuficiente para provir os requerimentos proteícos, pelo menos durante os meses mais críticos da mesma. O raleamento da caatinga com base nos hábitos alimentares dos animais aumenta o teor de proteína bruta, o consumo, e a digestibilidade da matéria orgânica nas dietas de caprinos e ovinos. Esta técnica, parece ser uma prática viável para atender os requerimentos proteícos desses animais durante a época seca. Por outro lado, o raleamento por si só, parece não ser suficiente para suprir os requerimentos energéticos dos animais em pastoreio durante toda a época seca, e a suplementação energética parece ser uma prática recomendável, pelo menos durante os meses mais críticos da estação seca. Estudos sobre a determinação dos requerimentos nutritivos de animais em pastoreio, e a quantificação do montante de nutrientes fornecidos pela caatinga manejada em diferentes situações e épocas do ano, são necessários para o estabelecimento de normas de manejo alimentar adequadas.

Termos para indexação: Caprinos, Ovinos, Caatinga, Raleamento, Suplementação energética, Manejo nutricional.

FEEDING HABITS AND SELECTIVITY OF FREE RANGING GOATS AND SHEEP: CONSIDERATIONS ABOUT NUTRIENT REQUIREMENTS DURING THE DRY SEASON IN NORTHEAST BRAZIL

ABSTRACT - The feeding habits and selectivity of free ranging goats and sheep in the semi-arid Northeast Brazil are discussed based on data available for that region. Goats and sheep are species well adapted to the "caatinga" ecosystem, and can be classified as intermediate feeders which vary their feeding habits according to the season of the year and the availability and quality of the forage. The data discussed seem to indicate that the uncleared "caatinga" by itself, does not furnish the energy requirements of the animals during the whole dry season,

and it is not able to supply the protein requirements, at least during the most critical months of the dry season. The thinning of the "caatinga" vegetation based on specific criteria of animals feeding habits increases the crude protein content, the intake and the organic matter digestibility in the diets of free ranging goats and sheep. This technique, seems to be a viable practice to meet the protein requirements of the animals during the dry season. On the other hand, dietary energy levels, even on thinned "caatinga" vegetation appear to be deficient for free ranging animals during the whole dry season, and energy supplementation seems to be a recommended practice, at least during the driest months of the year. Studies to determine the nutrient requirements of free grazing animals, as well as seasonal availability of these nutrients in uncleared and thinned "caatinga" vegetation types, are badly needed to develop adequate nutritional management guidelines.

Index terms: Goats, Sheep, "Caatinga" Vegetation, Thinning, Energy supplementation, Nutritional management.

Introdução

Um dos maiores problemas em produção animal em regiões semi-áridas tropicais é caracterizado por um acentuado decréscimo da produção durante a estação seca. Durante esse período, uma sensível queda na produção de biomassa é observada, e, dependendo do tipo de manejo e da taxa de lotação utilizada, essa redução pode representar de 57 a 81% da biomassa disponível durante a estação chuvosa (Mesquita, 1985). Afora essa diminuição na quantidade de matéria seca disponível, a qualidade da forragem sofre uma queda vertiginosa (Pfister, 1983; Kirmse, 1984), em decorrência do processo normal de maturação, processo este agilizado pelas altas temperaturas registradas durante a época seca.

Pequenos ruminantes, principalmente caprinos, têm sido indicados como animais possuidores de excelente capacidade de adaptação, que os coloca em condições de sobreviver em áreas adversas, como é o caso do trópico semi árido (Oliveira, 1979; Devendra & Coop, 1982). Esta habilidade tem sido atribuida a uma série de fatores, entre os quais uma maior eficiência digestiva na utilização de fibra (Gihad, 1976; 1980; Mia et al., 1960a; 1960b; Jang & Majumdar, 1962; Devendra, 1978), uma melhor economia de água e nitrogênio (Devendra & Coop, 1982), um maior tempo de mastigação e ruminação por unidade de parede celular (Louca et al., 1982), e uma maior habilidade seletiva por parte dos pequenos ruminantes (McDowell & Woodward, 1982; McDowell, 1984; Van Soest, 1982).

Uma maior habilidade seletiva por parte dos pequenos ruminantes parece ser a teoria mais comumente aceita por pesquisadores da área, muito embora outros fatores contribuintes sejam também reconhecidos. Huston (1978) classificou bovinos, ovinos e caprinos em ordem decrescente em termos de eficiência

digestiva, enquanto que esta sequência seria invertida quando a habilidade seletiva das mesmas espécies fosse considerada.

Este trabalho analisa a habilidade seletiva e comportamento alimentar de pequenos ruminantes, e tece considerações a respeito dos requerimentos energéticos e proteícos de caprinos e ovinos em pastoreio na região semi árida do nordeste do Brasil.

Classifição de Ruminantes de Acordo com os Hábitos Alimentares

Van Soest (1982) classifica os ruminantes em tres classes principais de acordo com os seus hábitos alimentares: 1) animais que selecionam alimentos concentrados; 2) animais selecionadores intermediários, e 3) animais utilizadores de volumosos. Esta classificação pode ser visualizada em maiores detalhes na Tabela 1.

De acordo com Van Soest (1982), os animais selecionadores de alimentos concentrados não conseguem tolerar grandes quantidades de fibra nas suas dietas, e são, consequentemente limitados a selecionar alimentos concentrados, e porções de plantas com baixo teor de fibra. Animais selecionadores intermediários são aqueles capazes de uma utilização limitada dos constituintes da parede celular, que apresentam uma alta velocidade de passagem, o que os permite ingerir quantidades suficientes de nutrientes fàcilmente fermentáveis. Os animais englobados nesta classificação apresentam uma grande flexibilidade alimentar e são adaptados tanto para o consumo de gramíneas, quanto para o consumo de dicotiledôneas herbáceas e brotos e folhas de árvores e arbustos. A terceira categoria de animais nessa classificação engloba aqueles ruminantes adaptados para uma velocidade de passagem mais lenta, e consequentemente aptos para uma melhor utilização dos constituintes fibrosos da parede celular das forragens.

Seletividade e Hábitos Alimentares de Caprinos e Ovinos no Nordeste do Brasil

Como pode ser observado na Tabela 1., caprinos e ovinos são classificados como animais selecionadores intermediários, no que diz respeito aos seus hábitos alimentares. Estes pequenos ruminantes são adaptados para consumir uma grande variedade de plantas, e apresentam um comportamento alimentar que pode ser classificado como oportunístico, e fàcilmente modificam as suas preferências alimentares de acordo com a disponibilidade de forragem e a estação do ano.

Este tipo de comportamento pode ser visualizado nos resultados obtidos por Pfister (1983) e Mesquita (1985) utilizando caprinos e/ou ovinos na região de Sobral, Ceará e sumarizados nas Tabelas 2 e 3.

Os dados de Pfister (1983) demonstram uma maior preferência de ovinos por gramíneas, quando comparados com caprinos, tanto na

TABELA 1. Classificação de ruminantes de acordo com o hábito alimentar.

CATEGORIA	RUMINANTES
Selecionadores de alimentos concentrados	
a) frutos e folhas	duiker, suni
b) brotos e folhas de árvores e arbustos	veado, girafa, kudu.
Selecionadores intermediários	
a) preferencialmente dicotiledôneas herbáceas e brotos e folhas de árvores e arbustos	moose, caprino, eland
b) preferencialmente gramíneas	ovino, impala
Consumidores de alimentos volumosos	
a) consumidores de gramíneas	búfalo, bovino, gnu, kob, oribi

FONTE: Van Soest, 1982.

TABELA 2. Composição botânica das dietas de caprinos e ovinos na região de Sobral, Ceará.

Tipo de forragem	OVINOS		CAPRINOS	
	estação chuvosa (Fev-Maio)	estação seca (Jun-Jan)	estação chuvosa (Fev-Maio)	estação seca (Jun-Jan)
Gramíneas	23,7 ± 14,1[a]	10,2 ± 4,2	13,6 ± 12,2	1,7 ± 0,8
Dicotiledôneas herbáceas	49,1 ± 12,4	38,3 ± 7,4	53,6 ± 12,4	40,2 ± 8,3
Brotos e folhas	26,4 ± 16,3	46,0 ± 8,2	31,6 ± 7,2	51,2 ± 7,6
Não identificadas	1,2 ± 0,2	5,5 ± 1,8	1,4 ± 0,7	6,1 ± 1,9

FONTE: Pfister, 1983.

[a]Média ± erro padrão

TABELA 3. Composição botânica da dieta de caprinos na região de Sobral, Ceará.

Tipo de forragem	Estação chuvosa	Estação seca
Gramíneas	35,3 ± 4,9[a]	27,3 ± 9,4
Dicotiledôneas herbáceas	19,4 ± 6,5	24,7 ± 6,8
Brotos e folhas	38,1 ± 12,6	39,7 ± 9,3
Não identificadas	7,2 ± 3,3	8.4 ± 3,8

FONTE: Mesquita, 1985.

[a]Média ± erro padrão.

estação chuvosa quanto na estação seca. Por outro lado, os caprinos demonstram uma maior preferência por dicotiledôneas herbáceas e brotos e folhas de árvores e arbustos em ambas as estações. Entretanto, ambas espécies animais mostram uma estratégia alimentar similar, diminuindo o porcentual de gramíneas e dicotiledôneas herbáceas na dieta, e aumentando o porcentual de brotos e folhas de árvores e arbustos, a medida que a estação seca progride e o grau de maturação das forrageiras herbáceas aumenta. Estes dados concordam plenamente com a classificação proposta na Tabela 1, e mostram o grau de flexibilidade na preferência alimentar de caprinos e ovinos nas condições do trópico semi-árido do nordeste do Brasil.

Os dados de Mesquita (1985), sumarizados na Tabela 3, demonstram a mesma tendência de variação estacional na preferência alimentar de caprinos em pastoreio. Os resultados mostram uma diminuição no porcentual de gramíneas na dieta, e um aumento no porcentual de dicotiledôneas herbáceas e brotos e folhas de árvores e arbustos da estação chuvosa para a estação seca.

Valor Nutritivo das Dietas de Caprinos e Ovinos no Nordeste do Brasil

Dados de valor nutritivo e consumo de matéria orgânica das dietas de caprinos e ovinos em pastoreio são mostrados nas Tabelas 4 e 5.

Os resultados mostram as mesmas tendências em ambas as tabelas, com um decréscimo nos valores de proteína bruta e digestibilidade in vitro da matéria orgânica (DIVMO) e um aumento nos teores de fibra em detergente neutro e lignina, a medida que a estação seca progride. Este decréscimo na qualidade da dieta é resultado do processo normal de maturação das forragens, processo este que é agilizado pelas altas temperaturas registradas durante a estação seca na região semi árida do nordeste do Brasil.

Os dados de Pfister (1983), mostram valores mais altos de proteína bruta, e valores mais baixos de fibra em detergente neutro e lignina, que os valores reportados por Kirmse (1984). De acordo com Pfister (1983), o nível de proteína bruta na dieta de caprinos e ovinos mantidos em pastoreio na região de Sobral, foi sempre superior a 11%, mesmo durante os meses mais críticos da estação seca. Entretanto, os dados de Kirmse (1984), mostram um decréscimo no porcentual de proteína bruta na dieta, com valores caindo de 10,3% em setembro para 7,3% em dezembro na dieta de caprinos, e de 8,6% para 7,4% na dieta de ovinos durante o mesmo período.

Por outro lado, com exceção dos valores para caprinos durante a estação chuvosa, os dados de digestibilidade in vitro da matéria orgânica reportados por ambos Pfister (1983) e Kirmse (1984), são bastante similares, como também os são os dados relativos ao consumo de matéria orgânica. Infelizmente, não foram

TABELA 4. Valor nutritivo e consumo de matéria orgânica nas dietas de caprinos e ovinos na região de Sobral, Ceará.

CONSTITUINTES	OVINOS		CAPRINOS	
	Estação chuvosa (Fev-Maio)	Estação seca (Jun-Jan)	Estação chuvosa (Fev-Maio)	Estação seca (Jun-Jan)
Proteína bruta (%)	16,3 ± 0,2[a]	14,4 ± 1,6	17,0 ± 0,2	14,6 ± 1,6
Fibra em detergente neutro (%)	37,3 ± 0,0	44,5 ± 2,7	38,1 ± 2,0	45,4 ± 2,9
Lignina (%)	7,1 ± 2,2	11,1 ± 1,0	10,4 ± 1,7	11,5 ± 0,7
DIVMO (%)	63,5 ± 2,9	52,1 ± 3,8	49,9 ± 3,0	50,5 ± 1,3
Consumo de matéria orgânica (% do peso vivo)	1,7 ± 0,5	2,4 ± 0,2	1,4 ± 0,3	2,2 ± 0,1

FONTE: Pfister, 1983.

[a]Média ± erro padrão.

TABELA 5. Valor nutritivo e consumo de matéria orgânica, nas dietas de caprinos e ovinos na região de Sobral, Ceará.

CONSTITUINTES	OVINOS		CAPRINOS	
	Estação chuvosa (Fev-Maio)	Estação seca (Jun-Jan)	Estação chuvosa (Fev-Maio)	Estação seca (Jun-Jan)
Proteína bruta (%)	14,3 ± 0,1[a]	9,7 ± 1,0	15,6 ± 0,2	10,9 ± 1,2
Fibra em detergente neutro (%)	43,9 ± 0,0	49,6 ± 3,1	42,3 ± 0,0	50,2 ± 4,1
Lignina (%)	11,7 ± 0,0	16,6 ± 1,0	11,0 ± 0,0	17,6 ± 1,0
DIVMO (%)	65,3 ± 0,0	53,9 ± 1,3	64,7 ± 0,0	53,3 ± 1,8
Consumo de matéria orgânica (% do peso vivo)	--	2,4 ± 0,4	--	2,0 ± 0,3

FONTE: Kirmse, 1984.

[a]Média ± erro padrão

encontrados valores para energia digestível, ou mesmo para energia bruta nas dietas dos animais estudados, na literatura consultada para a região nordeste do Brasil.

Requerimentos Nutricionais de Caprinos e Ovinos em Pastoreio

A grande maioria dos trabalhos relacionados com a determinação ou estimativa dos requerimentos nutricionais dos animais domésticos tem sido conduzida em regiões de clima temperado, e em condições controladas. Os animais são geralmente mantidos em confinamento, e as determinações são obtidas através do uso de calorimetria direta ou indireta. Os resultados destes trabalhos são sumarizados e reunidos em tabelas de requerimentos nutritivos para as diversas espécies animais, como são os casos das tabelas do NRC (1975, 1978, 1981, 1984) e ARC (1980), entre outras publicações técnicas. Estas tabelas fornecem importantes orientações para formulação de rações balanceadas, principalmente para animais mantidos em confinamento em regiões de clima temperado.

Entretanto, diferenças entre os requerimentos energéticos de animais confinados e aqueles mantidos em pastoreio têm sido reconhecidas. Young & Corbett (1972) indicam resultados encontrados na literatura para animais em pastoreio, variando de valores similares, até tres vezes superiores aos valores reportados para animais em confinamento.

Esta discrepância torna-se ainda mais crítica em regiões tropicais, onde os fatores ambientais impõem um gasto de energia ainda maior por parte dos animais em pastoreio. Este fato, associado a um valor nutritivo mais baixo das forrageiras tropicais, recomendam o uso de cautela na utilização das atuais tabelas de requerimentos, principalmente energéticos, em regiões tropicais. Ao mesmo tempo, torna-se clara a extrema necessidade da condução de trabalhos visando a determinação dos requerimentos energéticos de animais mantidos em pastoreio em climas tropicais.

Utilizando os valores de Kearl (1982) como base, e assumindo um gasto adicional de energia de 40% acima das necessidades de manutenção, os requerimentos de energia e proteina para um animal de 25 kg em pastoreio foram calculados, e são mostrados na Tabela 6.

Os dados obtidos por Pfister (1983) e Kirmse (1984), permitem estimar um consumo médio de matéria orgânica durante a estação seca da ordem de 2,2% do peso corporal dos animais, e uma digestibilidade da matéria orgânica da ordem de 50%. Usando os fatores de conversão descritos por Kearl (1982), 1kg de matéria orgânica digestível equivale a 4,63Mcal de energia digestível. Utilizando os valores mínimos de proteína bruta nas dietas de caprinos e ovinos em pastoreio na região de Sobral reportados no mes de dezembro por Pfister (1983) em 12% e por Kirmse (1984) em 7,3%, obtemos uma média das mínimas no valor de 9,7%.

TABELA 6. Requerimentos energéticos e proteícos para manutenção de caprinos e ovinos em pastoreio.

NUTRIENTES	OVINOS	CAPRINOS
Proteína bruta (g/dia)	53	49
Energia digestível (Mcal/dia)[a]	1.78	1.98

[a]Foi usado um fator de conversão de 1 Mcal EM = 1,22 Mcal ED.

O consumo de matéria orgânica calculado usando como base a média das estimativas de Pfister (1983) e Kirmse (1984), fornecem um valor de 0,55kg para um animal de 25kg. Considerando um teor de 9,7% de proteína bruta na dieta, teríamos um consumo de proteína bruta de 53,4 gramas, que seria o mínimo suficiente para atender os requerimentos proteícos dos ovinos. Por outro lado, considerando o mesmo nível de consumo da matéria orgânica, o teor mínimo de proteína bruta na dieta capaz de provir os requerimentos de manutenção dos caprinos seria reduzido para 9,0%.

Convém entretanto salientar, que Kirmse (1984), reportou teores de proteína bruta de 8,6; 7,9 e 7,4% na dieta de ovinos nos meses de setembro, outubro e dezembro, respectivamente, e de 8,3 e 7,3% na dieta de caprinos nos meses de outubro e dezembro, respectivamente. Considerando-se o mesmo nível de consumo de 2,2% do peso corporal, e baseando-se apenas nos dados de Kirmse (1984), uma pequena suplementação proteíca (50-60 gramas de torta de algodão por cabeça/dia) seria recomendavel durante os meses de setembro a dezembro.

Em termos de energia, entretanto, a situação seria bastante diferente. Considerando-se o mesmo nível de consumo de 0,55kg de matéria orgânica e uma digestibilidade média da matéria orgânica da ordem de 50% durante a estação seca, teríamos um consumo de matéria orgânica digestível estimado em 0,275kg. Usando os fatores de conversão descritos por Kearl (1982), 1kg de matéria orgânica digestível equivaleria a 4,63Mcal de energia digestível, e o consumo total de energia digestível por parte do animal seria igual a 1,27Mcal por dia. Este valor é definitivamente insuficiente para atender as necessidades energéticas de ambas as espécies animais durante toda a estação seca.

Se considerarmos o mesmo nível de consumo de matéria orgânica por parte dos animais, seria necessário que a digestibilidade mínima da matéria orgânica fosse de 70% na dieta dos ovinos, e de 78% na dieta dos caprinos para que os mesmos atingissem os requerimentos energéticos para manutenção. Naturalmente, o valor nutritivo das forrageiras disponíveis na caatinga durante a estação seca, tornam essa possibilidade bastante improvavel, senão impossível nas condições atuais.

Outra possibilidade seria um aumento do consumo de matéria orgânica acima do nível estimado de 2,2% do peso corporal dos animais. Para que os mesmos satisfizessem seus requerimentos energéticos, seria necessário um consumo mínimo de matéria orgânica da ordem de 3,1 e 3,5% do peso corporal de ovinos e caprinos, respectivamente. Esta hipótese, muito embora teoricamente possível, torna-se difícil de ser concretizada durante a fase mais crítica da estação seca, devido ao alto teor de lignificação da parede celular das forrageiras, o decréscimo na velocidade de passagem, e a consequente limitação imposta por esses fatores ao consumo de forragem.

Outra possibilidade seria a associação do aumento de consumo da matéria orgânica e o aumento da digestibilidade da mesma. Os dados de Kirmse (1984), sugerem um aumento da digestibilidade da matéria orgânica, e um aumento de consumo de forragem em caatinga raleada quando comparada com área não raleada. Os dados de Kirmse (1984), permitem uma estimativa conservadora de uma digestibilidade da matéria orgânica da ordem de 55% e um consumo voluntário médio de forragem da ordem de 2,6% do peso corporal dos animais.

Utilizando estes valores, teríamos um consumo de energia digestível de 1,66Mcal por dia, que ainda seria inferior em 0,12 e 0,32 Mcal/dia aos requerimentos energéticos para manutenção de ovinos e caprinos, respectivamente. Os resultados das possibilidades analisadas acima, são mostrados na Tabela 7.

Consequentemente, mesmo utilizando estimativas mais altas de consumo e digestibilidade da matéria orgânica, os animais ainda não conseguiriam satisfazer os seus requerimentos energéticos, e haveria uma necessidade de suplementação energética de aproximadamente 100 gramas de milho por cabeça/dia.

Conclusões

A avaliação dos resultados dos trabalhos sobre o comportamento e hábito alimentar de caprinos e ovinos em pastoreio na vegetação de caatinga predominante na região de Sobral, Ceará, permitem as seguintes conclusões:

1) Caprinos e ovinos demonstram um alto grau de adaptação ao ecosistema da caatinga. Ambas as espécies se enquadram como selecionadoras intermediárias e exibem um alto grau de flexibilidade alimentar, variando os seus hábitos alimentares de acordo com a estação do ano, disponibilidade e qualidade da forragem.

2) Apesar desse alto grau de adaptação dos animais, a caatinga nativa, por si só, parece ser insuficiente para fornecer os requerimentos energéticos de caprinos e ovinos em pastoreio, durante toda a estação seca, e os requerimentos proteícos pelo menos durante os meses mais críticos da mesma.

3) O raleamento ordenado da caatinga parece aumentar o teor de proteína bruta, o consumo, e a digestibilidade da matéria orgânica das dietas de caprinos e ovinos. Esta prática, por si só parece ser suficiente para fornecer os requerimentos proteícos de caprinos e ovinos em pastoreio durante a época seca, muito embora novos estudos devam ser conduzidos nesta área.

4) Apenas o raleamento da caatinga parece não ser suficiente para fornecer os requerimentos energéticos de caprinos e ovinos em pastoreio durante a época seca, e a suplementação energética parece ser uma prática recomendável, pelo menos durante boa parte da estação seca.

TABELA 7. Condições enfrentadas por caprinos e ovinos em pastoreio na região de Sobral, Ceará e possibilidades de satisfazerem seus requerimentos nutricionais durante a época seca.

CONDIÇÕES	OVINOS		CAPRINOS	
	Proteína (g/dia)	Energia (Mcal/dia)	Proteína (g/dia)	Energia (Mcal/dia)
Requerimentos	53	1,78	49	1,98
Caatinga	53,4	1,27	53,4	1,27
70% DIGMO	--	1,78	--	1,78
78% DIGMO	--	1,99	--	1,99
3,1% CONMO	--	1,79	--	1,79
3,5% CONMO	--	2,02	--	2,02
55% DIGMO + 2,6% CONMO	--	1,66	--	1,66
55% DIGMO + 2,6% CONMO + SUP	--	2,00	--	2,00

DIGMO = Digestibilidade da matéria orgânica.

CONMO = Consumo de matéria orgânica.

SUP = Suplementação.

Em sumário, existe uma carência imediata para condução de trabalhos visando a determinação dos requerimentos energéticos de caprinos e ovinos na região do trópico semi-árido. Ao mesmo tempo, existe a necessidade de um maior número de dados sobre a quantificação detalhada do montante de energia fornecido pela caatinga manejada em diferentes situações, e em diferentes épocas do ano.

Somente de posse de um volume de dados suficiente nas duas áreas acima citadas, poder-se-á sugerir sistemas de manejo adequados para a criação de caprinos e ovinos na região do trópico semi-árido.

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B. SANIDADE ANIMAL

B. ANIMAL HEALTH

BACTERIAL ISOLATIONS AND SHI TITERS ASSOCIATED WITH CASEOUS LYMPHADENITIS IN A SLAUGHTERHOUSE SURVEY OF GOATS AND SHEEP IN NORTHEAST BRAZIL

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ABSTRACT - A survey of caseous lymphadenitis was conducted at a goat and sheep slaughterhouse in northeastern Brazil. One hundred and fifty-eight goats and 43 sheep were examined for the presence of abscesses, with bacterial culturing for the etiologic agent. Blood was collected simultaneously for determination of serologic titer via the synergistic hemolysis inhibition (SHI) test which measures antibodies to an exotoxin of *Corynebacterium pseudotuberculosis*. Twenty-two of 158 (14%) of the goats had abscesses, with 15 of these 22 having mediastinal or pulmonary lesions (9.5% of total). Two sheep had abscesses, both with internal organ involvement. *C pseudotuberculosis* was the most frequently isolated organism. Of 7 goats with confirmed *C pseudotuberculosis* lesions, 6 were positive via the SHI test. Both of the sheep with abscesses had positive SHI titers. The proportion of serologic reactors was greater than the proportion of animals with abscesses. The SHI test may be detecting subclinically infected animals.

Index terms: Goats, Sheep, Caseous lymphadenitis, Northeast Brazil.

ISOLAMENTOS BACTERIANOS E TÍTULO SHI ASSOCIADOS COM LINFADENITE CASEOSA NUMA PESQUISA DE CAPRINOS E OVINOS REALIZADA NUM MATADOURO NO NORDESTE DO BRASIL

RESUMO - Foi conduzido num matadouro no Nordeste do Brasil um levantamento de linfadenite caseosa de caprinos e ovinos. Foram examinados 158 caprinos e 43 ovinos com presença de abscessos e feito cultura bacteriana para saber o agente etiológico. Simultaneamente, era coletado sangue para determinar o título sorológico pelo teste de inibição da hemólise sinérgica (SHI test) o qual mede anticorpos para a exotoxina do *Corynebacterium pseudotuberculosis*. Dos 158 caprinos 22 (14%) tinham abscessos, com 15 dos 22 tendo lesões mediastinal ou pulmonar (9.5% do total). Dois ovinos tinham abscessos, ambos com envolvimento interno do orgão. O organismo mais frequentemente isolado foi *C pseudotuberculosis*. De 7 caprinos com lesões confirmadas de *C pseudotuberculosis*, 6 foram positivo pelo SHI test. Ambos os ovinos com abscesses tinham SHI test título positivo. A proporção dos reagidos sorológicamente foi bem maior que a proporção de animais com abscessos. O teste de inibição da hemólise sinérgica pode ser util para detectar animais infectados subclinicamente.

Termos para indexação: Caprinos, Ovinos, Linfadenite caseosa, Nordeste do Brasil.

Introduction

Caseous lymphadenitis (CLA), caused by Corynebacterium pseudotuberculosis, is a disease of worldwide importance in sheep and goats (Burrell, 1980; Maddy, 1953; Nairn et al., 1977). It is characterized by abscessation of one or more lymph nodes, most commonly the large superficial nodes. The disease is insidious and there is increasing recognition of the involvement of internal nodes in the so-called visceral form of the disease.

Economic losses due to caseous lymphadenitis are most severe in the disseminated visceral form which can result in loss of the animal´s value by wasting, death or carcass condemnation due to the extensive internal abscesses (Stoops, et al., 1984). Visceral CLA has been implicated as one of the major causes of ill-thrift, the "thin ewe syndrome," in the United States (Renshaw et. al., 1979). Other occult losses can occur from a decrease in reproductive efficiency when internal abscesses are present (Gates et. al., 1977) Economic effects of the superficial form of CLA are less well-documented. A decrease in milk production has been reported in a dairy goat herd with a high incidence of mammary C pseudotuberculosis abscesses (Burrell, 1980), and hide values can be drastically slashed by flaws due to superficial abscesses (Figueiredo et. al,, 1982). Finally, concern about the spread of CLA can lower the market value of an animal with a superficial or skin abscess.

Control of CLA has been an area of major concern. Introduction of an infected animal into a previously uninfected herd can result in a surge of abscesses two to three years later (Ashfaq & Campbell, 1979; Ayers, 1977). Once endemic, it is almost impossible to eradicate as antibiotics are unable to penetrate the thick capsule of the abscess (Ashfaq, 1979), organisms can survive and persist in soil and on fomites (Augustine & Renshaw, 1982), and there are, as of yet, no commercially available vaccines in this country.

Diagnosis of CLA is straightforward when a mature superficial abscess is present. The abscess material is chasracteristically light green and slightly dry. The etiologic agent, C pseudotuberculosis, is readily cultivated on blood agar under normal aerobic conditions. However, prior to superficial abscess formation and in all cases of abscesses in internal nodes, the infection is not obvious on clinical examination. A reliable diagnostic assay is needed to detect animals with internal abscesses or in the sub-clinical phase of infection. Such a test would be of great benefit in protecting clean herds against introduction of infection and would allow for earlier diagnosis and earlier and more economic culling of those animals with visceral lesions.

The synergistic hemolysis inhibition (SHI) test is a serologic assay which measures antibodies to the exotoxin of C pseudotuberculosis (Knight, 1978). Originally designed for use in horses, it has been applied to goats with caseous lymphadenitis in an experimental setting with promising results.

This study was undertaken to examine the reliability of the SHI test for detecting the presence of abscesses, both external and internal, in field cases of CLA in sheep and goats. In the process, a rough estimate was obtained of the prevalence of both serologic reactivity and C pseudotuberculosis abscesses in slaughterhouse specimens in one of the world's most concentrated goat and sheep producing areas.

Materials and Methods

A survey of 200 adult animals (158 goats, 43 sheep) was undertaken at the municipal slaughterhouse of Petrolina in northeastern Brazil during the month of August 1984.

All animals were inspected briefly antemortem for the presence of any enlarged superficial lymph nodes or obvious signs of disease.

Blood for serology was collected at the time of exsanguination. Superficial nodes were palpated prior to skinning and examined again when the hide was removed. Viscera were inspected, with special attention to spleen and the mesenteric, tracheobronchial, and mediastinal lymph nodes. Lumbar nodes were checked in situ within the carcass. Purulent material was collected from all abscesses for bacteriologic culturing.

Samples for bacteriology were plated directly onto beef blood agar and incubated aerobically at 37°C. Identification was based on standard methods.

Serum samples were processed via the SHI test which is described elsewhere (Knight, 1978).

Results

A total of 158 goats (42 does and 116 bucks and castrated males) were examined. A wide range of ages was represented, with a mean of 2.1 years. All animals were of mixed breeding. A total of 25 abscesses were found in 22 animals (13.9%). Sixteen goats had internal lesions only, five goats had external lesions only, and one animal had both external and internal abscesses. Body distribution and frequency of the 25 abscesses is summarized (Table I). The most frequently affected site was the mediastinal lymph node, with 13 animals (8.2%) having an abscess at this location. In two of these animals, the mediastinal abscess had extended to involve abscessation of the pulmonary parenchyma.

TABLE I. Body location and frequency of 25 abscesses discovered at slaughter in 22 goats.

Internal abscesses	
mediastinal lymph node	13
tracheobronchial lymph node	2
lung	2
spleen	1
lumbar lymph node	1
Superficial abscesses	
parotid lymph node	2
mandibular lymph node	1
prescapular lymph node	1
prefemoral lymph node	1
subcutaneous tissue	1

Two other animals had abscesses in the tracheobronchial node, making a total of 15 goats (9.5%) with thoracic lesions. In all, 17 animals (10.7%) had internal abscesses.

The 43 sheep examined included 15 ewes and 28 rams and wethers. Ages ranged from 1 to 6 years, with the mean being 2.2 years. Most were mixed breed hair sheep. Abscesses were found in only two animals. One animal had a single tracheobronchial node abscess. The other displayed multiple lesions including an extensive subcutaneous pectoral abscess and series of abscesses in the mediastinal nodes, tracheobronchial nodes, and liver.

Of 21 abscesses cultured, 3 were from the sheep, and *C pseudotuberculosis* was successfully isolated from each. Of the 18 swabs from the goat abscesses, *C pseudotuberculosis* was isolated from 4 in pure culture and from another 3 in combination with either *Staphylococcus* sp. or Gram negative rods. One abscess yielded only *Moraxella bovis*. Gram negative rods were cultured from all of the remaining 10 abscesses. Isolates included *E coli*, *Enterobacter* sp., *Pseudomonas*, and others which were not identified.

Serologic results for the goats are presented (Table II). Forty-six percent of the animals were serologic reactors; 54% were serologically negative. Of the 22 animals with abscesses, 20 (19%) had positive titers. Of the 7 animals with confirmed *C pseudotuberculosis* abscesses, 6 had positive titers (85.7%). Two abscessed animals had negative titers. In one of these animals only gram-negative rods were cultured from the abscess. The other animal had only a very small (0.5 cm diameter) well walled-off mediastinal abscess, from which *C pseudotuberculosis* was successfully isolated.

Serologic results for the sheep are presented (Table III). Fourteen percent had positive titers; 86% had negative titers.

Both sheep with C. pseudotuberculosis abscesses had positive titers.

TABLE II. Incidence of serologic response and presence of abscesses in 158 goats.

	Animals with abscesses (22)	Animals without abscesses (136)
Animals with positive SHI titer (73)	20	53
Animals with negative SHI titer (85)	2	83

TABLE III. Incidence of serologic response and presence of abscesses in 43 sheep.

	Animals with abscesses (2)	Animals without abscesses (41)
Animals with positive SHI titer (6)	2	4
Animals with negative SHI titer (37)	0	37

Discussion

A striking finding in this study was the high incidence of abscesses (13.9%) in apparently healthy goats. The majority of these abscesses were internal. Of 22 abscessed goats, 17 (77%) had internal lesions, and in all but one case, these were in the absence of external abscesses. Intrathoracic locations were most popular, with mediastinal node abscesses seen in 11 of these 22 (52%) goats and tracheobronchial nodes and pulmonary parenchymal abscesses occurring in 4 of these 22 (18%). This preponderance of internal, primarily intrathoracic, lesions in the absence of external abscesses suggests that inhalation may be playing a role in transmission. Although methods of transmission of CLA have been the subject of some speculation, there is widespread support for abraded skin or oral mucous membranes as most probable portals of entry (Nagy, 1976; Asfaq & Campbell,

1980). Thoracic lesions have been produced by intradermal or subcutaneous inoculation of cultures and so hematogenous origin of abscesses in pulmonary nodes or parenchyma has been proposed (Nairn & Robertson, 1974). But in this study, the prominence of thoracic lesions in the absence of any involvement elsewhere in the body provided strong support for an airborne mode of transmission. C pseudotuberculosis is capable of long-term survival in soil (Augustine & Renshaw, 1982). Perhaps this area of Brazil which is hot, dry, and dusty throughout the year provides optimal conditions for generating a bacteria-laden dust aerosol which could be carried past the defenses of the upper respiratory tract and into the lung.

The recovery rate of C pseudotuberculosis from goat abscesses was disappointingly low. In all cases, the abscess material had the characteristically light green slightly dry appearance which is the organism's trademark. Although samples were handled in as sterile a manner as possible, many of the primary plates were overgrown with contaminants, making it very difficult to pick out the desired colony. This contamination is believed responsible for the inability to isolate C pseudotuberculosis from any of the abscesses. Another reason may be sampling from a sterile portion of the abscess. A third reason to be considered is that abscesses were caused by organisms other than C pseudotuberculosis.

An attempt was made to examine SHI titers in field cases of the disease. Of 7 goats from which C pseudotuberculosis was isolated, 6 (85.7%) had SHI titers greater than or equal to 1:32. Of the total 22 animals with abscesses, 20 (90.9%) were serologically positive (titer of 1:4 or greater). And of all goats, 46% were serologically positive. In sheep, both animals with abscesses (C pseudotuberculosis isolated successfully from each animal) had positive titers. In total, 13.9% of sheep were serologically positive.

Although the SHI test was positive for 6 of 7 (85.7%) goats and 2 of 2 sheep (100%) with C pseudotuberculosis abscesses, the numbers involved in this study are too small to make any definitive statements concerning the sensitivity of the SHI test for detecting animals with caseous lymphadenitis. However, previous work in an experimental setting indicates that sensitivity and specificity of the SHI test are very good (Brown et. al., 1985. In both sheep and goats, the percentage of serologic reactors was much greater than the percentage of animals with abscesses. CLA is noted for its chronic, recurring nature and the possibility exists that animals once infected develop persistent antibody titers. They may then harbor the organism for a subsequent recrudescence.

If positive SHI titers in animals without any current evidence of abscesses are a reflection of an infected carrier state, then the SHI test could be useful in a test-and-eradication scheme, with culling of animals that are strongly seropositive.

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PROTECTION OF GOATS AGAINST INTRADERMAL CHALLENGE WITH CORYNEBACTERIUM PSEUDOTUBERCULOSIS BY A TOXOID VACCINE

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ABSTRACT - Two groups of 5 goat kids each were vaccinated subcutaneously twice at a two-week interval with 2 different concentrations of a formalized exotoxin of Corynebacterium pseudotuberculosis along with Freund's incomplete adjuvant. Twenty days subsequent to the second vaccination, these kids, along with four unvaccinated controls, were inoculated intradermally with live C pseudotuberculosis. Animals were monitored for 13 weeks. At necropsy 5 of the 10 vaccinated animals had no C pseudotuberculosis lesions, 3 had abscesses limited to the inoculation site and draining lymph node, and 2 had disseminated bacterial lesions. In the 5 unvaccinated controls, 4 had disseminated abscesses and the fifth had a single abscess in an internal node. Serologically, 9 of the 10 vaccinated animals developed positive antibody titers to the organism's exotoxin within one week post-infection. The tenth seroconverted one week later whereas the group of control animals required three weeks to develop a positive antibody response. Antibodies to the exotoxin early in infection may protect against spread of the organism.

All animals were injected intradermally at regular intervals with a skin test reagent made of fragmented bacterial cells. There were no positive skin reactions prior to challenge. After challenge, grossly observable responses increased throughout the trial. Skin testing may prove useful in certain clinical and experimental situations.

Index terms: Goats, Caseous lymphadenitis, Vaccine.

PROTEÇÃO CONTRA O DESAFIO INTRADÉRMICO DO C PSEUDOTUBERCULOSIS USANDO UMA VACINA TOXOIDE PARA CABRAS

RESUMO - Dois grupos de 5 cabritos foram vacinados subcutâneamente duas vezes em intervalos de duas semanas, com diferente concentrações da exotoxina de Corynebacterium pseudotuberculosis formalizada com adjuvante incompleto de Freund's. Vinte dias depois da segunda vacinação, estes cabritos, com 5 controles não vacinados, foram inoculados intradêrmicamente com C pseudotuberculosis vivos. Os animais foram observados durante 13 semanas. Na necropsia de 5 dos 10 animais vacinados não tinham lesões de C pseudotuberculosis, três tinham abscessos limitados para o lado do inoculado e do linfonodo drenado, e dois tinham lesões bacteriana disseminada. Em 5 controles não vacinados, 4 tinham abscessos disseminados e o quinto tinha um único abscesso em um linfonodo interno. Sorológicamente, 9 dos 10 animais vacinados desenvolveram

anticorpos título positivo para a exotoxina do organismo dentro de uma semana pós-infecção. O décimo soro convertido uma semana tarde, visto que o grupo de animais controle necessitou três semanas para desenvolver uma resposta anticorpos positivo. Anticorpos para a exotoxina no princípio da infecção pode proteger contra a expansão do organismo. Todos animais foram injectados intradérmicamente em regular intervalos com um teste reagente de pele feito de fragmentos de células bacterianas. Não houve reações positivo de pele antes da infecção experimental. Depois da infecção experimental as reações clínicas aparente aumentaram por todo o experimento. O teste de pele pode ser útil em certas situações clínicas e experimentais.

Termos para indexação: Caprinos, Linfadenite caseosa, Vacina.

Introduction

Caseous lymphadenitis (CLA) of goats is recognized as a worldwide problem and a serious cause of economic loss to the goat industry (Burrell, 1981; Ashfaq & Campbell, 1980). Caused by Corynebacterium pseudotuberculosis (formerly C ovis), it is a chronic disease in which one or more lymph nodes, usually the larger superficial nodes, become abscessed. Less frequently internal nodes may be involved in a more serious visceral form of the disease.

Control of CLA has been challenging. The long incubation period and the recurring nature of the disease with clinically quiescent periods between bouts of abscess formation often make it impossible to distinguish between infected carrier animals and uninfected individuals. Introduction of an infected animal into a "clean" herd can result in a wave of abscesses two to three years later (Campbell et al., 1982). Once established, the disease is virtually impossibe to eradicate. The thick wall of the abscess renders it refractory to antibiotic therapy (Ashfaq & Campbell, 1979); the organisms are able to survive and persist in the soil and on fomites (Augustine & Renshaw, 1982a, 1982b); and attempts at environmental sanitation to decrease the incidence have been only marginally successful (Burrell, 1981).

Development of an efficacious vaccine would be valuable in efforts to control caseous lymphadenitis. Various preparations have been tested in sheep. Vaccination of lambs with whole cells or cell walls of C pseudotuberculosis resulted in a decreased number of pulmonary abscesses as compared to controls after intravenous challenge (Brogden et al., 1984). Formalized exotoxin protected sheep against a challenge of purulent material placed on fresh skin cuts (Nairn et al., 1977). A commercially made toxoid, "Glandvac" (Commonwealth Serum Laboratories, Melbourne, Australia) has recently become available for use in sheep in Australia. In a limited experimental trial, this commercial toxoid demonstrated some protection against challenge in Angora goats (Anderson & Nairn, 1984).

It was the aim of this study to examine the efficacy of a formalized exotoxin in producing protection against disseminated abscesses after intradermal challenge with C pseudotuberculosis in goats. Developing humoral and cell-mediated immune responses were evaluated using serology and skin testing, respectively.

Materials and Methods

To make the toxoid, a strain of C pseudotuberculosis was grown in brain-heart infusion broth for three days and then centrifuged. The supernatant (toxin) was vacuum filtered and titrated to determine hemolytic activity (Knight, 1978). Three percent formalin was added.

Fifteen male goats, three weeks of age and seronegative for C pseudotuberculosis by the synergistic hemolysis inhibition (SHI) test (Knight, 1978), were separated into three groups of equal size. Goats in Group I were vaccinated subcutaneously, twice, at a two week interval with 0.5ml of toxoid plus Freund's incomplete adjuvant (Sigma Chemical Company, St. Louis, Mo.). Goats in Group II were vaccinated in exactly the same manner, but received double the dose of toxoid (1.0ml). Group III goats were left as unvaccinated controls.

Twenty days after the second vaccination, all fifteen goats were inoculated intradermally with 4.2 X 10 (Augustine & Renshaw, 1982a) colony forming units of live C pseudotuberculosis.

Animals were monitored clinically throughout the duration of the trial, with frequent blood sampling for hematologic and serologic examination. Serologic tites were obtained by the SHI method as described (Knight, 1978).

A skin test reagent was made from killed, fragmented bacterial cells and skin testing carried out prior to challenge and at regular intervals post challenge. Reactions were measured, with skin punch biopsies performed at 72 hours after testing. In a test to verify that animals were not becoming sensitized to the antigen as a result of testing, five age-matched seronegative kids from the original herd were inoculated with the antigen three times at three-week intervals, and the reactions were measured and biopsied.

All 15 goats were killed at 13 weeks post challenge. Any abscesses seen at necropsy were cultured. Major viscera and portions of major lymph nodes were examined histopathologically.

Results

Clinical effects of vaccination - Group I animals had no abnormal clinical signs after the first vaccination, but for a short period following the second vaccination, one animal was depressed, and another was lame in the limb closest to the

vaccination site. In Group II, two animals were febrile, three were lame, and one had diarrhea following the first vaccination. After the second vaccination one animal was depressed, febrile, and diarrheic. Three of 10 vaccinated goats developed transient fibrous swellings at the vaccination site.

Production of clinical disease - All goats had a febrile episode of 24-48 hours following challenge. During the next four weeks all developed suppurative ulcerating lesions at the inoculation site and variably enlarged right prefemoral lymph nodes. In all other respects animals remained clinically normal.

Clinical pathologic examination - Within two weeks after challenge, all vaccinated animals and four controls had a transient leukocytosis and neutrophilia. Packed cell volume and plasma protein values remained constant.

Gross pathologic and bacteriologic examinations - *C pseudotuberculosis* was isolated from suppurative lesions at the intradermal inoculation sites of all 13 animals which were sampled within the first month after inoculation.

The distribution of body abscesses and cultural examination results obtained at necropsy are summarized (Table 1). In the Group I vaccinates one animal had no lesions, two had abscesses confined to the local lymph node, one had abscesses at both the local node and the inoculation site, and one had multiple abscesses. In the Group II vaccinates three were free of lesions, one had a small abscess at the vaccination site (negative for *C pseudotuberculosis*), and only one had multiple lesions. Of the controls four had disseminated abscesses, and one had a single abscess within a lumbar node.

Histopathologic examination of necropsied goats - In one Group II animal which had no gross abscess at necropsy both mandibular lymph nodes had several microscopic foci of caseation necrosis within the cortices. Special staining failed to demonstrate any bacteria. Other significant histopathologic findings were limited to the grossly abscessed lymph nodes. Nodal parenchyma was pushed aside by an expansive central mass composed of dead and dying macrophages and eosinophilic debris, all surrounded by a band of fibrous tissue containing aggregates of lymphocytes. Special staining highlighted clumps of gram-positive coccobacilli scattered throughout the central necrotic mass.

Serology - Only one of the vaccinated animals developed a positive titer (1:8) subsequent to the second vaccination. Within one week after challenge, nine vaccinated goats became seropositive, and the tenth animal seroconverted at two weeks post infection (p.i.). In the unvaccinated controls, only one goat had a positive titer by ten days p.i., with all being seropositive by three weeks p.i. Mean group titers are presented (Fig. 1). In no case did any animal's titer revert to negative.

TABLE 1. Distribution of body abscesses at necropsy in goats inoculated with *C pseudotuberculosis*.

Animal No.	Abscesses seen at necropsy	Bacterial isolation
GROUP I (VACCINATED WITH 0.5ML TOXOID)		
1	Right prefemoral lymph node	*C pseudotuberculosis*
2	Right prefemoral lymph node	*C pseudotuberculosis*
3	None	- - -
4	Inoculation site, and right prefemoral lymph node	*C pseudotuberculosis*
5	Inoculation site, right prefemoral, right lumbar lymph nodes, pleural abscess	*C pseudotuberculosis*
GROUP II (VACCINATED WITH 1ML TOXOID)		
6	Inoculation site, right prefemoral, tracheobronchial lymph nodes, pulmonary abscess	*C pseudotuberculosis*
7	None	- - -
8	Vaccination site	*Streptococcus viridans*
9	None	- - -
10	None	- - -
GROUP III (UNVACCINATED CONTROLS)		
11	Inoculation site, right prefemoral, tracheobronchial lymph nodes, splenic abscess	*C pseudotuberculosis* *C pseudotuberculosis* *Pseudomonas* spp. *C pseudotuberculosis*
12	Right prefemoral, mediastinal, tracheobronchial, left mandibular lymph nodes	*C pseudotuberculosis*
13	Right lumbar lymph node	*C pseudotuberculosis*
14	Inoculation site, right prefemoral, right lumbar, tracheobronchial, right parapharyngeal lymph nodes	*C pseudotuberculosis*
15	Inoculation site, right prefemoral, right lumbar, glossopharyngeal lymph nodes	*C pseudotuberculosis* *C pseudotuberculosis* *C pseudotuberculosis* *Acinetobacter* sp., and *Calcoaceticus* sp.

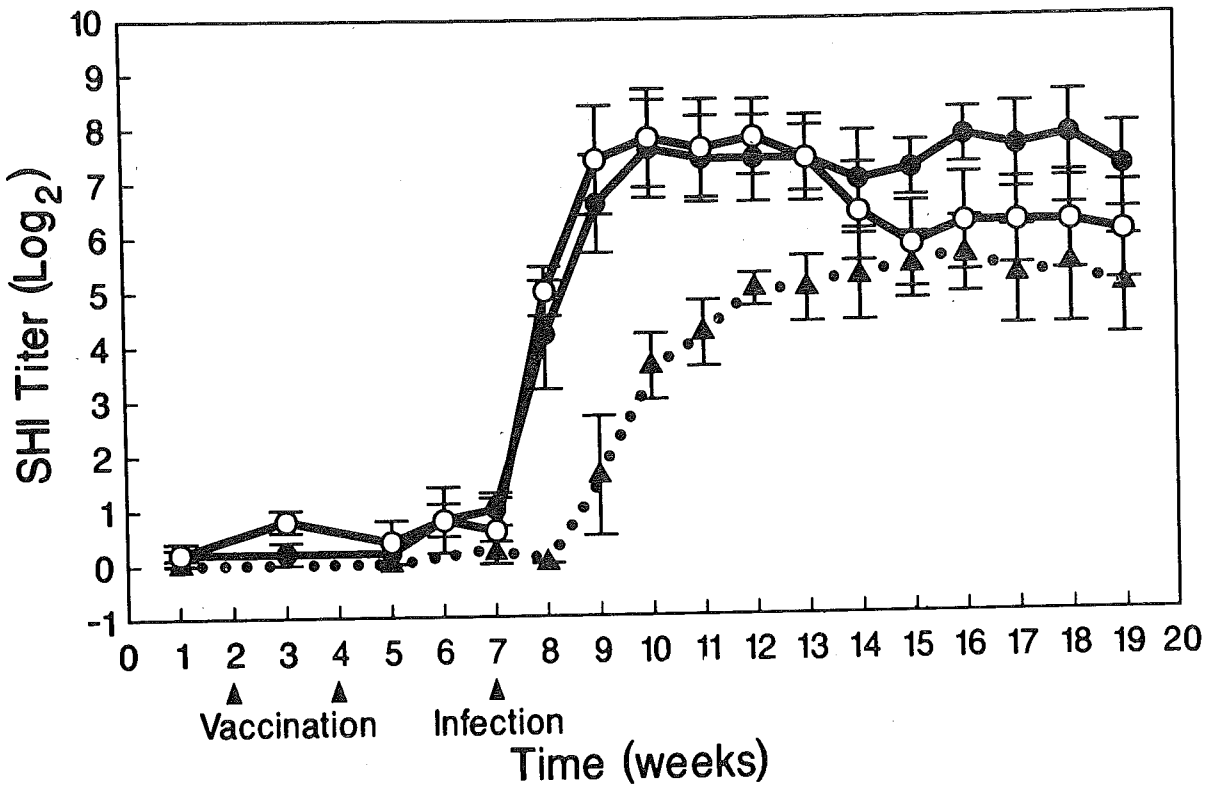

FIGURE 1. Mean synergistic hemolysis-inhibition (SHI) titers ± SEM for groups vaccinated with 0.5ml toxoid (○—○), 1ml toxoid (●—●), and unvaccinated controls (▲—▲).

Skin test results - There was no grossly observable reaction in any of the age-matched uninfected kids. Histologically, four of these five kids had a slight increase in cellularity around vessels which was of equal severity at all three sampling periods. Cell types were predominantly lymphocytes and macrophages, with a scattering of neutrophils. In the experimental kids there was no clinical response to skin testing prior to vaccination or after vaccination but before challenge. The histology of these biopsies was similar to those taken from the uninfected age-matched animals. After challenge all animals developed measureable reactions in response to skin testing. Mean diameters and indurations (double fold skin thickness) for the three groups after challenge are presented (Table 2). In all groups, there was a progressive increase in diameter between 10 days and four weeks p.i., and then again between eight and twelve weeks p.i. By light microscopy, these reactions consisted of focal yet spreading peri-vascular aggregates of macrophages and lymphocytes, and occasionally neutrophils. After one month post-infection, thrombosis of venules was a prominent feature, along with fibrin, edema, and often microabscesses.

TABLE 2. Clinical skin test responses (cm) at 72 hours in all three groups.

	Time post challenge			
	10 days	4 weeks	8 weeks	12 weeks
GROUP I (VACCINATED WITH 0.5ML TOXOID)				
diameter	0.73±.13	1.60±.13	1.56±.05	1.80±.14
inuuration	0.61±.10	1.17±.12	1.12±.05	1.20±.14
GROUP II (VACCINATED WITH 1ML TOXOID)				
diameter	0.76±.08	1.52±.06	1.52±.08	1.60±.10
induration	0.50±.05	1.07±.10	0.88±.05	1.00±.05
GROUP III (UNVACCINATED CONTROLS)				
diameter	1.20±.20	1.66±.14	1.64±.02	1.86±.04
induration	0.70±.10	1.03±.14	1.00±.05	0.92±.05

Discussion

Three months after challenge, 8 of the 10 vaccinated goats were free of disseminated C pseudotuberculosis lesions, whereas in the unvaccinated controls, 4 of 5 had disseminated bacterial lesions. Chi-squared test revealed significance ($X^2=5.0$) at $P<.05$. Although only one vaccinated animal had a measurable titer prior to infection, all but one developed strong positive titers within one week post-infection. In contrast no unvaccinated controls were seropositive until three weeks p.i. Antibodies to the exotoxin in the immediate postinfection period may have a protective effect. The exotoxin of C pseudotuberculosis, a phospholipase D, acts on sphingomyelin and has been shown in vitro to have a lytic effect on endothelial cells (Carne & Onone, 1978). It is thought to function in vivo as a permeability factor (Jolly, 1965), allowing for local spread of the organism and increasing the bacteria's chances of being carried to more distant sites (Brown, et al., in press). Anti-exotoxin antibodies present in the initial multiplication period may limit the local spread and general dissemination of the organism.

Protection was not complete, however. Of ten vaccinated animals two had disseminated abscesses at necropsy. The challenge dose of 4.2×10^6 CFU deposited directly intradermally was much higher than what might be expected under natural conditions. Although the mode of transmission of CLA in goats has not been firmly established, it is thought that contact of skin abrasions with contaminated soil or fomites is likely (Hein & Cargill, 1981). A gram of pus may contain 10^6 to 10^7 CFU of C pseudotuberculosis (Augustine et al., 1982), but as this pus becomes dried and dispersed in soil or on fomites, the concentration would fall, so that a natural challenge dose would be considerably lower than 4×10^6 CFU.

Skin testing may prove a useful tool for monitoring infection or exposure to C pseudotuberculosis. None of the animals responded significantly prior to infection, and repeated testing of age-matched uninfected controls was consistently clinically negative. All infected animals responded positively at each testing period. At 4 and 8 weeks p.i. the reactions were more extensive than at ten days p.i., with larger diameters and increased mononuclear cellularity, fibrin exudation, and thrombosis evident histologically. These reactions were even more pronounced at 12 weeks p.i. indicating the sequential development of a cellular immune response. Since C pseudotuberculosis is known to function as a facultative intracellular parasite (Hard, 1972), the development of a cell-mediated response would be expected to aid in protection. This skin testing may have a place in examining immune responses in experimental situations or in field cases where serology is impractical.

A surprising histologic feature of the skin biopsies was the presence of thrombosis and microabscesses along with the heavy

mononuclear cell infiltrate in many of those samples taken four weeks p.i. and later. The skin test antigen was crude, consisting of a suspension of bacterial cell fragments made by passage of killed whole cells through a high pressure apparatus (20,000psi), and so a wide range of antigens including not only desired cell wall components but also cytoplasm and subcellular organelles was presented to the immunocytes. A reaction to these non-specific organelles may account for some of the mild histologic responses seen in the uninfected animals. Also, exotoxin is present in small amounts in both the cytoplasm and the cell wall. Therefore, as antibodies to the exotoxin developed, there was a greater chance of a local Arthus reaction with thrombosis, infarction, and subsequent neutrophilic invasion. Another possiblity is that thrombosis was due directly to the action of the exotoxin, which is lytic for endothelial cells *in vitro*. However, the skin test reagent was heated to 100°C for 15 minutes which should have destroyed all exotoxin activity (Carne, 1940). Purifying the skin test reagent to remove exotoxin and cytoplasmic components should result in increasing the specificity of the test for detection of cell-mediated immunity to *C pseudotuberculosis*.

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SKIN TEST RESPONSES TO THREE DIFFERENT ANTIGENS IN GOATS AND SHEEP NATURALLY INFECTED WITH CORYNEBACTERIUM PSEUDOTUBERCULOSIS

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ABSTRACT - Nineteen goats and 18 sheep, all with histories of recent Corynebacterium pseudotuberculosis abscesses, were skin tested with 3 reagents - a crude antigen of formalin-killed C pseudotuberculosis bacterial cells, purified protein derivative of Mycobacterium avium (PPD-A) and PPD-B (Mycobacterium bovis). Eighteen goats (95%) and 8 sheep (57%) had positive skin reactions to the specific C pseudotuberculosis bacterial antigen. The failure of one goat to react was attributed to anergy. Skin testing with a specific antigen may be useful as a diagnostic method for caseous lymphadenitis in goats. Reactions to PPD-A and PPD-B were variable. Serum was collected simultaneously for determination of titer via the synergistic hemolysis inhibition (SHI) test which measures antibodies to the exotoxin of C pseudotuberculosis. All goats and 13 of 14 sheep had serologic titers greater than or equal to 1:16. The SHI test may be reliable serologic assay for caseous lymphadenitis in goats and deserves further testing in both goats and sheep.

Index terms: Goats, Sheep, Caseous lymphadenitis.

RESPOSTA DE TESTES EPIDÉRMICOS À TRÊS DIFERENTES ANTÍGENOS EM CABRAS E OVELHAS NATURALMENTE INFECTADAS COM C PSEUDOTUBERCULOSIS

RESUMO - Foram examinados com 3 reagentes de pele 19 caprinos e 18 ovinos, todos com história recente de abscessos com Corynebacterium pseudotuberculosis - foi usado um antígeno cru de formalin - células bacterianas de C pseudotuberculosis morto, um derivado de proteina purificado de Mycobacterium avium (PPD-A) e PPD-B (Mycobacterium bovis). Dezoito caprinos (95%) e oito ovinos (57%) tinham reações de pele positivo para o específico antígeno bacteriano C pseudotuberculosis. A falta de um caprino não reagir foi atribuída a diminuição da reactividade para o específico antígeno. Teste de pele com específico antígeno pode ser útil para um método de diagnóstico contra linfadenite caseosa em caprinos. Reações para PPD-A e PPD-B foram variáveus. Para determinar o tiPH´tulo pelo teste de inibição da hemólise singrgica (SHI) test o qual mede anticorpos contra a exotoxina do C pseudotuberculosis era coletado soro simultaneamente. Todos caprinos e 13 de 14 ovinos tinham títulos sorológicos maior ou iqual para 1:16. O SHI test pode ser um ensaio seguro para detectar linfadenite caseosa em caprinos; e merece fazer mais testes em caprinos e ovinos.

Termos para indexação: Caprinos, Ovinos, Linfadenite caseosa.

Introduction

Caseous lymphadenitis (CLA), caused by Corynebacterium pseudotuberculosis, is an important disease problem of sheep and goats worldwide (Ayers, 1977; Burrell, 1981; Nairn & Robertson, 1974). It is characterized by chronic, insidious, often recurring abscessation of one or more lymph nodes. Usually it is the larger superficial nodes which are affected but occasionally critical internal nodes are involved in a more serious visceral form of the disease.

Control of CLA has been an area of major concern. Due to the long incubation period of the disease and its recurring nature with clinically normal periods in between bouts of abscess formation, it is often impossible to distinguish between infected and non-infected animals on clinical examination alone. Introduction of an infected animal into a previously uninfected herd can result in a wave of abscesses two to three years later (Ashfaq & Campbell, 1979). Once endemic in a herd, it is virtually impossible to eradicate as the disease is refractory to antibiotics (Ashfaq & Campbell), the organisms survive and persist in the environment (Augustine & Renshaw, 1982), and there are no commercially available vaccines. A reliable diagnostic assay is needed for the detection of infection in order to prevent dissemination of infected animals.

The synergistic hemolysis inhibition (SHI) test is an assay which measures antibodies formed against the exotoxin of C pseudotuberculosis. Originally designed for use in horses (Knight, 1978), preliminary results in trials in goats and sheep have been promising (Almeida et al., 1983; Brown & Alves, 1984).

Due to the established modus operandi of C pseudotuberculosis as a facultative intracellular parasite (Hard, 1972; Tashjian & Campbell, 1983), skin tests might also be a means of diagnosing infection. Skin testing is a commonly accepted method for diagnosis of many of the mycobacterial diseases and C pseudotuberculosis and Mycobacterium spp. have many similarities in cell wall structure (Hard, 1975). Tuberculin elicited non-specific cross-reactions have been reported in sheep and goats both naturally and artificially infected with C pseudotuberculosis (Shulka et. al., 1971). Intradermal injection of sonicated C pseudotuberculosis bacterial cells provoked positive reactions in emaciated ewes with visceral CLA lesions, but the overall rate of reactivity was low (56%), perhaps due to anergy resulting from the disseminated nature of the disease (Renshaw et. al., 1979).

The purpose of the present study was to investigate the possibility of using skin testing as a means of diagnosis for C pseudotuberculosis infections. A specific C pseudotuberculosis antigen was used as well as two mycobacterial antigens, PPD-A and

PPD-B. In addition, the reliability of the SHI test for diagnosis of infection was examined, and both methods of diagnosis, i.e. skin tests and serologic reaction, were compared with the extent of clinical disease.

Materials and Methods

Nineteen adult (four years or older) does of mixed breeding and eighteen adult (three years or older) ewes of the exotic Morada Nova hair sheep breed were chosen from the reproduction groups at the Ceará State Agricultural Research Station (EPACE) in Quixadá, northeastern Brazil. Animals were selected on the basis of positive isolation of *C pseudotuberculosis* from at least one abscess within the previous five months.

A skin test reagent was prepared by centrifuging a broth culture of *C pseudotuberculosis*, adding formalin, heating, and washing twice in sterile saline. The density of the final solution was estimated on a spectrophotometer read at a wavelength of 325nm.

The purified protein derivatives of *Mycobacterium avium*, PPD-A, and *Mycobacterium bovis*, PPD-B, were commercial products, produced by the Brazilian Agricultural Research Organization (EMBRAPA).

Inoculations were made in small squares of shaved skin in the axillary regions of all animals. A volume of 0.1ml of *C pseudotuberculosis* reagent and SS was injected on the left side, and 0.1ml each of PPD-A (2,500 IU) and PPD-B (5,000 IU) were injected approximately 5cm apart on the right side. The diameter and induration of the response were measured with calipers at 24 and 48 hours.

Serum from blood collected just prior to skin testing was subjected to the SHI test described elsewhere (Knight, 1978).

Results

The results obtained by skin testing with the three antigens and serologic testing are summarized (Tables 1 and 2). There were no reactions to control injections with SS.

Of the 19 goats known to be infected with *C pseudotuberculosis*, 18 (95%) reacted positively to the *C pseudotuberculosis* intradermal antigen. The one doe (No. 6) which failed to respond was also non-reactive to PPD-A and PPD-B and clinically was thin and hirsute despite consistently high ambient temperatures. Of the six strongest responders, four were members of the group with histories of multiple abscesses. The doe with the most vigorous response (No. 9) also had among the largest diameter reactions to both of the PPD's.

Twelve of the nineteen does (63%) responded to PPD-A; six of the nineteen (32%) responded to PPD-B.

TABLE 1. Results of intradermal skin tests and SHI test in GOATS naturally infected with *Corynebacterium pseudotuberculosis*.

	Diameter of Skin Test Response (cm)						
	C pseudotuberculosis		PPD-A		PPD-B		
Animal number	24 hrs	48 hrs	24 hrs	48 hrs	24 hrs	48 hrs	SHI titer
1	- +	0.8	0.5	-	0.45	-	1:16
*2	-	1.05	-	-	-	-	1:32
*3	1.2	1.25	-	-	-	-	1:64
4	1.0	1.2	0.65	-	-	-	1:16
5	1.2	1.1	0.9	-	-	-	1:64
6	-	-	-	-	-	-	1:64
7	1.05	1.15	1.35	1.3	-	-	1:128
*8	1.1	1.35	1.0	-	-	-	1:1024
9	1.55	1.8	1.7	1.1	1.5	1.1	1:512
*10	1.15	1.0	-	-	-	-	1:32
11	-	0.65	-	1.6	-	-	1:128
*12	-	1.1	-	1.4	-	-	1:32
13	1.0	0.8	1.8	1.4	0.7	-	1:32
14	1.0	1.1	1.2	1.3	0.65	-	1:32
15	1.35	1.2	1.7	1.6	-	-	1:16
*16	1.7	1.6	-	-	0.8	1.1	1:128
17	-	1.05	-	-	-	-	1:16
*18	1.0	0.85	1.1	1.25	1.5	1.1	1:32
*19	1.2	1.34	-	-	-	-	1:512

+ "-" = no reaction.

*Animals with more than one *C pseudotuberculosis* abscess during the five months prior to testing.

All goats (100%) had serologic titers greater than 1:16 by the SHI test. The eight animals in the multiple abscess group demonstrated titers greater than 1:32. The animals with the strongest skin reaction to the *Corynebacterium* antigen also tended to have the highest titers.

Of the fourteen sheep known to be naturally infected with *C pseudotuberculosis*, only eight (57%) reacted positively to intradermal testing with the *Corynebacterium* antigen. These eight positive responders included five of the six animals with recent histories of multiple abscesses. Only one of the ewes failing to respond to the *C pseudotuberculosis* skin antigen also was non-reactive to both PPD-A and PPD-B.

TABLE 2. Results of intradermal skin tests and SHI test in SHEEP naturally infected with *Corynebacterium pseudotuberculosis*

	Diameter of Skin Test Response (cm)						
	C pseudotuberculosis		PPD-A		PPD-B		
Animal number	24 hrs	48 hrs	24 hrs	48 hrs	24 hrs	48 hrs	SHI titer
1	- +	-	1.1	1.2	1.1	-	1:128
*2	1.1	1.2	-	1.5	-	-	1:128
*3	1.0	1.1	1.3	-	0.9	-	1:256
4	0.8	-	0.8	-	-	-	1:128
5	0.5	1.1	-	-	-	1.8	1:128
6	-	-	-	-	-	-	1:1024
7	-	-	0.8	1.2	-	-	1:128
*8	0.8	0.95	0.4	-	-	-	1:1024
*9	1.6	1.4	0.6	1.2	0.6	1.4	1:1024
10	-	-	1.0	1.1	-	-	1:16
*11	-	-	1.2	1.4	1.1	1.2	1:64
12	-	-	1.1	1.9	0.7	1.1	1:64
*13	0.6	0.7	1.0	1.5	-	-	1:4
14	0.6	0.8	1.2	1.1	1.1	-	1:512

+ "-" = no reaction
*Animals with more than one *C pseudotuberculosis* abscess during the five months prior to testing.

The sheep as a group were more reactive to the PPD's than were the goats. Twelve of fourteen sheep (86%) responded to PPD-A; seven of fourteen (50%) responded to PPD-B. Four of five of the ewes which did not respond to the *Corynebacterium* antigen responded positively to one or both of the PPD's.

Thirteen of fourteen ewes (93%) had serologic titers greater than 1:16. Ewe No. 13 had a considered marginally positive titer of 1:14 on the day of skin testing while her titers three weeks before and after were 0 and 1:2, respectively. This animal had multiple abscesses and had a positive skin test to both the *C pseudotuberculosis* antigen and PPD-A.

Discussion

The results of this study indicate that skin testing with a specific bacterial antigen may be useful in goats for field diagnosis of caseous lymphadenitis or as an experimental tool to monitor progress of the disease. All goats but one (95%) reacted positively to skin testing with the *C pseudotuberculosis* antigen. The failure of one doe to respond may be explained by anergy, as

clinically this animal was in a debilitated state. Failure to respond to either of the other two skin test reagents, PPD-A and PPD-B, further suggests the possibility of anergy. In general, most vigorous responses were generated by those animals with multiple or recurring abscesses, so size of reaction may correlate with the severity of clinical disease.

In sheep with caseous lymphadenitis, the response rate to skin testing with the C pseudotuberculosis antigen was 57%. These results are similar to those obtained in a previous study, where only 56% of ewes with visceral caseous lymphadenitis responded to intradermal injection of the specific bacterial antigen (Renshaw et. al., 1979). Skin testing may be an unreliable means of diagnosing CLA in sheep.

Reactivity rates in the two species to either PPD-A or PPD-B were too low to suggest either one of these reagents might be useful for diagnosis of caseous lymphadenitis. Tuberculin has been reported to provoke positive reactions in goats and sheep infected with C pseudotuberculosis (Shulka et. al., 1971). Any shared antigenic components between Corynebacterium and Mycobacterium species may be present in the cruder tuberculin but lost in the progressive purification process leading to the PPD product.

The SHI test appears to be a reliable serologic assay for caseous lymphadenitis in goats, as all infected animals had measurable titers. The titers may also be a crude indicator of the extent of dissemination of lesions as the goats with multiple abscesses tended to have the highest titers.

Serologic results in the sheep were less conclusive. One ewe wavered between seronegative and weakly seropositive despite repeated culturing of C pseudotuberculosis from superficial abscesses. The SHI test deserves more testing in sheep to determine if it could be a valid indicator of disease in that species.

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THE SYNERGISTIC HEMOLYSIS INHIBITION TEST FOR SEROLOGIC DETECTION OF INAPPARENT CASEOUS LYMPHADENITIS IN GOATS AND SHEEP

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ABSTRACT - The synergistic hemolysis inhibition (SHI) test, a serologic test for detection of infection with Corynebacterium pseudotuberculosis, was applied to serum samples from 196 goats and 76 sheep, including animals both with and without C pseudotuberculosis abscesses. Fifty-one of 52 (98%) goats and 27 of 28 (96%) sheep with abscesses caused by C pseudotuberculosis had positive serologic titers. Titers remained positive on subsequent samplings, even after complete healing of the superficial lesion. The SHI test may be detecting subclinically infected animals, as well as animals with clinically recognizable lesions. Of the animals without abscessed, 53 of 186 (28%) goats and 4 of 41 (10%) sheep were serologically positive. Either the SHI test is lacking in specificity, or these titers are a reflection of a past or a current infection without any grossly visible abscesses.

Index terms: Goats, Sheep, Caseous lymphadenitis, Serologic test.

O TESTE SHI PARA A DETECÇÃO SOROLÓGICO DE LINFADENITE CASEOSA INAPARENTES EM CABRAS E OVELHAS

RESUMO - O teste de inibição da hemólise sinérgica (SHI), um teste sorológico usado para descobrir a infecção com Corynebacterium pseudotuberculosis, foi aplicado em amostras de soro de 196 caprinos e 76 ovinos, incluindo animais com e sem abscessos com C pseudotuberculosis. Cinquenta e um de 52 caprinos (98%) e 27 de 28 ovinos (96%) com abscessos causados pelo C pseudotuberculosis tinham título sorológico positivo. Os títulos permaneceram positivo em subsequente amostras, mesmo depois de curados por completo a(s) lesão(es) superficial(is). O teste SHI pode ser encontrar animais subclinicamente infectados, também animais reconhecidos clinicamente com lesões. Dos animais sem abscessos, 53 de 186 caprinos (28%) e 4 de 41 ovinos (10%) eram positivo sorologicamente. Ambos, ou o teste SHI está faltando especificidade, ou aqueles títulos são uma reflexão de um passa do ou uma infecção geral sem quaisquer abscessos aparentemente visíveis.

Termos para indexação: Caprinos, Ovinos, Linfadenite caseosa, Teste sorológico.

Introduction

Caseous lymphadenitis, an important disease of goats and sheep, is characterized by obliteration of one or more lymph nodes by the formation of abscesses. Caused by Corynebacterium pseudotuberculosis, it is a chronic and recurring problem, with new abscesses appearing subsequent to rupture or surgical excision of others. Usually the superficial nodes are affected, but in a more serious visceral form of the disease internal nodes are involved.

The disease may result in economic losses in a variety of ways. These include loss of the entire animal due to wasting or carcass condemnation when disseminated internal abscesses are present (Stoops, et al., 1984), a decrease in reproductive efficiency (Gates, et al., 1977), production losses when abscessed nodes interfere with necessary functions such as milking (Burrell, 1980a), labor costs and drugs in treatment of abscesses (Burrell, 1980b), and devaluation in hides because of flaws (Figuereido, et al., 1982).

Control of caseous lymphadenitis has been challenging. The organisms are liberated in massive numbers from ruptured abscesses and can survive and persist well in soil and on fomites (Augustine et al., 1982; Augustine & Renshaw, 1982a, 1982b) so that attempts at environmental sanitation to decrease the incidence have been only marginally successful. Antibiotics are unable to penetrate the thick wall of the abscess and consequently are of limited usefulness after an abscess has formed (Ashfaq & Campbell, 1979). Once the disease is established in a herd it is very difficult to eradicate. Various vaccine preparations, including a bacterin from South Africa (Cameron, 1972) and a formalized exotoxin in Australia (Nairn, 1977), have been tested, and are available for use in sheep in the field, but not in this country.

Diagnosis is straightforward when external abscesses are present, palpable, and accessible for bacterial culturing. But all too often infection is occult and not detectable by clinical examination, e.g. during the long incubation period, between bouts of abscess formation,or when only internal abscesses are present. A dependable means of identifying these usually subclinically infected individuals could help to decrease the incidence by allowing earlier and more economic culling and preventing introduction of affected animals into clean herds.

Several serologic assays have been devised for the detection of animals with caseous lymphadenitis, including an anti-beta-hemolysin inhibition test (Zaki, 1968), a double immunodiffusion test (Burrell, 1980), enzyme-linked immunosorbent assays (ELISAS) using various bacterial components as antigen (Shen et. al., 1982; Maki et al., 1985), and the synergistic hemolysis inhibition test (Knight, 1978; Almeida et al.,1983; Brown et. al., 1985).

It was the aim of this study to take one of these serologic tests, the synergistic hemolysis inhibition (SHI) test and apply it to both clinically affected and non-affected animals in a natural setting to determine its value as an indicator of subclinical disease.

Materials and Methods

Selection of animals, observation, and sample collection - Experimental animals were selected from breeding herds at two state research stations in northeastern Brazil.

At the Ceará state research station (EPACE), 45 adult animals (26 mixed breed goats, 19 Morada Nova sheep) were chosen on the basis of enlargement of one or more superficial lymph nodes. All goats were three years or older; the sheep were slightly younger, with an average age of 2.8 years. Clinical examinations and blood collections were made on each animal every 3 weeks for 27 weeks and individual records kept. As superficial abscesses developed and reached maturity, they were surgically drained and sampled for bacterial culture.

At the Paraibá state research station (EMEPA), 50 animals were chosen because they had mature superficial abscesses ready for excision. This group was composed of 34 goats of various breeds and 16 mixed breed sheep. The ages ranged from 1 to 5 years, with an average of 2.8 years. With these animals surgical excision and bacterial sampling of the abscesses were done on day 0, and blood samples were collected on days 0, 1, 7, 14, 21, and 28.

For controls, abscess-free animals were chosen from a group sent to slaughter at the municipal slaughterhouse of Petrolina, located in the state of Paraibá. Superficial nodes were palpated prior to slaughter, blood collected at the time of exsanguination, and both superficial and internal nodes were examined in the carcass. One hundred thirty-six goats and 41 sheep had no signs of either superficial or internal abscesses. All animals were of mixed breeding and ages ranged from 1 to 6 years, with a mean of 2.1 years.

Laboratory processing of samples - All serum samples were used in the SHI test which is described elsewhere (Knight, 1978).

Swabs of abscess material were streaked directly onto beef blood agar plates and incubated aerobically. Identification of isolates was based on standard methods.

Results

Results are presented separately for goats and sheep (Tables 1 and 2).

TABLE 1. Number of goats with and without abscesses and their serologic responses in the SHI test.

ABSCESSES	PRESENT			NOT PRESENT
SEROLOGY	C pseudo-tuberculosis	other organisms	not cultured	
+	51	5	3	53
-	1	0	0	83

TABLE 2. Number of sheep with and without abscesses and their serologic responses in the SHI test.

ABSCESSES	PRESENT			NOT PRESENT
SEROLOGY	C pseudo-tuberculosis	other organisms	not cultured	
+	27	2	4	4
-	1	1	0	37

In the long term study at EPACE, all 26 goats developed mature abscesses at some time during the 27 weeks, with C pseudotuberculosis being isolated from 22 animals. Of the remainder, three had mature abscesses which were opened by the herdsman and not available for bacterial culturing. One doe had an abscess which yielded Staphylococcus sp. and gram-positive aerobic rods but no C pseudotuberculosis. All EPACE goats had positive SHI titers at every sampling.

In the one month EMEPA study, C pseudotuberculosis was cultured from 30 of 34 goats. Abscesses in the remaining four animals yielded C pyogenes, Staphylococcus sp., and gram-negative aerobic rods. Twenty-nine of the 30 C pseudotuberculosis culture-positive goats were seropositive on all samplings. Of the 4 goats from which organisms other than C pseudotuberculosis were cultured, all were seropositive.

All 19 ewes in the long term (EPACE) study developed mature abscesses. C pseudotuberculosis was isolated from 14 animals. Four abscesses, having been opened by the herdsman, were unavailable for culture and one ewe had three external abscesses

which yielded Staphylococcus sp., Streptococcus sp., and C pyogenes. Thirteen of the 14 C pseudotuberculosis culture-positive animals were consistently seropositive. The other was seronegative on 7 of 9 samplings and only weakly seropositive (1:4) on the other two. The remaining five animals were consistently seropositive. In the one month EMEPA study C pseudotuberculosis was cultured from 14 to 16 sheep. Abscesses in the other two animals yielded a Staphylococcus sp. and unidentified gram-positive aerobic rods. All 14 C pseudotuberculosis culture-positive animals were seropositve on all samplings as was the animal infected with gram-positive rods. The sheep from which the Staphylococcus sp. was recovered was consistently seronegative.

Of the non-abscessed control animals 53 of 136 goats and four of 41 sheep were seropositive, with the remainder being seronegative.

Discussion

Combining results from both short and long term studies, 51 of 52 (98%) goats with abscesses from which C pseudotuberculosis was isolated had positive SHI titers. Titers remained positive even after complete healing of the lesion. The remaining eight goats with abscesses which either were not cultured or were associated with organisms other than C pseudotuberculosis were all SHI test positive as were 53 of 186 (28%) of the non-abscessed control animals.

Similar figures were obtained for the combined groups of sheep. Twenty -seven of 28 (96%) sheep with abscesses from which C pseudotuberculosis was isolated had positive titers via the SHI test. Titers remained positive even after all external evidence of abscesses had healed. Of the other seven sheep with abscesses that either were not cultured or yielded organisms other than C pseudotuberculosis, six were seropositive as were 4 of 41 10%) controls without abscesses.

In this limited survey, SHI titers remained positive even after complete resolution of superficial, palpable C pseudotuberculosis lesions. Consequently, the SHI test may be useful for detecting subclinically affected animals, i.e. infected carriers.

The high percentage of serologic positives among animals without abscesses and animals with abscesses which yielded organisms other than C pseudotuberculosis suggests that the SHI test lacks specificity. However, under the conditions of this experiment, it is possible that the positive serologic tests in these animals were a response to a past infection or to a current infection without a grossly visible lesion.

One of the main hindrances to control of CLA has been the lack of a reliable diagnostic test to detect infection. Large-scale screening procedures using the SHI test accompanied by rigorous culling of animals which are strongly seropositive could help to decrease the prevalence of this important disease.

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THE SEROLOGIC RESPONSE AND LESIONS PRODUCED IN GOATS EXPERIMENTALLY INFECTED WITH CORYNEBACTERIUM PSEUDOTUBERCULOSIS OF CAPRINE AND EQUINE ORIGIN

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ABSTRACT - Fifteen goat kids were experimentally inoculated with Corynebacterium pseudotuberculosis. Five were given a strain of caprine origin (nitratase-negative biotype) intradermally, five were given a strain of equine origin (nitratase-positive biotype) intradermally, and five were inoculated intranasally with the caprine-origin strain. Animals were monitored for 127 days. The goats given the inocula intradermally developed abscesses; those given caprine-origin strain had multiple lesions, both peripherally and in visceral locations (primarily endothoracid abscesses), whereas those given the equine-origin strain had abscesses only at injection sites and draining nodes. The difference in extent of lesions could be due to biotypic bacterial differences or to the individual strains used. Intranasally inoculated goats did not develop abscesses and were essentially no different from controls. The upper respiratory tract may not be an important portal of entry for C pseudotuberculosis.

Serum samples obtained monthly from all animals were subjected to the synergistic hemolysis inhibition (SHI) test, which measures antibodies to the exotoxin of C pseudotuberculosis. Animals with abscesses developed titers within one month of infection. Animals without abscesses remained seronegative. The synergistic hemolysis inhibition test may be a reliable diagnostic assay for caseous lymphadenitis in goats.

Index terms: Goats, Caseous lymphadenitis; Serologic test.

RESPOSTA SEROLÓGICA E LESÕES PRODUZIDAS EM CABRAS EXPERIMENTALMENTE INFECTADAS COM C PSEUDOTUBERCULOSIS DE ORIGENS CAPRINA E EQUINA

RESUMO - Foram inoculados experimentalmente com Corynebacterium pseudotuberculosis quinze cabritos. A cinco cabritos foi dado uma variedade de origem caprina (biotipo nitratase-negativo) intradérmicamente; a outros cinco foi dado uma variedade de origem equina (biotipo nitratase-positivo) intradérmicamente; e outros cinco foram inoculados intranasalmente com a variedade de origem caprina. Os animais foram observados durante um período de 127 dias. Os caprinos que receberam o inóculo intradérmicamente desenvolveram abscessos; aqueles que receberam a variedade de origem caprina tinham multiplas lesões, tanto periféricamente como visceralmente (abscessos endotorácicos primários); enquanto que aqueles que receberam a variedade de

origem equina tinham abscessos somente no local da infecção e em nodos drenados. A diferença em extensão das lesões poderia ser devido ao diferente biotipo bacteriano ou à variedade individual usada. Caprinos inoculados intranasalmente não desenvolveram abscessos e não foram essencialmente diferente dos controles. O trato respiratório superior pode não ser uma importante porta de entrada do C pseudotuberculosis.

Amostras de sôro eram obtidas de todos animais mensalmente e submetidas ao teste de inibição da hemólise sinérgica (SHI) o qual mede anticorpos para a exotoxina do C pseudotuberculosis. Os animais com abscessos desenvolveram títulos dentro de um mês de infecção e animais sem abscessos permaneceram soronegativos. O teste de inibição da hemólise sinérgica pode ser um ensaio seguro para o diagnóstico da linfadenite caseosa em caprinos.

Termos para indexação: Caprinos, Linfadenite caseosa, Teste sorológico.

Introduction

Caseous lymphadenitis (CLA) of goats is recognized as a worldwide problem (Burrell, 1981; Ashfaq & Campbell, 1980) and, in the United States, is one of the leading causes of economical loss to the goat industry (Ashfaq & Campbell, 1979). Caused by Corynebacterium pseudotuberculosis (formerly C ovis), it is a chronic, insidious disease in which one or more lymph nodes, usually the larger superficial nodes, are involved and often obliterated by abscesses. Less frequently, internal lymph nodes may be involved in a more serious visceral form of the disease.

Although CLA occurs in both sheep and goats, there are differences in distribution of affected superficial nodes (Campbell et al., 1982; Ayers, 1977), morphologic appearance of the lesions (Ashfaq & Campbell, 1980; Ayers, 1977), and frequency and severity of the visceral form (Ayersm 1977; Hein & Cargill, 1981).

Mode of transmission of CLA in goats has not been firmly established. In sheep it is thought to occur by contamination of shearing wounds Nairn & Robertson, 1974; Nagy, 1976) but this has little relevance for goats. Skin abrasions or fighting wounds may be a source of infection (Hein & Cargill, 1981). The high percentage of abscesses in the head and neck area indicated that traumatized buccal mucosa may be a portal of entry (Burrell, 1981; Ashfaq & Campbell, 1980). The frequent involvement of thoracic lymph nodes and pulmonary parenchyma indicates that inhalation may be a means of infection (Hein & Cargill, 1981), although the distribution is more characteristic of hematogenous or lymphogenous spread (Nairn & Robertson, 1974).

The pathogenesis of CLA in goats is also unclear. In vitro studies demonstrate that the organism's tough outer lipid coat allows it to resist digestion and remain as a facultative

intracellular parasite (Hard, 1972; Tashjian & Campbell, 1983) and ultimately cause destruction of the host cell (Hard, 1975). Production of a potent exotoxin which is lytic for endothelial cells may promote local spreading (Carne & Onon, 1978).

Control of caseous lymphadenitis has been challenging. The thick wall of the abscess makes the disease refractory to antibiotic treatment (Ashfaq & Campbell, 1979); the organism is able to survive and persist in the environment (Augustine & Renshaw, 1982), and there are, as yet,no commercially available vaccines for routine use in this country. Introduction of an infected animal into an infection-free herd can lead to a wave of abscesses within the herd two to three years later (Ashfaq & Campbell, 1979; Ayers, 1977; Williams, 1982). Due to the long incubation of the disease (Ashfaq & Campbell, 1980) and the absence of visible lesions between periods of abscess formation, it is clinically difficult to distinguish between infected and noninfected animals. There is increasing interest of goat owners for the development of a reliable diagnostic test for detection of infection.

The synergistic hemolysis inhibition (SHI) test is a simple, inexpensive serologic assay which detects antibodies formed against the exotoxin of *C pseudotuberculosis*. Originally devised for diagnosis of *C pseudotuberculosis* infection in horses (Knight, 1978), it has been applied to goats. In preliminary trials, it has had a high level of sensitivity and specificity for detecting caseous lymphadenitis (Almeida et al., 1983; Brown & Alves, 1984).

In addition to acting as the etiologic agent of CLA in sheep and goats, *C pseudotuberculosis* is the cause of a syndrome of chronic ventral abscesses in horses in the western United States, principally California (Hughes & Biberstein, 1959). Deep abscesses form in the pectoral and ventral abdominal regions, forearm, or gaskin, with occasional dissemination to distant sites (Hughes & Biberstein, 1959). *Corynebacterium pseudotuberculosis* is also seen in horses in rare instance of ulcerative lymphangitis and has been infrequently cited as the causative agent of abortion in mares (Rumbaugh et al., 1978; Miers & Ley, 1980). Strains of *C pseudotuberculosis* isolated from equine abscesses are biochemically distinct from those of small ruminant origin, consistently being able to reduce nitrate. In contrast, isolates from sheep and goats are almost always nitrate negative; thus, a division into two separate biotypes has been recognized (Biberstein et al., 1971). Even in horses, sheep, and goats grazing the same area, the infecting specific biotypes remains distinct. Explanations for this dichotomous distribution are speculative. There has been no investigation into the specificity of the two biotypes for mammalian hosts, particularly into the question of whether a *C pseudotuberculosis* strain from a horse is capable of causing CLA in a small ruminant.

The purpose in the present study was to experimentally produce caseous lymphadenitis in goats and to follow the development of disease both clinically and pathologically. Two different routes of inoculation, intradermal and intranasal, were used to compare possible modes of transmission. The serologic response, measured by the SHI test, was examined frequently to determine the validity of that assay as an indication of infection. In addition, a small group of animals was inoculated with a strain of equine origin to determine whether a nitratase-positive C pseudotuberculosis would cause CLA in a goat and how the disease might differ from that produced by the nitrate-negative biotype.

Materials and Methods

Twenty male goats, three months of age and seronegative for C pseudotuberculosis by the SHI test, were separated into four groups of equal size. Group I animals were inoculated intradermally in the right paralumbar fossa with 0.5 X 10^6 colony forming units of live nitratase-negative C pseudotuberculosis (goat origin). Group II animals were inoculated in the same manner with a nitratase-positive strain (equine origin). Goats in Group III received the goat-origin strain via intranasal administration. In Group IV, two goats were inoculated intradermally with broth culture filtrate (toxin controls) and the three remaining animals in Group IV were designated as uninoculated controls.

Animals were observed for 127 days, with blood sampling at frequent intervals for both hematologic and serologic examination. Any abscesses which developed and ruptured were sampled.

One goat each from Groups I through III was killed on post-infection day (PID) 2 for observation fo acute systemic lesions and culturing of internal organs. The remaining animals were killed PID 127. Abscesses seen at necropsy, as well as spleen and six major lymph nodes, were sampled for bacterial culturing. Major viscera and lymph nodes were examined histologically.

Results

Production of clinical disease - All animals injected intradermally with live organisms and the animal injected with filtrate from the equine strain experienced a transient fibrile response (1 to 2°C) within 48 hours after inoculation. At 72 hours, all remaining Groups I and II goats showed marked inflammatory reactions at the injection site, and by the end of the first week, all these sites were exuding purulent material. Animals with the equine-origin strain (Group II) had a more locally extensive and ulcerative process than did those given the strain of caprine origin (Group I); the inflammation in the Group II goats subsequently subsided and disappeared, whereas three of

four goats in Group I retained persistent abscesses at the inoculation site. Right prefemoral lymph nodes were large the first week and remained large and firm for the duration of the trial in three of the four goats in Group I and three of the four in Group II. There was no sign of disease in any of the intranasally inoculated or control animals. There was no marked difference in weight gains among the four groups.

Clinical pathologic examination - All animals displayed a mild persistent leukocytosis. Variations in packed cell volume and plasma protein values did not differ between the inoculated and control groups. In animals in Groups I and II, fibrinogen increase 2 to 5 times, remained level for three days after inoculation, then dropped back to base line.

Gross pathologic and bacteriologic examinations - *Corynebacterium pseudotuberculosis* was isolated from intradermal inoculation sites of all animals in Group I (strains were negative for nitrate reduction ability) and Group II (nitrate-reduction positive) within the first week after inoculation. Swabs taken during the first week from the left nasal sinus of intranasally inoculated animals yielded too much overgrowth to identify *C pseudotuberculosis*.

In the three animals killed on PID 2, significant gross changes were limited to the intradermal injection site, which was locally thickened by a gelatinous layer of dark serous fluid. There was no recovery of *C pseudotuberculosis* from any of the 21 tissues examined from these three goats.

The distribution of body abscesses and cultural examination results for the 17 goats surviving to the end of the trial are summarized (Table 1). The four animals inoculated intradermally with the caprine strain had multiple abscesses. Four had abscesses in the draining lymph node, and four had an abscess in either a thoracic lymph node or the pulmonary parenchyma. Two goats had abscessed parapharyngeal lymph nodes.

Of the four goats inoculated with the equine-origin strain, only three had abscesses, and all of these were single and confined to the draining lymph node.

Except for one pulmonary abscess in an intranasally inoculated animal which was negative for *C pseudotuberculosis*, there were no abscesses in any of the intranasally inoculated or control animals.

Histopathologic examination - Significant histopathologic findings were seen only in Groups I and II.

In the three animals killed at PID 2, skin at the inoculation site was distorted by a wide band of edema in the subcutis, lined on both sides by massive accumulations of acute inflammatory cells (Fig. 1.). The dermis and panniculus muscle were infiltrated by a uniform moderately dense population of

TABLE 1. Synergistic hemolysis-inhibition test titer and distribution of abscesses at necropsy in goats inoculated with *Corynebacterium pseudotuberculosis*.

No.	SHI test Titer*	Abscesses seen at necropsy	Bacterial isolation
GROUP I (INTRADERMAL INOCULATION WITH GOAT-ORIGIN STRAIN)			
1	1:128	Right prefemoral, Tracheobronchial, and Mediastinal lymph nodes	*C pseudotuberculosis*, No growth, and No growth
2	1:8	Right prefemoral, and Mediastinal lymph nodes	*C pseudotuberculosis*, *C pseudotuberculosis*
3	1:16	Injection site, and Right prefemoral, Left parapharyngeal, and Tracheobronchial lymph nodes	No growth
4	1:64	Injection site, Right prefemoral, Right lumbar, Left parapharyngeal, and Submandibular lymph node; and Pulmonary abscess	No growth *C pseudotuberculosis*
GROUP II (INTRADERMAL INOCULATION WITH EQUINE-ORIGIN STRAIN)			
6	1:16	Right prefemoral lymph node	No growth
7	1:8	Right prefemoral lymph node	*C psuedotuberculosis*
8		None	- - -
9	1:32	Right prefemoral lymph node	No growth
GROUP III (INTRANASAL INOCULATION WITH GOAT-ORIGIN STRAIN)			
11	0	Pulmonary	Mixed growth, negative for *C pseudotuberculosis*
12, 13, 14	0	None	- - -
GROUP IV (CONTROL)			
16, 17, 18, 19, 20	0		- - -

*0 titer = seronegative.

FIGURE 1. Acute inflammation and prominent vascular reaction at intradermal injection site at two days after inoculation H&E X 85.

inflammatory cells, mostly neutrophils. Lining cells of both vascular and lymphatic channels were reactive and degenerated, or had fallen away from the blood and lymphatic vessel margins. Special stains highlighted clumps of bacteria. Both intradermally inoculated animals had a moderately severe multifocal acute suppurative lymphadenitis of the right prefemoral lymph node, and in the animal which was given the strain of equine origin, the right lumbar node was similarly affected.

In animals killed on PID 127, the relevant histologic changes were in the affected lymph nodes where nodal parenchyma was pushed aside by the expanding abscess which comprised an amorphous central eosinophilic mass of dead macrophages, surrounded by a rim of degenerating neutrophils and, peripheral to this, a band of giant cells and fibrous tissue. Bacterial staining demonstrated gram-positive organisms in typical "chinese letter" configuration dispersed through the central necrotic mass.

Serologic examination - Within 23 days after inoculation, all animals in Groups I and II became seropositive (Fig. 2.). Goats inoculated with the strain of caprine origin had slightly higher titers. All goats in the intranasally inoculated and the control groups were consistently seronegative. One Group II goat had a titer which increased to 1:64 by one month after inoculation, but then fell to negligible levels at three and four months after inoculation. This was the only animal in either of the two groups inoculated intradermally with live organisms which had no abscess at necropsy. Titers from the last blood sample collection, at four months after inoculation, are presented (Table 1.).

Discussion

Only those animals inoculated intradermally with live organisms developed lesions of caseous lymphadenitis.

Although the high frequency of thoracic abscesses in CLA seemed to indicate that the respiratory tract is a protal of entry, goats inoculated intranasally with a broth suspension of the organism did not have signs of the disease and were essentially no different from controls. It may be that inhalation is not a normal means of transmission for *C pseudotuberculosis*. Perhaps, organisms are dealt with efficiently in the upper respiratory tract, but if they travel to distal, more susceptible airways, will produce abscesses. Study with bacterial aerosolization could be used to clarify the importance of the airborne route. The high frequency of pulmonary or mediastinal abscesses in the intradermally inoculated goats from Group I provides strong support for the systemic origin of thoracic lesions and is in agreement with other studies which intradermal or intravenous inoculation

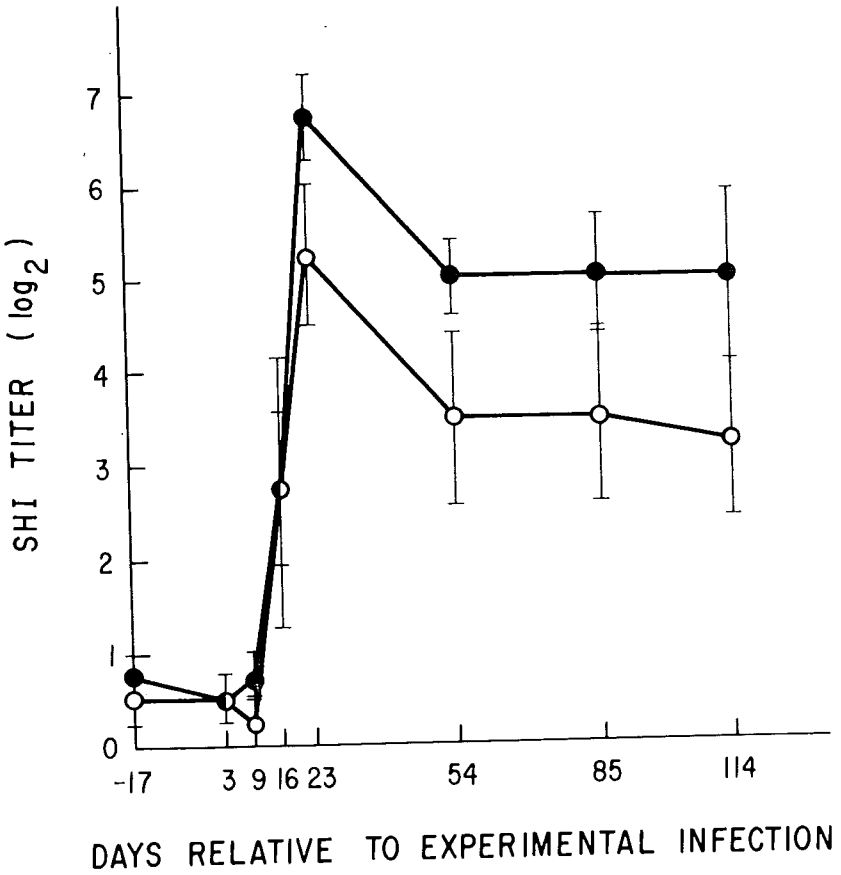

FIGURE 2. Mean SHI titers +SEM for groups of kids inoculated with strain of caprine origin (●—●) or strain of equine origin (○—○).

resulted in mediastinal and pulmonary abscesses (Ashfaq & Campbell, 1980; Brogden et. al., 1984).

There were obvious differences between the two intradermally inoculated groups. Those goats given the caprine-origin strain had more abscesses, with all developing both peripheral and visceral lesions. Those inoculated with the equine-origin strain had an initially more prominent reaction at the site of inoculation, but at the end of four months, one animal had no evidence of disease, and the other three had minimal abscesses found only in the draining node. The initial vigorous injection site reactivity of the Group II goats may have served to limit the spread of the organism. Additional studies are required to determine whether these differences are bacterial biotypic characteristics or peculiar to the individual strains used in this investigation. In any event, an equine-origin strain of C pseudotuberculosis inoculated into goats did cause lesions of CLA that were grossly and microscopically similar to those caused by the nitratase-negative biotype. The reason goats are not affected by nitratase-positive organisms under natural conditions is unknown. Epizootiologic factors and different modes of transmission may be keeping the two biotypes separate. In horses, insect vectors may have a part in the spreading of the disease (Miers & Ley, 1980). By contrast, insects have only minor, if any, importance in CLA. Biotype specificity may be related to this difference.

Histopathologically at PID 2, there was a prominent reaction in blood and lymphatic vessels at the site of intradermal inoculation, with endothelium displaying various degrees of reactivity, degeneration, and necrosis. The exotoxin of C pseudotuberculosis has been shown to have a lytic effect on endothelial cells in vitro (Carne & Onon, 1978). Presumably, the same mechanism is operating in vivo, allowing for local spread of the organism and for increased chance of bacterial carriage to more distal sites. Acute suppurative lymphadenitis in a lumbar node at PID 2 indicates that organisms already had passed through 2 intervening lymph nodes from the original inoculation site. One of the goats inoculated with filtrate of the broth culture (Group IV) experienced a brief period of malaise and fever, indicating that the exotoxin may have some systemic effects as well.

Mature abscesses comprised masses of dead macrophages, with cytoplasm filled with bacteria. This is consistent with descriptions of the capability of C pseudotuberculosis as a facultative intracellular parasite and its leukocidal effects (Hard, 1972; Hard, 1975; Tashjian & Campbell, 1983).

There were no differences among the four groups of goats with respect to clinical pathologic values, except for a temporary increase in fibrinogen concentrations shortly after inoculation in the 2 groups of intradermally inoculated animals. All groups experienced recurrent problems with coccidiosis, and

inflammatory reactions to the parasite may have masked subtle differences that would have been detectable otherwise.

The SHI test proved to be a reliable indicator of active infection. All animals with abscesses had a titer, and those with the most abscesses had the highest titers. Animals without abscesses due to C pseudotuberculosis were seronegative. The Group II goat which had a transient purulent reaction at the site of inoculation and no abscesses at necropsy had a titer early in the trial and subsequently became seronegative. Presumably, this animal had overcome the infection, and in the absence of circulating antigen, antibody levels dropped too low to be detected by the SHI test.

If these observations are typical, the SHI test should be a useful diagnostic test for active infection by C pseudotuberculosis and may prove useful in devising schemes for the control of CLA in goats.

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C. NUTRIÇÃO E SISTEMAS DE ALIMENTAÇÃO

C. NUTRITION AND FEEDING SYSTEMS

DIGESTIBILITY AND INTAKE OF VARIOUS NATIVE AND INTRODUCED FORAGES BY GOATS AND HAIR SHEEP IN NORTHEAST BRAZIL

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ABSTRACT - Results from a series of studies conducted at the EMBRAPA/CNPA were used to evaluate the quality of various native and introduced forages fed to goats and tropical hair sheep. Reduced forage quality was attributed to a decreased dry matter intake and digestibility, decreased nitrogen content and increased rumination and total chewing activities. Decreased intake appeared to be associated more with an increase in cell wall components, and a reduction in digestibility more with lignification. Dry matter intake and digestibility were affected by stage of maturity and forage species. Dry matter intake was lower for the grasses and digestibility was lower for the range species.

Index terms: Goats, Sheep, Digestibility, Forages, Semi-arid Tropics.

DIGESTIBILIDADE E CONSUMO DE VÁRIAS FORRAGENS NATIVAS E INTRODUZIDAS PARA CABRAS E OVELHAS LANADAS NO NORDESTE DO BRASIL

RESUMO - Uma série de estudos foram conduzidos no EMBRAPA/CNPC para avaliar a qualidade de várias forrageiras nativas e exóticas fornecidas a caprinos e ovinos deslanados. Reduções na qualidade das forrageiras estiveram associadas com decréscimos no consumo, na digestibilidade da matéria seca e no conteúdo de nitrogênio aliadas a aumentos na atividade de ruminação e mastigação. Aparentemente, o decréscimo no consumo esteve mais associado com o aumento nos componentes da parede celular enquanto que, as reduções na digestibilidade com a lignificação das forrageiras. Consumo e digestibilidade da matéria seca foram afetadas pelo estádio de maturidade e espécie forrageira. Aparentemente, a gramínea foi a menos consumida enquanto que, as espécies lenhosas apresentaram a menor digestibilidade.

Termos para indexação: Caprinos, Ovinos, Digestibilidade, Forragem, Trópico semi-árido.

Introduction

In the developing countries, most ruminants subsist wholly on forages. Forage quality is one of the most important factors limiting ruminant production, particularly in regions with

tropical climates. Forage intake by ruminants is greatly affected by forage quality. High quality forages are more digestible and have a lower retention time in the gastrointestinal tract, thereby maximizing energy intake.

In Northeast Brazil, year round forage availability is also an important factor affecting ruminant performance. The regional precipitation patterns mark two defined seasons within the year. During the wet season there is an abundance of forage in the native range (caatinga). During the first months of the dry season, which may extend for as many as eight months, a relatively abundant biomass exists in forms such as dried leaf litter from deciduous trees. This source of feed becomes scarce by the end of the dry season at which time goats and sheep may lose weight if they are not supplemented (Pfister et al., 1983).

Ideally, feeding systems should be developed to diminish the variable nutrient availability resulting from the large seasonal fluctuation in forage biomass production from the caatinga. Preservation of forage as silage has an advantage over hay-making during the wet season. However, ensiling requires that the forage contain enough nonstructural carbohydrates for adequate fermentation. Less material is lost in the hay-making process and it may be more suitable for preservation of small amounts of forage by small holders.

Forage quality evaluation studies conducted at the CNPC had as objectives: (1) to adapt forage preservation methods for both dry season range supplementation and confinement systems; and (2) to evaluate the quality of various native and introduced forages and its effect on the digestive and metabolic function of goats and sheep.

Materials and Methods

Several studies (Barros et al., 1985; Carneiro et al., 1985; Freire et al., 1985; Kawas et al., 1985; Vale et al., 1985) were conducted at the EMBRAPA/CNPC to evaluate the quality of various native and introduced forages fed to goats and tropical hair sheep. All goats were SRD (undefined genotype) and all sheep were of the Santa Inês genotype. The legumes studied were cunhã (*Clitoria ternatea*) and mata pasto (*Cacia cericea*). Forage sorghum (*Sorghum vulgare*) and some woody species (juazeiro leaves, *Zizyphus joazeiro*; and jurema preta seedpods, *Mimosa acutistipula*, a woody legume) were also studied. Forages were preserved as silage, hay, or both. Before ensiling, the forage material was sun-wilted to reduce its water content. The forages were ensiled in concrete stave silos, 2m high and 1.5m in diameter.

In one study (Kawas et al., 1985), stage of maturity of the ensiled forage was evaluated. Areas cultivated with cunhã (*Clitoria ternatea*) and forage sorghum (*Sorghum vulgare*) were divided into equal parts and cut at two stages of maturity. The

cunhã was harvested at 42 (ECT) and 70 (LCT) days after a uniform cutting. In a similar manner, forage sorghum was cut at the milk and late stages of maturity.

In all experiments 9 or 10 animals were confined in metabolism crates for a 14-day adaptation and 7-day collection period. Forages were offered ad libitum as the only feed, twice daily, allowing for a 15% feed refusal. Animals had free access to water and to a trace mineral-salt mix.

Body weights were recorded two days before the beginning and two days before the end of the collection phase. Dry matter intake (DMI) and digestibility (DMD) (total fecal collection) were determined in all studies. Nitrogen balance and chewing activity (eating and rumination times recorded every 5 minutes for a 24 hour period) were obtained in some of the studies (Barros et al., 1985; Kawas et al., 1985).

Oven-dried (60C) forage, refused feed and fecal samples were ground through a 1mm screen before analysis. Absolute dry matter (DM) was determined after oven drying at 105C for 24 hours. Samples were analyzed for neutral detergent fiber (NDF), acid detergent fiber (ADF), and $KMnO_4$ lignin (Goering & Van Soest, 1970). Nitrogen content of all samples was determined by Kjeldahl (AOAC, 1975).

Results and Discussion

Chemical composition of the forages (% dry matter) is presented in Table 1. Dry matter content of silages and hays ranged from about 30 to 83% and 86 to 93%, respectively. In general, CP content was highest for legumes, intermediate for woody species and lowest for grasses. An exception was the annual legume mata pasto (7.0-7.6% CP) which was cut at a mature stage at the end of the wet season. The cell wall components, hemicellulose and cellulose, were higher for the grasses than for both woody species and legumes. Lignin, however, was higher in woody species.

Results on the intake of dry matter (DM) and digestible DM by goats and hair sheep are in Table 2. Kawas et al. (1985) reported a greater DM consumption by goats fed the legume cunhã (CT) than goats fed forage sorghum (FS) at any stage of maturity. Digestibility of DM decreased with an advance in maturity of either CT or FS (Table 3). Concurrently, there was a tendency for digestible DM to decrease with an advance in maturity. Time spent ruminating by goats fed ECT, LCT, EFS and LFS were 407^{b}, 474^{ab}, 554^{a}, and 575^{a} min/day, respectively. Time spent eating by goats fed ECT, LCT, EFS and LFS were 369^{a}, 357^{a}, 285^{b}, and 254^{b} min/day, respectively. Goats consuming FS silages spent more ($P<.05$) time ruminating and less ($P<.05$) time eating than with CT and with an advance in maturity of the forages. Total chewing time (min/day) was significantly higher ($P<.05$) for ECT (831 min/day) than for LCT (776 min/day). Goats consuming the

TABLE 1. Chemical composition of forages fed to goats and tropical hair sheep.

FORAGE	STAGE OF MATURITY[a]	METHOD OF PRESERVATION	DRY MATTER (%)	CRUDE PROTEIN (%)	CELL WALL COMPONENTS (% of DM) NDF[b]	HEMI-CELLULOSE	CELLULOSE	KMnO4 LIGNIN	REFERENCE No.
LEGUMES									
Cunha	SPF	Hay	92.5	22.6	49.7	17.4	23.8	8.3	4
Cunha	42 DWC	Silage	69.4	19.2	49.8	15.1	24.7	9.6	6
Cunha	70 DWC	Silage	83.1	17.6	55.9	21.3	23.4	10.7	6
Mata Pasto	Mature	Hay	90.9	7.6		16.4	15.9	7.8	2
Mata Pasto	Mature	Silage	36.8	7.0	55.3	16.8	28.0	7.8	2
GRASSES									
F. Sorghum	Milk	Silage	30.5	4.6	77.4	29.0	39.3	8.4	6
F. Sorghum	Mature	Silage	38.0	4.9	69.3	26.3	33.3	9.2	6
WOODY SPECIES									
Juazeiro (leaves)	Mature	Hay	92.3	15.2	66.7	24.8	27.6	14.2	4
Jurema Preta (seedpods)	Mature	Hay	86.0	12.7	52.9	17.4	22.1	12.7	8

[a] SPF, seed pod formation; DWC, days within cuts.

[b] NDF, neutral detergent fiber; DM, dry matter.

Table 2. Intake of dry matter (DM) and digestible DM by goats and hair sheep.

FORAGE	STAGE OF MATURITY	METHOD OF PRESERVATION	AVERAGE WEIGHT (Kg)		INTAKE (g/Kg.75) DRY MATTER		DIGESTIBLE DRY MATTER		REFERENCE No.
			GOATS	SHEEP	GOATS	SHEEP	GOATS	SHEEP	
LEGUMES									
Cunha	SPF	Hay	25.7	37.7	68.0 (13.0)	78.9 (13.0)	42.9 (7.9)	42.0 (7.9)	4
Cunha	42 DWC	Silage	21.0	--	75.5 (11.7)	--	50.8 (5.2)	--	6
Cunha	70 DWC	Silage	21.0	--	77.2 (12.6)	--	46.0 (7.7)	--	6
Mata Pasto	Mature	Hay	23.1	36.6	10.0 (3.5)	48.7 (9.6)	--	25.5 (5.9)	2
Mata Pasto	Mature	Silage	13.5	23.9	72.0 (12.0)	86.6 (10.8)	60.4 (2.5)	53.8 (4.5)	2
GRASSES									
F. Sorghum	Milk	Silage	21.0	--	65.9 (8.7)	--	51.0 (8.3)	--	6
F. Sorghum	Mature	Silage	21.0	--	59.6 (4.9)	--	43.2 (5.4)	--	6
WOODY SPECIES									
Juazeiro (leaves)	Mature	Hay	26.9	37.7	76.6 (15.7)	87.1 (14.2)	33.5 (8.7)	34.8 (10.1)	4
Jurema Preta (seedpods)	Mature	Hay	19.0	24.1	69.5 (9.4)	69.2 (6.0)	33.4 (8.9)	32.8 (2.4)	8

[a] SPF, seed pod formation; DWC, days within cuts.

[b] ( ), standard deviation.

Table 3. Forage digestibility (DMD) and nitrogen balance by goats and hair sheep.

FORAGE	STAGE OF MATURITY	METHOD OF PRESERVATION	DRY MATTER DIGESTIBILITY (%)		NITROGEN BALANCE (G / DAY)		REFERENCE No.
			GOATS	SHEEP	GOATS	SHEEP	
LEGUMES							
Cunha	SPF	Hay	54.8 (4.6)	53.2 (4.2)	15.3 (2.8)	16.7 (9.9)	4
Cunha	42 DWC	Silage	66.8 (1.8)	--	10.1 (3.5)	--	6
Cunha	70 DWC	Silage	59.8 (3.8)	--	9.7 (1.7)	--	6
Mata Pasto	Mature	Hay	--	53.9 (3.7)	-2.4 (4.2)	0.9 (1.5)	2
Mata Pasto	Mature	Silage	53.2 (4.1)	60.4 (2.5)	--	--	2
GRASSES							
F. Sorghum	Milk	Silage	77.4 (1.4)	--	1.2 (0.4)	--	6
F. Sorghum	Mature	Silage	72.3 (3.6)	--	1.4 (0.6)	--	6
WOODY SPECIES							
Juazeiro (leaves)	Mature	Hay	43.7 (3.9)	39.9 (7.2)	6.7 (4.5)	6.0 (3.2)	4
Jurema Preta (seedpods)	Mature	Hay	48.0 (8.9)	47.4 (3.3)	--	--	8

[a] SPF, seed pod formation; DWC, days within cuts.

[b] NDF, neutral detergent fiber.

[c]

three silages with greater fiber component levels spent the same time chewing, about 14 hours.

In a study by Barros et al., (1985), both sheep and goats consumed more of the legume mata pasto when it was preserved as silage rather than as hay. Digestibility estimates were not comparable due to the marked differences in intake between the two methods of preservation. We have observed that mata pasto, an annual range legume, is not consumed by sheep or goats in the green form.

From all forage intakes reported (Table 1), that of forage sorghum was lowest probably due to its highest cell wall content. Digestibility of woody forages by both goats and sheep (Table 3) was lower than for other forage species perhaps due to their higher lignin content. Digestibility of the sorghum silages was higher than expected.

Several studies (Barros et al., 1985; Freire et al., 1985; Vale et al., 1985) in which both goats and sheep were used, DM intakes tended to be greater for sheep than for goats on a $kg^{.75}$ basis. Barros et al. (1985) reported that sheep fed the same diet as goats spent more time ruminating (479 vs. 420 min/day). However, DM digestibilities reported were not different between the two animal species.

Nitrogen balance of sheep and goats (Table 3) appeared to be dependent on the nitrogen content of the forage as well as on the feed intake. Negative nitrogen balance of goats consuming mata pasto hay was due to the low feed intake (10 $g/kg^{.75}$) and consequently to a low N intake.

Conclusions

Reduced forage quality was associated to a decreased intake and digestibility, decreased N content and increased rumination and total chewing activities. DM intake and digestibility were affected by stage of maturity of forages and forage species. DM intake was lower for the grasses, and digestibility was lower for the range species. With the information available, it is not clear how much of the nitrogen in the range forage species is utilized and if lignin phenolic components or other secondary compounds are affecting nitrogen utilization.

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CONSUMPTION AND DIGESTIBILITY OF CAATINGA LEAF LITTER PEN FED TO NATIVE GOATS

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ABSTRACT - A feeding trial was conducted to determine the effect of incremental energy supplementation on intake of leaf dry matter (LDMI), total dry matter (TDMI) and crude protein (CPI) and *in vivo* digestibility of dry matter (DMD) and crude protein (CPD) of caatinga leaf litter, the predominant forage available to animals grazing native range during the dry season. Forty-four individually penned, mature SRD goat wethers were fed 1.7kg/ day of previously collected dry season caatinga leaf litter *ad libitum*, in two feedings. Mean initial body weight (BW) was 20.6kg. Eleven animals blocked by BW within treatment (TRT) were assigned to one of four corn supplementation levels, expressed as % of BW as fed: (A) 0, (B) .3, (C) .6 and (D) 1.2. A 21-day adaptation phase was followed by a 7-day feed intake and fecal output measurement period. Means for TRT A, B, C and D were: LDMI (percent of BW) 3.57, 3.54, 3.31 and 3.20; TDMI (percent of BW) 3.57, 3.80, 3.95 and 4.23; DMD (%) 66.2, 67.6, 63.1 and 69.3; and CPD (%) 50.4, 49.4, 43.1 and 51.1. There was a tendency for LDMI to decrease and TDMI to increase with increasing levels of supplementation. TDMI for TRT D was higher ($P<.05$) than for TRT A. A two-way ANOVA demonstrated no treatment differences ($P>.05$) for DMD or CPD.

Index terms: Goats, Semi-arid tropics, Native tree leaves, Energy supplementation, Intake, Digestibility.

CONSUMO E DIGESTIBILIDADE DAS FOLHAS DE CAATINGA EM CABRAS SRD EM CONFINAMENTO.

RESUMO - Foi conduzido um ensaio para determinar o efeito de suplementação energética incremental sobre o consumo de matéria seca de folhas (CMSF), o consumo de proteína bruta (CPB), e a digestibilidade *in vivo* da matéria seca (DMS) e da proteína bruta (DPB) das folhas caídas das árvores da caatinga, representantes da forragem predominante disponível aos animais que permaneçem na caatinga durante a época seca. Para os 44 caprinos adultos, castrados, do tipo SRD, confinados individualmente, foram fornecidos *ad libitum* um total de 1.7 kg, 2 vezes por dia, de folhas de caatinga previamente coletadas durante a época seca. A média inicial do peso corporal (PC) foi 20.6 kg. Os animais distribuidos em 11 blocos ao acaso pelo PC, foram designados para receber um de 4 níveis de milho (% de PC): (A) 0, (B) .3, (C) .6 e (D) 1.2. O período de adaptação de 21 dias for seguido por um período de medição do consumo da dieta e da produção fecal. A sobra foi coletada uma vez por dia e os sacos de fezes foram esvaziados 2 vezes por dia. As médias para os tratamentos A, B, C e D foram:

CMSF (% de PC) 3.57, 3.54, 3.31 e 3.20; CMST (% de PC) 3.57, 3.80, 3.95 e 4.23; DMS (%) 66.2, 67.6, 63.1 e 69.3; e DPB (%) 50.4, 49.4, 43.1 e 51.1. Houve uma tendência para o CMSF a diminuir e para o CMST a aumentar a medida que o nível de suplementação cresceu. O CMST foi maior ($P<.05$) no tratamento D que no tratamento A. O ANOVA não demonstrou diferenças significativas entre tratamentos ($P>.05$) para DMS ou DPB *in vivo*.

Termos para indexação: Caprinos, Trópico semiárido, Folhas de árvores da caatinga, Suplementação energética, Consumo, Digestibilidade.

Introduction

Goats, widely distributed throughout the semi-arid Northeast, contribute significantly to smallholder farm income and economic security. Native range (caatinga) is generally the sole source of forage to which these animals have access (Gutierrez et al., 1981; Neumaier, 1986; Primov, 1982). A consequence of the highly seasonal rainfall of the region is a pronounced annual fluctuation in quality and quantity of caatinga forage. Adverse effects of the precipitous dry season decline in forage available to grazing stock have been documented in a number of studies at the CNPC (Bellaver et al., 1979; Figueiredo et al., 1980a, 1980b).

Supplemental feeding is one way to mitigate the body weight losses (15-30%) which frequently occur in grazing goats during the dry period (Pfister et al., 1983). However, given that supplemental feed is expensive for the small producer (Primov, 1982), it would be preferable that it neither substituted for nor decreased the utilization of the caatinga forage base.

Supplementation will increase total dry matter intake; however, the net effects of supplementation on forage intake and digestibility are not consistent. Supplementation may increase, decrease or not affect forage utilization depending on the interaction of such factors as the physiological state of the animal with the quality of the basal forage diet and the quantity and energy/protein ratio of the supplement. Low supplemental energy levels tend not to decrease intake if the forage is of poor quality and the animals are not in a highly demanding physiological state (i.e. lactation) (Campling & Murdoch, 1966; Combellas & Martinez, 1982; Crabtree & Williams, 1971; Mott et al., 1968; Yazman et al., 1982).

It is often found that the first factor limiting performance of animals consuming poor quality forage is energy, not protein (Leibholz & Kellaway, 1982). The work of Pfister (1983), conducted in the caatinga of Sobral, tends to confirm that a deficiency of dietary energy, rather than crude protein, is likely the primary cause of poor dry season animal performance. Caatinga leaf litter, for as long as it lasts, is the major feed supply from approximately mid-dry season until the onset of the

next rains, but very little is actually known about its value as a forage (Pfister et al., 1983). Our objective was to study the effect of energy supplementation on the intake and apparent digestibility of this critical dry season feed resource.

Methods

A digestibility trial was conducted with 44 individually confined, mature native (SRD) goat wethers fed a total of 1.7kg of previously collected dry season caatinga leaf litter, *ad libitum* in two feedings per day. The quantity of feed offered allowed for at least a 40% selection margin on a dry matter (DM) basis. Eleven animals, blocked by weight within treatment (TRT) were assigned to each of 4 corn supplementation levels. Table 1 shows the TRT's expressed as % of body weight (BW), as fed, and as % of total dry matter intake. Mean initial BW was 20.6kg. A 21-day adaptation period was followed by a 7-day feed consumption and fecal output measurement period. Total orts were collected once daily and fecal bags were emptied twice daily. Eight individual samples of feed offered were collected each time a new leaf batch was mixed (about every 2 days). Orts and feces were composited by animal across days. All samples were analyzed for DM and crude protein (CP) (AOAC, 1975) as well as total cell wall fiber (NDF) and permanganate lignin (Goering & van Soest, 1970). Statistical analyses of the data were performed using two-way ANOVA, the LSD test being performed if TRT effects were significant ($P<.05$).

TABLE 1. Levels of corn supplementation for the 4 treatments.

Corn level expressed as:	Treatment groups			
	A	B	C	D
% of body weight	0	.3	.6	1.2
% of total DM intake	0	6.9	13.5	24.6

Results and Discussion

Chemical analyses of the caatinga leaf litter (Table 2) showed it to be low in CP and high in NDF. The corn also was lower in CP and higher in NDF than tabular values (NRC, 1981).

TABLE 2. Chemical composition of the dietary components (%).

	Crude protein	Neutral detergent fiber	Lignin
Leaf litter	6.6	64.5	18.3
Ground corn	8.4	20.4	.2

Table 3 presents the means for leaf DM, total DM and CP intake. There was a tendency for leaf DM intake to decrease, as a % of BW, and total DM and CP intakes to increase with increasing levels of supplementation. Although TRT differences were not significant for leaf DM intake, groups C and D had a slightly lower leaf intake (% of BW). Total DM intake for TRT D was higher ($P<.05$) than for TRT A. Despite low CP levels in the diets, mean CP intake was equal to or in excess of published requirements (NRC, 1981) for all treatments.

TABLE 3. Daily intake of leaf dry matter (DM), total dry matter and crude protein.

Corn level (% of BW)	Leaf DM intake		Total DM intake		Crude protein intake	
	g	% of BW	g	% of BW	g	% of BW
0 (TRT A)	636	3.57	636	3.57a	41	.23
.3 (TRT B)	669	3.54	717	3.80ab	47	.25
.6 (TRT C)	693	3.31	800	3.95ab	48	.26
1.2 (TRT D)	692	3.20	916	4.23b	63	.29

a,bMeans in the same column not followed by the same letter differ at $P<.05$.

Mean digestibility coefficients for DM and CP are shown in Table 4. Two-way analysis of variance indicated no significant TRT effects ($P>.05$).

TABLE 4. Apparent digestibility of dry matter and crude protein.

Treatment	DM digestibility (%)	CP digestibility (%)
A	66.2	50.4
B	67.6	49.4
C	63.1	43.1
D	69.3	51.1

Table 5 presents the changes in BW over the 28-day experiment. Only the TRT D animals registered a net gain in weight over this short period. However, increasing supplement levels were associated with decreasing weight losses for TRT's A, B and C.

TABLE 5. Changes in body weight (BW) over the 28-day experimental period.

Treatment	Initial BW (kg)	Final BW (kg)	Percent change
A	20.5	18.1	- 12
B	20.4	18.9	- 7
C	20.8	20.4	- 2
D	20.7	21.7	+ 5

Conclusions

Our results generally agree with what has been found previously when low quality forages have been supplemented with energy. The lowest corn level, 53 g/day (TRT B) did not affect leaf DM intake. The tendency for a decreased leaf intake, hence substituting supplement for forage, was evident at higher corn intake levels. This effect, as well as the increase in total DM intake as supplement levels increased, is consistent with previous reports. The fact that total DM digestibility did not change even when corn comprised up to 25% of the diet (TRT D) can be interpreted to imply a decrease in leaf litter digestibility as corn levels increase, assuming corn DM digestibility to be higher than the recorded mean diet DM digestibilities. This decrease, if real, could be due to a lower selectivity index, or to a faster rate of passage; but not likely to both effects since they are contradictory. Digestibility of DM in all TRT's was somewhat higher than might be expected from a forage with NDF and lignin concentrations as high as we observed. This could be due to the chemical or physical nature of the "lignin" fraction, and represents a point which merits further investigation. Crude protein digestibility was lower than total DM digestibility, which indicates that even when dietary protein offered seems adequate, protein availability could be a factor limiting animal productivity during the dry season. This is another area warranting further study. Based on our findings it appears that low levels of supplementation might be of some benefit in reducing dry season weight losses without the substitution effect which is evident with higher levels of supplementation. A continuing effort should be made to use agricultural byproducts and readily available local plant foliage to develop low cost supplementation schemes which are within the means of typical small producers.

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ACCEPTABILITY OF TROPICAL FORAGES FED AS SILAGE OR HAY TO SHEEP AND GOATS

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ABSTRACT - In a cafeteria study conducted at the CNPC, Sobral, forages preserved as hay or silage were offered to tropical hair sheep and native goats, 1kg/animal/day for four consecutive days. Offered as both silage and hay were Leucaena leucocephala (LEU), Stylosanthes humilis (STY), Cassia sp. (CAS), Wissadula sp. (WIS) and Croton sonderianus (CRO). The species Crotalaria juncea (CRJ) and Combretum leprosum (COM) were offered only as hay, and the species Setaria sp. (SET) and Paspalum sp. (PAS) only as silage. Concentrations of protein and neutral-detergent fiber (%) of the hays were, respectively: STY 14.2, 47.2; LEU 20.2, 42.3; CAS 14.8, 33.1; CRJ 16.8, 54.3; WIS 13.3, 53.0; COM 9.0, 34.6; CRO 8.9, 39.8. The ensiled forrages showed the following concentrations: STY 11.4, 47.2; LEU 16.5, 41.8; CAS 10.6, 45.4; WIS 9.7, 58.7; CRO 7.6, 73.9; SET 5.8, 70.2. In goats, the acceptability of the hays varied in the following descending order: STY, WIS, LEU, CRJ, CAS, COM, CRO; while in sheep the order of preference was the following: LEU, STY, WIS, CRJ, CAS, COM, CRO. The goats preferred the silages according to the following order: CAS, LEU, STY, WIS, PAS, CRO, SET; and the sheep: CAS, LEU, STY, WIS, PAS, SET, CRO. The results suggest that preference by small ruminants is toward forrages of high protein and low fiber content. Method of preservation did not affect order of acceptability. However, other factors may affect the acceptability of specific forage species.

Index terms: Tropical forages, Acceptability, Sheep, Goats.

ACEITABILIDADE DE FORRAGENS TROPICAIS OFERECIDAS SOB A FORMA DE FENO E SILAGEM AOS OVINOS E CAPRINOS

RESUMO - Num ensaio de cafeteria realizado no CNPC, Sobral, for oferecido 1kg de forragem/animal/dia durante quatro dias consecutivos, sob a forma de feno e silagem as seguintes forrageiras: Leucaena leucocephala (LEU), Stylosanthes humilis (STY), Cassia sp. (CAS), Wissadula sp. (WIS) e Croton sonderianus (CRO). As espécies Crotalaria juncea (CRJ) e Combretum leprosum (COM) somente foram ofertadas como feno e as espécies Setaria sp. (SET) e Paspalum sp. (PAS) somente como silagem. Os percentuais de proteína e de fibra em detergente neutro das forrageiras fenadas foram, respectivamente: STY 14,2, 47,2; LEU 20,2, 42,3; CAS 14,8, 33,1; CRJ 16,8, 54,3; WIS 13,3, 53,0; COM 9,0, 34,6; CRO 8,9, 39,8. As forrageiras ensiladas mostraram os seguintes percentuais: STY 11,4, 47,2; LEU 16,5, 41,8; CAS 10,6, 45,4; WIS 9,7, 58,7; CRO 7,6, 73,9; SET 5,8, 70,2. Em caprinos, a

aceitabilidade das forrageiras como feno decresceu de acordo com a seguinte ordem: STY, WIS, LEU, CRJ, CAS, COM, CRO; enquanto que em ovinos ocorreu a seguinte sequência: LEU, STY, WIS, CRJ, CAS, COM, CRO. Os caprinos preferiram a silagem conforme a seguinte ordem: CAS, LEU, STY, WIS, PAS, CRO, SET; e os ovinos: CAS, LEU, STY, WIS, PAS, SET, CRO. Os resultados sugerem que os animais têm preferência por forrageiras com um teor proteico elevado, baixa fibra, porém, outros fatores possivelmente afetam a aceitabilidade específica de cada forragem.

Termos para indexação: Forrageiras tropicais, Aceitabilidade, Ovinos, Caprinos.

Introduction

The preservation of forages as hay or silage is an appealing alternative in areas like Northeast Brazil which suffer from a prolonged dry season and where grazing animals, consequently, require supplementation in order to produce at efficient levels. Furthermore, it is possible that preservation will improve the acceptability of certain forages by neutralizing secondary compounds which may otherwise have an anti-quality or intake-reducing effect. The objective of the present study was to determine the acceptability and relative preference of several forages that can be grown in the Northeast, when fed to sheep or to goats in the form of hay or silage.

Materials and Methods

A cafeteria trial was carried out at the CNPC, Sobral, Ceará, during four days. Each animal was offered 1kg/day of the following forages: preserved as hay and silage, *Leucaena leucocephala* (LEU), *Stylosanthes humilis* (STY), *Cassia* sp. (CAS), *Wissadula* sp. (WIS) and *Croton sonderianus* (CRO). The species *Crotalaria juncea* (CRJ) and *Combretum leprosum* (COM) were offered only as hay, and the species *Setaria* sp. (SET) and *Paspalum* sp. (PAS) only as silage. Table 1 shows the chemical composition of the forrages.

Results and Discussion

The comparative intake of dry matter from the several forages on offer is shown in Figures 1, 2, 3 and 4. For those forages fed both as hay and silage, relative acceptability was not greatly influenced by the method of preservation. Relative rankings were also similar for sheep and goats. The consistently most preferred species were *Leucaena leucocephala* and *Stylosanthes humilis*, both legumes. Of intermediate ranking were the Cassia, Crotalaria, and Wissadula species. The least preferred were the Combretum, Croton, Paspalum and Setaria species.

TABLE 1. Chemical composition of the hays and silages, % of dry matter.

Forages	Chemical Composition[a]					
	CP	NDF	ADF	HC	Lignin	Cel
		Hays				
Cassia sp.	14.8	33.1	15.7	17.4	4.1	11.4
Combretum leprosum	9.0	34.6	22.4	12.2	7.1	17.4
Crotalaria juncea	16.8	54.3	23.0	31.3	8.6	17.3
Croton sonderianus	8.9	39.8	26.5	13.3	8.4	18.4
Leucaena leucocephala	20.2	42.3	20.8	21.4	6.6	16.9
Stylosanthes humilis	14.2	47.2	31.2	16.0	7.2	23.5
Wissadula sp.	13.3	53.0	32.5	20.5	7.3	24.7
		Silages				
Cassia sp.	10.6	45.4	29.1	16.5	7.7	20.7
Croton sonderianus	7.6	46.9	34.4	12.6	11.6	22.0
Leucaena leucocephala	16.5	41.8	26.0	15.8	8.1	17.8
Paspalum sp.	4.5	73.9	48.3	25.6	8.8	32.8
Setaria sp.	5.8	70.2	43.5	26.7	8.4	33.9
Stylosanthes humilis	11.4	47.2	31.9	15.3	7.8	25.3
Wissadula sp.	9.7	58.7	40.6	18.1	7.8	30.5

[a] CP=Crude protein, NDF=Neutral detergent fiber, ADF=Acid detergent fiber, HC=Hemicellulose, and Cel=Cellulose.

There are many factors which influence the intake of forages by ruminants. Tropical grasses very low in crude protein (below 6%) and high in fiber (above 60% NDF) cannot be expected to be consumed as supplements to low quality grazing conditions; rather, if offered to sheep or goats, they will simply substitute for forage already being consumed in the caatinga. Also, it is highly probable that some forages would be acceptable if offered alone, or if offered over a long period of time, but are among the lesser preferred in a cafeteria situation or over a very short period which does not allow the animals to adapt to them.

The two legumes, *Leucaena* and *Stylosanthes*, which were consistently consumed well, should be given high consideration as candidates for dry season supplementation for sheep or goats grazing on caatinga. Apparently, if a satisfactory job is done of making hay or silage with these legumes, both forms of preservation are acceptable both to tropical hair sheep and to native goats in the Northeast.

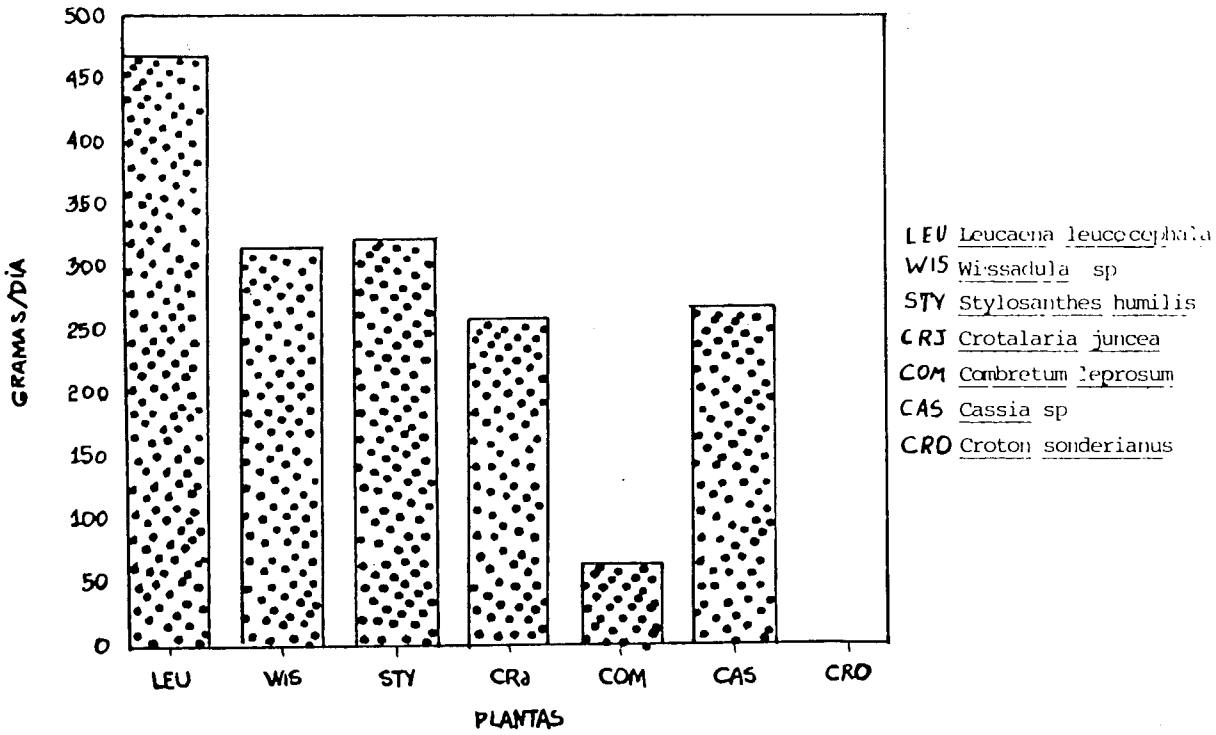

Fig.1- Consumo de feno (g/dia) por ovinos.

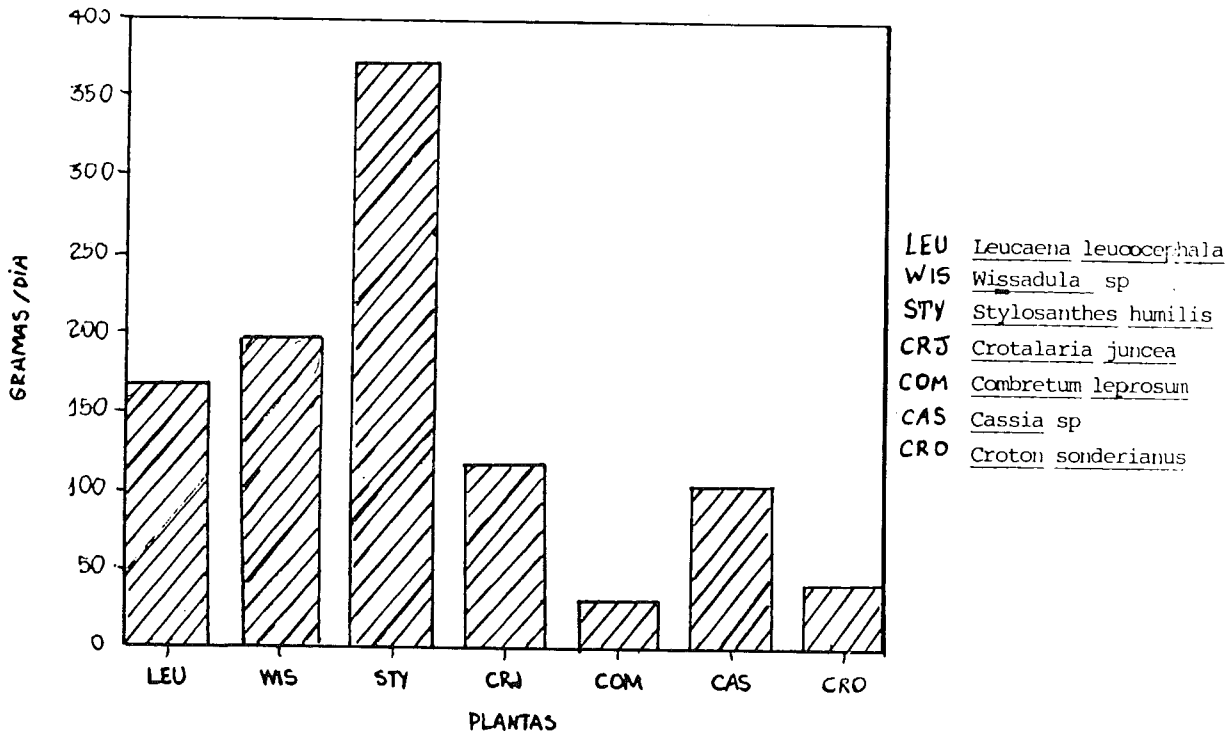

Fig.2-Consumo de feno (g/dia) por caprinos.

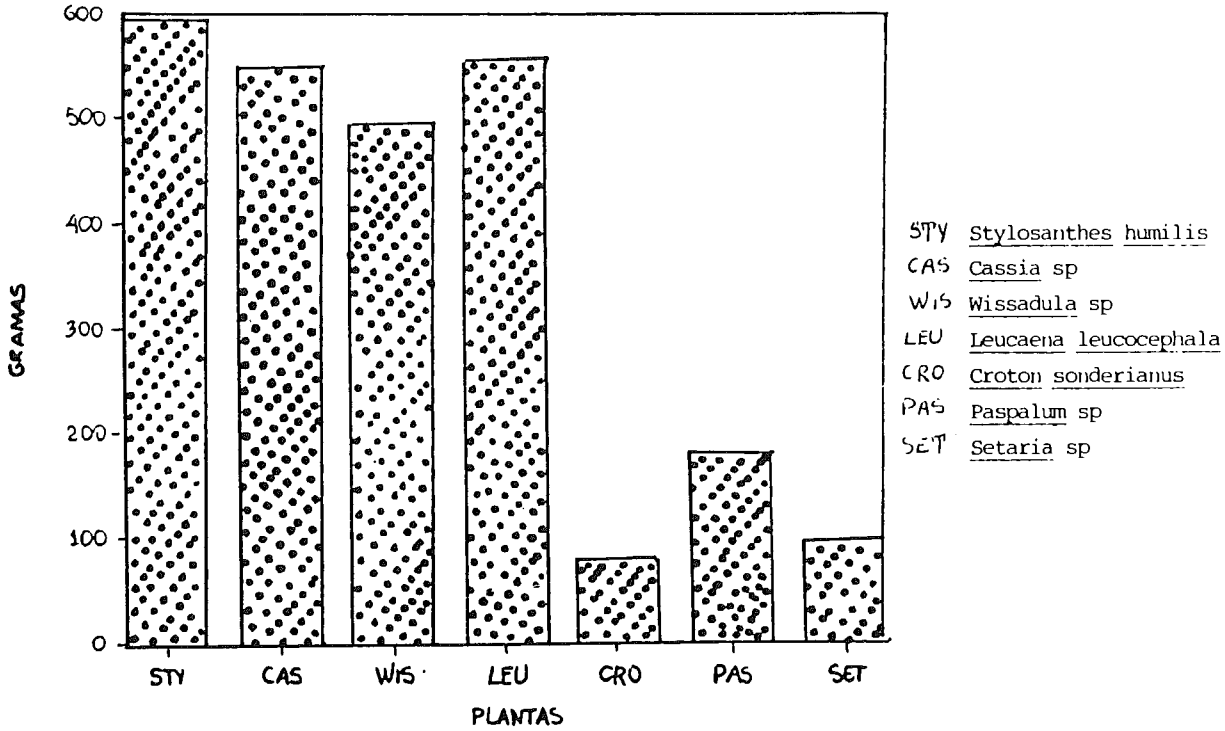

Fig.3-Consumo de silagem (g/dia) por ovinos.

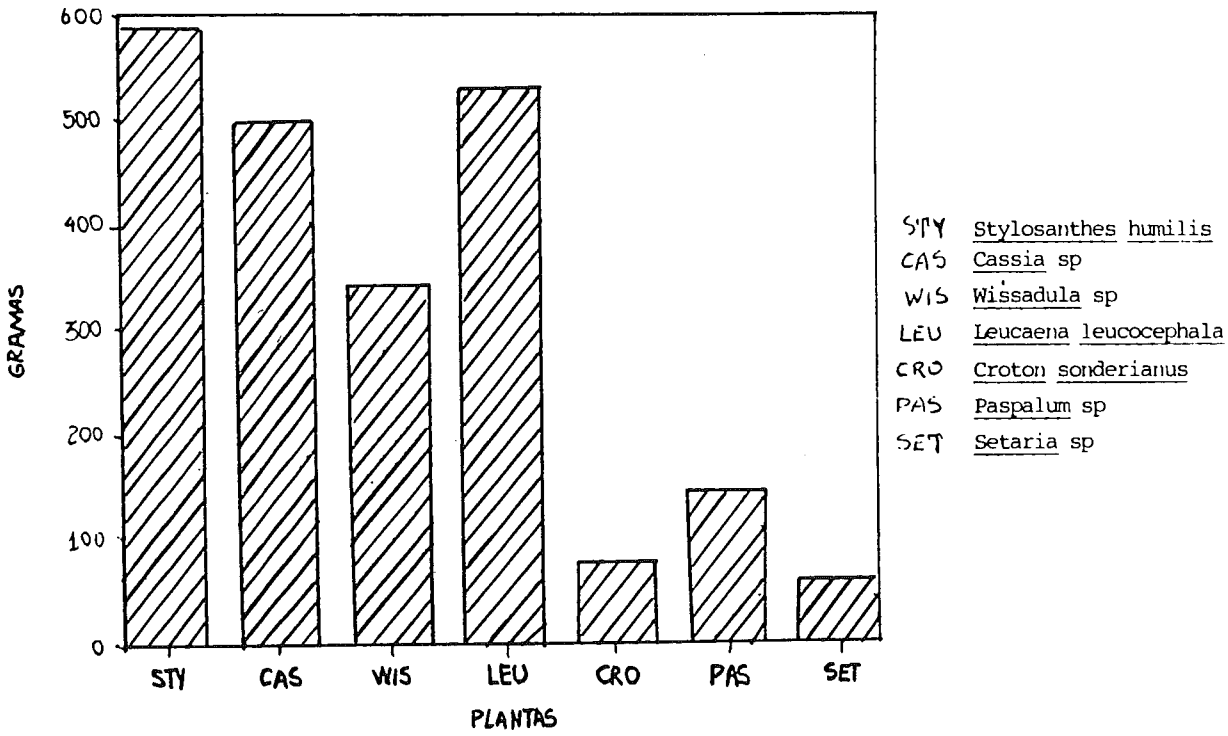

Fig.4-Consumo de silagem (g/dia) por caprinos.

TREE LEAVES AND AGRICULTURAL BY-PRODUCTS AS SUPPLEMENTS TO LOW QUALITY ROUGHAGE DIETS FOR SHEEP AND GOATS

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ABSTRACT - Tree leaves and certain crop by-products can play an important role in improving the utilization of diets based on high fiber materials. This paper reviews limitations in the use of such forages as dietary supplements and research on their effect on the utilization of the basal diet. In general, their use is feasible and economical under small farm conditions. Anti-quality factors may restrict the level at which they can be fed as supplements; however, such restricted levels are generally higher than the levels which result in maximum utilization of the basal diet and at the same time give satisfactory animal performance. When used as supplements to green tropical grasses, leguminous tree leaves do not substantially improve the digestibility of cell wall fiber. However, digestibility may be improved when the basal diet consists of poor quality fibrous feeds. Use of forage supplements usually decreases the intake of the basal diet but increases total dry matter intake; however, at very low levels of supplementation, the basal diet intake may remain constant or even increase. The main benefit of forage supplements seems to be attributable to their superior protein quality; even when the basal diet seems adequate in crude protein, forage supplements can improve the efficiency of microbial protein production and increase the supply of protein to the small intestine.

Index terms: Goats, Sheep, Dietary supplementation, Tropics.

A FOLHAGEM DE ÁRVORES E SUBPRODUTOS DE CULTURAS COMO SUPLEMENTOS EM DIETAS FIBROSAS DE BAIXA QUALIDADE PARA OVINOS E CAPRINOS

RESUMO - A folhagem de árvores e certos subprodutos de culturas podem contribuir para melhorar a utilização das dietas baseadas em forragem de baixa qualidade para os cordeiros e cabritos em crescimento. Neste trabalho se discute as limitações no uso dos suplementos forrageiros, e seu efeito na utilização da dieta base. Nas condições de pequenos productores o uso de suplementos forrageiros é bem factivel. Alguns componentes anti-qualitativos podem limitar o nível de uso como suplemento, entretanto, estes limites geralmente são maiores que os níveis que resultam em utilização máxima da dieta base com um comportamento adequado dos animais. Quando a dieta base consiste de gramíneas tropicais verdes, a folhagem de árvores não melhora a digestibilidade das paredes celulares, mas, no caso duma dieta base de muita baixa qualidade, a digestibilidade sim, pode ser melhorada. Com a suplementação, o consumo da dieta base sofre um decréscimo, mas o consumo total aumenta. Entretanto quando o suplemento é oferecido

a um nível muito baixo, o consumo da dieta base ou não muda ou aumenta um pouco. O principal benefício da suplementação se manifesta no grau de utilização da dieta base, devido à melhor qualidade da proteína. Ainda nos casos onde o nível de proteína parece adequado, os suplementos forrageiros podem melhorar a eficiência da produção de proteína microbiana e assim aumentar o aporte de proteína ao duodeno.

Termos para indexação: Caprinos, Ovinos, Suplementação dietária, Zonas tropicais.

Introduction

Under tropical conditions low quality forages and crop residues constitute the dominant feed source for ruminants. However, their utilization is often limited by low intake and digestibility. These limitations are more serious for small than large ruminants; size and physiological characteristics reduce the capacity of sheep and goats to utilize low quality feeds (Demment & Van Soest, 1983). Free grazing sheep, and especially goats, compensate for this disadvantage by a higher degree of selectivity; however, opportunity for selective intake is greatly reduced with full or partial confinement. Ideally, on mixed livestock farms the lowest quality feeds will be given to large ruminants. Small ruminants should be offered only better quality feeds, or their diet should allow for a large degree of selectivity. In practice, however, this is rarely the case and small ruminants are forced to survive on low quality, fibrous diets.

Methods are available to improve the nutritive value of roughages, by physical or chemical treatments. However, these methods generally are not practical or economical under tropical, small farm conditions (Jayasuriya, 1981). Furthermore, results of experiments in which treated roughages were fed to small ruminants have been disappointing and supplemental feeds continue to be necessary (Ibrahim, 1981).

For small ruminants, supplementation is often the most effective way to improve productivity on roughage based diets. The relative scarcity of good quality supplements determine the objectives of supplementation strategies: to provide a balanced supply of nutrients to meet minimum requirements for moderate growth and production; and to maximize utilization of the low quality roughage. These objectives imply levels of productivity below genetic potential; however, small ruminant producers in the tropics are generally more interested in relatively low but sustained levels of production at minimum inputs, than in maximum output (Knipscheer et al., 1983; Primov, 1982).

Types of Supplements and Limitations to their Use

Gutierrez et al. (1981) found that when mixed livestock producers in Ceará used supplements it was most often for cattle; they would occasionally feed supplements to sheep, but almost never to goats. In other countries, also, small farmers are often unwilling to pay full cost for management improvements (for example, see Amir et al., 1985, who report on-farm experience from Indonesia). Options to be considered are therefore limited to high quality crop by-products, and leaves from trees or shrubs--in other words, feeds that can be obtained at zero or minimal cash cost. Excluded from consideration for the small holder are many of the agro-industrial by-products which might be used by commercial farmers, and in most cases, forage crops that require irrigation and fertilization.

A list of crop by-products and tree leaves that can be used as supplements to low quality roughages is provided in Table 1. The majority of the feeds listed are common in the humid tropics where all are used to some extent by small farmers (Hutagalung, 1979; van Eys et al., 1983). Many are also suitable to areas with low rainfall or a pronounced dry season. The list is not exhaustive; additional materials may be available in a given region, depending on agricultural practices and the predominant tree species. Not included are most of the trees and shrubs of the caatinga, as compiled by Kirmse et al. (1983), the feeding value of which may be comparable to some of the species listed. Nutrient composition and content of anti-quality components should be determined on the common caatinga species which lend themselves to harvest and use as supplements.

TABLE 1. Chemical composition of forage supplements.

Feedstuff	DM (%)	Composition of dry matter (%)						Maximum feeding level
		CP	NDF	CF	ME(kJ)	Ca	P	
Acacia leaves	32	20	-	20	2.09	1.00	.23	?
Algaroba leaves	25	24	45	25	-	0.86	.25	?
Albizia foliage	37	24	37	-	-	1.40	.10	25
Calliandra foliage	39	24	24	-	-	1.60	.20	25
Cassava leaves	24	28	34	12	2.52	1.15	.45	25
Erythrina foliage	12	34	40	-	2.50	1.53	.42	-
Gliricidia foliage	26	27	50	15	2.66	1.58	.29	75
Indigofera herbage	23	17	-	32	1.97	4.26	.23	50
Soybean straw	80	14	78	36	2.66	0.94	.18	-
Jackfruit leaves	33	16	32	17	2.02	1.60	.39	-
Leucaena foliage	28	27	38	21	2.13	1.40	.21	60
Sesbania foliage	23	28	37	17	2.44	1.29	.47	-
Sweet potato vines	9	22	36	15	2.39	1.79	.24	?
Water hyacinth	6	16	43	25	2.22	1.62	.60	25

Even when small ruminant producers recognize the high feeding value of certain legume trees and crop by-products, their use of these feeds is often inefficient. Rather than using them as supplements, they are fed as the sole feed for short, intermittent periods (van Eys et al., 1983). Most of these feeds are high in crude protein. When fed alone or as the major dietary constituent a large proportion of the nitrogen may be lost as NH_3-N.

When the feeds are used as supplements to grass diets they do not need to be fed with every meal, or even daily. Rangkuti et al. (1985) did not find differences in growth of lambs or kids when the same amount of gliricidia foliage was fed daily, every two, or every three days. However, with very low quality feeds which do not provide sufficient nutrients for maximum rumen fermentation, more frequent supplementation should prove beneficial.

Chemical composition of these supplements compares favorably with most agro-industial by-products, although their energy density is lower. Their total cell-wall fiber (NDF) is lower than that of tropical grasses and many crop residues. Mineral values indicate their usefulness in correcting mineral imbalances, especially Ca/P ratios. Dry matter (DM) content of the supplements is lower than that of most crop by-products but higher than most fresh tropical grasses. Important exceptions are erythrina leaves, sweet potato vines and water hyacinth, the high water content of which may limit DM intake when fed at high levels.

Characteristic of many forage supplements is their high level of anti-quality components such as tannins, cyanogenic glucosides, mimosine or soluble oxalates (Table 2). However, precise information is lacking on nutritional and sub-clinical effects of their occasional or continuous ingestion. Few of them will cause acute toxicity at moderate feeding levels; however, continous ingestion may reduce productivity.

TABLE 2. Anti-quality factors in forage supplements.

Feedstuff	Anti-quality factors
Acacia leaves	possible: HCN, tannins, fluoroacetic acid, oxalate
Albizia foliage	tannins (2-3%)
Calliandra foliage	tannins (10-24%)
Cassava leaves	HCN, tannins
Indigofera herbage	indospicine, 3-nitropropanic acid
Soybean straw	cell wall constituents
Leucaena foliage	mimosine
Sweet potato vines	low DM
Water hyacinth	nitrates, oxalates, low DM

Tannins are among the more prevalent of the anti-quality components, especially in legume foliage. High levels of low molecular weight, reactive tannins will depress voluntary intake and rumen carbohydrate digestion. However, these same compounds are highly efficient in reducing ruminal plant protein degradation, thus increasing amino acid supply to the animal (Barry & Reid, 1984). Dietary levels of high tannin feeds should be balanced to take into account both positive and negative effects.

Toxicity of some labile compounds can be altered through storage, heat treatment, or crushing. In the case of cassava leaves the enzyme linamarase will react with the glucoside during wilting, releasing part of the HCN present (Oke, 1978). However, much of the HCN appears to be cell-wall bound and may have a subclinical effect on animal growth. Mathius et al. (1983) showed that growth rate of sheep and goats increased when napier grass diets were supplemented at 20-25% with wilted cassava leaves. Higher levels of supplementation did not increase weight gain. Further, growth rate did not respond to additional supplementation with an energy or protein source, suggesting that at 25% inclusion of cassava leaves, HCN limited animal performance (Mathius et al., 1984; 1985).

Stage of harvest is also important. Nitrogenous toxins such as cyanoglucosides, specific amino acids and alkaloids are commonly present in highest concentration in meristimatic tissue. Feeding more mature material will therefore reduce the risk of toxicity.

Geographic differences may affect the animal response to feeding potentially toxic materials. These differences may be related to soil, climate or plant variety, or they can be associated with the animal itself. An example is the mimosine toxicity associated with the feeding of Leucaena species. Mimosine, and its metabolite DHP (3-hydroxy-4(1H)-pyridone), severely limits the use of leucaena by ruminants in most of the tropics. However, in Hawaii and parts of Asia ruminants have been shown to detoxify DHP from leucaena, in the rumen (Jones & Lowry, 1984).

Because of anti-quality components, many forage supplements should be used only at low levels. For only a few of them is sufficient information available to establish the optimum level of use. The maximum levels of feeding given in Table 1 are based on anti-quality components. Economic goals such as maximum utilization of the basal diet were not taken into account. In most practical situations levels lower than these maximums can be fed.

Supplementation - or Substitution?

Due to the fibrous character of forages that can be used as supplements, intake of the basal diet will generally decrease

with increasing levels of supplementation. Figure 1 shows the effect of supplementation with tree legume foliage on DM intake of medium quality napier grass. The decrease in napier grass intake is most pronounced at higher levels of supplementation. Since the supplement is generally more palatable than the basal diet it will be consumed preferentially. In this study, lambs consumed the legume first and appeared to add napier grass to a level of maximum rumen fill. Total indigestible fiber intake was not influenced by type or level of supplementation.

In the absence of toxic components and with adequate nutrients for the rumen microbes, intake of roughage diets is primarily limited by ruminal digestion of the fiber component. Although the rate of fiber degradation for tropical legumes is greater than for tropical grasses, the extent of digestion, which has the largest effect on intake, is equal or lower (Ali & Stobbs, 1980; Lane, 1982). These fiber digestion parameters may have less effect on intake with some agricultural by-products than with legume tree foliage. For example, rate and extent of cell wall disappearance in sweet potato vines and cassava leaves are higher than in leucaena, erythrina, or gliricidia (Roldan, 1981). Meyreles et al. (1979) showed that supplementation of sweet potato vines to sugar cane pith-urea diets did not depress intake, compared to the basal diet.

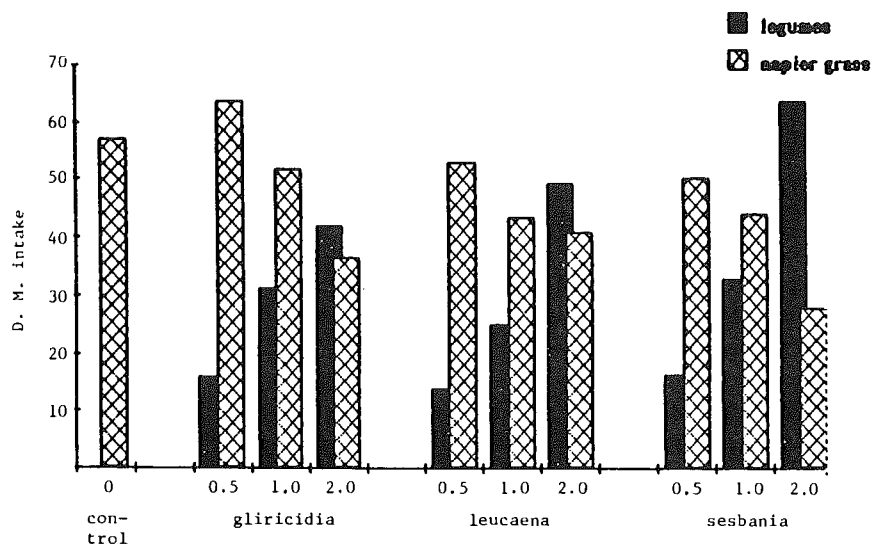


Figure 1. Dry matter intake (g/kg $BW^{.75}$/d) by lambs of napier grass and fresh legume tree foliage fed at 0.5, 1.0 and 2.0 kg/head/day.

The substitution effect is not limited to forages. Supplementation with concentrates will also decrease intake of a roughage diet but the effect may be less pronounced, especially at low feeding levels. Figures 2a and 2b demonstrate the difference between alfalfa and cottonseed meal supplementation for animals fed low quality bermudagrass hay. When diets were iso-nitrogenous for a given level of supplementation, intake decreased more with alfalfa than with cottonseed supplementation.

In experiments where high quality supplements have comprised less than 20% of the diet, no change or a slight increase in roughage intake has been noticed, as evidenced by data presented in Figures 1, 2a and 2b. At a low level of legume supplementation (Figure 1) there was no significant difference in napier grass intake. In Figure 2a bermudagrass hay intake by goats actually increased when either cottonseed meal or alfalfa were fed at 10% of the diet. For sheep the same increase was observed with cotton seed meal but not with alfalfa. Hay intake was not affected when supplementation was doubled. These results suggest that at low levels the supplement contributes little to rumen fill, but does help correct nutrient deficiencies for microbes and host animal.

Energy and Protein Value of Forage Supplements

Forage supplements can provide nutrients that are limiting in diets based on low quality roughages. Their effect on animal performance, however, is confounded, and the fact that protein is also a source of energy is often overlooked. Table 3 presents DM digestibility and intake by sheep of some roughages, supplements and mixed diets. Digestibility and intake data of the individual feeds are based on results of experiments where these feeds were fed alone. The list is brief and reflects a lack of information, especially on the supplementation of roughage diets with a single forage species.

Many supplements with proven beneficial effects have digestibilities equal to or lower than roughages, perhaps due to condensed tannins or other anti-quality factors; when fed alone, as in a conventional digestibility trial, the concentration of these compounds in the digesta may increase to levels that interfere with microbial digestion. Given the intake substitution effect, forage supplements are unlikely to furnish a major increase in dietary energy, especially when fed with grasses. Limited information on mixed diets suggests that for tropical grasses the associative effect of supplements on digestibility is not large. Large depressions in DM or cell wall digestibilities have not occurred with high quality forage supplements at high levels, which is not surprising given their composition. Changes in ruminal pH and microbial composition associated with this type of supplementation, however, have not been studied.

FIGURE 2A. D.M. INTAKE BY GROWING SHEEP AND GOATS (G/KG MBW)

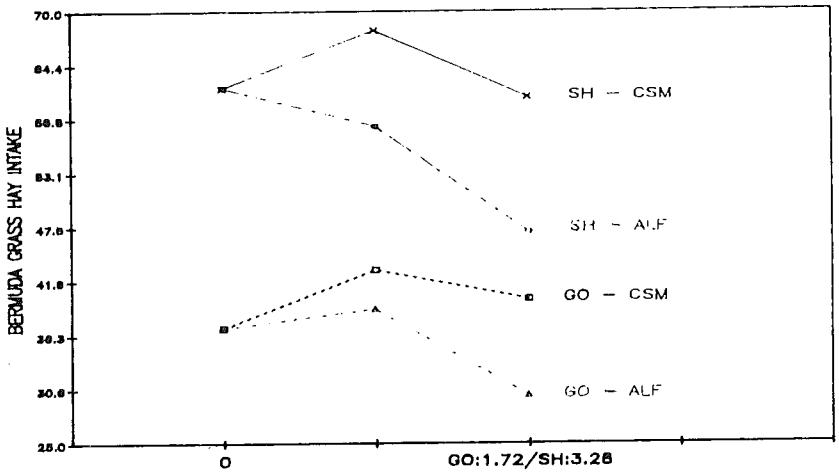


FIGURE 2B. D.M. INTAKE BY GROWING SHEEP AND GOATS (G/KG MBW)

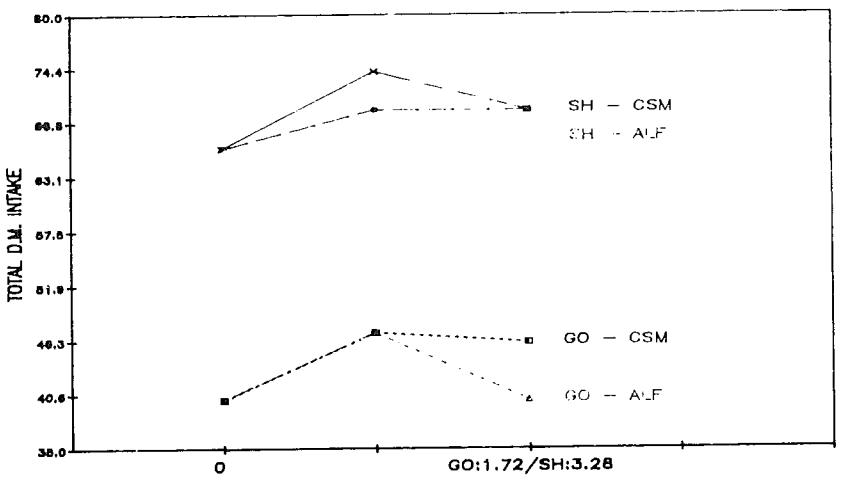


TABLE 3. Digestibility and intake of roughages, supplements, and mixed grass-legume diets by sheep.

Feedstuff	Dig. DM (%)	DM intake (g/kg BW)	Reference
Crop by-products and grasses:			
Corn stalks	55	14	Cheva-Isarakul, 1982
Guinea grass (anthesis)	59	29	Lane, 1982
Napier grass (anthesis)	57	28	van Eys et al, 1986
Rice straw	43	18	Cheva-Isarakul, 1982
Tree foliage:			
Albizia	39	20	Mahyudin, 1984
Calliandra	41	17	"
Gliricidia	55	30	"
Leucaena	64	23	Cheva-Isarakul, 1982
Mimosa	55	19	"
Sesbania	65	36	"
Grass-legume diets:			
Napier-gliricidia (80:20)	63	36	van Eys et al., 1986
Napier-leucaena (80:20)	59	39	"
Napier-sesbania (80:20)	58	33	"
Guinea-leucaena (70:30)	58	37	Lane, 1984

A possibly more efficient utilization of digestible energy (DE) from forage supplements is suggested by their metabolizable energy values (Table 1), which are higher than tropical grasses (about2.0 kcal/kg for napier and guinea grass) or rice straw (1.5-1.8 kcal/kg). Greater efficiency of DE utilization could be due to reduced rumen fermentative losses, or increased nutrient by-pass to the small intestine. Tree legumes may increase rumen turnover rates when used as a supplement in grass diets, if they have the same effect as shown by Thornton & Minson (1973) for herbaceous tropical legumes. This would help explain the observed increase in DM intake (Table 4), which, especially at low levels of supplementation, is the major reason for the higher DE intake associated with supplementation.

Improvements in digestibility of supplemented diets have been observed when the nitrogen content of the basal diet was too low to maintain maximal microbial digestion in the rumen, as is frequently the case with low quality by-products such as straws and corn stalks. Improved tropical grasses, especially when cut at early growth stages, generally have adequate nitrogen for optimal ruminal fermentation. Table 5 gives an overview of crude protein content and solubility of tropical grasses and tree legume foliages. Protein concentration in tree legumes is approximately twice that of grasses while protein solubility is equal or less. The high level of protein solubility in grasses assures adequate levels of ruminal ammonia-N for maximal

TABLE 4. Effect of supplementation with tree legume foliage on DM intake of the basal and total diet.

Animal species, basal diet, and supplement	DM intake, g/day: Basal diet: No suppl.	Basal diet: With suppl.	Experimental diet	Reference
Cattle:				
Rhodes grass, +				Flores
- leucaena (7%)	5,746	5,594	6,003	et al.,
- leucaena (13%)	5,746	5,642	6,460	1979
Goats:				Mathius
Napier grass & cassava leaves, +				et al.,
- gliricidia (11%)	458	430	485	1985
Lambs:				
Napier grass, +				
- leucaena (25%)	469	521	650	van Eys
- gliricidia (25%)	469	434	546	et al.,
- sesbania (25%)	469	412	544	1986a

TABLE 5. Protein content and solubility in tropical forages.

	Regrowth (wk)	Total protein (%)	Solubility (%)	Reference
Soluble in Burroughs mineral solution:				
Chloris gayana	6	13.4	28.8	Ali &
Pennisetum clandestinum	6	17.5	35.2	Stobbs,
Setaria anceps	6	10.1	28.9	1980
Digitaria decumbens	6	8.8	27.8	
Panicum coloratum	6	12.1	39.9	
Brachiara mutica	6	13.9	40.8	
Leucaena leucocephala	?	31.8	21.1	Flores et al., 1979
Rumen soluble after 2 hr:				
Pennisetum purpureum	6-8	11.9	45.6	van Eys
				et al.,
Leucaena leucocephala	12-14	26.9	27.4	1986b
Gliricidia maculata	12-14	25.6	27.5	
Sesbania grandiflora	12-14	28.1	42.5	

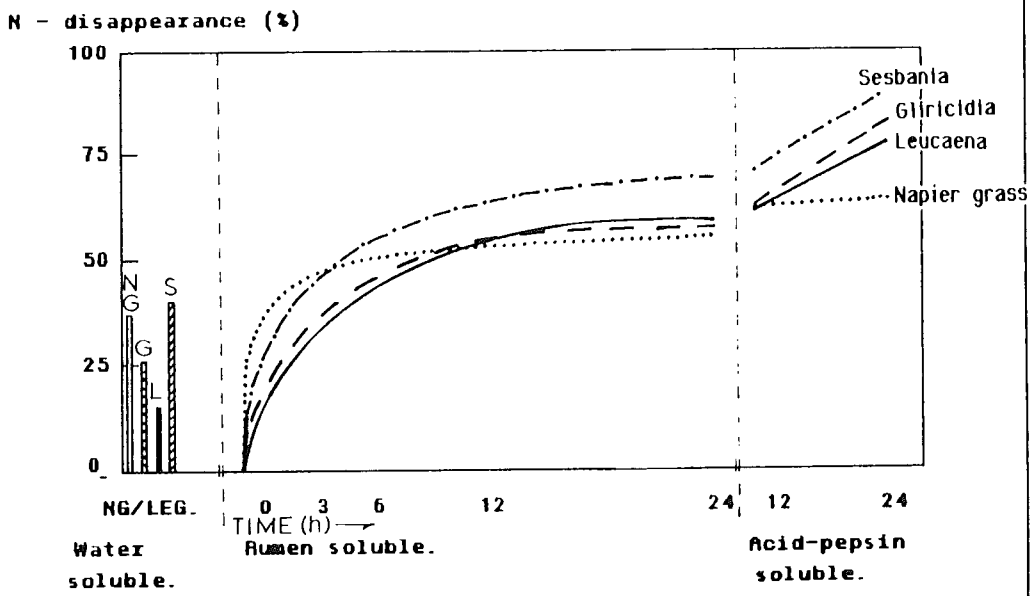
digestion and microbial protein production. On grass diets, the soluble nitrogen from supplemental legume tree foliage will contribute little if anything to ruminal fermentation. Parenthentically, although no direct comparisons were made, protein solubility in situ was higher than that measured with Burroughs mineral solution.

Levels of rapidly fermentable carbohydrates (CHO) in crop residues and tropical grasses are low. Flores et al. (1979) estimated 5% soluble CHO in Rhodes grass; soluble CHO in leucaena has been estimated to be 12%. The unbalanced and unsynchronized release of ammonia and CHO in the rumen of animals fed tropical grasses may limit efficiency of microbial fermentation and lead to significant losses of nitrogen. However, immature tropical grasses could be used as a soluble nitrogen supplement for low quality crop residues. Beneficial responses to the inclusion of napier grass in rice straw diets were observed by Sitorus (1985).

Differences in disappearance of the insoluble protein fraction have also been shown between grasses and legumes. In a comparison of napier grass and legume tree foliage (Figure 3), the insoluble, slowly disappearing protein fraction was larger in the legumes than in napier grass, and the rate of protein disappearance was also higher. Acid-pepsin treatment increased the availability of protein from legumes but had only a small effect on napier grass. Aii & Stobbs (1980) showed similar differences between guinea grass and leucaena. Tree legume foliage, and probably many other shrub and tree leaves that could be used as supplements, provide a high level of true protein. Amino acids from these proteins can increase the efficiency of rumen fermentation, or they may escape rumen fermentation. In both cases protein supply to the small intestine increases. However, when leucaena and sesbania were compared to formaldehyde-treated soybean meal (van Eys et al., 1986), it was concluded that at low levels of supplementation protein from the tree legumes had only limited by-pass quality. At higher levels of supplementation larger quantities of protein may escape microbial degradation. By-pass protein is only useful if it can be digested post-ruminally and has an amino acid composition comparable or superior to that of microbial protein. The acid-pepsin soluble fraction of tree legumes (Figure 3) suggests high levels of available protein, but little is known about their amino acid composition.

The tree legumes studied are not considered to be rich in tannins. Low levels of condensed tannins may increase the supply of dietary nitrogen to the duodenum, but high levels will interfere with ruminal digestion of carbohydrates. Species with high tannin levels such as calliandra, albizia and acacia, if used at low levels, can improve protein utilization on grass-based diets.

Fig. 3. Nitrogen disappearance from napier grass and foliage of three tropical legume trees.



Conclusions

Crop by-products of good quality and leaves from trees and shrubs can play a major role in improving the utilization of low quality roughage diets and the nutrition of high producing animals. A major advantage for the small farmer is the low cash cost associated with the use of these types of supplements. Anti-quality components may restrict their incorporation in roughage diets. However, maximum levels of feeding imposed by known toxic components are generally higher than the supplementation levels that combine maximum utilization of the roughage and satisfactory animal performance. When used in combination with forages, the contribution of shrub and tree leaves to the improvement in energy provision and digestibility of cell wall constituents is limited. Protein quality of legume tree foliage is superior to that of grasses. When high-quality by-products and tree or shrub foliage are used to supplement nitrogen-poor roughages or grasses that are apparently adequate in crude protein, the efficiency of microbial protein production and supply of protein to the small intestine can be greatly improved.

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THE INTERACTION OF ENVIRONMENTAL VARIABLES (TIME OF DAY AND SHADE VS SUN) AND LEVEL OF NUTRITION ON ANIMAL RESPONSE (BODY TEMPERATURE, RESPIRATORY RATE, WATER INTAKE AND WEIGHT GAINS) WITH HAIR SHEEP

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ABSTRACT - Santa Inês male lambs were used in an experiment to study the effect of sun vs shade, feed level, and time of day on body temperature, respiratory rate, and for the effect of the first two variables on water intake and body weight gains. Animals exposed to direct sunlight throughout the day were able to maintain normal body temperatures through increased respiratory rates. There was some interaction between the time of the day and the need for shade. The animals in direct sunlight were more stressed in the afternoon, but respiratory rates were not excessive even under these conditions. A higher plane of nutrition resulted in elevated body temperatures and respiratory rates, but did not result in a serious degree of stress. As expected, plane of nutrition markedly affected weight gains and feed to gain ratio. Animals exposed to the sun consumed more water than those maintained in the shade. Under the conditions of this experiment, high temperature stress did not appear to be a major constraint to animal performance.

Index terms: Environment, Nutrition, Growth, Hair sheep.

A INTERAÇÃO DAS VARIÁVEIS DO MEIOAMBIENTE (HORA DO DIA, SOMBRA VS SOL) E NÍVEL DE NUTRIÇÃO E RESPOSTA DO ANIMAL (TEMPERATURA CORPORAL, RESPIRAÇÃO POR MINUTO, CONSUMO DE ÁGUA E GANHO DE PESO) COM OVELHAS LANADAS

RESUMO - Os cordeiros desmamados da raça Santa Inês foram usados em um experimento para estudar os efeitos da exposição a radiação solar vs sombreamento, nível de alimentação sobre a temperatura retal, taxa respiratória, consumo de água e ganho de peso. Animais expostos diretamente a radiação solar através do dia foram capazes de manter a temperatura corporal normal, embora a taxa respiratória tenha se elevado. Houve algumas interacões entre a hora do dia e a necessidade por sombra. Os animais expostos diretamente a radiação mostravam-se mais estressados durante o período da tarde, mas as taxas respiratórias não foram muito elevadas sob estas condicões. Plano nutricional mais alto, resultou numa elevada temperatura corporal e taxa respiratória, entretanto, os animais não ficaram muito estressados.

O plano nutricional afetou significativamente o ganho de peso e a taxa de consumo por ganho de peso.

Os animais expostos ao sol consumiram mais água do que mantidos na sombra.

Sob as condições deste experimento o stress devido à alta temperatura parece não ser um sério problema para a performance dos animais.

Termos para indexação: Meioambiente, Nutrição, Crescimento, Ovinos sem lã.

Introduction

The environment impacts many aspects of animal production. There is a need to study the effects of environmental variables on amimal performance and their interactions with various management practices. The overall goals should be to measure the degree to which these variables effect animal performance, and to determine management practices which might be implemented to circumvent any adverse effects. The interaction of high environmental temperatures and shade is one of the points of interest. It is known that high temperatures, or more appropriately temperature stress, reduces feed intake, and more importantly this effect is greater for high roughage rations of the type that would be utilized by the grazing animal in the tropics (Beede & Collier, 1986). Environmental temperatures are difficult to control under laboratory conditions and this approach is impossible under field conditions. However, one variable which often influences animal performance and behavior and which can be controlled is the provision of shade. The present experiment was undertaken to study the importance of shade and the interaction of shade with feed level in respect to a number of animal performance variables, and to appraise the level of stress under prevalent conditions. A secondary interest was to study energy intake levels with respect to requirements under tropical conditions. This latter aspect is not being discussed in this report.

Materials and Methods

A total of 40 male Santa Inês type sheep were used in the experiment. These were randomly divided into 8 lots of 5 animals each, and used in a factorial experiment. Two factors were shade vs no shade (sun). The other part of the factorial experiment consisted of 4 different levels of the same ration. The length of the experiment was 56 days with 7 days considered as a preliminary period and 49 days in the experimental period. These dates were October 22 to December 17 which coincides with the end of the dry season in this part of Brazil in which the sun would be expected to shine during most of the daylight hours.

The four feed levels chosen were below maintenance, approximately maintenance, medium and a high level approximating *ad libitum* intake. In the latter case, the animals were

restricted to the extent that they cleaned up all of their feed. The levels of feeding varied as they gained weight. Any refused feed was weighed back on a daily basis contributing to some variation in recorded intake. The ration was composed of 1/3 ground corn stover and 2/3 of the following concentrate mix:

Corn----------71%
Soybean----------27%
Mineral Mix---------- 2%

This concentrate was formulated to contain approximately 20% crude protein. The measurements taken included body weight change, water intake, body temperature and respiratory rates. The body temperatures and respiratory rate measurements were taken at both AM and PM every four days. Thus for these two measures, a further variable was introduced. Water intakes, corrected for evaporation loss, was taken on every fourth day as the body temperature and respiratory rate measures were taken. Body weights were taken weekly.

Results and Discussion

The analysis of variance for the main effects and their interactions as related to rectal temperatures and respiratory rates are shown in Table 1. The mean values are shown in Table 2. The provision of shade did not have a significant effect on rectal temperatures. However, the provision of shade did significantly reduce ($P<.05$) the respiratory rate. This difference however, was small (2.63 respirations per minute). This indicates that the animals exposed to the sun can maintain their body temperature by elevating their respiratory rate. Plane of nutrition significantly effected both body temperature and respiratory rate with both values being increased by an increase in feed intake. Although highly significant, these differences tended to be of low magnitude and likely represent the incresed heat of fermentation from digestion of the added feed consumed. Time of the day (morning vs afternoon) had a highly significant effect on both body temperature (BT) and respiratory rate (RR). The animals were showing more temperature stress in the afternoon. Also, there was a significant interaction between sun vs shade and time of day for both of these variable (Tables 3 and 4). This was most marked in respect to RR in which those animals exposed to the sun had a mean RR which was 7.15 higher in the afternoon.

There was also a significant interaction between plane of nutrition and time of the day in respect to RR (Table 5). There was a consistent increase in RR with increases in feeding level with a difference of 16.5 between the two extremes.

In general, these data indicate or confirm that direct sunlight results in some degree of heat stress as the day advances (afternoon readings), but that by only a modest increase in the RR, the animals are able to control their temperature

within the normal range. Also, the RR recorded are not extreme as much higher values are obtained when the animals are subject to more extreme stress. For instance, wool sheep exposed to direct sunlight often have respiratory rates between 100 and 200 (Lawson & Shelton, 1982).

TABLE 1. Analysis of variance (mean squares) for the main effects and their interactions for rectal temperature.

Variable	DF	Mean squares	
		Rectal Temperature	Respiratory Rate
Shade vs. sun (S)	1	0.04	227.81*
Plane of nutrition (PN)	3	0.53**	434.78***
Time of day (T)	1	5.68***	13,184.12***
S X PN	3	0.11	22.31
S X T	1	0.51*	285.01*
PN X T	3	0.07	157.88
S X PN X T	3	0.28	8.85
Error	64	0.12	54.95

*, $p<0.05$; **, $P<0.01$; ***, $P<0.005$.

TABLE 2. Means for the effects of various factors on rectal temperature and respiratory rate.

Variable	Rectal Temperature (C)	Respiratory Rate
Sun	39.45^{a}	50.37^{b}
Shade	39.40^{a}	47.00^{a}
Plane of Nutrition		
High	39.63^{c}	53.35^{c}
Medium	39.47^{c}	51.25^{bc}
Maintenance	39.36^{ab}	47.40^{ab}
Below Maintenance	39.25^{a}	42.75^{a}
Time of Day		
Morning	39.16^{a}	35.85^{a}
Afternoon	39.69^{ab}	61.52^{b}

^{abc}Means with different superscript are significantly different at the $P<0.05$ level.

TABLE 3. Means for rectal temperature as influenced by the interaction of sun vs shade on time of day.

Variable	Time of Day[a]	
	Morning	Afternoon
Sun	39.10	39.80
Shade	39.23	39.9

[a]Time of day effect significant (P0.05).

TABLE 4. Means for respiratory rate as influenced by the interaction between sun vs shade and time of day.

Variable	Time of Day[a]	
	Morning	Afternoon
Sun	35.65	65.10[b]
Shade	36.05	57.95[c]

[a]Time of day effect significant ($P<0.05$).
[bc]Sun vs shade different ($P<0.05$).

TABLE 5. Means for respiratory rate as influenced by the interaction between plane of nutrition and time of day.

Variable	Plane of Nutrition			
	High	Medium	Maintenance	Below Maintenance
Morning	38.50	36.30	34.80	33.80
Afternoon	68.20[b]	66.20[bc]	60.00[c]	51.70[d]

[a]Time of day effect is significant ($P<0.05$). Plane of nutrition effect is significant ($P<0.05$), afternoon only.
[bcd] Means with different superscript are significantly different at the $P<0.05$ level.

A higher level of feed intake significantly increased heat load. Again this stress is not extreme as indicated by the RR. Perhaps a point of greater interest would be the effect of heat stress on level of feed intake. In this experiment, the level of feed intake was controlled, but there appeared to be no problems at the levels employed. This may well not have been the case if the animals had been required to graze, in which case physical activity might add to the heat load, or heat stress might reduce grazing activity.

Shown in Table 6 are the mean squares for the effect of sun vs shade and feed intake on water intake and daily gains. Table 7 contains the actual mean values by treatment groups. The animals exposed to the sun consumed more water than those in the shade (2.95 liters per day as compared to 2.24). This would be expected as a direct result of the increased RR since this action reduces body temperature through the evaporation of moisture from the respiratory tract. Feed level did not significantly affect water intake. In this experiment, feed intake was controlled, and thus could not be subjected to statistical analysis. The minor differences recorded can be explained by weigh back of refused feed. Weight gains and feed efficiency values are largely dictated by the different levels of feed intake. As would be expected, rates of gain were significantly affected by plane of nutrition.

TABLE 6. Analysis of variance (mean squares) for the main effects and their interaction on water intake and rate of gain.

		Mean Squares	
Variable	DF	Water Intake	Daily Grain
Sun and Shade (S)	1	4.79***	1768.9*
Plan of Nutrition	3	0.16	31068.9***
S X PN	3	0.09	400.1
Error	32	0.25	325.2

*, P<0.05; **, P<0.01; ***, P<0.005.

The lambs maintained in the shade gained significantly better than those in the sun (P<.05). However, the difference was small and not consistent between feed levels. It was only at the full feeding level that the differences actually favored those maintained in the shade.

In this study the gains, even at the highest feed level, were quite low (136gms. per day) by most standards. The reason for this is not clear. The feeding period was of short duration. Feed efficiency figures (feed to gain ratios) at the highest level of feed intake compare reasonably well with those from the

TABLE 7. Mean values (actual) for the effects of sun vs shade and plane of nutrition, weight gains, feed efficiency and water intake.

Variable	Plane of Nutrition	Feed Intake (G/Day)	Weight Change (G/Day)	Feed Efficiency (G/G)	Water Intake (L/Day)
Sun	High	801	130	6.3	2.71
	Medium	673	96	7.1	3.03
	Maintenance	491	13	39.0	2.85
	Below Maint.	331	-55	----	3.20
Shade	High	802	145	5.5	2.26
	Medium	654	90	7.3	2.23
	Maintenance	518	11	48.9	2.21
	Below Maint.	326	-25	----	2.26

literature. The generally low levels of gains obtained appear to warrant further study. At the higher level of feed intake was approximately 4.9% of initial body weight.

In general, these studies suggest that high temperature stress was not a major impediment under the conditions of this experiment. Other studies (Arruda, et al., 1984 & Pant et al., 1985) have also shown that with modest increases in respiratory rates, sheep and goats are able to maintain their body temperatures within the normal range under conditions found in Northeast Brazil.

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THE RESPONSE OF LACTATING NATIVE AND EXOTIC BREEDS OF DAIRY GOATS TO COMPLETE RATIONS INVOLVING VARYING LEVELS OF UREA AND TWO ENERGY SOURCES (ALGAROBA PODS VS. CORN)

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ABSTRACT - Mature does entering their third lactation were selected from the flock at the Fazenda Pendência near Soledade, Paraîba. They were used in an experiment to study ration formulations utilizing two energy sources which were corn vs ground algaroba pods (Prosopis juliflora) and three protein sources consisting of cottonseed meal or 1 or 2 percent urea for a total of six ration formulations. The animals were used in a reversal type study in which each animal received each ration. Only the last two weeks of the test period were used in the analyses. The rations containing corn resulted in significantly higher level of lactation than those containing algaroba pods. Corn has a higher energy level and the performance on the two rations was approximately in ratio to their energy content. The performance on the 1% urea ration did not differ significantly from the ration utilizing only cottonseed meal as a protein source. The two percent urea rations proved to be less satisfactory than those receiving CSM or 1% urea. Urea tended to give a better response with the corn based ration than the algaroba based ration.

Index terms: Goats, Lactation, Supplementation.

RESPOSTA DAS CABRAS LEITERAS EM LACTAÇÃO NATIVAS E EXÓTICAS A RAÇÕES COMPLETAS ENVOLVENDO VÁRIOS NÍVEIS DE URÉIA E DUAS FONTES DE ENERGIA (VAGENS DE ALGAROBA VS MILHO)

RESUMO - Cabras adultas entrando na terceira lactação foram selecionadas dentro dos rebanhos da Fazenda Pendência, no município de Soledade, Paraîba. Elas foram usadas em um experimento sobre formulação de raçoes utilizando-se duas fontes de energia (milho versus vagens de algaroba) e três fontes de proteîna (torta de algodão, sozinha ou com a adição de uréia a 1% e 2% na torta de algodão) para um total de seis formulações de ração. Os animais receberam todas as rações em um sistema rotacional por período porém apenas as duas últimas semanas do período experimental foram usadas nas análises. As rações contendo milho contribuiram para níveis de lactação significativamente maiores do que aquelas contendo vagens de algaroba. Rações contendo milho apresentaram niveis de energia mais elevados e a performance de cada ração foi na razão direta do nível de energia. Performance na ração com 1% de uréia não diferiu significativamente da ração contendo somente torta de algodão como fonte de proteîna. As rações com 2% de ureîa

provaram ser menos satisfatórias do que aquelas recebendo torta de algodão ou 1% de uréia. A uréia tendeu a apresentar uma melhor resposta com as rações de milho do que com as rações de algaroba.

Termos para indexação: Caprinos, Lactação, Suplementação.

Introduction

The goat population of Brazil is concentrated in the northeastern region, which is often referred to as the drought polygon of the country (Mason, 1980). Improved dairy goat breeds represent only a small percentage of the total goat population. Native types have not been highly selected for milk production. The most numerous type of goats is the so called SRD (Sem Raça Definida) or "Without a Defined Breed." These are widespread in the Northeast and often represent mixtures of native and exotic breeds. Due to this mixing of breeds, and possibly some selection, they are generally somewhat better milk producers than the smaller so called native types which are often distinguished largely by their color. Exotic breeds such as the Anglo Nubian and Alpine have been introduced on more than one occasion.

Only limited use is made of the goat as a milk producer in this region, but there is increased interest in this practice. There is little doubt that the use of the goat for a home milk supply under small holder conditions should be encouraged. The feasibility of commercial exploitation of the goat as a source of dairy products is currently being explored. Native forage resources of the area are not suitable or adequate to support a high level of milk production, especially during the extended dry period. Soil resources, climate and socio-economic constraints make it difficult to produce high quality feeds or forages for use by goats. Thus, there is a need to develop least cost rations utilizing NPN and locally available products. The present study compares various levels of urea and cottonseed meal, algaroba pods (Prosopis juliflora) versus corn in rations containing sugarcane by-products. The algaroba is a perennial tree which is widespread in the arid tropics (Leaky & Last, 1980). It was introduced into Brazil around 1942 and since this date its use has been encouraged as a source of livestock feed (forage and seed pods) and wood (Araujo et al., 1984). It is currently produced in the states of Paraíba, Pernambuco, Bahía and Rio Grande do Norte.

The literature relating to the use of NPN (urea) is extensive, but not necessarily as related to goats or its interaction with different energy sources (Harmeyer & Martens, 1980).

Materials and Methods

Twelve mature does entering their third lactation were randomly selected following parturition from the dairy goat herd of the Fazenda Pendencia, Soledade, Paraíba. Four does of each of the following breeds were used: Anglo-Nubian (AN), Sem Raça Definida (SRD) and German Alpine (GA), to test the response in performance (milk production and body weight gains) to the feeding of six experimental rations as shown in Tables 1 and 2. The animals were fed in sheltered confinement with feed and water available at all times.

TABLE 1. Composition of experimental diets.

		Algoroba rations[a]			Corn rations[a]		
	Intn'l Reference Number	CSM (1)	1% urea (2)	2% urea (3)	CSM (4)	1% urea (5)	2% urea (6)
Urea	5-05-070	0.0	1.0	2.0	0.0	1.0	2.0
Cottonsead meal	5-11-561	20.0	12.0	5.0	20.0	12.0	5.0
Algoroba pods	1-10-398	40.0	40.0	40.0	0.0	0.0	0.0
Yellow corn	4-02-879	0.0	0.0	0.0	40.0	40.0	40.0
Sugarcane mol.	4-04-696	10.0	10.0	10.0	10.0	10.0	10.0
Sugarcane bag.	1-04-686	10.0	10.0	10.0	10.0	10.0	10.0
Wheat bran	4-05-190	19.0	26.0	32.0	19.0	26.0	32.0
Salt-mineral mix	-	1.0	1.0	1.0	1.0	1.0	1.0
Totals	-	100.0	100.0	100.0	100.0	100.0	100.0

[a]The numbers in parentheses refer to ration number.

Each breed was fed two of the rations during any 28 day interval or period of the experiment with ration changes being made at the onset of a new interval. An exception to this was that the first period was only three weeks. The experiment included six intervals and thus spanned the first 161 days of lactation. To reduce possible carryover effects of the diets, only the last two weeks of the experimental period were used in analyses.

Feed allowance was kept at approximately 25% in excess of the normal estimated intake. Amounts offered and orts were weighed each morning after milking. The does were milked three times daily at 06:00, 13:00 and 17:00 hours. All does were allowed one hour exercise after each milking in an adjacent paddock where they had access to water and a salt-mineral mix. Feed ingredients were ground or processed before mixing as follows: sugar cane bagasse was sieved and ground to a size of approximately 10-20mm, algaroba pods were ground to a size not larger than 25mm, cottonseed cake and corn were ground to a meal texture.

TABLE 2. Chemical composition of the experimental rations as calculated from literature values[a].

Ration(treatment)	DM%	Energy TDN%	Energy NE_p[b,c]	CP%	P	CF%		
Algaroba + CSM(1)	89.49	58.52	2.58	1.322	14.20	0.443	0.448	16.21
Algaroba + CSM + 1% urea(2)	89.53	56.84	2.51	1.283	15.03	0.440	0.525	16.11
Algaroba + CSM + 2% urea(3)	89.61	55.29	2.44	1.247	16.08	0.438	0.591	16.01
Corn + CSM(4)	87.25	67.44	2.99	1.554	14.28	0.409	0.440	9.13
Corn + CSM + 1% urea(5)	87.30	65.76	2.91	1.515	15.11	0.332	0.517	9.03
Corn + CSM + 2% urea(6)	87.37	64.21	2.85	1.479	16.16	0.330	0.583	8.93

[a]Source - McDowell, 1974.
[b]Expressed in Mcal/kg.
[c]Net energy for production calculated by $NE_p = (0.0245x \% TDN) - 0.12$.

Body weights were recorded at seven day intervals. The first two weeks of each experimental period were considered as an adaptation period, and have not been considered in the analysis. The does were maintained on the experiment even though some had virtually ceased lactation. Management practices such as deworming or other prophylactic measures were carried on as needed at the beginning of each experimental period.

The data was analyzed with least-squares procedures for unbalanced experimental designs (SAS Institute Inc., 1982) using a nested analysis-of-variance model. Means of the performance characters measured, namely milk production, voluntary feed intake and body weight change, amongst rations were compared with contrasts. The following contrasts were analyzed:

(a) Algaroba vs. corn - rations containing algaroba pods as an energy source were compared to those rations containing corn (rations 1, 2, and 3 vs. rations 4, 5 and 6).
(b) Cottonseed meal (CSM) vs. 1% urea - rations based on CSM alone as a protein source were compared to those rations containing 1% urea as a partial substitute for CSM (rations 1 and 4 vs. rations 2 and 5 .
(c) Cottonseed meal (CSM) vs. 2% urea - rations based on CSM alone as a source of protein were compared to those rations containing 2% urea as a major substitute for CSM (rations 1 and 4 vs. rations 3 and 6).
(d) Interaction of 1% urea with algaroba vs. corn - this contrast is designed to test the interation of 1% urea with the algaroba and corn rations. The comparison determines whether the difference in performance level between the straight algaroba ration and the algaroba ration with 1%

NPN significantly differs from that between the straight corn and corn with 1% NPN rations.

(e) Interaction of 2% urea with algaroba vs. corn - this contrast is designed to test the interaction of 2% urea with the algaroba and corn rations. Similarly to the previous contrast, the intention is to compare the divergence in the performance of does on the straight corn and corn plus 2% NPN rations.

Least-squares estimates of means for performance characters are reported by both breeds and rations. An associated probability matrix was employed to detect least-squares mean values which significantly differ.

Results and Discussion

This work evaluates the performance level or, more specifically, the milk production, body weight gains and feed intake for the three breed groups during their first 23 weeks of lactation; this period has been labeled as phase I. Limited information is also available concerning their performance during the second part of lactation (Phase II) which spanned the next 24 weeks. Data on phase II is included only in Table 3. Table 3 lists the true means of voluntary feed intake of the experimental rations for both phases. Although this analysis is quite preliminary, certain trends are of interest. Marked differences were noted in feed intake between breeds and rations.

TABLE 3. Unadjusted true means of voluntary intake of experimental rations during early-mid lactation according to breed - kg/day[a].

Ration	Anglo Nubian	Sem Raça Definida	German Alpine
Algaroba + CSM(1)	2.391	1.293	2.837
	(0.145)	(0.236)	(0.074)
Algaroba + CSM + 1% urea(2)	2.337	1.220	2.670
	(0.203)	(0.175)	(0.049)
Algaroba + CSM + 2% urea(3)	1.954	0.913	2.507
	(0.191)	(0.161)	(0.039)
Corn + CSM(4)	2.083	1.411	2.456
	(0.203)	(0.056)	(0.150)
Corn + CSM + 1% urea(5)	1.778	1.358	2.398
	(0.090)	(0.080)	(0.105)
Corn + CSM + 2% urea(6)	1.736	0.923	2.329
	(0.047)	(0.118)	(0.079)
Mean	2.046	1.186	2.533

[a]Figures in parentheses refer to standard error of mean (SEM).

The feed intake of the GA does were markedly higher, the SRD does were lowest with the Anglo Nubians being intermediate. There appeared to be a lower intake of the corn rations, which can no doubt be explained by their higher energy content. There appeared to be little difference in intake of the cottonseed meal and 1% urea rations, but a marked reduction in the intake of the two percent urea rations.

The nannies were milked three times daily producing approximatlely 58.0, 28.2 and 13.8% of the daily total at the morning, noon and evening milking, respectively. The distinctly depressed evening milk collection may simply be an artifact of the time lapse between the noon and evening milking, only four hours; in contrast, a thirteen and seven hour rest period precede the morning and noon milkings. Devendra (1982) suggests that a lowered evening milk production may result from the combination of the high diurnal environmental temperature of the tropics and a ration with a high heat increment. Since a majority of the day's milk is collected at the morning milking and the mean daily total just exceeds 1 kilogram, the efficacy or gain from thrice-daily milking is questionable.

Table 4 lists the least squares means for daily milk production, average daily gain and feed intake, and a ratio of feed consumed per unit of body weight. Table 5 provides statistics relating to contrasts between treatments.

TABLE 4. Least squares means by ration for daily total milk production, average daily gain, daily feed intake and the ratio of feed intake to body weight.

Experimental Ration	Daily Milk Production (kg)	Average Daily Gain (kg)	Daily Feed Intake (kg)	Feed Intake to Body Weight Ratio
Algaroba + CSM(1)	1.16^{abc}	0.09^{a}	2.21^{abc}	0.051^{abc}
Algaroba + CSM + 1% urea(2)	0.99^{d}	-0.12^{a}	2.06^{abcd}	0.048^{abc}
Algaroba + CSM + 2% urea(3)	0.79^{e}	-0.01^{a}	1.76^{cde}	0.040^{cde}
Corn + CSM(4)	1.14^{bc}	0.09^{a}	1.97^{abcde}	0.046^{abcd}
Corn + CSM + 1% urea(5)	1.23^{ab}	-0.09^{a}	1.90^{bcde}	0.045^{abcde}
Corn + CSM + 2% urea(6)	1.07^{bcd}	0.08^{a}	1.67^{de}	0.040^{bcde}
Standard Error LS Mean	0.03	0.09	0.07	0.002

^{a,b,c,d,e}Least-squares means in the same column without a common letter in the superscript differ significantly ($P<.01$).

TABLE 5. OVERALL EFFECT OF RATION ON DAILY MILK PRODUCTION AND VOLUNTARY FEED INTAKE BY CONTRAST ANALYSIS.

Comparison	DF	Sums of Squares	F-Value	Probability (PR F)	Contrast LS Means		
Ration Type I vs. Ration Type II					Ration Type I	vs.	Ration Type II
For Milk Production							
Algaroba vs. Corn	1	0.916	13.00	0.005	0.98	vs.	1.15
CSM vs. 1% Urea	1	0.037	0.32	NS[a]	1.15	vs.	1.10
CSM vs. 2% Urea	1	1.047	14.25	0.005	1.15	vs.	0.93
Interaction of 1% Urea with: Algaroba vs. Corn	1	0.356	5.05	0.050	-0.17[b]	vs.	0.09[b]
Interaction of 2% Urea with: Algaroba vs. Corn	1	0.488	6.92	0.025	-0.37[c]	vs.	-0.07[c]
For Voluntary Feed Intake							
Algaroba vs. Corn	1	0.817	3.57	0.100	2.01	vs.	1.85
CSM vs. 1% Urea	1	0.277	1.21	NS[a]	2.09	vs.	1.98
CSM vs. 2% Urea	1	3.063	13.37	0.005	2.09	vs.	1.71
Interaction of 1% Urea with: Algaroba vs. Corn	1	0.030	0.13	NS[a]	-0.15[b]	vs.	-0.08[b]
Interaction of 2% Urea with: Algaroba vs. Corn	1	0.119	0.52	NS[a]	-0.45[c]	vs.	-0.30[c]

[a]Non-significant.
[b]The least-squares mean value reported is the difference between the base ration mean (either algaroba or corn) and the mean of the same ration with 1% urea.
[c]The least-squares mean value reported is the difference between the base ration mean (either algaroba or corn) and the mean of the same ration with 2% urea.

Differences in body weight changes were not consistent or statistically significant. The corn based rations supported a higher level of milk production, but this difference was in the same ratio as the difference between energy content of the two rations. This suggests that algaroba rations are used with approximatley equal efficiency, realizing its lower energy and higher fiber content. These differences in performance were not great enough to indicate a preference for corn if feed energy could be obtained more economically through algaroba, which was the case in these studies.

Significant differences (reduction) were observed when urea was substituted for cottonseed meal. However, this was statistically significant only when urea was fed at 2% of the ration. This suggests that urea can likely be used at the 1% level, thus reducing ration costs, with very little adverse effects on performance. The negative or adverse effects of urea (especially at 2% level) were more marked when fed with algaroba as contrasted to the higher energy corn based rations.

Table 6 reports breed comparisons for milk production, feed intake, body weight gain and production efficiencies. Both daily milk production and feed intake differed significantly amongst the breeds. The larger German Alpine (GA) does notably consumed more feed and produced more milk; the Sem Raça Definida (SRD), by contrast, tended to be of smaller size, consume less feed and yield less milk. The variability in milk production observed among the breeds probably represents differences in genetic potential. However, a strong relation between milk yield and voluntary feed intake is apparent and thus may explain some of the differences in yield. Sauvant and Morand-Fehr (1981) reported a highly significant correlation of 0.791 for milk yield with feed consumption. Higher milk yields have been obtained from animals of the same breeds at this experiment station (Rodrigues et al., 1982) when lactation commenced in the rainy season rather than at the peak of the dry season as in this study. The generally lower milk yields realized may be traced to forage and climatic conditions during breeding and gestation prior to the experimental period, since the experimental rations were formulated to meet the goats' requirements and were provided ad libitum.

The efficiency of milk production and body gain is of some interest. The GA nannies were more efficient in turning feed into milk and body weight gain than the Anglo-Nubian (AN) and SRD nannies, respectively. Actual weight gains did not significantly differ among the breeds, although the GA nannies tended to gain the most rapidly. Although the GA nannies consumed the greatest total amount of feed, the intake did not differ when expressed as a function of body weight.

TABLE 6. LEAST-SQUARES MEANS BY BREED FOR DAILY MILK PRODUCTION, AVERAGE DAILY GAIN, DAILY FEED INTAKE, BODY WEIGHT, THE RATIO OF FEED INTAKE TO BODY WEIGHT, AND FEED EFFICIENCY RATIOS, WITH A TWO WEEK ADJUSTMENT FOR CARRY-OVER EFFECTS, kg.

Breed	Daily Milk Production	Average Daily Gain	Daily Feed Intake	Body Weight	Feed Intake to Body Wt. Ration	Ratios[a]	
						Feed: Milk	Feed: Gain
Anglo Nubian (AN)	0.91[c]	-0.053[b]	2.09[c]	43.31[c]	0.047[b]	2.31	--
Sem Raca Definda (SRD)	0.52[d]	0.019[b]	1.18[d]	32.24[d]	0.037[c]	2.26	61.03
German Alpine (GA)	1.76[b]	0.055[b]	2.51[b]	48.82[b]	0.051[b]	1.42	46.02
Standard Error LS Mean	0.03	0.066	0.05	1.14	0.001	--	--

[a]These ratios were calculated from the appropriate columns in this table.

[b,c,d]Least-squares means in the same column without a common letter in the subscript differ significantly (P<.01).

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CONFINEMENT DIETS FOR DAIRY GOATS IN PARAÍBA

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ABSTRACT - Two experiments were conducted with lactating "Parda Alemão" (PA) and Anglonubian (AN) does at the Pendência research farm in Paraíba. Five does of each breed were assigned to each of four dietary treatments, 2 days post-partum in exp. I and 3 months post-partum in exp. II. Average initial weight was 43-44kg. Treatments in exp. I were buffel grass (B) or sorghum (S) hay ad libitum plus 250g/day of cottonseed cake, with (M) or without (N) 400g/day of ground maize grain (BN, BM, SN and SM). In exp. II sorghum greenchop (ad libitum) was supplemented with 500g/day of ground maize grain, plus one of four combinations of protein feeds: 300g cottonseed cake (C3); 200g cottonseed cake and 175g jackbean meal (C2J1); 100g cottonseed cake and 350g jackbean meal (C1J2); or 530g jackbean meal (J3).

Milk yields in exp. I and II averaged 1220 and 1112g/day for PA, and 912 and 614g/day for AN; being higher ($P<.05$) for S than B and higher ($P<.05$) for M than N in exp. I; and averaging 1028, 871, 789 and 763g/day for C3, C2J1, C1J2 and J3 treatment groups, respectively, in exp. II. Treatment means for daily DM intakes paralleled milk yields in exp. I (2.0, 2.8, 2.8 and 3.6% of body weight for BN, BM, SN and SM treatments) but varied inversely with milk yield in exp. II (4.0, 4.1, 4.3 and 4.3% of BW for C3, C2J1, C1J2 and J3, respectively). Digestibility of DM was 66, 76, 68 and 69% for BN, BM, SN and SM, and 70, 66, 64 and 61% for C3, C2J1, C1J2 and J3. Digestibility of fiber fractions paralleled that of total DM. In exp. I does lost an average of 6.2kg during the first 90 days of lactation, except that on the SM treatment weight losses were only 300g. In exp. II the does were able to maintain their initial weight; however, exp. II does were in a more advanced stage of lactation compared with the does of exp. I, and were producing less milk while consuming more DM.

It is concluded that a high quality diet is necessary to maintain milk yields at 800-1000g/day in either of these two breeds, in a semi-arid tropical climate similar to that of Paraíba; and that maintaining a high intake level (between 3.5 and 4.5% of body weight) is especially important. Further research should explore ways to maintain satisfactory intake levels with less dependence on cereal grain and greater use of high quality forages.

Index terms: Dairy goats, Nutrition, Semi-arid tropics.

DIETAS PARA CABRAS LEITERAS EM CONFINEAMENTO, EM PARAÍBA

RESUMO - Foram conduzidos 2 experimentos com cabras das raças Parda Alemão (PA) e Anglonubiana (AN), em lactação, na fazenda experimental Pendência, Paraíba. Cinco animais de cada raça (peso initial 43-44kg) foram utilizados para cada um dos 4 tratamentos, 2 dias pós-parto no exp. I e 3 meses pós-parto no exp. II. Os tratamentos experimentais no exp. I consistiram de feno de capim buffel (B) ou sorgo (S) oferecido ad libitum, mais torta de algodão (250 g/dia) com (M) ou sem (N) 400 g/dia de grão de milho moído (BN, BM, SN e SM). No exp. II a forragem (sorgo, verde) foi oferecido ad libitum com um suplemento de milho, 500 g/dia, mais uma de 4 tratamentos de alimentos protêicos: torta de algodão, 300 g/dia (C3); torta de algodão, 200 g/dia, e Canavalia ensiformis (leguminosa), 175g/dia (C2J1); torta de algodão, 100 g/dia, e a leguminosa, 350 g/dia (C1J2); e a leguminosa, 530 g/dia (J3).

O rendimento diário de leite nos exp. I e II foi de 1.220 e 1.112 g/dia para as cabras PA e 912 e 614 g/dia para as cabras AN. O rendimento de leite no exp. I foi maior ($P<.05$) com o pasto S, e também maior ($P<.05$) com o suplemento M. No exp. II as médias de rendimento diário de leite foram de 1.028, 871, 789 e 763g nos tratamentos C3, C2J1, C1J2 e J3. Os consumos diários da matéria seca (MS) foram de 2,0, 2,8, 2,8 e 3,6% do peso vivo para os tratamentos BN, BM, SN e SM no exp. I e 4,0, 4,1, 4,3 e 4,3% do peso vivo no exp. II. Da mesma maneira as digestibilidades da MS variam de 66, 76, 68 e 69% nos tratamentos BN, BM, SN e SM, e de 70, 66, 64 e 61% nos tratamentos C3, C2J1, C1J2 e J3. A digestibilidade das várias frações de fibra variam paralelamente com a MS. No exp. I as cabras perderam peso, 6,2kg durante os primeiros 90 dias de lactação com excepção do tratamento SM no qual as cabras so perderam 300g. No exp. II as cabras mantiveram seu peso inicial, entretanto, foram num estado mais avançado de lactação com uma produção menor de leite e um consumo maior de MS por dia, em comparação com as cabras do exp. I.

Para manter rendimentos diários de 800-1.000g de leite com essas raças, em condições do trópico semi-árido, é necessário prover de uma dieta de alta qualidade. Outrossim, é aparente que o nível de consumo é ainda mais importante que a digestibilidade e deve manter-se entre 3,5-4,5% do peso vivo. É preciso realizar outros experimentos para buscar a maneira de manter un nível satisfatório de consumo, sempre com menos dependência nos cereais, com maior uso das forragens de alta qualidade.

Termos para indexação: Cabras leiteiras, Nutrição, Trópico semi-árido.

Introduction

There is a growing interest in using goats for milk production in Northeast Brazil. One of the primary concerns for researchers working with dairy goats is to develop economical

feed resources, especially for use during the prolonged dry season (6-8 months) when goats grazing the native caatinga can barely find enough feed for maintenance, and mortality rates can be high (Primov, 1983). Since producers in the Sertão are not likely to accept recommendations which necessitate large cash outlays (Primov, 1982), feeding systems for lactating goats must be based on feed resources which the farmer can produce himself.

The objectives of the experiments reported below were to evaluate the productivity of lactating does when fed forage-based diets in confinement, and to contribute to knowledge about alternative feed sources for the dairy goat enterprise.

Materials and Methods

Two experiments were conducted with lactating "Pardo Alemão" and Anglo-nubian does, group-fed forage in confinement. Forage, water, and trace-mineral salt were fed ad libitum; supplemental diets were offered twice a day during milking (6am and 5pm). Individual forage intake levels were measured by confining individual does for four days, on a rotational schedule, at least three times during the 90-day trial. During one of these confinements fecal grab samples were also collected, and diet digestibilities were estimated by using acid-detergent lignin (Goering & Van Soest, 1970) as an internal marker.

In both experiments, five does of each of the two breeds were assigned to each of four dietary treatments, which are described in Tables 1 and 2. The 90-day observation started two days after parturition in Experiment I, and 3 months after parturition in exp. II. Milk yields were measured daily. Milk fat, total solids, and solids-not-fat were determined on am-pm samples at 10 intervals during exp. I and twice during exp. II. Feed samples were analyzed for crude protein and fiber constituents.

Results and Discussion

Yields and composition of milk produced by the does in the two experiments are shown in Tables 3 and 4. In both experiments the German Alpines produced more milk, but with lower percent fat, solids not-fat, and total solids, than the Anglo-Nubians. Milk yield was significantly affected by diet. In exp. I goats consuming sorghum hay produced more milk than those consuming buffel grass hay, with or without supplementation; and the goats receiving the maize supplementation produced more than those that received no maize. In exp. II there was a marked tendency for milk yield to decrease as jackbean meal replaced cottonseed cake as the major protein supplement.

Milk yields in exp. I, but not exp. II, were closely related to daily DM intake (Table 5). In exp. I sorghum hay was

TABLE 1. Components of the four dietary treatments of exp. I, with daily amounts fed and chemical composition.

	Dietary ingredients			
	Buffel grass hay	Sorghum hay	Cotton-seed cake	Ground maize
Diet no.			g/day	
1	Ad lib.	-	250	-
2	Ad lib.	-	250	400
3	-	Ad lib.	250	-
4	-	Ad lib.	250	400
Composition (% of DM)				
Crude protein	6.5	6.3	25.2	9.3
Neutral-detergent fiber	69.0	72.4	30.9	22.2
Hemicellulose	28.3	32.4	8.0	17.6
Cellulose	36.9	35.5	13.7	5.0
Acid-detergent lignin	3.7	4.1	9.6	.8

TABLE 2. Components of the four dietary treatments of exp. II, with daily amounts fed and chemical composition.

	Dietary ingredients			
	Sorghum green chop	Ground maize	Cotton-seed cake	Jack-bean meal
Treatment no.			g/day	
1	Ad lib.	500	300	-
2	Ad lib.	500	200	175
3	Ad lib.	500	100	350
4	Ad lib.	500	-	530

Composition (% of DM)

		Concentrate mixtures			
Chemical fraction	Sorghum green-chop	Trmt. 1	Trmt. 2	Trmt. 3	Trmt. 4
Crude protein	17.9	23.4	23.1	23.1	19.9
Neutral-detergent fiber	64.0	46.0	48.0	52.0	58.4
Hemicellulose	31.9	27.7	29.2	32.4	34.3
Cellulose	27.2	11.7	14.4	15.5	18.8
Acid-detergent lignin	2.9	5.0	4.6	4.9	5.1

TABLE 3. Milk yield and composition, and doe weight changes, exp. I and II. Dietary treatment effects.

Diet (N.B.)	Milk yield g/day	Fat %	Total solids %	Solids not-fat %	Doe wt. change kg/90 da.
		Experiment I			
B, CS	848a	3.7ab	11.9	8.2	-5.6ab
B, CS, M	1042b	3.6a	11.8	8.2	-7.7b
S, CS	990ab	4.0b	12.2	8.2	-5.5ab
S, CS, M	1351c	3.7ab	11.9	8.3	- .3a
		Experiment II			
0:100	1028b	2.3	10.9	8.6	.8
33:67	871b	2.4	10.7	8.3	- .5
67:33	789ab	2.7	10.8	8.1	.2
100:0	763a	2.7	11.0	8.3	- .6

(N.B.) Exp. I - B = buffel grass, S = sorghum hay, CS = cottonseed cake, M = ground maize.
Exp. II - proportions of crude protein from cottonseed cake and jackbean meal.
Means within a column, followed by different letters, are significantly different ($P<.05$); each experiment is independent from the other.

TABLE 4. Milk yield and composition, and doe weight changes, exp. I and II. Breed effects.

Breed	Milk yield g/day	Fat %	Total solids %	Solids not-fat %	Doe wt. change kg/90 da.
		Experiment I			
German Alpine	1220	3.0	10.8	7.8	-2.3
Anglo-Nubian	912	4.4	13.0	8.6	-6.9
		Experiment II			
German Alpine	1112	1.9	9.8	7.9	.4
Anglo-Nubian	614	3.2	11.9	8.7	- .4

All breed differences within each experiment are significant at $P<.01$, except doe weight change, for which $P<.05$ for exp. I and n.s. for exp. II.

apparently more palatable than buffel grass. Also maize supplementation, as expected, increased total DM intake as well as intake of digestible DM (inferred from the product of daily DM intake x the coefficient of DM digestibility). In exp. II total

daily DM intake increased slightly as jackbean meal replaced cottonseed cake; digestibility of DM, however, decreased, the net result being almost identical intakes of digestible DM across treatments ($\bar{x}$ = 1,160 g/day). The failure of the diets with highest levels of jackbean meal to maintain milk yield on a par with the diet which contained no jackbean meal is not readily explainable. Crude protein levels were apparently adequate in all diets. Even though jackbean meal seemed to cause a slight depression in milk yield, its use may be more economical than relying solely on cottonseed cake as a protein supplement.

TABLE 5. Intake and digestibility of DM and fiber fractions. Dietary treatment effects.

Diet (N.B.)	DM intake		Digestibility (%)				
	g/day	% BW	DM	NDF	HC	Cell	N
B, CS	874	2.0	66a	63a	68a	75bc	69a
B, CS, M	1221	2.8	76b	68b	74b	78c	76b
S, CS	1242	2.8	68a	66ab	70ab	73ab	72a
S, CS, M	1579	3.6	69a	62a	67a	69a	69a
			Experiment II				
0:100	1688	4.0	70b	80c	56c	71c	78b
33:67	1724	4.1	66ab	72bc	52bc	65bc	66a
67:33	1821	4.3	64a	63ab	46ab	59ab	64a
100:0	1886	4.4	61a	59a	42a	56a	65a

(N.B.) Exp. I - B = buffel grass, S = sorghum hay, CS = cottonseed cake, M = ground maize.
Exp. II - proportions of crude protein from cottonseed cake and jackbean meal.
Means within a column, followed by different letters, are significantly different ($P<.05$); each experiment is independent from the other.

Does in early lactation (exp. I) lost more weight during the experimental period than does in later lactation (exp. II). Only when daily intake was increased to 3.6% of body weight by a combination of sorghum hay and maize supplementation, was the early lactation weight loss prevented in exp. I. It has been shown that lactating dairy cows do not reach maximum levels of voluntary intake until 15-18 weeks after parturition (Johnson et al., 1966). The results of the present experiments, taken together, indicate the possibility that lactating goats may behave similarly; however, since the two experiments were conducted at different times and with different diets, this hypothesis needs to be substantiated. It seems certain, however, that a minimum intake level of 3.5-4.0% of body weight is necessary to maintain reasonable levels of milk yield while preventing undue losses of body weight. A high quality diet (highly digestible, adequate crude protein, without excess cell-

wall fiber) must be provided if this minimum level of intake is to be attained. The search must continue for dietary ingredients that meet these criteria and which can be obtained at minimum cost to the farmer.

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ACABAMENTO DE CAPRINOS E OVINOS DURANTE A ÉPOCA SECA, NO NORDESTE

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RESUMO - Nos cinco experimentos conduzidos, sendo três com ovinos e dois com caprinos, as rações continham o restolho do milho como seu componente maior. Tanto para caprinos como para ovinos foi avaliado os restôlhos do milho (planta inteira, palha da espiga e sabugo) como fração volumosa das rações. Com ovinos, foi testada a substituição da torta de algodão por feno de mata pasto (Cassia sp.) ou cunhã (Clitoria ternatea). Com caprinos, se avaliou diferentes níveis de fibra com ou sem melaço em confinamento ou semi-confinamento. O delineamento experimental adotado foi o inteiramente casualizado. Todos os animais tiveram livre acesso à água e uma mistura de sal comum + farinha de ossos. Os animais foram confinados individualmente e o consumo de matéria seca medido diariamente. O consumo de matéria seca médio dos ovinos foi 94 g/kg^{0,75} e os ganhos de peso foram superiores a 100g para a raça Santa Inês e 90 g/dia para a raça Morada Nova. O consumo de matéria seca foi reduzido ($P<0,05$) somente quando a torta de algodão foi substituída totalmente por ambas as leguminosas estudadas. No entanto, o ganho de peso só foi afetado no case do mata pasto e ao nível de substituição total. Com caprinos, o consumo e ganho de peso médios obtidos foram 66 g/hg^{0,75} e 39 g/cabeça/dia, representado apenas 70 e 36% do valor médio obtido para ovinos, respectivamente. O semi-confinamento só melhorou ($P<0,05$) a digestibilidade de matéria seca. No entanto, verificou-se uma tendência a se obter melhores resultados devido a esta prática. O melaço não influenciou significativamente ($P>0,05$) em nemhuma das variáveis estudadas.

Termos para indexação: Ovinos sem lã, Caprinos, Trópico semi-árido, Rações de acabamento, Restolhos de cultura.

FINISHING OF KIDS AND LAMBS DURING THE DRY SEASON IN NORTHEAST BRAZIL.

ABSTRACT - Five experiments were conducted, three with lambs and two with goats. The forage component was corn stover. Cottonseed cake in diets of lambs was substituted by ground mata pasto (Cassia cericea) or cunhã (Clitoria ternatea). Diets balanced for goats, with various levels of fiber, were evaluated with or without molasses in confinement and semi-confinement. Experimental designs were all completely randomized. All animals had free access to water and a salt-bone meal mix. Daily feed intake was measured for animals maintained in individual pens. Mean dry matter intake of lambs was 94 g/kg$^{0.75}$ and weight gains were higher than 90 g/day for Morada Nova lambs and higher than 100 g/day for Santa Inês lambs. Dry matter intake decreased

(P<.05) only when cottonseed cake was totally substituted by any of the legumes. However, weight gained was only affected (P<.05) when mata pasto totally substituted cottonseed cake. With goats, dry matter intake and weight gained were 66 g/kg$^{.75}$ and 39 g/day, respectively. These represent only 70 and 36%, respectively, of values obtained for sheep. Under semi-confinement, kids tended to perform better. Molasses did not significantly influence (P<.05) kid performance.

Index terms: Hair sheep, Goats, Semi-arid tropics, Finishing rations, Crop residues.

Introdução

A caprinocultura e a ovinocultura do Nordeste representam, respectivaments, 92 e 34% do efetivo do Brasil (FUNDAÇÃO INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATISTICA - FIBGE, 1984). A produtividade destes animais está afetada pela prolongada estação seca da região. O longo período de estiagem da região acarreta, dentre outros problemas, uma redução na capacidade de suporte das pastagens, decorrente de uma diminuição na disponibilidade de alimento, tanto em quantidade como em qualidade.

A estação de monta preconizada pelo Centro Nacional de Pesquisa de Caprinos (CNPC, 1980) proporciona nascimento de cabritos e cordeiros em épocas de abundância de alimento (abril/maio). Apesar disto, uma boa parte dos animais nascidos neste período não atingem o peso de abate ao final da estação seca (outubro/novembro). Desta forma, os animais que não atingem o peso de abate são mantidos no rebanho competindo com as matrizes pelo alimento já escasso.

Uma das alternativas para solucionar este problema seria o confinamento durante o período seco, daqueles animais que não atingirem o peso de abate ao final da estação seca. Isto não só reduziria a pressão de pastejo, durante o período de escassez de alimento, mas também aumentaria a oferta da carne durante o período de entressafra bem como propiciaria um mais rápido retorno do capital investido.

O objetivo deste trabalho foi testar rações para acabamento de caprinos e ovinos, durante a época de escassez alimentar no semi-árido do Nordeste do Brasil.

Materials e Métodos

Foram conduzidos cinco experimentos, sendo três com ovinos e dois com caprinos, durante os anos de 1980 e 1983, no Centro Nacional de Pesquisa de Caprinos, em Sobral, Ceará.

Nos experimentos 1, 2 e 3 os animais tiverem livre acesso à água e uma mistura de sal comum e farinha de ossos(1:1). O

delineamento experimental adotado foi o inteiramente casualizado. Os animais em regime de confinamento total e semi-confinamento foram confinados individualmente, onde receberam os tratamentos apresentados na Tabela 1. O consumo de matéria seca foi medido diariamente. O período experimental foi de 70 dias. No experimento 1 se utilizou 18 animais da raça Santa Inês com peso médio inicial de 27,4kg. Seis destes animais foram abatidos ao início do experimento para avaliação de carcaça (animais referência, AR). Nos dois seguintes experimentos (2 e 3) foram utilizados 50 borregos, machos, inteiros, Morada Nova e Santa Inês com pesos médios de 17,1 e 20,4kg., respectivamente. No experimento 2, metade dos animais de cada tratamento foram levados para gaiolas de metabolismo para determinação da digestibilidade das dietas experimentais e o restante abatidos para avaliação quantitativa de carcaça.

Nos dois experimentos seguintes (4 e 5) foram utilizados animais SRD (Sem Raça Definida) com pesos médios iniciais de 18 e 17kg., respectivamente. Todos os animais foram confinados individualmente e tiveram o mesmo manejo alimentar e delineamento experimental utilizados para os ovinos nos experimentos 1, 2 e 3. Os tratamentos e a composição das dietas experimentais estão apresentadas na Tabela 2. No experimento 4 os animais foram abatidos ao final do período experimental para avaliação de carcaça enquanto que, no experimento 5 somente metade dos animais foram usados para avaliação de carcaça e o restante levados para gaiolas de metabolismo para determinação da digestibilidade das dietas.

Resultados

Os resultados referentes a composição química das dietas experimentais estão apresentados nas Tabelas 1 e 2, enquanto que os relacionados com o desempenho animal e digestibilidade das rações estão sumarizados nas Tabelas 3 e 4.

No primeiro experimento as dietas experimentais foram isofibrosas, com os teores médios com fibra detergente neutra e proteína bruta de 55,2 e 10,1%, respectivamente. No entanto, nos dois experimentos seguintes a substituição da torta de algodão por feno das leguminosas utilizadas provocaram reduções nos teores de fibra e aumento na proteína da dieta dos animais de até 50 e 16%, respectivamente. Nos dois experimentos, onde se utilizou caprinos (experimentos 4 e 5), o teor de proteína bruta das dietas dos animais ficou em torno de 10% exceto para o tratamento 4 o qual foi de 13,3%. A parede celular no experimento 4 variou de 54 a 57% enquanto que no experimento 5 as variações foram de 44,1 a 52,6%.

Experimento 1

Não foi detectada diferença significativa ($P>0,05$) para nenhuma das variáveis estudadas, embora o ganho de peso dos animais no tratamento 3 tenha sido 26,5% mais elevado que no

TABELA 1. Tratamentos e composição das rações para ovinos em confinamento, experimentos 1, 2 e 3.

	Rações experimentais											
No. de experimento	1[a]			2[b]				3[c]				
No. de tratamento	1	2	3	2	3	4	5	2	3	4	5	6
	Ingredientes (%)											
Milho, restò de cultura												
-planta enteira	51			51	51	51	51	51	51	51	51	51
-palha de espiga		51										
-sabugo			51									
Torta de algodão	28	28	28	28	23	18	13	28	14		14	
Milho, grão	20	20	20	20	20	20	20	20	20	20	20	20
Mata pasto, feno									14	28		
Cunhã, feno											14	28
Sal comun	1	1	1	1	1	1	1	1	1	1	1	1
	Composição química (% MS)											
Proteina bruta	11	10	10	10	9	8	7	10	8	5	9	7
Fibra dtrg. neut.	54	56	56	56	56	57	58	57	68	66	66	68
Hemicelulose				22	22	22	22	24	26	28	26	26
Celulose				25	25	25	25	26	31	28	32	31
Lignina				8	9	9	9	6	9	10	8	9

[a] Arruda et al. (1981).

[b] No tratamento 1, exper. 2, os animais foram permitidos a pastorear na caatinga, sem suplemento.

[c] No tratamento 1, exper. 3, os animais foram permitidos a pastorear na caatinga, com um suplemento de 200g de milho (grão) por cabeça por dia.

tratamento 1. Apesar de não ter havido diferença significativa para circunferência do coxão e rendimento da carcaça entre tratamentos estas variáveis foram melhoradas em 24 e 19%, respectivamente, nos animais confinados em relação aos animais referência (AR, Tabela 3).

Experimento 2

A substituição da torta de algodão por feno de mata pasto não afetou consumo, ganho de peso, conversão alimentar e rendimento da carcaça, mesmo ao nível de substituição de 54% da torta de algodão utilizada (T_2 vs. T_5). No entanto, os animais mantidos em pastagem nativa (T_1) perderam 10 g/animal/dia, sendo este valor significativamente ($P<0,05$) inferior ao de todos os valores obtidos para os animais confinados. Também, o confinamento melhorou ($P<0,05$) a circunferência do coxão em relação aos animais em pastoreio (Tabela 3).

TABELA 2. Tratamentos e composição das rações para caprinos em confinamento e semiconfinamento, experimentos 4 e 5.

	Rações experimentais								
No. de experimento	4[a]				5				
No. de tratamento	1	2	3	4	1	2	3	4	5
	Ingredientes (%)								
Milho, resto de cultura									
-planta enteira	51				50	40	30	30	30
-palha de espiga		51							
-sabugo			51	15					
Capim elefante[b]				AL					
Torta de algodão	28	28	28	34	23,5	21,5	19	18	19
Milho, grão	20	20	20	50	20,5	32,5	45	51	45
Sal comun	1	1	1	1	1	1	1	1	1
Melaço					5	5	5		5
	Composição química (% MS)								
Proteína bruta	11	11	10	13	10	10	9	11	9
Fibra dtrg. neut.	55	55	57	54	53	50	44	47	44
Hemicelulose					24	26	27	29	26
Celulose					24	20	16	15	16
Lignina					4	4	2	3	2

[a]Barros et al. (1982). No tratamento 4 o capim elefante foi oferecido ad libitum (AL) e o restante da dieta foi restrito a 2% do peso corporal do animal. No tratamento 5, exper. 4, os animais foram permitidos a pastorear na caatinga, sem suplemento; a vegetação da caatinga continha 6,5% de proteína bruta e 60% de fibra detergente neutra.

[b]O capim elefante continha 4,6% de proteína bruta e 71% de fibra detergente neutra.

Experimento 3

O consumo de matéria seca dos animais confinados foi reduzido ($P<0,05$) pela substituição da torta de algodão por ambas as leguminosas estudadas porém, somente ao nível de substituição total. Todavia, o ganho de peso só foi influenciado ($P<0,05$) pela substituição total da torta de algodão por feno de mata pasto. Todos os animais confinados, exceto os do tratamento no qual torta de algodão foi substituída totalmente por feno de mata pasto, tiveram ganhos de peso superiores ($P<0,05$) ao dos animais em pastoreio + suplementação energética (tratamento 1). Para conversão alimentar e digestibilidade da matéria seca das dietas experimentais, dos animais confinados, não foi detectada diferenças ($P<0,05$) significativas entre tratamentos.

TABELA 3. Desempenho de ovinos Santa Inês e Morada Nova mantidos ou não em confinamento, e digestibilidade das dietas experimentais.

Exper. e trat.	Consumo de MS por dia	Consumo de MS por kg peso met.	Ganho de peso	Conv. alimentar	Rend. de carcaça	Circum. de coxão	Dig. de MS
	g	g	g/dia		%	cm	%
			Experimento 1				
An. ref.[a]					44,7	31,4	
1	1.294	92,4	129[b]		52,5[b]	39,0[b]	
2	1.244	87,6	134[b]		48,7[b]	36,3[b]	
3	1.204	91,9	164[b]		50,3[b]	38,4[b]	
			Experimento 2				
1			-11[c]		45,8[c]	29,8[c]	
2	999[c]	89,6[c]	95[d]	10,6[c]	47,4[c]	35,0[d]	
3	993[c]	89,9[c]	106[d]	9,4[c]	46,2[c]	35,3[d]	
4	1.014[c]	94,9[c]	103[d]	9,9[c]	46,1[c]	33,5[d]	
5	999[c]	93,8[c]	93[d]	11,0[c]	46,8[c]	38,8[d]	
			Experimento 3				
1			42[e]				
2	1.096[g]	110,9[g]	122[f]	10,5[e]			56,4
3	1.025[g]	104,1[g]	113[f]	10,4[e]			54,3
4	709[e]	78,1[e]	55[e]	13,3[e]			54,6
5	1.050[g]	106,5[g]	116[f]	16,1[e]			56,0
6	886[f]	91,4[f]	102[f]	8,1[e]			55,1

[a]Animais referência, abatidos no início do experimento.

[b]Médias na misma coluna seguidas da misma letra não diferem ($P>0,05$; exper. 1).

[cd]Médias na misma coluna seguidas de letras diferentes diferem ($P<0,05$; exper. 2).

[efg]Médias na misma coluna seguidas de letras diferentes diferem ($P<0,05$; exper. 3).

Experimento 4

Não foi detectada diferença significativa ($P<0,05$) para nenhuma das variáveis estudadas. O ganho de peso médio dos animais cuja ração era constituída de sabugo, como volumoso (T_3), representou apenas 50% (19 g/cabeça/dia) da média dos demais tratamentos em confinamento (tratamentos 2, 3 e 4), do corrente, em parte, da redução no consumo. Embora, aparentemente, o

TABELA 4. Desempenho de caprinos SRD mantidos ou não em confinamento, e digestibilidade das dietas experimentais.

Exper. e trat.	Consumo de MS por dia	Consumo de MS por kg peso met.	Cons. de N	Ganho de peso	Conv. ali-mentar	Rend. de carcaça	Circum. de coxão	Dig. de MS
	g	g	g/dia	g/dia		%	cm	%
				Experimento 4[a]				
1	528	56	9,9	37	14	42,9	28,0	
2	641	62	9,6	39	16	45,9	29,0	
3	432	48	6,6	19	29	41,4	27,1	
4	491	52	14,0	38	13	44,3	29,8	
5				-25		40,8	24,7	
				Experimento 5				
1	781	85	13,4	37	21	42,3		53,7
2	736	82	12,6	49	15	41,6		58,7
3	662	74	9,6	62	11	42,2		70,3
4	574	65	9,8	30	19	43,1		66,8
5	720	74	9,9	73	10	54,4		77,2
Comparações estatísticas (exper. 5):								
1,2,3	ns	ns	ns	ns	ns	ns		P<0,05
3,4	ns	ns	ns	ns	ns	ns		ns
3,5	ns	ns	ns	ns	ns	ns		P<0,05

[a]Não houve diferencas entre as médias no experimento 4 (P>0,05).

[b]Médias na misma coluna seguidas da misma letra não diferem (P>0,05; exper. 1).

[cd]Médias na misma coluna seguidas de letras diferentes diferem (P<0,05; exper. 2).

[efg]Médias na misma coluna seguidas de letras diferentes diferem (P<0,05; exper. 3).

consumo de energia e proteína pelos animais do T_4 tenha sido superior ao nos demais tratamentos o ganho de peso não foi melhorado (P<0,05). Dos seis animais mantidos em pastagem nativa três morreram e o restante apresentaram uma perda de peso de 25 g/cabeça/dia. Os animais confinados mostraram uma tendência a apresentar melhores rendimentos de carcaça que os em pastoreio.

Experimento 5

O nível de fibra não influenciou significativamente (P<0,05) consumo, ganho de peso, conversão alimentar e rendimento de carcaça. No entanto, quando o nível de fibra detergente neutra

decresceu de 52,6 no tratamento 1 para 50,0 e 44,1% nos tratamentos 2 e 3 respectivamente, verificou-se uma tendência de reduções no consumo de matéria seca e nitrogênio, e de aumentos no ganho de peso e na conversão alimentar. Por outro lado, à medida que se reduziu os níveis de fibra da dieta dos animais houve aumento ($P<0,05$) significativo na digestibilidade da matéria seca das rações utilizadas. Das variáveis estudadas, nenhuma foi melhorada significativamente ($P<0,05$) pela adição de melaço à ração dos animais (tratamentos 3 vs 4, Tabela 4). No entanto, o melaço mostrou uma tendência a melhorar as demais variáveis estudadas tendo inclusive verificado-se um expressivo aumento, embora não significativo ($P<0,05$), no ganho de peso da ordem de 106%. Das variáveis estudadas, o semi-confinamento melhorou significativamente ($P<0,05$) somente a digestibilidade da matéria seca embora tenha se verificado uma tendência de se obter melhores resultados nas demais variáveis estudadas, devido a esta prática de manejo (tratamentos 3 e 5, Tabela 4).

Discussão

O consumo médio de matéria seca por ovinos nos três experimentos foi muito semelhante, sendo a média de todos animais de 93,6 $g/kg^{0,75}$/dia. Este valor é semelhante ao preconizado pelo NRC (1975) de 96,5 $g/kg^{0,75}$. A redução no consumo de matéria seca verificada quando a torta de algodão foi substituída totalmente pelos fenos de cunhã ou mata pasto (T_4 e T_6 vs T_2, experimento 3) deve ser decorrente não só da elevação dos níveis de fibra mas também da redução dos teores de proteína da dieta dos animais. Por outro lado, o consumo médio de matéria seca por caprinos nos experimentos 4 e 5, representou apenas 70% do verificado para ovinos. O valor médio obtido (63 $g/kg^{0,75}$) representa apenas 76% do preconizado pelo NRC (1981) de 86 $g/kg^{0,75}$.

O ganho de peso dos ovinos confinados foram superiores a 100 g/cabeça/dia para a raça Santa Inês (experimentos 1 e 3) enquanto que para a Morada Nova os ganhos foram em torno deste valor. A significante ($P<0,05$) redução no ganho de peso dos animais no tratamento 4 do experimento 3, (T_2 vs T_4) onde a torta de algodão foi totalmente substituida pelo feno de mata pasto, pode ser explicada, em parte, pelo baixo consumo da matéria seca aliado ao reduzido teor de proteína (5,2%) da dieta. Isto indica que o feno de mata pasto só pode substituir a torta de algodão até o nível de 50%. Por outro lado, os resultados mostram que este concentrado protêico pode ser substituído totalmente por feno de cunhã. A análise econômica efetuada (Costa et al., 1983) mostrou que a ração com 100% de torta de algodão (28% da ração, T_2 do experimento 3) apresentou a menor eficiência econômica, enquanto que no tratamento em que a torta de algodão foi totalmente substituída por feno de cunhã (T_6, experimento 3) verificou-se a melhor eficiência econômica. Tendo sido o único a apresentar margem bruta de lucro positivo. A perda de peso dos animais mantidos unicamente em pastagem nativa (10 g/cabeça/dia, T_1, experimento 2) e o baixo nível de ganho dos animais que receberam

suplementação energética em pastoreio (42,1 g/animal/dia, T_1, experimento 3) refletem as condições das pastagens da região semi-árida do Nordeste, ao final da estação seca. Apesar de Pfister (1983) ter demonstrado, com base na análise de vegetação coletada através de fístulas esofágicas, que ovinos são capazes de selecionar uma dieta adequada em proteína, Schacht et al. (1985) verificaram que não só energia mas também proteína é limitante para caprinos, ao final da estação seca. Isto sugere que proteína pode ter sido limitante no ganho de peso dos animais em pastoreio + suplementação energética (T_1, experimento 3). O mesmo comportamento verificado para o consumo dos caprinos em relação aos ovinos verificou-se no ganho de peso. O ganho de peso médio destes animais em confinamento (39 g/cabeça/dia) apresenta apenas 36% do ganho médio verificado para ovinos em idênticas condições. Vale ressaltar que as dietas dos caprinos continham um elevado nível de concentrado (49 - 80%) enquanto que para os ovinos o nível de concentrado variou de 20 - 49%. Isto demonstra a grande potencialidade do ovino deslanado para a produção de carne em regime intensivo, o que não se encontrou com o caprino.

Tendência similar foi observada quanto a conversão alimentar, rendimento de carcaça e circunferência do coxão onde os ovinos apresentaram uma superioridade sobre os caprinos da ordem de 55,7; 12,2 e 26,4 respectivamente, para os animais confinados. Tendo em vista que o coxão constitui o "corte nobre" da carcaça desses animais estes dados evidenciam ainda mais a superioridade do ovino deslanado sobre o caprino SRD para produção intensiva de carne.

O aumento na digestibilidade da matéria seca com a redução do nível de restolho do milho na dieta dos animais (experimento 5) pode ser explicado pelas reduções nos níveis de fibra das rações. Resultados similares foram obtidos por Arruda et al. (1984), que trabalharam com ovinos alimentados com rações com 60 a 80% de restolho do milho. Os resultados obtidos não oferecem subsídios para explicar as elevações ($P<0,05$) na digestibilidade de matéria seca devido ao semiconfinamento (T_3 vs T_5, experimento 5). No entanto, esta deve ser a explicação para a tendência de se obter melhor consumo, digestibilidade e ganho de peso por caprinos em semiconfinamento em relação ao confinamento.

Conclusões

Nas condições em que foram conduzidos estes experimentos, conclui-se que:

Ovinos deslanados, das raças Morada Nova e Santa Inês, apresentaram uma grande potencialidade para a produção de carne em confinamento. No entanto, em regime de pastoreio, ao final da época seca, o desempenho destes animais não foi satisfatório.

O caprino SRD no Nordeste, não responde satisfatoriamente ao confinamento, para a produção de carne, mostrando-se mais adequado ao regime de semi-confinamento.

O feno de mata-pasto pode substituir a torta de algodão em rações para ovinos deslanados em confinamento, em níveis de até 50%.

O feno de cunhã pode substituir totalmente a torta de algodão em rações para ovinos deslanados em confinamento.

A análise econômica mostrou que a substituição da torta de algodão pelo feno de ambas as leguminosas estudadas melhorou a eficiência econômica das dietas, tendo sido obtida margem bruta de renda positiva quando este concentrado protéico foi substituído totalmente por feno de cunhã.

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INFLUENCE OF LEVEL OF ENERGY SUPPLEMENTATION ON FORAGE INTAKE AND PERFORMANCE OF SOMALI SHEEP

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ABSTRACT - An 84-day growth and digestion study was conducted to determine the influence of level of energy supplementation on forage and total diet dry matter intake and weight gains of Somali hair sheep. Thirty-six lambs were randomized among four treatments. All lambs were offered a protein supplement at 0.5% of the body weight and an energy supplement (cassava meal) at 0.4, 0.8, 1.2 and 1.6% of the body weight. The protein supplement was comprised of 80% soybean meal, 10% urea and 10% of a mineral-salt mix. Napier grass (*Pennisetum Purpureum*) greenchop was offered *ad libitum*. Lambs had free access to water. Body weights were recorded weekly. Lambs were harnessed the last 7 days of the study for total collection of feces. The last day of the trial, all lambs were slaughtered to determine their empty body weight. Forage and total dry matter (DM) intake were significantly ($P<.05$) decreased with an increase in energy supplementation. Forage intake was 81.1, 75.3, 75.7 and 64.9 $g/kg^{.75}$ and total DM intake was 98.2, 100.2, 109.2 and 107.2 $g/kg^{.75}$, respectively. Dry matter digestibility, digestible DM intake, body weight and feed efficiency were increased ($P<.05$) with an increase in the level of energy in the diet. Body weight gains were 44, 51, 72 and 95 g/day, respectively.

Index terms: Sheep, Semi-arid tropics, Nutrition, Energy supplementation.

EFEITO DO NÍVEL DE SUPLEMENTAÇÃO ENERGÉTICA NO CONSUMO DE FORRAGEM E COMPORTAMENTO DE OVINOS SOMALIS

RESUMO - Durante 84 dias foi conduzido um estudo de desempenho animal para determinar a influência da suplementação de energia no consumo de forragem e consumo da dieta total por ovinos da raça Somalis. O delineamento experimental foi inteiramente casualizado com quatro tratamentos. Todos os animais receberam um suplemento protêico na base de 0.5% do peso corporal e um suplemento energético (raspa de mandioca) a 0,4; 0,8; 1,2 e 1,6% do peso vivo. Capim elefante (*Pennisetum purpureum*) triturado foi ofercido *ad libitum*. O consumo de forragem e o de materia seca (MS) total da dieta foram reducidos ($P<.05$) com o aumento dos niveis de energia das dietas experimentais. Os consumos de forragem foram 81,1; 75,3; 75,7; 64,9 $g/kg^{.75}$ e os de MS total foram 98,2; 100,2; 109,2 e 107,2, respectivamente. Digestibilidade da matéria seca, consumo de MS digestível, ganho de peso e converção alimentar foram aumentados ($P<0.05$) com o

incremento nos níveis de energia das dietas. Os ganhos de peso foram 44, 51, 72 e 95 g/dia, respectivamente.

Termos para indexação: Ovinos, Trópico semi-árido, Nutrição, Suplementação energética.

Introduction

One of the most important factors limiting the productive performance of ruminant animals in tropical areas is the quality and nutritive value of forages. Research in Brazil (da Silva & da Silva, 1976; Barros, et al., 1986) has shown that 70% of forages studied had apparent digestibility coefficients between 35 and 60% as opposed to values of 55-75% normally found with forages grown in temperate zones. A low intake of digestible energy of tropical grasses is due to the high cell wall content. The low protein content of tropical grasses may also restrict performance. To improve energy and protein intakes and performance of growing ruminants fed tropical grasses, supplementation of energy and protein is generally required. An undesirable effect of supplementation would be the relative substitution by ruminants of forage for concentrate. This occurs primarily with low quality forages.

This study was conducted to determine the influence of level of energy supplementation on forage and total diet dry matter intake, digestible energy intake and weight gains of Somali hair sheep fed Napier grass (Pennisetum Purpureum) as the only forage. Preliminary results are presented.

Methodology

Thirty-six recently weaned Somali lambs, weighing about 16.6kg, were randomly assigned among four treatments. Lambs were confined in individual pens for a period of 84 days. Body weights were recorded weekly and for two consecutive days at the beginning and end of the study.

The four experimental diets are shown in Table 1. All lambs were offered a protein supplement at 0.5% of the body weight and an energy supplement (cassava meal) at 0.4, 0.8, 1.2 and 1.6% of the body weight. The protein supplement was comprised of 80% soybean meal, 10% urea and 10% of a mineral-salt mix. Napier grass (Pennisetum Purpureum) greenchop was offered ad libitum (25% above the previous day's forage intake). Lambs had free access to water.

Lambs were harnessed the last 7 days of the study for total collection of feces to determine digestibility. The last day of the trial, all lambs were slaughtered to determine their empty body and carcass weights.

TABLE 1. Experimental feeds and feed levels.

Ingredient	Percent of Supplement	Feed Level (% of BW)			
		T-1	T-2	T-3	T-4
Protein Supplement		0.5	0.5	0.5	0.5
Soybean meal	80%				
Urea	10%				
Mineral-Salt	10%				
Energy Supplement		0.4	0.8	1.2	1.6
Cassava meal	100%				
Forage		AL	AL	AL	AL
Napier grass					

BW = body weight; T = treatments; AL = Ad libitum.

Results and Discussion

Mean intakes of concentrate and forage, and total dry matter intakes, are presented in Table 2. Forage intake was significantly ($P<.05$) decreased with an increase in energy supplementation. The substitution of forage for concentrate was expected. Dry matter intake also increased ($P<.05$) when concentrate was offered up to the level of 1.7% of the body weight, with no further increase at the level of 2.1%.

TABLE 2. Mean intake of concentrate, forage and total dry matter by Somali sheep.

Concentrate Level (% of body wt.)	Dry Matter Intake ($g/kg^{.75}$)		
	Concentrate	Forage	Total
0.9%	17.1^{a}	67.9^{b}	85.0^{a}
1.3%	24.9^{b}	62.4^{b}	87.3^{a}
1.7%	33.6^{c}	63.1^{b}	96.7^{b}
2.1%	42.3^{d}	54.5^{a}	96.6^{b}

Means in the same column with different superscripts differ ($P<.05$).

Dry matter digestibility and digestible DM (DDM) intake increased ($P<.05$) with an increase in the level of energy in the diet (Table 3). No further increases ($P<.05$) in digestibility or DDM intake were obtained when supplementation increased from the level of 1.7 to 2.1% of the body weight.

TABLE 3. Dry matter (DM) digestibility and digestible DM intake of Somali sheep.

Concentrate Level (% of body weight)	Dry Matter Digestibility (%)	Digestible DM Intake ($G/kG^{.75}$)
0.9%	48.2^a	41.0^a
1.3%	50.0^a	43.6^a
1.7%	57.4^b	55.5^b
2.1%	59.8^b	57.8^b

Means in the same column with different superscripts differ ($P<.05$).

Body weight gains were 44, 51, 72 and 95 g/day, respectively (Table 4). Feed efficiency was improved ($P<.01$) between live body weight and empty body weight of the Somali lambs.

There was a high correlation ($r = .98$, $P<.01$) between live body weight and empty body weight of the Somali lambs.

TABLE 4. Body weight gains and feed efficiency of Somali sheep.

Concentrate Level (% of body wt.)	Initial Body Weight (kg)	Weight Gain (g/d)	Feed Efficiency (g/g)
0.9%	16.4	44^a	18.5^b
1.3%	16.6	51^a	17.0^b
1.7%	16.5	72^b	13.7^a
2.1%	16.9	95^c	10.8^a

Means in the same column with different superscripts differ ($P<.05$).

Conclusions

Substitution of concentrate for forage occurred with an increase in the energy supplementation. With an increase in the level of supplementation was a concommitant improvement in weight gain and feed efficiency. However, the overall low weight gains of Somali lambs were probably due to the low digestible energy content of the diets. Further studies should be conducted to see if growth performance of hair sheep could be improved by utilizing napier grass at earlier stages of maturity.

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EFEITO DA SUPLEMENTAÇÃO ENERGÉTICA NO CRESCIMENTO DE CABRAS PASTEJANDO A CAATINGA REBAIXADA DURANTE AS ÉPOCAS SECA E ÚMIDA

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RESUMO - Em um estudo realizado no CNPC, Sobral, Ceará, avaliou se o efeito da suplementação com 150g de milho em grãos em 45 caprinos meio sangue Anglo-nubiano, com seis meses de idade, castrados, mantidos em 30 hectares de caatinga rebaixada durante a época seca (setembro-dezembro) e o início da época úmida (janeiro-fevereiro) e distribuídos completamente ao acaso em três tratamentos, durante um período de 20 semanas. O primeiro tratamento, suplementação durante todo o período experimental; o segundo, somente durante o final da época seca e o terceiro, não recebeu suplementação. A caatinga rebaixada apresentou uma produção de matéria vegetal de 3738 kg/ha no início do experimento decrescendo a 2348 kg/ha no final. A análise das variações de peso dos animais não revelou diferenças estatísticas entre tratamentos (P>0,05), porém, pode se notar uma perda de peso mais acentuada nos animais não suplementados. Considerando-se que o milho oferecia aproximadamente 20% dos requerimentos de manutenção do animal em atividade média, os resultados sugerem que a oferta de forragem da caatinga rebaixada limitou o crescimento animal na época seca, e não pode ser compensada pela suplementação.

Termos para indexação: Caprinos, Trópico semi-árido, Suplementação energética, Crescimento.

EFFECT OF ENERGY SUPPLEMENTATION ON THE GROWTH PERFORMANCE OF GOATS GRAZING LOWERED CAATINGA DURING THE DRY AND WET SEASONS

ABSTRACT - Forty-five half breed Anglo-nubian castrated male goats, six months old were used in a grazing study conducted at the CNPC, Sobral, Ceará. The goats grazed 30 hectares of a lowered caatinga range for a total of 20 weeks during the dry season (September-December) and the beginning of the wet season (January-February). The design was completely randomized with three treatments as follows: (1) supplementation with 150g of corn during all the experimental period; (2) supplementation beginning at the end of the dry season and (3) not supplemented control. The caatinga range yielded 3738 kg/ha of dry matter at at the initiation of the experiment decreasing to 2348 kg/ha at the end of the dry season. Weight gain differences obtained between treatment groups were not significant (P>.05). However, at the end of the dry season, animals without supplementation

tended to lose more weight than supplemented animals. Since corn supplementation fulfilled about 20% of the maintenance energy requirement for goats under medium activity (NRC, 1981), these results suggest that forage availability of the lowered caatinga range at the end of the dry season limited the growth potential of the goats and could not be compensated for by supplementation.

Index terms: Goats, Semi-arid tropics, Energy supplementation, Growth.

Introdução

A maior parte do rebanho caprino em regime de pastoreio nas regiões tropicais recebe pouco ou nenhuma suplementação. A produção animal enfreta limitações inerentes ao ecosistema onde a produção vegetal primária está sujeita aos ciclos estacionais. Esta estacionalidade se reflete na perda de peso dos pequenos ruminantes durante a época seca, a função reprodutiva se vê alterada diminuindo a fertilidade, baixando a capacidade de produção de leite, no caso das cabras, e dificultando o desenvolvimento das crias no período prédesmame e impedindo que os animais pósdesmame atinjam seu peso ideal para abate. Se esses animais permanecerem nas pastagens, além de perderem peso, vão competir com as matrizes na disputa pelas forragens escassas. Através estudos conduzido por Schacht et al., (1985) chegou-se a conclusão que caprinos na caatinga nativa ao final da época seca têm deficiência de proteína e energia. A aplicação de tecnologia na produção de caprinos e ovinos enfrenta limitações extremas, dado ao baixo nível econômico do produtor e a pesquisa deve necessáriamente ser dirigida prioritariamente a um aumento da base alimentar do animal, quer num aprimoramento da pastagem nativa através da manipulação, quer pela adoção de método de suplementação.

Material e Métodos

O experimento foi realizado no CNPC, Sobral, Ceará. Foram utilizados 45 caprinos meio sangue Anglo-nubiano com aproximadamente 6 meses de idade, castrados, mantidos em 30 hectares de caatinga rebaixada durante a época seca (setembro-dezembro) e o início da époco úmida (janeiro-fevereiro) e distribuidos completamente ao acaso em três tratamentos durante um período de vinte semanas, com quatro anteriores para adaptação. O primeiro tratamento, suplementação durante todo o período experimental; o segundo, somente durante o final da época seca e o terceiro, não recebeu suplementação.

A lotação da pastagem foi de 0,66 ha/ano por animal, com todos os grupos mantidos na mesma pastagem.

Os animais suplementados foram alimentados com 150 gramas de milho fornecidos diariamente em cochos individuais administrados duas vezes ao dia (6 e 17h).

Para medir a produção de matéria seca do estrato herbáceo na área experimental, foi usado um retângulo 50 x 60cm, realizando-se 37 amostragens no início, meio e fim do experimento.

A avaliação do ganho de peso em função dos dias de suplementação foi feita através da análise de regressão e correlação. O ganho de peso específico foi calculado dividindo-se o ganho sobre o peso do animal.

Resultado e Discussão

A caatinga rebaixada apresentou uma produção de matéria vegetal de 3738 kg/ha a 2348 kg/ha no início e final do período experimental respectivamente.

O peso vivo, ganho de peso e ganho de peso específico encontram-se respectivamente nos Figuras 1, 2 e 3.

A análise de variações do peso dos animais (Tabela 1) não revelou diferenças estatísticas entre tratamentos ($P>0,05$), porém, pode-se notar uma perda de peso mais acentuada nos animais não suplementados. Considerando-se que o milho oferecia aproximadamente 20% dos requerimentos de manutença do animal em média atividade, os resultados sugerem que a oferta de forragem da caatinga rabaixada limitou o crescimento animal na época seca, e não pode ser compensada pela suplementação.

TABELA 1. Ganhos de peso por dia e a correlação (R) do tempo com o peso dos animais nos três grupos experimentais.

Época	Primeiro		Segundo		Terceiro		Todos	
	R	Ganho	R	Ganho	R	Ganho	R	Ganho
Início da Seca	0.710	9.00	-0.940	10.20	-0.580	- 8.40	-0.224	- 2.90
Fim da Seca	-0.730	27.00	-0.859	-38.00	-0.837	-42.00	-0.808	-36.10
Início Úmida	0.986	76.00	0.990	81.00	0.950	77.00	0.977	78.50
Total	0.499	29.22	0.376	26.70	0.320	20.30	0.396	24.00

No presente experimento se utilizaram comparativamente as duas opções: suplementação com grão de milho visando o aumento do consumo energético e manipulação da caatinga através do rebaixamento seletivo da vegetação arbustiva arbórea, tentando aumentar a disponibilidade das espécies herbáceas e do detrito vegetal no chão, especialmente na época chuvosa.

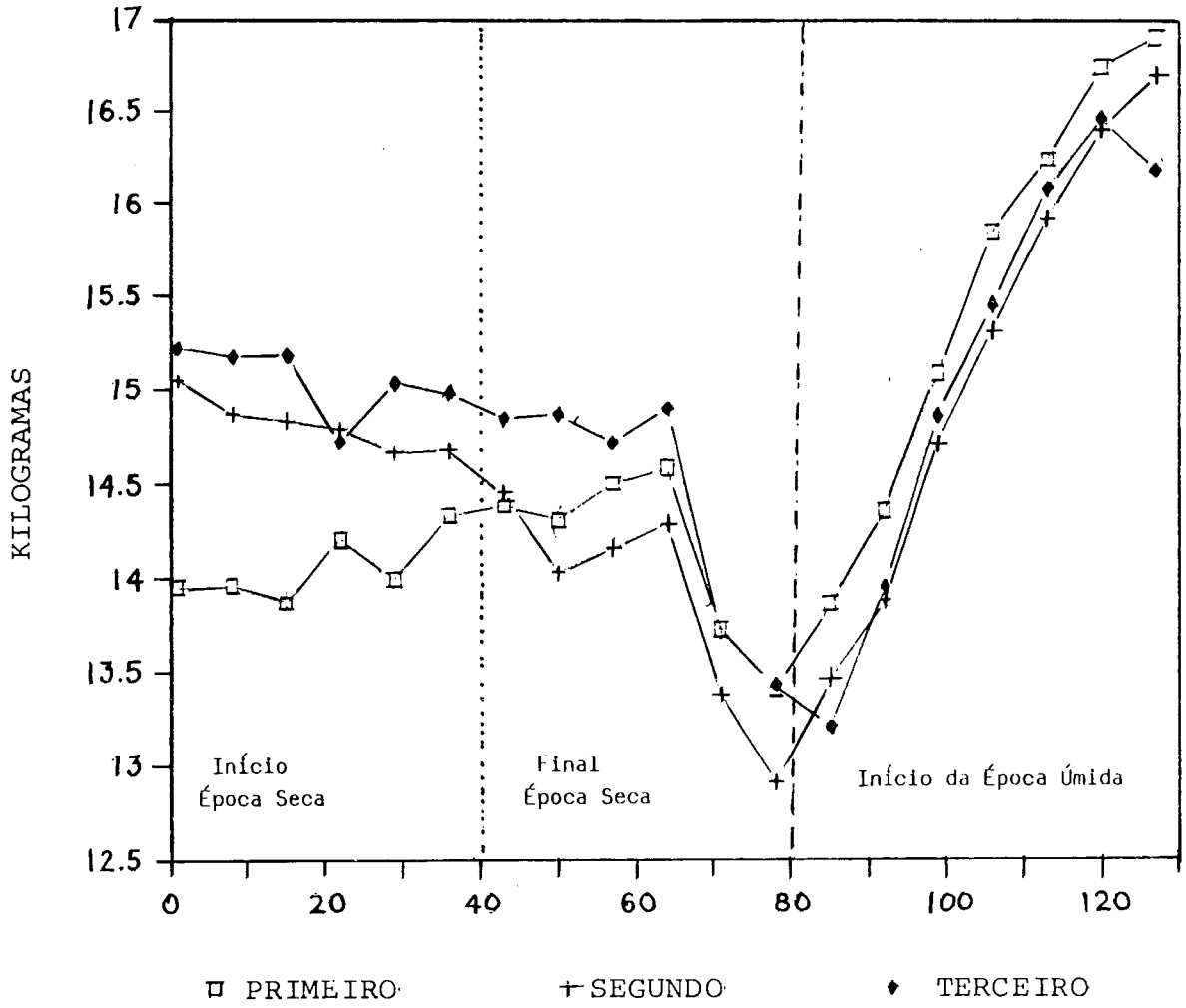

Fig.1-Peso vivo semanal por caprinos.

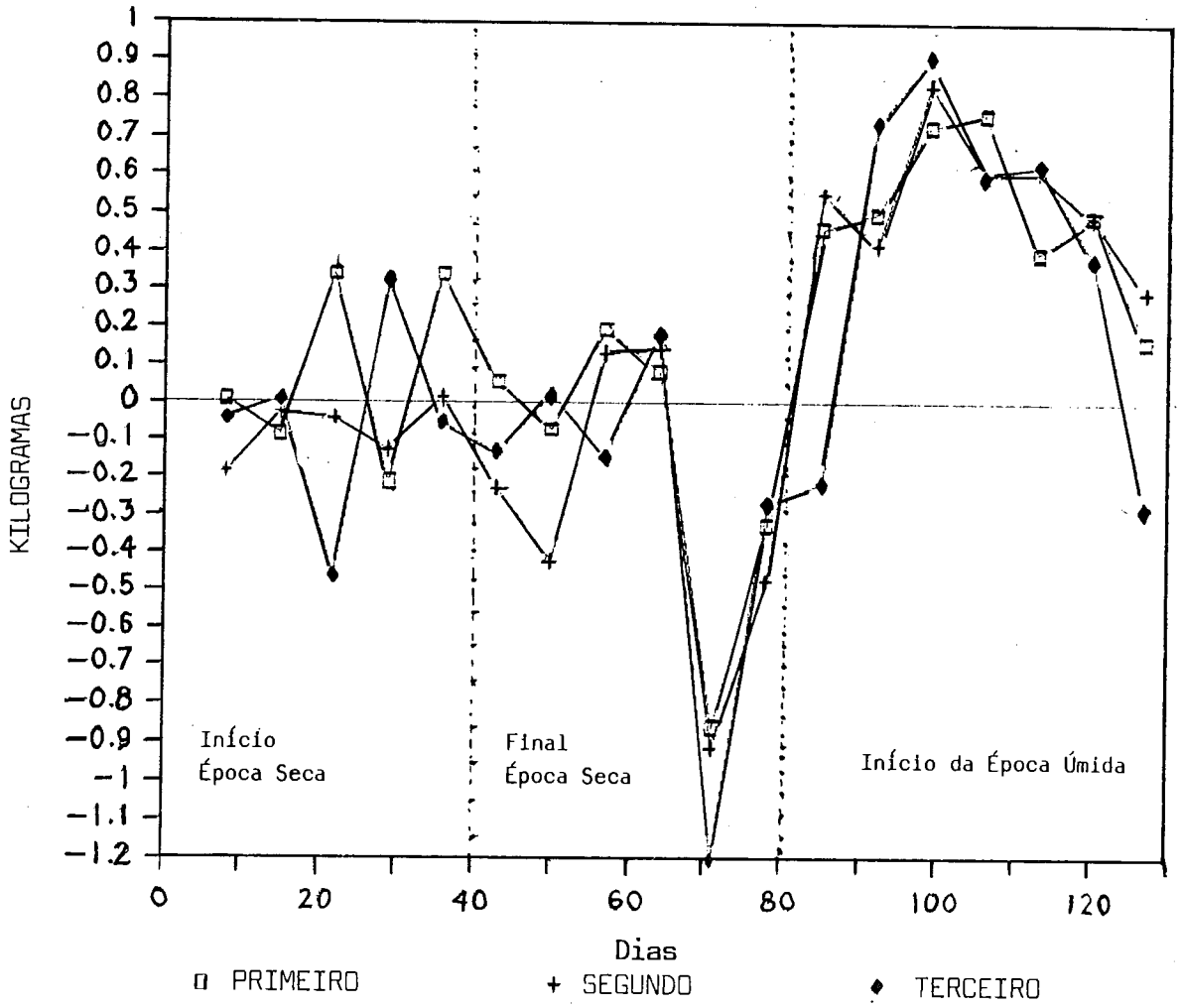

Fig.2-Ganho de peso semanal por caprinos.

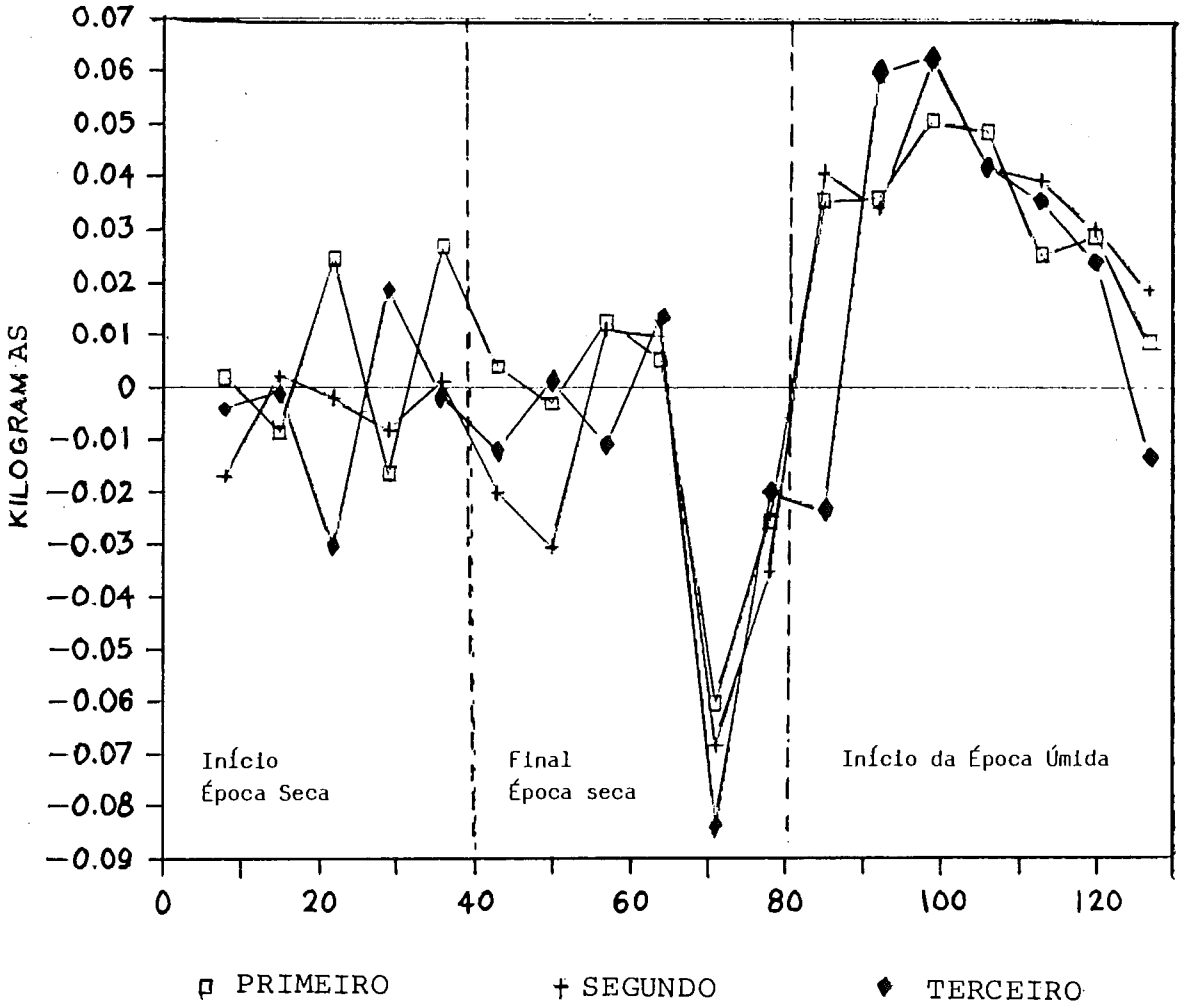

Fig.3-Ganho de peso especifico semanal nor caprinos.

As perdas de peso experimentadas pelos animais suplementados e não suplementados evidenciam que o rebaixamento da caatinga não providenciou suficiente base alimentar ao animal e que esta deficiência é maior que o que se pode compensar-se com a suplementação de grão ao nível utilizado nesta experiência.

No caso de que o rebaixamento da caatinga efetivamente incrementara a disponibilidade do alimento para o animal, seria necessário determinar o nível mínimo de suplementação adicional para satisfazer o requerimento dietético e factibilidade econômica dela.

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D. MELHORAMENTO

D. ANIMAL BREEDING

GENETIC AND ENVIRONMENTAL PARAMETER ESTIMATES FOR GROWTH TRAITS IN MORADA NOVA SHEEP

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ABSTRACT - The objectives of this study were to (1) estimate the relative importance of genetic and environmental sources of variation affecting growth and reproduction characters and (2) obtain estimates of gentic and phenotypic parameters for growth and production of Morada Nova sheep. Data were obtained from 1,338 ewes and 989 lambs sired by 50 rams at the Iracema Farm - EPACE - Quixadá, Ceará, Brazil from 1979 to 1984. The growth traits studies were birth weight (BW), weaning weight (WW), and yearling weight (YW). Environmental factors considered were year and location of birth, age of dam, sex of lamb, and type of birth and rearing. All environmental factors significantly affected (P<.01) BW, WW and YW. Some factors, such as age of dam, had great effect early in life and decreased as lamb age increased. Estimates of heritability calculated from paternal half-sib correlations were 0.35, 0.36 and 0.29 for BW, WW and YW, respectively. Estimates of genetic and phenotypic correlations between BW and WW, BW and YW, and WW and YW were 0.70 and 0.34, 0.86 and 0.25, and 0.74 and 0.49, respectively.

Index terms: Hair sheep, Growth, Genetic Parameters.

ESTIMADOS DOS PARÂMETROS GENÉTICOS E MEIOAMBIENTAIS PARA FACTORES DE CRESCIMENTO NOS OVINOS MORADA NOVA

RESUMO - Um estudo foi conduzido com dados colhidos de 989 cordeiros de raça Morada Nova, nascidos de 1979 até 1984, na Fazenda Iracema - EPACE - Quixadá, CA., Brasil. Os cordeiros eram filhos de 50 carneiros diferentes. Os dados foram utilizados para (1) estimar a importância relativa dos fatores genéticos e de ambiente sobre o crescimento dos cordeiros, (2) obter estimativas dos parâmetros genéticos e fenotípicos das mesmas características. As características de crescimento estudadas foram peso ao nascer (BW), peso à desmama (WW) e peso a um ano de idade (YW). Os fatores de ambiente influenciaram significativamente (P<0,01) BW, WW e YW. Alguns fatores como idade da mãe tiveram grande efeito na primeira fase de vida do cordeiro (até a desmama). Esse efeito decresceu com a idade do cordeiro. As estimativas de heritabilidade calculada da correlação de meio-irmão paternos foram 0,35; 0,36 3 0,29 para BW< WW e YW, respectivamente. As estimativas das correlações genéticas e fenotípicas entre BW e WW, BW e YW e entre WW e YW foram 0,70 e 0,34; 0,86 e 0,25 e 0,74e 0,49, respectivamente. Selecão para WW parece ser efetiva e deverá produzir ganhos

genéticos no YW, uma vez que esses pesos são correlacionados genetica e positivamente, entretanto os dados necessitam ajustamento para fatores de ambiente.

Termos para indexação: Ovinos sem lã, Crescimento, Parâmetros genéticos.

Introduction

Efficiency of meat production in sheep is largely a function of the number of lambs produced (reproductive rate) and the growth rate or weight of lambs marketed for slaughter. Growth rate of lambs in its turn is affected by environmental factors such as age of ewe (Nelson & Venkatachalam, 1949; Walstrom et al., 1976; Sidwell et al., 1970; & Alrawi et al., 1982), year of birth (Vesely & Robison, 1970; Dickerson et al., 1975; Walstrom et al., 1976; Alrawi et al., 1982; & Singh et al., 1982), sex of lamb (Hohenboken et al., 1976; Vesely & Robison, 1970; Dickerson et al., 1972; & Alrawi et al., 1982), and type of birth and rearing (Blackwell & Henderson, 1955; Vesely & Robison, 1970; Walstrom et al., 1976; Galal & Awgichew, 1981; & Figueiredo et al., 1982). Growth rate is also a function of the genetic potential of the animals (Vesely et at., 1970; Dzakuma et al., 1978; & Mavrogenis et al., 1980).

Besides the environmental factors, the growth traits are affected by the genetics of the character and by genetic by environment interaction. Since only the additive genetic effects contribute to the permanent gain from selection in a population, estimates of heritability in the narrow sense are desirable measures for predicting the results of a selection program. Estimates of heritability (h^2) for birth weight (BW) and weaning weight (WW) of lambs based on correlations among half-sibs were found to be 0.13 and 0.36 for Chios sheep (Mavrogenis et al., 1980), and 0.14 and 0.73 for Awassi sheep (Alrawi et al., 1982), respectively. Also using the correlation between paternal half-sibs, Dzakuma et al. (1978) and Galal et al. (1981) reported heritability estimates for yearling weight (YW) of 0.11 and 0.34 for Hampshire and Adal sheep, respectively.

Since selection for one trait alone is a condition which is seldom desirable in any livestock enterprise, it is obvious that heratibilities are not sufficient to describe adequately the genetic properties of a population. Thus, information on genetic and phenotypic correlations has to be considered on selection programs that include more than one trait.

Based on data from Awassi sheep, Alrawi et al. (1982) estimated genetic correlations between BW and WW, BW and YW, and WW and YW of 0.68, 0.77, and 1.00, respectively. Dzakuma et al. (1978) reported phenotypic correlations between BW and WW, BW and YW, and WW and YW of 0.25, 0.23, and 0.77 in Hampshire sheep, respectively.

Considering the environmental and genetic factors affecting body weight of lambs, this study was conducted to (1) estimate the relative importance of genetic and environmental sources of variation affecting growth characters of Morada Nova sheep, (2) to obtain estimates of genetic and phenotypic parameters for growth characters of Morada Nova sheep, and (3) to evaluate the potential of the Morada Nova sheep as a way for increasing the animal productivity (sheep meat production) of the northeastern region of Brazil.

Materials and Methods

The Morada Nova breed of sheep is found throughout the northeast region of Brazil. This breed is characterized as a hair sheep (woolless) unique to Brazil (Shelton & Figueiredo, 1981). The breed is a dual-purpose breed which provides meat and skins. This breed is small but very adapted to the environmental conditions of the "drought polygon" (Sertão) in Northeastern Brazil, and weighs 38.0 and 31.0kg, respectively for adult male and adult female (Figueiredo et al., 1983).

The data used in this study were collected over a 6-year period (1979-1984) from the Morada Nova sheep flock of Fazenda Iracema - Sertão Central Research Unit - which belongs to the "Empresa de Pesquisa Agropecuaria do Ceará" (EPACE), which is located at Quixada, Ceará, Brazil, situated at 5 South Latitude at an altitude of approximately 180 meters. The average temperature ranges between 26.4 and 27.6°C in the cooler and warmer months, respectively, indicating little season variation. The rainfall is highly variable but averages about 800mm annually concentrated from January until May.

Due to unequal subclass numbers least-squares analysis of variance technique (Harvey, 1977) was utilized for estimating the sources of variation affecting each growth trait. The Duncan's multiple range test was used to evaluate differences among means. The following general linear model was used to describe the variation of the factors on each of the growth traits:

$$Y_{ijklmn} = \mu + (AL)_i + R(AL)_{ji} + E_k = S_l = B_m + E_{ijklmn}$$

Where:

Y_{ijklmn} = Observation on the nth lamb of the lst sex born from the mth type of birth and/or rearing sired by the jth sire within the ith location and year of birth and from the kth age of ewe class.

μ = overall mean,

$(AL)_i$ = ith year of birth within location of birth effect.

$R(AL)_{ij}$ = effect of the jth sire within year and location of birth.

E_k = kth age of dam effect.

S_l = lth sex of lamb effect.
B_m = mth type of birth and/or rearing effect.
e_{ijklmn} = random error.

Year of birth nested within location of birth, sex of lamb, type of birth and/or rearing and age of dam were considered as fixed effects and sire within year and location of birth was considered as a random effect in the above model.

When estimating genetic parameters for various traits, the same model was utilized since all factors significantly affected each of the growth characters studied. Estimates of heritability were obtained by paternal half-sib correlations (Falconer, 1981) using the Harvey's (1977) procedures. Analysis of variance and covariance procedures were used to estimate the genetic and phenotypic correlations between the growth traits.

Results and Discussion

Year-location, sire within year location, sex of lamb, type of birth and age of dam had a significant effect ($P<0.01$) on birth, weaning and yearling weights (Table 1).

TABLE 1. Analysis of variance of birth, weaning and yearling weights of Morada Nova lambs.

Source of Variation	Birth Weight		Weaning Weight		Yearling Weight	
	DF[a]	F	DF[a]	F	DF[a]	F
Year of Birth (Location)	6	3.75**	6	47.63**	4	11.69**
Sire (YLOC)[b]	43	2.89**	43	2.65**	33	2.08**
Sex of Lamb	1	12.53**	1	11.54**	1	17.34**
Type of Birth	1	194.86**	2	250.31**	2	72.23**
Age of Dam	4	7.71**	4	7.22**	2	4.25**
Error	933		788		491	

[a]DF = Degrees of Freedom.
[b]YLOC = Year of Birth (Location).
** P<.01.

The least-squares means and respective standard errors for birth weight are shown in Table 2, for weaning weight in Table 3 and for yearling weight in Table 4. Lambs born in 1983 has the highest mean value for BW (2.64kg) while lambs born in 1980 had the lowest (2.28kg); however, weaning weights were higher for lambs born in 1980 and 1981 than for lambs born in 1983 (14.71

TABLE 2. Least-squares means and their standard errors for birth weight of Morada Nova lambs.

Effect	Number of Lambs	Birth Weight (kg)
Overall Mean	989	2.47 ± 0.037
Year of Birth (Location)		
1. 1980 (Area One)	63	2.28 ± 0.124[f]
2. 1981 (Area One)	89	2.56 ± 0.080[b]
3. 1982 (Area One)	70	2.48 ± 0.099[bc]
4. 1983 (Area One)	112	2.81 ± 0.080[a]
5. 1981 (Area Two)	96	2.28 ± 0.089[f]
6. 1982 (Area Two)	257	2.41 ± 0.052[cde]
7. 1983 (Area Two)	302	2.46 ± 0.063[bcd]
Sex of Lamb		
1. Male	497	2.53 ± 0.040[a]
2. Female	492	2.41 ± 0.040[b]
Type of Birth		
1. Single	462	2.71 ± 0.041[a]
2. Twin	527	2.23 ± 0.045[b]
Age of Dam		
1. One year to less than two	211	2.30 ± 0.052[e]
2. Two years to less than three	227	2.46 ± 0.050[bcd]
3. Three years to less than four	188	2.46 ± 0.051[ab]
4. Four years to six	294	2.58 ± 0.045[a]
5. Older than six-years	69	2.47 ± 0.07[abc]

[a,b,c,d,e,f]Least-squares means followed by the same letter within column and subclasses do not differ significantly. All others differ significantly ($P<.05$).

versus 10.90kg); also there was a clear tendency for yearling weight (YW) to decrease with year, that is from 1981 to 1983.

Lambs born in 1981 were 15.44% and 24.32% heavier than those born in 1982 and 1983, respectively, at yearling time.

The differences in BW, WW and YW due to year of birth can likely be explained as reflections of varying climatic condition. Thus, reflecting the availability of native pastures to the

pregnant ewes in case of BW, and to the lactating ewes and its lambs in case of WW and YW.

TABLE 3. Least-squares Means and Standard Errors for Weaning Weight of Morada Nova Lambs.

Effect	Number of Lambs	Weaning Weight (k-g)
Overall Mean	845	13.22 ± 0.218
Year of Birth (Location		
1. 1980 (Area One)	59	14.80 ± 0.567[b]
2. 1981 (Area One)	82	17.24 ± 0.393[a]
3. 1982 (Area One)	61	13.88 ± 0.489[c]
4. 1983 (Area One)	93	11.79 ± 0.404[ef]
5. 1981 (Area One)	82	12.00 ± 0.439[e]
6. 1982 (Area One	210	12.81 ± 0.280[d]
7. 1983 (Area One)	258	10.00 ± 0.326[g]
Sex of Lamb		
1. Male	414	13.48 ± 0.231[a]
2. Female	431	12.95 ± 0.230[b]
Type of Rearing		
1. Single lamb raised as single	429	15.39 ± 0.22a[a]
2. Twin lamb raised as twin	357	11.47 ± 0.228[c]
3. Twin lamb raised as single	59	12.79 ± 0.345[b]
Age of Dam		
1. One year to less than two	178	12.39 ± 0.283[e]
2. Two years to less than three	195	13.34 ± 0.273[abc]
3. Three years to less than four	166	13.57 ± 0.276[ab]
4. Four years to six	252	13.60 ± 0.248[a]
5. Older than six	54	13.18 ± 0.374[abcd]

[a,b,c,d,e,f]Least-squares means followed by the same letter within column and subclasses do not differ significantly. All others differ significantly ($P<.05$).

Related to differences in location of birth, lambs born at location one were heavier than those born at location two, at birth and weaning. The difference in BW and WW of lambs born at location one and two, may be explained by the fact that ewes at location one were raised in smaller groups (average: 70 ewes/year) than at location two (average 160 ewes/year),

TABLE 4. Least-squares means and their standard errors for yearling weight of Morada Nova lambs.

Effect	Number of Lambs	Yearling Weight (kg)
Overall Mean	536	18.24 ± 0.333
Year of Birth (Location)		
1. 1982 (Area One)	39	18.86 ± 0.672[b]
2. 1983 (Area One)	57	17.18 ± 0.590[cd]
3. 1981 (Area One)	47	21.01 ± 0.590[a]
4. 1982 (Area Two)	177	17.54 ± 0.476[c]
5. 1983 (Area Two)	216	16.62 ± 0.421[cd]
Sex of Lamb		
1. Male	231[a]	18.79 ± 0.366[a]
2. Female	305[b]	17.70 ± 0.349[b]
Type of Rearing		
1. Single lamb raised as single	289	19.89 ± 0.343[a]
2. Twin lamb raised as twin	208	16.45 ± 0.353[c]
3. Twin lamb raised as single	39	18.39 ± 0.542[b]
Age of Dam		
1. One year to less than two	144	17.29 ± 0.417[e]
2. Two years to less than three	140	18.61 ± 0.417[a]
3. Three years to less than four	91	18.26 ± 0.461[abcd]
4. Four years to six	131	18.55 ± 0.393[ab]
5. Older than six	30	18.51 ± 0.627[abc]

[a,b,c,d,e]Least-squares means followed by the same letter within column and subclasses do not differ significantly. All others differ significantly ($P<.05$).

consequently less competition for feed (native pasture) supply and less probability of stress and infestation with internal parasites.

Related to sex differences, the BW of males (2.53kg) was superior to the females (2.41kg) (Table 2), and the WW of rams was 4% superior to females (Table 3). This difference increased to 17.80% at yearling age (Table 4). The findings for BW are in agreement with those reported by Vesely & Robison (1970), Dickerson et al. (1972), and Alrawi et al. (1982); however, disagree with Bogart et al. (1957), and Trail & Sacker (1969), who found no significant difference in weight between male and female lambs at birth.

The sex differences in WW were similar in direction and magnitude to those reported from Carter et al.(1971), Dickerson et al. (1972), and Alrawi (1982); however, do not agree with Arora & Acharya (1972), and Singh et al. (1982), who found no significant variation in WW due to sex differences.

The sex differences in YW are in agreement with those reported by Trail & Sacker (1969), Galal & Awgichew (1981) and Alrawi et al. (1982).

Related to type of birth and rearing, single lambs were 21.52% heavier at birth than twins (Table 2) but at weaning such difference was 34.18 and 20.33% when single were raised as singles over twins raised as twins, and twins raised as singles, respectively. In addition, twin lambs raised as singles had higher WW (11.51%) than twins raised as twins (Table 3). At yearling, in terms of kilos, single lambs raised as singles weighed 19.89kg, respectively, (Table 4). Both differences were significant ($P<.05$).

Such superiority of single versus twins in BW, were also found by Nelson & Venkatachalam (1949), Vesely & Robison (1970), and Figueiredo et al. (1982); in WW by Sidwell et al.(1970), Walstrom et al. (1976), and Alrawi et al.(1982), and in YW by Sidwell et al.(1970) and Galal & Awgichew (1981).

The effects of type birth and rearing were smaller on yearling than on weaning weight. This may be explained based on the fact that lamb growth up to weaning time is basically a function of the milk supply from its dam, while after weaning the lamb growth is more likely an expression of its own genetic potential and of the nutritional level under which it is raised.

There was a tendency for increasing BW of lambs born from older ewes. Lambs born from four-year up to six-year old ewes were 12% heavier than lambs born from ewes less than two years old (Table 2). The same tendency was also present in WW (Table 3) and in YW (Table 4). In general, lambs born from two-year to less than three-year old ewes were 7.6% heavier than those from one-year to less than two-year old ewes. However, there were no significant differences in YW between lambs born to year to less

than three-year old ewes, and lambs born to the other age of ewe classes. In addition, the estimates of age of dam effects were smaller at yearling than at weaning and birth time. This would appear to be a reflection of the lamb diet after weaning when lambs became independent of the influence of milk supply (basic diet from birth up to weaning time) from their mothers. Results obtained from the present study are in agreement with those reported by Sidwell et al. (1970), and Alrawi et al. (1982); however, Galal & Awgichew (1981) reported that age of dam did not have significant influences on yearling weights in Columbia and Adal lambs, respectively.

The estimates of heritability (h^2) for BW was 0.354 ± 0.102 (Table 5). This value exceeded the estimates obtained by Gjedrem (1967), Dzakuma et al. (1978), Mavrogenis et al. (1980), and Alrawi et al. (1982). However, Eloksh et al. (1962) found a h^2 of 0.54 for crossbred Columbia x Rambouillet lambs. On the other hand, the h^2 in this study is in close agreement with the value (h^2 = 0.30) found by Chapman & Lusk (1932) and Vesely et al. (1970) for Hampshire and Rambouillet sheep, respectively.

TABLE 5. Estimates of heritability and standard errors of growth traits of Morada Nova lambs.

Trait	Number of Sires	Number of Observations	h^2
Birth Weight	50	989	0.354 ± 0.102
Weaning Weight	50	845	0.362 ± 0.110
Yearling Weight	36	536	0.290 ± 0.125

The heritability estimate of 0.362 ± 0.110 (Table 5) for WW was in close agreement with those previously reported by Hazel & Terril (1945) (h^2 = 0.32 in Corriedale), and Mavrogenis et al. (1980) (h^2 = 0.36 in Chios). However, Fahmy et al. (1969) and Alrawi et al. (1982) found high values of 0.45 and 0.73 in Barki and Awassi sheep, respectively. On the other hand, the h^2 for WW in Morada Nova sheep was larger than those reported by Karam (1959) in Rahamani sheep (0.18) and Galal et al. (1981) in Adal sheep (0.02). Despite the differences among the various h^2 estimates reported in literature, the h^2 for WW in Morada Nova lambs can be considered a reasonable estimate and of special interest since selection of replacement lambs is generally made when lambs are this age.

The estimated heritability of YW (h^2 = 0.29) agrees closely with estimates reported by Vesely et al. (1970) in Rambouillet (0.26) and Galal et al. (1981) in Adal sheep. It is larger than those obtained by Karam (1959) in Rahamani (0.19) and Alrawi et

al. (1982) in Awassi (0.10). However, it is much smaller than the etimates of 0.82 and 0.41 reported by Basset et al. (1967) and Fahmy et al. (1969), respectively.

All genetic correlations were high and positive, which is expected for correlations among weights at birth (BW), weaning (WW) and yearling (YW) times. The genetic correlations found in this study between BW and WW, and BW and YW, and WW and YW were 0.70, 0.86, and 0.77, respectively. These values agree with the values reported by Alrawi et al. (1982) in Awassi sheep for the same genetic correlations.

These findings with respect to genetic correlations make it appear that single-trait selection for increased weaning weight (WW) should make genetic gains on yearling weight (YW) since WW and YW are genetically correlated in a positive manner.

All phenotypic correlations among the various growth traits were positive (Table 6), ranging from a low of 0.25 between BW and YW to a high of 0.49 between WW and YW. The phenotypic correlations between BW and WW, and BW and YW found in this study are in close agreement with the values reported by Dzakuma et al. (1978) for the same correlations. However, they found a much larger phenotypic correlation betweem WW and YW (0.77) in Hampshire sheep than the findings in this study (0.49) in Morada Nova sheep.

TABLE 6. Genetic and phenotypic correlations between growth traits of Morada Nova lambs[a].

Trait	Birth Weight	Weaning Weight	Yearling Weight
Birth Weight		0.339	0.247
Weaning Weight	0.704 ± 0.162		0.492
Yearling Weight	0.856 ± 0.196	0.744 ± 0.180	

[a]Phenotypic correlations above diagonal, genetic correlations below.

Summary and Conclusions

1. All environmental factors considered in this study (year and location of birth, age of dam, sex of lamb, and type of birth and rearing) significantly influenced birth weight (BW), weaning weight (WW) and yearling weight (YW) of Morada Nova lambs. Thus, adjustments for those factors need to be considered in selection programs.

2. The heritability estimate of 0.36 for WW should be considered a reasonable etimate and of special interest since selection of replacement lamb is generally made when lambs are this age.

3. Selection for increased WW seems to be feasible and selection for this trait should make genetic gains on YW since WW and YW are genetically correlated in a positive manner.

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REPRODUCTIVE PERFORMANCE OF MORADA NOVA SHEEP

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ABSTRACT - The objectives of this study were to (1) estimate the relative importance of genetic and environmental sources of variation affecting reproduction characters and (2) calculate repeatability of twinning rate in Morada Nova sheep. Data were obtained from 1,338 ewes and 989 lambs sired by 50 rams at the Iracema Farm - EPACE - Quixadá, Ceará, Brazil from 1979 to 1984. The reproductive characters studied were parturition, lambing, weaning and twinning rates, lamb production and lamb survival up to weaning and up to yearling. Morada Nova ewes had parturition, lambing and weaning rates of 83, 118 and 102% respectively. Twinning rate was analyzed by least-squares procedures. Location of lambing had a significant ($P<.05$) effect on twinning rate while age of ewe was highly significant ($P<.01$). A twinning rate of 37% was observed in 1,062 lambings in this study. Location and year of lambing, age of ewe, and type of lambing had a highly significant ($P<.01$) effect on lamb production. Ewes having twins produced 3.48 kilograms more of lamb than ewes with single lambs. Lamb survival rates up to weaning, up to yearling were analyzed by Funcat procedures. Sex of lamb, type of birth, and class of birth weight all had highly significant ($P<.01$) effects on survival rates. Ewe lambs, single lambs, and lambs with heavier BW had better survival rates than ram, twin and lighter lambs, respectively, to weaning and to yearling ages.

Index terms: Hair sheep, Reproduction.

DESEMPENHO REPRODUTIVO DOS OVINOS MORADA NOVA

RESUMO - Os objetivos deste estudo foram (1) avaliar a importância relativa dos fatores genéticos e de ambiente sobre a performance produtiva e reprodutiva dos ovinos Morada Nova e (2) estimar a repetibilidade para partos múltiplos em ovelhas Morada Nova. Os dados foram coletados de 1.338 ovelhas e 989 cordeiros filhos de 50 reprodutores na Fazenda Iracema - EPACE - Quixadá, Ceará, Brasil de 1979 até 1984. As carcterísticas reprodutivas estudadas foram as taxas de parição, nascimento e prolificidade, produção de cordeiros e sobrevivência de cordeiros ao desmame e a um ano de idade. Ovelhas Morada Nova apresentaram taxas de parição, nascimento e desmame de 83, 118 e 102%, respectivamente. Taxa de parto múltiplo (TPM) foi analisada pelos procedimentos de quadrados mínimos. Local de nascimento teve significante ($P<0,05$) efeito sobre TPM enquanto idade da matriz foi altamente significante ($P<0,01$). A TPM de 37% foi observada em 1.062

nascimento neste estudo. Local e ano de nascimento, idade da ovelha, e tipo de parto foram efeitos altamente significante (P<0,01) na produção de cordeiros. Ovelhas que tiveram partos múltiplos produziram 3,48kg a mais do que aquelas que deram partos simples. As taxas de sobrevivência de cordeiros ao desmame e aos 12 meses de idade foram analisadas pelos procedimentos de Funcat. Sexo do cordeiro, tipo de parto, e classe de peso ao nascer foram efeitos altamente significativos (P<0,01) sobre as taxas de sobrevivência. Marrãs, cordeiros de partos simples, e cordeiros com os maiores pesos as nascer apresentaram melhores taxas de sobrevivência do que cordeiros machos, cordeiros de partos duplos e cordeiros com menores pesos ao nascer, respectivamente, ao desmame e aos 12 meses de idade.

Termos para indexação: Ovinos sem lã, Reprodução.

Introduction

Animal productivity is the result of the genotype, the environment and of possible interactions between them.

Meat production can be expressed as a function of the reproductive efficiency, growth rate and carcass characteristics of any genotype in a given environment.

Significant effects of ewe weight on lambing rate have been reported by Coop (1962), Bowman (1966), and Cumming et al. (1975). However, Laster et al. (1972), Dyrmundsson (1976), and Hohenboken et al. (1976) concluded that body weight of ewe at beginning of the breeding period has no significant (P>.05) effect on the reproductive performance of ewe of different breeds.

The influence of age of ewe at mating on her reproductive performancehas been analyzed by many researchers (Coop, 1962; Shelton, 1963; Turner & Dolling, 1965; and Turner, 1969a).

With regard to lamb survival rate Vesely et al.(1977) found that lambs from young ewes (bred as ewe lambs) and from 9-year-old ewes had a survival rate of 11% and 15% lower than lambs born to 2- to 8-year old ewes, respectively.

Significant influences on lamb survival rate due to year of birth were reported by Sidwell et al. (1962), Mullaney & Brown (1969), and Dickerson & Glimp (1975). However, year of birth was not a significant source of variation on lamb survival rate according to the results found by Vesely et al. (1977).

Turner & Dolling (1965) reported an interesting point that single females had a better survival rate than single males; however, Vesely et al. (1977) did not find significant influences on lamb survival rate due to sex of lamb.

Shelton (1963) found that twin lambs had a 9.2% higher death loss than single lambs. Other researchers (Vetter et al., 1960; and Vesely & Peters, 1981) found similar results regarding the effects of type of birth and rearing on lamb survival rate.

Studying reproductive efficiency of the Sonora and McGregor Rambouillet sheep flocks, Shelton & Menzies (1970) estimated, for each flock, repeatabilities of 11.66 and 14.73%, -0.56 and 9.43%, and 6.05 and 10.48% for prolificacy, fertility, and lamb survival, respectively. An estimate of repeatability for number of lambs born was reported by Dzakuma et al. (1982) in crossbred sheep (0.138 ± 0.67). Also, Young et al. (1963) reported, low estimated repeatabilities of 0.05 ± 0.02 and 0.08 ± 0.03 for lambs born and weaned in Austrilian Merino sheep, respectively.

Considering the environmental and genetic factors affecting reproductive performance of ewes, this study was conducted to (1) estimate the relative importance of genetic and environmental sources of variation affecting reproduction characters of Morada Nova sheep, (2) to calculate repeatability of twinning rate in Morada Nova ewes and (3) to evaluate the potential of the Morada Nova sheep as a way for increasing the animal productivity (sheep meat production) of the northeastern region of Brazil.

Materials and Methods

The Morada Nova breed of sheep is found throughout the northeast region of Brazil. This breed is characterized as a hair sheep (woolless) unique to Brazil (Shelton & Figueiredo, 1981). Also, this is a dual-purpose breed which provides meat and skins.

The data used in this study were collected over a 6-year period (1979-1984) from the Morada Nova sheep flock maintained by the Experimental Reasearch Unit of the "Empressa de Pesquisa Agropecuária do Ceará" (EPACE) at the Experimental Iracema Farm. This farm is located at Quixadá, Ceará, Brazil at 5° South latitude at an altitude of approximately 180 meters. The average temperature ranges between 26.4 and 27.6°C in the cooler and warmer months, respectively indicating little season variation. The rainfall is highly variable but averages about 800mm annually concentrated from January until May.

During the experimental period management procedures and pasture conditions remained relatively stable. The Morada Nova sheep flock remained on the native pastures throughout the year with mineral supplementation provided ad-libitum. The herd health program included vaccinations against rabies and drenching for internal parasites as necessary to insure survival. The breding season lasted for sixty days each year. The females were run with sterilized males to determine estrus which was detected twice a day and ewes standing in heat were bred by natural service in the corral by a previously selected ram. The ewes were mated from November 1st until December 30 with subsequent

lambing season of April and May of each year. The weaning was at 112 days and occurred from July 1st until August 30. After weaning the males were separated from females.

Reproduction characters examined in this study included: fertility (ewes lambing per ewe exposed to sterilized rams), prolificacy (lambs born per ewe lambing, lamb survival (lambs weaned per lamb born and lambs yearling per lamb born), and lamb production (kilograms of lamb weaned per ewe lambing).

To analyze the genetic and environmental sources of variation affecting twinning rate, 1,062 lambings from a total of 1,338 ewes during the period of 1980 to 1984 were used. The data were analyzed by least-squares procedures as outlined by Harvey (1977), and Duncan's multiple range test was used to evaluate differences among means. The model used in analyzing this trait was:

$$Y_{ijkl} = \mu + L_i + E(L)_{ij} + A_k + e_{ijkl}$$

where:

Y_{ijkl} = observation on the lth lambing of the jth ewe within the ith location and with this ewe from the kth age.

μ = overall mean.

L_i = ith location effect.

$E(L)_{ij}$ = effect of the jth ewe nested in the location.

A_k = kth age of ewe effect.

e_{ijkl} = random effect.

Location of lambing and age of ewe considered as fixed effects and ewe nested within location was considered as a random effect.

Repeatability of twinning rate was estimated by analysis of variance procedures using this model.

Lamb production (kilograms of lamb wenaed per ewe lambing) was analyzed by least-squares procedures using the procedure as described in SAS manual (1982). The multiple range test as described by Duncan (1975) was used to measure differences among means. This analysis included 723 lambings and weaning records from the years of 1980 to 1983. The model used was:

$$Y_{ijklmn} = \mu + L_i + A_j = I_k + T_l + W_m + e_{ijklmn}$$

where:

Y_{ijklmn} = Observation on nth ewe of the kth class of age, lth type of birth and mth weight at breeding

from the ith location in the jth year.

μ = overall mean.

L_i = ith location effect.

A_j = jth year of lambin effect.

I_k = kth age of ewe effect.

T_l = lth type of lambing effect.

W_m = mth weight of effect.

e_{ijklmn} = random error.

Location, year of lambing, and age of ewe, were considered as fixed effects. Weight of ewe at breeding was included as a covariate.

Lamb production was adjusted to 112 days based on the following formula:

$$TKL = TKL_l + \frac{TKL_i - TKL_b}{DW} \times (112 - DW)$$

where:

TKL = Total kilos of lamb adjusted to 112 days.

TKL_i = Total kilos of lamb produced at weaning time.

TKL_b = Total kilos of lamb produced at birth.

DW = number of days at weaning time.

Survival rate of lamb was considered at two different ages, i.e., weaning and yearling ages. Records from 989 lambs were used to estimate lamb survival to weaning, while only 767 records were utilized to calculate lamb survival to a year of age. Because survival rate is a categorical variable, it was analyzed using the FUNCAT procedure as outlined in the SAS manual (1982). Also, birth weight (BW) was categorized in three different classes: one (BW < 1.50kg), two (1.50 <BW $\leq$ 2.20kg), and three (BW > 2.20kg). The following general model was fitted to describe this categorical variable response:

$$\log \frac{P_{ijklmno}}{1 - P_{ijklmno}} = \mu + L_i + A_j + I_k + S_l + T_m + C_n$$

where:

$P_{ijklmno}$ = probability of survival for lambs of the lth sex born from the mth type of birth and the nth class of birth weight and born in the ith location and the jth year from the kth age of ewe class.

μ = overall mean.

L_i = ith location of birth effect.

A_j = jth year of birth effect.

I_k = kth age of dam effect.

S_l = lth sex of lamb effect.

T_m = mth type of birth effect.

C_n = nth class of birth weight effect.

Results and Discussion

Reproductive performance of the Morada Nova ewes in this study is summarized in Tables 1, 2, and 3.

During the experimental period (1979-1984) 1,338 ewes were exposed to sterilized males and 90.88% of those ewes were mated with proviously selected rams. A total of 1,062 lambings were recorded from those matings with fecundity and parturition rates of 79.37 and 87.34%, respectively (Table 1).

In addition, this Morada Nova ewe flock had a fertility rate (number of lambs born per ewe exposed) and a lambing rate (number of lambs born per ewe mated) of 1.07 and 1.18, respectively. A reasonable prolificacy rate of (1.35 lambs born per ewe lambing) was observed on the average during the experimental period (Table 2). EPACE (1979) reported lower prolificacy rates for Morada Nova ewes raised under native pasture (1.06), clear native pasture (1.05), and buffel grass pasture (1.15).

Differences due to location (areas one and two) on reproductive performance as measured through fecundity, parturition, fertility, lambing and prolificacy rate, can be explained based on two facts. First, the flock of ewes at location one had a higher average age (3-year to 6-year old) than the flock at location two (1-year to 3-year old). Second, the nutritional level (forage availability) at location one was apparently better than at location two since the level of competition (number of animal/grazing area) was lower than at location two.

Age of dam had remarkable effects on the reproduction traits considered in the study. The fecundity and parturition (Table 1) rates (87.28 and 90.45%, respectively) were highest for 3-year-

up to 4-year-old ewes, while yearling ewes had the lowest fecundity rate (68%) and ewes older than six years had the lowest parturition rate (84.38%). Observing the fertility, lambing, and prolificacy rates (Table 2), there was a clear tendency for these to increase with increase of age of ewe up to 6-year-old and with a light for ewes older than six years. Four years up to 6-year-old ewes had the fertility, lambing and prolificacy rates (1.26, 1.32 and 1.51, respectively). On the other hand, the yearling ewes (one year to less than two-year old) had the lowest (0.79, 0.99 and 1.16, respectively).

TABLE 1. Summary of the reproductive performance of Morada Nova ewes.

Effect	Number of Ewes Exposed	Ewes Mated (%)	Fecundity Rate[a] (%)	Parturition Rate[b] (%)
Overall	1,338	90.88	79.37	87.34
Year[c/d]				
1. 1979/1980	71	85.92	81.69	95.08
2. 1980/1980	211	79.62	66.35	83.33
3. 1981/1982	293	96.93	80.89	83.45
4. 1982/1983	348	91.38	82.76	88.05
5. 1983/1984	415	92.77	81.69	88.05
Location				
1. Area One	345	95.36	80.29	84.19
2. Area Two	993	89.33	79.05	88.50
Age of Ewe				
1. One yr to less than two	350	79.14	68.00	85.92
2. Two yrs to less than three	299	92.98	81.61	87.77
3. Three yrs to less than four	228	96.49	87.28	90.45
4. Four yrs to six	360	95.83	83.33	86.96
5. Older than six	101	95.05	80.20	84.38

[a]Fecundity Rate = $\frac{\text{Total Number of Ewes Lambing}}{\text{Total Number of Ewes Exposed}} \times 100.$

[b]Parturition Rate = $\frac{\text{Total Number of Ewes Lambing}}{\text{Total Number of Ewes Mated}} \times 100.$

[c]Year of Breeding Season.

[d]Year of Lambing Season.

The consistent effects of age of dam on the reproductive performance of Morada Nova ewes as measured in this study are in close agreement with similar analyses made by other researchers under different conditions and with sheep breeds

TABLE 2. Reproductive performance of Morada Nova Ewes at lambing.[a,b]

Effect	Number of Ewes Exposed	Number of Ewes Mated	Number of Ewes Lambing	Fertility Rate[c]	Lambing Rate[d]	Prolificacy Rate[e]
Total	1,338	1,216	1,062	1.07	1.18	1.35
Year[f/g]						
1. 1979/1980	71	61	58	0.89	1.03	1.09
2. 1980/1981	211	163	140	0.88	1.10	1.32
3. 1981/1982	293	284	237	1.12	1.15	1.38
4. 1982/1983	348	318	288	1.19	1.30	1.44
5. 1983/1984	415	385	339	1.06	1.14	1.29
Location						
1. Area One	345	329	277	1.19	1.24	1.48
2. Area Two	993	887	785	1.03	1.15	1.30
Age of Ewe						
1. One yr to less than two	350	277	238	0.79	0.99	1.16
2. Two yrs to less than three	299	278	244	1.05	1.13	1.28
3. Three yrs to less than four	228	220	199	1.17	1.21	1.34
4. Four yrs to six	360	345	300	1.26	1.32	1.51
5. Older than six	101	96	81	1.20	1.26	1.49

[a]Based on data collected 1979 to 1984.

[b]Total number of lambs born = 1,429.

[c]Fertility rate = $\frac{\text{Number of lambs born}}{\text{Ewe Exposed}}$.

[d]Lambing rate = $\frac{\text{Number of lambs born}}{\text{Ewe mated}}$.

[e]Prolificacy = $\frac{\text{Number of lambs born}}{\text{Ewe lambing}}$.

[f]Year of breeding.

[g]Year of lambing.

(Turner & Dolling, 1965; Bichard et al., 1974; Baker et al., 1978; and Vesely & Peters, 1981). However, Coop (1962); Mullaney & Brown (1969); and Chang & Rae (1970) reported no significant effect on reproductive performance of ewes due to age of dam differences.

Reproductive performance of Morada Nova ewes up to weaning of their lambs (Table 3) was analyzed based on data collected from 1979 to 1983. A total number of 923 ewes exposed, 723 lambings and 663 weanings with 845 lambs, were considered to study the reproductive performance of ewes at weaning time measured as the number of lambs weaned per ewe mated and ewe lambing. The overall means were 1.02 and 1.17 lambs weaned per ewe mated and per ewe lambing (Table 3).

The number of lambs weaned by location is shown in Table 3. Ewes at area one had better performance (1.09 and 1.37 lambs weaned per ewe mated and per ewe lambing, respectively) than those at location two (0.98 and 1.11 lambs weaned per ewe mated and per ewe lambing). These differences in reproductive performance at weaning due to location have similar explanations as given for differences in fertility, lambing and prolificacy rates discussed earlier.

The effects of age of dam on number of lambs weaned as found in this study are consistent with the results reported by Sidwell et al. (1962), Turner & Dolling (1965), Iwan et al. (1971), and Vesely & Peters (1981). The same type of trend that occurred in relation to age of dam on fertility, lambing and prolificacy rates was observed on the number of lambs weaned. Mature ewes (3 years to 6-year-old) weaned, on the average, more lambs (1.27 lambs per ewe lambing) than young (1 year to less than 3-year-old) and old (older than 6-year-old) ewes which weaned 1.07 and 1.20 lambs per ewe lambing, respectively. The results from the present study confirm that mature ewes have a better mothering ability (probably due to higher milk production) than young and old ewes.

Twinning rate (number of multiple parturitions/total number of parturitions) was analyzed using records of 1062 lambings that occurred during the experimental period of 1980 to 1984 (Table 2).

Least squares analysis using Harvey's procedures (1977) was used to describe the sources of variation affecting twinning rate.

The analysis of variance for twinning rate is shown in Table 4. The significant ($P<.05$) effect on twinning rate due to location factor, can be explained as a result of higher average age of ewes at area one (3 years to 6-year-old) than at area two (yearling ewes to 4-year-old). Another point is that the ewes at area one apparently had a better nutritional level (forage availability) than ewes at location two based on the low feed competition level (animal per grazing area) existing at area one.

TABLE 3. Reproductive performance of Morada Nova ewes (N=845) up to weaning time (1979-1983).

Effects	Number of Ewes			
	Exposed	Mated	Lambing	Weaning
Total	923	831	723	663
Year[a/b]				
1. 1979/1980	71	61	58	56
2. 1980/1981	211	168	140	130
3. 1981/1982	293	284	237	214
4. 1982/1983	348	318	288	263
Location				
1. Area one	281	270	216	211
2. Area two	642	561	497	452
Age of Ewe				
1. One yr to less than 2-yr-old	269	209	182	163
2. Two yrs to less than 3-yr-old	209	192	168	157
3. Three yrs to less than 4-yr-old	155	149	138	128
4. Four yrs to 6-yr-old	236	228	190	176
5. Older than 6-yr-old	54	53	45	39
	Index of Lambs Weaned Per Ewe			
Total	0.92	1.02	1.17	1.27
Year[a/b]				
1. 1979/1980	0.83	0.97	1.02	1.05
2. 1980/1981	0.78	0.98	1.17	1.26
3. 1981/1982	0.92	0.95	1.14	1.27
4. 1982/1983	1.01	1.10	1.22	1.33
Location				
1. Area one	1.05	1.09	1.37	1.40
2. Area two	0.86	0.98	1.11	1.22
Age of Ewe				
1. One yr to less than 2-yr-old	0.66	0.85	0.98	1.09
2. Two yrs to less than 3-yr-old	0.93	1.01	1.15	1.24
3. Three yrs to less than 4-yr-old	1.08	1.12	1.21	1.30
4. Four yrs to 6-yr-old	1.07	1.11	1.33	1.43
5. Older than 6-yr-old	1.00	1.02	1.20	1.38

[a]Year of breeding.
[b]Year of lambing and weaning.

TABLE 4. Analysis of variance of twinning rate in Morada Nova ewes.

Source of Variation	Degrees of Freedom	Mean Square	F
Location	1	1.0378	3.883*
Ewe (Location)	442	0.2653	1.514**
Age of Ewe	4	0.6047	3.426**
Error	614	0.1765	

* P<.05
** P<.01

Ewes at location one had 9% more twin parturitions than ewes at two (Table 5).

TABLE 5. Least-squares means and standard errors for twinning rate in Morada Nova ewes.

Effect	Number of Lambings	Twinning Rate* (%)
Overall Mean	1062	37 ± 0.020
Location		
1. Area One	277	42 ± 0.035[a]
2. Area Two	785	33 ± 0.024[b]
Age of Ewe		
1. One year to less than two	238	24 ± 0.46[e]
2. Two years to less than three	244	33 ± 0.39[cd]
3. Three years to less than four	199	32 ± 0.38[c]
4. Four years to six	300	44 ± 0.34[b]
5. Older than six	81	53 ± 0.066[a]

[a,b,c,d]Least-squares means followed by the same letter within column and sub-class do not differ significantly. All others differ significantly (P<.05).

$$*\text{Twinning Rate} = \frac{\text{Number of Multiple Births}}{\text{Total Number of Lambings}} \times 100$$

Age of ewe had a highly significant (P<.01) effect on twinning rate (Table 4). A clear and significant tendency for twinning rate to increase with increasing age of ewe was observed in this study (Table 5). Old ewes (older than 6-year-old) had the highest twinning rate (53%) while yearling ewes (one year to less than 2-year-old) had the lowest (24%). Also, mature ewes (four years to 6-year-old) had a high twinning rate of 44% while

ewes from two years to less than 4-year-old had 32.5% twinning lambings (Table 5). The findings from this study are in remarkable agreement with other studies made by other researchers under other conditions with different sheep breeds (Maijala, 1967; Hulet & Price, 1975; Quirke, 1978; and Vesely & Peters, 1981).

Repeatability for twinning rate was calculated based on the analysis of variance techniques using Harvey's procedures (1977). This analysis used 1062 lambing records that occurred during the period of 1980 to 1984. A repeatability value of 0.20 ± 0.04 was found for twinning rate. This value was higher than the repeatability values reported by Shelton & Menzies (1970) of 11.66 and 14.73% for prolificacy and fertility rates in Rambouillet sheep. Also, it was higher than the repeatability (0.138) for number of lambs born per ewe exposed as found by Dzakuma et al. (1982) in crossbred sheep.

Kilograms of lamb produced at weaning per ewe lambing were analyzed by least-squares techniques (SAS, 1982).

A general linear model was used to analyze the sources of variation affecting the total kilos of lamb produced at weaning (TKLW).

The analysis of variance of the model is shown in Table 6. All factors, with the exception of weight of ewe, had highly significant ($P<.01$) effects on the total kilos of lamb produced at weaning (TKLW) per ewe lambing.

The significant differences on TKLW due to location effects can be explained as was suggested earlier in the discussion of the reproduction performance of ewes measured as the number of lambs weaned per lamb born. Another point was that lamb survival to weaning was higher at location one than at location two. Ewes at location one produced 4.24 kilos of lamb more than ewes at area two at weaning time (Table 7).

Total kilos of lamb produced at weaning (TKLW) was significantly ($P<.01$) influenced by year of lambing (Table 6). Ewes lambing in 1981 had the highest average (Table 7) of TKLW (18.48kg) while those lambing in 1983 had the lowest TKLW (14.06kg). The significant differences on TKLW due to year of lambing effects reflect the yearly differences in nutrition (forage availability) and climate conditions which generally affect the lamb production. Also, the lowest TKLW in 1983 could be a reflection of the cumulative adverse effects of the critical drought period which occurred in Northeast Brazil from 1979 to 1983.

Age of ewe had a highly significant ($P<.01$) effect on the TKLW (Table 6). Similar findings were reported by Holtmann & Bernard (1969), and Hohenboken et al. (1976). Two-year- to six-year-old ewes, on the average, produced 1.79 and 3.01 kilos of lamb more than young (one-year to less than two-year-olds) and

old (older than six-year-olds) ewes, respectively (Table 7). Those differences on TKLW due to age of dam apparently are a reflection of better mothering ability (milk production) of middle-age and mature ewes than young and old ewes.

TABLE 6. Analysis of variance of the total kilograms of lamb produced at weaning time (TKLW).

Source of Variation	Degrees of Freedom	Mean Square	F
Location	1	1315.8124	37.44**
Year of Lambing	3	659.6579	18.77**
Age of Ewe	4	159.2456	4.53**
Type of Lambing	1	2276.4624	64.77**
Weight of Ewe	1	23.1777	0.66 n.s.
Error	712	35.1483	

**P <.01.
n.s. = not significant.

TABLE 7. Least-squares means and standard errors of TKLW.

Effect	Number of Lambings	Total Kilos of Lamb
Overall Mean	723	14.96 ± 0.468
Location		
1. Area One	216	18.65 ± 0.457[a]
2. Area Two	497	14.36 ± 0.479[b]
Year of Lambing		
1. 1980	58	16.55 ± 0.903[bc]
2. 1981	140	18.48 ± 0.547[a]
3. 1982	237	16.90 ± 0.448[b]
4. 1983	288	14.06 ± 0.405[d]
Age of Ewe		
1. One year to less than two	182	15.67 ± 0.585[d]
2. Two years to less than three	168	17.24 ± 0.519[ab]
3. Three years to less than four	138	17.94 ± 0.532[a]
4. Four years to six	190	17.20 ± 0.503[abc]
5. Older than six	45	14.45 ± 0.951[e]
Type of lambing		
1. Single	467	14.51 ± 0.343[b]
2. Multiple	256	18.49 ± 0.444[a]

[a,b,c,d,e]Least-squares means followed by the same letter within column and sub-class do not differ significantly (P<.05).

The effect of type of lambing was significant (P<.01) on the total kilos of lamb produced at weaning (TKLW) per ewe lambing (Table 6). Sidwell (1956), and Vesely & Peters (1981) reported similar effects on TKLW due to type of lambing effects. weaning time than ewes having single lambs (Table 7). This positive and significant effect of lambing rate on TKLW would apparently support the need to increase reproductive performance of Morada Nova ewes through a selection program for increasing twinning rate.

Survival rate of Morada Nova lambs up to weaning (SRW) and up to yearling (SRY) were analyzed by Funcat procedures (SAS, 1982). The analysis of variance for SRW (Table 8) was based on 989 lamb records while for SRY (Table 8) was based only on 767 records.

TABLE 8. Analysis of variance of survival rate of Morada Nova lambs up to weaning time (SRW) and up to yearling age (SRY).

Source of Variation	SRW DF[a]	SRW C-S[b]	SRY DF[a]	SRY C-S[b]
Intercept	1	107.86**	1	0.01
Location	1	4.80*	1	0.02
Year of Birth	3	1.34	3	3.13
Age of Dam	4	7.88	4	6.06
Sex of Lamb	1	4.82*	1	19.69**
Type of Birth	2	28.34**	1	30.55**
Class of Birth Weight	2	17.22**	2	11.83**
Residual	189	252.51	149	221.91

[a]DF = Degrees of Freedom *P<.05.

[b]C-S = Chi-square **P<.01.

Differences in survival rate attributable to location of birth were significant (P<.05) on SRW. Lambs born at area one, on average, had a higher survival rate up to weaning (88.32%) than those born at area two (83.82%) as shown in Table 9. This may be explained as a reflection of less competition and a lower level of stress at area one since they were in small groups. Parasitism and disease would be expected to be less under these conditions. Survival rates (up to weaning) of 78.3 and 81% were found for Morada Nova lambs born and raised under native pasture and clear native pasture, respectively (EPACE, 1980).

Location of birth did not affect SRY. This was reasonable since all lambs (only divided by sex) were raised together under the same conditions after weaning.

TABLE 9. Survival rate of Morada Nova lambs up to yearling time based on class of birth weight by sex of lamb and type of birth.

Effects	Class of Birth Weights						Total	
	One[a]	(%)	Two[b]	(%)	Three[c]	(%)		(%)
Sex:								
Male	(27)	48.15	(113)	51.33	(227)	70.48	(367)	62.94
Female	(36)	47.22	(132)	76.52	(232)	80.17	(400)	76.00
Type of Birth:								
Single	(20)	65.00	(80)	77.50	(251)	84.86	(351)	82.05
Twins	(43)	39.53	(165)	58.79	(208)	63.94	(416)	59.38
Total	(63)	47.62	(245)	64.90	(459)	75.38	(767)	69.75

[a]Birth Weight <1.5kg.

[b]1.50kg <Birth Weight <2.20kg.

[c]Birth Weight >2.20kg.

Note: Figures in parentheses mean the total number of lambs born in this class.

Year of birth and age of dam did not influence SRW or SRY. However, many studies suggested significant differences on lamb viability due these factors (Sidwell et al., 1962; Turner & Dolling, 1965; Mullaney & Brown, 1969; and Vesely et al., 1977).

The effect of sex on survival rate up to weaning (SRW) was significant (P<.05) and on survival rate up to yearling (SRY) was highly significant (P<.01) as shown in Table 9, and Table 10. Ewe lambs had a higher survival rate to either age than did ram lambs (Table 9 and Table 10). Sex differences in this study were similar in direction, but of greater magnitude than those reported by Vetter et al. (1960), Lax & Turner (1965), and Vesely & Peters (1981).

The sex differences in survival rate increased with age of lambs. Females had 4.1 and 13.06% greater survival rates than male lambs up to weaning and yearling, respectively (Table 9 and Table 10). The higher survival rate for females could be due to factors associated with differences in birth weight, or from differences in body composition between female and male lambs. According to Oliver et al. (1967), carcasses of females contained more chemical fat and less protein and water than male lambs. Thus, this high fat percentage in females should be a favorable factor for surviving under the conditions of Northeast Brazil. However, additional studies need to be conducted to explain the

causes and reasons for the large difference in SRY between females and males under those conditions.

The most striking factor contributing to survival rate was the effect of type birth. Survival rate to weaning (SRW) and to yearling (SRY) age was greatly influenced ($P<.01$) by type of birth (Table 9 and Table 10). Single lambs had 13.29 and 22.6% greater survival rates than twin lambs up to weaning and yearling, respectively (Table 9 and Table 10). These results were similar to those reported by Vetter et al. (1960), Shelton (1963), Turner (1969b), and Vesely & Peters (1981).

The high morality of twin lambs is no doubt a reflection of lighter birth weights or to an inadequate milk supply for the lambs from dams under the range conditions. This factor has a marked influence prior to and after weaning since twin lambs are weaned on the average with an inadequate body weight for support during the critical drought period following weaning where the forage availability (quantity and quality) is low and normally does not meet the nutritional requirements of the animals raised under the range conditions in this part of Northeast Brazil.

The significant influence on survival rate up to weaning (SRW) and up to yearling (SRY) due to birth weight effects are shown in Table 9 and Table 10. Similar findings were reported by Shelton (1963).

Survival rates (SRW and SRY) were greatly affected ($P<.01$) by birth weight of the lambs, with survival increasing from a low of 65.22 and 47.62% for lambs weighing equal to or less than 1.50kg to a high of 88.96 and 75.38% for lambs weighing more than 2.20kg for SRW and SRY, respectively (Table 9 and Table 10).

Summary and Conclusions

1. The Morada Nova sheep breed is very adapted to the environmental conditions of northeastern Brazil.
2 This is quite a prolific sheep breed (1.35 lamb born/ewe lambing) and they show a good weaning rate (1.02 lamb weaned/ewe mated).
3. Survival rates of twin lambs up to weaning and up to yearling (79.13 and 59.38%, respectively) were lower than of single lambs (92.42 and 82.05%, respectively).
4. Ewe lambs had higher survival rates than ram lambs. The great difference (14%) in survival rates up to yearling between female and male lambs is not completely understood.
5. The repeatability estimate for twinning rate (0.20) is a reasonable value, and should be useful in breeding or selection programs because it should indicate the extent to which selection practiced at any stage will affect subsequent performance of the sheep flock.
6. The total production of kilograms of lamb at weaning (TKLW) was affected by year and location of lambing, age of ewe,

TABLE 10. Survival rate of Morada Nova lambs at weaning time based on class of birth weight by sex of lamb, type of birth, and location of birth.

Effects	Class of Effects	Class of Birth Weight			
		One[a]	Two[b]	Three[c]	Total
Sex	Male	(32)62	(158)77	(307)89	(497)83
	Female	(37)68	(173)88	(232)89	(492)87
Type of Birth	Single	(25)76	(106)90	(331)94	(462)92
	Twin	(44)59	(225)80	(258)82	(527)79
Location of Birth	Area One	(15)40	(101)93	(218)89	(334)88
	Area Two	(54)72	(230)79	(371)89	(655)84
Total		(69)65	(331)83	(589)89	(989)85

[a]Birth weight ≤ 1.50kg.
[b]1.50kg < birth weight ≤ 2.20kg.
[c]Birth weight 2.20kg.
Note: Figures in parentheses mean the total number of lambs born in this class.

and type of lambing. Thus, adjustments for those factors need to be considered in selection programs.

7. Ewes having twins produced 27% more kilograms of lamb at weaning than ewes having single lambs. This positive and significant effect of lambing rate on TKLW appears to support the need to increase reproductive performance of Morada Nova ewes by a selection program for increasing twinning rate.

8. However, selection programs for increased twinning rate need to be considered with care in the management conditions of the production systems used in the region. Improvements in the management conditions could be made for taking advantage of twinning as an effective way for increasing total lamb production.

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DESEMPENHO PRODUTIVO E REPRODUTIVO DA RAÇA SOMALIS

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RESUMO - O desempenho produtivo e reprodutivo de 146 crias da raça Somalis foram avaliados na Fazenda Experimental Várzea Alegre em Independência, Ceará, durante os anos de 1984 e 1985. Os dados analisados mostram que o sexo das crias exerceu influência importante sobre os pesos aos 180 e 365 dias de idade ($P<0,05$).

O tipo de nascimento influenciou significativamente ($P<0,05$) sobre todas as variáveis estudadas, exceto peso aos 365 dias de idade.

A interação sexo X tipo de parto só foi significativa ($P<0,05$) aos 365 dias de idade. O índice de prolificidade para os dois anos foi de 1,39 e o de fertilidade 91,5%.

Termos para Indexação: Melhoramento, Somalis, Produção, Reprodução, Consanguinidade, Monorquidismo e Criptorquidismo.

PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF SOMALIS SHEEP

ABSTRACT - The productive performance of 146 Somalis sheep was evaluated from birth to one year of age, at the Fazenda Várzea Alegre in Independência, Ceará, during 1984 and 1985. A difference in weight attributable to sex was observed at 180 and 365 days of age ($P<0.05$).

Type of birth was significant ($P<0.05$) for all variables studied, except weight at 365 days.

The prolificacy index was 1.39 and fertility at birth was 91.5%.

Index terms: Breeding, Somalis, Production, Reproduction, Inbreeding, Monorchidism and Cryptorchidism.

Introdução

A raça Somalis brasileira pertence ao grupo de ovinos de garupa gorda, de origem controvertida na Ásia Central (Viera & Santos, 1967) ou na África Oriental (Fitzhugh & Bradford, 1979) e também criada em parte da China e Sibéria (Viera & Santos, 1967), África (África do Sul), América do Sul (Brasil, Bolívia e Colombia) (Simplício et. al., 1982) e Trinidad e Tobago). Foi introduzida no Brasil em 1939 (Pinheiro, 1973), por criadores do

Rio de Janeiro. Poucas informações existem sobre o trabalho de melhoramento da mesma, desde a sua introdução até a década de setenta. Com a criação do Centro Nacional de Pesquisa de Caprinos (CNPC), o interesse pela raça foi renovado e vários produtores no Nordeste do Brasil foram identificados como criadores da raça Somalis, nos municípios de Quixadá, Independência, Crateús e Caucaia, no Estado do Ceará e no Estado do Rio Grande do Norte (Município de Lages).

Experimento realizados no CNPC por Figueiredo & Melo Lima (1982), demonstraram que entre as raças de ovinos estudadas (Santa Inês, Morada Nova e Somalis), durante três anos (1980, 1981 e 1982), a Somalis foi a que apresentou maior porcentagem de anomalia genética (mono e criptorquidismo), causada possivelmente por problemas da consanguinidade (Ponce de León, 1982). A seleção contra esta anormalidade demonstrou ser eficaz (Enseminger, 1979; Santos, 1977; Owen, 1977; Warwick & Legates, 1979).

Objetivando estudar com maior profundidade os parâmetros: Desenvolvimento ponderal das crias, a eficiência reprodutiva e o índice de mortalidade da raça, o Centro Nacional de Pesquisa de Caprinos desenvolve um projeto na fazenda experimental Várzea Alegre no município de Independência, Ceará.

Material e Métodos

Os dados para análises dos desempenhos produtivo e reprodutivo de ovinos da raça Somalis foram coletados durante o período de 1984 a 1985, oriundos de programa de melhoramento de ovinos Somalis, implantado na fazenda experimental do CNPC. A fazenda está localizada no município de Independência no Estado do Ceará. A precipitação pluvial média anual é de 600mm.

A alimentação básica para os animais durante todo o período em estudo foi de pastagem nativa e pastagem nativa melhorada pelo raleamento, sendo que as áreas raleadas foram usadas, após a verificação de carência de pastagem nativa normalmente utilizada pelos animais.

A mineralização do rebanho foi feito através do oferecimento, em cochos cobertos, de uma mistura mineral composta de sal comum iodado e farinha de ossos, na proporção de 1:1 à vontade e durante todo o ano.

O rebanho foi vermifugado quatro vêzes ao ano, seguindo a estrátegia de ação recomendada pelo CNPC para essa região (Costa & Viera, 1984).

Os dados analisados levou-se em consideração o desenvolvimento ponderal das crias, a eficiência reprodutiva e o índice de mortalidade. Apenas os pesos ao nascer aos 28 dias, aos 112 dias (desmame), aos 180 dias e aos 365 dias de idade foram analisados estatisticamente o modelo estatístico utilizado

para análises foi: $Y_{ijkk} = \mu + S_i + T_j + (ST)_{ij} + \varepsilon_{ijk}$

Onde:
μ = Efeito média geral, comum a todas as observações,
S_i = Efeito de sexo do animal,
T_j = Efeito de parto
$(ST)_{ij}$ = Efeito da interação sexo X tipo de parto
ε_{ijk} = Efeito do erro aleatório comum à todas as observações e assumindo ser normalmente destribuído e independente.

Resultados

As análises dos pesos na fase de crescimento foram feitas separadamente por ano, devendo a próxima análise ser incluído o efeito de ano no modelo matemático.

A Tabela 1, mostra as análises de variância dos pesos na fase de crescimento para o ano de 1984. O sexo das crias apresentam influência importante sobre o peso aos 180 dias e 365 dias de idade. O tipo de parto influenciou significativamente ($P<0,005$) para todas as variáveis estudadas, com exceção para o peso aos 365 dias de idade. A interação sexo x tipo de parto so foi significativa ($P<0,05$) para o peso aos 365 dias de idade. Na Tabela 2, estão mostradas as médias e erros-padrão, para peso na fase de crescimento até 365 dias de idade. Os dados desta tabela mostram que os machos e fêmeas atingiram 31,0kg e 23,42kg de peso vivo , respectivamente, aos 365 dias de idade. O peso ao desmame (112 dias) no macho foi de 15,82kg, enquanto que na fêmea foi de 14,90kg. A média do peso ao nascer do macho foi semelhante ao da fêmea, com o peso de 2,41 e 2,35kg, respectivamente ($P>0,05$).

As médias do desenvolvimento ponderal, relativo ao ano de 1985, estão mostradas na Tabela 3. Observa-se que neste ano as análises só foram feitas até aos 180 dias de idade. Os dados desta tabela mostraram que as crias oriundas de partos simples foram significativamente ($P<0,05$) mais pesadas, em todos os pesos estudados, do que aquelas oriundas de partos duplos. O peso ao desmame do macho foi de 14,97kg, enquanto que da fêmea foi de 14,40kg, não havendo diferença significativa ($P>0,05$) entre eles. Já o peso aos 180 dias de idade apresenta diferença significativa ($P<0,005$) a favor dos machos, que obtiveram em média, 0,95kg, a mais que as fêmeas.

O desempenho reprodutivo das matrizes está mostrado na Tabela 4, onde a fertilidade foi de 91,5% e o índice de prolificidade foi de 1,39.

Os dados relativos à mortalidade estão mostrados na Tabela 5. Observa-se que o índice de mortalidade está correlacionado com a faixa etária dos animais, ou seja os maiores índices são verificados nos animais mais jovens. Ainda na mesma tabela, observou-se o baixo índice de mortalidade da raça Somalis, caracterizando-a como uma raça rústica e bem adaptada à região Nordeste.

TABELA 1. Análise de variância do desenvolvimento ponderal dos cordeiros da raça Somalis, durante a fase de crescimento - 1984.

Causas de variação	G.L.	Quadrados médios				
		Peso ao nascer	Peso aos 28 dias	Peso aos 112 dias	Peso aos 180 dias	Peso aos 365 dias
Sexo	1	0,06^{NS}	0,01^{NS}	15,63^{NS}	43,33*	488,68**
Tipo de parto (T)	1	0,96*	37,22**	219,65**	202,87**	3,27^{NS}
Interação (S x T	1	0,04^{NS}	0,12^{NS}	0,01^{NS}	13,14^{NS}	25,21*
Erro	(a)	0,16 (66)	2,78 (68)	5,27 (60)	6,89 (57)	4.19 (33)

(a) = Os números entre parênteses representam os graus de liberdade referente aos quadrados médias cada ano.
^{NS} P>0,05).
* P<0,05).
** P<0,005).

TABELA 2. Médias (± EP) do desenvolvimento ponderal dos cordeiros da raça Somalis, durante a fase de crescimento - 1984.

Classificação		Médias ± erros-padrão em kg				
		Peso ao nascer	Peso aos 28 dias	Peso aos 112 dias	Peso aos 180 dias	Peso aos 365 dias
Tipo de parto:						
Simples	$\bar{x}$	2,48^{a}	4,74^{a}	16,96^{a}	21,05^{a}	27,54^{a}
	EP	0,07	0,32	0,35	0,45	1,22
	n	41	41	36	36	16
Múltiplos	$\bar{x}$	2,26^{b}	3,32^{b}	13,17^{b}	17,33^{b}	26,92^{b}
	EP	0,07	0,20	0,50	0,50	0,97
	n	29	28	27	25	18
Sexo:						
Machos	$\bar{x}$	2,41^{c}	4,28^{c}	15,82^{c}	20,31^{c}	31,0^{c}
	EP	0,08	0,32	0,52	0,62	0,63
	n	35	35	32	32	17
Fêmeas	$\bar{x}$	2,35^{c}	4,22^{c}	14,90^{c}	18,65^{d}	23,42^{d}
	EP	0,06	0,30	0,51	0,50	0,45
	n	35	34	31	29	17

^{abcd}Médias seguidas por letras iguais na mesma classificação não diferem estatisticamente entre si (P>0,05).

TABELA 3. Médias ± (E.P.) do desenvolvimento ponderal dos cordeiros da raça Somalis durante a fase de crescimento - 1985.

Classificação		Médias ± erro-padrão em kg			
		PN	28 dias	112 dias	180 dias
Tipo de parto					
Simples	$\bar{x}$	2,67[a]	5,48[a]	16,96[a]	19,37[a]
	ER	0,05	0,32	0,58	0,78
	n	40	40	38	12
Múltiplos	$\bar{x}$	2,04[b]	3,76[b]	12,08[b]	15,08[b]
	ER	0,06	0,30	0,42	0,54
	n	36	36	28	12
Sexo					
Machos	$\bar{x}$	2,46[c]	4,57[c]	14,97[c]	17,43[c]
	ER	0,05	0,28	0,79	0,96
	n	45	45	38	12
Fêmeas	$\bar{x}$	2,28[c]	4,56[c]	14,40[c]	16,48[d]
	ER	0,09	0,37	0,65	0,98
	n	31	31	28	12

[abcd] Médias seguidas por letras diferentes na mesma classificação diferem estatisticamente (P>0,05).

TABELA 4. Desempenho reprodutivo das matrizes Somalis nos anos de 1984-1985 em Independência, CE.

Parâmetros	Raça Somalis
Número de fêmeas em estação de monta	156
Número de fêmeas cobertas N(%)	153 (98,1)
Número de fêmeas que pariram N(%)	135 (86,5)
Número de fêmeas que abortaram N(%)	5 (3,2)
Número de fêmeas não fertilizadas N(%)	31 (19,8)
Número de fêmeas que morreram N(%)	11 (7,1)
Número de partos simples N(%)	83 (61,5)
Número de partos duplos N(%)	51 (37,7)
Número de partos triplos N(%)	1 (0,8)
Número de nascimentos	188
Índice de prolificidade	1,39
Índice de fertilidade (%)	91,5

TABELA 5. Mortalidade dos cordeiros da raça Somalis de 1984-1985 em Independência, CE.

Idade	Raça Somalis
Nas primeiras 72 horas N(%)	7 (3,7)
De 72 horas até 7 dias N(%)	4 (2,1)
De 7 dias até 90 dias N(%)	5 (2,6)
De 90 dias até o desmame 112 dias	8 (4,3)
TOTAL	24 (12,7)

Conclusões

A - Os machos só foram mais pesados que as fêmeas à partir de 18 meses de idade.

B - As crias nascidas de parto simples foram mais pesadas do que as oriundas de partos duplos, em todos os pesos estudados.

C - O baixo índice de mortalidade associado com o bom desempenho reprodutivo caracteriza a excelente adaptabilidade da raça Somalis na região nordestina.

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POTENTIAL GENOTYPES FOR MORADA NOVA SHEEP

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ABSTRACT - An experiment of a factorial structure of three genetic potentials for mature size (WMA) (30, 40 and 50kg of body weight) by three genetic potentials for milk production (MILK) (1.125, 1.500, and 1.875kg of milk x ewe^{-1} x day^{-1} at the peak day of lactation) by three genetic potentials for ovulation rate (OVR) (1.65, 2.20 and 2.75 ova x ovulation^{-1}) in a total of 27 genotypic combinations were simulated.

Simulation results showed efficiency of sheep meat production for Northeast Brazil (total weight sold x ton of dry matter consumed by the flock^{-1} x year^{-1}) increased with increases in genetic potential for ovulation rate and with increases in genetic potential for milk production, but it decreased with increases in genetic potential for mature size. The most efficient genotype was the one with medium WMA, medium MILK or high OVR, followed closely by the genotypes with medium WMA, low MILK and high OVR, and by low WMA, medium MILK and high OVR. High WMA genotypes were not present in the eleven genotype combinations ranked above the base genotype.

Index terms: Simulation, Sheep, Genetic potential, Milk, Ovulation, Mature size.

GENOTIPOS POTENCIAIS PARA OVINOS MORADA NOVA

RESUMO - Foi conduzido um experimento simulado com desenho em estrutura fatorial com três potenciais genéticos para tamanho à maturidade (WMA) (30, 40 e 50kg de peso vivo), tres potenciais genéticos para produção de leite (MILK) (1,125. 1,500 e 1,875kg de leite x dia^{-1} x ovelha no pique de lactação^{-1}) e três potenciais genéticos para taxa de ovulação (OVR) (1,65, 2,20 e 2,75 óvulos x ovulação^{-1}) num total de 27 combinações genotípicas.

Os resultados da simulação mostraram que a eficiência de produção de carne ovina no Nordeste do Brasil (peso total comercializado x matéria seca total consumida pelo rebanho^{-1} x ano^{-1}) aumenta com aumentos no potencial genético para produção de leite, mas diminui com aumentos no potencial genético para peso à maturidade. O genótipo mais eficiente foi aquele com WMA médio, MILK médio e alta taxa de ovulação seguido de perto por genótipos com médio WMA, baixo MILK e alto OVR e por baixo WMA, médio MILK e alto OVR. Genótipos com alto WMA não apareceram na lista das onze combinações genotípicas superiores as genotípo base.

Termos para indexação: Ovinos, Potencial genético, Leite, Ovulação, Peso à maturidade.

Introduction

Lamb production is a function of the number of lambs born as well as of their survival and growth to market. Improvement in efficiency can be accomplished by improving the three characters mentioned, either temporarily, through the environment (nutrition, management, disease control, etc.), or permanently and cumulatively through improvement in the genetic potential of the flock. Genetic improvement usually requires some parallel improvement in the environment.

The magnitude of the parallel environmental improvement required is unique to a particular region. The maximum genetic potential, which might require a large improvement in the environment, may not be desired. The selection of the most appropriate breeding program is difficult because of the large number of plans to be considered. Examining all possible breeding plans is not usually feasible due to time and resources constraints.

An approach to decision making concerning the feasibility of genetic versus environmental improvement can be taken through the use of systems analysis techniques. An investigation through simulation of several genetic potentials in several alternative environments provides a basis for making an immediate decision about the feasibility of possible combinations between breeding plans and levels of environmental improvement.

Systems analysis, as described by Forrester (1968), consists of systematic orderly evaluation of complex systems and can be applied in biology as well as in other sciences. Systems analysis has been used in animal breeding to provide a way to overcome some of the difficulties such as defining merit objectively and realistically, especially in terms of production and mating systems (i.e., in terms of production populations rather than in terms of individuals whose effects may not be additive (Cartwright, 1979)). Also, systems analysis has been used in animal breeding to design selection and breeding systems to cope with nonlinearity of economic values of characters and to cope with genetic-environmental interations, where the genetic component includes mating systems and the environmental component includes time and space variables. Specific selection and mating plans or strategies can be designed for given objectives and environments.

The efficiency of sheep production can be measured in many different ways. According to Sanders (1977), profitability and return on investment are two different measures of economic efficiency; the ratio of energy stored in animal products to grass energy consumed by the herd, and the ratio of animal protein production to crude protein consumed by the herd are two

measures of biological efficiency. Simulation analyses of meat sheep systems (Large, 1970) and beef cattle systems (Fitzhugh et al., 1975; Wilton & Morris, 1976) indicated substantial advantages in efficiency for systems mating large males to small females, over systems mating males and females of similar body weight, due to increased rate and efficiency of growth of the slaughter produce and reduced cost of maintaining the breeding female.

Sheep production has already been simulated for some parts of the world. Blackburn (1984), using the TAMU sheep model, studied genotypic combinations in a four-year period in which two nutritional environments were assumed. He showed that the most productive genotypes were 35.0kg of body weight with 1.30kg of daily milk production and 45.0kg of body weight with 1.75kg of daily milk production. The genotypes were ranked for flock efficiency for protein, energy, weight sold, and milk production per unit of dry matter intake. In Australia, White et al. (1983) simulated the physical, biological and economic consequences of changes in stocking rate and date of lambing. In Great Britain, France et al. (1983) described a model to compare different lamb production systems; to estimate the metabolizable energy (ME) and concentrate requirements of the flock or a particular group of sheep; to provide monthly estimates of concentrate costs associated with a particular production system for flock management purposes; and to compare and contrast feed and forage input costs with the expected revenue from the flock. The use of simulation in sheep production is a useful approach to investigate potential production systems and can be used to increase understanding of the relationships among the component parts of the system as well as to compare alternative genotypes and management practices plus their interactions in the region of interest. Considering such a background, the objective of this study was to identify, through simulation, potential optimum genotypes to serve as goals for breeding programs in Northeast Brazil.

Materials and Methods

This study was accomplished through a series of simulations to investigate the effect of different genetic potentials for prolificacy on extensively managed systems of sheep production in Northeast Brazil. The Single Animal Version (SAV) and the Flock Model (FM) of the Texas A&M Sheep Simulation Models were used; these are simulation models, programmed in Fortran IV, developed to simulate, respectively, single animal and flock performance of sheep on an individual animal basis (Blackburn, 1984). Both models have the general characteristics of a 15-day time increment for a period of simulation with conception and lambing occurring at the end of a period of simulation.

The SAV is capable of simulating the biological response of one ewe, her nursing offspring (until weaning) and fetuses she may be carrying. The FM incorporates the biological components

of the SAV and adds to it the accounting and flock management practices required to simulate a sheep flock. The FM has the capability of simulating six flocks of sheep with 12 classes of animals per flock. Animal classes of the FM represent differences in age and sex of the simulated sheep. The flock may also be divided into management groups and pasture assignments. More details about the structure of the simulation models used are given by Blackburn (1984).

The main inputs for the simulation study were the nutritional environment and the animal genetic potentials. The first is defined by availability, crude protein percent and digestibility of the consumed forage. These values were available from Pfister (1983) and Kirmse (1984) (Table 1) for the region around Sobral, Ceará, Brazil. The genetic parameters, the second kind of input necessary, included potential mature size (WMA), potential peak daily milk production (MILK), maturing rate, ovulation rate, and seasonality of breeding. These parameters were obtained from data on the Morada Nova breed evaluated at Sobral.

The FM was used to run a factorial experiment 3^3, where three levels of genetic potential for mature size (30, 40 and 50kg of live weight) by three levels of genetic potential for milk production (1.125, 1.500 and 1.875kg of milk x ewe^{-1} at the peak day of lactation) by three levels of genetic potential for prolificacy (1.65, 2.20 and 2.75 ova x $ovulation^{-1}$) were studied. All 27 combinations were simulated for a period of eight years.

The genetic potential values were generated starting from the base genotype, (40 WMA, 1.5 MILK and 2.2 OVR) and adding 25% of each of the base genotype values to obtain the high level in each parameter and decreasing 25% of the respective values to obtain the low level of each parameter. The base genotype represents simulated values corresponding to Morada Nova parameters, as obtained by the validation of the model.

In that experiment, the animals were allowed to graze and(or) browse in a native type of brush called caatinga. Such brush remains green from January to June and then due to drought loses its leaves, forming a litter on the ground. The caatinga vegetation is a deciduous woodland with a heterogeneous mix of deciduous trees and shrubs with an annual herbaceous understory well noted by its density and diversity, as well as an absence of perennial grass cover (Pfister, 1983).

The animalswere allowed to graze reserved paddocks during the dry season and received approximately 200g of chopped Napier grass per day.

Results and Discussion

The simulation experiment was conducted for a period of eight years to simulate the conditions used in the sheep breed

TABLE 1. Availability (AVC), digestibility (DIG), crude protein (CP) and supplementation amount and quality used as forage parameter for the simulation experiment.

MONTH	AVC, kg	DIG, %	CP, %	SUPPLEMENTATION AMOUNT, kg	DIG, %	CP, %
JAN	.40	63	23.6	.20	57	7.0
FEB	.40	62	18.0	.20	57	7.0
MAR	.60	58	18.0	-	-	-
APR	.80	56	18.0	-	-	-
MAY	.90	53	18.0	-	-	-
JUN	1.65	53	17.0	-	-	-
JUL	1.90	51	13.0	-	-	-
AUG	1.40	52	13.0	-	-	-
SEP	.75	47	13.0	-	-	-
OCT	.60	48	13.0	.20	57	7.0
NOV	.60	48	12.0	.20	57	7.0
DEC	.40	48	12.0	.20	57	7.0

evaluation experiment conducted at Sobral, CE, Brazil, where Morada Nova, Santa Inês and Brazilian Somali were compared under the same conditions.

The simulated four-year average and respective coefficients of variability for the number of breeding ewes across years, the lambing percentage and the lambing rate according to genotype are presented in Table 2. The number of breeding ewes was intended to be fixed in every run by replacing 20% of the breeding ewes per year. As a result, 35 new breeding ewes were incorporated to the flock every year. The fluctuation of the number of breeding ewes, therefore, reflects the differential fertility and mortality rates in each genotype. In general the number of breeding ewes was in the 180's, 170's and 160's for L--, M-- and H-- genotypes for WMA, respectively.

A similar trend was observed in the lambing percentage and size. In terms of lambing rate (the number of lambs born x ewe lambing^{-1} x 100), the genotypes L-- was at least 10 units higher than the M-- genotypes, and M-- at least 10 units above the H-- genotypes. This can be seen by comparing genotypes with the same MILK and OVR, and different genetic potential for WMA. Therefore these results indicate that, in terms of reproduction, there is little interaction and that smaller animals are better suited for the extensively managed flocks in Northeast Brazil.

TABLE 2. FOUR-YEAR-AVERAGE AND COEFFICIENT OF VARIABILITY (%) FOR NUMBER OF BREEDING EWES, LAMBING PERCENTAGE AND LAMBING RATE OF DIFFERENT SIMULATED GENOTYPES

GENOTYPE[a]	NO. EWES		LAMBING %		LAMBING RATE	
	AVG.	CV	AVG.	CV	AVG.	CV
LLL	185.5	2.8	97.6	1.3	142.5	2.6
LLM	187.0	1.6	97.7	1.0	182.5	2.1
LLH	188.7	1.7	96.7	1.3	216.7	1.6
LML	181.0	1.2	96.0	1.7	138.2	1.2
LMM	186.0	1.8	97.2	1.0	179.5	2.3
LMH	182.5	.7	96.7	.5	211.2	.4
LHL	180.5	1.8	97.2	.5	135.5	2.1
LHM	179.2	.5	97.7	.6	177.2	.7
LHH	188.7	2.1	97.2	1.0	209.5	1.1
MLL	175.7	1.9	94.0	2.4	132.2	2.8
MLM	178.0	1.0	93.5	2.0	173.5	3.3
MLH	182.5	2.1	92.7	2.2	207.2	2.8
MML	177.7	3.5	95.0	2.6	127.5	.8
MMM	177.5	1.3	93.2	1.3	166.0	2.9
MMH	180.2	1.4	92.2	2.4	204.5	1.3
MHL	179.5	1.0	94.5	2.8	124.5	.8
MHM	176.0	1.5	93.7	1.6	165.7	.6
MHH	173.2	2.0	92.0	.9	199.2	.9
HLL	169.5	3.2	81.7	1.5	123.2	2.8
HLM	173.7	.5	79.5	4.1	159.7	3.7
HLH	171.5	1.5	77.2	1.9	195.0	1.4
HML	166.2	1.3	83.2	1.1	119.5	1.1
HMM	168.0	1.9	79.7	4.3	163.0	3.8
HMH	175.2	1.3	80.2	3.7	191.5	3.0
HHL	169.5	2.8	82.7	5.9	118.7	3.0
HHM	166.7	2.9	79.5	3.0	157.2	1.6
HHH	174.0	3.1	81.2	1.6	188.5	2.0

[a]The first letter represents WMA, the second MILK and the third OVR; L = low, M = medium and H = high.

Weaning weights (Table 3) decreased linearly from L to H OVR and increased approximately linearly from L to H MILK. They also increased approximately linearly from L to H WMA. The highest weaning weight was produced by the HHL and the lowest by the LLH. The number of lambs sold, as a measure of offtake from each genotype, was highest for genotypes L--, intermediate for genotypes M-- and lowest for genotypes H--; at least a 20 lamb-difference existed from one WMA to another. The lowest figure was 83 lambs sold from genotype HLL and the highest 247 from genotypes LHH and LMH.

The total weight sold x genotype^{-1} was highest for L-- genotypes, intermediate for M-- and lowest for H-- genotypes. The lowest figure was 2,937.2kg of lambs sold from genotype HLL and the highest 6,830.2kg from genotype LHH. In terms of average weight of the lambs sold, the genotypes L--, M-- and H-- weighed approximately 27.0, 33.0 and 33.0kg, respectively. The lightest lambs were sold from genotype LLH (26.2kg) and the heaviest from the genotype HLL (35.4kg). It was expected that the lightest lambs would be produced from the LLH genotype due to the low milk production and high prolificacy, which means less milk x lamb^{-1}; however, it was expected that the lambs from genotype HHL would be the heaviest instead of the lambs from genotype HLL. This fact may mean that ewes from genotype HHL were not able to support the lactation allowed by their genetic potential due to insufficient nutrients for maintenance and lactation.

There was no increase in size of the lambs sold from genotype H-- in relation to those of genotypes M--, but there was an increase of approximately 7.0kg from genotypes L-- to M--. This increase means that there is a possibility for increasing size from L-- to M--; that is, M WMA can be supported, but the zero increase from M-- to H-- means that M WMA is near the limit for that kind of environment and therefore no more increase is recommended.

For preweaning and adult mortality, the genotypes L-- and H-- ranked from lowest to highest (Table 4). Preweaning mortality ranged from 11.2% for LML to 43.4% for HLH. In terms of adult mortality the figures were approximately equal for all genotypes, except for LLL, LMH and MHH, which deviated more from the average figure of 13%, but there was an increase with increases in MILK in genotypes L-- and M--. The mortality increased more in genotypes L-- than in genotypes M-- and did not change much in genotypes H-- with increases in MILK.

The average amount of milk suckled by single and twin lambs per day increased with MILK. The amount of milk reported decreased with increases in OVR in all genotypes. This is a result of lower body condition in genotypes of higher OVR. The amount of milk reported was higher for genotypes L--, intermediate for genotypes M-- and lower for genotypes H-- due to lower body condition of the ewe.

TABLE 3. FOUR-YEAR-AVERAGE AND COEFFICIENTS OF VARIABILITY (%) FOR WEANING WEIGHT OF LAMBS (kg), NUMBER OF LAMBS SOLD, TOTAL WEIGHT SOLD (kg) AND AVERAGE WEIGHT OF THE LAMBS (kg) OF SIMULATED GENOTYPES

GENOTYPE[a]	WWS		WWM		NOS		TWS		AWS
	AVG.	CV	AVG.	CV	AVG.	CV	AVG.	CV	AVG.
LLL	15.3	.2	9.9	2.3	159.7	2.8	4567.7	3.6	28.6
LLM	14.6	4.2	9.8	1.1	207.7	1.5	5698.7	1.1	27.4
LLH	12.6	4.0	9.6	.9	242.5	3.1	6358.5	2.2	26.2
LML	16.4	.6	11.4	.8	159.7	4.5	4629.7	3.6	29.0
LMM	15.9	1.1	11.3	.5	212.7	3.0	5991.0	2.3	28.2
LMH	14.5	3.0	11.0	1.7	245.7	4.3	6714.2	5.0	27.3
LHL	16.8	.2	12.1	2.1	158.0	7.4	4701.7	6.5	29.7
LHM	16.3	.5	11.6	4.9	212.0	1.5	6014.2	1.5	28.4
LHH	15.2	.7	11.7	2.6	246.7	3.6	6830.2	2.8	27.7
MLL	16.9	.5	10.7	2.7	127.7	5.3	4159.7	5.1	32.6
MLM	15.3	1.3	10.6	.9	165.7	5.1	5389.2	4.8	32.5
MLH	13.7	4.0	10.5	1.6	181.5	11.7	5883.7	11.6	32.5
MML	17.8	1.6	12.1	1.0	130.2	4.2	4515.7	3.3	34.7
MMM	16.2	2.0	11.9	1.2	157.2	6.0	5244.7	5.1	33.4
MMH	18.8	.6	12.1	1.5	193.2	4.4	6264.2	4.0	32.4
MHL	19.4	.6	12.6	2.0	128.2	5.2	4333.2	4.8	33.8
MHM	18.4	1.3	12.5	1.8	159.5	4.0	5215.2	3.2	32.8
MHH	16.8	3.8	12.3	1.8	193.0	1.5	5999.7	2.5	32.0
HLL	18.3	1.1	11.7	4.0	82.9	7.0	2937.2	7.8	35.4
HLM	16.7	1.5	11.7	5.9	105.0	10.0	3492.7	8.9	33.3
HLH	15.0	2.2	12.4	14.7	106.0	10.6	3514.5	10.2	33.1
HML	20.5	1.7	12.5	4.2	94.0	7.9	2938.0	7.9	31.3
HMM	18.8	3.9	12.7	1.6	101.7	3.3	3300.5	3.2	32.4
HMH	17.5	1.3	12.5	1.1	126.7	7.4	4266.5	6.9	33.7
HHL	21.4	1.5	12.5	1.3	93.7	6.6	2857.7	5.1	30.5
HHM	19.4	1.9	12.5	2.9	104.0	4.5	3407.5	4.9	32.8
HHH	17.3	3.8	12.4	1.0	125.2	11.3	4158.0	11.0	33.2

[a]The first letter represents WMA, the second MILK and the third OVR; L = low, M = medium, and H = high.
WWS and WWM = weaning weight of single and multiple born lambs.
NOS and TWS = number and total weight of lambs sold.
AWS = average weight of lambs sold.

TABLE 4. FOUR-YEAR-AVERAGE AND COEFFICIENTS OF VARIABILITY (%) FOR PREWEANING AND ADULT MORTALITY AND AMOUNT OF MILK CONSUMED BY SINGLE AND MULTIPLE LAMBS OF DIFFERENT SIMULATED GENOTYPES

GENOTYPE[a]	PREWEANING		ADULT		MILK, g	
	AVG. %	CV	AVG. %	CV	SINGLES	MULTIPLES
LLL	14.2	26.7	9.7	18.5	390	473
LLM	19.8	11.3	14.6	24.5	380	456
LLH	23.5	9.2	12.3	26.3	360	439
LML	11.2	7.9	12.0	13.6	464	559
LMM	17.3	16.0	13.3	19.2	464	548
LMH	16.5	28.5	19.7	12.4	447	525
LHL	11.3	26.4	12.6	19.9	532	609
LHM	15.9	9.4	15.7	23.2	512	555
LHH	16.9	9.0	15.9	9.4	485	569
MLL	20.1	7.1	12.6	32.5	355	427
MLM	26.9	8.1	14.2	25.1	344	433
MLH	29.6	11.1	14.6	17.2	366	433
MML	14.3	13.1	14.7	10.2	454	523
MMM	22.4	7.2	13.5	19.5	442	521
MMH	25.4	10.7	16.6	26.9	417	504
MHL	15.8	13.4	11.0	12.9	505	552
MHM	20.7	7.9	15.1	25.2	489	556
MHH	25.1	22.3	19.1	23.9	470	550
HLL	19.2	3.8	13.5	13.7	315	418
HLM	28.9	10.4	13.9	8.6	333	438
HLH	43.4	4.9	13.6	26.6	322	423
HML	15.7	22.4	13.1	10.9	421	492
HMM	30.1	11.6	13.2	23.0	409	496
HMH	37.0	5.0	13.3	17.6	391	471
HHL	14.9	30.3	12.2	11.0	473	473
HHM	28.7	9.9	14.4	23.9	448	494
HHH	39.7	9.8	13.1	14.2	424	490

[a]The first letter represents WMA, the second MILK and the third OVR; L = low, M = medium and H = high.

The four-year averages and respective coefficients of variability for total weight sold, total dry matter consumed by the flock per year and the ratio of total weight sold per ton of dry matter consumed, a measure of the efficiency of each genotype, are given in Table 5. The total weight sold increased with increases in OVR and with increases in MILK in all genotypes, but it decreased with increases in WMA. The highest figure was 7,655.0kg of weight sold from genotype LHH and the lowest was 3,973.0kg from genotype HLL.

The amount of dry matter consumed by the flock per year decreased with increases in WMA, due to decrease in size of the flock. The lowest figure was 92,145.0kg for genotype HML and the highest figure was 141,236.0kg for genotype LHH.

The efficiency increased with increases in OVR, but it decreased from genotypes M-- to H-- and it increased only slightly from genotype L-- to M--. The lowest efficiency figure was 41.3 for genotype HHL and the highest was 55.6 for genotype MMH, although several other efficiencies had approached this level, namely 54.6, 54.2, 55.4 and 54.2 for genotypes LMH, LLH< MLH and MHH, respectively. Any of these genotypes could therefore be sued as the goal to be achieved through genetic improvement. The efficiency of the base genotype (50.9) was lower than for LLM (51.5), LLH (53.6), LMM (52.1), LMH (54.2), LHM (52.8), LHH (54.2), MLM (51.9), MLH (55.4), MMH (55.6), MHM (52.6) and MHH (54.2).

The simulation study indicated that the Morada Nova breed is a well suited genotype for the kind of environmental conditions found in Northeast Brazil. However, it was found that there exists some room for genetic improvement in such a genotype. For example, the genotypes LLM, LLH, LMM, LMH, LHM, LHH, MLM, MLH, MMH, MHM and MHH had higher efficiencies, defined as the ratio of total amount of weight sold, including lambs and culling ewes x ton of total dry matter consumed by the flock^{-1} x year^{-1}. The above list of genotypes, includes six of the nine genotypes of low WMA, and five of the genotypes with medium WMA. The sixth medium WMA genotype is the base genotype. These simulations support the conclusion that large WMA genotypes do not perform well in such environment, therefore selection for high WMA should be avoided.

Another evident point is that genotypes with low OVR are not present among the eleven more efficient ones, therefore, OVR and(or) prolificacy should be kept at the current levels or increased through selection.

A third important point is that all levels of MILK are present among the nine more efficient genotypes in equal proportions. Such a fact means that the MILK variations used in the experiment were not so critical in the test conditions. Probably the lower level was already enough to support adequate growth of the offspring. That value was 1.125kg of milk per day at the peak day of lactation for ewes in good body condition.

TABLE 5. FOUR-YEAR-AVERAGE AND COEFFICIENTS OF VARIABILITY (%) FOR TOTAL WEIGHT SOLD (WT.), TOTAL DRY MATTER CONSUMED (DM) AND EFFICIENCY IN DIFFERENT SIMULATED GENOTYPES

GENOTYPE[a]	WT., kg		DM, kg		EFFICIENCY[b]	
	AVG.	CV	AVG.	CV	AVG.	CV
LLL	5448.7	2.4	116606.2	1.4	46.7	1.3
LLM	6551.5	.8	127181.5	1.0	51.1	1.5
LLH	7254.5	2.4	135397.5	1.5	53.6	1.8
LML	5479.7	3.5	116482.5	1.2	47.0	3.2
LMM	6870.7	2.6	131936.2	.8	52.1	2.4
LMH	7568.5	4.3	138607.5	1.4	54.6	2.9
LHL	5550.0	5.8	116047.5	1.5	47.8	4.9
LHM	6817.5	2.5	129157.0	1.1	52.8	2.0
LHH	7655.7	3.3	141236.5	2.7	54.2	1.2
MLL	5205.5	4.2	109593.7	.2	48.3	3.0
MLM	6308.2	4.2	120258.7	1.0	51.9	1.6
MLH	6858.2	10.2	126375.0	.0	55.4	2.3
MML	5584.5	3.0	116771.2	1.5	47.8	2.3
MMM	6207.5	6.4	119895.0	2.3	50.9	3.9
MMH	7247.2	4.5	130237.5	.6	55.6	4.7
MHL	5400.5	5.2	111686.2	2.9	47.5	4.0
MHM	6251.0	2.0	120416.2	.6	52.6	3.2
MHH	7142.7	1.6	129041.2	1.9	54.2	8.3
HLL	3973.5	8.5	96000.0	1.9	41.3	7.9
HLM	4653.2	5.1	103376.2	1.1	45.0	4.4
HLH	4667.2	7.7	102645.0	2.4	45.4	5.4
HML	4065.0	6.2	92145.0	2.2	44.1	4.3
HMM	4408.0	5.5	98205.0	1.6	44.9	5.3
HMH	5206.2	14.2	109766.2	3.1	47.3	12.0
HHL	4016.7	6.6	92711.2	1.6	43.3	6.1
HHM	4435.5	7.3	97882.5	1.3	45.3	7.2
HHH	5375.5	9.2	108476.2	5.0	49.5	6.1

[a]The first letter represents WMA, the second MILK and the third OVR; L = low, M = medium and H = high.
[b]Efficiency is expressed as the total weight sold·ton of DM intake^{-1}.

Such a value represents 25% below the current level of the base genotype, but apparently it was still high enough to support growth and robustness of the lambs.

The monthly weights of breeding ewes were highly influenced by levels of MILK. Within the same WMA, ewes with higher MILK had lower body condition from the beginning of lactation until two to three months after weaning. They probably made it through lactation because this phase is synchronized with the best forage production phase of the year. Another important fact contributing to the success of the higher MILK was the fact that only one breeding season per year was used and that gives time for the ewes to regain body reserves.

Higher MILK results in faster preweaning growth. Faster preweaning growth would mean that lambs could reach slaughter weight, on pasture, two or three months after weaning. That fact could be a great management improvement policy adopted in the sheep production system of Northeast Brazil, because it would require less forage inputs to the system in the most critical time for forage production in the region, the second half of the dry season. If such lambs could be sold with adequate slaughter weight by mid-September to mid-October, the forage resources of dry season could be entirely directed toward breeding ewes. This point deserves further investigation through specific simulation studies as well as through experimentation to test the reality of such an approach.

Increases in MILK slightly increased efficiency within WMA. Such an increase was mainly due to the shorter time the lambs remained at the ranch after weaning. They were sold earlier for slaughter. It is locally recommended that lambs should not be slaughtered before they reach at least 24.0kg of live weight to avoid reduced skin size. That was the minimum weight used to sell in this simulation study. The age of the lambs from high MILK to achieve the required weight was shorter and such lambs were sold earlier therefore consuming less DM. This point should be emphasized and simulation extended to study the optimal age and weight for selling the lamb crop if the genetic potential of the ewes for milk production is increased.

The higher efficiency of the lower WMA genotypes is different from the results reported by Blackburn (1984) for a simulation experiment conducted in Kenya with the Flock Model. He concluded that the genotype 45/1.75, (WMA/MILK), his higher levels in both parameters, was the one almost always ranking first for efficiency in the several measures of efficiency studied. His second most efficient genotype was 35/1.30, the medium levels of both parameters. A possible explanation to this discrepancy is the fact that Blackburn (1984) simulated ewes of low genetic potential for prolificacy. The reproductive rate of his ewes was 118%. The ewes simulated in this study ranged from 123 to 216% lambing rate, i.e., his study did not cover the range of reproduction level covered in this study. Another potential source for discrepancy is the large difference in forage

availability in both studies. This study used the forage parameters indicated by Pfister (1983) and Kirmse (1984). Both authors reported low forage digestibility contents in the forage (Table 1). According to these authors the limiting forage parameter in the region is availability and(or) energy. The forage availability listed in Table 1 shows that there is a forage availability restriction from mid-September through mid-February. Blackburn's simulations for nomadic herds involved a different situation, wherin the flock was moved to fresh pastures whenever the vegetation in the campsite had been consumed. In this situation forage availability is less limiting than in Northeast Brazil, where the animals simulated were in closed native caatinga pastures under a stocking rate of 1.7 ha x head^{-1} of sheep of 35.0kg of live weight, thus imposing a restricted dry season availability. Blackburn's simulations also considered year-round breeding, instead of limited breeding season as in this study. The contrasting results of this and Blackburn's simulation reflect the sensitivity of the simulation model to different production systems.

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E. REPRODUÇÃO

E. REPRODUCTION

FACTORS AFFECTING REPRODUCTION

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ABSTRACT - A series of coordinated research projects were conducted under the existing environmental conditions of Northeast Brazil on the reproductive potential of hair sheep and exotic and native genotypes of goats. Some differences were observed among genotypes, primarily related to body size and ovulation rate. Both male and female sheep and goats breed and are fertile throughout the year. Seasonal differences in reproduction appear to be related to changes in forage availability. Increased reproductive performance could be enhanced by changing management to fit reproduction cycles to feed production cycles. The native pasture under the conditions the studies were carried out appear to provide at least minimal nutrient requirements for reproduction. Improved nutrition in both species can increase body weight and decrease age at puberty. Important differences occur among years for all traits measured. The causes for these differences have not been identified but are assumed to relate to variation in climate and to feed quality and quantity. Detailed information is also presented for each research project and reproductive trait studied during the time of the collaborative research among the SR-CRSP, Utah Reproduction Project and the EMBRAPA/CNPC.

Index terms: Hair sheep, Goats, Reproduction traits, Production.

FATORES QUE AFETAM A REPRODUÇÃO

RESUMO - Uma série de projetos de pesquisa foi conduzido nas condições ambientais do Nordeste do Brasil para avaliar o potencial reprodutivo de ovinos deslanados e caprinos nativos e exóticos. Algumas diferenças foram observadas entre os genotipos, primariamente relacionadas com o peso corporal e taxa de ovulação. Ambos, machos e fêmeas de ovinos e caprinos podem ser acasalados e são férteis durante todo o ano. Diferenças reprodutivas estacionais parecem ser devidas as variações em disponibilidade de forragem. Um aumento no desempenho reprodutivo pode ser conseguido através da mudança do manejo reprodutivo para ajustar os ciclos reprodutivos as variações estacionais de disponibilidade de forragem. A pastagem nativa sob as condições nas quais os estudos foram conduzidos parecem proporcionar os requerimentos nutricionais mínimos para a reprodução. Um plano nutricional mais elevado em ambas espécies pode aumentar o peso corporal e diminuir a idade a puberdade. Diferenças importantes ocorrem de ano para ano em todos os parâmetros estudados. As causas destas diferenças não foram identificadas, mas podem estar relacionadas com as variações climáticas e consequentes diferenças em quantidade e qualidade da

forragem disponível. Informações detalhadas são apresentadas para cada projeto de pesquisa e parâmetros reprodutivos estudados durante o tempo que este trabalho foi conduzido de forma cooperativa entre o projeto Utah reprodução do SR-CRSP e o EMBRAPA/CNPC.

Termos para indexação: Ovinos deslanados, Caprinos, Reprodução, Produção animal.

Introduction

The research conducted by SR-CRSP Utah Reproduction Project has two primary objectives. The first is to establish reproductive parameters for the endogenous genotypes of sheep and goats under the existing environmental conditions, and the second is to develop and test management practices expected to improve reproductive performance.

We have planned and conducted our research from the premise that without reproduction there can be no production and that the information generated should be such as to contribute to improved production.

We have been concerned with measuring the basic reproductive parameters of puberty, fertility, estrus, prolificacy (and ovulation rate), peri- and postnatal survival of offspring, parturition intervals, and semen production, and how they are affected by endogenous genotypes of sheep and goats and by the climatic environments (primarily wet and dry seasons), level of nutrition (supplementation) and management (pasture vs. confinement).

The majority of the work has been conducted at the National Goat Research Center but significant research has also been carried out with producers.

All research has been conducted cooperatively at the CNPC and at officially approved projects. The project leader in each case has been a national scientist from the Center.

The major Brazilian scientists are Dr. Aurino A. Simplicio, Dr. José F. Nunes, Dr. Emidio F. Diaz Silva and Eng. José Ubiraci Alves. SR-CRSP collaborating personnel are Drs. Warren Foote and G. Simon Riera (USU) and Dr. Edward Nelson (CSPU).

Research Results

Goats

Puberty in Male Moxotó Goats

Eleven Moxotó buck kids (6 singles and 5 twins) were used to obtain the age, live body weight, scrotal volume and scrotal

circumference at penis detachment from the prepuce and at the first ejaculation containing sperm cells. The mean age and body weight at penis detachment from the prepuce and the first ejaculation with motile sperm into the artificial vagina were 124.8 ± 18.8 days, 12.7 ± 1.6kg, and 128 ± 23.0 days, 12.8 ± 1.7kg, respectively, for single and twin bucks. Statistical difference ($P.<0.02$) among single and twin kids were found only for live body weight at the penis detachment and at the first ejaculation. No statistical differences ($P>0.05$) were found for age, live body weight, scrotal volume and scrotal circumference at the time of penis detachment compared with the information obtained at the time of the first ejaculation containing sperm cells, indicating that these two events are very closely associated in time of occurrence. The information available from this study provides a practical means for better management of goats such as the stage of growth for culling, castration and sex separation based on penis detachment to avoid undesirable matings.

Fertility Study in Adult Male Goats

Semen of ten Moxotó goats housed and grazed together on native pasture were observed weekly during a two year-period. Differences ($P<0.05$) were observed between seasons for ejaculate volume, sperm concentration and mass motility. The ejaculated volume was lower during the dry (0.66 ± 0.03ml) than in the wet season (0.78 ± 0.02ml), while the sperm concentration (3.12 ± 0.04 x 10^9/ml) and mass motility score (3.07 ± 0.04) were higher during the dry season compared to the wet season (2.39 ± 0.03 x 10^9/ml and 2.59 ± 0.05, respectively). Sperm incubated at 37°C for 5 and 120 minutes during the wet season were statistically ($P<0.05$) higher in sperm motility (56.7, 29.7%) than during the dry season (50.6, 24.5%). No difference ($P>0.05$) occurred among seasons for progressive individual motility in the incubated sperm. The percent of abnormal sperm in semen obtained during the dry season (19.2%) was statistically higher ($P<0.05$) than during the wet season (12.0%).

In conclusion, semen obtained during the dry season had a higher sperm concentration, mass motility and abnormal sperm and lower ejaculate volume. Sperm incubated at 37°C for 5 and 120 minutes had a higher sperm motility during wet season than during dry season.

In the present study, the seasonal effect perhaps has more to do with the availability of green fodder during the rainy season than with the weather. However, the semen quality was adequate during both the wet and dry seasons to provide for fertile matings throughout the year.

Effects of Scrotum Morphology on
Semen Characteristics of Moxotó Goats

The scrotum of 25-30 percent of the goats in Northeast Brazil has some degree of division (each testicle in a separate

scrotal pouch). Six bucks with divided scrotum (score of 2-4 from scoring system of 0-5; where 0 = no division and 5 = complete division) and four bucks with non-divided scrotum (score of 0), managed continuously on native pasture at the National Goat Research Center, were used in this study. All characteristics tended to be more favorable in semen collected from bucks with divided scrotum than from bucks with non-divided scrotum. However, statistical differences ($P<0.05$) occurred only for ejaculated volume (0.8 vs 0.6ml.) and sperm abnormalities (7.7 vs 23.2%) for the two groups, respectively. As can be seen, the incidence of abnormal sperm cells was higher in the semen from bucks with non-divided scrotum. The testicle temperature (intrascrotum) in animals with and without divided scrotum did not differ. But, the temperature difference of 3.5°C between the spermatic cord (36.7°C) and the tail of the epididymis (33.2°C) confirms previously reported findings. It seems that the scrotum morphology has no influence in reducing the temperature of the testis.

In conclusion, further studies need to be conducted to define the reliability of these results and consequently introduce this factor in the selection schemes of goats for higher reproductive efficiency.

Puberty in Female Goats

A total of 99 native female kids (11 Canindé, 13 Marota, 64 Moxotó and 11 Repartida) grazed on native pasture of the National Goat Research Center were used in this study. Body weight and age were obtained at the first pubertal estrus detected using teaser bucks. Breed or type of birth did not significantly ($P>0.05$) affect the age and weight at puberty. The ovulation rate at prepuberal and puberal estrus was 1.00 and 1.04, respectively ($P>0.05$). A total of 40.4 percent of the kids had ovulated prior to puberal estrus and no differences were found among breeds ($P>0.05$); 100% ovulated at puberal estrus. Ovulation occurred more frequently from the right (57.8, 57.6 and 57.6%) than the left ovary (42.2, 42.4 and 42.4%) at prepuberal ($P<0.01$), puberal ($P<0.05$) and overall ($P<0.025$), respectively. Simple correlation was found between birth weight and age at puberty. The positive relationship in this case may result from an extended growing period to puberty.

The results of this study indicate that all doe kids ovulated accompanied by estrus at a mean age of 363.3 days and 12.5kg live body weight. Approximately 40 percent of kids ovulated prior to the first puberal estrus.

Estrus and Ovulation in Goats
Under Two Feeding Management Systems

This study was carried out at the National Goat Research Center to determine the influence of feeding-management system, year and season on the monthly occurrence and distribution of estrous activity, length of estrous cycle, ovulation rate and the

incidence of does ovulating, during two years (August 1980-July 1982) in three genotypes of goats (Marota, Moxotó and SRD). The goats were assigned to two groups. A group of 36 animals (12 of each genotype) was kept in native pasture, with a stocking rate of one animal/1.8 ha/year. A second group of 72 does (24 of each genotype) was group fed in confinement (mixture of cottonseed meal and cornmeal, 16.7% crude protein, and green chopped elephant grass ad libitum). The animals in both groups received fresh water and a mixture of equal parts of sodium chloride and bonemeal free choice. The goats were weighed at the beginning of the experiment and monthly throughout the experimental period. The animals were treated for internal parasites and vaccinated against foot and mouth disease. One brisket-painted, vasectomized adult buck per 12 does was used to identify females in estrus. Animals not showing estrus activity during a period greater than 63 days were considered to be in anestrus. The length of the estrous cycles was classified as short (less than 17 days), normal (17 to 24 days) and long (25 to 63 days). Each month a group of 36 does, 12 from native pasture (4 of each genotype) and 24 from confinement (8 of each genotype), were laparotomized to evaluate ovarian activity in terms of presence or absence of corpora lutea.

The mean monthly incidence of does showing estrus and ovulating varied from 46.8 to 92.1% and from 56.9 to 86.1%, respectively, throughout the year. This response confirms that the goats in Northeast Brazil behave as continuous breeders in response to the close relation to the equatorial line. This reproductive physiological behavior enables the goats to be bred and to kid throughout the year, with a significant positive influence on goat production. The mean occurrence of short (16.6%) and long (25.8%) estrous cycles might be a potential problem in goat production. The incidence of short estrous cycles are interpreted as anovulatory cycles or cycles associated with short lifespan corpora lutea. Long estrous cycles might be multiples of undetected estrous cycles or ovarian cycles (CL) without estrus. In practice, both short and long estrous cycles negatively influence goat productivity. From the total number of estrous periods observed, 33.1%, 27.5 and 39.4% were observed for Marota, Moxotó and SRD, respectively. The goats kept in native pasture showed more estrous periods than goats in confinement (53.0 vs. 47.0%), and during the second year than the first year (55.7 vs. 44.3%) of the experimental period. Ovulation rates of 1.4, 1.4 and 1.7 were found for Marota, Moxotó and SRD, respectively. A higher proportion of does ovulated during the second year than during the first year (76.6 vs. 65.6%). The percent incidence of ovulation in does kept in native pasture was similar to does in confinement (69.8 vs. 72.5%). The results obtained on ovulation rate are interpreted as a difference due to genotype.

None of the genotypes demonstrated improved reproductive performance under conditions of confinement with harvested feed compared to native pasture during any season of the year. This is interpreted to be due during the first year to inability to

adapt to the conditions of harvested feed and confinement. The lack of increased response during the second year suggests (1) a permanent inability to adapt or (2) nutritional adequacy of native caatinga even during the dry season to elicit an optimum response. Because some variation does occur in reproductive performance as a result of season, it is concluded that under the conditions of the two years studied, the experimental animals failed to adapt to confinement including the consumption of harvested feed.

A difference exists among genotypes in reproductive performance potential with the SRD having the greatest and the Moxotó the least potential under the conditions measured.

Although does showed estrus and ovulated with approximately equal frequency during each month of the year, the proportion of does ovulating during the dry season or transition to the dry season is reduced, indicating a limiting factor in relation to the wet season. These results demonstrate that breeding and therefore kidding can occur throughout the year. This indicates a great flexibility in the development of management programs under tropical conditions but also demonstrates the need to develop management programs to best relate reproductive cycles to natural patterns of feed production.

Reproductive Efficiency in Producer Flock Receiving Different Levels of Supplementation During Late Gestation and Early Lactation

This study was conducted on cooperator-producer farms. Approximately 100 SRD goats (2-6 years of age) were allotted at random to four experimental groups of 25 each. Treatment 0 served as a control and received no supplementation. Treatment 1 received feed supplementation for 45 days prior to the expected mean date of paturition. Treatment 2 received supplementation for 45 days after paturition. Treatment 3 received feed supplementation for 45 days prepaturition and for 45 days after parturition (90 days supplementation). According to the treatments, the animals were group fed, at the rate of 400 g/day/doe, a mixture of cornmeal, wheat bran and soybean meal containing 16% crude protein and 75% TDN. The controlled breeding season was during September-October, 1982.

The results show that heavier birth and weaning weights were recorded for kids born from does supplemented 45 days before kidding than for kids from the non-supplemented control does and does supplemented 45 days postpartum. The kids from does supplemented 90 days (45 days before and 45 days after kidding) tended to show better performance than kids from the control does and from does supplemented 45 days before kidding. The body weights of does at kidding showed the same trend based on the level of supplementation. In terms of mortality, no differences were found among kids from non-supplemented does and does supplemented pre- and postpartum. However, does supplemented 45

days before parturition only had the highest survivability rate (0% mortality). Higher abortion rates were recorded for the control group (16%) and does supplemented during lactation (12%) than for does supplemented 45 days before kidding (8%). No differences were found among treatments on the length of the postpartum interval. Does supplemented 45 days before parturition tended to show shorter postpartum intervals.

Pregnancy Diagnosis in Goats
Using Ultrasound

A total of 203 mature does from six breeds were checked for pregnancy using ultrasound equipment (Scanopreg, R) designed specifically for sheep. The individual does varied from 86-118 days post breeding with an average over all breeds of 109.5 days, and this average by breed varied from 107.2 to 114.2 days. Accuracy of diagnosis for all breeds based on kidding information was 93.1% with values of 68.4% for the Bhuj, 84.4% for Anglo-nubian, 96.6% for Moxotó and 100% for the Canindé, Marota and Repartida. The percent accuracy in diagnosing animals that were pregnant was 84.3% over all breeds and varied from 40.0% for the Bhuj to 100% for the Canindé, Marota and Repartida. The percent accuracy in diagnosing animals that were non-pregnant was 100.0% overall and thus for all breeds. None of the does were clipped before the diagnosis, and this may have contributed to the error since the breeds with the lowest accuracy had the greatest hair growth.

In conclusion, the accuracy of pregnancy diagnosis in goats using ultrasound was similar to that found in sheep. The high degree of accuracy and the simplicity of procedures makes this technique practical on a routine basis as a management tool to increase reproduction and production performance. The correct diagnosis of 93.1% associated with the simple operating skill necessary, enables a recommendation of the ultrasound technique as a routine practice in goat management for better reproductive efficiency.

Length and Frequency of Estrous Cycle
and Period in SRD Goats

This research was conducted at the National Goat Research Center, with thirty randomly chosen does at 1.5 to 2.0 years of age and two vasectomized bucks, all of nondescript native (SRD) type. The does were maintained on native range at a stocking rate of 2.3 ha/head/year for one year with water, salt and bonemeal, ad libitum. All animals were treated for internal parasites and vaccinated against foot and mouth disease.

The dry season was arbitrarily established as the period from July 11 to February 26 and the wet season from February 27 to July 10.

Fourteen does were supplemented with chopped green elephant grass (*Pennisetum purpurem*, Schum) when the native range

vegetation was sparse (November 2 to February 26). The amount of supplementation was calculated in terms of dry matter at the rate of two percent of average live body weight. The remaining 16 does received no supplementation.

The proportion of recorded estrous periods was evenly distributed among different months, showing no evidence of variation associated with seasons or with calendar months. Overall means of 4.6, 1.42 and 17.03 estrus periods were obtained per day, month and year, respectively.

The overall mean estrous cycle length was 21.2 days. Individual lengths varied from 5 to 69 days. There was some indication that the estrous cycle tends to be shorter during the wet season (21.8 vs 20.6 days, P=0.06). A significant proportion (11.0%) of the total estrous cycles are of short duration (5-9 days) which seems to be characteristic of goats in several regions.

Supplementation of does during the dry season, when the quantity and quality of range fodder was lowest had no influence on either estrous period or estrous cycle duration. Nearly 50 percent of the estrous periods were over 60 hours duration, about 28 percent between 45 to 59 hours and the remaining 22 percent between 15 to 44 hours. The information shows some concentration around 60 to 70 hours of estrous period length. This is higher than the majority of reports indicating around 36-42 hours of estrous period duration. The estrous period was significantly ($P<0.01$) longer during wet season (62.0hrs) compared to dry season (51.2hrs).

It is interesting to note that during the wet season the highest frequency of estrous cycle length was 60 hours compared to 48 hours during the dry season. Feed supplementation during the dry season did not appear to extend or shorten the estrous periods. The frequency distribution of the estrous cycle was not affected by season (wet or dry) or by supplementation. These results agree with other studies conducted at the Center.

Influence of Time to First Suckling on Survivability of Newborn Kids

This study was conducted at the National Goat Research Center, with six genotypes of goats (Canindé, Marota, Moxotó, Nubian, Repartida and SRD) over a two year period. The objective of this study was to establish the influence of birth weight, sex and type of birth on the interval from parturition to first suckling and the survivability of the kids.

The results show a significant difference ($P<0.01$) among genotypes, type of birth, and sex for birth weight of kids, and no statistical difference ($P>0.05$) for the interval from kidding to first suckling. It was expected that kids with heavier birth weights would suckle within a shorter period after parturition than kids with lighter birth weights and that this would also be

reflected in survival. However, using pooled data there were no significant ($P>0.05$) relationships among birth weights, weaning weights and intervals from parturition to first suckling.

Sheep

Semen Characteristics of Brazilian Somali Rams

No information was previously available on the reproductive performance of rams in Northeast Brazil. The seasonal variation in the size and consistency of the testis and in semen characteristics were studied for two years.

Five Brazilian Somali rams of 1.5-2.0 years of age at the beginning (1980-1981) were used in this study. One ejaculate using the artificial vagina was collected weekly throughout the two years. Immediately after collection, the ejaculate volume, mass movement (score of 1-5), individual sperm motility, sperm concentration, and the percent of stained sperm (alive/dead) were recorded. The testis volume by water displacement, length, diameter and circumference of the testis using vernier callipers and metric tape where appropriate were also recorded.

All characteristics of semen and testis except the consistency of the testis varied statistically ($P<0.05$) among the wet and dry seasons and the transition periods.

The results of this research indicate that the Brazilian Somali ram is adapted to the northeast environmental conditions and is fertile throughout the year.

Brazilian Somali Semen Characteristics During the Dry and Wet Seasons

During the dry and wet seasons in the years 1982 and 1983, five rams were used to study characteristics of fresh and incubated (37°C) semen. The data show that ram semen is fertile in both seasons. The mating behavior and libido were not different among seasons, indicating breeding and semen collections can be performed at any time of the year. However, statistically higher ($P<0.05$) values were obtained for ejaculate volume (0.5ml) and mass motility score (3.74) during the dry season compared to those obtained during the wet season (0.3ml and 2.70, respectively). The sperm concentration during the wet season (4.25×10^9/ml) was significantly greater ($P<0.05$) than during the dry season, indicating that an inverse relationship exists between ejaculate volume and concentration and is a result of changes in volume.

The forward sperm motility and the individual sperm motility in semen incubated at 37°C for 5 or 120 minutes were

statistically greater ($P<0.05$) in semen collected during the dry season compared to semen collected during the rainy season.

In conclusion, the semen of Brazilian Somali sheep is fertile and useable throughout the year. However, the fresh semen characteristics and the thermo-stress test indicate that the semen obtained during the dry season is much better than semen collected during the rainy season.

Semen Characteristics of Santa Inês and Brazilian Somali Sheep

A one year study was conducted with ten rams (5 Santa Inês and 5 Somali) to evaluate and compare the semen characteristics of these two breeds during the dry and wet seasons. Results demonstrate that the Santa Inês sheep showed statistically higher ($P<0.05$) fresh semen quality than the Brazilian Somali sheep in almost all characteristics observed except mass motility. No significant differences ($P>0.05$) were found among breeds for forward and individual sperm motility in semen incubated at 37°C for 5 and 120 minutes. When the data were pooled by dry and wet seasons, statistical differences ($P<0.05$) were found for ejaculated volume and sperm concentration, except mass sperm motility, among seasons. The dry season showed greater ejaculate volume and lower sperm concentration compared to the wet season. No statistical differences ($P>0.05$) were found for forward and individual sperm motility among breeds or seasons.

In conclusion, the fresh semen of the Santa Inês was higher overall than the Somali breed. Both breeds during both seasons produced semen with good fertilizing capability based on the thermostress test at 37°C incubation for 5 and 120 minutes.

Puberty in the Female Breeds of Hair Sheep

This experiment was carried out with 112 ewe lambs (32 Morada Nova, 63 Brazilian Somali and 17 Santa Inês) grazed on native range (from 7:00a.m. to 4:00p.m.) of the National Goat Research Center. Weights were recorded at birth and at four-week intervals until the first puberal estrus. The date, time of day and body weights were recorded to obtain the age and weight at first puberal estrus. Approximately 40-60 hours after estrus was detected using teaser rams, the ovaries of each lamb were observed via laparotomy to determine the occurrence and rate of prepuberal and puberal ovulations.

The body weights both at birth and at weaning were statistically different among breeds ($P<0.01$). Brazilian Somali (2.0, 13.2kg) were lighter than Santa Inês (2.6, 19.1kg); the Morada Nova (2.2, 16.4 kg) breed was intermediate. Single born ewe lambs showed heavier body weight ($P<0.01$) at birth and at weaning (2.6, 18.4kg) compared to those from multiple births (2.0, 14.0kg).

The Santa Inês breed (24.0kg) was statistically ($P<0.05$) heavier at puberty than the Morada Nova (21.2kg) and Brazilian Somali (19.7kg). The latter two breeds did not differ statistically ($P>0.05$). There was no difference ($P>0.05$) for weight or age at puberty due to type of birth. The advantage of single compared to twin born lambs in body weight at birth and at weaning was lost as the animals approached puberty. Twin born ewe lambs were neither lighter nor younger at puberty (22.1kg and 304.8 days) than singles (21.1kg and 312.4 days, $P>0.05$). No differences ($P>0.05$) were found among breeds for age at puberty.

A strong tendency existed for heavier lambs to reach puberty at a younger age than lighter lambs when data from all breeds were pooled. This is shown by the significant negative correlation ($P<0.05$) between body weight at weaning ($r = -0.485$) and at puberty ($r = -0.290$) with age. Also, positive significant ($P<0.05$) correlation coefficients existed between body weight at puberty and at birth ($r = 0.595$) and at weaning ($r = 0.715$).

Differences among breeds in occurrence or rate of ovulation were not significant ($P>0.05$). All ewes ovulated at puberal estrus with a mean ovulation rate of 1.31. During the prepuberal period, 77.3 percent of the ewes ovulated with an ovulation rate of 1.15. This indicates that the majority of ewe lambs ovulate first without estrus. This ovulation is then followed by ovulation accompanied by behavioral (puberal) estrus. The right ovary was found to be significantly ($P<0.01$) more active (62.8%) than the left ovary (37.2%) during the prepuberal period, a difference that seemed to disappear at the puberal ovulation (49.6 and 50.4%).

In conclusion, ewe lambs demonstrate first puberal estrus at any time of the year, indicating that onset of puberty is not affected by environment. Mean body weight at puberty represents 72.1 percent of adult live body weight of the dams at lambing. Weight of lambs at puberty was negatively correlated with age at puberty indicating that heavier lambs reach puberty at a younger age than lighter lambs. The Morada Nova breed tended to have a higher ovulation rate than the Brazilian Somali or the Santa Inês. A total of 77.3 percent of the ewe lambs ovulated without estrus during the prepuberal period. The fact that lambs at puberty achieved 72.1 percent of their adult weight at a mean age of 306 days indicates that the lambs could be bred to conceive during the first year of life in order to increase lifetime productivity.

Reproductive Capabilities of Three Genotypes of Sheep Under Two Nutrition-Management Systems

This study was conducted with 72 ewe lambs beginning at weaning (24 each Morada Nova, Santa Inês and Brazilian Somali breeds) equally assigned to two nutrition-management systems (fed in confinement and native pasture). In confinement, the ewe lambs received chopped elephant grass ad libitum plus one percent

of their body weight per day of a concentrate mixture (cottonseed meal and chopped corn) containing 16 percent crude protein and 75 percent TDN. Feed intake was measured only for the confinement group.

Overall mean age and weight at puberty, regardless of breed and nutrition-management, was 303.5 days and 25.2kg, respectively. A significant effect of nutrition-management on puberty was found. For the three breeds combined, the lambs in confinement reached puberty at 250.2 days of age and 28.2kg body weight compared to 356.8 days of age and 22.2kg body weight for ewes on native pasture ($P<0.01$). The Brazilian Somali and Morada Nova sheep showed lighter weights than the Santa Inês. The Brazilian Somali attained puberty at an older age than both Morada Nova and Santa Inês. The ovulation rate at puberty tended to be higher ($P>0.05$) in ewes fed on native range (1.17) compared to confinement (1.09). The Morada Nova breed showed a higher ovulation rate (1.23) than Brazilian Somali and Santa Inês (1.14 and 1.04).

Preliminary information (June 1982-May 1984) shows that the Morada Nova sheep have a higher ovulation rate (1.4 and 1.7) than the Santa Inês (1.3 and 1.1) and Brazilian Somali (1.3 and 1.5) under confinement and native pasture, respectively. No seasonal effect was found for ovulation rate, incidence of ovulation and incidence of estrus. A higher ovulation rate was found in sheep grazing on native pasture than sheep fed in confinement. These findings indicate that the feed quality and availability in native pasture is as good as in confinement when proper stocking rate is provided. The monthly mean incidence of ovulation was similar in sheep fed in confinement (81%) and in native pasture (80.8%). However, the incidence of estrus in the confined group of sheep was higher than in sheep fed on native pasture. More information will be provided when all post-pubertal experimental data is statistically analyzed. However, the following conclusions can be anticipated:

1. There is a significant effect of the level of nutrition on puberty showing a negative relationship between live body weight and age.

2. Ewe lambs (breeds combined) fed in confinement attained puberty 106.6 days younger and 6kg heavier than ewe lambs fed in native pasture.

3. Ovulation rate in ewes grazed on native pasture was unexpectedly higher than in ewes fed in confinement.

4. The Morada Nova and Santa Inês breeds attained puberty at a younger age than the Somali breed. The Morada Nova and Somali sheep had similar body weights at puberty, but both were lighter than the Santa Inês breed.

5. Observations during the first post-pubertal year showed that the Morada Nova breed had a higher ovulation rate followed by Brazilian Somali and Santa Inês.

6. Ewes maintained in native pasture showed a higher ovulation rate than ewes in confinement, as was also shown for puberal ovulation.

7. No seasonal effect was detected on the monthly incidence of estrus and ovulation, indicating that the sheep in Northeast Brazil have the potential to be bred at any time of the year if proper management is provided.

Pregnancy Diagnosis in Sheep
Using Ultrasound

A total of 112 mature ewes (32 Morada Nova, 29 Santa Inês and 51 Brazilian Somali) were checked for pregnancy using ultrasound (Scanopreg, mod 738). The individual ewes varied from 53 to 105 days post fertile breeding with an overall breed average of 92.2 days of gestation.

The accuracy of diagnosis for all breeds based on the lambing information was 92% with values of 81.3% for Morada Nova, 100% for Santa Inês and 94.1% for the Brazilian Somali. The percent accuracy in diagnosing animals that were pregnant was 100% over all breeds. The accuracy in diagnosing ewes that were not pregnant was 59.1% over all breeds and varied form 33.3% for Morada Nova, 70% for Brazilian Somali and 100% for Santa Inês.

In conclusion, the correct diagnosis of 92% associated with the simple operating skill necessary, enables the ultrasound technique to be introduced for pregnancy diagnosis in sheep of Northeast Brazil as a routine practice to detect barren ewes and expose them to an alternate management to improve reproductive efficiency.

Influence of First Suckling on
Survivability of Newborn Lambs

This study was conducted at the National Goat Research Center with three breeds of hair sheep (Morada Nova, Santa Inês and Somalis) during two lambing seasons. The main objective of this study was to measure the influence of breed, birth weight, type of birth and sex of lamb on the interval from lambing to first suckling and their influence on survivability.

The analysis of data showed that there is a significant difference ($P<0.01$) among breeds for body weight at birth and the interval from lambing to first suckling. The mean interval from parturition to first suckling was significantly shorter in Morada Nova (22.2min) than in Brazilian Somali (28min) and Santa Inês (41.2min).

The Morada Nova breed had a higher proportion of twinning (1.47) than Santa Inês (1.21) and Brazilian Somali (1.23). Even though the interval from lambing to first suckling in Morada Nova was shorter, the proportion of lamb losses was higher than in Brazilian Somali and Santa Inês. This may be due to the higher incidence of twins and the resulting lower birth weight in the Morada Nova. Within breeds, lamb losses were observed in a higher proportion shortly after birth or at a younger age when the first suckling was delayed compared to those lambs suckled within a shorter interval after birth. Consequently, this information provides a practical application in terms of newborn lamb management to increase the level of survivability and to increase lamb production per ewe lambing.

The relationship between birth weight and the interval from birth to first suckling ($r = -.231$, $n = 226$, $P<0.01$) and the relationship between the interval to suckling and the weaning weight was negative and significant ($r = -.142$, $n = 226$, $P<0.05$).

IN MEMORIUM

Dr. Gerardo Simón Riera Gúzman, co-author of this and two subsequent papers, was killed in an automobile accident in his home country of Bolivia on September 6, 1986. His tenure as an IICA consultant at the National Goat Research Center is remembered for his effective contributions toward the development of research philosophy and organization, as well as leadership in the reproduction area. He subsequently served as a Research Associate Professor at Utah State University, with responsibilities in the SR-CRSP reproduction project. His colleagues regret his untimely death, just as he was resuming a career of service to his native country, where earlier he had served as Executive Director of the Bolivian Institute for Agricultural Technology.

DESCRIPTIVE RESEARCH IN REPRODUCTION AND RELATED PHENOMENA

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ABSTRACT - This paper reports results of research carried out primarily with the producers and also in the Center on reproduction and production in goats and sheep. A high reproduction potential exists in producer goat flocks measured under conditions of traditional management. Production losses occur due to infertility, high abortion rate, high postnatal kid loss and poor growth rate of kids. Reproduction in producer flocks can be increased by introducing improved low cost management practices including weaning, restricted breeding season, navel disinfection, culling of nonproductive breeding stock and selection and/or exchange of breeding males. High incidence of supernumerary teats and moderate incidence of polledness might be related to decreased reproductive performance. Producers respond positively to practices they can apply and observe to be beneficial. Major factors that limit reproduction performance include light weight and delayed puberty, long interval between parturition and the following conception, and kid mortality. Some management practices are not applicable to the needs and resources available to all producers. Detailed quantified information is also presented for each research project and trait studied.

Index terms: Goat, Hair sheep, Reproduction, Production, Management systems.

PESQUISA DESCRITIVA EM REPRODUÇÃO E FENÔMENOS RELACIONADOS

RESUMO - Este trabalho relata resultados de pesquisa obtidos primariamente a nível de produtor e também no CNPC en parâmetros de produção e reprodução de caprinos e ovinos deslanados. Um alto potencial reprodutivo foi encontrado a nível de produtor nas condições de manejo tradicional. Decréscimos no potencial produtivo e reprodutivo ocorrem devido a infertilidade, altas taxas de aborto, altas taxas de mortalidade de cabritos, e baixas taxas de crescimento. O desempenho reprodutivo a nível de produtor pode ser aumentado através da introdução de práticas de manejo de baixo custo, incluindo desmame, monta estacionada, desinfecção do umbigo, descarte orientado e seleção e/ou troca de reprodutores. Uma alta incidência de tetas supranumerárias e moderada incidência de animais mochos podem estar relacionados com o decréscimo no potencial reprodutivo. Os produtores respondem positivamente ao uso de práticas simples no manejo de caprinos que podem ser adotadas com facilidade e proporcionem resposta visível. Dentre os fatores que mais limitan o potencial reprodutivo podem ser incluidos: baixo peso corporal e puberdade tardia, longo intervalo entre o parto e a concepção, e alta

mortalidade de cabritos. Algumas das práticas de manejo recomendadas, entretanto, não são aplicáveis à todos os produtores, e dependem das necessidades e recursos disponíveis. Informações detalhadas de cada projeto de pesquisa e parâmetros estudados são apresentadas.

Termos para indexação; Caprinos, Ovinos deslanados, Produção, Reprodução, Sistemas de manejo.

Introduction

The research included in this paper is that conducted primarily with producers and also in the Center. It describes reproduction and production responses to traditional management practices as well as selected management practices. Although complete control was not possible in all of these studies, the results are interpretable for comparative purposes, to measure general responses and determine the willingness of the producer to trust and apply new practices. In addition, results of some of these studies have provided a useful measure of overall reproduction and production performance for goats and sheep.

General conclusions and recommended alternative management practices for research presented in this and the preceding paper are presented as part of this paper.

The scientists primarily involved in our research are the same as those acknowledged in the preceding paper.

Research Results

On-farm Reproduction and Production Performance of Goats

This study was conducted in five municipalities (Caninde, Independência, Granja, Sobral and Tauá) with two to three flocks in each municipality and a total of 17 farms during a three year period (October 1981 to September 1984). The type of goats were primarily nondescript SRD, but this varied from flock to flock due to the degree of crossbreeding with Nubian or Bhuj goats. One herd in each municipality served as a control flock; it was managed traditionally to establish the constraints and the reproduction and production potential of the goats. Management in the other two flocks was altered, imposing one improved management practice. The fourth flock in two municipalities was altered to include a combination of five improved management practices. The improved management practices were: (1) breeding season limited to October-November; (2) navel disinfection in newborn kids with 10% iodine; (3) directed culling (selection of breeding does, animals discarded based on fertility, health, age, sex and to decrease the stocking rate); (4) yearly exchange of the same type of breeding males (sires) to reduce inbreeding; and (5) weaning of kids at about 120 days of age.

The data collected were: flock structure, frequency of some visible congenital defects, frequency of kidding throughout the year, kidding percentage, type of birth, kidding interval, kidding rate, age at first kidding, mortality rate, interval between parturition and the first postpartum estrus.

The information obtained at the initiation of the study from 4,379 animals (3,371 females and 1,008 males) showed 51.4, 19.0 and 6.5% of adults, yearlings and kid females, respectively. In males, the proportion was 4.04, 13.3 and 5.7% for adults, yearlings and kids, respectively. These data show the low proportion of kids, indicating that a high mortality rate or low fertility rate and/or prolificacy in female goats exists in the flocks (Table 1). Table 1 also shows mean body weights by category. The estimated coefficient of variation indicates that a high variation exists among and within farms. Concerning the incidence of two congenital defects, 29.7% of the animals have supernumerary teats and 9.4% of the animals are polled. The males showed a lower incidence of supernumerary teats and a higher proportion of polledness. Sixteen color patterns and combinations were found in the goat flocks of this project.

Kiddings in Northeast Brazil occur throughout the year, showing that the goats are continuous breeders. Preliminary and partial information shows that 29.2% of the kiddings occur during the wet season and 70.8% occur during the dry season. The overall prolificacy in the five control farms was 1.29 (1712 kids born/1323 kiddings), indicating that 71% and 29% of the kiddings were singles and twins, respect-ively. No variation in prolificacy was found among years (1.30, 1.29 and 1.29 for the first, second and third years, respect-tively), but among farms, the variation was from 1.13 to 1.51. The estimated interval between kiddings was 291.8 ± 78.4 days with a coefficient of variation of 28.6%. This figure indicates that this interval is appropriate and permits the does to kid at least once each year. From this interval, it can also be deduced that the service period is approximately 142 days, and that the postpartum interval is even shorter if repeated matings in some does is expected to occur before conception. The proportion of kiddings varied among years and farms. The sex ratio was 50.8 and 49.2% for males and females, respectively, with no differences were found among farms.

The mean body weights of does at parturition and birth weights of kids are given in Table 2. No substantial variation in birth weights of kids were found between seasons. However, some farms had heavier birth weights than others. This may be due in some degree to crossbreeding with a larger breed. The same effect was observed with weight of does at kidding. However, greater parturition weights were recorded from does kidding multiples (31.9kg) than those kidding singles (27.8kg).

TABLE 1. Mean (± SD) live body weight and proportion of animals by category at the beginning of the project.[1]

Category[2]	N	%	Live Body Weight (kg)	C.V.
Females				
Adults	2,255	51.5	30.6 ± 8.65	28.3
Yearlings	833	19.0	17.2 ± 4.74	27.6
Kids	282	6.5	6.8 ± 3.79	55.7
Subtotal	3,373	77.0	--	--
Males				
Adults	177	4.0	35.8 ± 13.46	36.3
Yearlings	583	13.3	16.7 ± 4.30	25.7
Kids	248	5.7	5.9 ± 3.50	59.8
Subtotal	1,008	23.0	--	--
Total	4,379	100.0	--	--

[1] Total number of animals in 22 farms in 5 municipalities at the beginning of the project before the selection of producer cooperators.

[2] Adults = one year of age or older; yearlings= from weaning age up to one year; kids = from birth to weaning age.

The overall mortality rate was 21.6%. Mortality varied among farms (9.8 to 36.3%). These differences are probably due to the differential management used in each particular farm and also the limited feed resources available for a proper stocking rate. The age of kids at which a major loss occurred was 0-7 and 31-180 days. The incidence of mortality throughout the year is not yet available. However, it can be anticipated that the majority of births occurred during the dry season and kid losses occurred due to deficient lactation of the does. Kid losses at advanced ages (31-180 days of age) might be due to the transition from the dry season, which is characterized by deficient grazing conditions, to the rainy season with the consequent stress on sick and weak goats.

Additional information has shown that some management practices improve reproductive and productive performance. When a restricted breeding period (October-November) was imposed on a private farm, 95.7% of the does were bred with 83% fertility at parturition, 1.1% abortion rate and 3.2% mortality rate from birth to six months of age (Table 3) compared to 92.2, 5.9 and 25.7% fertility, abortion and mortality rates, respectively, in

TABLE 2. Mean live body weights (kg) of does at parturition and kids at birth by farm and season.

Farm	Wt. at Birth of Kids			Wt. at Parturition of Does		
	Dry[1]	Wet	Combined	Singles[2]	Multiples	Combined
Caninde	2.6	2.5	2.6	27.6	31.8	29.7
Granja	2.3	2.5	2.4	24.7	28.0	26.3
Independência	2.8	2.7	2.7	28.1	35.0	31.6
Sobral	2.3	2.4	2.7	31.6	36.9	34.3
Tauá	2.7	2.6	2.7	27.1	27.9	27.5
Mean	2.5	2.5	2.6	27.8	31.9	29.9

[1] Dry and wet season.
[2] Single or multiple parturition of does.

the control farm. Prolificacy was similar in both farms (1.61 vs. 1.59). Additional information on sex ratio, percent of twinning and birth weight of kids is also presented in Table 3.

The practice of weaning is one which showed difficulties in establishing and adoption by the producer because of its limitations in cost and labor. In flocks with some degree of improvement by crossbreeding with dairy goats, the weaning practice induced mastitis, especially during the wet season, characterized by good forage availability and when milk production was the highest. When the weaning practice was applied during the dry season, the problem reversed, and the weaning practice was accepted. This observation truly proves that not all technological recommendations are accepted by the producer, and a technical and economical validation is required before innovative management practices can be recommended for implementation through an outreach program.

Navel disinfection of newborn kids was completely adopted because of its simplicity and low cost, with a surprising efficiency to save kids, reducing mortality especially during the first 30 days of life.

More detailed information will be given after the completion of an MS thesis which is in preparation from this project by an EMBRAPA scientist, José U. Alves, at Santa Maria University.

Length of Estrous Cycle and Period in Sheep

This study was conducted at the National Goat Research Center to evaluate the influence of breed (Morada Nova, Santa Inês and Brazilian Somali), year (1978-1980) and season (dry and wet) on the duration of estrous period and estrous cycle.

TABLE 3. Reproductive performance of goats exposed to a restricted breeding season compared to goats in the control farm (1981 - 1983).

Reproductive Traits	Flock with Breeding Season		Control Flock	
	n	%	n	%
Does exposed to male	187	100.0	204	100.0
Does bred	179	95.7	-	-
Fertility rate	155	82.9	188	92.2
Abortion rate	2	1.1	12	5.9
Kid mortality rate[1]	8	3.2	77	25.7
Kids born	250	100.0	300	100.0
Male	132	52.8	162	54.0
Female	118	47.2	138	46.0
Type of parturition	155	100.0	188	100.0
Singles	62	40.0	88	46.8
Multiples	93	60.0	100	53.2
Kid body wt. at birth (kg)				
Singles	2.30		2.65	
Multiples	2.05		2.35	

[1] Kid mortality from birth to 6 months of age.

All ewes were managed and grazed together in native pasture with water, salt and bonemeal, ad libitum, for a period of three years. Control for internal parasites and vaccinations against foot and mouth disease were also provided.

The dry and wet seasons were arbitrarily established as the periods from July to February and from March to July, respectively.

The ewes were exposed to vasectomized rams continuously for estrus detection and the observations were made in the mornings (6-7a.m.) and in the evening (4-6p.m.) as well as in the field during the grazing hours (7a.m.-4p.m.).

The overall (breed, season, age and year combined) mean duration of the estrous period was 31.3 ± 0.34 (6-96) hours. No statistical differences were found among breeds, years, or seasons, or for the interaction among these variables.

The overall mean estrous cycle length was 18.2 ± 0.1 (7-43) days. It appears to be longer than the majority of literature

reports, which indicate about 16.5-17.0 days of estrous cycle duration. Statistical differences ($P<0.05$) were found among breeds. Morada Nova ewes showed a shorter (17.4 days) estrous cycle than Somali (18.9 days). The length of estrous cycle for Somalis did not differ from Santa Inês ewes, and this breed failed to show significant differences ($P>0.05$) compared to Morada Nova ewes.

The duration of estrous periods and cycles by class intervals are shown in Tables 4 and 5. The majority of the estrous periods (78.6%) were approximately 30 (24-36) hours, and 7.4% and 14.0% were short and long, respectively.

TABLE 4. Overall frequency distribution for estrous periods and estrous cycles in sheep.

Class Intervals	n	%
Estrous Period (hours)		
6 - 18 (short)	66	7.4
24 - 36 (normal)	705	78.6
42 - 60 (long)	115	12.8
60 (longer)	11	1.2
Total	897	100.0
Estrous Cycle (days)		
16 (short)	27	3.7
16 - 19 (normal)	635	88.2
19 (long)	58	8.1
Total	720	100.0

From the overall estrous cycles observed, 3.7, 88.2 and 8.1 percent were classified as short, normal and long estrous cycles. A significant proportion of long estrous cycles of 34 and 35 days were recorded indicating that probably one estrous was missed between two detected estrous periods. Table 5 shows that the Morada Nova breed had a greater proportion of normal length estrous cycles compared to the other two breeds. The Brazilian Somali breed showed a higher proportion of long estrous cycles.

In conclusion, the data indicate that the length of the estrous period was not influenced by breed, year or season. There was statistical difference among breeds for estrous cycle duration. The sheep in Northeast Brazil have the potential to be bred any time of the year, when proper management is provided, indicating that they behave as continuous breeders.

TABLE 5. Frequency distribution for estrous cycles by breed of hair sheep.

Class Intervals (days)	Morada Nova		Santa Inês		B. Somali	
	n	%	n	%	n	%
< 16 (short)	7	2.9	8	3.7	12	4.6
16 - 19 (normal)	233	95.1	189	87.9	213	81.9
> 19 (long)	5	2.0	18	8.4	35	13.5
Total	245	100.0	215	100.0	260	100.0

Postpartum Interval (PPI) in Sheep

This study was conducted at the National Goat Research Center to evaluate the influence of breed, year, type of parturition and age of the ewe on the length of the postpartum interval. All ewes were managed in one flock on native pasture. A total of 279 postpartum intervals were recorded in ewes exposed to teaser rams immediately after the lambing season was initiated.

The overall mean PPI was 65.0 ± 1.42 days. Statistical differences were found among breeds, type of parturition ($P<0.05$) and years ($P<0.01$), and no differences were found among age of the ewes ($P>0.05$). The Santa Inês breed showed statistically longer (77.0 days) PPI compared to Brazilian Somalis (61.9 days) and Morada Nova (65.0 days). Ewes lambing twins returned to the first PP estrus significantly later (72.3 days) than ewes lambing singles (63.7 days). During the year 1982, the ewes showed significantly shorter PPI (53 days) than during 1980 (66.6 days) and 1981 (84.4 days). This performance was probably due to better weather conditions which provided an increased feed availability during the 1982 year.

In conclusion, the Santa Inês breed showed a longer PPI, the Brazilian Somalis a shorter, and the Morada Nova was intermediate. This performance indicates that the shorter postpartum interval in the Brazilian Somali breed may result from better adaptation to the drought conditions of Northeast Brazil.

General Conclusions

1. Some differences occur among genotypes for both sheep and goats. These are primarily related to body size and to ovulation rate.

2. Both male and female sheep and goats breed and are fertile throughout the year. There is no appreciable change in fertility or in ovulation rate.

3. Seasonal differences that do occur in reproduction appear to be due to changes in the availablity of quantity and quality of feed.

4. Increased reproductive performance could likely be achieved by changing management to fit reproduction and production cycles to feed production cycles.

5. The native pasture, under the conditions in which the studies were conducted, appeared to provide at least minimal nutrient requirements for reproduction. Improved nutrition, through supplementation or access to better pasture, would increase performance for some reproduction processes, such as increased growth rate to produce better developed, heavier animals at puberty; improved development of fetus during late gestation; decreased abortion; increased postpartum survival; and improved milk production by the dam during early lactation.

6. Improved nutrition can increase weight at puberty (sheep and goats) of males and females with some reduction in age at puberty, and improve reproductive performance at parturition and postpartum (dam and offspring) in goats.

7. High reproduction potential exists in the producer flocks of goats measured under conditions of traditional management (flock size of 100 to 600). These potentials are not achieved because of inadequate management. Lack of resources to producers often limits their ability to improve management.

- Reproduction and production losses occur due to infertility, high abortion rates, high kid loss (neonatal and later probably associated with feed availability), and poor growth rate of kids.

- Reproduction in producer flocks can be increased by proper use of management practices including early weaning (care must be taken to avoid mastitis in higher lactating dams), restricted breeding season, navel disinfection, culling of nonproductive breeding stock, and selection of breeding males from other flocks.

- Certain traits occurring in producer flocks, such as a high incidence of supernumerary teats and moderate incidence of polledness, may be related to decreased reproductive performance, although exact relationships have not been established. The noted high incidence of divided scrotum might be beneficial; a divided scrotum may improve semen quality and thus affect fertility.

- Producers respond to practices which they can apply and observe to be beneficial.

8. Major factors that limit reproductive performance include light weight and delayed age at puberty, low fertility, and a relatively long postpartum interval.

9. Major factors that are available to increase reproductive performance include year-round breeding by both males and females and reasonably high prolificacy.

10. The average lambing interval measured in some producer flocks is less than once a year but the period from parturition to conception is long under conditions of continuous breeding, indicating reduced fertility.

11. Ultrasound provides an accurate, simple procedure for pregnancy diagnosis as a management tool to improve reproductive performance.

12. Important differences occur among years for all traits measured. The causes for those differences have not been identified but are assumed to relate primarily to variation in climate and to feed quantity and quality availability.

13. The same technology (management practices) cannot apply to all producers. Management practices must be selected to meet the needs and resources of individual producers.

Recommended Alternative Management Practices to Increase Reproductive Performance in Sheep and Goats in Northeast Brazil

The use of these practices depends on the available resources and production constraints to the producer.

1. Develop and adopt some form of record keeping commensurate with resources of producer. If written records are not possible, then marking high producing or low or non-producing animals can be used to introduce a recording system.

2. Restrict the breeding season (i.e. 45 days for sheep and 60 days for goats) to provide a shorter and better managed parturition period.

3. Breed to give birth at an estimated one to two months after the beginning of the rainy season, to take advantage of increased feed for improved nutrition during late pregnancy, growth of offspring, and increased milk production of dam.

4. Wean offspring prior to puberty, select replacement females and place them on the best feed available so they will be larger and better developed for breeding.

5. Separate male offspring from dams, or sterilize, to avoid unplanned matings. Use penis detachment to estimate time to separate (puberty).

6. Obtain breeding males from outside own flock. This will encourage selection of better quality males and eliminate inbreeding.

7. Disinfect the navel. The use of 10% iodine at birth can significantly reduce early post natal loss.

8. Evaluate each animal in the breeding flock each year and remove unhealthy, non-reproducing animals.

9. Check the testicles and penis as well as the general health of breeding males just before the breeding period, to evaluate for potential fertility and breeding problems.

10. Place pregnant females on best pasture available or on supplement during the last one to two months of pregnancy and early lactation.

11. Diagnose for pregnancy. Nonpregnant females can be identified for culling at the most economical time or placed on lower quality pasture. Pregnancy diagnosis can be made using painted teaser males beginning at the end of the breeding season (or painted fertile males during the breeding season) or by use of ultrasound equipment (i.e. as a service by the EMATER) at about 60 days after the end of the breeding period.

12. If production of offspring more frequently than once a year is profitable, planned periods of breeding should be established to shorten the parturition interval and take advantage of annual feed production cycles.

BREEDING SEASON EFFECTS ON REPRODUCTIVE PERFORMANCE, BODY WEIGHT AND MILK PRODUCTION OF NATIVE GOATS GRAZING CAATINGA RANGE IN CEARÁ

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ABSTRACT - Fifty-four native does were used in a study to evaluate the effect of breeding season on reproductive performance, body weight and milk production. The treatments (TRT) were as follows: (A) half the does were randomly assigned to the October 1983 breeding season (mid-dry season); (B) the other half to the January 1984 breeding season (early wet season, considered traditional). The kidding seasons were in March (mid-wet season) and June (mid-dry season) for TRTs (A) and (B). TRT (A) had a greater mean maximum weight gain than TRT (B), 2.4 vs 0.4kg ($P<.05$) and also a lower mean maximum weight loss, -3.8 vs -8.4kg ($P<.01$). Kidding rate was higher ($P<.05$) for TRT (A) than TRT (B), 1.7 vs 1.3 kids/doe. Mean total milk production for TRT (A) was higher ($P<.01$) than for TRT (B), 55.8 vs 22.9 kg/head/lactation. This result can be attributed to lactation length, 7 vs 4 months for TRTs (A) and (B), because there was no difference ($P>.05$) in the mean individual production/day between the two breeding groups, 0.30kg vs 0.27kg for TRTs (A) and (B).

Index terms: Goats, Semi-arid tropics, Breeding season, Milk production, Native range.

O EFEITO DA ESTAÇÃO DE MONTA SOBRE COMPORTAMENTO REPRODUTIVO E PONDERAL E PRODUÇÃO DE LEITE DAS CABRAS NATIVAS NA CAATINGA CEARENSE

RESUMO - Um ensaio utilizando 54 cabras das raças nativas e SRD foi desenvolvido para avaliar-se o efeito da estação de monta no comportamento reprodutivo e ponderal e na produção de leite. Os tratamentos (TRT) foram os seguintes: (A) a metade das cabras escolhidas ao acaso foram cobertas em out. 1983 (época seca); (B) a outra metade em janeiro 1984 (época chuvosa, considerada tradicional). As parições ocorreram em março (época chuvosa) e junho (época seca) para TRTs (A) e (B). TRT (A) teve uma média de ganho de peso máximo maior do que TRT (B), 2.5 vs .4kg ($P<.05$) e uma média de perda de peso máximo menor, -3.8 vs -8.4kg ($P<.01$). TRT (A) teve mais cabritos/cabeça do que TRT (B); 1.7 vs 1.3 ($P<.05$). TRT (A) produziu, em média, mais leite total ($P<.01$) do que TRT (B), 55.8 vs 22.9 kg/cabeça/lactação. Este resultado pode ser atribuido a duração de lactação porque não houve uma diferença ($P>.05$) na média da produção individual/dia, 0.30 vs 0.27kg para TRTs (A) e (B).

Termos para indexação: Caprinos, Trópico semi-árido, Estação de monta, Produção de leite, Caatinga nativa.

Introduction

Goats, widely distributed throughout tropical semi-arid Northeast Brazil, contribute significantly to the subsistence smallholders' farm income and ecomonic security, especially in the harsh interior (sertão). Native range (caatinga) is commonly the sole source of forage to which these animals have access (Gutierrez et al., 1981; Neumaier, 1986; Primov, 1982). One consequence of the highly seasonal rainfall in this region is a pronounced annual fluctuation in the quality and quantity of the caatinga feed supply. The adverse effects of the precipitous dry season decline in forage available to grazing stock have been documented by EMBRAPA. High kid mortality, one of the most crucial dry season losses, results from several factors. Two important ones are low birth weights and insufficient milk production by the dam, both of which are related to year-round maternal nutritional plane (Bellaver et al., 1979; Figueiredo et al., 1980a and 1980b; Melo Lima et al., 1983; Morand-Fehr & Sauvant, 1980; Nunes & Simplicio, 1980; Sachdeva et al., 1973; Shelton, 1978).

Improved goat performance in the sertão must therefore be oriented towards improving the year-round nutrient supply. One such strategy is to manipulate the production cycle by changing the breeding season so that periods of physiological stress, hence high nutritional demand, coincide with periods of maximum forage supply. This could be a means of more efficiently utilizing the existing yearly fluctuations in forage availability without depending on costly supplementation schemes. Although early pregnancy would coincide with the dry season, this phase of gestation does not carry a greater nutrient requirement than maintenance in goats (NRC, 1981). EMBRAPA researchers have proposed a mid-dry season breeding corresponding to a mid-wet season kidding in order to maximize potential kid production (Figueiredo et al., 1980b; Nunes & Simplicio, 1980). This system opens an avenue for increasing length of lactation as well, by allowing for kidding 3 months earlier in the year.

The objective of this study was to investigate the effects of changing the breeding season on milk production and reproductive performance.

Methods

Fifty-four native does were assigned randomly to treatments (TRT) as follows: (A) 28 to the October 1983 breeding season (mid-dry season); (B) 26 to the January 1984 breeding season (early wet season, considered traditional). TRT (A) received an energy flush (100g maize/head/day) during the breeding season in order to insure an adequate conception rate during the dry season. TRT (B) did not receive a breeding flush and neither group received supplementation during lactation. The kidding seasons were in March (mid-wet season) and June (early dry season) for TRTs (A) and (B). The does were weighed once per

week over the duration of the trial and milked 2 times/day, 3 days/week from parturition until the following October 1, 1984, which resulted in a lactation length of 7 months for TRT (A) and 4 months for TRT (B). Data on breeding and kidding performance were also collected.

Results and Discussion

As can be seen in Table 1, TRT (A) had a lower kidding percentage than TRT (B); 57 vs 69%. However, there was an apparent breed/TRT interaction in that the October Marota does had a 17% kidding rate compared to 71% for the January does. This difference alone accounted for the apparently different overall mean kidding percentages. When the data for the Canindes and SRDs were combined within TRT, the kidding rate was 68% for both TRTs (A) and (B).

TABLE 1. Kidding performance of experimental does.

	OCTOBER - TRT (A)			JANUARY - TRT (B)		
BREED	Bred	Kidded	%	Bred	Kidded	%
Caninde	15	10	67	13	10	77
SRD	7	5	71	6	3	50
Marota	6	1	17	7	5	71
TOTAL	28	16	57	26	18	69

Total offspring born (Table 2) did not appear to differ between TRT (A) and TRT (B), 27 vs 24 kids. However there was a higher percentage of twin births in TRT (A) than TRT (B), 69 vs 33%, or 1.7 vs 1.3 kids/doe, (Table 3) ($P<.05$). The higher twinning rate in the October does may be due to the energy flush, a practice which is known to increase ovulation rate in sheep (NRC, 1985). Table 4 shows that there were significant differences between the TRT groups in mean maximum weight gain and weight loss. Using kidding weight as the basis of calculation, the January does, when compared to the October does, gained 84% less weight, .4 vs 2.5kg, ($P<.05$) and lost 220% more weight, 8.4 vs 3.8kg, ($P<.01$) between parturition and their subsequent breeding season.

Table 5 shows that there was no significant breeding season effect ($P>.05$) for either mean individual daily milk yield or mean peak milk yield. There was, however, a highly significant difference ($P<.01$) in mean total lactational yield per doe, 55.8 vs 22.9kg for TRTs (A) and (B), respectively. The higher production for TRT (A) compared to TRT (B) is due to their longer lactation interval, 7 vs 4 months.

TABLE 2. Birth record: single vs. twin births.

	OCTOBER - TRT (A)				JANUARY - TRT (B)			
BREED	Single	Twin	Total	% Twin	Single	Twin	Total	% Twin
Caninde	4	6	10	60	6	4	10	40
SRD	1	4	5	80	2	1	3	33
Marota	0	1	1	100	4	1	5	20
TOTAL	5	11	16	69	12	6	18	33
TOTAL KIDS	5	22	27		12	12	24	
% Twin Kids				81.5				50.0

TABLE 3. Comparison of single vs twin frequencies by kidding season.

Kidding Season	Total Births	Mean Kids/Doe	SD
March 1984	16	1.7[a]	.5
June 1984	18	1.3[b]	.5

a,b - Difference is significant (P<.05).

TABLE 4. Comparisons by treatment group of doe body weight changes (kg) between parturition and subsequent breeding season.

Maximum Weight Gain	n	Weight Change (kg)	SD
October - TRT (A)	13	2.5[a]	2.6
January - TRT (B)	15	0.4[b]	2.8
Maximum Weight Loss			
October - TRT (A)	13	-3.8[c]	1.9
January - TRT (B)	15	-8.4[d]	2.1

a,b Difference is significant (P<.05).
c,d Difference is significant (P<.01).

TABLE 5. Comparisons of mean milk production by breeding season.

PRODUCTION	n	Milk Yield	SD
Individual Daily (g)			
October - TRT (A)	15	309.3	94.0
January - TRT (B)	15	270.0	106.6
Peak Daily (g)			
October - TRT (A)	15	624.2	193.0
January - TRT (B)	15	507.8	202.9
Total/Doe/Lactation (kg)			
October - TRT (A)	14	55.8[a]	15.0
January - TRT (B)	14	22.9[b]	9.3

a,b - Difference is significant ($P<.01$).

Conclusions

The TRTs did not appear to affect birth rate except for the Marota breed. The higher twinning rate for TRT (A) is likely due to the energy flush which was provided to overcome possible difficulties with conception rate in the dry season. The differences in body weight changes between the breeding seasons were striking. The October group lost an average of 3.8kg primarily in early lactation, which they completely recovered by the following breeding season. The January does lost an average of 8.4kg mostly during the dry season after they had completed their lactation and were, therefore, in much poorer condition for the next breeding period. It appears that due to the longer lactation interval, an October breeding season favors a larger total milk yield than can be obtained using the traditional January breeding season. Since the January group, although not lactating, was unable to meet their nutrient requirements for maintenance during the dry season, it seems unadvisable to attempt to maintain lactation during this period, unless a high level of supplemention can be provided.

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FEEDING TO INFLUENCE AGE OF PUBERTY IN MORADA NOVA SHEEP

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ABSTRACT - Tropical hair sheep (Morada Nova breed) were utilized to study the effect of energy intake on age and weight at puberty. Twenty-four ewe-lambs, 140 ± 1.2 days of age and weighing 12.5 ± .25kg, were assigned to receive 50, 200, 350 or 500g of maize grain per day (T1, 2, 3 and 4, respectively) along with 150g of cottonseed cake and a ground maize stover/cob mixture ad libitum. Between the beginning of the experiment and first estrus, one lamb was removed from T3 and one from T4 due to rumen disorders. Also, one lamb from T1 was removed for reasons not related to experimental treatments. The remaining 21 lambs gained at rates of 42 ± 6, 49 ± 5, 60 ± 8 and 74 ± 9g.day^{-1} for T1, 2, 3 and 4, respectively. First estrus, detected by vasectomized rams, was displayed at 283 ± 13, 294 ± 15, 310 ± 16 and 266 ± 16 days of age and 19.1 ± 1.2, 20.6 ± 1.2, 23.4 ± 2.0 and 20.8 ± 1.4kg of weight for the 4 treatment groups. Treatment differences were not significant (P>.05) for age or weight at first estrus. Performance of Morada Nova ewe-lambs in this experiment indicates that post-weaning feeding should provide for average daily gains within the range of 35 to 75g.day^{-1}; that animals thus fed will display first estrus at 260-320 days of age (irrespective of weight) or at 18-22kg weight (irrespective of age); and that a higher energy intake level will not accelerate age of first estrus.

Index terms: Hair sheep, Semiarid tropics, Energy supplementation, Growth rate, Age at puberty.

ALIMENTAÇÃO PARA INFLUENCIAR A IDADE DE PUBERDADE NOS OVINOS TROPICAIS SEM LÃO.

RESUMO - Foram utilizados ovinos tropicais sem lão da raça Morada Nova para estudar o efeito de consumo de energia na idade e peso na puberdade. Vinte e quatro cordeiras, 140 ± 1.2 dias de idade e 12.5 ± .25kg de peso, foram designados para receber 50, 200, 350 ou 500 g/dia de farelo de milho (T1, 2, 3, 4, respectivamente) juntamente com 150g de torta de algodão e uma mistura moída de restolho e sabugo de milho, ad libitum. Entre o começo do experimento e primeiro estro, uma cordeira foi removido do grupo T3 e uma do grupo T4 devido à desordems no rúmen. Também uma cordeira foi retirado do grupo T1 por razões não relacionadas ao tratamento experimental. As 21 cordeiras que permaneceram ganharam peso a taxas de 42 ± 6, 49 ± 5, 60 ± 8 e 74 ± 9 g.dia^{-1} por T1, 2, 3 e 4, respectivamente. O primeiro estro, detectado por rufiões, foi manifestado na idade de 283 ± 13, 294 ± 15, 310 ± 16 e 266 ± 16 dias e ao peso de 19.1 ± 1.2, 20.6 ± 1.2, 23.4 ± 2.0 e

20.8 ± 1.4kg para os 4 grupos. Diferenças entre grupos de tratamento não foram significativas (P>.05) por idade ou peso no primeiro estro. O desempenho das cordeiras Morada Nova neste experimento indica que a dieta pós-desmame deve prover uma média de ganho diário entre 35 e 75 $g.dia^{-1}$; que animais alimentados desse modo apresentarão primeiro estro aos 260-320 dias de idade (independente de peso) ou aos 18-22kg de peso (independente de idade); e que um consumo maior de energia não vai acelerar o aparecimento do primeiro estro.

Termos para indexação: Ovinos sêm lão, Trópico semiárido, Suplementação de energia, Taxa de crescimento, Idade na puberdade.

Introduction

The economic return to a sheep production enterprise depends on several factors: genetic capacity of the breed used, the level of management and nutrition imposed relative to the genetic capacity, and costs of major inputs such as feed. For replacement breeding females the age at which puberty (first estrus) is attained is an important determinant of the ewe's overall lifetime productivity and return above cost of rearing.

Under normal caatinga conditions ewe-lambs of tropical hair breeds born at the beginning of the rainy season do not gain sufficient weight for breeding by the end of the subsequent dry season. Consequently lambs are bred either at a less than desirable weight, or so long after the rainy season starts that they will lamb in the middle of the next dry season. Either option causes productivity to be lower than genetic potential.

At tropical latitudes photoperiod is not a factor in determining the reproductive cycle of sheep (Dyrmundsson, 1973). This makes the level of feeding and management all the more important as an influence on onset of puberty (Allen & Lamming, 1961) by facilitating an adjustment of the breeding calendar to best take advantage of natural cycles in feed availability.

With these factors in mind the present experiment was designed to test the effect of four levels of post-weaning energy intake on growth and the subsequent age and weight at puberty (defined as first manifest estrus) of Morada Nova ewe-lambs raised in confinement during the dry season, in Sobral.

Materials and Methods

At the National Center for Goat Research (CNPC), where this experiment was conducted, normal maximum and minimum monthly temperatures are 35 and 22°C, with little yearround variability. Mean precipitation is 759mm per year, usually falling entirely within the period of January to May.

Twenty-four Morada Nova ewe-lambs which had been weaned at about 112 days of age were assigned randomly to one of the four experimental diets shown in Table 1. In addition to these diets all animals were offered a mixture of ground maize stover (70%)

TABLE 1. Composition of post-weaning supplemental diets fed to experimental Morada Nova ewe-lambs.

Item	Diet no. 1	2	3	4
	per animal, per day			
Cottonseed cake, g	150	150	150	150
Ground maize grain, g	50	200	350	500
Total concentrate offered, g	200	350	500	650
Digestible protein[a], g	33	43	53	63
Metabolizable energy[a], Mcal	0.7	1.2	1.7	2.3

[a]Estimated from published values (National Research Council, 1975).

and ground maize cobs (30%), ad libitum. Animals were penned in groups of three, and received water and a common salt-bone meal mixture ad libitum. Their initial age and weight were 140 ± 1.2 days and 12.5 ± .25kg. Animals were weighed every 28 days; individual growth rates were estimated by linear regression of weight as a function of age between the beginning of the experiment and the first weight after first overt estrus. An estimated weight at first estrus was calculated for each lamb with these regression coefficients, except for two lambs whose calculated weights seemed too deviant from actual weights recorded on the day following first estrus, and for which actual weights were thus used. Estrus was detected by exposing all lambs twice daily to teaser rams; lambs in estrus were bred to intact rams. Pregnancy was diagnosed by laparotomy at 35 days following last breeding.

One animal was removed from each of groups T3 and T4, due to rumen disorders which may have been related to high levels of starch intake. From group T1, one animal was removed due to a problem not related to the experiment. Weight gains and first estrus data for the remaining 21 lambs were analyzed in a completely randomized design (Steel & Torrie, 1980) with three degrees of freedom for treatments and 17 for residual effects. Intake data for pen groups were analyzed in the same design, with four residual degrees of freedom. Duncan's multiple range test was used to compare means among dietary treatment groups.

Results and Discussion

Over the 20 weeks of the experiment, total dry matter intake (DMI) was 61 ± .9g per kg metabolic weight (MW) per day. The mean for T3 was higher (64.5g, P<.05) than for the other three diets (60.2, 59.1 and 59.4g for T1, 2 and 4). DMI was similar to that reported for Barbados Blackbelly (a tropical hair breed) X Dorset and/or Suffolk wether lambs consuming wheat straw with up to 65% concentrates (Brown & Johnson, 1985) or coastal bermudagrass or fescue hay (Luginbuhl & Johnson, 1982). Growing lambs of a tropical breed in Indonesia, however, were reported to consume 79 g DM/kg MW when offered green forages and crop foliages (Haryanto et al., 1982). And in Brazil, Morada Nova wethers similar in weight to the ewe-lambs in the present study consumed about 90g DM/kg MW per day when offered a diet with 50% maize crop residue (Oliveira et al., 1982).

The maize crop residue portion of the diet, offered ad libitum, was consumed in decreasing amounts (P<.05) as concentrate intake increased (Table 2). The net effect was to shift the roughage/concentrate ratio from 62/38 for T1 to 38/62, 24/76 and 19/81 for T2, 3 and 4. For the latter three diets, refusals of concentrate measured 3, 8 and 30% of the amounts offered.

Total daily DMI per pen increased as the animals grew, for T1, 2 and 3. However, for the highest concentrate diet (T4) daily DMI was lower during the final weeks of the experiment than at the beginning. For all treatments, when DMI was corrected for body weight or MW it was lower in weeks 13-20 than in weeks 1-12 (Table 2). There was a reversal of treatment effects in these two sub-periods: during weeks 1-12, groups T3 and T4 consumed more (P<.05) than groups T1 and T2; but during weeks 13-20, group T4 consumed <u>less</u> (P<.05) than the other three groups.

Average daily gain responded (P<.05) to the increased energy concentration of the diets consumed (Table 3). The highest rates of gain, 60 and 74 g/day on diets 3 and 4, were still considerably lower than those reported by Oliveira et al. (1982) for Morada Nova wether lambs.

In spite of faster rates of gain for the animals which consumed more energy, average ages and weights at puberty were not significantly different for the four dietary groups (Table 3). Regardless of dietary treatment, all lambs except two (one each from treatment groups 1 and 4) had achieved at least 18kg body weight before first display of estrus, and all lambs except a different two (again, one each from groups 1 and 4) were at least 260 days old by first estrus. These results could be interpreted to define the minimum age and weight for puberty in sheep of this breed (when exposed daily to a ram). By the same token all but one of the lambs of the lower dietary energy treatments (groups 1 and 2) manifested first estrus before reaching 320 days of age and 22kg weight, which could be interpreted as defining the upper limits for optimal ranges of

age and weight for first estrus. All but one lamb of these two groups gained at least 35 but not more than 62 $g.da^{-1}$.

TABLE 2. Feed intake by experimental animals.

Item	Diet no. 1	2	3	4
	per animal, per day			
Concentrate offered, g	200	350	500	650
Concentrate refused, % of offered	0	3	8	30
Dry matter intake, g				
Concentrate	182	304	414	408
Roughage	298^{a}	189^{b}	133^{c}	94^{d}
Total	480^{a}	493^{a}	547^{b}	502^{a}
DM intake, % of body weight				
Wk 1-12	3.1^{a}	3.1^{a}	3.5^{b}	3.4^{b}
Wk 13-20	2.9^{a}	2.7^{a}	2.7^{a}	2.2^{b}
DM intake per $W^{.75}$				
Wk 1-12	62^{a}	61^{a}	70^{b}	68^{b}
Wk 13-20	58^{a}	56^{a}	57^{a}	47^{b}

[abcd]Means in the same row not followed by the same letter are different ($P<0.05$).

Lambs receiving the higher dietary energy treatments (groups 3 and 4) generally did not display first estrus any earlier than those in groups 1 and 2. On the contrary, there was a tendency (non-significant) for first estrus to occur at an age older than 320 days (two lambs of group 3) or at body weights higher than 22kg (five lambs or 50% of groups 3 and 4).

All lambs became pregnant after 1 or 2 services; only 5 of the 21 lambs required a second service, and this requirement was independent of dietary treatment (Table 3).

We conclude from these results that Morada Nova ewe-lambs, if fed to achieve post-weaning daily gains of at least 35 but not more than 60g, and exposed to a ram, will reach puberty (first estrus) at 18-22kg body weight or at 260-320 days of age. Increasing the energy concentration of the diet to the point where average daily gain exceeds 60g is probably uneconomical as a feeding practice.

TABLE 3. Weight gains and age and weight at first estrus for experimental Morada Nova ewe-lambs.

Item	Diet no. 1	2	3	4	Overall mean ±SE
Starting age, da[a]	136	138	141	144	140 ± 1.2
Starting weight, kg[a]	12.8	12.5	12.3	12.2	12.5 ± .25
Weight gains, g/da[b]	42[c]	49[cd]	60[cd]	74[d]	56 ± 4.2
Age at 1st estrus, da[b]	283[c]	294[c]	310[c]	266[c]	288 ± 7.8
Wt at 1st estrus, kg[b]	19.1[c]	20.6[c]	23.4[c]	20.8[c]	21.0 ± 0.8
No of lambs pregnant[b], conceived at:					
1st service	4	5	4	3	
2nd service	1	1	1	2	

[a]n=6 for all treatments.
[b]n=5 for treatments 1, 3 and 4; n=6 for treatment 2.
[cd]Means in the same row not followed by the same letter are different ($P<0.05$).

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III. PESQUISA SOBRE A TRANSFERENCIA E ADOÇÃO DE NOVA TECNOLOGIA

III. RESEARCH ON TRANSFER AND ADOPTION OF NEW TECHNOLOGY

SOCIOLOGICAL ASPECTS OF PEASANT PRODUCTION IN PARAÍBA: SUGGESTIONS FOR A PEASANT-ORIENTED RESEARCH AND EXTENSION GOAT PRODUCTION PROGRAM

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ABSTRACT - The major purpose of this paper is to emphasize the need for a thorough understanding of the peasantry's nature and strategies for household survival and reproduction, as a means to develop realistic peasant-oriented research and extension programs. The research was conducted in two countries of the Cariris Velhos semi-arid microregion, Soledade and São João do Cariri, in the state of Paraíba. A total of 43 (forty-three) peasants were interviewed between October 1982 and March 1983. Suggestions are made for the development of a methodology for the characterization of both the peasant total production systems, their goat production strategies, and the integration among researchers, extensionists, and the small farmers.

Index terms: Goats, Sociology, Peasants, Research and extension programs.

ASPECTOS SOCIOLÓGICOS DE PRODUÇÃO DO CAMPESINATO EM PARAÍBA: SUGESTÕES PARA UMA PROGRAMA DE PESQUISA E EXTENSÃO DE CAPRINOCULTURA ORIENTADO AO CAMPESINATO

RESUMO - O principal objetivo deste trabalho é enfatizar a necessidade de um profundo conhecimento da natureza e das estratégias adotadas para a sobrevivência e reprodução do campesinato, como meio para o desenvolvimento de programas realistas de pesquisa e extensão orientados aos pequenos agricultores do Nordeste semi-árido do Brasil. A pesquisa foi realizada em dois municípios da micro-região semi-árida de Cariris Velhos: Soledade e São João do Cariri Paraíba). Um total de 43 agricultores foram entrevistados durante o período de Outubro de 1982 a Março de 1983. Sugestões são feitas para o desenvolvimento de uma metodologia para a caracterização e análise dos sistemas de produção camponeses locais e das estratégias utilizadas na caprinocultura, assim como para a integração entre pesquisadores, extensionistas e pequenos agricultores.

Termos para indexação: Caprinos, Sociologia, Campesinato, Programa de pesquisa e extensão.

Introduction

Modern agricultural technology is often considered a means for introducing changes in rural social relations of production for the eventual improvement of the quality of life of saml1

producers. However, modern technology will not necessarily be adopted by small farmers, nor will it necessarily improve the quality of life of those who adopt them. It might, nonetheless, provide the means for social changes to occur in rural social relations of production.

The fact that low-income small farmers in developing countries have not had access to modern technologies, or that in those cases where they have adopted some of these technologies this has not contributed to improving farmers' appropriation of benefits, has become a society-wide concern. While much technology is theoretically scale neutral, access to all the elements of the technology packages may be unevenly distributed.

Research and extension agencies in Brazil have become increasingly aware of the need to develop socially appropriated technologies, as well as of the need to a new approach concerning the diffusion of technologies. In fact they have become increasingly aware that small farmers present crucial differences as compared to medium and large farmers and that, as such, there is a need to develop a new methodology to approach this category. Such a need emerged from the following set of problems: (a) the available human and financial resources are not sufficient to deal with the magnitude of problems faced by low income small farmers; (b) these resources are not sufficient to reach the large numbers of these farmers; and, (c) the level of integration among researchers, extensionists, and small farmers is low.

It is our understanding that the above problems have led to two main issues. First, that it is crucial that both government institutions and the small farmers themselves become jointly involved in identifying problems, as well as in deciding on the best ways to solve them. Second, that it is also important that emphasis is placed on understanding the complexity of small farm production systems as a whole, as well as on understanding these systems' relation to other sectors of society. This can only be done if there is a shift from the analysis of products to the analysis of production systems.

This paper has two main objectives. First, to present some of the research results obtained from a study on peasant goat production in Paraíba. Second, to contribute to the development of a methodology which might lead to a better understanding of small farm goat production in the Northeast, within a broader context of total production systems.

Literature Review

Understanding the total production system is a means to increase the chances that technological innovation will be adopted and will have positive overall consequences on small farm production units. As such, the starting point for this kind of

analysis is to understand peasant nature and strategies for survival.

Deere & De Janvry (1979) show that the nature of peasant production lies in three main elements: the predominance of economic calculations primarily for simple reproduction rather than for profit, the predominance of unpaid labor, and the production of commodities with the ultimate goal of household consumption. Peasant production units are also characterized by a partial integration to the market (Friedmann, 1980), and such an integration is greatly influenced by household needs for cash. Furthermore, peasants do not as rapidly respond to changes in market prices as capitalist producers, since their strategies for survival are the outcome of long-term adaptations to local ecological, socio-economic and political situations which are highly variable from year to year.

Increasing productivity might not be a priority on the small farmer point of view, since this might involve either a much higher demand for labor, capital, land, or still a greater integration with the market. Considering that most commercialization channels to which small farmers have access, are the main constraints to the farmers appropriation of value, a greater market integration might lead to a greater dependence on commercial capital.

Starting peasant production analysis with the analysis of a particular line of production allows for the identification of the resources, types of technology, and level of organization which will be required for production (Saint, 1977). While assessing the role of a particular product within the total production system, it is crucial to also assess the potentials and constraints to increase its productivity.

The concept of the dialectical relationship between livestock and crop production is particularly relevant in this sense. It allows for the determination of the integrative and the non-integrative factors among all products in terms of land, labor and capital allocation. It has been found, for instance, that in areas of short supply of land, intensified animal production ultimately implies a conflict between human and animal needs.

The importance of understanding both the dialectical relationship among different crops and livestock, and the external relations of peasant producers is also stressed by Galina & Juarez (1982). They reported that the Mexican State dairy goat development project for the ejidos largely failed, since the recommended crop for improving goat nutrition (alfalfa) competed with cotton for irrigation. Since cotton was an important cash crop for the local small farmer, alfalfa was not given enough water and could not, therefore, contribute to a significant improvement in goat milk production. As the ejidos milk production increased, the prices fell; the banks did not

provide enough credit and the coopertives ran out of money to support the activity.

These examples support the fact that technological innovation by small farmers is neither easily accepted as a priority, or successful, when small farm development programs are not based on a thorough understanding of both the peasant total production systems and the peasant position and relations to the larger society.

Methodology

The sample consisted of 43 (forty-three) resident-owner small producers, and was selected by means of a strategy of purposive sampling. All of the producers owned goats and a maximum of 150ha of land. The number of cases within each of the farm size categories was proportionate to their approximate percentage in the counties. This yielded 30 (thirty) cases for farms of the less than 50ha category, 7 (seven) for those of the 51-100ha farms, and 6 (six) for those of the 101-150ha. Twenty-five of these producers were in Soledade, and 18 (eighteen) in São João do Cariri, state of Paraîba.

Farmers were interviewed individually at their farms, between October 1982 and March 1983, by means of two kinds of questionnaires. Data collected in this study provided the basis for the identification of the elements to be considered in developing a methodology for dealing with peasant goat production in the Northeast.

Research Results and Conclusions

Research results are presented in three sections. First, results concern the local peasants' nature and strategies for survival by means of an analysis of the total production systems. Second, the results concern the level of technology utilized in goat production, as well as the kind of community organization under which goats are raised. And, third, the results show the constraints and potentials to increase small farm goat and goat by-products production and commercialization.

Small Farm Nature and Strategies for Survival

The local peasant households are composed primarily of nuclear families who are the main suppliers of labor for the production unit. Family labor produces both use and exchange values. Neither kinship or friendship ties provide significant levels of reciprocal labor. Instead, most producers (63 percent) reported hiring wage labor occasionally. Hiring wage labor was not related to farm size. It was, on the other hand, determined by household composition (age and gender), cash availability, and levels of labor demand.

Producers who hired wage labor occasionally, as well as those who didn't hire any labor also occasionally worked for wages. This was particularly relevant during the dry seasons, when jobs were more easily found whether at the drought relief government programs, or at the larger farms (making fences, cleaning water ponds, etc.).

Land ownership seemed to be largely related to the previous generation's ability to own land, since 43 percent of the farms were obtained by inheritance alone, 26 by both inheritance and purchase, whereas only 30 percent obtained land by purchase only. On the other hand, land concentration by large landowners does not seem to be in progress in these counties, since 57 percent of the farms had remained the same size since they were first bought, and the other 43 percent had in fact increased in size.

The number of goats per farm was not related to farm size. Both the largest and the smallest herds (200 and 7 goats, respectively), for instance, were found within the less than 50ha farms. It was, however, determined by three factors: topography, size of surrounding farms and extent of fencing. The "serras," the areas in which small, medium and large farms are concentrated, and those areas with low levels of fencing, were considered the most appropriate sites for goat production.

Farm size categories below 150ha was not a determining factor to the production and commercialization strategies adopted by these farmers. Cotton is the only crop grown exclusively for the market. Cattle, sheep and goats are primarily raised for sale, even though they can eventually be utilized for home consumption. Corn, beans, swine and poultry, are primarily for subsistence, although they might be occasionally sold.

Livestock is considered the single most important source of income by 39 percent of the producers. Thirty-eight percent considered both crops and livestock as equally important. The relatively higher importance of livestock as compared to crops is due to five main reasons. First, the high levels of weather variability in the region makes crop production activity which can be disposed more often. Thirdly, since crop products are mainly oriented towards household subsistence, medium and large livestock can be more oriented towards sale. Forth, livestock market demand allows the peasant household to obtain cash whenever needed. And, fifth, the extensive livestock management systems adopted involve the minimization of risks due to the low costs of production, and to the maximum utilization of the available resources.

Level of Technology and Community Organization Concerning Goat Production

The level of technology utilized in crop and livestock production is one indicator of the degree to which small farmers have access to other sectors of society, as well as to the format it takes. As a general rule, the small farmers interviewed

utilize technologies which allow them to make the best use of the available resources and also allow them to be relatively independent of market forces.

The importance attached to goats can be assessed by the fact that 56 percent of the farmers interviewed would rather improve the quality of the goat herd alone, and 35 percent would improve both the goat and sheep herds, particularly through improvements in health and nutrition. Furthermore, 43 percent would rather increase the number of goats alone, and 26 percent would increase the number of both goats and sheep.

Although the above data could support the argument that since producers are willing to both improve and increase their goat herds they would be willing to adopt technological innovations; another set of data provide some clues on what kind of technologies these farmers would be willing to adopt. As such, 74 percent of all producers agreed that goats are the easiest animals to raise; all of them agreed that goats are raised because of the extremely low levels of labor and capital required for production; and, 61 percent agreed that they are easy to sell.

Since the advantages of raising goats are primarily that they are easy and cheap to raise, and easy to sell, technological innovation should involve low cost, low labor techniques, and should make it easier to increase goat herds. Increasing goat herds is likely to improve small farm production and reproduction activities since the flow of cash is likely to also increase.

The management system utilized in goat production is land extensive. By and large goats graze both on native vegetation (open caatinga) and on crop residue. Only 9 percent of the farmers reported cultivating pasture. Corn is the only supplemental feeding provided, mainly given to kids and lactating does. The producers' rationality is that goats must be raised free, can live on their own, and "acquire and transmit disease when confined." Goats are only confined in the evenings, in roughly built facilities. Confinement is a means to prevent theft and loss from predators rather than a technique to improve health conditions. Full-time confinement occurs only for lactating does, a technique utilized by 74 percent of the farmers interviewed, and for kids, by 61 percent.

Seventy-seven percent of the producers reported that diseases were the main problem in goat production. The main health problems identified were Caseous-lynphadenitis, in 78 percent of the herds; endoparasites, in 48 percent; and, ectoparasites, in 22 percent of the herds. Very few producers provide proper health care to the goat herds. The main reasons are that they do not know which medicine to buy, that the prices are high, and that medicines are seldom found at the village.

The second major problem identified was goat trespassing (for 63 percent of the producers). Goat trespassing involves two

aspects. First, trespassing to the neighbors' fenced crop plots. Fencing crop plots is an old time tradition in the area, since it is much cheaper to fence small plots than the whole farm.

The second aspect concerning goat trespassing is related to the recent changes in the area, which are characterized by a tendency for medium and large farmers to intensify livestock production by means of cultivating pasture, growing algaroba, and fencing the whole farm. The impact on small farm livestock, and particularly goat production, is that the amount of common grazing land available has decreased significantly. Most of the producers interviewed said that, in the future, the only ones to raise goats will be the medium and large farmers.

The overall characteristics of these two counties, therefore, seem to indicate that although land concentration has not occurred, the process of increasing fencing is likely to cause the same kind of constraints on peasant livestock production as if it were occuring. The foreseen consequences are, on the one hand, a greater difficulty for peasants to obtain cash through the sale of the product which is the most adapted to those harsh ecological conditions. On the other hand, a decrease either of the number of livestock raised by small farmers, or a decrease in the area utilized in crop production, as part of the land now utilized in crop production might be needed to grow pasture.

Constraints and Potencials to Increase Small Farm Goat and Goat By-products Production and Commercialization

Increasing small farm goat production in these counties seems to be a real possibility, since most producers would rather increase the number and the quality of these herds as compared to the others. Furthermore, there is a constant market demand for goat meat, hide, and cheese, both at the village level and at the larger urban centers such as Campina Grande, João Pessoa, and Recife.

Due to the fact that very few families had the habit of milking the goats, and also due to the fact that goats are sold alive, we suspected that most producers would consider raising goats for meat as more profitable than for milk. However, producers were relatively evenly divided: 48 percent considered meat production as the most profitable, and 39 percent considered milk production.

When producers were asked whether or not they would be able to increase goat milk production, 73 percent said they would not. The main reasons were the lack of adequate pasture and rations (52 percent) and the quality of the local goats (35 percent). Sixty percent of all producers felt they would not be able to purchase improved goats. The main reasons were that such goats are not available locally and that, even if they were, their prices would probably be too high.

The reported difficulty in obtaining improved goats in the region does represent a constraint to increase goat milk production and can not be resolved unless there is some kind of government effort. Such an effort should involve not only making improved goats available to low-income farmers, but also providing the means by which the herd health and nutrition are improved. Such improvements, however, are not likely to be channeled to increase goat milk production since goat milk commercialization is very difficult in the area.

In the case of goat cheese, however, 98 percent of the producers agreed that marketing is not a constraint. However, in order for this to happen, increases in goat milk production would have to be significantly high. For 96 percent of the producers, goat cheese would only be sold after the milk was enough for the kids and the household consumption needs. Under current conditions, however, goat milk is hardly enough for the kids alone.

The quality of the native goats is extremely poor as compared to the quality demanded for milk production. Since most producers do not have access to either extension services or technologies, it can not be expected that the development of modern technologies will benefit these farmers. This will only be possible when the development of socially appropriated technologies becomes one of the elements of a much larger government program which is directed exclusively to the low-income small farmers of the Northeast.

Since any small farm development program for the semi-arid Northeast must necessarily involve goat production, the following elements should be taken into account. First, that producers' access to land, labor and capital are low. Second, that technologies must therefore be simple and low cost. And third, that incentives to increase productivity of any crop or product should be based on studies concerning the regional infrastructure, the availability of common grazing lands, as well as the availability of natural resources.

Developing A Methodology for Small Farm Oriented Research and Extension on Goat Production

Two main theoretical approaches are the guidelines for the methodology. First, that even though the development of modern technologies might be scale neutral, access to them is not. The development of socially appropriated technologies is likely to significantly increase the chances that rural development programs are successful. Second, that no development program directed towards improving the quality of life of low-income small farmers can be successful unless this social group becomes involved in the whole process of technology develoment, adoption, and evaluation.

Even though small farm participation in research and extension programs is not easily attained, it is crucial for many

reasons. Among these, the most important may be that even though both peasants and researchers/extensionists basically identify the same problems at the production unit level, peasant priorities and means to resolve problems do not always coincide with those of the technicians. It is our understanding that this is mostly due to the fact that technicians usually work under ideal and highly controlled conditions, whereas producers work under highly unfavorable and unstable conditions.

In order to develop a methodology which accounts both for the heterogeneity of small-farm goat production in the semi-arid Northeast and for the small farmer participation in developing, adopting and evaluating technologies, the following criteria could be considered. First, that both secondary and primary data are collected and analysed. Second, that research be conducted also at the small farm level and that research results be discussed both at the farm and the rural community levels. Third, that a data bank on small-farm goat production be formed. The data collected should provide the elements needed for a typification of small farm goat production in the semi-arid Northeast.

At the state level, secondary data should provide for both an assessment of the environmental conditions and for the identification of the predominant production systems as well as of the major goat producing microregions. At the microregional and county levels, both secondary and primary data should provide more detailed information on both the physical and socio-economic characteristics of the area. Among the former, the following factors should be known: topography, soil and vegetation conditions, water resources, etc. Among the latter, a more detailed analysis of the predominant production systems should be conducted, by considering: the level of technology utilized, the land tenure and use, the socio-economic role of the different crops and livestock, and the constraints and potentials to increase production. All of the above should be approached within an historical perspective.

Studies on infrastructure and on commercialization channels should be conducted both at the microregional and county levels. All of the above information should be utilized for the selection of those production units which are well representative of all of the predominant goat production units. Only then researchers should choose those rural communities and farms where research will be conducted.

At the farm level the case study method may be utilized. Producers' participation at this point becomes crucial, although it might start simultaneously to the microregional and county levels diagnosis. Earlier participation of producers, however, is only possible if the participatory research methodology is utilized. Researchers and extensionists working in an interdisciplinary team should also conduct research on the traditional practices utilized in goat production. This could contribute to a better understanding of the constraints and

potentials to increase productivity and lead to new research demands. Special attention should be given to those integrative and non-integrative factors between crop and livestock production, in terms of land, labor and capital allocation. There should be an effort to develop a schedule to the continuous evaluation of the impact of the new technologies on the whole production system.

As researchers, extensionists and producers work jointly in developing, adjusting, and evaluating technologies according to both the physical and socio-economic conditions of the production units themselves, as well as according to the units' relation to other sectors of society, there emerges the need to organize a data bank. The data bank should contain information of various nature in what relates to small-farm goat production. Analysis of these data shall provide the elements for a typification of peasant goat production in the semi-arid Northeast. According to the research results, some of these elements are: a) quality and quantity of natural resources; b) amount of common grazing lands; c) socio-economic role of goats; d) level of technology utilized in both agriculture and goat production; and, e) overall characteristics of the total production systems.

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CHARACTERISTICS, CONSTRAINTS AND TECHNOLOGY RECOMMENDATIONS FOR THE SMALLHOLDERS AT SACO DO BELÊM

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ABSTRACT - The testing and evaluation of technology recommendations developed by the CNPC will be carried out at the Saco do Belém Agrarian Reform project in four stages: 1) site description and problem diagnosis; 2) technology design; 3) technology testing; and 4) technology evaluation. The project is divided into three areas with 66 smallholders per area. Each smallholder received four parcels of land: 0.5ha for a house, 5.0ha for crops, 20.0ha for improved pasture and 62.5ha for community native pasture. Seventeen smallholders per area were surveyed in early December 1985. The majority of the producers lived, farmed and grazed their animals on the 20.0ha parcel. They had an average of 4.06ha of land in cultivation and an average herd size of 17 goats, 16 sheep and 10 head of cattle. The major constraints to improving the production system were determined to be the poor health condition of the animals, nutritional constraints during the dry season, lack of reproductive management, poor facilities, lack of credit, lack of training, and the poor infra-structure. Potential technology recommendations focus on improving the health condition of the animals, nutritional deficiencies, reproductive management and improved facilities.

Index terms: Small farms, On-farm technology testing.

CARACTERÍSTICAS, LIMITAÇÕES E RECOMENDAÇÕES DE TECNOLOGIA PARA O PEQUENO FAZENDEIRO DE SACO DO BELÊM

RESUMO - O teste e a avaliação das recomendações tecnológicas desenvolvidas pelo CNPC serão executados, no projeto de reforma agrária da Fazenda Saco do Belém, em quatro estágios: 1) descrição da área e diagnóstico do problema, 2) desenho da tecnologia, 3) teste da tecnologia, 4) avaliação da tecnologia. O projeto esta dividido em três áreas com 66 parceleiros por área. Cada parceleiro recebeu uma parcela de terra composta de: 0,5ha para uma moradia, 5,0ha para cultivos, 20,0ha para cultivos de pastagem melhorada e 62,5ha para pastagem nativa comunitária. Dezessete parceleiros foram entrevistados por área no início de dezembro de 1985. A maioria dos produtores moravam, cultivavam e colocavam os animais na parcela de 20ha. Eles tinham em média 4.06ha com culturas e um rabanho médio de 17 caprinos, 16 ovinos e 10 bovinos. As principais restrições a melhoria dos sistemas de produção foram determinados como sendo as precárias condições de saúde dos animais, limitação de alimentação na estação seca, falta de manejo reprodutivo, instalações precárias, falta de crédito, falta de treinamento e péssimas condições da infrastrutura. As recomendações das tecnologias em potencial

visam melhorar a saude dos animais, diminuir as deficiências nutricionais, melhorar o manejo reprodutivo e as instalações.

Termos para indexação: Pequenas fazendas, Avaliação de tecnologia em fazendas.

Introduction

Small ruminants represent an important component of the agricultural system in Northeast Brazil, where 91 percent of the country's goats and 33 percent of the sheep are produced (Fundação Instituto Brasileiro de Geografia e Estatística, 1983). Research conducted at the National Goat Research Center (CNPC) in Sobral, Ceará has focused on improving production practices for these animals. The next logical step, but one which often is not taken, is to test the research with actual users.

This study was initiated to develop and evaluate technology recommendations, based on work conducted at the CNPC, designed to improve the performance of sheep and goat production systems used by small farmers in Northeast Brazil. The purpose of this paper is to: 1) present the methodology used in conducting the study; 2) describe the agrarian reform project (Saco do Belém) where the study will be conducted, the project site, and the characteristics of the smallholders and their families and farms; 3) identify the major constraints to improving the performance of the production system at Saco do Belém; and 4) present potential technology recommendations to be implemented there.

The generally accepted methodology of Farming Systems Research and Development (Bernstein et al., 1983) was used. The first step was site description and problem diagnosis to be followed by technology design, technology testing and technology evaluation. A team of researchers at the CNPC was assembled consisting of specialists in the fields of animal health, animal nutrition, animal breeding, economics, range science and reproduction. These individuals were consulted to aid in designing the survey, diagnosing the problem, developing the technology recommendations and evaluating the technology.

The Saco do Belém Agrarian Reform Site

The Saco do Belém agrarian reform project was chosen as the site of this multi-disciplinary study. Several factors influenced the site choice, the primary one being the homogeneity of the producers. Each farmer had the same amount of land and the land quality was relatively equal in most cases. Other conditions such as length of time on the farm, types of animals and crops raised, etc., were also similar, much more so than would be expected in the state of Ceará in general, or even in any region of the state. The project's proximity to the CNPC (160km) was also a contributing factor to the choice, since conducting the experiment would require frequent visits. Saco do

Belém was also the site of an existing EMBRAPA (Brazilian Corporation for Agricultural Research) project. Further, working relationships between INCRA (National Institute for Colonization and Agrarian Reform) and EMATERCE (Corporation for Technical Assistance and Rural Extension of Ceará) were already established. The only major concern was the difficult access during the rainy season.

Physical Description

The Saco do Belém agrarian reform site consists of approximately 20,000 hectares situated in a basin surrounded by 7 mountain ranges (Anonymous, 1982). The nearest city is Santa Quitéria, which is located approximately 55 kilometers to the west. The state capital of Fortaleza lies about 190 kilometers to the northeast.

The project is administered by INCRA. The land was expropriated in 1980, divided into three areas designated A-I, A-II and A-III, settled in 1982, 1983 and 1984, respectively. A total of 198 families (66 per area) were chosen to receive land, including 47 families which previously resided on the property and about 15 of their children. Most of the remaining smallholders came from nearby counties.

The majority of the soils in the area may be classified as light and shallow with underlying bedrock. They are of medium to high fertility, although the many stones and rocks make the land unsuitable for mechanization. The terrain ranges from flat to mountainous with the area near the center of the basin being slightly hilly to hilly, becoming very hilly to mountainous as the perimeters bounded by the mountain ranges are approached. Approximately 70 to 80 percent of the land is suitable for crops and pasture. Approximately 6 to 10 percent of the land is unsuitable for any agriculture at all with the remainder supporting only extensive animal agriculture.

The average annual precipitation varies greatly from year to year. The region is characterized by prolonged droughts followed by several years of above average rainfall in 1984, 1985 and 1986. The seasonal rainfall pattern is fairly predictable, with the rainy season usually starting in January and continuing until May.

Project Description

As previously discussed the project is divided into three areas or nuclei. It is planned that each nucleus will have its own center with an administration building, a school, a general store, a playground and a sports field. The rural center for the entire project will include a health post, police station, church, storage buildings, cooperative general store, gas station and a residence along with several other buildings. The only structures which currently exist are the administration building which also serves as the residence, the health post, a

cooperative general store and a school, all located at the rural center. There has been no development of the individual nuclei.

Each smallholder has received four separate parcels of land. The division of the parcel into four separate plots was made to ensure a relatively equal distribution of land suitable for the various uses, i.e. crops, improved pasture and native pasture. The fourth parcel was made to provide land for a house to be constructed in close proximity to the center of each nucleus. Each smallholder was allocated a total of 88ha: 0.5ha for a house (urban lot), 5.0ha for crops (crop parcel), 20.0ha for improved pasture (animal parcel) and 62.5ha for native pasture (rural parcel). The rural parcel is part of a large unfenced common area of slightly more than 14,000ha. Approximately 1000ha has been allocated for research by EMBRAPA.

The Survey

The principle objectives of the survey were to: 1) assess the situation of the smallholders, their famlies and their property, 2) determine the level of the management practices in use, 3) discover the major problems, and constraints to improving the performance of the production system, and 4) evaluate the potential of each smallholder surveyed to participate in the study. A secondary objective was to establish an historical record of the smallholders' status which could be used to monitor the progress of the INCRA project.

The questionnaire was designed with the research team and in consultation with the INCRA staff responsible for the Saco do Belém project. It was pre-tested in late November 1985 with 5 producers. At least one producer was selected from each of the three areas. The questionnaire was modified following the pre-test. A sample size of 51 producers was chosen, representing slightly more than 25 percent of the total population of 198 smallholders. Seventeen producers were randomly selected from each area. The survey was administered over a six-day period in early December 1985.

General Characteristics

Most of the smallholders have moved to the project site. Only area III had a substantial number of smallholders (more than one-third) which had not yet settled at the project. This was due to the settlement schedule which started in 1982 with area I, followed by area II in 1983, and area III in 1984. The average date of arrival for the three areas was May 1983, December 1984 and March 1985, (for those smallholders which were living at the project site) for areas I, II and III, respectively. Some producers were encountered working in area III who were either still living outside of the project or who had moved to the project but had not yet brought their families. The typical family consisted of between 7 and 8 people, the male being in his early forties and having less than one year of schooling.

Health and Education

In September 1984 INCRA administered two questionnaires to 81 of the 195 families living at the project. The first questionnaaire concerned the socio-economic and sanitary conditions; the second concerned health conditions. The results of the questionnaire were used to obtain, on a general level an understanding of living conditions at the project (INCRA, 1985).

The level of education was very low. Of the 317 people surveyed who were at least 6 years old, 51 percent had completed one year or less of school. Only 6 percent of those surveyed had advanced to the second level of schooling, corresponding to at least four years of study.

The major components of the average family's diet were beans, corn, ground cassava and rice. Beans and corn were produced in large quantities by the smallholders. Cassava, although not produced extensively within the project, is produced in large quantities in Northeast Brazil and is a staple of the Northeasterner's diet. The only meat which was commonly consumed on a monthly basis was goat meat. Eggs and milk were consumed less than once a month by 62 percent of the families. Fruits and vegetables were consumed less than once a month by 80 percent of the families. The most common desert was a large lump of brown sugar called "rapádura."

Virtually no medical help was available at the project. Visits by physicians were only infrequently provided by INCRA. The nearest medical help was in Santa Quitéria. Some vaccinations have been furnished by INCRA for the children. The annual death rate was 1.6 percent of the total population during the two years before the survey was conducted. All of the reported deaths were of children less than three years old. The birth rate during the same two-year period was approximately 3.6 percent of the total population.

The majority of the houses were constructed of wood supports and clay (91 percent). The remaining 9 percent were constructed of clay bricks. The roofs were all constructed of tiles. Ninety-nine percent of the floors were dirt. The only electricity was available at the center, provided by a diesel generator. A shortwave radio was the only available means of rapid communication with the outside world. Both the electricity and radio were operated only during the short visits by INCRA personnel.

The most common sources of drinking water were a water hole (64 percent), reservoir (14 percent), well (11 percent) and river (10 percent). Most of the families used a reservoir (48 percent) or a water hole (35 percent) for washing their clothes, and a reservoir for bathing (77 percent).

Land Use

Very few of the smallholders followed the land use pattern planned by INCRA of residing on the urban lot, planting crops on the crop parcel and using the animal parcel for pasture. Most producers conducted all three activities on just one plot of land. Informal discussions revealed that this plot was usually chosen to be the largest of the three plots which had land suitable for farming activities. In areas I and III, where the animal parcel was generally of good quality, the great majority of producers built their homes, planted their crops and kept their animals on the animal parcel. Because much of the land in area II was deemed unsuitable for crops and improved pasture, many producers were forced to choose the crop parcel for both their crops (63 percent) and pasture (38 percent). Area II also contained the only sizable number of producers which had built their homes on the urban lot (19 percent).

Crops

Of the 37 smallholders who had lived at Saco do Belém for at least a year, 36 had planted crops. The smallholders in area I had almost double the amount of land in cultivation (6.29ha) as those farmers in both areas II and III (2.5 and 2.44ha, respectively).

There was a clear preference for mixed cropping over monocropping. There was an average of 3.48ha devoted to mixed cropping as opposed to 0.59ha devoted to monocropping. The most common mixed cropping system was to plant corn, beans and cotton (59 percent) or corn and beans (14 percent). Castor beans, broad beans and manoic were occasionally included in the mixed cropping system. Seventy-five percent of the farmers which monocropped had annual cotton, 25 percent had perennial cotton and 17 percent had castor beans.

Fifty-seven percent of the producers had their crops completely fenced. The large majority of producers allowed their animals to graze on the crop residues after harvest.

Animals

Many of the smallholders did not have any animals, particularly in the areas which were recently settled. Eighty-two percent of the smallholders in area I had goat, sheep or cattle as compared with only 69 and 25 percent in areas II and III, respectively. Almost all of the farmers had goats, if they had any animals at all. Relatively few farmers had sheep (18 percent) and cattle (25 percent).

The average herd size was 16.61 goats, 16.13 sheep and 10.10 head of cattle. The typical goat herd consisted of a buck with the rest of the herd being divided fairly evenly between does and kids. The ratio of female to male kids was about 2 to 1. The

composition of the sheep flocks was similar except that the ratio of female to male lambs was about 2.5 to 1.

The majority of the producers managed their animals allowing their animals to graze in the common areas after their crops were planted at the start of the rainy season. After harvest they would let the animals graze on the crop residues and in their private pasture. This strategy had two major advantages. The first is that by keeping the animals out of their private pasture during the rainy season, they could ensure that it would be in the best possible shape for the dry season. Secondly, by letting the animals graze in the common area after planting, they protected the crops, which in many cases were not fenced, from the animals. Most of the producers gathered their animals at night and returned them to their pens.

Sixty-eight percent of the producers had some type of facilities for their animals. Seven percent had a simple corral, 52 percent had pens and 42 percent had a pen with a covered area. One producer had an elevated, slatted wooden floor, the rest were made of dirt. Ninety-two percent of the producers said that they cleaned their facilities. The average interval between cleanings was two weeks.

Animal Nutrition

Only in area I was there any significant amount of improved pasture. Area I had an average of 3.85ha per farm which had seeded back from the previous years crops and 1.21ha planted to forage. No smallholders in area II and only one in area III had rotational fallow or forage planted. Seventy percent of the producers with forage cut it to feed to the animals, while 20 percent let the animals graze on it and 10 percent used both systems. Elephant grass was by far the most common type of forage. Only 36 percent of the producers with forage had the forage completely fenced.

Thirty-nine percent of the smallholders gave their animals some kind of supplement. Of the producers which supplemented their animals, 60 percent of the producers supplemented their cattle, 38 percent supplemented their sheep and 23 percent supplemented their goats. This is consistent with the Gutierrez & Ponce de Leon study which found that cattle received first priority with respect to resource allocation, followed by sheep and finally goats. The most common supplement was usually given to the animals during the last part of the dry season. Seventy-nine percent of the producers said that they provided their goats and sheep with salt. Thirty-six percent of those which used salt added minerals.

Reproduction

Virtually no reproductive management was practiced at Saco do Belém. Only 17 percent of the smallholders separated the male from the female animals. However, because the smallholders

generally allowed their animals to graze in the common areas with many other animals, it is doubtful whether this practice proved very successful. The producers did indicate that when selling the young animals they tried to retain the better animals for reproductive purposes. Eighty-eight percent of the producers castrated their sheep and goats at an average age of 5 months. Bucks and rams were used an average of 3.63 years; while does and ewes were used an average of 6.23 years.

About half (56 percent) of the producers separated the animals which were about to give birth. The goats gave birth to twins slightly more than half of the time, while the sheep gave birth to twins about two-thirds of the time. Thirty-eight percent of the producers weaned their sheep and goats at an average age of 6 months.

Animal Health

The questions concerning animal health were focused mainly on symptoms which were evidenced in the animals. Ideally a veterinarian would have been present during the questioning to give a more accurate diagnosis of the problems.

The health conditions at the project were, in general, very poor. The most serious health problems mentioned by the producers were internal and external parasites. About half of the goats and sheep were said to have foot infections. Pneumonia or other respiratory disorders were also frequently mentioned. The mortality rate was very high during the last year, which was characterized by extremely heavy rains. Sixty-three percent of the goats and 38 percent of the sheep were reported to have died. Abortions were not thought to be a serious problem for either sheep or goats.

When asked how many kids or lambs died during the first month of life, the most common response was a few. Although only 4 percent of the producers cut and disinfected the umbilical cords of newborn sheep and goats, infections were not perceived to be a problem. About half of the goats and over half of the sheep had diarrhea during the first month of life -- an indication that they might not be receiving sufficient colostrum, or that they might not be receiving it early enough. Although 88 percent of the producers said that the kids and lambs received colostrum during their first 24 hours of life, their responses to the question "How do you verify this?" indicated that this was probably just an assumption rather than something which they observed.

Eighty-five percent of the producers dewormed their animals, on average 1.77 times per year. Only 54 percent of the smallholders vaccinated their animals. Only a few of the producers knew what kind of vaccination their animals received. Both the vaccinations and dewormings were sponsored by INCRA. During the last year only 4 percent of the producers treated their animals with antibiotics.

Conservation

The smallholders showed a good knowledge of the plant species which existed on their parcels. Most of them could identify which tree species served best for logs, fence posts, firewood and forage material. They could also identify many plant species which were palatable to sheep and goats. However, when it came to improving the productivity of the pasture, only 22 percent said they had any idea of what to do. The majority of the smallholders (84 percent) said that they intended to maintain the production of wood on their parcels. Sixty-six percent of them said they would do so by leaving a portion of their land uncut. Eleven percent said they would plant more trees, 5 percent said they would fence the area after it was cut to protect it from the animals. Thirteen percent of those who said they planned to ensure a continuous supply of wood on their land said they had no idea as to how they were going to do it.

Product Marketing

The market for sheep and goat products consisted entirely of live animals. An average of 15.71 goats and 4.14 sheep were sold per family, per year. Most of the animals were sold by buyers which came to the project to purchase the animals. An average of 1.43 sheep and 4.38 goats were consumed per family per year. Approximately 71 percent of the smallholders with goats milked them, although all of the goat milk was consumed on the farm.

Major Constraints and Technology Recommendations

The major constraints and technology recommendations for improving animal production, based on the survey data, were arrived at by consensus of the research team. The major constraints were determined to be the:

1) Poor health of the animals;
2) Lack of proper nutrition during the dry season;
3) Lack of reproductive management;
4) Lack of or poor condition of facilities;
5) Lack of credit;
6) Lack of training and technical support; and
7) Poor infrastructure.

Potential technology recommendations to improve the performance of the production system are:

1) Use of a complete mineral salt mix supplement;
2) Regular vaccinations against major diseases;
3) Regularly de-worming of the animals;
4) Regular visits by a veterinarian;
5) Separating female animals about to give birth and proper care of the newborn animals;
6) Cutting and treating the umbilical cords of newborn animals;

7) Castrating young males not to be used for reproduction;
8) Weaning young animals;
9) Selection of animals to be removed from the breeding stock;
10) Flushing female animals; and
11) Improved facilities.

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RECOMENDAÇÕES

RECOMMENDATIONS

RECOMENDAÇÕES

Os participantes da I[a] Reunião Técnico-Científica do Programa de Apoio à Pesquisa de Pequenos Ruminantes, em sessão plenaria, adotaram uma série de recomendações, em duas categorias: tecnologias novas e provadas, geradas da pesquisa e recomendadas para a aplicação imediata; e recomendações para as prioridades na pesquisa futura.

(Participants of the First Workshop of the Small Ruminant Collaborative Research Support Program, in plenary session, adopted a series of recommendations, in two categories: new and proven technology, generated by research and recommended for immediate application; and recommendations for future research priorities.)

TECNOLOGIAS RECOMENDADAS

Da avaliação da tecnologia gerada da pesquisa, se considera que os seguintes recomendações são imediatamente aplicaveis a nivel de fazenda.

1. Disponibilidade de sombra para todos os animais a fim de reduzir o estresse do calor.

2. Se os animais são confinados, adotar-se o número mínimo de horas por dia de confinamento a fim de se maximizar o consumo de pastagem ao campo.

3. Construção de abrigos, particularmente para caprinos.

4. Os animais devem ser suplementados com sal.

5. As fêmeas devem ser suplementadas durante o período de escassez de forragem no campo, utilizando-se fontes de proteínas de baixo custo para complementar (sem substituir) os nutrientes da caatinga de acordo com os recursos disponíveis.

6. Deve se encorajar a produção e conservação de forragem para preencher as necessidades durante o período crítico. Silagem, feno ou verde picado (isto é, sorgo, cunhá, algaroba) são sugeridos onde forem economicamente possíveis.

7. Para a produção de leite, aos animais devem ser proporcionado forragem de alta qualidade (15% de proteína bruta, ao mínimo, e 60% de fibra em detergente neutro, ao máximo).

8. Seguir o calendário de vacinação recomendado.

9. Seguir o calendário de vermifugação recomendado.

10. Certificar-se de que as crias mamem logo após o nascimento.

11. Cortar e tratar (com solução a 10% de iodo) o cordão umbilical logo após o nascimento da cria.

12. Animais jovens podem ser mantidas em lugares quentes e secos e protegidos das correntes de vento.

13. Desenvolver e adotar alguma forma ou sistema geral de escrita de acordo com os recursos dos produtores.

14. Os animais devem ser desmamados entre 3.5 a 4 meses de idade e as fêmeas de substituição devem ser colocadas no melhor pasto disponível. Os machos devem ser colocados separados das cabras ou esterelizados.

15. Os reprodutores devem ser obtidos de outros rebanhos a cada dois anos.

16. Os produtores devem ser encorajados a avaliar cada animal do seu rebanho de reprodução todo ano, e retirar do rebanho os animais com problemas de saúde e de reprodução.

17. Na seleção de machos para reprodução, verificar os testículos, o pênis e as condições gerais de saúde pelo menos um mes antes do período de cobertura a fim de se avaliar os problemas potenciais com fertilidade e garantir sucesso na cobertura.

18. Diagnose da prenhez deve ser feita a cada 90 dias e as fêmeas prenhas devem ser colocadas na melhor pastagem disponível ou em suplementação, nos ultimos dois meses de gravidez e durante o início da lactação.

19. A vegetação (caatinga) deve ser rebaixada a cada três ou quatro anos, levando em consideração os hábitos e preferências da espécie animal.

20. O manejo animal deve incluir pastoreio multiplo com a proporção das especies e a carga animal dependendo do potencial da área.

21. Selecionar os substitutos do rebanho de reprodução a partir dos pais que apresentam melhor desempenho reprodutivo.

22. Não usar reprodutores caprinos mochos para melhoramento.

23. Considerar o uso de machos Anglo-nubianos para os cruzamentos iniciais a fim de se melhorar as taxas de crescimento e a produção de leite.

24. As organizaçãoes de melhoristas e grupos de criadores devem desenvolver programas de melhoramento genético utilizando a informação e a assistência técnica disponíveis.

25. Devem ser continuados os rebanhos de preservação, melhoramento e disseminação de raças nativas ou indígenas.

26. Não usar para cruzamento animais brancos puros sem pigmentação na pele.

27. Se o objetivo é produção de leite é necessário a infusão de sangue de caprinos leiteiros.

TECHNOLOGY RECOMMENDATIONS

From the evaluation of technology generated from research, it is considered that the following recommendations are immediately applicable at the farm level.

1. Shade should be made available to all animals to reduce temperature stress.

2. If animals are confined, they should be confined the minimum number of hours per day to maximize feed intake from grazing.

3. Shelters should be made available, particularly for goats.

4. Animals should be supplemented with salt.

5. Female animals should be supplemented during the period when feed is not available on the range, utilizing sources of low cost protein to complement (without substituting) nutrients from the caatinga, according to the resources available.

6. The production and conservation of forages to fulfill nutrient needs during critical times is encouraged. Silages, hay or green chop (e.g. sorghum, cunhã, algaroba) are suggested where economically feasible.

7. If milk is produced, the animal should be provided with a high quality forage (minimum of 15 percent crude protein and maximum of 60 percent total cell wall fiber or NDF).

8. Follow recommended vaccination schedules.

9. Follow recommended de-worming schedules.

10. Make sure that the new-born animals suckle after birth.

11. Cut and treat (with a 10 percent iodine solution) the umbilical cord as soon after birth as possible.

12. Young animals should be kept as warm and dry as possible and out of the draft.

13. Develop and adopt some form of general record keeping system commensurate with the resources of the producers.

14. Animals should be weaned between 3.5 and 4 months of age and replacement females should be placed on the best feed available. Male offspring should be separated from the dams, or sterilized.

15. Breeding males should be obtained from outside the flock every two years.

16. Producers should be encouraged to evaluate each animal in their breeding flock every year and unhealthy, non-reproducing animals should be removed from the flock.

17. When selecting studs to reproduce, the testicles and penis as well as the general health of the males should be checked at least one month before the breeding period to evaluate for potential problems with fertility and ensure that they are able to breed.

18. A diagnosis for pregnancy should be made at about 90 days, and when resources permit, the pregnant females should be placed on the best pasture available or on supplement during the last one or two months of pregnancy and during early lactation.

19. The vegetation (caatinga) should be lowered every 3 to 4 years taking into consideration the habits and preferences of the animal species.

20. Animal management should be mixed species grazing with the combination and stocking rate depending on the area.

21. Select replacement breeding stock from those parents which have been more productive.

22. Do not use polled male goats for breeding.

23. Consider the use of Anglo Nubian males for initial crosses to improve growth rates and milk production in goats.

24. Breed organizations and producer groups should develop breed improvement programs utilizing available scientific information and assistance.

25. Preservation, improvement and dissemination flocks of native or indigenous genotypes should continue.

26. Discourage breeding of pure white animals without some pigment in the skin.

27. If milk production is a goal, some infusion of goats of dairy breeds will be needed.

RECOMENDAÇOES DE PESQUISA

As seguintes recomendações incluem as áreas nas quais se considera que uma maior pesquisa é de alta prioridade.

Sistema Animal

Reprodução

1. Estudo andrológico e da tecnologia do sêmen objetivando apoiar aos programas de melhoramento através da seleção e disseminação de machos superiores em programas de inseminação artificial.

2. Estudar a época e taxa de ovulação em relação aos níveis hormonais plasmáticos.

3. Taxa de nascimento e eventos fisiológicos nos períodos pré e pós-parto.

4. Época do desmame e sua influência na sobrevivência e desenvolvimento ponderal das crias e desempenho produtivo das fêmeas adultas.

5. Economia comparativa de dois métodos de controle da estação de parição: controlar a estação de monta, ou sincronizar o ciclo estral.

Sanidade

1. Teste da vacina contra Linfadenite caseosa.

2. Estudos epidemiológicos das doenças principais de ovinos e caprinos.

3. Determinação da patogenicidade de: pododermatite (doença dos cascos); pneumonia; tumor nasal; eimeriose; e mastite.

4. Avaliação de esquemas estratégicos de vermifugação em relação à estação de chuvas.

5. Estudar a possível resistência de parásitos gastrintestinais aos vermífugos usados rotineiramente.

6. Avaliar o efeito de plantas nativas (ervas, árvores, etc.), como vermífugos.

Melhoramento

1. Avaliar a nível de fazenda, o cruzamento absorvente de ovinos e caprinos, utilizando genótipos Santa Inês para ovinos e Anglo-nubiano para caprinos.

2. Avaliar o potencial para o cruzamento de raças.

3. Delinear e implementar programas de melhoramento apropriado para as raças mais importantes.

Nutrição

1. Limitações e requerimentos nutricionais de ovinos e caprinos em pastejo e em confinamento com relação a:
   a) Energia
   b) Proteína (degradável e não degradável no rume)
   c) Componentes da fibra e seus efeitos na utilização de energia
   d) Minerals (P, S, Ca, Cu, Co, Zn).

2. Fatores nutricionais e seus efeitos na produção animal, incluindo: crescimento, acabamento, lactação, ovulação, prenhez, peso ao nascer e desmame (precoce ou normal), e resistência à doenças.

3. Comportamento animal em regime de confinamento (seleção de forragem, digestibilidade e taxa de consumo relacionado com a composição).

4. Avaliações de fontes de alimentação regional (forrageiras nativas e introduzidas, resíduos de cultura e sub-produtos de agro-indústria).

5. Métodos de preservação de alimentos (silagem, feno).

6. Formação de bancos de dados com a finalidade de confeccionar uma tabela de composição de alimentos e requerimentos nutricionais dos animais.

7. Sistemas de alimentação para cabras de leite.

Sistema de Produção de Forragem (Caatinga)

1. Avaliar os fatores nutricionais que limitam a produção dos animais na caatinga tais como:

   a) Quantificar a utilização de energia durante o ano (qualidade e disponibilidade de forragens e fatores que afetam o comportamento do animal tais como stress de calor e insetos, ou excessiva umidade durante a época chuvosa).

   b) Avaliar o comportamento alimentar e a seleção da dieta de acordo com a disponibilidade de forragem e as condições climáticas.

2. Identificar e desenvolver as proporções de espécies de caatinga para otimização da produção animal.

a) Determinar a cobertura vegetal e sua relação com a produção de matéria seca do estrato herbáceo (para os diferentes tipos de solos e regimes de precipitação).

b) Determinar os melhores períodos de corte e densidade das espécies arbóreas para provocar a rebrota que extendera o período de disponibilidade da vegetação verde.

c) Testar, em condições naturais de pastejo, especies exóticas e nativas que tenham potencial para uso na caatinga.

d) Avaliar o efeito do período e intensidade de pastejo no crescimento, reprodução e mortalidade das espécies arbóreas mais importantes.

e) Avaliar os métodos mais promissores (biológico, químico e mecânico) para controlar as espécies não desejáveis.

f) Desenvolver uma técnica, usando animais jovens, para estimular o consumo de espécies não desejáveis.

3. Desenvolver um enfoque de análise de sistemas integrados de fazendas na pesquisa e no manejo da caatinga.

a) Quantificar a produção potencial de lenha das espécies arbóreas nas diferentes manipulações da caatinga.

b) Quantificar a contribuição nutricional (produção e quantidade) dos resíduos agrícolas e espécies nativas durante o ano.

4. Em todos os casos acima citados, fazer análise econômica para identificar a melhor utilização dos recursos disponíveis.

Interação Humana: Sistema de Manejo

Economia

1. Caprino leiteiro

a) Determinar o lucro potencial das fazendas atualmente envolvidas na produção de caprinos leiteiros.

b) Examinar o potencial de comercialização de leite e seus derivados.

c) Caracterizar a indústria de caprino leiteiro no Sudeste do Brasil.

2. Descrição geral do sistema de exploração a nível de fazenda: expandir a pesquisa realizada em Ceará a outros estados do Nordeste.

3. Avaliação de tecnologia a nível de fazenda:

a) Testar tecnologias adequadas a nível de fazendas de diversas condições representativas do Nordeste.

b) Envolver os técnicos da EMATER no planejamento, execução, supervisão e avaliação de projetos de pesquisa a nível de fazenda.

c) Tomar em consideração os fatores socioeconômicos.

d) Testar o uso de feno e silagem de boa qualidade como suplementação na época seca.

e) Avaliar o uso de "bancos de proteína" de espécies nativas e exóticas (exemplo: sabiá, algaroba, leucaena) como suplementação na época seca.

4. Conduzir pesquisa visando caracterizar a infraestrutura do sistema de comercialização de caprinos e ovinos e seus derivados a nível regional.

Manejo

1. Estudar sistemas alternativos de manejo para produção de caprinos e ovinos.

2. Estabelecer programas a longo prazo em fazendas préselecionadas onde a composição da pastagem nativa será avaliada em função das práticas de pastejo e manipulação da caatinga.

3. Desenvolver práticas de manejo para minimizar a mortalidade de ovinos e caprinos no início da época chuvosa.

4. Determinar o grau de perda de peso durante a estação seca o qual permitira a sobrevivência dos animais com taxas adecuadas de reprodução.

RESEARCH RECOMMENDATIONS

The following recommendations include areas in which further research is considered to be of high priority.

The Animal System

Reproduction

1. Andrological study and semen technology of goats and sheep to support a program of selection and dissemination of superior males through AI.

2. Time and rate of ovulation in relation to the blood hormone profile in goats and sheep.

3. Fertility at parturition and physiological processes during pre- and post-partum periods of sheep and goats.

4. Schedules of weaning and their influences on kid survival and performance of adult female dairy goats.

5. Economics of restricted breeding season vs. estrous cycle synchronization methods.

Health

1. Test vaccines for Caseous lymphadenitis.

2. Epidemiological studies of the principal diseases of goats and hair sheep.

3. Determination of the pathogenesis of footrot, bronchial pneumonia, nasal tumors, coccidiosis, and mastitis.

4. Strategy approach to deworming, related to rainy season.

5. Investigate possible resistance of parasites to commonly used vermifuges.

6. Efficiency of native products (herbs, tree extracts, etc.) as vermifuges.

Breeding

1. Evaluate, at farm level, grading-up of sheep and goat herds, using improved genotypes of Santa Inês sheep and Anglo Nubian goats.

2. Evaluate potential for cross-breeding.

3. Design and implement appropriate improvement programs for the most important breeds.

Nutrition

1. Nutritional requirements or limitations of sheep and goats on the range and in confinement, with respect to:
   a) Energy
   b) Protein (rumen-degradable and nondegradable)
   c) Fiber components as they affect energy utilization
   d) Minerals (P, S, Ca, Cu, Co, Zn).

2. Effects of nutritional factors on various measures of animal performance, including growth, finishing, lactation, ovulation, pregnancy, birth weights, weaning weight (early and normal), and resistance to disease and parasites.

3. Nutritional behaviour of pen-fed animals (food selection, digestibility and intake related to composition).

4. Evaluation of locally available feed resources (harvested introduced and native forages, crop residues and agro-industrial by-products).

5. Methods of feed preservation.

6. Assembly of nutritional data bank on feed composition and requirements of goats and hair sheep.

7. Feeding systems and feed evaluation for dairy goats.

The Forage Production System (Caatinga)

1. Understand nutritional factors that limit animal production on rangelands:

   a) Quantify energy nutrition on year-long basis (forage quality and availability, and factors related to animal behavior such as stress from insects, excessive wet conditions and heat).

   b) Quantify feeding behavior and diet selection in relation to forage and environmental conditions.

2. Develop plant communitites that optimize animal production:

   a) Determine caatinga canopy cover and understory biomass production relationships (for various soil types and precipitation zones).

b) Determine optimum species and density of woody plants for cutting to encourage coppice growth that extends period of green browse.

c) Test, under grazing conditions, selected native and exotic forage species that have potential for use in range seeding.

d) Evaluate the effect of time and intensity of browsing on growth, reproduction and mortality of important woody species.

e) Evaluate promising methods (biological, chemical, mechanical) for control of undesirable woody plant species.

f) Develop animal and plant management techniques to improve utilization by animals of unpalatable species.

3. Develop a whole-farm systems view of research and management of the caatinga:

a) Quantify wood production potential of various caatinga types.

b) Quantify the nutritional contribution (forage production and quality) made by crop residues and weed fields to the yearly forage balance.

4. Develop, in all possible cases listed above, research approaches that will yield data suitable for economical analysis.

Human Interactions: The Management Systems

Economics

1. Dairy goats:

a) Determine profit potential of farms now engaged in dairy goat production.

b) Examine market potential of goat milk and milk products.

c) Describe the dairy goat industry in southeastern Brazil.

2. General description of small farm systems throughout the northeastern states of Brazil, as has been done in Ceará.

3. On-farm testing:

a) Test appropriate technology on farms which are diverse and representative of conditions throughout the Northeast.

b) Include state EMATER personnel in the design, supervision and evaluation of on-farm experiments.

c) Socio-economic factors must be considered.

d) Test the use of good quality hay and silages for dry season supplementation.

e) Evaluate the use of "protein banks" of native and exotic species (e.g. sabiá, algaroba, leucaena) for dry season supplementation.

4. Conduct research on regional infra-structure for commercialization of sheep and goat products.

Management

1. Study alternative management systems for sheep and goat production.

2. Establish long-term monitoring programs on selected farms where range composition is evaluated as a function of grazing practices and caatinga manipulation.

3. Develop management practices to control sheep and goat mortality during early rainy season.

4. Determine the degree of weight loss during the dry season that will allow animals to survive and maintain adequate reproductive performance.