REPUBLIC OF NIGER
MINISTRY OF RURAL DEVELOPMENT
LIVESTOCK SERVICE

TECHNICAL REPORT ON ANIMAL PRODUCTION IN THE PASTORAL ZONE OF NIGER

RECOMMENDATIONS FOR IMPROVEMENT

DISCUSSION PAPER

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To the Reader,

This report was prepared with the purpose of encouraging discussion about the causes of the low and variable animal productivity in the pastoral zone in Niger.

I would appreciate your comments concerning the issues raised in this report, and particularly your suggestions about simple, appropriate, and economical techniques that should be incorporated into the program of interventions for Phase II, the Integrated Livestock Project.

Thank you in advance for your comments and suggestions.

SUCHET L. LOUIS

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INTRODUCTION

To reach the primary objective of this report, it is essential at the outset to gather, discuss, and evaluate available data on animal production in the pastoral zone of Niger. With this in mind, numerous observations will be made regarding the accomplishments of the Niger Range and Livestock (NRL) Project and the various reports on the Livestock sector in Niger published by the Livestock Service, the livestock projects, and foreign and international institutions.

This report is divided into five chapters. The first will consider the importance of research in animal production in the NRL Project, as well as ways to fill gaps in this area. A research plan will be sketched out, including the verification of simple techniques to facilitate the collection of data on the traditional approach to animal production. In the second chapter, an overall view of herding in the pastoral zone will presented. Available nutritional and animal resources will be disussed and compared. The relationship between livestock and the environment will be evaluated with the purpose of bringing out the triple influence of vegetation, animals, and herders on the balance of the ecosystem, which is sustained in spite of negative ecological factors.

Chapter 3 will look at types of animal production and their characteristics. First, consideration will be given to desirable economic characteristics within the context of Sahelian livestock management. Next, the characteristics actually observed in the pastoral zone of Niger will be examined. For example, we will attempt to answer the question: what must be known in order to evaluate the profitability of traditional herding? Data from certain State ranches, the results of the NRL grazing trials, and data published by INRAN will be analyzed. These analyses will make it possible to evaluate current animal performance and to know by how much animal production needs to be improved.

In Chapter 4, the causes of low animal productivity will be presented and analyzed. The nutritional requirements of livestock will be compared with the contribution of available feed resources. It will be demonstrated that the rangelands of the pastoral zone cannot possibly satisfy livestock requirements. The impact of the principal nutritional defiencies on livestock performance will be described.

Finally, in Chapter 5, recommendations will be presented for improving animal productivity in the pastoral zone. Several recommendations already proposed in the literature will be reviewed, discussed, and analyzed. Next, simple intervention techniques considered to offer a good chance of success will be plainly formulated, by order of priority. In conclusion, we will present a series of simple techniques and pratices that could be applied by the average herder in the pastoral zone.

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CHAPTER I

I.I. Role of animal production research in the NRL Project

The fundamental activities of the Niger Range and Livestock (NRL Project have been applied and directed research. One area of research concerned animal production applied to existing conditions in the pastoral zone. The goal was to determine the costs and benefits of a comprehensive program of animal production for nomadic herders. The program would attempt to increased productivity, while preserving existing forage resources. Research in animal production would provide a field test of several intervention techniques, with the goal of improving the productivity of nomadic or transhumant herding practices. However, it wasn't clear, at the beginning, that even simple intervention techniques could be justified in the present socio-economic circumstances of the pastoral zone, unless research were first done on the actual cost of production inputs essential to new, improved practices such as:

- 1) providing protein, vitamin, and mineral supplements to calves and lactating cows during the dry season and
- 2) complete health coverage, including vaccinations and treatment of internal and external parasites

This pilot study was to be conducted on nomadic herds which would be representative samples of the pastoral zone. Experimental and control herds would make it possible to compare the effects of improved techniques on mortality, weight gain, milk production, fertility, birthrate, calving intervals, , nutritional deficiencies, etc. The study was to be complemented by an evaluation of the prospects for the Livestock Service to progressively absorb the cost of interventions in the pastoral zone.

This was the fundamental direction that animal production research was to take. Apart from the study of livestock markets to determine the components of the current system and its effectiveness from the viewpoint of the livestock producer, the NRL was to furnish assistance to the Livestock Service in the three following areas:

- 1) vaccination campaign in the pastoral zone,
- 2) construction of veterinary posts and vaccination chutes,
- 3) establishment of an outreach program adapted to the zone.

I.2. Critique by the Project Evaluation

There is no question that the project strategy of conducting thorough research before moving on to a second phase of livestock productivity is sound and laudable. Based on the positive results of the NRL Project (Phase I), the Integrated Livestock Project (Phase II) would undertake specific actions and practices directly applicable to herders, their animals, and the pastoral zone. This is why, before the end of Phase I, an evaluation team performed a technical analysis of the studies and interventions conducted in the area of animal production in order to point out what has been accomplished.

In the beginning, it was decided to eliminate the study of the costs and benefits of intervention techniques in the pastoral zone because of anticipated difficulties, in collecting data on pastoralists' herds. Problems would result from the unequal treatment of the experimental and control herds. The evaluation team (ET) tried to justify eliminating this study by taking into account the incomplete character of the cost-benefit estimates presented in the project paper (PP) and the optimistic character of the hypothesis that herders would voluntarily cooperate with the NRL project.

In the place of this basic study, the results of which would be very useful in planning activities for Phase II, it was decided to substitute other studies, easier to conduct in the pastoral zone, as follows:

- 1) collection of data on herd dynamics in a limited portion of the Tchin-Tabaraden arrondissement;
- 2) collection of data on herd composition and production, on an intensive basis, by the socio-economic team working among the Twareg and the WoDaaBe;
- 3) study of animal health in order to define more carefully the the infectious and parasitic diseases which strike herds in the zone, and to determine the means to prevent them or treat them as ocassionally as possible;
- 4) aerial survey of the status of the population, livestock, and the environment in the central region of the zone the two seasons;
- 5) preliminary study of the production of hay during the rainy season in order to determine the cost of production, actual yield, profit, and nutritional value.

To this list should be added other studies conducted by TSA Dana Glazier on a WoDaaBe herd during an entire year. The data collected included the composition of the herd under study, morbid diseases and treatments administered, birth and mortality rates, the approximate age of animals, partial milk production, and girth measurements. However, the data were taken for a sample that is too small and not sufficiently representative. Other data on grazing habits and herd movements over a 24 hour period are even less broad and cannot produce representative averages through statistical analysis.

In brief, none of the above-mentioned studies could furnish the key information that would come from the original study of the costs and benefits of intervention techniques, not even the study by Dana Glazier which is more directly linked to traditional management of animal production.

In Chapter III, production data from certain government ranches will be reviewed in order to evaluate the effect of improved practices on production and to gain an idea of what their impact would be on traditional livestock production. In spite, of the validity of the justification for the new direction of research on animal production, it still would be desirable that the original idea be taken up again in Phase II, while modifying the approach previously proposed in the PP.

I.3. Filling the Gap in Research on Animal Production

On the recommendation of the evaluation team, an animal production specialist (APS) should be engaged during the six to twelve final months of the project, with the purpose of collecting and analyzing animal production data currently available in the NRL, existing in the literature on Niger, or gathered by the socio-economic team among the WoDaaBe and the Twareg. According to the ET, a study should be made of the applicability and actual cost of intervention techniques such as the following:

a) the use of feed supplements,
b) specific veterinary treatments,
c) the development of new water points, and
d) improved range management

I.4. Materially possible Contribution by the APS

Arriving in Niger on 19 July 1982, the APS was, in fact, recruited belatedly. According to the ET, he would be much more useful at the beginning of the project in order to coordinate animal production studies with those conducted on range management and the socio-economic conditions of the pastoral zone. Unfortunately, a specialist was not identified to fill this position on a long term basis. Despite the late arrival of the APS, the following is a list of possible contributions:

- 1) On the basis of available scientific literature, data gathered at the State ranches and the grazing trials, observations of the pastoral zone and of traditional herding practices, published socio-economic studies, and the intensive study of the traditional management of animal production, a preliminary report and a final report will be presented at the end of October and the end of December, respectively. The report will include:

  a) an exhaustive review of nutritional and animal resources in the pastoral zone,

  b) the characteristics of current and desirable animal production,

  c) possible causes of the low and variable productivity, and

  d) recommendations for increasing productivity.

- 2) Determine the nutritional potential of the forage resources of the zone in the rainy season and the dry season, in order to establish the specificity of nutritional deficiencies and their magnitude and to evaluate the contribution of browse species to the diet of ruminants during the dry season.

- 3) Establish the foundations for a quantitative study of traditional management of animal production, which would make it possible to modify the approach to be adopted in studying the effect of improved techniques on livestock productivity.

I.5. Model for Animal Production Study

This study should begin as a short term (one year) pilot study. It will later be extended to several herds across the pastoral zone and could last until the completion of Phase II. The goal of the pilot study will be twofold: a) to become familiar with the monitoring techniques of the traditional management of animal production, and to train Nigerien technicians assigned to the project within the framework of the study.

A. Title: Study of traditional management of Animal Production

B. Objectives:

The ultimate goal of this applied study is to solve a specific problem: the low and variable productivity of traditional herding. Consequently, the immediate goals will be to determine:

a) the parameters of animal production for the four species of domestic ruminants which make up the herds of the pastoral zone; these parameters will be explained later in detail, however, they will be limited to the most important and the easiest ones toobtain under the conditions of traditional management;

b) the costs and benefits of production inputs, i.e. the effects on animal productivity of intervention techniques, which will be defined below in the section on materials and methods.

C. Justification

This study should have been undertaken and completed before the end of the NRL Project. Its importance was justified by the PP in 1978, and its neglect criticized by the NRL evaluation in 1981.

In fact, there is very little published animal production data for the NRL zone in particular, and for the entire pastoral zone of Niger in general. It is therefore indispensable and even imperative to fill this gap before proposing valid, adequate, and appropriate solutions for increasing animal productivity.

Too much time has elapsed since the implementation of the NRL Project, and it would be desirable to begin this study before the beginning of the ILP, or Phase II. The socner the results are known, the sooner it will be possible to begin applying with certainty appropriate intervention techniques.

D. Materials and Methods

1. Materials

1.1. It is important to establish necessary contacts, for the purpose of developing an understanding and wareness among herders who voluntarily accept to participate in the study and collaborate with the NRL Project.

Contact will be established with nomad camps, at least one WoDaaBe camp and one Twareg camp. The socio-economic team will be responsible for developing an awareness on the part of the herders. The following points will be considered:

a) incentives for herder participants,
b) livestock products will be quantified but remain their property,
c) means of identifying animals,
d) visits to consenting herders and their herds before beginning the study.

1.2. Herd Selection

At the start, two herds will be carefully chosen among the consenting herders. The choice will be based on the representativeness of their herds in terms of the number and presence of the four species of ruminants: cattle, sheep, goats, and camels. In order to study the two predominant breeds of cattle, Bororo and Azawak, a WoDaaBe herder and a Twareg herder will be chosen. As for the other species composing the study herds, the breeds available will simply be recorded.

1.3. Equipment and other accessories which will be needed to obtain production data:

1) a sufficiently sensitive portable scale capable of weighing adult cattle, calves, and adult small ruminants,

2) hand scale and measures for weighing and measuring milk,

3) branders for identifying animals, or simple markers,

4) books, notebooks, pencils, etc.,

5) buckets and bottles for giving milk to calves,

6) movable panels for constructing a paddock when necessary,

7) ropes,

8) gloves

9 folding rulers,

10) miscellaneous items.

2. Methods

2.1. Management Decisions

All decisions regarding herd movements to provide pasture and water will be made by participating herders and will in no way be influenced by the NRL Project. However, the animals will be vaccinated during the annual vaccination campaign as usual. Itineraries of the herds will be known in advance in order to facilitate monitoring and the collection of production data.

2.2. Herd Composition

Herds chosen for the study will be carefully and continuously described in terms of their composition and dynamics.

2.3. Monitoring Weight

All the animals contributing to the production of the herd will be periodically weighed. Weights will be recorded at birth and monthly. The following

animals will be weighed:

a) calves, cows, young bulls, and heifers,
b) lambs and ewes,
c) camels if possible
d) kids and goats.

Weight cards will be filled out.

2.4. Monitoring milk Production

Cow's milk and camel's milk are most widely consumed in the pastoral zone. However, all milk consumed by participating nomads will be monitored. The other lactating females in the herd will be milked on a selective basis with the agreement of the herder.

Total milk production will be observed. Earlier, simple techniques for periodic monitoring will be confirmed or established. The most reliable technique will be adopted for monitoring milk production. Individual milk production cards will be filled out.

2.5. Determining other parameters

Other production parameters will be determined whenever possible.

a) Cattle

1. Age at first calving of milk cows, breeder bulls, calves heifers, and young bulls. The teeth or horns method will be used. The age given by the herder will be considered if necessary.

2. Ratio between breeder cows and bulls (sex ratio).

3. Months of lactation. To be determined starting from the date of calving.

4. Frequency of estrus.

5. Frequency of calving.

6. Length of gestation.

7. Interval between births.

8. Calving rate.

9. Mortality and morbidity

10. Other unspecified parameters.

b) Sheep

1. Age of ewes, rams, and lambs.
2. Age at first lambing.
3. Frequency of lambing.
4. Interval between births.
5. Fertility rate.
6. Ratio between ewes and rams (sex ratio).
7. Mortality and morbidity.
8. Other unspecified parameters.

c. Goats

1. Age of females, males and kids.
2. Age at first birth.
3. Frequency of births.
4. Fertility rate.
5. Interval between births.
6. Ratio between adult females and males (sex ratio).
7. Mortality and morbidity.
8. Other unspecified parameters.

d. Camels

1. Age of camels.
2. Sex ratio.
3. Frequency of births.
4. Interval between births.
5. Frequency of estrus.
6. Other unspecified parameters.

2.6. Description of Diet

The diet will be qualitatively described each time the herd moves to a new location. The following information will be observed and recorded seasonally:

1) the predominant species of grasses, shrubs, and trees ;

2) the height of the grass cover when herd arrives at and leaves a campsite;

3) the density of the grass biomass ;

4) the use of supplements and salts, including quantities and cost ;

5) the frequency of browsing on shrubs and trees, and the preference for these species in relation to the different animal species present ;

6) the distances covered between campsites;

7) the approximate pasture area at each campsite;

8) the time spent in grazing, in walking to the grazing area, in rumination, and at rest, during a day. Dana Glazier's study should be consulted before making these observations.

2.7. Water Composition

Watering the herd is an important aspect of traditional management. To be observed:

1) the frequency of watering;

2) distances between campsites and and water points;

3) approximate quantities consumed per herd and, if possible, per animal;

4) the origin of the water.

2.8. Analysis of diet and water

In order to know the chemical composition of what animals consume, feed and water will be chemically analyzed.

Representative samples of feed and water will be taken each time the herd changes location, dry matter will be determined, and samples properly prepared for analysis. Refer to the report on the NRL zone (St. Louis, September 1982) for the technique to be used.

2.9. Intervention techniques

To reach the second objective of this study it is important to carefully choose the inputs to be tested, i.e. the means of intervention to be studied with respect to their effects on production, their costs and benefits, and the possibility for the herder to adopt them easily.

In the beginning, two types of animal will be considered, young animals and lactating females the former in order to ensure good growth within the herd, and the latter in order to assure a level of milk production that is better, or at least that doesn't drop too severely, during the long dry season. This is why, at the start, interventions will focus on the period from December to June.

Descriptive details concerning inputs will be provided later. However, in the beginning, it is recommended that only two areas of intervention be considered, based on the possibility of obtaining early results and convincing herders to adopt the new techniques. The two areas are: diet and veterinary care. Other areas, including selection, will be considered later.

2.9.1. Diet

The ILP should obtain sources of energy and protein, on the one hand, and also sources of vitamin A and phosphates, in sufficient quantities for two herds of 100-200 animals. The ILP will have responsibility for ensuring that the sources of energy and protein are available in sufficient quantities in the pastoral zone, particularly at the time when they are needed by herders. The same will be true for the sources of vitamin A and phosphates, which could be imported and provided by Vetophar on an ongoing basis through the veterinary posts. However, the sources of energy and protein should be produced, if not in the pastoral zone itself, then in the agricultural zone.

2.9.2. Veterinary Care

We will leave to the ILP veterinarians the task of describing the types of treatment likely to have considerable short term impact on production. These treatments will be explained in detail later.

2.9.3. Experimental and Control Groups

It is recommended that each herd in the study be divided into two groups, with one serving as a control group. This experimental design will have the advantage of producing an immediate effect on the particiapting herder. The control groups will always receive placebos.

2.10 Verification and Adjustments of Simple Technique for monitoring milk production and weight

A. Monitoring Milk Production

1) Daily diagonal milking

	(1)[1]	(2)[2]	front	teats	F1	and	F2	1	2
Left			right	or	R1		R2		
	(3)	(4)	back	teats	B1	and	B2	3	4
	1	1		or	L3		R4		

1.1. Milking of 24 Cows over 10 Days

a) F1 (1) and B2 (4) = Q1
b) F2 (2) and B1 (3) = Q2

1.2. Hypothesis Q1 = Q2

If the hypothesis is confirmed, what is the margin of error? A correlation factor or adjustment factor (CF, AF) should be developed.

1.3. Method

a. Do a complete milking morning and evening.
b. Give milk to the calf in a bucket or a bottle
c. Choose cows at random, preferably in different months of lactation.
d. Fill out joint daily cards.

1.4. Data Collection

Day 1 - Day 10

Cow	M/E	Q1	Q2
1	M	-	-
	E	-	-
2	M	-	-

3	M	-	-
	E	-	-
10	M	-	-
	E	-	-
$\bar{X}$	M	-	-
	E	-	-

1.5. Materials

1) a hand scale (in Kg) or a liter measure
2) buckets
3) materials for recording data: pencils, paper, etc.

B. Monthly Milking (MM), twice-monthly (2 MM), or three-monthly (3 MM)

2.1. Monitor 24 cows for a period of 30 days each, choosing the cows in relation to date of calving.

2.2. Hypothesis

MM the 15th: $\bar{X}$ 1 x 30 = Milk production MP1
2 MM the 10th and the 20th: $\bar{X}$ 1 x 30 = MP2
3 MM the 5th, 15th, and 25th: $\bar{X}$ 1 x 30= MP3

If the hypotheses are confirmed, it should be determined which is most reliable, i.e. where the margin of error is smallest. A correlation factor or adjustment factor should be developed.

2.3. Method

a. Do a complete milking morning and evening.
b. Give milk to the calf in a bucket or a bottle.
c. Choose cows in different months of lactation and record the difference.

Group I = 8 in months 1 and 2
Group II = 8 in months 3,4 and 5
Group III = 8 in months 6,7,8 and 9

d. Fill out individual monthly cards.

2.4. Data Collection

Group I Cow 1 - Group III, Cow 2

Day	M	E	Total
1	-	-	-
2	-	-	-
30	-	-	-
$\bar{X}$	-	-	-

2.5. Calculations

Cow 1 Group 1 = C1 G1

Production on day 15 x 30 = MP1

Average production on days 10 and 20x30 = MP2

Average production on days 5,15,25 x 30 = MP3

MP 1 = MP2 = MP 3 = real TP for month

If the cows are watered every two days, the preceeding calculation will be performed as follows:

Group I : $\bar{X}$ 15 + 16 x 30 = MP1

Group II : $\bar{X}$ (9+10; 19 + 20) x 30 = MP2

Group III : $\bar{X}$ (4+5; 14+15; 24+25) x 30 = MP3

C. Monitoring Weight by means of body measurements

1) Develop a trend line between actual weight, on the one hand, and girth (G) and body length (BL), on the other hand.

2) Verify the following formula

Weight = G2 X BL $\frac{0}{0}$ 300

(Weight in pounds; G and BL in inches)

1 inch = 2.5 cm 1 cm = 0.4 inch

1 pound= 0.454 Kg 1 Kg = 2.2 pounds

3) Method

a. Choose several heifers, young bulls, calves, and cows.
b. Record their age.
c. Weigh them monthly for 3 to 6 months.
d. At the time of weighing, measure the G and BL.
e. Compare actual weights and weight calculations.

4) Materials

1. Scale
2. Measuring tape and rule
3. Writing materials
4. Miscellaneous

2.11. Preliminary results

2.11.1 Diagonal milk production monitoring for 15 cows during two milkings: the following results were obtained:

Q1 = 0.46 ± 0.05liters; variation coefficient = 12.3%
Q2 = 0.48 ± 0.06 liters; vc = = 11.8%

The first results are quite promising, and final results will be obtained toward mid-December and tested statistically with the "Student" test. The second half of the verification will continue through January 1983.

A special report will be submitted later to the project director.

2.11.2. Monitoring Weight by means of body measurements

The following table provides the premilinary results of cattle weights estimated by means of the trend line and body measurements.

Table 1. Estimation of Cattle weight by using the trend line between actual weight and body measurements (expressed in pounds 1 for calculation purposes)

Type of Cattle	Linear equation and calculated correlation	Body Measur. (X) (exampl.)	Weight estim. by using the trend line (Y)	Actual weight
		47,6	135	132
Calves	Y= 0,98 x - 10,1	159,8	147	151
		166,6	153	152
	r =+0,98	184,2	170	169

(Table 1 Continued)

Type of Cattle	Linear equation and calculated correlation	Body measurements (X) (examples)	Weight estimat. by using the trend line (Y)	Actual Weight
	N = 8	109,8	98	112
Average:			143	143
Heifers:	Y=0,79 x + 97,7	556,8	537	550
		373,9	417	405
	r= + 0,94	477,4	474	477
		686,8	640	634
	N = 60	574,1	601	570
		667,2	625	627
Average			549	544
Cows	Y= 0,75 x + 213,5	717,5	752	691
	r= + 0,85	805,4	817	739
	N= 8	765,2	787	790
		691,9	732	643
		760,4	784	673
		606,4	668	583
Average			757	687

1) 1 Pound = 2,2 Kg.

These preliminary results are quite encouraging. Data collection will continue for six months, after which calculations will be made based on much more data than is presently available.

The results for calves and heifers are better than for cows. We will pay particular attention to the possible causes of this difference. In the meantime, it is not unreasonable to predict that a tool is being developed that will prove useful to our work in traditional herd management conditions.

CHAPTER II. HERDING IN THE NRL ZONE

In this chapter, we will briefly review the status of the livestock sector after the major drought at the beginning of the last decade, while bringing out the need for the currently existing livestock projects. Then we will analyze the products of primary production, i.e. feed resources, and the key factors of secondary production, i.e. animal resources. Finally, from an ecological perspective, we will establish the relation between livestock and the environment in order to uncover the beneficial and detrimental consequences that could result from the interaction between the two entities.

2.1. The Livestock Sector after the Drought of 1973-1974

Shortly before the drought of 1973-74, 60% of the GNP of Niger came from the rural sector, representing 80% of the value of all exports. The development of the mining sector in the late 1970's changed these figures to 40% and 30% respectively. After the last drought, the livestock sector was seriously disorganized, resulting in a drastic reduction of the cattle, sheep, and goat populations, amounting to 48%, 23% and 20% respectively, with the camel population less affected. While waiting for statistics to be presented on the past and recent population of the four species of ruminants in the zone, the latest data from the aerial Survey revealed that the various herds have reached their pre-drought size. Furthermore, the disorganization naturally affected market prices of animals and meat according to variety. Four years ago, the figures representing the percentage of GNP and exports further decreased, to 12% and 20% respectively.

Herding in the pastoral zone is still conducted according to traditional methods and characterized by nomadism and transhumance. At issue, are not only herding techniques justified by the constraints of a harsh environment, but also a way of life necessary for the actual survival of the livestock sector in the pastoral zone. Between the pastoral zone in the north and the agricultural zone in the south, there is a hypothetical, so-called tolerance zone where sedentary herders practicing both agriculture and animal husbandry are encountered.

In the evolution towards modernization of the livestock sector in the zone, this small group of sedentary herders could have an important role to play in growing forage crops or haymaking. We will return to this point later.

Currently, the necessary hydrological infrastructure has been established in the pastoral zone, although it is not sufficient for watering all the herds during the eight or nine months of the dry season. The NRL is in the process of preparing a map of water points in the zone. This map will make it possible to pinpoint regions with shortages. In general, such regions include pasturelands that are not utilized during the dry season. This situation represents a loss of feed resources which the phase II of the Project should consider in its efforts to develop the grass biomass in the zone.

While much remains to be done to modernize herding in the pastoral zone, a serious effort was made by the Government of Niger following the calamities of the 1973-74 drought. Indeed, after the drought left approximately 75,000 families without livestock, the government began to establish a plan of intervention in the livestock sector with the goal of rebuilding the national herd, increasing productivity, assuring herder revenues, and <u>above all</u> avoiding the disastrous consequences of another drought. The task was of course enormous. Problems existed in many areas: low animal productivity, difficult rural communications, widely dispersed natural resources, the poverty of herder families, and the lack of State financial resources. Thanks to foreign assistance provided largely throught the "Club des Amis du Sahel", Niger was able to address the major problems in its plan of assistance for the development of the livestock sector, considered a key production sector.

Large-scale actions were undertaken and positive results obtained: 1) intensified health protection by means of annual vaccination campaigns targeting epizootic diseases most harmful to animal production, 2) extensive hydrological development in the pastoral zone, 3) the creation of livestock multiplication centers with the goal of producing quality animals to be distributed among herders, 4) the intervention of three projects, the Sud-Tamesna Project, the Niger Centre-Est Project, and the NRL Project, with

the goal of increasing animal production and herder revenues and improving herder living conditions. In all of these efforts, the key question remains the management of the natural range in order to protect it from overgrazing and deterioration. This appeared to be particularly pressing because of the risk of desertification and the progressive elimination of pastoral activities. We will return to this issue in section 2.4.

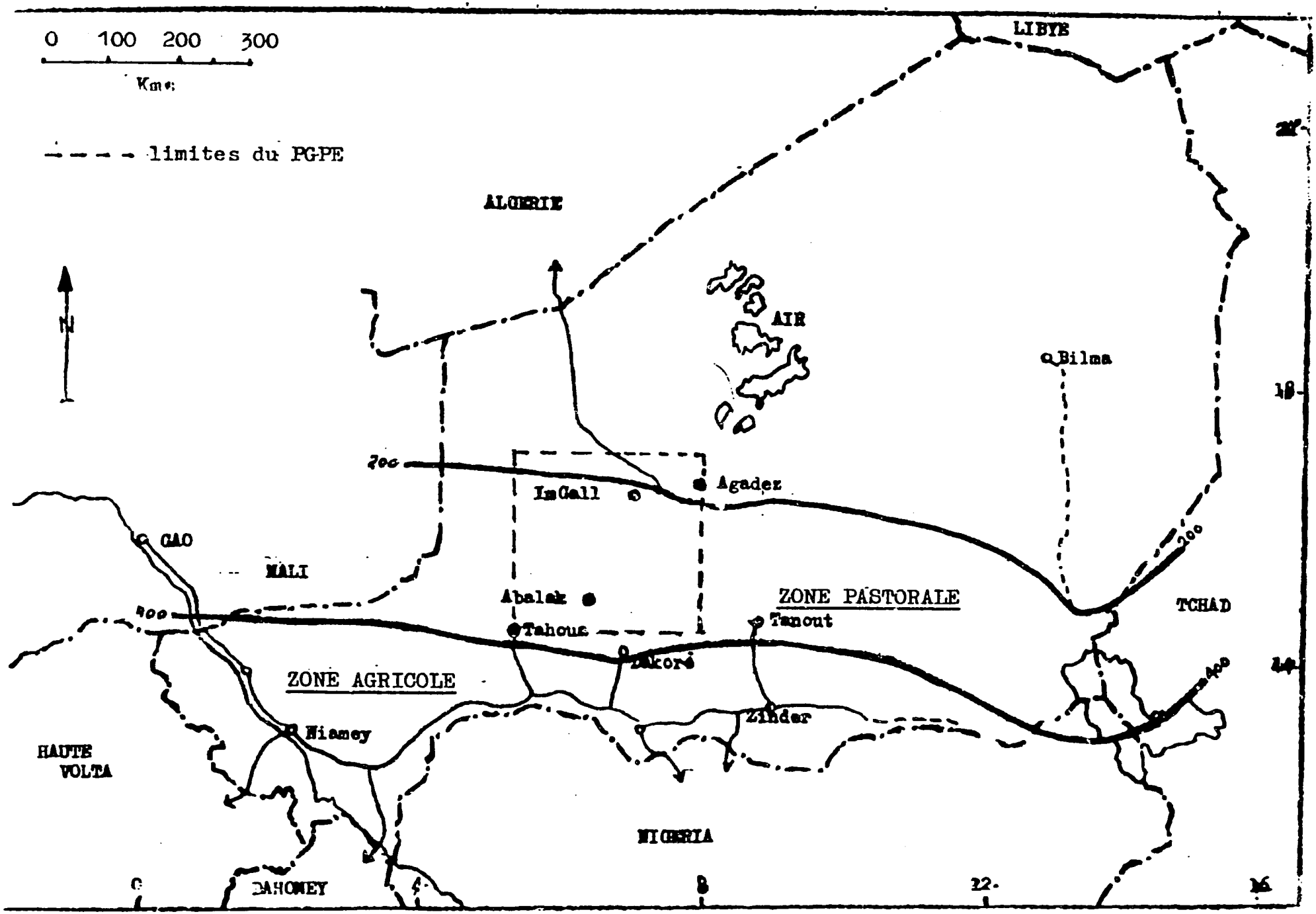
2.2. Feed Resources

Available food resources and their successful utilization remain the foundation of extensive herding. In this section, we will briefly describe the pastoral zone in which the NRL operates, the grass and browse pastures available in the two seasons, and the agricultural and industrial by-products transported to the zone at critical moments of the year. We will also present the nutritional value of the feed resources used and discuss the seasonal influence on the nutritional value of pastures

2.2.1. Natural Grass and Browse Pastures

The following map indicates the limits of the pastoral zone and the NRL Project zone. The latter has been slightly modified during implementation. Located approximately between the 200 and 400 mm isohyets, the pastoral zone extends along roughly 1,500 km of the Malian border, to the west, across to Lake Tchad, in the east. The zone includes an area of approximately 23,500,000 hectares. Law 61-5 of 26 May 1961 defined the southern limit of the zone as the 400 mm isohyet, or just south of Tahoua, Dakoro, and Tanout. In theory, agriculture remains forbidden to the north of this boundary. However, some millet is grown by nomads who lost their herds during the drought.

The NRL zone is located within the pastoral zone. It was to be bounded by Abalak, In-Gall, Agadez, and Aderbissinat, but this demarkation proposed earlier was slightly modified. It includes roughly 4,500,000 hectares of pastureland. The livestock population is slightly higher than 150,000 tropical bovine units. The human population is a little more than 50,000. The NRL operates in a zone that covers only 1/5 of the pastoral zone, but which is considered to be representative of the entire Sahelian pastoral zone in terms of range use and the level of animal production.



MAP. LOCATION OF THE NRL ZONE WITHIN THE PASTORAL ZONE

The Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux (IEMVT) and the Institut National des Recherches Agronomiques Nigériennes (INRAN) have published several reports on the pastoral zone in Niger, concerning its grass and browse pastures. These reports have concentrated not on the NRL zone of intervention, but rather on neighboring zones where the ecology is altogether the same, such as Dallol-Maouri, Sud-Tamesna, and Ekrafane, for example. One of the IEMVT studies concerned pasture regeneration in Tchin-Tabaraden, but it was abandoned in 1974 and the work transferred to the Ekrafane ranch.

In our opinion, the IEMVT and INRAN publications on the Sahelian rangelands of Niger, and on agropastoral production and development activities, constitute a body of scientific literature which should be fully exploited in formulating a national policy for managing and exploiting the natural rangelands, with the purpose of modernizing herding in the pastoral zone. All new research on the rangelands of Niger which does not take into account this earlier work risks repeating what's already been done and published, thereby wasting economic resources and failing to utilize advisedly the available human resources. Furthermore, this would constitute a loss of time which would hold up other applied research, the results of which would help to solve, once and for all, the major problem, the low productivity of herding. For information purposes, here are some of the subjects that have already been studied.

1) Principal causes of the regressive evolution of the Sahelian zone.
2) Plant/animal interaction.
3) Study of forage in Niger.
4) Livestock behavior in the Sahelian zone.
5) Intensification of forage production in the Saharo-Sahelian zone.
6) Introduction of techniques to improve livestock productivity.
7) Balance between livestock and grazing area.
8) Importance of fallow land for herding.
9) Problems posed by integrated herding and agriculture.
10) Dynamism and evolution of pasturelands.

11) Forage value of palatable species.

12) Proximate analysis of forage species.

13) Forage potential: productivity, nutritional value, palatability.

14) Seasonal influences on the nutritional value of forage species.

15) Traditional management: herd movements over a 24 hour period.

16) Plant composition of Sahelian pasturelands.

17) Complete study of biomass in a grazing area during the two seasons.

18) Grazing trials during the rainy and dry seasons.

19) Weight gain and stocking rates.

20) Practical value of stocking rate and grazing trials.

The great variety of research subjects listed above indicates the abundance of data available. We will refer again to this research in the present section on feed resources.

The feed resources available in the NRL zone consist of rainy season pastures and dry season pastures. In both cases, there is low-density grass cover and shrubberg. We will analyze the food resources of the two seasons in order to see whether they have always satisfied the nutritional needs of animals. All of the available plant species do not have the same forage appeal for ruminants. This is why it is useful to group them in two large categories: palatable and unpalatable species. The notion of palatability applied to a forage species, grass, legume, or shrub, is quite relative. According to Klein, and Mesnil (1981), in a single year (1978) the percentage of palatable grasses varied with the type of soil, 85-98% on dunes and 65-92% on glacis. Moreover, on the same type of soil, the percentage of palatable grasses varied from year to year; this variation may be due to rainfall patterns.

In any case, here is a list of palatable and unpalatable species:

1) Palatable: Cenchrus biflorus, Cenchrus prieurii, Aristida mutabilis, Eragrostis tremula, Brachiaria xantholeuca, Citrullus lanatus, tragus berteronianus, Schoenefeldia gracilis, Alysicarpus ovalifolius, Crotalaria podocarpa, and Tribulus terrestris.

2) Unpalatable: Polycarpaea corymbosa, Citrullus colocynthis, Fimbristylis hispidula, Heliotropium strigosum, Corchorus tridens, Aristida adscencionsis, Calotropis procera, and Certhoteca sesamoides.

The matter category includes certain species which are grazed during the dry season, for example Calotropis procera, Chrozophora brocchiana, and Fimbristylis hispidula.

A plant is considered a feed if it is consumed by animals. Animals behavior concerning natural pastures informs us about the feed value of plants. Table 2 shows the frequency of grazing in decreasing order for some species in the Ekrafane region. The order of preference among cattle is indicated as follows: 5+ very frequently grazed; 4+ frequently grazed; 3+ fairly frequently grazed; 2+ not frequently grazed; 1+ rarely grazed.

These observations were made during the months of March and April 1979. However, it would be desirable to repeat them during the rainy season.

Table 2. Frequency of grazing for palatable plants in the Ekrafane region

Palatable Plants	Palatable Parts	Frequency of grazing
I. Herbaceous Plants		
Citrullus lanatus	Fruit, dry hay	5+
Cucumis melo	Fruit, dry hay	3+
Schoenefeldia gracilis	Upper half	4+ to 5+
Aristida mutabilis	Upper half	4+ to 5+
Cenchrus biflorus	Upright stalks without seedheads and fallen stalks	3+ to 5+
Cenchrus preurii	Upper half with or without seedheads	2+ to 3+
Eragrostis tremula	Everything from the first leaf	1+ to 3+
Tephrosia leptostachya	Terminal leaves	1+ to 2+
Aristida sieberana	Some dry leaves	1+
II. Shrubs and Trees		
Boscia senegalensis	New leaves and ends of branches	2+ to 3+
Maerua crassifolia	Leaves and small branches	2+
Guiera senegalensis	Young leaves	1+ to 3+
Chrozophora brocchiana	Buds and terminal leaves	2+
Combretum micranthum	Young leaves	1+ to 2+
Balanites aegyptiaca	Green and dry leaves	1+
Acacia laeta	Pods	1+
Acacia senegal	Dry pods	1+

Although the above table is far from being complete, it provides useful information to ranchers who wish to relate the calving value of natural pastures to the plant composition, based on grazing frequency.

Another important factor of the feeding value of pasturelands is the forage density per hectare. Density isvery low and quite variable in the pastoral zone. Apparently it is influenced by the year, the rainfall distribution and the plant composition of the range.

Here, as an example, are data on forage densities at three locations in the pastoral zone, the Ekrafane station, the Ibecetene ranch, and the North Dakoro ranch.

TABLE 3. Density of Herbaceous Plant biomass in Pastoral Zone, Kg dry matter/hectare (Air dried)

Location	Year	Annual rainfall	Rainy season (Aug-Sept)	Dry season (early)	Annual average
		MM	Kg dry matter/hectare		
EKRAFANE	78/79	331	300	387	344
EKRAFANE	79/80	279	300	393	346
NORTH DAKORO	80/81	239	1,368	1,448	1,365
NORTH DAKORO	81/82	172	324	622	443
IBECETENE	80/81	192	655	835	745
IBECETENE	81/82	124	417	677	547
Average =		223±28	561±155	727±146	644±143

The forage production of the natural range is closely linked to annual rainfall and rainfall distribution. The unpredictable character of these climatic factors make it difficult to predict forage density, and consequently animal production, from one year to the next. It should also be noted that the low plant productivity results from the interaction of several factors, including rainfall, soil conditions, and forage species. By way of comparison, forage production reaches 8,000 Kg/Hectare in humid tropical conditions and 30,000 Kg/Hectare with irrigation. We will return to this question in Chapter IV, which discusses the causes of low animal productivity. However, it should be noted that plant production in the rainy season is measured at the same time that grazing is occurring, while plant production in the dry season was measured only early in the season. This accounts for the difference between the two seasons.

In the pastoral zone, the low forage productivity of grasses is compensated by browse species, including trees, shrubs, and bushes. Their leaves and fruits represent the basic ingredients of what is commonly called browse, which plays an important role in animal nutrition during the dry season. Most trees and shrubs remain green throughout the year. It is interesting to note that some lose their leaves in the rainy season but then grow them back during the dry season. In spite of their thorns and spines, they are well grazed by all species of ruminants to the extent that they can be reached. Because of their height, camels are most able to benefit from them.

In 1977, the IEMVT published the results of a sampling of browse species, taken from relatively thickly wooded low-lying areas.

Table 4. Average Contribution of Browse Species in low-lying areas of Niger

Browse Species	% per Hectare
Maerua crassifolia	15
Balanites aegyptiaca	20
Acacia laeta	30
Acacia senegal	R a r e
Acacia raddiana	10
Boscia senegalensis	10
Cadaba farinosa	8

This list of browse species is far from being complete. The reader can refer to the publication by R. Bartha (1970) on forage plants in the Sahelian zone of Africa for additional information.

In general, the forage yield of browse species is much lower than that of herbaceous plants. The average yield for the species listed does not exceed 65 Kg of palatable dry matter per hectare. The average fruit production of Balanites is 45 kg per adult tree in a single harvest. The value of cucurbitacae such as Cucumis melo and Citrullus lanatus, should not be underestimated. In

the hot season, Zebus are particularly partial to them and can consume more than a hundred fruits on the average per day. We will discuss their nutritional contribution to the dry season diet later.

Without a doubt, browse species make it possible to compensate for the low forage value of straw, since the livestock manage in part to maintain their condition. The following section will discuss the nutritional value of forage resources and the contribution of these two types of pasturage will be emphasized.

2.2.2. Nutritional Value of Forage Resources

One factor of animal production is diet. The quality of the diet is measured in terms of the nutritional value of available food ingredients. As yet no work has been done on the NRL zone. In this section, first we will present available data on the most common species in the pastoral zone, and discuss seasonal influences on their nutritional value. Next, we will present the research currently being conducted by the animal production specialist.

2.2.2.1. Available Data

The principal reference works are IEMVT and FAO, 1969; Bartha, 1970; IEMVT and RN, 1970; and IEMVT and MDR, 1977. The following table presents only the nutriments that are most likely to be limiting factors or to be influenced in content by the seasons or the soil conditions: crude protein (CP), digestible nitrogenous matter (DNM), fodder units (FU), crude fiber (CF), cellulose (C), calcium (Ca), and phosphorus (P).

2.2.2.2. Seasonal influence on the nutritional value of the Range

This section does not examine nutritional details, which will be discussed later (Section 4.2). In order to understand the data presented in the following table, it is important to recall the changes that occur seasonally in herbaceous and browse strata.

Table 5 Proximate analysis of certain forage species commonly found in the NRL zone on dry matter basis)

Species	Ref.	CP	CF	C	Ca	P	FU	DNM
Herbaceous		%	%	%	%	%		g
Cenchrus biflorus	2	10.0	34.6	-	0.35	0.28	0.54	37
Aristida mutabilis	2;3	9.6	36.0	-	0.32	0.15	0.47	27
Schoenefeldia gracilis	2;3	7.9	35.8	-	0.26	0.15	0.55	30
Cenchrus preurii	2;3	9.1	37.1	-	0.23	0.15	-	-
Aristida pallida	2	6.3	43.5	-	0.14	0.16	-	-
Andropogon gayanus	1;3	6.9	36.3	38.8	0.21	0.12	0.68	88
Dactylo aegyptium	3	8.7	32.4	-	0.84	0.35	0.63	39
Tragus racemosus	3	-	-	-	-	-	0.54	34
Eragrostis tremula	1;2	9.4	37.9	34.9	0.25	0.16	0.66	34
Fimbristylis exilis	2	8.9	26.6	-	0.43	0.28	-	-
Pennisetum pedicellatum	1;2	12.5	35.2	35.5	0.30	0.26	0.38	26
Cyperus conglomeratus	3	-	-	-	-	-	0.67	71
Non Herbaceous								
Chrozophora brocchiana	2	14.4	17.5	-	1.45	0.25	0.62	20
Cadaba farinosa	2;4	30.6	9.3	-	0.92	0.16	0.65	126
Maerua crassifolia	2;3	28.8	10.4	-	2.06	0.17	0.95	212
Acacia albida (leaves)	2	19.7	19.6	-	1.00	0.23	-	-
Acacia albida (fruit)	2	14.3	24.7	-	1.11	0.14	-	-
Acacia laeta	2	26.4	18.9	-	2.02	0.18	-	-
Salvadora persica	2	16.0	14.1	-	2.44	0.15	0.61	118
Balanites aegyptiaca	1	20.0	-	20.2	1.09	0.19	0.81	159
Boscia senegalensis	1;3	35.1	-	15.2	0.26	0.19	1.05	300
Cassia sieberiana	1	15.8	-	21.4	0.37	0.22	0.85	117
Acacia senegal	3	-	-	-	-	-	0.69	158
Acacia raddiana	3	17.8	17.2	-	1.55	0.21	0.98	138
Citrullus lanatus	2	10.0	17.1	-	1.96	0.46	-	-
Cucumis melo	2	27.3	16.9	-	2.98	0.68	-	-

References: (1) IEMVT and FAO, 1969;
(2) Bartha, 1970; (3) IEMVT and RN, 1970; (4) IEMVT and MDR, 1977

In fact, beginning with the first rains in July, the herbaceous stratum grows and reaches its maximum cover and height two weeks after the most abundant rains, in late August. The herbaceous plants dry out rapidly once the rains end in late Septemnber. However, certain elements of this stratum remain green until December. The overall effect is one of spontaneous and severe degradation. The browse stratum benefits from the rains by producing foliage and fruit which remain green and very palatable during the dry season. However, the productivity of this stratum is relatively low.

Table 6 Seasonal influence on the nutritional value of some herbaceous species in the Pastoral Zone

Species	Season	FU	DNM (g)
Aristida	R	0.47	27
mutabilis	CS	0.42	20
	HS	0.37	10
Aristida	R	0.45	19
funiculata	CS	0.39	22
	HS	0.36	9
Cenchrus	R	0.54	37
biflorus	CS	0.41	16
Schoenefeldia	R	0.55	30
gracilis	CS	0.47	21
	HS	0.33	11
Andropogon	R	0.68	88
gayanus	CS	0.71	37

Source: IEMVT and RD, 1970. Rainy Season (R) from July to October; cold dry season (CS) from November to February; hot dry season (HS) from March to May. For additional information See Chapter IV.

In reviewing the literature to prepare tables 5 and 6, the following observations were made.

a) Data from the analysis of the same forage species coincide only very rarely, which could be due to soil conditions, the time of sampling, the plant parts analyzed, and perhaps the methods of analysis employed;

b) The analysis table for the species under consideration is not complete;

c) The values published do not directly concern the NRL zone described earlier;

d) For the five species under consideration, there is a clear seasonal influence on their nutritional value.

Stated differently, the dry season gradually reduces the content of fodder units and digestible nitrogenous matter.

The incompleteness of the data, and the fact that, for the most part, they do not come from the pasturelands of the project zone, led us to reconsider the problem in the following manner.

2.2.2.3. Research in Progress

After an initial field trip in the NRL zone, the regions of heavy herd concentrations were observed and ecological variations reflected in the pastures were recorded. The following map is based on these observations. The triangles indicate the approximate locations where herbaceous and browse forage samples were taken. The study will cover two very distinct periods. The first sampling was done in the middle of the rainy season (late August and early September 1982). The second sampling will be done at the same locations at the beginning of the dry season (early December 1982). A third sampling could be conducted in the hot dry season (April 1983) if required by the initial results.

Although in collecting forage samples by hand it is not impossible to duplicate exactly the selection of grasses that ruminants would make, and to obtain grab samples similar to grazing animal in gestation, we tried as much as possible, to follow the preference of animals in an area of one hundred square meters at each location indicated on the map. Our samples were composed of leaves

young shoots, flowers, and in some cases the upper halves of plants. Two types of sample were taken, composite samples and single species samples. The composite samples were taken at random in an area of 100 square meters. The single species samples represent those species most abundant in the zone, for example Cenchrus biflorus, Cenchrus preurii, Schoenefeldia gracilis, Aristida mutabilis, Tragus spp. We limited ourselves to the most abundant species because these can influence considerably the proximate analysis of the pasturage. Furthermore, separate samples of stalks, leaves, and flowers were also sent to be analyzed.

During the sampling of dry season pastures all the shrubs, trees and non-grasses which remain green and constitute the browse species will also be sampled. As was emphasized earlier, these plants make a double contribution to the dry season diet of ruminants. Their contribute to the nutritional intake of digestible nitrogenous matter and vitamin A (See table 5), and also to the dietary bulk when the straw has been totally grazed. To the north, the browse stratum represents the dietary base for goats and camels, while it serves only as a dietary supplement for cattle. It is more accessible to goats and camels and does not greatly benefit cattle.

The analysis of the samples taken has already begun at INRAN (Niger) and the University of Georgia (USA). The nutriments to be analyzed are: crude energy, crude protein, cellulose, lignin, acid detergent fibers and neutral detergent fibers, calcium, magnesium, phosphorus, sodium, and vitamin A. The initial results (rainy season) will be presented if possible in the final report. Later, the results of the nutritional value of pastures in both seasons will be published. The results will provide precise information concerning nutriments which are lacking in the dry season and the magnitude of present deficiencies. This research will make it possible to understand more fully the problems raised by the exploitation of the feed resources of the natural Sahelian range.

MAP OF FORAGE SAMPLING IN THE NRL ZONE

KEY

- ▲ SAMPLING SITE
- 1-30 REFERENCE NUMBERS OF SAMPLES
- ⊙ DEPARTMENT SEAT
- ● ARRONDISSEMENT SEAT
- ♁ ADMINISTRATIVE POST
- • VILLAGE

SCALE 1 : 2 500 000

Km 50

0 50 100 150 200 250 Km.

31 A

Table 7 Sampling sites and predominant species in the samples analyzed

Code	Site	Predominant Species
1	Corrywadje	C. Biflorus (Cb); B. ramosa (Br)
2	Abalak	c.b; D. aegyptium (Da); A. mutabilis (Am) Tragus spp (T).
3	Abalak	C. Preurii (Cp); S. gracilis (Sg); T
4	Abouhaya	Da ; Cb ; T.
5	Bermo	Cb ; Br ; AM.
6	North Dakoro	Sg ; Cb; Br; T
7	North Dakoro Ranch grazing trial	(moderate, rainy season) Sg; Cb
8	Grazing trial (ND)	(moderate, dry season) Sg; Am; Cb; Br
9	Intouila	Sg ; AM ; Cb ; Br.
10	Dakoro	Da ; Am ; Sg ; Br.
11	Gadabeji	Cb ; Eragrostis tremula (Et ; Am)
12	Gadabeji (enc)	Am ; Fimbristylis exilis (Fe).
13	Bathe	Cb ; Br ; T.
14	Bathe Ranch	Sg ; Br ; Cb.
15	Bathe Ranch	Sg ; Cb ; Da ; Am ; Br.
16	Bathe-Aderbissinat	T ; Br ; Sg ; Cb ; Da.
17	Bathe-Aderbissinat	T ; Sg ; Cb.
18	Aderbissinat	Cb ; Am ; Sg.
19	Aderbissinat-Agadez	Am ; Cb.
20	Agadez	Pennisetum pedicellatum (Pp)
21	In-Gall	Am ; Sg ;Eragrostis pimosa (Ep)
22	In-Gall	Maerua crassifolia (Mc)
23	In-Gall	Am.
24	In-Gall-Abalak	Da ; Ep ; Sg.
25	In-Gall-Abalak	Cb.
26	Tchin-Tabaradene	Da ; Cb ; Am ; Br.
27	Tchin-Tabaradene	Da ; Cb ; Sg ; T.
28	Ibecetene	Cb ; Am ; Sg; Br.
29	Tchin-Tabaradene	
30	Tchin-Tabaradene	
31	Tchin-Tabaradene	T
32	" " "	Sg
33	" " "	Cp
34	" " "	Am
35	" " "	Cb
36	" " "	Ep
37	" " "	Da
38	" " "	Composite sample (+ A. funiculata)
39	" " "	Composite sample (stalks)
40	" " "	Composite sample (leaves, flowers)

Table 8 Nutritional value of the rainy season pastures in the NRL project zone (mineral composition)

Code	P%	Ca%	Mg%	Na%	K%
1	0.26	0,64	0,34	0,01	3,35
2	0.33	0,64	0,29	0,01	2,11
3	0.26	0,40	0,38	0,01	1,40
4	0.26	0,56	0,10	ND	1,70
5	0.18	0,40	0,24	ND	2,81
6	0.28	0,48	0,20	0,01	2,42
7	0.17	0,48	0,20	0,01	2,03
8	0.22	0,56	0,10	ND	1,90
9	0.27	0,48	0,05	ND	1,60
10	0.25	0,64	0,24	ND	2,40
11	0.16	0,32	0,14	ND	1,70
12	0.31	0,40	0,24	ND	2,80
13	0.25	0,48	0,24	ND	3,90
14	0.35	0,48	0,20	ND	2,10
15	0.20	0,32	0,10	ND	1,70
16	0.20	0,40	0,24	ND	2,10
17	0.26	0,32	0,10	ND	1,30
18	0.17	0,40	0,14	ND	1,70
19	0.29	0,40	0,24	ND	2,70
20	0.33	0,80	0,10	ND	4,60
21	0.25	0,48	0,24	ND	1,90
22	0.14	1,60	0,82	ND	3,30
23	0.17	0,40	0,20	ND	1,70
24	0.29	0,48	0,10	ND	2,90
25	0.31	0,32	0,05	0,01	4,40
26	0.17	0,40	0,14	0,01	1,50
27	0.16	0,24	0,24	0,01	1,50
28	0.13	0,24	0,14	ND	1,50
29	0.28	0,48	0,20	0,01	2,90
30	0.26	3,40	0,34	0,11	4,40
31	0.16	0,32	0,20	0,11	2,20
32	0.19	0,32	0,20	ND	2,20
33	0.23	0,24	0,24	ND	2,90
34	0.22	0,24	0,20	ND	0,90
35	0.24	0,40	0,24	0,01	3,60
36	0.30	0,40	0,24	ND	1,30
37	0.24	0,48	0,50	ND	3,02
38	0.20	0,44	0,22	0,01	2,25
39	0.13	0,56	0,30	0,02	3,20
40	0.19	0,56	0,20	0,01	1,70

Table 9. Nutritional value of the rainy season pasturage in the NRL Project zone (proximate analysis)

Code	Crude energy Cal/g	Crude protein %	Cellulose %	Lignin %	NDF/ADF %	Vitamin A IU/kg
1	3.314	9,81				5,400
2	3.514	7,00				9,500
3	3.735	6,25				7,600
4	3.825	6,25				3,800
5	3.717	9,25				9,500
6	3.735	9,50				4,600
7	3.878	4,76				4,600
8	3.731	6,37				4,600
9	3.817	8,31				3,800
10	3.621	14,18				4,600
11	3.950	7,0				4,600
12	3.879	9,75				7,000
13	3.591	18,06				7,600
14	3.802	12,0				7,600
15	3.848	7,68				9,200
16	3.806	10,62				7,600
17	3.906	5,62				10,800
18	3.894	6,56				9,200
19	3.781	12,87				9,200
20	3.490	21,12				12,700
21	3.938	11,81				4,600
22	3.606	24,87				5,400
23	3.965	7,87				3,800
24	3.735	8,68				4,600
25	3.608	12,68				5,400
26	3.938	4,43				4,600
27	3.908	6,25				4,600
28	3.957	5,00				4,600
29	3.725	14,12				9,200
30	3.564	14,62				9,200
31	3.766	6,06				6,200
32	3.873	8,62				5,400
33	3.783	5,62				7,800
34	3.918	8,87				7,600
35	3.677	7,31				5,400
36	3.843	5,12				5,400
37	3.766	11,18				4,600
38	3.798	8,5				4,600
39	3.744	5,37				4,600
40	3.910	8,56				5,400

2.2.3. Major Problem

To evaluate fully the Sahelian pastures , it is important to recall that the various forage species in the area develop normally during the rainy season but then behave differently during the dry season. Some species, such as Sesbania leptocarpa, lignify quickly and lose their leaves at the end of the rainy season. Others, such as Panicum laetum; perish completely as soon as the dry season begins. In some cases, including Aristida mutabilis, the stubble dries but provides feed for animals throughout the dry season. Certain species, such as Tephorosia purpura, remain green during almost all of the dry season. Finally, there are non-grass species whose leaves and fruits compensate for grass deficiencies, such as Alysicarpus spp. and Chrozophora spp.

The major problem in the pastoral zone of Niger can be simply stated: in no way can the pastures satisfy the needs of all animal species during the whole year. Granted, animals attempt to supplement their diet by consuming green browse plants or other more nutritional dry matter. However, as we have already seen dry forage production at the beginning of the dry season scarcely exceeds 800 kg of dry matter per hectare, and browse stratum production is even lower, less than 80 kg of dry matter per hectare. As a result, the dry matter and nutritional needs of animals remain unsatisfied and the animals continuously grow thinner. While they may manage to survive on a diet that is far from adequate, a large number lose their commercial value or die from under-nutrition complicated by malnutrition. This already alarming situation becomes even graver during the months of May and June, the period called the soudure.

The "soudure" is the most difficult period for nomadic herding. It is characterized by the emergence of a sparse growth of grass following the first rains; the desintegration and rotting of straw from the previous year, due to the humidity; the inadequacy of available forage for satisfying cattle; a preference for young shoots, as animals abandon straw; diarrhea and weight loss among cattle.

2.2.4. Solutions

To solve this problem, several solutions have been proposed, and some have been tested. Given that diet remains the number one factor in animal production, different solutions to the problem of livestock diet will be discussed in Chapter 5. In the meantime, the following options can be listed.

a) To exploit to the optimum the abundant forage which grows during the rainy season, remains unused, and dries or lignifies or perishes at the beginning of the dry season, by establishing forage reserves of hay or silage.

b) To burn pastures in the late dry season in order to free them of old lignified plants and bothersome bushes and to increase forage production,

c) To seed the pastures with persisitent forage plants that are drought resistant and have a higher nutritional value than the natural species.

d) To plant trees to which livestock are partial and which provide shade.

A final solution would consist of importing agricultural and industrial by-products to the pastoral zone.

2.2.5 Agricultural and industrial by-products

The use of agricultural and industrial by-products in the project zone is quite common during the dry season and particularly during the "soudure." Cottonseed, wheat bran, and peanut hay are the by-products most frequently used by herders in the pastoral zone. Cottonseed and peanut hay are quite expensive toward the end of the dry season and supplies often run out without satisfying the demand. An inventory of these feed resources for livestock in the pastoral zone and their nutritional value will make it possible to understand better the overall problem of diet and the obstacles to finding quick and permanent solutions.

The by-products used as feed supplements are presented in two categories.

A/ Concentrates	Quantities (tons) Produced	Imported	Year
1. Cottonseed	885	1.621	81-82
2. Wheat bran	-	1.428	81-82
3. Rice bran	870	-	81-83
4. Peanut bran	-	-	-
5. Peanut cake	1.481	-	-
6. Peanut fragments	-	-	-
B/ Roughage			
1. Cowpea hay	-	-	-
2. Peanut hay	-	-	-
3. Bush hay	-	-	-
4. Millet stubble stalks	-	-	-

Table 10. Nutritional value of agricultural by-Products (on dry matter basis) used in Niger

Crop Residues	CP %	Cel %	Ca %	P %	FU Per Kg	DNM (g)
Peanut hay (1)	8.1	33.1	0.89	0.15	0.62	41
Cowpea hay	13.6	24.3	0.53	0.12	0.80	94
Peanut hay (2)	14.8	22.8	0.81	0.15	0.75	107
Rice straws (3)	5.5	38.2	0.13	0.05	0.30	28
Millet leaves (4)	3.7	40.0	0.55	0.14	0.36	5

Source: IEMVT and FAO, 1969

(1) Hay stored after shelling

(2) Hay removed after uprooting; (3) Straw baled at the paddy at harvest time

(4) dried leaves stored after the cereal harvest.

Table 11 Nutritional value of industrial by-products on dry matter (DM) basis

	DM %	CP %	CEL %	CA %	P %	DP %
Wheat bran (average)	88.9	15.5	14.3	0.15	1.14	11.9
Rice bran	90.4	8.9	22.2	0.09	0.61	5.9
Millet bran	88.2	13.8	4.6	0.08	0.48	10.3
Sorghum bran	88.2	10.5	7.9	0.09	0.64	7.9
Peanut cake	89.8	55.5	7.5	0.11	0.64	51.0
Peanut bran	93.6	14.1	20.3	0.15	0.04	4.9
Peanut shells	91.1	4.1	66.6	0.20	0.18	1.5
Cottonseed (whole)	92.6	23.6	25.7	0.18	0.36	16.6

Source: Min. Coop. Franc. Memento de l'Agronome, 1974

Tables 10 and 11 are far from being complete. They only make it possible to compare the nutritional value of forage species available in the pastoral zone with the nutritional value of supplements that are brought into the zone, either to help animals maintain their condition or to increase milk production. Concentrates should not replace roughage in any way.

Apart from these feed supplements, there are also the mineral salts of Niger, which are sold at almost all markets in the pastoral zone and widely used. They can be grouped according to their principal mineral contents.

Herders add salts to the diet of their herds either during the salt cure (la Cure Salée) of the rainy season, or at will. Apparently, using salts poses no problem. It remains to be seen whether the animals truly into account the quality of the salts and the ways in which they are used. This question will be considered later.

Table 12 - Mineral salts available in Niger

Source of	Name of salt	Origin	Principal Content	
Na	White natron	Lake Tchad	Na_2CO_3	50%
	Pink natron	Achenouma	NaCl	20%
Na Cl	Bilma	Beza	NaCl	80%
		Bantou	NaCl	65%
NaCl	Salt earth	T.N'Tessoum	NaCl	70%
NaCl	Boboye	-	NaCl	68%
NaCl	Fogha	Gaya-Azemou-raba	NaCl	45%
NaCl	Fogha	Bara	NaCl	75%
Ca and P	Malbaza	-	Ca	41%
Ca and P	Crushed bone (green)	Bush	Ca:24.2%	P: 11.2%
Ca and P	Crushed bone (meal)	Bush	Ca:35%	P: 15.5%
Ca and P	Coprolites of In Akker	Tahoua (1)	Ca:36.5%	P:15%
Macro and trace elements	Growth salt	Nigeria	NaCl	48%
			Ca	15%
			P	7.5%
			Co	0.02%
			Zn	0.0028%
			I	0.0032%
			Cu	0.015%
			Fe	0.07%
			Mn	0.034%

Source: personal communication (1) the high fluorine content (3.6%) represents a problem for nutrition.

2.3. Animal Resources

Four species of ruminants form the basis of animal production in the pastoral zone of Niger: cattle, sheep, goats, and camels. In this section, we will consider these ruminants as available factors of production. Thus, the following points will be presented and discussed:

1) national and NRL project zone statistics,
2) herd distribution and predominance in different regions of the pastoral zone,
3) herd composition in general, and the production potential of herds.

2.3.1. National and zone statistics

In the present conditions of the pastoral zone, it is quite difficult to obtain exact statistics on livestock. In general, animals are counted at vaccination centers during the annual campaigns, and the data are adjusted according to a formula which indicates an approximate annual growth rate of 5%. Based on information from campaign officials, the reluctance of herders to bring all their animals to the vaccination centers is the principal reason that the true livestock population is underestimated. The alternative approach involves an aerial survey of herds during the two seasons. Coordinated by Dr. K. Milligan, several aerial surveys and mappings of the project zone have already been conducted by ILCA (International Livestock Center for Africa). Because of the constant movements of nomadic and transhumant herders and their herds, the statistics from the aerial surveys reveal that the number of animals counted, based on photographs, varies seasonally.

Thus, it is not unreasonable to question the exactness of the statistics resulting from the ordinary census based on the annual vaccination campaign. If the data from the aerial surveys are closer to the truth than those used until now by the Livestock Service, then it would be advisable to extend the technique to the two other pastoral zones, the Sud-Tamesna and Niger Centre-Est zones.

Unfortunately, published national estimates do not always agree.

Table 13 National estimates of the livestock population in Niger from 1972 to 1981 (in Thousands of head)

Year	Cattle	Sheep	Goats	Camels
1972	4,110	2.650	6.100	330
1976	2,671	2.354	5.946	283
1977	2,850	2.556	6.540	345
1978	2,990	2.650	6.700	352
1979	3,257	2.764	6.871	359
1980	3,354	2,875	7.043	366
1981	3,421	2,900	7.219	373

Source: MDR.

Donkeys and horses are omitted from this list because of their slight contribution to animal production per se. This table indicates the slow growth of the animal population in general, and shows that the pre-drought levels have already been reached, except for cattle, based on these figures.

As a result of the drought, the size of the national herd dropped from 4,900,000 tropical bovine units (TBU) in 1972 to 3,000,000 TBU in 1974. One TBU is equal to 250 Kg of live weight. Thus 1 camel = 1 TBU; 1 bovine = 0.80-0.75 TBU 1 sheep or goat = 0.1 - 0.15 TBU and 1 donkey = 0.5

Table 14 shows a 30% increase in the number of cattle from May to October 1982. In May, 53% of the cattle were of the Bororo breed, whereas in October the figure grew to 66%. For the Azawak breed, the October figure shows a 5% drop. Accordingly to Milligan (ILCA, 1982), these results suggest that the Azawak cattle for the most part remain inside the survey area, in contrast with the Bororo cattle, which are subject to long transhumant movements. If these results are confirmed on the ground, they should be given careful attention during future interventions of Phase II of the Project. This will be particularly important given that the two breeds are managed by different ethnic groups who have different ways of life and who, perhaps, would require different approaches.

TBU or UBT is comparable to Livestock Standard Unit.

Table 14 Estimate of the Livestock Population in the NRL zone (1), in May and October 1981 (2)

Species	Total number of head		Stocking Rate	
			Hectares/Head	
	May	October	May	October
Cattle	288,653	376,533	28.2	21.6
Bororo	152,814	246,900	53.5	33.0
Azawak	135,839	129,632	59.9	62.9
Sheep & Goats	780,289	1,147,914	10.4	7.1
Camels	70,162	89,314	116.3	90.9
Donkeys	13,540	20,041	588.2	400.0
UBT (3)	410,465	533,921	19.2	15.3

(1) The area surveyed covered 81,555 sq. km., or 1.81 times larger than the initial project zone.

(2) Source; ILCA, 1982.

(3) The UBT equivalents are shown above.

Regarding small ruminants, the difference between the figures for May and October is even greater, amounting to an increase in the estimates of 47.11% at the end of the rainy season. This increase in the total number of small ruminants was not reflected in the number of sheep and goat herds in the two surveys: 1,546 in May and 1,465 in October. The discrepancy is explained by an increase in the average size of the herds, from 46 head in May to 70 head in October. We will return to this subject in section 2.3.3.

Concerning camels, there was no significant difference between the two surveys, in terms of total number of head, number of herds, and average herd size.

The situation of donkeys is somewhat particular. The reader is referred to ILCA, 1982, page 17 for details.

2.3.2. Herd distribution and predominance

The specific zone of the project (Phase I) covers only certain parts of four arrondissements: Tchin-Tabaradene, Agadez, Dakoro, and Tanout. The Livestock Service estimates provide figures only for the entire arrondissements. There are no precise data on the distribution of herds in the pastoral zone. The only available estimate before ILCA (1982) was done by IEMVT for the period 1969-70. According to this source, the estimate of the actual animal population in the pastoral zone reaches 1,410,000 TBU in the dry season and 1,730,000 TBU in the rainy season. A rather curious phenomenon occurred after the drought. About 60% of the national herd utilized the pastoral zone during the rainy season. Then a large number of herds moved southward to the agricultural zones. As a result, only about 35% of the national herd remains in the pastoral zone during the dry season.

Table 15 Seasonal distribution of livestock in Niger between the pastoral zone (PZ) and the agricultural zone (AZ) for the year 1980, in thousands of TBU

Species	Dry Season (Dec. to June)		Wet Season (July to Nov.)	
	PZ	AZ	PZ	AZ
Cattle	450	1,790	1,340	900
Sheep & Goats	185	685	330	540
Camels	310	-	310	-
Horses & Donkeys	75	195	140	130
T O T A L:	1,020	2,670	2,120	1,570

Source: Ministry of Plan, Niger

According to these figures, there is a movement of livestock toward the agricultural zone in the dry season and toward the pastoral zone in the rainy season. But rather, curiously, the agricultural zone continues to support 42.5% of the national herd during the rainy season when pasturelands to the north are abundant and under-utilized.

It is traditionally held that during the rainy season(July-September), the herds disperse toward the Agadez region to the North (In-Gall, Tiggidan-Tessoum) for the cure salée. However, the aerial observation of the project zone revealed that the heaviest concentration of livestock is September 1982 was not in the salt earth regions (I. Turawa - personal communication).

Recent data from the aerial surveys (ILCA, 1982) have shed light on the distribution of herds during both seasons in different regions of the project zone.

a) During both seasons, there is a rather clear concentration of herds of cattle toward the south. The observed concentrations are 74% in May and 83% in October. The regions of heavy concentration appear to the east of the Tahoua-Agadez national road, from Abalak to Aderbissinat. There is also a difference in the distribution of the two breeds. In May, the Azawak breed is chiefly concentrated in the southwestern regions between Tahoua and Tchin-Tabaradene, while the Bororo breed is concentrated in the southern and Aderbissinat. In October, this difference in distribution is even more pronounced, although there is a heavy concentration of Azawak cattle in the area around Tahoua and, to a lesser extent, Tchin-Tabaradene.

To sum up, the two breeds are by and large divided by the Tahoua-Agadez road. The Bororo cattle of the WoDaaBe to the east are very mobile, while the Azawak cattle of the Twareg to the west are less so.

b) During both seasons, sheep and goats are ralatively evenly distributed throughout the zone surveyed by ILCA. In May, the lowest densities are observed north of Agadez, while in October, the density increases around the city.

c) Camels are fairly evenly distributed throughout the portion of the pastoral zone that was surveyed. Apparently there are two regions of heavy concentrations in the month of May: around Tassara and between Abalak and Agadez. In October, heaviest concentrations are in the regions around Agadez, Abalak, and Aderbissinat.

2.3.3. Herd Composition and Size

There is little statistical information on herd composition under traditional management. The NRL has undertaken a study of the composition and dynamics of the nomadics herds in the regions of Agadez and Tchin-Tabaradene. The Tchin-Tabaradene study, conducted by I. Turawa of the NRL, will be published shortly. In the meantime, the portion of the study done in Agadez provided the data presented below.

The Agadez study was performed on WoDaaBe and Twareg herds totalling 720 and 285 respectively. For the sake of comparison, the herd composition results are presented simultaneously.

Table 16 Herd Composition in the Agadez Region

Species	WoDaaBe			Twareg		
	Distribution %	Average Size (1)	Males %	Distrib. %	Aver. size(1)	Males %
Cattle	47.4	47	25.2	2.9	30	23.3
Sheep	32.4	32	18.7	40.8	79	19.9
Goats	18.6	18	17.4	43.4	84	18.6
Camels	1.6	1-2	9.3	12.9	25	30.2

(1) Average number of head per herd.

Based on the preceeding table, the species breakdown and the average herd composition are very different for the two etthnic groups.

Cattle represent the most numerous species among the WoDaaBe (47.4%), and the least numerous species among the Twareg (2.9%). In contrast, small ruminants are more numerous among the latter group (84.2%) than among the former (51.0%). The same is true of camels: 12.9% vs. 1.6%.

Moreover, males represent about 25% of cattle of herds, and 18-20% of flocks of sheep and goats. We should consider the structure of cattle herds in terms of age.

Table 17 Structure of cattle herds according to age

Age Class	WoDaaBe	Twareg
Years	%	%
0 - 2	34.6	32.1
2 - 4	17.2	15.2
4 - 6	19.2	25.5
6 - 8	16.4	16.3
8 +	9.1	7.0
Castrated males	3.1	3.9

The age structure of herds is almost identical between the WoDaaBe and the Twareg, with the exception of cattle between the ages of 4 and 6, which are more numerous in the Twareg herds. If the herds are divided into two large groups, under age 4 above age 4, the tendency is the same for WoDaaBe and Twareg herds, i.e. 10-16% more animals in the second group. In brief, it can be stated older animals (above age 4 approximately) represent, if not the majority in herds of the Agadez region, at least a relatively high percentage. This would mean that the movement of animals within the herds is slow and that the rejuvenation of livestock is not a priority.

The data on average herd sizes for the whole pastoral zone surveyed by ILCA are presented in Table 18. The data represent global figures except in the case of cattle. The tendency is the same in Turawa's data and the ILCA data, i.e. WoDaaBe herds have more cattle (Bororo) than do Twareg herds (Azawak). However, the data on small ruminants do not coincide. The aerial survey underestimated small ruminants in Twareg herds, where their number may reach 170 head. This discrepancy points out the importance of regional surveys which come closer to reality.

Table 18 Herd sizes in the pastoral zone surveyed in 1981

Species	Number of head per herd	
	May	October
Cattle	33.2	37.2
Bororo	38.0	45.4
Azawak	29.0	28.2
Sheep and goats	46.0	69.5
Camels	5.4	5.6
Donkeys	6.8	6.3

Source: ILCA, 1982

It should ne noted that the size of the Azawak herds did not significantly change between the two seasons, while the size of the Bororo herds increased by 19.4% in October. Similarly, the size of sheep and goat flocks increased by 50%. For additional information on patterns of didtribution, see ILCA, 1982.

2.4. Relationship between Livestock and the Environment

Faced with an extremely difficult environment, characterized by limited feed resources and the near impossibility of providing livestock with an adequate and nutritious diet, herders inevitably rely on nomadism. Nomadism is a way of life and requirement for survival in the Sahelian pastoral zone. It enables herders to exploit vast areas, seeking new pastures to supply livestock with certain indispensable nutritional elements that are lacking in bare and overgrazed regions.

At the center of the interaction between herbivorous livestock and the browse and grass strata of the environment, are herders, who influence natural evolution through the decisions they make regarding transhumance or nomadism when and where they consider it necessary.

As emphasized earlier, the basis of herding is diet. In the extensive herding of the pastoral zone, diet is based on the biomass. Without the biomass, herding in the Sahel would be unthinkable and even impossible. It is naturally influenc-

ed by ecological and climatic factors, but is profoundly modified by the influence of man and livestock. Thus, in this section, we will discuss the triple influence of the specific biology of forage plants, of livestock, and, of herders on the equilibrium of the pastoral zone ecosystem.

2.4.1. Influence of the specific biology of forage plants

Drought in the Sahel has nearly resulted in the disappearance of certain perennial species, including Andropogon gayanus, Cymbopohon proximus, and Cyperus conglomeratus. This near disappearance is due to their particular capacity for reproduction and seed dissemination and their ability to germinate. Research conducted by IEMVT (IEMVT and MDR, 1977) has demonstrated that a single early rain suffices for almost all the seeds of the perennial species to germinate and if a period of drought then follows, as frequently occurs in the Sahel, all the young shoots may disappear after the entire stock of seeds has been used up. Thus, their survival would require a favorable distribution of rainfall. Their importance in the ecosystem is undeniable and their disappearance would have repercussions at many levels. Concerning nutrition, for example, the presence of perennial grasses in a natural pasture contributes to the energy, protein, and carotene supply at a time of year when dried out annual grasses are partially or totalling lacking in these important nutriments.

Regarding annual grasses, their regeneration in a natural prairie is not assured unless fructification is not disturbed by livestock. In general, their vegetative cycle is short, particularly so when water is the limiting factor. Obviously the way in which grazing occurs influences forage production and natural seeding.

The big question that arises in this particular context is the following: What would be the best time for grazing in order to avoid pasture degradation and constantly maintain the equilibrium of the ecosystem?

Early grazing can destroy several germinations. It should be recalled that grazing eliminates the photosynthesizing parts, which leads to a reduction of the radicular system and thus a decrease in water absorption.

Grazing during the period of growth point elevation can reduce the number of flowering tillers and thus the quantity of seed.

Grazing during fructification of annuals can lead quite simply to the destruction of a species unless it keeps animals away through the presence of protective fruits, such as the burs of Cenchrus biflorus.

Under natural conditions, with no external influences, a grazing rotation occurs because of the vast area available and the rainfall variability. Nomads possess a science of range management (Maliki, 1982). According to Maliki, the WoDaaBe "take great care to vary widely the type of pastures made available to the herd". Their extreme mobility becomes a strategy for finding forage species of quality and abundance, which vary from one region to another. The mobility of herders in the pastoral zone ensures periodic resting of pasturelands, which is essential to maintain the equilibrium between vegetation and livestock.

2.4.2. Influence of Livestock

The influence of livestock is great on the perennial species which do not regenerate sexually. By grazing the existing clumps, animals may progressively eliminate the parts which photosynthesize glucose, and consequently exhaust reserves. Plants unable to develop their roots soon offer from lack of water and die. Termites complete the work of extinction and degradation.

The trampling and pulling up of young annual shoots during early grazing can also lead to the destruction of annual species. The good herders knows when to move his herd along to avoid the worst.

The influence of livestock on the browse stratum is quite obvious.

The browse stratum has undeniable importance for the diet of the livestock in the Sahel. Livestock are always in better condition and less cachexic where browse species are present than in treeless areas.

This is why it is important to control the impact of animals so as to encourage the normal evolution of the stratum and its productivity. The technique of deferred grazing by rotation is recommended. We will return to this point later.

2.4.3. Influence of Herders

Although grazing is free and unrestricted, decisions made by herders influence the equilibrium of the ecosystem. The influence is negative when they concentrate too many animals in a relatively small area and thereby increase the stocking rate. This sets off the process of degradation of the vegetation, and occurs in either of the following cases.

a) A herder decides to graze his animals in an area already abandoned by another herder who judged it to be sufficiently exploited.

b) The construction of a borehole leads to a heavy concentration of livestock in the vicinity.

2.4.4. Conclusion

The solution for preserving the ecosystem and ensuring good forage productivity in the pastoral zone calls for techniques of deferred grazing and the creation of forage reserves. The approach is not easy, and application of these techniques will require constantly developing the awareness of the beneficiaries themselves.

CHAPTER III. ANIMAL PRODUCTION

3.1. General Considerations

The mutual dependence and interrelationship of livestock and the environment were emphasized earlier. Animal production is strongly affected by environmental factor such as climate, soil types, and water. In the Sahel, animal production is limited by these factors. Only ruminants are found in the pastoral zone because available food resources are not suitable for raising non-ruminants. Current livestock activity is the result of a long, natural selection. However, the growth of ruminants and their productivity are closely tied to the quantity and quality of forage, trees, and shrubs which grow naturally in the pastoral zone? The quantity and quality of pastures depend in turn on the amount and distribution of rainfall, the type of soil and its nutritive element content. Unfortunately, conditions in the Sahel are such that it is presently unthinkable and uneconomical to fertilize the range in order to improve, and thus stop the continuous decline in productivity.

If herding in the Sahel is to become a profitable enterprise, it will first be absolutely necessary to improve the environment in spite of natural constraints. The ultimate goal is not to alter completely herding as it now exists, i.e. nomadism and transhumance, but rather to improve the way in which herds are managed, as well as livestock health and diet, especially during the long dry season. The improvement of the nutritional status of livestock will no doubt be the most important change ever achieved in the Sahel.

To increase the profits that herders make from their herds, we do not recommend changing, even gradually from the nomadic life to a sedentary existence. Nomadism is a way of life and a means of survival under Sahelian conditions. Such a change would give birth to too many problems, and to solve them would prove a colossal task.

There is abundant literature on the means for improving animal production in the pastoral zone. Some suggestions are unrealistic, others too ambitious. In Chapter V on recommendations, the various proposals will be reviewed, and those with the greatest likelihood of success will be identified, analyzed, and simply stated.

The two principal animal products of the zone are meat and milk. These can be produced separately by specialized herds or together by herds with a dual purpose. In the Sahel, cattle are exploited for both meat and milk. The milk of camels is consumed quite a bit, especially in the regions of In-Gall and Agadez. Small ruminants are exploited primarily for meat. Camels, donkeys, and sometimes cattle are raised for transportation. Later, in considering the characteristics of animal production, we will limit ourselves to the two principal animal products in Niger, meat and milk.

In the meantime, it is not superfluous to emphasize here that the producer does not produce in a vaccum. He produces for a marketplace. The movement of his products and the prices at which he sells them represent a determining factor for developing his production and expanding his enterprise. If the market is not sufficiently developed and prices are too low, the herder-producer will not have the necessary impetus for expanding his activities. This could explain in part the traditional reluctance of the Sahelian herder to sell his livestock at the end of the rainy season. Selling at the right time would rejuvenate his herd, increase his offtake, and improve the turnover of his capital.

The reader is referred to Makinen and Ariza-Nino (1982) for economic analyses concerning the influence of marketing on animal production in the pastoral zone.

3.2. Desirable Characteristics

The two predominant breeds in the zone, Azawak and Bororo, and their crosses have survived by adapting to the inclement conditions of the environment. In spite of their low production potential, the many surviving herds are the result of a certain natural selection. Selection work done with the Azawak breed, begun more than three decades ago at the Toukounous station, has shown that solely by means of selection, without adding outside genes, the potential for cattle production can be significantly improved. The same could be said of the red Maradi goats.

Certainly the cattle, sheep, and goat herds of the zone, to mention only three species, demonstrate production characteristics that are inferior to the standards for profitable industrial livestock raising. These characteristics are measurable and are together referred to as zootechnical parameters of production. Evaluating the following characteristics in the pastoral zone is not an easy task.

Beginning with cattle, how can we best evaluate the fertility of cows, their maternal fitness, and the viability of calves?

3.2.1. Fertility

Fertility is measured in terms of the conception rate, the calving percentage, and the interval between two successive births. In Africa, it is reported (Sjoberg and Perssons, 1974) that the calving percentage is not higher than 50, which means that on the average a cow produces a calf once every two years, whereas in a profitable operation she should produce a calf each year. This low fertility is due in large measure to the poor nutritional status of the cow. A phosphated supplement given to zebu cows in East Africa (Lampkin et al, 1961) had a positive effect on their fertility. It is mainly during the dry season that interventions are needed since at this time the straw is lacking in digestible protein and vitamin A. To these deficiencies should be added phosphorus, which is deficient in all semi-arid soils (Ensminger and Olentine, 1978).

The conception rate and the number of times a cow is mounted per conception are difficult to determine in the pastoral zone and even at the multiplication centers, because mounting is neither restricted nor monitored. This information is important for good management since sterile and unproductive cows should be eliminated.

The third criterion for evaluating fertility is the interval between two births. The interval should average 365 days, or 280 to 290 days for gestation and 75 to 80 days before conceiving again. In general, the period of gestation does not vary greatly unless there are health complications. In contrast, the period before conceiving again can be greatly prolonged due to malnutrition leading to a state of cachexia in the lactating cow. The result is lengthened anestrus and the impossibility of conceiving again 80 to 85 days after parturition.

3.2.2. Maternal Ability

Maternal ability is evaluated in terms of milk production, which affects calf survival between birth and weaning. This milk production on which the calf relies is linked to the age of the cow. Old cows are not as good producers as young ones, since they reach their peak lactation between 6 and 8 years of age. Thus,

maternal ability, in general, is linked to the age of the cow. Rejuvenation of the herd is a sound management practice.

3.2.3. Calf Viability

Calf viability is linked to mortality and is measured in terms of the percentage of calves who survive weaning. In general, the most common causes of mortality are pneumonia and digestive problems which good management could control. The critical age runs from birth to three months, during which time 75% of deaths occur.

3.2.4. Age at First Calving

To make herding profitable in the pastoral zone, animals should not be kept until they die of undernutrition or old age.

A milk cow which reaches the age of six to eight years should be considered unfit and sold for slaughter between two and two and a half years. For this, it would be necessary to improve the breed such that heifers can be covered at 16 months and calve at 25 months. In the Sahel, the age of primipares varies between 30 and 70 months. This would be unacceptable in a profit-making enterprise. Clearly, first calving at the age of 25 months is not easy to obtain in current conditions. However, the advanced age of 50 months reported by Armour et al (1961) for zebus in Nigeria could be lowered with good diet from birth and sound management.

3.2.5. Quality of the Carcass

In Africa, due to market limitations, there is very little interest in producing high quality carcasses. If access to external markets is to be gained as a means of expanding the animal industry, it will be necessary to begin producing meat according to the standards required by these markets. This is not easy when one considers that high quality carcasses come from young animals.

3.2.6. Sound Management

In the pastoral zone, use of the range is unrestricted, but the constraints are enormous. There is a short rainy season (3-4 months) during which forage for the whole year is produced. This is why sound management of the limited available resources is indispensable to the profitability of extensive herding. One example of good management is to concentrate births at the beginning of the rainy season. This is practiced at the Toukounous station with positive results. The advantages are that: (1) the high nutritional requirements of pregnant cows are met and they calve in good condition; (2) the calves can drink more milk which provides them with a good start; and (3) the cows will remain in good condition until their next conception.

Another example of good management consists of ensuring an adequate diet for the herd during the long dry season. In the pastoral zone, this is difficult problem to solve. Until now, expedient use has been made of feed supplements (cottonseed, for example), in clearly insufficient quantities. The result is that net growth is low and takes place in stages.

In brief, sound management should take into account the seasonal cycle in breeding animals, in improving the range, and in conserving rainy season forage surplus.

3.2.7. Age at Slaughter

In Niger, as in many other Sahelian countries, the average age at slaughter oscillates between 4 and 6 years (Makinen and Ariza-Nino, 1982). This is explained in part by the slow growth in stages of the livestock in the pastoral zone. Later, typical growth curves will be presented, and methods for preventing heavy weight losses after compensatory gains will be discussed. It is unacceptable to allow cattle to reach marketable weight at the age of 4 to 5 years.

3.2.8. Rate of Gain

One characteristic that is measured directly in economic terms or in revenues is the rate of gain. This is what is known as output. It can be

evaluated either in terms of individual gain per day or in terms of total gain per hectare. The higher the rate of gain, the sooner an animal reaches marketable weight, and the less expensive it is to practice livestock raising or growing out. The key to success lies in the efficiency of converting grass to meat, provided the pasture is abundant and good. There is a positive correlation between rate of gain and efficiency of gain, which is equal to the quantity of feed per unit of gain. The rate of gain is higher from birth until weaning (RG 1) than from weaning to age 2 (RG 2), for example. The ratio RG1/RG2 can reach 1.5 for African bovine breeds such as the Afrikander, and 2.0 for European breeds introduced in Africa such as the Hereford. The rapid growth of calf before weaning is the result of its high physiological requirements. Thus, this period is critical for its development. If the calf suffers from under-nutrition for lack of maternal milk or because it already shares the milk with the herder, its maturation will be retarded. Clearly this has disastrous consequences for overall pastoral exploitation. A net RG1 of 0.6 Kg and a net RG2 of 0.4 kg per day would be acceptable in the conditions of the pastoral zone.

3.2.9. Milk Production

The other economic characteristic which is measured directly is milk production. It should be encouraged in the areas surrounding large cities and where transportation is not difficult. The example of the Toukounous station which delivers about 1,000 liters of milk every two days to OLANI should be encouraged although it is far from perfect. The Ibecetene Center, which currently has about 800 lactating cows, could supply milk to the city of Tahoua if the market were organized.

In the pastoral zone, cow's milk is consumed more than any other kind of milk (camel, goat, donkey and ewe). However, camel's milk is consumed more to the north of the zone, in the regions of In-Gall and Agadez for example. Very few data exist on milk production in general. There are some data at the multiplication centers and the grazing trials, but these data are incomplete. Under traditional management conditions, there are no data. A study to determine the parameters of animal production under traditional management conditions will begin shortly. It is hoped that, if all goes well, the void will soon be filled.

But in the meantime, it is not unreasonable to say that milk production is low, taking into account the incomplete data available at the ranches and those published by Dr. Loutan (1982). We will return to this question later. Through selection and improved diet, milk production can increase significantly. At the Toukounous station, the selection of Azawak cows, begun in 1947-48, has produced very encouraging results. The production of the Azawak cow varies between 800-1000 kg per lactation, and the record for 10 months of lactation is 1,494 kg, or an average of 4.9 kg per day. The Bororo cow does not surpass 400 kg of milk in 6 months. (Min. Coop. Franc., 1974).

In general, milk feeds both calves and the herder and his family (Maliki, 1981). The problem is not so much to increase production during the rainy season as to prevent its drastic decline in the dry season. This is important for the subsistance and even the health of the herder and his family. According to Dr. Loutan (1982), the amount of milk available each day for each individual in the pastoral zone varies between 2.5 liters in September and 0.37 liters in May. In other words, the deficit of 2.13 liters/person/day is the problem to solve.

In section 3.3. on the characteristics of production in Niger, we will return to the Toukounous example. But in the meantime, one could hope for an expansion of the work being done on selection and a wider distribution of improved heifers among herders in the pastoral zone, provided that this distribution is accompanied by adequate training to avoid a decrease in fertility and production. The effect of the environment on the performance of the improved Azawak cows introduced into the pastoral zone should be carefully monitored with techniques that are precise and easy to use. Of course, techniques for monitoring milk production have existed for a long time and are used at the government ranches. However, we doubt there is any such technique that has been adapted for traditional herding and demonstrated to be reliable. This will be done before starting the study mentioned above.

3.3. Characteristics of Animal Production in the Pastoral Zone

It is generally accepted that there are no data on animal production under traditional management conditions. The NRL was expected to furnish such data but so far has not. One of the goals of the study mentioned above is to produce these data, in the absence of which it is difficult to plan the interventions necessary for increasing productivity and also to know whether the interventions have truly resulted in an improvement. In the meantime, it will be useful to present and discuss here some data from the ranches near the project zone and the Toukounous station, as well as data from the grazing trials and data published by INRAN for the Ekrafane region.

3.3.1. What must we know to evaluate the Profitability of herding?

The evaluation criteria listed below represent economic characteristics which will not be difficult to determine if management conditions allow. In principle, obtaining this information should present no problem at the ranches (Louis, 1982). The criteria concern cattle, sheep, and goats.

1) Length of lactation, in days or months
2) Milk production, in liters or kgs per lactation
3) Length of dry period, in days or months
4) Length of gestation, in days or months
5) Length of estrous cycle, in days
6) Interval between parturitions in days or months
7) Age at first parturition
8) Age at puberty, in years
9) Fertility rate, . %
10) Conception rate, , %
11) Rate of mortality, %
12) Abortion rate, %
13) Individual gain, in kg per day
14) Gain per hectare, in kg/hectare
15) Birth weight, , in kg
16) Weaning weight, , in kg
17) Prolificity, particularly important for small ruminants, %

This list is not complete and is limited to economic characteristics considered, if not indispensable, at least useful for those working in animal production in Niger. Why is it useful to have this information? We can respond to the question with examples.

a) Interval between parturitions

A short interval is a sign of fertility. This is the most important characteristic for cattle intended for slaughter. As already mentioned, it is important that a cow produce a calf each year. The longer the interval, the longer it takes for the herd to renew itself.

b) Weight at Weaning Weight

A high weight at weaning confirms the maternal fitness of the cow and ensures good weight gain after weaning.

c) Individual Gain

This is closely correlated to the efficiency of weight gain. The higher it is, the shorter the time required to reach market weight.

3.3.2. The Government Ranches

The following data concern the ranches at Ibecetene and Fako and the Toukounous station. These centers were visited. Our impressions were recorded and criticism offered in earlier reports (Louis, 1982a, 1982b).

The data currently collected and published are limited to cattle, and concern only the following parameters: population according to category of animal; births, by sex and by month; mortality and abortion rates; fertility and prolificity rates; weight at birth; herd growth; milk production and length of lactation. The last two characteristics are published only for the Toukounous station. Azawak cattle are predominant at Ibecetene and Toukounous, and Bororo cattle at Fako.

Table 19. Some Parameters of Animal Production at the Ibecetene and Fako centers and the Toukounous Station

Parameters	Ibecetene (1) (Azawak)	Fako (1) (Bororo)	Toukounous (2) (Azawak)
Fertility rate (calves born/100 cows)	63.2	48.5	67.0
Abortion rate (Abortions/100 cows)	1.2	1.0	-
Prolificity rate (calves/100 births)	100	100	-
Sex ratio (males / 100 births)	53.3	50.7	-
Age at first calving (years)	3-4	3-4	3-5
Mortality rate (%)			
- adults	2.6	4.8	-
- young animals	0.9	2.7	-
- calves	7.9	10.9	-
Apparent herd growth (%)	17.8	28.2	-
Real herd growth (%)	37.1	106.4	-
Birth weight (Kg)			
- male calves	22.8	22.8	-
- female calves	19.2	19.2	-
Length of gestation (days)	-	-	272-314
Calving interval (days)	-	-	390-570
Length of lactation (days)	-	-	293±43
Milk production			
- Kg/day	-	-	3.0±0.9
- Kg/lactation	-	-	908±322
Butter production			
- butyric rate (%)	-	-	38 ± 7
- Kg butter/lactation	-	-	37 ± 14

(1) For the year 1979; Source: DPRC and CM, 1979

(2) For the year 1980; Source: Louis, S.L. 1982 (b)

The preceeding table is incomplete. It lacks important data which would make it possible to evaluate animal production at these centers. Constructive criticism of these gaps was presented in earlier reports (Louis, L.S. 1982 a and 1982 b). Nonetheless, in light of the existing data and information obtained during our recent visits, the following remarks can be made.

a) The highest concentrations of births take place during the period from May to July (43.86%) and the period from December to February (20.88%), as shown in figure 3. These monthly rates, resulting from the fact that breeding is unrestricted, have an effect on milk production and calf growth. In fact, calves born during the cold dry season demonstrate slower growth because of lower milk production, resulting from a decline in the quality in the quality of the range, if not its quantity, since at the ranches deferred grazing is practiced on about 75% of the rainy season pastures (see section 3.3.3.). Similarly, calves born in May and June have nearly the same fate for the same reasons, coinciding with the end of the period known as the soudure. However, they are able to recover quickly and continue normal development during the rainy months of July, August, and September, when the range is better and milk production reaches its maximum point.

Improving this situation does not appear easy at first sight. However, altough breeding is unrestricted, keeping the stud bulls away from the cows, if this is possible, could produce satisfactory results. At Toukounous, there

is no such problem, because of pasturelands are divided into parcels; moreover, they are in the process of establishing a new system of controlled breeding which will make it possible to have the maximaum number of births when the temperature is lowest and forage production is best. This is an example to follow.

b) The mortality rates are relatively low. Except for some cases of pasteurellosis at Fako and blackleg at Ibecetene, the most common causes are fractures, enteritis among young animals, and the ingestion of foreign bodies in cases of apparent nutritional deficiencies (in trace elements, for example). Malnutrition should not be underestimated, since at Fako 80% of deaths were not diagnosed.

c) The fertility rates are relatively low. The advanced age of cows, nutritional defiencies, and diseases such as brucellosis and rickettsial diseases are probable causes. The rejuvenation of the herd, an improved diet, and systematic treatment of these diseases could raise the fertility rate at the ranches.

d) The birth weight of calves is acceptable for the breeds in question. Weight at weaning and weight gain are not satisfactory. We recommend that everything possible be done to facilitate the ongoing collection of these important data.

e)Data on milk production are lacking at the multiplication centers. The Toukounous example should be followed to a certain point, as their goal is different.

f) There are more data on the Azawak breed than on the Bororo breed (Min. Coop. Franc. : 1974). Given the importance of the latter in the pastoral zone of Niger, filling this gap is, in our view, overdue.

g) We attempted to analyze some weight data taken from the records of the Toukounous station. The purpose of the analysis was to : 1) determine the rate of gain from birht to weaning, and 2) evaluate the effect of the seasons on growth after weaning. The results are presented in figures 4 and 5. The calf growth curve (figure 4) is somewhat particular because the calves received all the mother's milk until weaning. Therefore, their growth was good, with an average daily gain equalt to 0.37 kg. However, after weaning individual gain dropped due to tge adjustment to the new diet. Figure 5

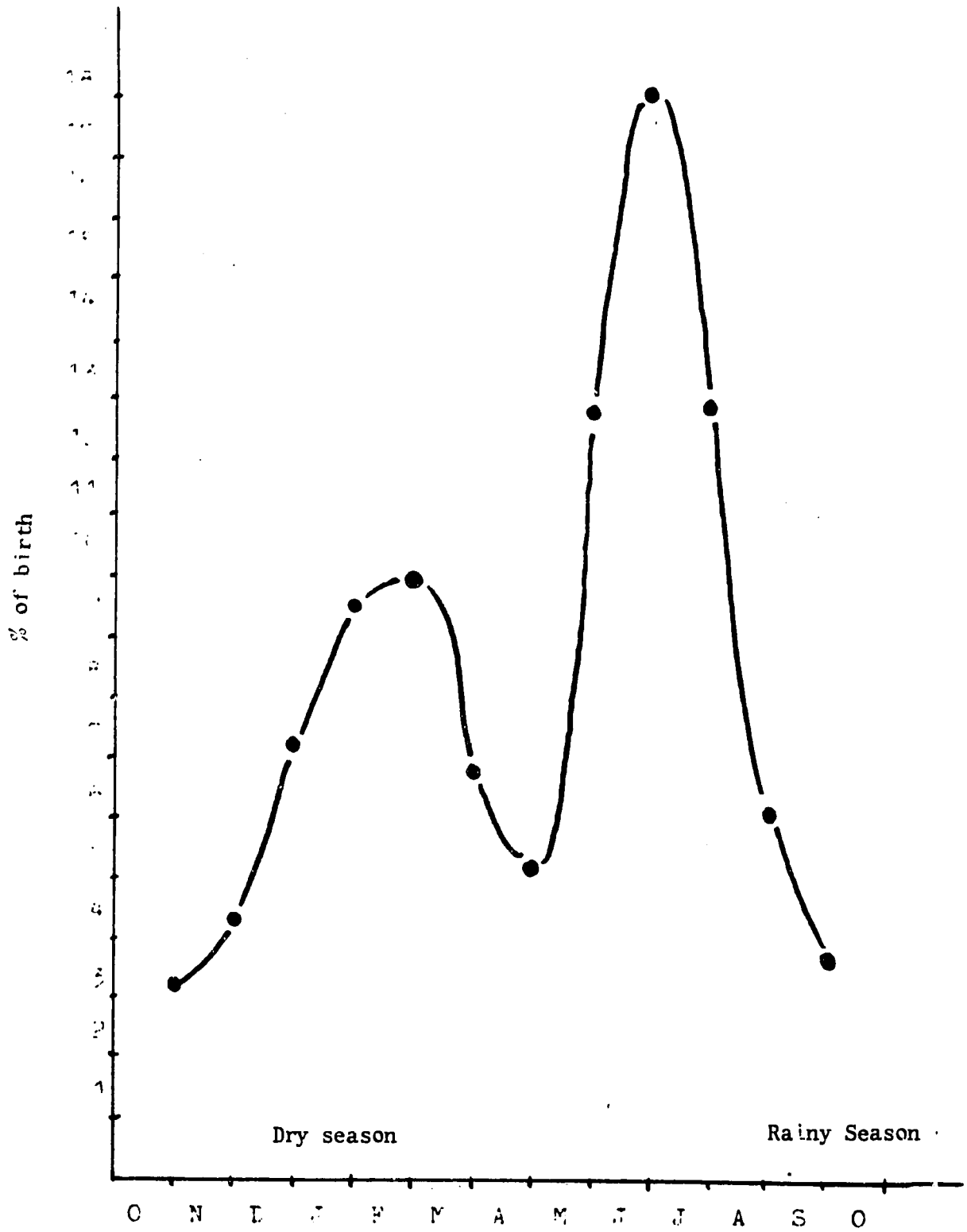


Figure No. 3 Graph of births recorded during the year 1979 at the Ibecetene and Fako Centers)

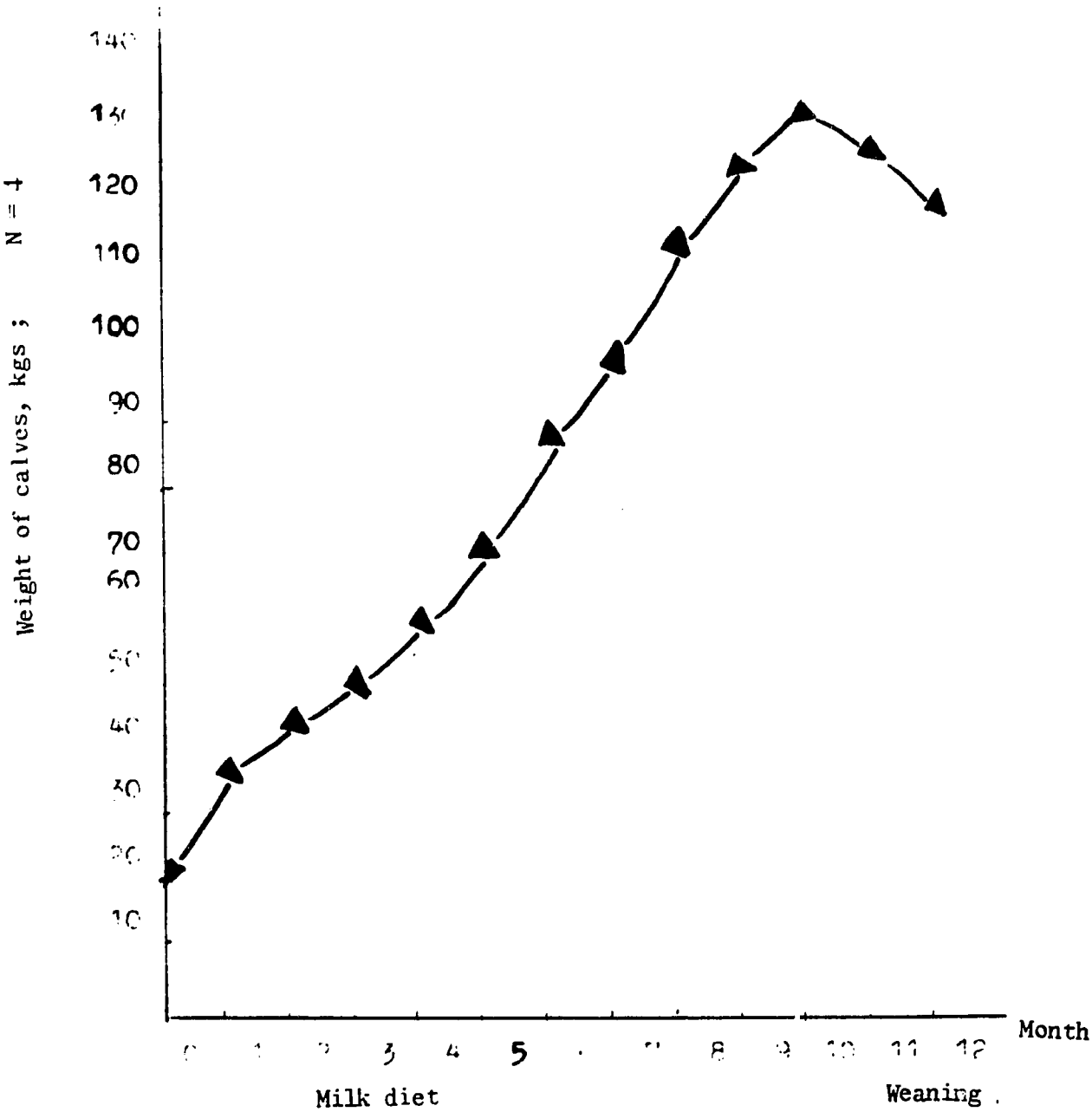


Figure No. 4. Graph of calf growth, Toukounous Station, 1980

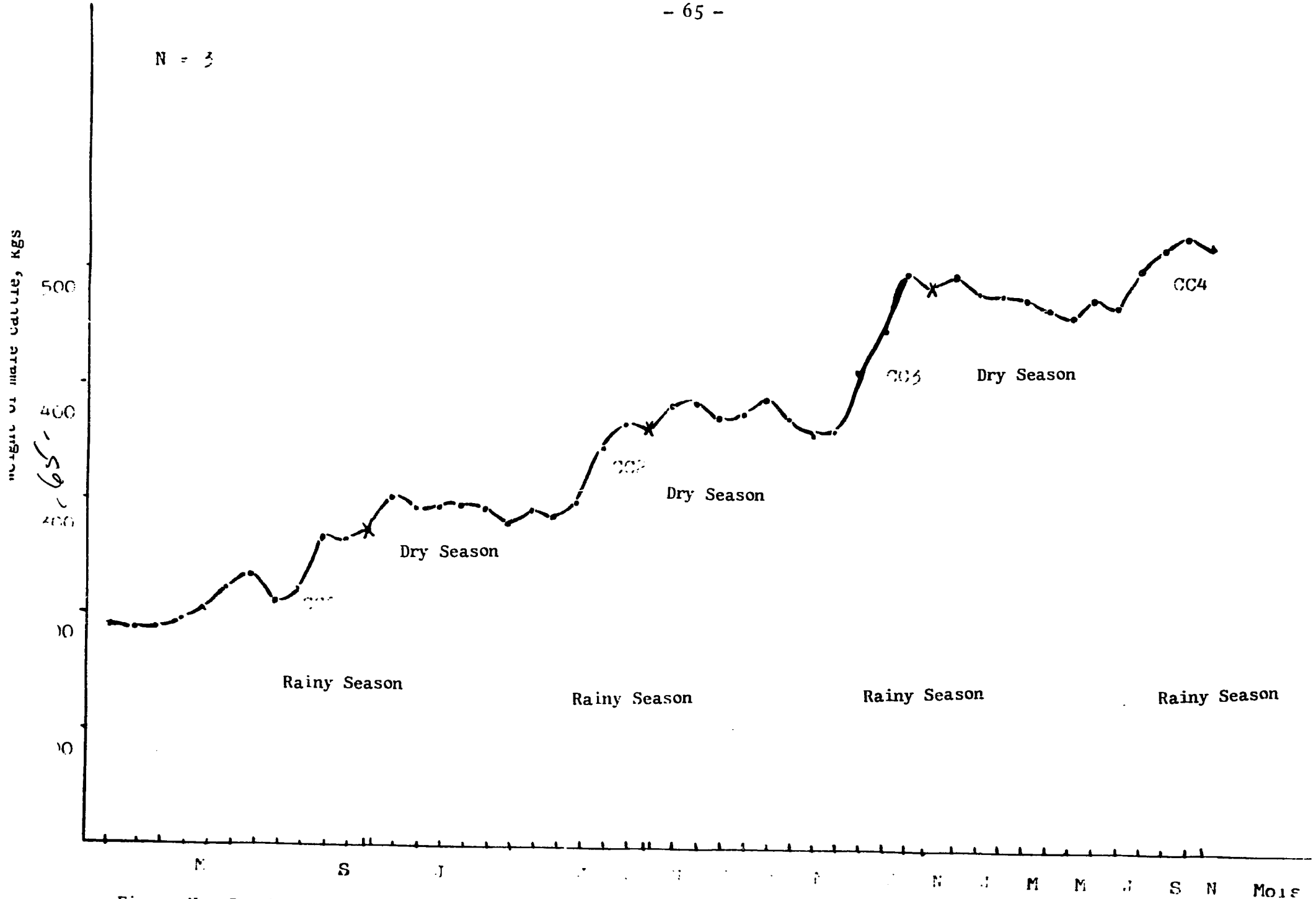


Figure No. 5. Growth curve of male cattle at the Toukounous Station (Post-weaning)

shows growth during 4 years. This graph indicates clearly the seasonal influence on growth, and we observe the typical pattern of growth by stages which characterizes cattle in the Sahel. During the 4 years, compensatory growth (CG) coincides with the different rainy season (RS). For the most part, these stages correspond to weight losses during the long dry season. A more thorough analysis of the monthly weights of these animals has shown that after 5 years of age, they stopped gaining weight. After reaching a maximum of 545 kg, on the average, they gradually lost weight. Thus, keeping these animals not for reproductive purposes represented a wasteful burden on the station, and even a loss.

3.3.3. Grazing trials

Trials were conducted inside the ranches at Ibecetene and North Dakoro (Fako). In general, the climatic conditions are identical. However, there are differences regarding the breed of cattle under study, the species composition of the pastures, and sometimes the rainfall. At Ibecetene, the dominant cattle breed is Azawak, while at North Dakoro the dominant breed is Bororo. The dominant forage species are Aristida mutabilis and Cenchrus biflorus at Ibecetene and Cenchrus biflorus Schoenefeldia gracilis at North Dakoro (Bement, 1980). In 1980, the forage production was 941 and 1,112 kg/Hectare respectively. Moreover, rainfall for the same year amounted to 192 and 238 mm respectively. Given the difference between the environmental conditions, and for the purpose of comparison, animal production data for the two trials will be presented and discussed. It should be noted that the way in which the data will be presented here differs from the form utilized by Bement in his various reports on range management (Bement, 1980, 1981, 1982a and 1982b).

a) Seasonal influences on milk production

The influence of the seasons on milk production is clearly demonstrated in figures 6 and 7. In general, milk production is higher during the rainy season than during the dry season : 5 to 6 times higher at North Dakoro and 2 to 3 times higher at Ibecetene. The difference between the two seasons is easily explained by the condition of the range and the different nutritive value. The lowest average production was observed in the month of April, and the highest in the month of August. The data are presented in table 20.

Table No. 20. Average maximum and minimum milk production in the two trials, kg/day

Month	Ibecetene	North Dakoro
August	2.39	1.89
April	0.97	0.32
August/April	2.47	5.85

The data represent corrected morning production. In the absence of a technique for evaluating total milk production, the individuals in charge of the trials adjusted the partial production from the morning milking. Only morning milkings were performed, and these were not complete. Some milk is always left for the calf. The two forward teats are milked when the calf is young, and the two rear teats when the calf is older. This method, which is close to traditional practices, does not provide valid data on total milk production. Thus, a new technique will be developed to evaluate more precisely milk production under traditional management conditions (Chapter I). But in the meantime, it should be noted that the data presented in figures 6 and 7 were obtained by adjusting the partial morning milking. This is why the evaluation of total morning production is not totally exact. In other words, the data presented above are approximate. However, this does not prevent the seasonal influences from whowing up clearly at the two ranches and for the three grazing intensities of the trials.

Regarding animal production, the dry season stocking rate has little effect. Milk production is drastically reduced whatever the grazing intensity. No matter how much straw is consumed by cows, it cannot maintain milk production at an acceptable level because of the decrease in the nutriment content. It is only during the rainy season, when the nutritional value of the range is good, that the effect of the stocking rate begins to appear.

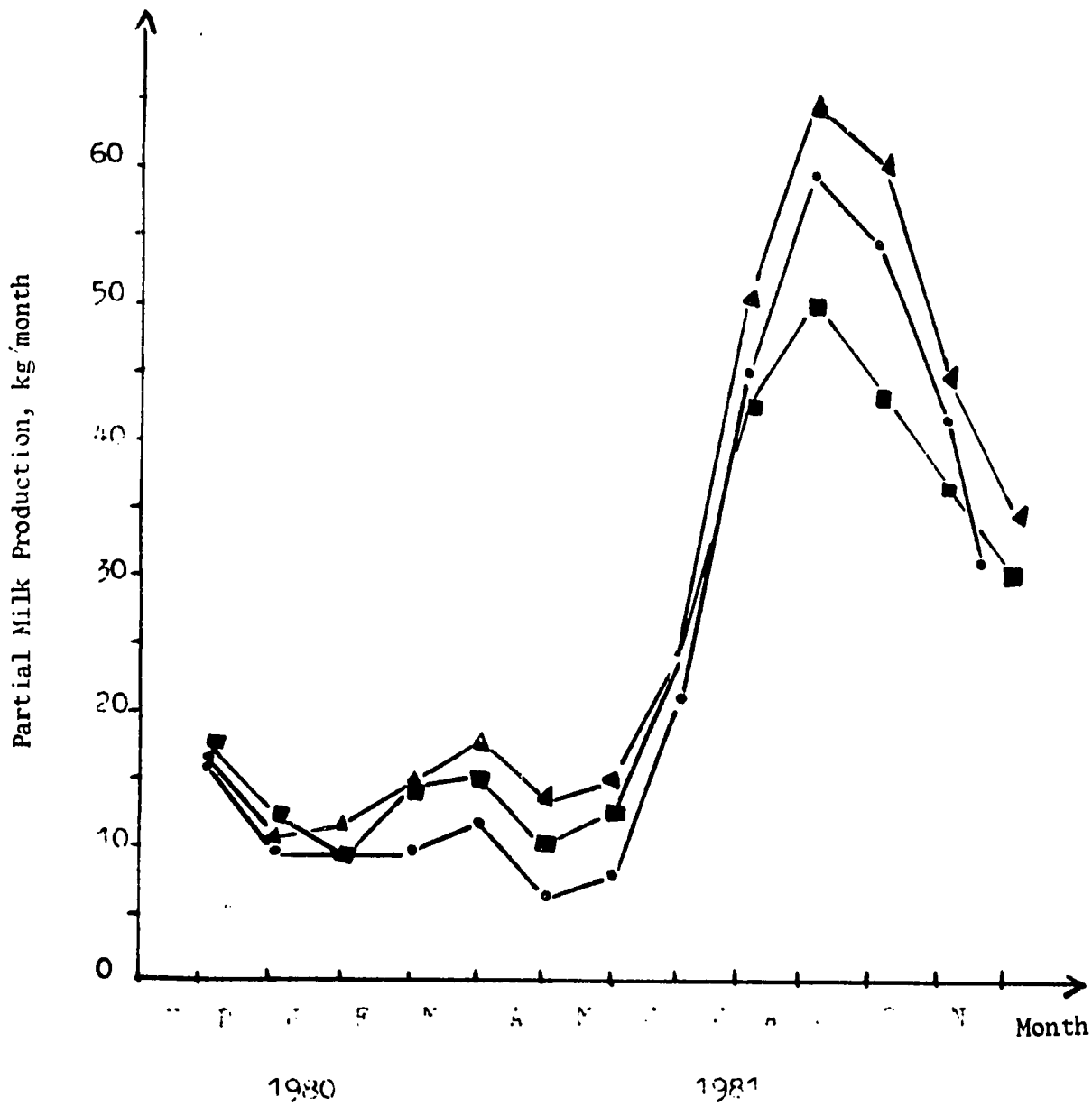


Figure 6 Seasonal effect on milk production (based on corrected milk production)

Heavy intensity

Moderate intensity

Light intensity

In the North Dakoro grazing trials

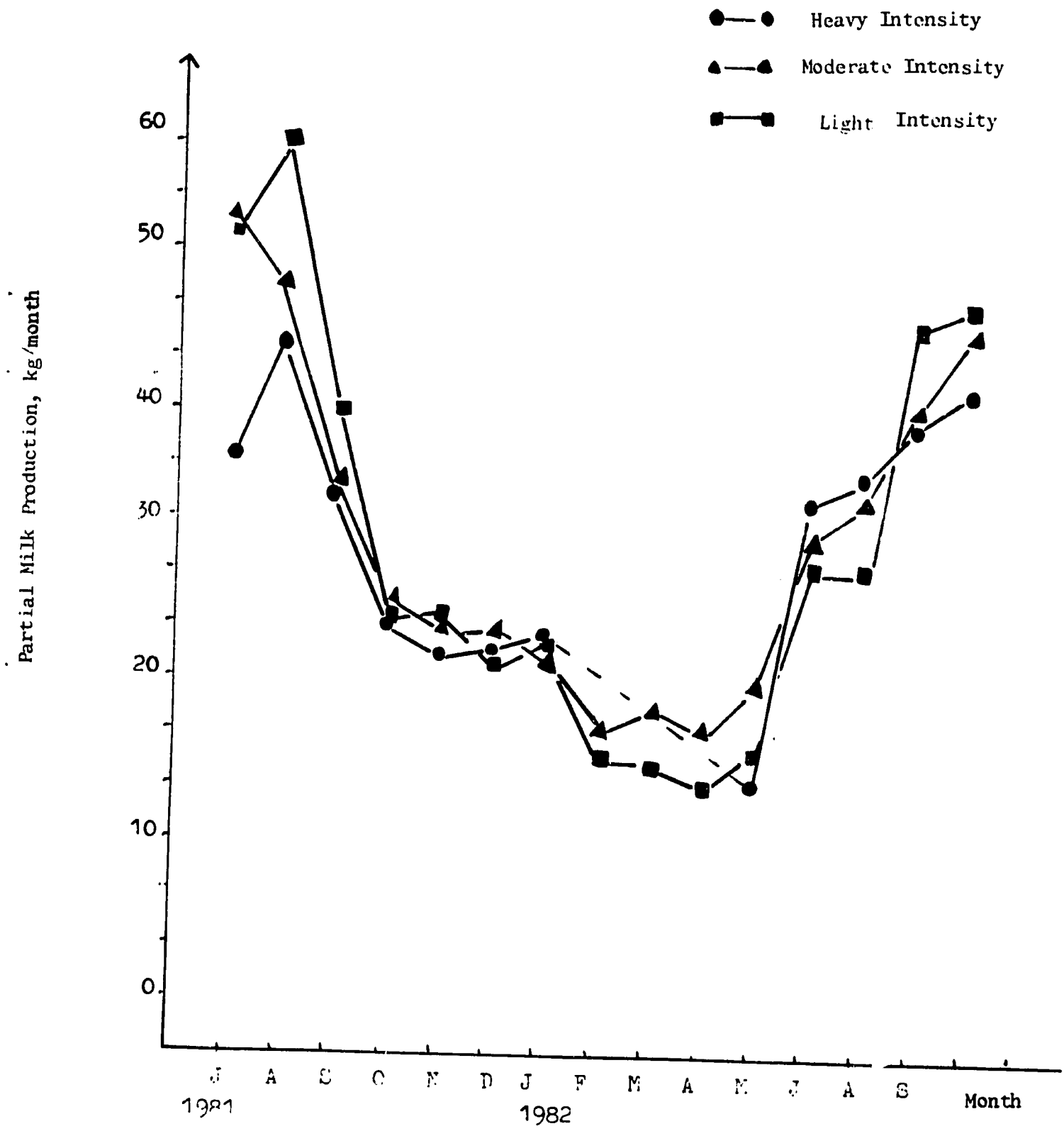


Figure No. 7. Seasonal Influence on Milk Production in the Ibecetene Grazing Trials

The milk production data were statistically analyzed. The F test and the Newman-Keul test were used to evaluate the differences between the averages obtained under various grazing intensities : heavy, moderate, and low.

The computer at AGRHYMET was used with the assistance of Barry Grushkin.

At Ibecetene, for the year 1981-1982, the differences between the milk production averages for the various grazing intensities were not significant in the rainy season or the dry season. At North Dakoro, for the year 1981, there was similarly no significant difference during the rainy season. The monthly variations during the rainy months probably increased the experimental error. The lowest milk production during this season was normally obtained under heavy grazing conditions, and the highest under moderate conditions. However, in the 1980 dry season, the heavy and moderate stocking rates produced almost the same production results, in both cases statistically higher than those obtained under low grazing intensity ($P \leq 0.05$). Nonetheless, this result is difficult to interpret, because performance under low grazing intensity should be, if not superior, at least never significantly inferior.

In light of this, we can conclude that, despite the tendency for milk production to be lower when stocking rates are high, and higher when they are moderate or low, the differences in milk production were not statistically significant either because of the small number of cows studied [1] ($N = 4$ per grazing intensity) or because of the considerable variation between months of a single experimental period. The variation between months was normal and expected. Before ending this section 3.3.3.a, we would like to emphasize that it was not possible to gather daily, individual data on milk production. Thus, in order to compare statistically the different conditions, average monthly production was used rather than individual total productions for each of the two seasons. In so doing, we were aware of the monthly variation introduced into the analysis of the variance. This explains why, considering months as replications, we found a significant monthly effect ($P \leq 0.01$) in every season except for a dry season at Ibecetene.

We suggest repeating the statistical analyses as soon as individual milk production data are available. The model to use is the F test (one way).

1/ The number of cows with available data was relatively low.

Milk production in the two seasons was not compared statistically because the differences were too obvious. However, it should be emphasized that there is nonetheless a difference in the level of production between the Bororo (North Dakoro) and Azawak (Tbecetene) breeds, and that the decline in milk production caused by the dry season was more pronounced among Bororo cows than Azawak cows. However, we cannot compare the milk performance of the two breeds, as they were not placed from the beginning in the same experimental conditions.

b) Seasonal influence on weight change of calves and their lactating mothers

Figure 8 illustrates the influence of the seasons on the weight of calves and their mothers, and, what is most important, the relation between the development of the calf and the physical condition of the cow.

During the rainy season, the calf and its mother gain weight, although in this case, the calf gains less than the mother. This result is rather curious because other data (ranch) showed the same tendency in the month of October. It is when the nutritional value of the range begins to decline that the cow enters a critical period. She gradually loses weight in order to continue providing milk, although, little, to ensure calf growth. But what has occurred? The quantity of milk is so low that the growth of the calf slows down considerably, to almost zero during the months of February and March.

It is at this moment that interventions should supply cows with feed (good hay, for example) and supplements (minerals and vitamins). Lack of water was not a problem.

Reserves accumulated by cows, expressed in weight gain (0.26 kg/day), did not enable them to produce enough milk to ensure normal calf growth.

c) Seasonal influence on calf growth

Figure 9 is another illustration of the effect of the dry season on calf growth. The low quantity of available milk slowed growth significantly. The effect is even more pronounced on calves at the ranch because they receive less milk due to sharing with the herders who perform the milking. The reasons explaining the slowed growth were given above.

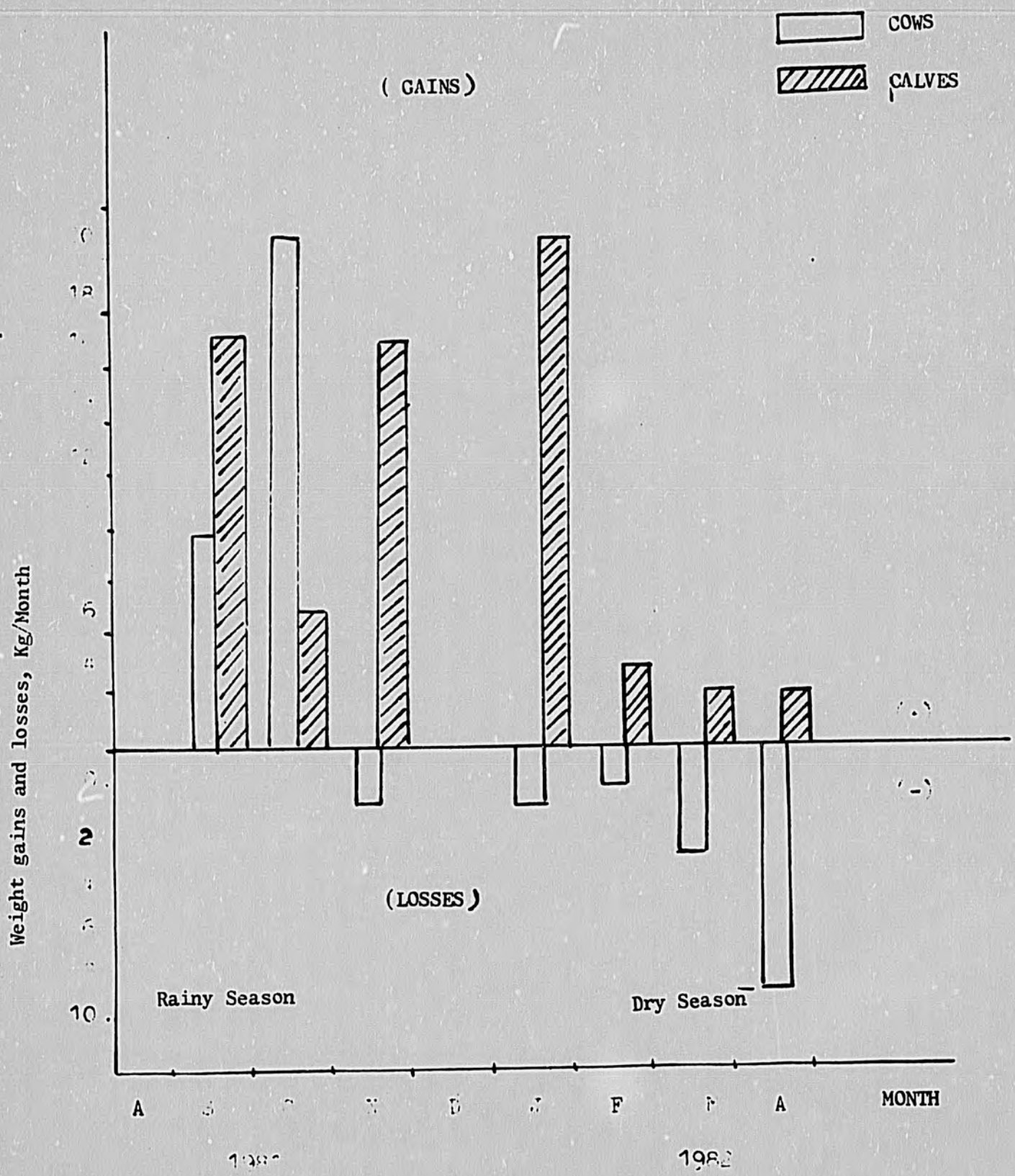


Figure 8. Seasonal effect on weight change of calves and lactating mothers

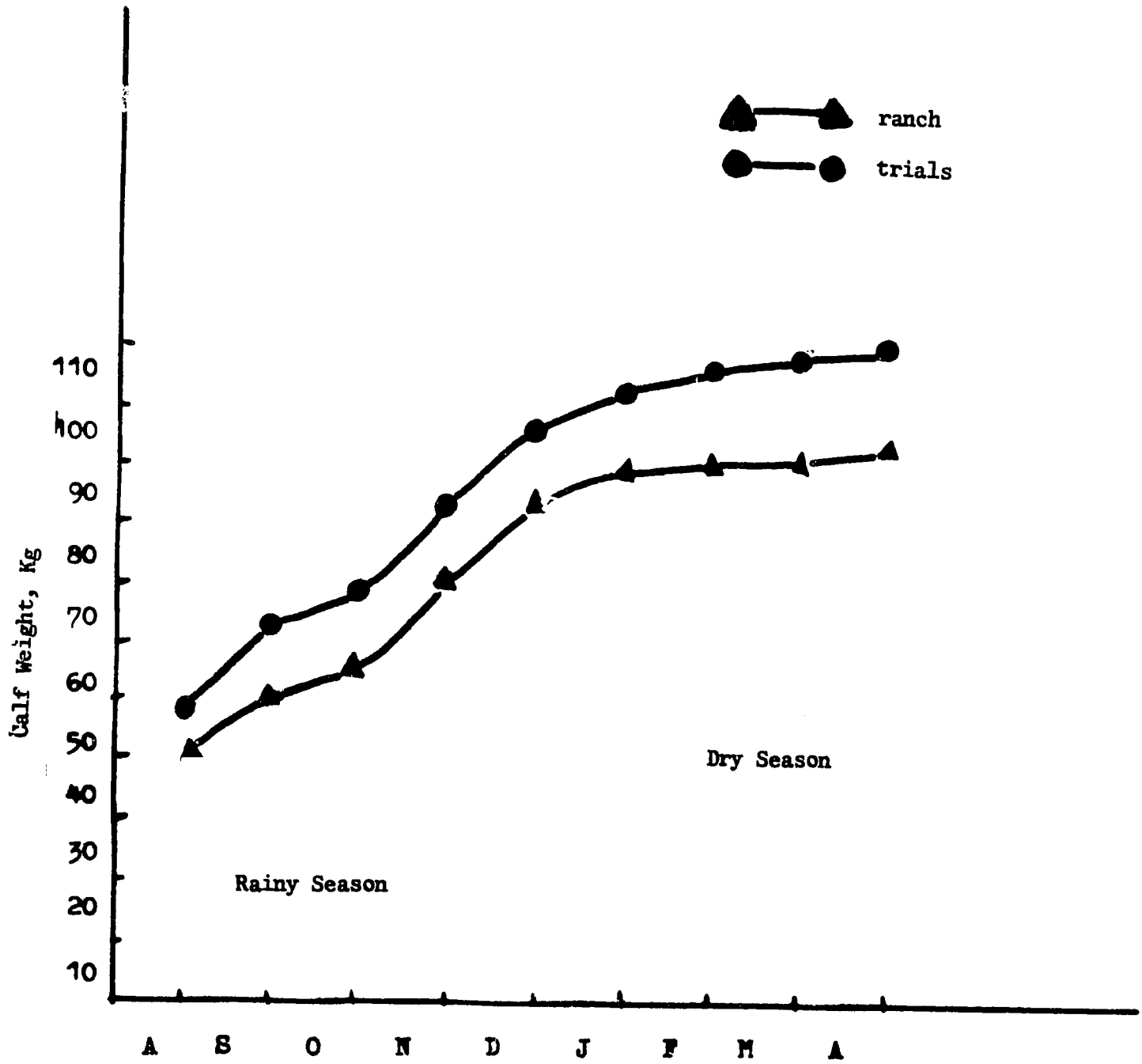


Figure 9. Seasonal influence on calf growth in the grazing trials and at the ranch at North Dakoro

d) Rate of gain or individual gain

The following observations should be made regarding the grazing trials.

1) Whatever the grazing intensity, all animals lose weight during the dry season.

2) During the rainy season, there is a compensatory weight gain, but it is influenced by the grazing intensity.

3) In general, heifers are not monitored from one season to the next. New animals are used for each trial; this makes it difficult to determine "total net gain", which has great economic significance for the herder. Table 21 serves as an illustration.

Table 21 Seasonal influence on individual gains by heifers in the North Dakoro trials

Period	Heavy grazing intensity (1)	Moderate intensity (2)	Light intensity (3)
	KG / DAY / HEAD		
Dry season (1981)	- 0.090	- 0.083	- 0.063
Rainy season (1981)	+ 0.390	+ 0.589	+ 0.608
Dry season (1982)	- 0.163	- 0.161	- 0.152

N = 12. The data will be statistically analyzed.
(1) 0.70 hectare /animal/127 days, or 2.01 ha/animal/year;
(2) 4.02 ha/animal/year; (3) 6.03 ha/animal/year.

With the goal of determining net gain, we conducted research on what data was available and were able to identify heifers that have served in two or three successive grazing trials. The number of heifers is admittedly not large, but the results obtained are interesting and convincing.

Table 22 Net Gain by Heifers approximately two years old during a period of 1 to 1 1/2 years, in the North Dakoro grazing trials

Period	Number of days	Number of cows	Net Gain kg/day/head
July to June 1982	365	7	0.134
January 81 to June 1982	547	4	0.076

It is evident that net gain is extremely low. At this rate, it is not difficult to understand why maturation is slow and first calving occurs between the age of 3 and 5.

The data in the following table (Table 23) have been statistically analyzed in order to evaluate significance of differences between averages. The same statistical model was used as before.

Table 23 Average gain and loss of weight in the grazing trials during both seasons (Kg/day/heifer).

Ranch and cattle breed	Rainy season			Dry season		
	Intensity			Intensity		
	Heavy	Moderate	Low	Heavy	Moderate	Low
NO. Dakoro (1) Bororo	+0.42	+0.59	+0.61	-0.18	-0.[illegible]7	-0.17
Ibecetene (2) Azawak	+0.58	+0.51	+0.34	-0.24	-0.15	-0.09

(1) 1981 rainy season and 1982 dry season

(2) 1981 rainy season and 1982 dry season

In general, heifers tend to gain more weight during the rainy season when the stocking rate is low, and similarly to lose less weight during the dry season. No clear, consistent trend is shown by the results just presented.

At North Dakoro, the difference between the average gains during the rainy season is significant ($P \leq 0.01$). The gain for the low stocking rate is higher than for the two other rates, which are not significantly different. This result conforms to predictions and is easily explained. During the dry season, however, there is no significant difference between the averages. Regardless of the stocking rate, the heifers lost about the same amount of weight. The seasonal variations from one region to another account for very different results at Ibecetene.

For example, there is indeed a significant difference between the average weight gains obtained during the rainy season ($P \leq 0.01$). However, the highest gain was obtained with the heavy stocking rate, and the lowest gain with the light one(See figure 10). These results, which are the opposite of what one would expect, can only be explained by poor forage quality and quantity in the light stocking rate pasture.

The dry season results appear normal and are easy to explain. The weight loss for the heavy stocking rate was significantly higher ($P \leq 0.01$) than for the other rates, while there was no significant difference between the moderate and low rates.

The last results (1982 dry season at Ibecetene) have been studied more closely. Relationships were established between grazing intensities and the length of time that heifers remained above a maintenance level (See figure 11).

In dry season pastures, the lower the stocking rate, the longer the heifers remained above a maintenance level, i.e. before losing weight. Rotation on pastures with a lightstocking rate also increased the length of time in question. Table 24 summarizes the respective data.

Table 24. Length of time that heifers remained above a maintenance level during the dry season at Ibecetene (1)

Grazing intensity	Length of time (days)
Heavy	45
Moderate	80
Light	120
Light in rotation	145

(1) Total duration of trial : 159 days

3.3.4. The Ekrafane Ranch

The data to be presented in this section were published by INRAN researchers in 1981 (Klein, H.D.; Keita, I.; and Mesnil, J.C.). Although Ekrafane is located outside the project zone, its climatic conditions are similar to those of the pastoral zone under study. This is why the INRAN results are of interest to us in more than one way.

This is the first study conducted in Niger that attempts to compare animal production resulting from "improved management" with animal production resulting from "traditional management". Before discussing the results we will summarize them in a table.

Table 25. Weight gain by young, castrated Azawak bulls under conditions of improved and traditional management, at the Ekrafane ranch.

Management	Grazing intensity (2) Ha / Head	Individual gain (3) Kg/Day	Gain per hectare Kg/Ha
Improved (1)	11.6 (heavy)	+0.194	+6.1
Improved (1)	23.3 (light)	+0.242	+3.8
Traditional	23.0 (light)	+0.215	+3.4

(1) Improved management differs from traditional management in terms of: a) centripetal grazing, i.e. gradually drawing closer to boreholes during the dry season, and b) watering everyday during the hot season and every two days during the cold season.

(2) On the average, animals gained weight, however, little, during the cold dry season, but lost weight during the hot dry season and after the first rains of June-July, since regrowth was too limited to satisfy needs. The animals abandoned the damp fallen straw.

(3) On avarage, animals gained weight, however little, during the cold dry season and after the first rains of June-July, for regrowth was too limited to satisfy needs. The animals abandoned the damp fallen straw.

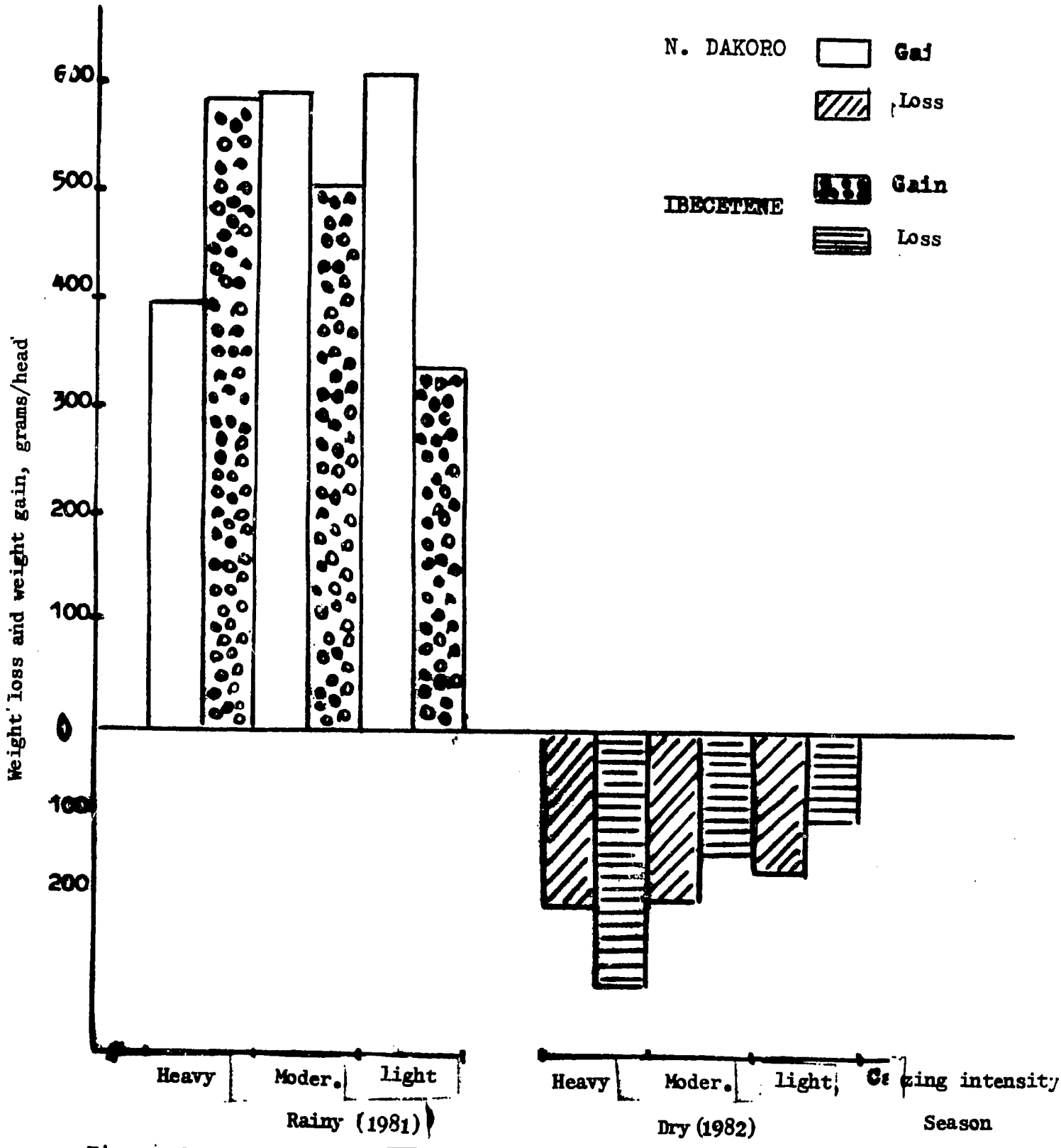


Figure 10. Double effect of seasons and grazing intensities on individual weight gain of heifers in the grazing trials at North Dakoro and Ibecet ene

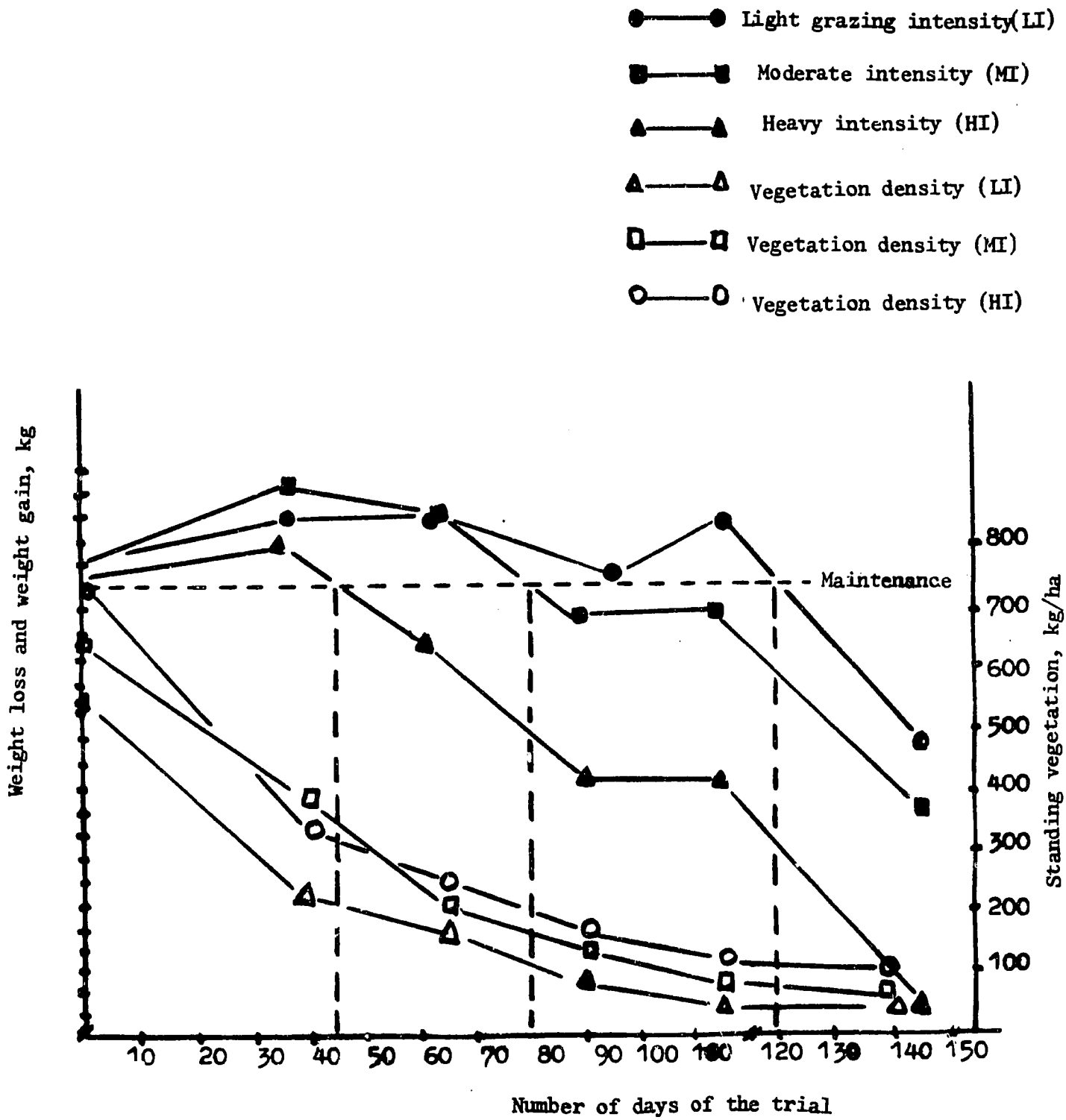


Figure 11 Weight gain and loss during the dry season from January to June 1982, and relative density of standing vegetation in the grazing trials

IBECETENE

The statistical analysis showed that :

(a) Individual gain with a light stocking rate is significantly higher than with a heavy rate, under improved management.

(b) When the stocking rate is the same light improving management significantly increases individual gain.

(c) However, there is no significant difference if management is improved and the stocking rate is doubled at the same time.

(d) Finally, whatever the type of management, the gain per hectare is significantly higher with a heavy stocking rate than with a light rate.

The following observations can be made regarding this study:

(1) Of course, it is not difficult to improve upon traditional management under experimental conditions, but the researchers did not attempt to accomplish the same results in the pastoral zone, where controlled grazing is impossible without fences.

(2) The question of optimal grazing intensity, allowing for a compromise between individual gain and gain per hectare, is also difficult problem to solve in the pastoral zone. The intensities proposed by Klein et al (1981) of 15.5 - 12.5 ha/TBU/year for a biomass of approximately 400 kg of straw per hectare are difficult to put into practice. Similarly, the figures proposed by Dr. Bement (Bement, R. 1982), 180 kg/ha of forage at Ibecetene and 320 kg/ha at North Dakoro during the rainy season, in order to optimize animals production, are not presently applicable to the pastoral zone.

(3) The individual gains achieved at Ekrafane are higher than in the North Dakoro trials. The difference could be due to the grazing intensity (See table 21), to the density of the herbaceous biomass during the rainy season, and/or to the quality of the range at the outset. Despite the difference, in both cases the rate of gain is very low.

3.4. Characteristics of other categories of animal production

There is a lack of production data for sheep, goats, and camels in the pastoral zone. The multiplication centers located in the zone concentrate exclusively on cattle. The study that will soon be undertaken, which was mentioned earlier, will have among its goals the collection of some data on small ruminants and camels under traditional management conditions.

In the meantime, we believe it is appropriate to provide at this time some data for the Sahelian zone in general. The following table (Table 26) includes certain parameters available in the literature, their values, and their sources.

The only goat research station in Niger is the one established for red goats in Maradi. This station has the necessary infrastructure and adequate personnel to conduct continuous research, important for the development and distribution of this breed in the agricultural zone, and perhaps the pastoral zone as well if it proves to be adaptable to those conditions. In the Sahel, goats are exploited for their meat and their milk. Furthermore, the red goat is also raised for its skin, which has a high industrial value, and there is consequently a great market demand both nationally and internationally.

Despite its infrastructure and staff, the goat research station encounters many problems in its operations and its research. The principal problems are: a) the lack of financial means for operating suitably ; b) the poor condition of the pastures, overrun with Cenchrus ; c) the non-selection of the various herds; d) the need to practice destocking. It is truly deplorable that there is no comprehensive, systematic data collection on goat production at Maradi, and that records of past data are absent. We would recommend that the Service

for Rebuilding the National Herd seek assistance to upgrade the level of work at the station, if the national budget is now unable to support the operating costs. But in the meantime, there is a minimum that can be done in terms of improving the conditions of the pastures, which the goats have trouble grazing. It is desirable that a relationship of cooperation be established between the goat research station and the livestock projects in the department of Maradi.

Regarding sheep, very little has been done. INRAN and ESA of the University of Niamey are conducting research on sheep diet and physiology respectively. Intense efforts need to be lade during Phase II to obtain such date, clearly of great importance in improving the productivity of sheep in the pastoral zone.

Table 26. Some parameters of sheep and goat production

Parameters	Values	Sources
- Annual rate of exploitation (%) ,	30	Ketebars, J., 1978
- Fertility rate (%)	100	" " "
- Age at first parturition (years)	1 - 1 ½	" " "
- Yield at slaughter (%) (goats)	50	Min. Coop. Franc., 1974
- Milk production (Kg/lactation) (Sahel goat)	100-120	" " " "
- Length of lactation (days) (Sahel goat)	120	" " " "
- Prolificity (kids/birth)		
- Sahel goat	2	" " " "
- Maradi goat	2	Wilson, 1982 (1)
- Weight of goat at maturity (Kg)	35-40	" " " "
- Age of goat at first kidding (days)	484	" " " "
- Kidding interval (days) (days)	250	
- Prolificity (kids/birth)	1.12-1.24	Wilson, 1982
- Percentage of multiple births (goats)	12.4-22.0	" " " "
- Weight of young goats at 150 (days (Kg)	9.5-12.9	" " " "
- Rate of gain at 150 days (grams/day)	49.3-70.7	" " " "
- Mortality rate (%)	14.5-19.1	" " " "

(1) The data reported by Wilson, 1982, concern Tchad and Mali

3.5. Conclusion

There is no doubt that animal production in the pastoral zone is far from being optimal. Nomadic and transhumant herders deserve praise for their tireless age-old struggle to conquer an inclement, poor, sometimes hostile environment, for the well-being of their families and their survival. Helping them to solve the problem of low productivity is a difficult but not impossible task. To understand clearly what needs to be done at all levels and in all related sectors, let us analyze the causes of low productivity.

CHAPTER IV. CAUSES OF LOW ANIMAL PRODUCTIVITY IN THE PASTORAL ZONE

4.1. CAUSES

The causes of low productivity are many, and are not mutually independant. The principal ones are as follows:

1) continual degradation of the rangelands
2) archaic practices of herd management and livestock diet
3) low genetic potential of local breeds
4) epizootic diseases, most of them under control, and nutritional deficiencies
5) livestock transportation resulting in a loss of weight and money
6) absence of control and organization of the livestock market in order to ensure timely sales and avoid low dry season prices
7) inadequacy of water points during the dry season, resulting in some cases in a daily walk of more than 20 km to water livestock, and the non-utilization of many pastures.

It is incontestable that the Government of Niger has begun to solve some of these problems, and that positive and truly encouraging results have been obtained. Given the close relationship between the causes mentioned above, the ultimate objective, which is to increase productivity, has not yet been achieved. The goal of this chapter is not to develop all the causes of the problem, as this has already been done elsewhere (UN Secretariat, 1973; Sollod, A.E., 1982 ; Bement, R.; 1982; Maïga, A., 1981; Aronson, D.R., 1982; and Makinen, M., and Ariza-Nino, E.J., 1982). We will limit our attention to a) two problems which

the Government of Niger has attacked in particular, and b) the problem of diet and nutrition, which remains the most important problem for the time being.

4.2. Animal Health Problems

Through annual vaccination campaigns, the major endemic diseases has been, for the most part, brought under control in the pastoral zone. Rinderpest, anthrax, and bovine pleuro-pneumonia, for example, have been nearly eradicated. However, there is still much to be done to ensure the prefect health of the various animal populations, particularly in the following areas: parasitic diseases, nutritional deficiencies, and the extension of veterinary care (Sollod, A.E., 1981; and Loutan, L., 1982).

4.3. Problem of Pastoral Water Supply

Another problem that has been attacked at the national level is the problem of pastoral water supply. Boreholes and wells have been dug throughout the pastoral zone. A map of water points has been prepared by the NRL, but as of this date, it has not been made public. The indiscriminate development of boreholes in the pastoral zone could not only seriously harm the surrounding range, due to overgrazing, but also lower considerably the water table. While boreholes have had a negative impact on the environment in some places, such an effect is not at all generalized. On the contrary, the benefits of water ad libitum are enormous and can be measured in economic terms.

The other side of this problem is the inadequacy of water points in vast areas where good pasturelands are found, for example to the southwest of Tassara. Controlled opening of boreholes or wells in these regions would make more grazing land available to herds during the dry season. The reader is referred to Aronson, D.R., 1982; pages 48-49, for additional details.

It is a fact that animals will no longer die of thirst in such large umbers. But will they die of hunger?

4.4. Problem of Diet and Nutrition

4.4.1. The Problem

Dr. Aronson (ARONSON, D.R., 1982), in his synthesis report on the accomplishments of the NRL, expressed himself in these terms: "In general, the NRL project team has not engaged in the intensive examination of livestock nutrition. No laboratory facilities for the analysis of feed composition and value were established, and the grazing trials have seen the animals as a kind of black box through which range grasses are put, with the outcome in animal growth measured."

Further, for reasons discussed in the 1981 NRL Project Evaluation Report, the technical advisory position in animal production was never filled, and certain pilot activities in nutrition called for in the Project Grant Agreement (with feed supplements and minerals) have not been carried out."

It is clear from this statement that the problem, recognized by the NRL has not yet been attacked. In chapter I, it was explained how the animal production specialist intends to approach this problem in order to produce a solution as rapidly as possible. In chapter III, the extremely low productivity of the pastoral enterprise was underlined, despite the lack of direct data. The following examples are quite persuasive: sexual maturity occurs late, at 3-4 years; the calving rate is low (about 50%); the rate of net weight gain is quite low (0.100 - 0.200 kg/day). This poor performance is the result, in most cases, of undernutrition and malnutrition during the 7 or 8 months of the dry season. Apparently the most frequent problems are:

a) energy deficiency
b) vitamin A deficiency
c) protein deficiency and
d) phosphorus deficiency

Before proposing solutions to this problem, we will attempt to analyze the various parts of the problem : understanding the parts will help to find appropriate solutions. Thus, we will discuss in succession the nutritional requirements of animals, the nutritional contribution of feed resources during the critical period (dry season), and the near impossibility of dry season pastures to satisfy all nutritional needs despite the presence of the highly nutritious browse stratum.

4.4.2. Nutritional Requirements of Animals

Nutritional requirements can be expressed either in units (Kg, gr, IU/Kg) of food dry matter, or in units per live weight or per animal.

In the tables showing nutritional requirements, all nutriments will not be presented. The data will be limited to nutriments that are often lacking during the dry season and thus represent a serious problem. There are four such nutriments: energy, protein, phosphorus, and vitamin A. For data on the nutritional requirements of cattle, sheep, and goats, two sources were consulted: the National Research Council, National Academy of Sciences, U.S.A. (1976), and the tables of nutritional needs used by the European countries (MCF, 1974). The reader should note that the following data were obtained for animals in temperate regions, and should therefore be applied with caution to animals living in dry tropical regions such as the Sahel. It is very unfortunate to be unable to find directly applicable data. If such data exist, their use is not yet generalized. See tables 27 and 28.

The two systems consulted, Anglo-Saxon (USA) and European, do not use the same units for energy and protein. The fodder unit (FU, Europe) is the equivalent of 1,880 kcal for ruminants (MCF, 1974). The European system uses Digestible Nitrogenous Matter (DNM) which includes protein and non-protein nitrogen.

The FU represents net energy (NE) and varies with the physiological condition of the ruminant: 1 FU = 1,650 kcal of NE for fattening, and 2,100 kcal for milk production. The figure of 1,880 kcal represents an intermediate value.

The conversion of metabolizable energy (ME) to net energy (NE) will be necessary to use the data presented below. The formula for the conversion is:

$$NE = ME - (DM \times 1)$$

One kcal/g of dry matter represents the energy expended as a heat increment in the metabolic process, thus it is unavailable for production purposes. For example, if the ME is equal to 3,000 kcal/kg DM, the NE will be equal to 3,000 - (1,000 X 1) = 2,000 kcal/kg DM. In the context, the NE will not be divided into growth NE according to the recommendation of Lofgren and Garret.*

To understand fully the energy value of forage, it needs to be evaluated in terms of its digestibility, which is influenced by its crude cellulose content. The higher the cellulose content, the lower the digestibility and the energy value or FU content. Forage with 0.6 FU per kg DM would mean that a ruminant could only obtain 0.6 X 1,880 = 1,128 kcal of net energy. The tables published by Boudet and Rivière (1978) make it possible to estimate the energy value of forage based on cellulose and ash content.

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* University of California, Davis, CA, USA. Instead, the NE will be presented as a global value in order to facilitate the conversion to FU.

TABLE No. 27. Some Nutritional Requirements of Ruminants, Units/Animal/Day

A/ CATTLE	GAIN, KG/DAY	DP, Kg	NE, Kcal	P, g	VIT. A IU
Weight (Kg)					
150 (young steers	0.00	0.13	3,000	5	6,000
	0.50	0.28	4,500	12	9,000
250 (heifers)	0,00	0.20	4,840	7	9,000
	0.30	0.33	5,970	12	14,000
350 (milk cows)	0.00	0.22	6,900	11	15,000
(with calves) per kg milk, 4% fat	-	0.051	1,130[1]	2	-
B/ SHEEP					
50 (males)	0.010	0.048	1,980	2.8	1,275
50 (lactating ewes) (8 weeks)	-	0.173	5,630	8.9	4,250
C/ GOATS					
27 (males)	0.020	0.070	2,500	2.7	-
27 (lactating goats)	-	0,120	3,800	3.5	-

Source: NRC, NAS, 1976

(1) Metabolizable energy

TABLE No. 28. Daily Requirements of Cattle and Sheep

	Maintenance	Growth	Gestation	Lactation
A/ CATTLE				
-Energy, FU				
150 kg	1.6	2.7/kg gain	0.2/100 kg LW	0.38/kg milk
250 kg	2.3	(12-18 mos)	at 8th month	(4% fat)
- DNM, g (Mad)	0.6/kg LW	120/FU M + G (12 - 18 mos)	100/FU	60/kg milk (4% fat)
- Vit. A, IU/kg/DM	3-4,000	3-4,000	5 - 6,000	5-6,000
- P,g	3/100 kg LW	6/kg gain	5.5/100 kg LW	2.5/KG MILK
B/ SHEEP				
- energy, FU	0.47	0.21/100 g gain	50% E requirement	0.6/KG MILK
30 kg				
- DNM, g	0.8/KG LW	175 g/UF (m+g)	1.5/kg LW	102/kg milk
- Vitamin A, IU	1-1,500	750-1,500	-	-
P,g	0.3/10 kgLM	2.5 (total needs)	3.0 (total needs)	4.5/liter milk

Source: Min. Cooper. Franc.1974

Similarly, Demarquilly's formula (Boudet, 1978) allows us to estimate digestible nitrogenous matter (DNM) based on crude nitrogenous matter (CNM), i.e. the percentage of nitrogen (N) multiplied by 100/16. Forage with 2.5% nitrogen (N) contains 2.5 X 100/16 = 15.62% CNM or crude protein. A ruminant could only obtain: 9.29 (15.62) - 35.2 = 109.9, i.e. 109.9 g of DNM per kg of DM, or 10.99% digestible protein.

It is also possible to use equations (Ensminger and Olentine, 1978) to estimate the digestible protein of forage based on crude protein content. Formulas have been developed for cattle ($Y = 0.850 X - 2.11$), sheep ($Y=0.930 X$ 3.01), and goats ($Y =0.933 X - 3.44$). Y equals digestible protein and X equals crude protein. Moreover, for the same species of ruminants, different equations have been established for the rainy and dry seasons. For example, for cattle the equations are $Y_1 = 0.850 X - 2.11$ and $Y_2 = 0.886 X - 3.06$ respectively. Y_2 is always less than Y_1 because of only of the increased lignin and cellulose content but also lower percentage of crude protein during the dry season. In short, regarding energy and protein content it is possible to move back and forth between the Anglo-Saxon and European systems by means of the preceeding conversion formulas. If the reader wishes additional information, he is referred to the following works: Ensminger and Olentine, 1978; Rivière, 1978; and Boudet, 1975.

4.4.3. Nutritional Contribution of available ~~Red~~ Resources

Earlier, in section 2.2.2.3., we mentioned the research currently being done to establish the chemical composition and nutritional value of pasture species in both seasons and the principal browse species. The complete results will be known in June 1983. In the meantime, we will present data drawn from MCF (1974) which seem appropriate to the subject under discussion. Table 29 gives the

nutritional value of two forage plants that are very common in the project zone, Cenchrus biflorus and Aristida mutabilis, as determined in both the rainy and dry seasons. Table 30 gives the nutritional value of three browse species frequently found in the Sahel. Their nutritional value is reported for the dry season only. The data in table 29 clearly indicate that the content of all nutriments decreases, sometimes considerably, during the dry season. For Aristida more than Cenchrus, the phosphorus and digestible protein content drops almost to nothing in the month of April (hot dry season). Conversely, the concentration of dry matter and cellulose increases as the dry season progresses. The browse species, on the other hand, are very rich in nutriments (Table 30). They represent true plant supplements. Unfortunately, their forage volume (density per hectare) is low, and they are not sufficiently grazed by cattle. Only camels and goats benefit from them during almost the whole year.

4.4.4. Can Nutritional Requirements be met during the Dry Season?

To answer this question, let us try to solve two practical problems.

Problem I: A young steers weighs 150 kg. He grazes on a light mixture of Cenchrus and Aristida, and walks 2 km per day in the rainy season and 10 km in the dry season. He consumes 3.75 kg of DM per day. Are his nutritional requirements satisfied during both seasons, during the months of August and April for example, by consuming only green grass (RS) and straw (DS)? Can he meet his requirements by supplementing his dry season diet by stimultaneously consuming browse species?

A/ NUTRITIONAL REQUIREMENTS

1) Total Energy Requirements (TER)

Maintenance + growth (0.5 kg/day) = 1.6 + 1.35 = 2.95 FU
Walking = 0.022 FU/100kg LW/km covered
Rainy season = 0.022 FU X 1.5 X 2 = 0.066
TER = 2.95 + 0.066 = 3.016 FU (EUR)

By using the NE in table 27

4.500/1.650 = 2.727 FU

TER = 2.727 + 0.066 = 2.97 FU (USA)

Walking (dry season) = 0.022 X 1.5 X 10 = 0.33 FU
TER = 2.95 + 0.33 = 3.28 FU (EUR)
TER = 2.727 + 0.33 = 3.05 FU (USA)

2) Protein Requirements

0.28 kg DP/day

3) P Requirements = 12 g/day (total requirements) (USA)

Maintenance = 3 X 1.5 = 4.5 g
Growth = 6 X 0.5 = 3.0 g

Total requirements = 7.5 (EUR)

Because of the absence of reported ' the vitamin A content for these grasses, the requirements for this nutriment have not been calculated.

B/ NUTRIMENTS INGESTED

1) August (rainy season)

DM consumption = 3.75 kg/day (2.5 % LW), half (1.875 kg) Cenchrus, half Aristida

	Energy, FU	DP, Kg	P, gr
Cenchrus =	1.012	0.0918	2.62
Aristida =	1.256	0.0975	3.56
Consumption =	2.268	0.189	6.18
Requirements X 2/3 =	1.990	0.184	4.95
Balance =	+0.278	+0.005	+1.23

Table No. 29. Seasonal Influence on Nutritional Value of Forage Plants (on DM basis)

Period of the Year		DM %	CP %	Cel %	Ca %	P %	DP %	Energy FU/kg DM
A/ Cenchrus biflorus								
July (RS)	BO	23.0	16.0	30.3	0.50	0.16	11.7	0.64
September (RS)	FL	28.0	8.8	33.2	-	-	4.9	0.54
September (DS)	FR	39.2	5.4	38.9	0.46	0.13	2.7	0.42
November (DS)	ST	92.8	3.7	39.1	0.27	0.10	0.6	0.39
April (DS)	ST	94.4	2.6	40.0	0.18	0.07	0.4	0.37
B/ Aristida mutabilis								
July (RS)	BO	32.6	12.6	30.6	0.53	0.19	8.5	0.68
August (RS)	FL	34.7	9.1	31.1	0.48	0.19	5.2	0.67
October (DS)	FR	54.9	3.4	37.6	0.41	0.11	1.6	0.51
December (DS)	ST	94.4	2.5	42.1	0.15	0.03	0.2	0.33
A April (DS)	ST	95.3	0.9	44.3	0.14	0.02	0.0	0.26

Source: Min. Coop. Franc., Mémento Agro 1974. DS = dry season ; RS = rainy season ; BO = "boot" stage, FL = flowering stage, FR = fruiting stage ; ST = straw ; DM = dry matter ; CP= crude protein ; DP = digestible protein ; Cel = cellulose ; Ca = calcium ; P = phosphorus ; FU = fodder unit.

Table No. 30. Nutritional Value of some Browse Species in the Sahel (on DM basis)

Species and parts analyzed	DM %	CP %	Cel %	Ca %	P %	DP %	FU FU / kg DM
A/ Acacia albida							
1) Dry leaves (February)	30.7	17.8	17.5	1.08	0.22	13.7	0.89
2) Dry pods (March)	86.5	12.0	20.1	0.51	0.15	7.8	0.91
B/ Acacia raddiana							
1) Dry pods (April)	91.9	18.5	18.4	1.19	0.26	12.0	0.88
2) Green pods (April)	31.0	14.1	21.8	0.72	0.25	9.8	0.84
3) Green leaves (April)	39.0	15.1	17.7	0.89	0.17	11.4	0.87
C/ Balanites aegyptiaca							
1) Green leaves (December)	38.9	12.2	13.0	1.98	0.10	10.2	0.90
2) Leaves and flowers (April)	35.4	20.0	20.0	1.10	0.19	15.9	0.81
3) Whole fruits (January)	88.2	7.9	5.7	0.23	0.08	-	-

Source: Min. Coop. Franc., 1974

The abbreviations are the same as in table 29.

2/ April (dry season)

	Energy, FU	DP, Kg	P, gr
Cenchrus	0.693	0.0075	1.3
Aristida	0.487	0.0000	0.37
Consumption	1.180	0.0075	1.67
Requirements X 2/3	2.164	0.184	4.95
Balance	- 0.984	- 0.176	- 3.28

If one assumes that the nutritional requirements are to be two-thirds (2/3 satisfied which is acceptable, since presumably the nutritional requirements of cattle are lower in tropical countries than in temperate countries, it can be seen that, during the rainy season, the FU, DP, and P requirements are largely satisfied by the theoretical mixture of Cenchrus and Aristida.

On the other hand, in the middle of the dry season (April), the balances are all negative, i.e. the requirements for these three nutriments are far from being even two-thirds satisfied.

To answer the second question, let us assume that the steer in question consumes, in addition, green pods and leaves from Acacia raddiana, and that total consumption of dry matter does not exceed 2.5% of live weight, or 150 X 0.25 = 3.75 kg. Then we can adjust the dry season calculations as follows:

3/ Dry season (April)

Consumption	DM, Kg	Energy, FU	DP, Kg	P, gr
Cenchrus	1.0	0.37	0.004	0.7
Aristida	1.0	0.26	0.000	0.2
Acacia - pods	0.75	0.63	0.073	1.87
leaves	1.00	0.87	0.114	1.70
Total	3.75	2.13	0.191	4.47
Requirements X 2/3		2.164	0.184	4.95
Balance		- 0.034	+ 0.007	- 0.48

The simultaneous consumption of a single shrub, Acacia raddiana, in a plausible proportion (40.6%), given the low density of the browse stratum, reduced considerably the energy, digestible protein, and phosphorus deficiencies of the growing steer. It should be noted that Acacia raddiana pods and leaves are among the most nutritious elements of the pastoral zone browse stratum. An increase in the consumption of this shrub would make it possible for the steer to cover its needs fully.

Problem II : A milk cow weighing 350 kg grazes on a pasture composed of 50% Cenchrus biflorus and 50% Aristida mutabilis. She walks 2 km per day in the rainy season and 10 km in the dry season. She produces 3.5 kg of milk with 4% fat during the rainy season, and 1.5 kg during the dry season. She ingests 8.75 kg of dry matter per day. Are her nutritional requirements met during both seasons? How can her dry season diet be improved through the consumption of green shrubs?

A/ NUTRITIONAL REQUIREMENTS

1) Total energy requirements (TER)

Maintenance = 6,900 kcal NE or 3.67 FU
Walking (Rainy season) = 0.022 X 3.5 = 0.154 FU
Walking (Dry season) = 0.022 X 1.5 X 10 = 0.77 FU
Milk production:
Rainy season: 0.38 FU X 3.5 = 1.33 FU
Dry season: 0.38 FU X 1.5 = 0.57 FU
TER (Rainy season) = 3.67 + 0.154+1.33 = 5.15 FU
TER (Dry season) = 3.67 + 0.77 +0.57 = 5.01 FU

2) Total protein requirements (TPR)

Maintenance = 0.22 kg digestible protein
Production
Rainy season = 0.051 X 3.5 = 0.178 kg
Dry season = 0.051 X 1.5 = 0.076 kg
TPR (Rainy season) = 0.22 + 0.178= 0.398 kg
TPR (Dry season) = 0.22 + 0.076= 0.296 kg

3) Total phosphorus requirements (TPR).

Maintenance = 3 X 3.5 = 10.5 g

Production :

Rainy season = 2.5 X 3.5 = 8.75 kg

Dry season = 2.5 X 1.5 = 3.75 g

TPR (Rainy season) =10.5 + 8.75=19.25 g

TPR (Dry season) =10.5 + 3.75=14.25 g

B/ NUTRIMENTS INGESTED

1) August (rainy season)

Consumption of DM = 8.75 kg/day (2.5% LW),
half Cenchrus and half Aristida, i.e. 4.375 kg of each.

	FU	DP, Kg	P, gr
Cenchrus	2.36	0.214	6.56
Aristida	2.93	0.227	8.31
Consumption	5.29	0.441	14.87
Requirements X 2/3	3.40	0.262	12.70
Balance	+ 1.89	+ 0.179	+ 2.17

2) April (Dry season)

	FU	DP, Kg	P, gr
Cenchrus	1.62	0.0175	3.06
Aristida	1.14	0.0000	0.87
Consumption	2.76	0.0175	3.97
Requirements X 2/3	3.30	0.195	9.40
Balance	- 0.54	- 0.178	- 5.43

In the rainy season, the milk cow in the example, can readily satisfy 2/3 of the FU, DP, and P requirements. During the dry season, however, these needs are far from being met; the situation is similar to Problem II. Let us consider the case where the cow's dry season diet of straw is supplemented with green shrubbery, in the form of Acacia raddiana pods and leaves.

3) April (dry season)

Ingredients	Consumption			
	DM, Kg	FU	DP, Kg	P, gr
Cenchrus	2.50	0.925	0.010	1.75
Aristida	2.50	0.650	0.000	0.50
Acacia				
pods	1.25	1.05	0.122	3.12
leaves	2.50	2.175	0.285	4.25
Total	8.75	4.8	0.417	9.62
Requirements X 2/3		3.3	0.195	9.40
Balance		+ 1.5	+ 0.222	+ 0.22

Consumption of this shrub (pods and leaves) amounting to 42.8% of total diet would allow the cow to satisfy two thirds of the nutritional requirements considered here.

If the results of the preceeding calculations are verified in the field, it will not be difficult to understand why growth is slow and why all cattle lose weight during the dry season. The calculations will be repeated later when we have complete data on the nutritional value of forage plants in the pastoral zone during both seasons. We can already anticipate that the figures will not be exactly the same, but that the trends indicated here will not change greatly.

For example, we have calculated the amount of energy expended in walking based on data collected by Dana Glazier (TSA, NRL), who observed a herd under traditional management conditions over 24-hour periods. For a day without watering, the energy expenditure during 24 hours was 0.76 FU for a heifer, 0.021 FU

for a ewe, and 0.029 FU for a female goat. On a day when the herd was watered, the expenditures were 1.21 FU, 0.057 IU and 0.042 IU respectively. Based on these preliminary results, livestock expend 1.5 to 3 times more energy in walking to and from the water point. On the other hand, while time spent walking is much greater (4 times greater for cattle) on watering days, the time spent grazing is twice as little. This cannot fail to have a negative effect on diet during those days when the herd must walk to the water point.

This model for calculating the nutritional balance can also be applied to sheep and goats in the pastoral zone.

In the following section, we will briefly review the impact of these deficiencies on the livestock.

4.4.5 Impact of nutritional deficiencies on livestock

In the dry season, livestock suffer from undernutrition and malnutrition because available feed sources rapidly become deficient in digestible energy and other nutriments (See table 29). Standing or fallen straw can in no way satisfy the requirements of animals. The consumption of shrubs in sufficient quantities could help satisfy certain needs, but their production is too low to cover dry matter requirements. Thus, inevitably, deterioration of body tissue (adipose and muscular) occurs, in order to meet maintenance energy requirements. The results is a worsening of physical condition and weight loss.

Let us examine the specific symptoms of the following deficiencies.

4.4.5.1. Although cattle, for example, manage to survive energy deficiencies over a considerable period of time, the consequences vary with the degree of undernourishment, and may include slowed growth; arrested growth, including skeletal growth; failure to conceive; increased mortality due to lowered resistance to infectious diseases and parasites; and increased mortality due to toxic plants.

4.4.5.2. Protein

Among cattle, calves, pregnant cows, and lactating cows have the highest protein requirements. When these are not satisfied, the animals suffer from: lack of appetite, which may lead to decreased energy consumption; continual loss of weight; slowed growth; irregular oestrus; and decreased milk production.

4.4.5.3. Phosphorus

The soils of the Sahel are poor in phosphorus (Mafga, A., 1981); the PPS group recently demonstrated this anew. It is clear that the Sahelian range cannot provide sufficient quantities of phosphorus for livestock. Moreover, the phosphorus content of the range diminishes with maturity and drying (dry season, see table 29). Thus, phosphorus deficiencies are encountered in livestock that survive for a long period on dry season pasture (standing straw). This deficiency has many effects on animal health and production. These include: loss of appetite; difficulty in achieving normal reproduction; decreased milk production; low rate of growth; failure to attain normal weight at adulthood; greater mortality; frequent bone fractures

4.4.5.4. Vitamin A

Ruminants need vitamin A to maintain their health, for reproduction, and for production. A vitamin A precursor, beta-carotene, exists in forage plants. Cattle are not very efficient at converting carotene into vitamin A (only 25%), and one mg of carotene is equivalent to 400 IU of vitamin A. The conversion takes places partly in the liver.

There are many problems related to the availability of carotene and its conversion by animals. During the dry season, straw no longer contains the same amount of carotene as one finds in green grass (to be demonstrated by the NRL). Moreover, when the temperature is high, the conversion of beta-carotene into vitamin A decreases significantly. What are the consequences of this deficiency among livestock?

When the deficiency is severe, night blindness occurs, which may lead to permanent blindness among young cattle, for example. Stud bulls experience a decline in sexual activity and sperm motility. Among cows, the rate of conception declines, while the rates of abortions and stillbirths increase.

It should be noted that, the younger the animal, the more rapidly it will suffer from vitamin A deficiency. Older animals, however, can store enough vitamin A in the liver to last six months.

4.5. CONCLUSION

In this chapter, we have discussed the principal causes of low and variable animal productivity in the pastoral zone. Based on the actual problems encountered, and an understanding of their causes, we will now, in the next chapter, present appropriate recommendations for preventing drops in production, and, secondly, increasing productivity. Their implementation is not one of the goals of this report.

CHAPTER V. RECOMMENDATIONS FOR IMPROVING ANIMAL PRODUCTIVITY

Most of the references consulted in preparing this report include recommendations for improving animal productivity in the pastoral zone. Taking into account the environmental conditions and natural limitations, some of them appear unrealistic, too theoretical, too ambitious, or difficult to apply.

Many recommendations were even formulated in the form of programs of action or programs of intervention well before the NRL project. Some may have been taken into consideration in preparing the NRL, PID or PP. However, Phase I (NRL) had the task of testing in the field several simple and appropriate intervention techniques, with the eventual goal of improving traditional herding practices. Nonetheless, for reasons presented in the first chapter (1.1.), the research in animal production was not carried out. There is good reason for hoping that this research will start to materialize during the intermediate phase between the NRL Project and the Integrated Livestock Project (ILP), and will continue at the beginning of the ILP.

A list will be presented at the beginning of this chapter, showing the programs or means of intervention already proposed for either Niger, in particular, or the Sahel in general. Then we will analyze these proposals while stressing their likelihood of success or failure. The most important intervention techniques will be discussed and formulated, and we will attempt to establish a list in order of priority.

We share the view that it is no longer a time for trials, but rather for action. We are convinced that if the objectives of the ILP are modest, realistic, and gradual, they will be achieved to the satisfaction of the beneficiaries.

5.1. Programs of intervention already proposed

1) To create pastoral associations and develop socioeconomic relations between herders in the pastoral zone (nomads) and farmers in the agricultural zone (sedentary population).

2) To construct boreholes where they can be supervised and easily closed when necessary in order to protect the range from overgrazing. In other words, to distribute water points as widely and evenly as possible to encourage uniform grazing.

3) To stabilize the market demand and prices for livestock, meat, and by-products in order to encourage production of high quality meat. This point would be developed along with no. 1

4) To develop a national policy for the establishment of livestock feed reserves in the form of high quality hay, not straw, without which regular and sustained animal production is impossible.

5) To take full advantage of local agricultural by-products (millet stalks , peanut hay, cowpea hay, and millet bran) and industrial by-products (cottonseed, rice bran, peanut cake, and C.S. meal cotton cake) in order to supplement the diets of young cattle and milk cows as a priority.

6) To enforce a policy of protecting natural resources from erosion and deforestation.

7) To continue to make additional efforts to increase the health coverage of livestock. The results of the annual vaccination campaigns are remarkable. Improvements will concern the organization of the vaccination campaigns, laboratories, clinics, and training of veterinarians, assistants, and particularly veterinary auxiliaries.

8) To link agriculture to herding through the sale of draft animals benefiting farmers and agricultural by-products benefiting herders. Similar to no. 1.

9) To assist herder economically by means of a low interest credit system and technical training to assure them of a stable market; to guarantee that the livestock remains in their hands; to facilitate the formation of cooperatives or associations among nomads or between farmers and herders. See no. 1 and no. 3.

10) To avoid accelerated rebuilding of herds until herders adopt and master new techniques of range management. Otherwise there would be a risk of upsetting the balance between the number of animals and the grazing capacity of the range.

11) To concentrate efforts on increasing animal weight rather than increasing herd size.

12) To reduce the number of males in herds intended mainly for milk production. To eliminate males whose growth is not satisfactory.

13) The projects attempting to improve animal production should begin by taking a census of nomads and livestock, by evaluating potentials, by making an inventory of natural resources, and by evaluating the requirements of animal production and the existing capacities. The objectives during implementation should be: to maintain the livestock in good health by vaccinating against infectious diseases and by controlling parasites and nutritional deficiencies; to provide herders with incentives or bonuses; to normalize relations between herders and farmers; to encourage intensive fattening of animals with the joint participation of those who fatten and raise calves; to establish livestock market routes and equip them with feed reserves and water points; or, if economical, to utilize monitorized transportation (UN Secretariat, 1978, no. 1 to no. 13).

14) To coordinate the following activities: establish forage reserves (hay or even straw from bush); implement deferred grazing in certain fragile zones; rationalize the use of pasture zones by means of rotation; regulate the periods of use; introduce improved forage species (legumes and grasses) (Maïga, 1981).

15) a) To close large capacity boreholes during the rainy season, and b) to disperse herds during the period of regrowth in order to avoid degradation of the natural vegetation.

16) To reserve for the hot season the pastures located around permanent water points, and protect their forage potential against fire.

17) To determine and control the optimal stocking rate around water points. In accordance with the rates determined, to modify methods of exploiting the range. (IEMVT and LNERV, Niamey, 1971; no. 15, 16, 17).

18) To concentrate research efforts on range management, animal production, disease control, and market development. On the basis of the data obtained, to propose a new and adapted system of animal production (Nestel, 1972).

19) To improve the means by which animals reach markets. To construct slaughter houses near livestock production centers and transport frozen meat to consumption centers. In order to avoid serious weight loss, to transport livestock by trucking with rest stops for watering and feeding, or by trekking with similar stops every 30 kilometers.

20) To produce young cattle for sale to fattening operations, or to sell animals (young bulls fattened only on the range, at the end of the rainy season (Abercrombie, 1980; no. 19 and no. 20).

21) To divide the objectives of the development program into short, medium, and long range goals.

a) In the short term, to establish an effective policy of development and range management, by using water points as a tool for managing natural forage resources --- in other words, to create water points where there is good dry season pasture in order to avoid overgrazing around boreholes; to improve health coverage once water and forage are adequately supplied to livestock, to begin to improve existing breeds by introducing new genes when the nutritional level of livestock has been improved.

b) In the medium term, to improve prices to encourage production; to grant credit for the development of ranches; to establish market circuits; to revise the pastoral community system to grant herders certain rights of first occupant.

c) In the long term, to develop a regional program for eradicating the major endemic diseases; to identify potential markets on a regional level; to develop fattening operations in the South in association with pastoral herders; to diversify animal production by including cattle,

sheep, goats, and camels; to generalize the use of protein, vitamin (A, D, and E), and mineral (NaCl, Ca, P) supplements to avoid major weight loss during the dry season, and reduce the time needed to reach maturity and market weight (Abercrombie, 1980).

22) To adjust the number of grazing animals to the amount of available vegetation in order to optimize animal production, taking into account both individual production and production per hectare. To apply, through the herder associations, the technique of deferred grazing for given zones, by reserving them until such time as it is necessary to open them for grazing. This technique should preserve forage quality until the dry season, and furnish a source of protein to animals grazing on low quality forage at the end of the dry season. This additional source of protein should be produced by the plants of the zone. It will first be necessary to make certain that the new system of grazing produced positive results, and to determine what is lacking in order to perfect it before proposing it to herders (Bement, R., 1982 b).

5.2. Analysis of proposals

In the preceeding section (5.1.), a summary of recommendations and suggestions for improving productivity in the pastoral zone was presented. This summary, in our opinion, is quite complete. Almost all the means of intervention have already been proposed. Some have been tested, with or without success. Others are in the process of being implemented. Still others remain exercises on paper and have sadly forgotten. In general, taking into account the multiple problems which confront the modernization of herding in the pastoral zone, almost all aspects of production have been considered, such that the contents of any new recommendation will not necessarily be new. Originality should lie, if not in the contents, then at least in the priorities to be established during implementation. The merit of any program of intervention will be in its simplicity, its realistic character, and its chance of success.

5.2.1. Forming herding associations and developing socioeconomic relations between herders and farmers

The development of herder associations is in total agreement with the concept of the Development Society, which originated in Niger at the end of the last decade. The national spirit of "cooperativism" took hold among sedentary farmers in the south through the cooperative movement, the Union Nigérienne de Crédit et de Coopération (UNCC). The UNCC is a state-controlled institution responsible for organizing and assisting agricultural cooperatives. It has flourished due to credit made available to farmers by the Caisse Nationale de Crédit Agricole (CNCA). Moreover, it has undertaken the taks of similarly organizing cooperatives in the pastoral zone no later than 1983. Encouraged by this position on the part of the government, the NRL decided, in December 1981, to work out a charter governing herder associations and allowing for the formation of several such associations across the whole project zone. At this date, close to ten herder associations have been established through the initiative of the socioeconomic team.

Before mutually beneficial and dynamic relations are established between the agricultural cooperatives in the South and the herder associations in the North, the latter must achieve a certain degree of socioeconomic activity and cooperative spirit. The agricultural cooperatives are more than ten years old, while the herder associations have existed for only a few months, or are yet to be created. The nature of cooperatives in the pastoral zone will no doubt be different than in the agricultural zone. Since herders are not sedentary, systems of credit, loan repayment, and accounting are likely to encounter problems which could harm the rapid development and progress of herder associations. However, it is desirable that these associations multiply without too many problems, that their activities symbolize a true revolution in the pastoral zone, and finally that they constitute the socioeconomic base entities for the modernization of herding in the Sahel.

The collaboration between herders and farmers is nowhere defined. Mention is made of the various shapes it could take. Aronson (1982) reports the result of meetings between representatives of the UNCC and the NRL held in Tahoua and Tchin-Tabaraden. Many areas of collaboration have been suggested, including granting credit to herders and supplying essential goods. It seems desirable for the NRL to assist the UNCC in granting credit, as well as in supplying and transporting essential goods.

This recommendation will be accepted because the advantages of collaboration between herders and farmers will have a positive effect on animal production in the pastoral zone. The form that this collaboration should take will be described in detail elsewhere.

In the meantime, the reader may refer to recolmendations no. 8, 13, 20 and 21 of section 5.1 for examples of areas of collaboration.

5.2.2. Improving pastoral water supply

The development of the pastoral water supply in Niger after the major drought of 1973 could be criticized if uncontrolled use of certain boreholes had caused overgrazing in the surrounding area, leading to a negative change in the herbaceous biomass and the browse stratum. However, apart from this long term drawback, there are many short term benefits, the most obvious being to keep animals from dying from lack of water. This recommendation has been proposed a great number of times (see recommendations no. 2, 6, 15, 16, 17, and 21, section 5.1.).

In fact, the Government of Niger has made considerable progress through its policy of pastoral water supply. The presence of numerous large capacity boreholes throughout the pastoral zone represents, in and of itself, an important stride in the struggle against thirst among animals. The points raised by the recommendations mentioned above — such as closing boreholes as needed to protect the surrounding pastures from overgrazing, and the opening up of pastures that are currently unexploited during the dry season by constructing new boreholes — are part of the general policy of the Government of Niger for improving herding in the pastoral zone. Some of these recommendations

have already been put into practice (no. 15a and 16), while others are not easily applicable (no. 15b and 21a) due to particular management conditions or the heavy additional expense they would require.

In general, the improvement of existing pastoral water supply is a recommendation that should be accepted although it is not a priority: animals are no longer dying from lack of water even although they expend too much energy in reaching water points during the dry season.

5.2.3. Improving animal health

The positive results achieved in the general animal health policy certainly represent an important step toward improving animal production in the pastoral zone. The current health status of the livestock is not perfect, of course, but the major endemic diseases have been controlled in part. Animals no longer die in great numbers from epizootic diseases such as rinderpest, pleuro-pneumonia, anthrax, and blackleg.

The additional efforts proposed by recommendation no. 7 are truly justified. This recommendation will be accepted, and the ILP, or Phase II, should take it into account in order to maintain animal health in the pastoral zone, which can only be guaranteed at the price of considerable effort and money.

5.2.4. Developing a national policy of pastoral feed supply

To make sure that animals in the pastoral zone no longer starve to death, a national policy of "pastoral feed supply" is necessary, of the same scope as the policy of pastoral water supply. Most herds are maintained at a low nutritional level to the detriments of productivity. Productivity should not be measured in terms of increased herd size, but rather in terms of the individual weight gain of animals.

The recommendation that the improvement of livestock diet in semi-arid zones should be based on corrected stocking rates and improved range management (Sjoberg and Persson, 1974) is inadequate for solving the problem of undernutrition. Recommendations no. 4, 5, and 14 should be accepted and incorporated into a national food supply program to benefit nomadic and transhumant herders.

A true revolution is called for, if not in forage cultivation, as proposed by René Dumont (UN Secretariat, 1978), then at least in the preservation of forage growing naturally in the pastoral zone (Louis, 1982b).

Solving the problem of undernutrition will help prevent, to a large extent, energy, protein, mineral, and vitamin deficiencies. We will return to this subject in section 5.3.

5.2.5. Stabilizing markets and livestock and meat prices

The modernization of herding in the Sahel is closely linked to livestock and meat marketing. It was emphasized earlier that, in principle, the herder produces for a market or markets which have their own requirements and standards. In return, he should return a fair and encouraging price for his products. (See no. 3, 21b abd c.)

Products in demand, especially at foregin markets, must be of good quality. In Niger, only meat is legally exported to neighboring African countries such as Nigeria. To guarantee these foreign markets, the national animal industry must continue to produce meat of good quality. For this purpose, the fattening of generally older animals (cattle) is widely practiced in the southern part of the country. Obviously, this is not a good system for producing quality meat. Quality meat normally comes from young animals whose meat is, for example, more tender. Nonetheless, the system of livestock fattening practiced in the agricultural zone by small farmers (Thomas Peterhans, 1982) or on the Soneran, Tiaguiriré ranches (Louis, 1982b) is definitely profitable. However, it is more profitable to those who fatten the animals than to the herders. Fattening cattle that are at least three years old, on the average, consists mainly of increasing the amount of fat and the carcass yield at slaughter. Attempts to improve the present system would encounter certain difficulties, the first of which is the supply of young animals. Taking into account livestock practices in the pastoral zone andthe traditional knowledge of herders, fattening young animals cannot be easily generalized (See no. 20).

Another factor affecting the carcass and, the quality of the meat is the way in which livestock are brought to market. (See no. 19). The long walk tires the livestock and inevitably leads to considerable weight loss and decreased yield at slaughter. The result is a loss of revenue for herders and for the national economy. The construction of refrigerated slaughterhouses near fattening centers could solve part of the problem. What about transporting livestock from herding regions (pastoral zone) to fattening centers (agricultural zone)? What about transportation to markets that are sometimes very distant? Livestock are not transported by truck in Niger. Transportation on hoof, as practiced, could be improved but not easily. To do this, it would be necessary to know the market circuits and to anticipate rest points every thirty kilometers or so, where the livestock could rest, drink, and, eat. This solution would of course be ideal, but it is not immediately applicable.

In our opinion, a viable solution would be to create several centers for the sale of livestock intended for fattening (certain rural markets, for example) and to provide transportation by truck, on an individual or collective basis.

This recommendation should be accepted, and implemented in the medium or long term.

5.2.6. Improving herd management

For a very long time nomads have managed their herds according to tradition, and herding has survived up to the present. Some studies have concluded that herders practice the "science" of herding (Maliki, 1981). Unquestionably, they have "knowledge" of animals, of the range, and of how to manage both to ensure their subsistence. Nonetheless, it is still true that the result is relatively poor and that patterns of herd management need to be improved. Herding is still at the stage of picking and gathering.

Improving herd management in the pastoral zone is as difficult as improving range management. Herding is community-based. Traditionally, herd management is linked to common exploitation of grazing areas. Thus,

the proposals made until now (no. 10, 11, 12, 21b, and 22), although viable in themselves, are not easy to apply and therefore haven't yet been attempted.

The recommendation to revise the pastoral community system such that herders receive certains occupancy rights would have many ramifications, including the sedentarization of herding. Thus, the chance of success of this intervention would be low. We advocate improving herding while preserving nomadism. This approach is more realistic, even though it calls for slow, long term progress.

The traditional herder is more concerned with herd size than with individual weight. The reasons for this are well known. Herders must be made aware of the significance of the problem by means of a comprehensive outreach program, in order to reverse this tendency and produce the following changes:

a) reduce the number of male animals per herd (25% in cattle herds in the Sahel, in general; Swift, 1979); and sell all animals that are no longer gaining weight, or that are not useful for reproduction.

b) show herders how to improve gradually the fertility of cows; concentrate the highest percentage of calf births in the rainy season; and decrease the interval between births.

c) ensure better growth for calves, young bulls, and heifers.

d) reduce the age of primipares (first calving).

We believe that the nutritional approach is most likely to succeed in improving fertility, increasing the rate of conceptions, and reducing the age at first calving. Undernutrition of cows and heifers must be avoided, and protein, mineral, and vitamin supplements administered at the right time. A simultaneous healthy diet for stud bulls, and drying up cows after nine months of lactation, are management practices that are not difficult to implement, and that are likely to contribute to a regular production of calves.

In contrast, controlling the time of conception or covering and thus of calving, would be difficult for herders to achieve because the stud bulls are kept with the cows throughout the year and covering is unrestricted. Once the oestrus cycle has been regularized, by an improved diet, it should be expected that births will be spread out through the entire year. Separating the stud bulls has been advocated to solve this problem. This strategy is feasible on the ranches but not in the pastoral zone.

Similar, appropriate considerations are needed regarding sheep, goats, and camels before developing methods of intervention for improving management practices for these species. They have different reproductive cycles and mating patterns.

5.2.7. Improving range management

This intervention technique is expressed in recommendations no. 6, 10, 14, 21a, and 22.

Nomadic herders possess knowledge of the range and the value of rotation grazing (Maliki, 1981). Moreover, the very basis of nomadism is movement guided by the environment (the condition of the range) and the response of the livestock to the environment (milk production, for example).

Furthermore, if herders were not "good rangers ", today there wouldn't be as much pasture (Louis, 1982a). Still, due to particular circumstances, overgazing and deforestation do exist in the Sahel. This is why, in a national policy for improving animal production, the protection of natural resources or the improvement of range management must be considered a priority. This should be closely tied to the issue of pastoral water supply, the establishment of regional stocks of animal feed, and the development of agricultural and industrial by-products.

The type of range management best suited to the pastoral zone is a controversial question. There are several aspects.

a) Deferred grazing is quite a popular technique. In our opinion, it provides good results when used to protect certain fragile zones (Maïga, 1971). However, these results are debatable when it comes to preserving

pastures for the dry season. It was demonstrated in chapter 4 that the dried grass (straw) which results from deferred grazing practices cannot satisfy the maintenance requirements of cattle, much less their growth and milk production requirements, during the dry season. Moreover, it is difficult to apply this technique to the pastoral zone, where there is shared, unrestricted use of the range. Even with the herder associations, volontary deferred grazing would have little chance of success. Using water points, as a tool for managing forage resources is not easy everywhere.

b) The tehnique of adjusting the number of grazing animals to the amount of available vegetation (density of ungrazed grass) in order to optimize animal production(Bement, 1982b) is not applicable to present pastoral zone conditions. The notion of grazing capacity is quite relative. It has no meaning if the nutritional value of the pasturage under consideration has not been defined.

Moreover, where pastures are not fenced off, it is impossible to know the stocking rate at a given time in the grazing process. When many herds graze simultaneously and freely, the stocking rate cannot be controlled.

In the case of fenced pastures, for example the grazing trials at Ibecetene and North Dakoro, the low stocking rate (2.10 ha/animal/4 months) seemed to produce a better effect than the high rate (0.7 ha/animal/4 months) on compensatory growth among heifers and milk production among cows during the rainy season (Bement, 1980; 1981; 1982a). On the other hand, during the dry season, the influence of the stocking rate on weight gain or milk production is not significant and varies from year to year and from pasture to pasture. Whatever the rate, the heifers and cows do not succeed in satisfying their maintenance needs during the entire trial (4 to 5 months). The result is gradual and inevitable weight loss. From the animal production perspective, the slight difference in weight loss per animal and per stocking rate was not important in most cases. However, the area where dry season stocking rates could have practical importance is in the length of time during which the animal satisfies its maintenance requirements before starting to lose weight (See table 24).

Similarly, an analysis of the milk production data from the trials has shown that the drop in production was so drastic in the dry season that it nullified the effect of the stocking rate.

To sum up, we can conclude that this range management technique cannot, by itself, solve the nutritional problem of livestock in the pastoral zone. Supplementary diet, as mentioned in section 5.2.4., is a necessary condition to ensure regular, sustained production throughout the year.

5.3. Intervention Techniques in order of priority

Intervention techniques proposed for improving animal production in the pastoral zone should be based on the results of pilot research. Since such research was not conducted by the NRL (chapter I), it is now impossible to predict the success of various techniques. Although the ILP, or Phase II, is to be a production phase, we recommend that it include short term applied research. This research will be planned with the goal of solving practical problems of traditional herding. In this section, we will present a list of research activities and a list of programs of intervention in order of priority.

5.3.1. Applied research

5.3.1.1. Monitoring animal production under traditional management conditions

The herder associations would be the ideal framework for this study if it were considered possible to make association members sufficiently aware of its value at the beginning of Phase II. The herds will be selected from the two major ethnic groups, the Twareg and the WoDaaBe, which will make it possible to study the two predominant cattle breeds, Azawak and Bororo. Herds composed of all species of ruminants will be studied.

The other aspect of this study will consist of testing the costs and benefits of production inputs with the goal of improving productivity. The study will be concerned with improving health, management, and diet.

An experimental draft was presented in chapter I, section 5.1.

5.3.1.2. Demonstration of vitamin A and phosphorus deficiencies and the effect of supplements on growth, milk production, and reproduction

We do not believe the NRL has yet conducted a serious study of nutritional deficiencies in livestock. Bruce Wylie (TSA) provided us with data from a small experiment on milk cows conducted at the North Dakoro and Ibecetene ranches. Administering vitamin A supplements during the dry season, in the amount of 800 IU for cows and 1,600 IU for calves each week for a one month period, produced no significant effect. Here are two illustrative results:

1. An average daily weight gain of 156 g per calf for the group of cows receiving vitamin A, and 150 g per calf for the control group.

2. An average daily weight gain of 106 g per calf for the group of calves receiving vitamin A, and 83 g per calf for the control group.

In this case, administering vitamin A produced no effect, probably for two reasons: the dose was too small (See table 9 on nutritional requirements) and the period of administering vitamin A was too brief.

Vitamin A and phosphorus deficiencies should be demonstrated by analyzing the dry season diet of animals (straw and shrubs) as well as their blood. These data and the deficiency symptoms will provide information on the actual existence and especially the rate of incidence of these deficiencies. Based on the results, appropriate curative and preventive treatments will be recommended.

The second portion of this study will determine the effect of vitamin A and phosphate supplements on production (growth or weight gain), milk production, and fertility (reproduction). The use of vitamin A in tablet form is particularly recommended. The best form of phosphate to be used will be determined later.

5.3.1.3. Seasonal influence on the nutritional value of the range

We have scarcely begun this study, which will continue during the 1983 dry season. This was mentioned in chapter II. The study is concerned with herbaceous biomass and the browse stratum.

5.3.1.4. Determining the cost-effectiveness of hay production

This study was begun by the NRL at Ibecetene but has been inconclusive. The hay that was sold was not of good quality, and no data on costs and benefits were published.

The ideal zone for producing hay should be determined. One suggestion would be to have hay produced in the intermediate zone, where rainfall is relatively good and and sedentary families are found, which is necessary for success.

Work should focus initially on pilot families, and the quality hay produced will be used in the study on the effects of improved diet (5.3.1.1.).

See chapter I, section 1.5.

5.3.1.5. Improving the natural range and traditional management

In collaboration with the agrostology section of INRAN, the possibility of seeding the range with drought resistant, short cycle leguminous plants should be carefully studied. New approaches, with the feed of better understanding range management as practiced by nomads, will need to be adopted before applying viable techniques that have already been demonstrated, such as centripetal grazing and controlled burning of pastures.

This list is not closed. Other types of applied research for solving problems will be considered.

5.3.2. Program of intervention

5.3.2.1. Continuing to develop functional herder associations

The implementation of the program of intervention will take place through the herder associations. Thus, it is essential that associations be established that are functional in all respects.
Quality must not be sacrified for quantity. Once formed, an association should receive technical and financial training and supervision. A system of pastoral credit through the CNCA will be studied thoroughly. Loans will be carefully granted to members who make a request. Technical training and supervision should include specific areas, including the following:

a) prevention of nutritional deficiencies;
b) treatment of diseases and wounds;
c) total participation in vaccination campaigns;
d) selection of improved breeding stock;
e) growing-out program for young steers during the rainy season;
f) livestock sales and marketing.

All these activities, along with other unspecified ones, will constitute a comprehensive program of intervention. To this end, the mobilization of all the technical personnel of the ILP will be necessary.

5.3.2.2. Continuing and intensifying logistic and technical support for the Livestock Service during the ILP

The ILP should help the Livestock Service to: a) train and assist the veterinary auxiliaries, b) construct vaccination chutes in areas of heavy concentrations of livestock, c) equip the veterinary posts built by the NRL and furnish the technical agents with a means of rapid transportation, d) solve the regional problems of the vaccination campaigns.

5.3.2.3. Improving livestock diet

Based on the results of the pilot study (5.3.1.4), hay production and marketing should be extended. Agricultural and industrial by-products and vitamin and mineral supplements should be furnished in sufficient quantity

by means of a stock established for herder associations. The nutritional program will be implemented through the technical training and supervision provided by the ILP. It should take the form of a national program of pastoral feed supply.

This program of intervention is incomplete. Nonetheless, it includes activities considered to be priorities, taking local conditions into account. It is indeed modest but will have a good chance of success if we all set to work.

Other aspects of the modernization of traditional herding will be considered later.

5.4. Some technical advice for herders and extension workers in the pastoral zone

What follows is a sort of technical guide that the herder may follow to improve his production and increase his revenue. It can be used by his extension worker to facilitate his work in the field. This guide includes three types of information: (1) what the herder must know; (2) what he must have; and (3) what he must do.

5.4.1. What the herder must know

1. Where to find help? Two types of extension worker will be quite close to the herder: Secouristes and veterinary auxiliaries. The former will be provided with modest veterinary supplies enabling them to offer first aid to animals at the camps. The latter, having received more technical training, will be based at the veterinary posts. They will be responsible for supervising many secouristes, and the secouristes, for their part, will work in close collaboration with the veterinary auxiliaries. Herders can contact veterinary posts either directly or through their respective associations.

2. Who can help him?

The individuals who can help the herder are not limited to his immediate extension workers: the secouristes and the veterinary post personnel. Additionally, the ILP will place technicians at several levels to train the

herder. The herder may approach the technical adviser of his association to request his assistance.

3. When can help be requested?

Help can be requested at any time: as soon as his herd shows signs of disease, or whenever he experiences a need regarding herding.

4. What must he know?

The technical education of the herder can be accomplished through his association. Elements of new knowledge will include:

a) the need to possess feed reserves for his livestock during the most critical months of the year (April, May and June),

b) how to obtain feed reserves for example the technique of preparing hay, and where to purchase cottonseed,

c) how to distribute feed reserves to the herd: what quantities, and which animals as a priority,

d) centripetal grazing management,

e) the use of vitamin and mineral supplements, and how to obtain them,

f) the herder association regulations and participation in the different activities,

g) the pastoral credit system,

h) functional literacy training,

i) how to build and repair wells,

j) craft activities, such as tanning, weaning, rope braiding, etc...,

k) how to select animals for better milk and meat characteristics,

l) the technique of destocking the herd to ensure better management,

m) the best time to sell livestock in order to increases revenues and avoid losses,

n) knowledge of the best markets and how to reach them as rapidly as possible.

5.4.2. What the herder must possess

(1) He must possess enough animals for a herd that is profitable and that meets the subsistence needs of his family. The ILP should help the herder, within the framework of his association, to rebuild his herd with the goal of increasing its productivity and ensuring his self-sufficiency. Establishing a community herd of females already represents one means of intervention intended to help the poorest herders reach this goal.

(2) At the end of the rainy season, the herder should establish food reserves for his herd. Nomadism would appear,at first sight,to interfere with this activity. However, through the assistance of the ILP and his herder association, the herder will be able to have at this disposal a stock of feed reserves proportional to his herd. It is important that he be well informed and that he understand that dry season pasturage is poor in nutritional elements and unable to last until the abundance of the rainy season pastures. The reserves will be sufficient for at least two to three months.

The reserves in question will be calculated on the basis of the following quantitative requirements. The quantities are expressed in kg per live weight and per day.

Feed	Milk cow kg/100kg LW/day	Young steer kg/100kg LW/day	Heifer kg/100kg LW/day
Cowpea hay or peanut hay	3.0	2.5	2.7
Hay from the bush	1.8	2.5	2.5
cotton cake	1.5	-	0.5
or cottonseed	1.0	0.5	0.5

feed	Lactating ewe or milk goat kg/50 kg LW/day	Young sheep or young goat kg/10 kg LW/day
Cowpea hay or peanut hay	2.0	0.3
Hay from the bush	2.9	0.6
or cottonseed	0.2	0.03

Based on this information, the herder associations will establish stocks of livestock feed reserves by taking into account the following data:

a) the number of cattle: how many milk cows, dry cows, young bulls, heifers, bulls, and calves,

b) the number of small ruminants; how many lactating ewes, milk goats, rams and male goats, lambs and kids.

(3) A stock of medicines for parasite treatments should be established. The quality and quantity of medicines will be determined with the assistance of the veterinarian of the ILP or the Livestock Service in accordance with the number of animals to be treated in the herds belonging to the members of each association. Vitamin and mineral supplements and anti-parastic medicines will be ordered through VETOPHAR.

(4) A stock of vitamin A and phosphates should be established.

a) The sources for these supplements will be determined later.

Vitamin A will be used in tablet form. One source is the Laprovet laboratory in Veigne, France. This laboratory provides tablets of 2,000,000 IU of vitamin A and 200 mg of vitamin E.

Quantities of tablets to stock per year, per animal, to prevent avitaminosis A

Milk cows	1 X 6	=	6 tablets
Dry cows	1 X 6	=	6 tablets
Bulls	1 X 6	=	6 tablets
Young bulls	1 X 6	=	6 tablets
Heifers	1 X 6	=	6 tablets
Calves	1/2 X 6	=	3 tablets
Lactating ewes	1/2 X 6	=	3 tablets
Milk goats	1/2 X 6	=	3 tablets
Rams	1/2 X 6	=	3 tablets
Males goats	1/2 X 6	=	3 tablets
Lambs and kids	1/4 X 6	=	1.5 tablets

To treat avitaminosis among calves : 1/2 X 24 = 12 tablets
Among kids or lambs: 1/4 X 24 = 6 tablets.

The herder should administer a tablet every two months to prevent a vitamin A deficiency, and every half-month to treat avitaminosis A.

b) Regarding phosphates, the Tahoua phosphate, containing 15% P and 36.5% Ca, should be tried. Phosphates will be imported for use as supplements if the local phosphate proves to be ineffective or problematical, due to its high rate of fluorine (3.0%). The source of phosphorus selected should provide 8 grams daily to calves, 10 to heifers and young bulls, 15 to dry cows, and 40 to milk cows.

c) The use of growth salt (Nigeria) is recommended for young and lactating animals. It has a better balance of mineral elements (major and trace elements) than the local salts.

d) Five to ten blocks of this salt per herder per year represents a sufficient quantity. After the first year of use, the new stock will be determined more precisely.

5.4.3. What the herder must do

The knowledge and skill of the herder in the pastoral zone were emphasized earlier. However, through the acquisition of new knowledge within the framework of the ILP, there will be a series of new attitudes which the herder will need to adopt in order to improve his productivity.

a) To manage wisely the range and his herd, with the collaboration of his extension workers. He will be taught the centripetal grazing system;

b) To accept responsibility for establishing feed reserves or at least for purchasing them once they are available to him;

c) To administer sufficient quantities of supplements to young and lactating animals as a priority;

d) To treat his whole herd for parasites according to the recommendations of his extension workers;

e) To lead his entire herd to the vaccination site during the annual campaign;

f) To water his entire herd as often as possible;

g) To attend regularly the meetings of his association, and participate in the various activities;

h) To inform his veterinary agent or secouriste immediately when there is an outbreak or a suspicion of a contagious disease;

i) It is a fact that the length of lactation among cows is influenced by the herder's need for milk. As far as possible, the herder will be urged to dry up cows in order to decrease the interval between births and increase calf production.

This temporary guide was prepared within the context of the larger technical report on the improvement of animal productivity. It will be completed and explained in detail before Phase II, the production phase of the Project. For example, numerical data on nutritional reserves and veterinary medicines will be included, in order to facilitate their acquisition by the herder associations.

GENERAL CONCLUSION

Many aspects of traditional herding and means for improving it have been considered. These considerations are intended to provide a basis of discussion before adopting a particular program of intervention. Due to time constraints in preparing this technical report, we were not able to complete an exhaustive review of the vast amount of available literature on herding in the pastoral zone. However, in spite of the abundance of the literature, there are very few data on animal production under traditional management conditions. Unfortunately, Phase I was unable to produce data of this sort to fill the gap, which clearly interferes with developing a valid program of intervention for improving animal productivity. Productivity is simply "the ability if the animal to produce more than what is needed for survival."

The necessity of increasing the output of the animal industry of Niger has been demonstrated with examples drawn either from the government ranches or from the NRL grazing trials. The key factor in low productivity (diet) was brought out with simple examples of the balance between animals' requirements and their consumption of nutriments during the dry season. In fact, rational feeding on the natural range, accompanied by supplements and veterinary care, can reduce the calving interval, the age at first calving; and the age at which market weight is attained. Presently, the cattle population is exploited at a rate below 12%, and the small ruminant population at a rate below about 25%. There is no doubt that the potential for exploitation could increase to 30% and 50% respectively, if a national policy of pastoral feed supply became a priority.

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