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A.

REPORT, INVENTORY AND PRELIMINARY MANAGEMENT PLAN FOR THE NIGER RANGE AND LIVESTOCK PROJECT

Prepared For:

The Agency for International Development

November 1976

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I. MAJOR CONSTRAINTS AND SUMMARY RECOMMENDATIONS

This report gives an overview of a very complex situation as observed during a relatively short period of time (two months). Problems are identified and suggestions made for changes based upon the survey team's experience in a comparable ecological area in the United States (Arizona).

Lack of total rainfall, variable precipitation from year to year and seasonable distribution are major natural constraints that dictate any future development in the project area. This moisture constraint controls the type and amount of forage available and therefore the number of cattle that can be grazed. The moisture factor also determines the location of permanent and seasonal water resources for the human and livestock population.

A second major constraint identified by the survey team was the sociological factors inherent in the native population of the area. These factors combine to create a situation that is difficult to change. There is a suspicion of outsiders. A traditional nomadic pattern of life exists. There is seemingly a much greater attachment to capital resources for production purposes (livestock) than to money or to land. The existing systems have developed over generations and reluctance to change is to be expected.

The report prepared by the Rangeland Resource Inventory and Analysis team provides a general description of the area, detailed information on physical resources and plans for future management of these resources for maximum development. In addition, certain specific recommendations are made as detailed below.

Recommendations

A. Grasses

1. Maintenance of a good vegetative cover would provide a defense against wind erosion.
2. The maximum amount possible of perennial plants should be maintained in the vegetative mixture of the rangeland. Perennial grasses would also help to solve the dry season protein deficiency problem.
3. In order to allow the area to improve, organic matter and litter to accumulate and to allow perennial grasses to become re-established only 50% of the annual grass production should be harvested. The height of plant stubble left on the range should appear about two inches high when new growth appears.
4. Yearly clipping studies should be made to determine the current carrying capacity and stocking rates should be adjusted accordingly.

B. Water

1. Permanent potable water supplies for both livestock and human needs is the number one priority.
2. Water sources for livestock should be spaced so that the animals will not have to travel more than 3 miles to water. This will provide the greatest utilization of available range.
3. Earthen type structures should be built to collect and store rain water for use during the dry season. The deep pit charco is recommended as having the most universal application, cheapest to construct and with the smallest loss to evaporation.

C. Livestock

1. Goat numbers should not be allowed to increase and existing animals should be kept under strict control.
2. The present breeds of cattle are recommended for the area.

D. Animal disease control measures

1. All animals from birth to 4 years of age should be vaccinated annually against Blackleg.
2. All animals over 6 months of age entering the project area should be vaccinated against Rinderpest and contagious Bovine Pleuropneumonia (CBPP) with the bivalent "Bissec" vaccine and revaccinated on an annual basis.

3. A survey should be made of the incidence of Hemoragic Septicemia in the project area and until the incidence is known, all animals 6 months of age or older should be vaccinated annually one month prior to the rainy season.
4. Spray races should be made available to spray all animals to control ticks and other external parasites. Monthly applications of toxophene are recommended during the rainy season and once during the middle of the dry season. This will cut down on diseases such as piraplasmosis, anaplasmosis, trypanosomiases and heartwater disease.
5. Diagnostic facilities and procedures should be developed to determine the presence of internal parasites in all classes of livestock and treatments carried out as required.
6. An area diagnostic laboratory should be established to determine the incidence of brucellosis and vibriosis. Three veterinary positions should be established to handle this facility. If it is found that these diseases are present to the extent that they are lowering the reproduction rate, a vaccination program should be initiated.
7. A study should be made of forage and animal specimens to determine the existing nutritional deficiencies. It is expected that mineral, vitamin, carbohydrate and protein shortages are all present and in the short run it is recommended that information already available from Dakar Horn Laboratory from other trials be used to formulate a temporary mineral, vitamin and possibly protein supplement.

8. All goats and possibly all sheep over 6 months of age entering the project area should be vaccinated for CCPP.
9. The incidence of sheep pox, an exotic disease reportedly brought in from Mauritania two years ago, should be studied to determine the need for future vaccination programs.
10. Vaccination centers should be built within the project area. They should contain facilities for vaccinating, branding, tagging, castrating, dehorning, applying pesticides, and weighing the animals.
11. All animals entering the project should be identified by branding or ear tagging. This would enable the project personnel to maintain individual animal records on ownership, age, health, vaccination and reproduction.

E. Livestock marketing

1. The present marketing system can be improved by the following:
   a. Collecting statistics
   b. Marketing intelligence
   c. The licensing of major livestock dealers and middlemen
   d. The control of central markets
   e. The sale of cattle by live or carcass weight
   f. Credit should be provided to buyers

F. Animal nutrition

1. Applied research should be carried out to determine an effective year-round vitamin, mineral and salt supplementation program.
2. Studies should be conducted to determine an economical supplementary feed to use during periods of low forage availability.
3. Salt and phosphorus should be made available to all lactating animals.
4. The by-products of the peanut, rice and cotton industries in Niger should be developed as sources of supplementary feed for livestock.

G. Forest

1. The amount of forest required for shade and browse for larger animals will be provided by trees and shrubs through natural reproduction.

H. Fire

1. Uncontrolled burning of rangeland should be eliminated.
2. Fire lookout towers should be constructed and a pattern of dual purpose access roads and fire breaks should be built throughout the area.
3. The people inhabiting the area should be educated as to the damage caused by fires.

I. Roads

1. A modest network of north-south, east-west roads should be constructed to give access to the area.

J. Management practices

1. The flow of people and livestock into the project area should be controlled to prevent overgrazing.
2. The land should be divided into grazing units and herdsmen assigned given areas depending upon their needs. These units should each have a range management plan based upon the carrying capacity of the ranges in different zones. There should be a provision to control the use of the areas provided to individual groups.
3. Educational programs for herdsmen should be established to teach them about improved livestock and range management practices.
4. The long term nature of a range improvement program should always be considered and no results can be expected in the short run.

K. Education

1. In order to communicate effectively with the nomadic tribes that utilize the grazing lands of Niger an extension program should be developed to meet their needs.
2. A cadre of trained extension aides should be formed from the members of the Peul, Tuarez, and Fulani tribes.

3. These extension aides should work with members of their own tribes and take to them knowledge of improved technology and get them involved in future range management planning.

4. The professional extension workers should be limited to program organization and administration, extension aid selection, training and program maintenance.

L. Research and demonstration efforts

1. The group feels that it is not necessary to carry out any basic research in order to develop a range management improvement system in the project area. However, extensive use should be made of research results from similar areas of the world.

2. It is recommended that a demonstration grazing unit be established as a training center and to carry out practical applied research efforts. Demonstrations and information gathering should be carried out in the following subject areas:

   a. meteorological information

   b. range reseeding

   c. soil conservation and erosion control

   d. stock water development

   e. pasture rotation and deferred grazing

   g. an effective year-round vitamin, mineral and salt supplementation program

h. supplementary feeding of locally produced feeds

i. animal health

j. culling and selection programs

REPORT, INVENTORY AND PRELIMINARY MANAGEMENT PLAN FOR PROJECT AREA, NIGER RANGELAND LIVESTOCK PROJECT

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II. ABSTRACT

Nomadic tribesmen have grazed livestock in the pastoral zone of Niger for centuries. Due to extremes in precipitation, large numbers of animals, and uncontrolled grazing over the years, much of the area is producing far below its potential.

A survey of present range and livestock resources was conducted on a project area, representative of the pastoral zone during June and July, 1976 to determine the possibility of improving plant and animal management in the area.

A report reflecting the opinion of the four man survey team of range and animal specialists describes various short and long term improvement practices that are suited to the area.

III. INTRODUCTION

Range livestock production is vital to the economy of the nomadic and semi-nomadic herdsmen of the pastoral zone of central Niger. The dependence and abiding relationship that exists between these people and their animals is legendary and deeply ingrained in the history of Western Africa. It is unfortunate, however, that with the passing of time, the unrelenting forces of nature coupled with the ways of man have claimed a heavy toll on the grazing resources of the land.

The combined effects of large livestock numbers, uneven animal distribution, undependable stockwater, recurrent drought and a general lack of sound grazing management have resulted in a decline in forage production and a downward trend in range productivity over the years. Today, however, there is reason to believe that action may be taken, that in time, may slow and conceivably reverse this trend in forage and animal productivity in the pastoral zone. The proof here lies in the fact that the Government of Niger in cooperation with representatives of USAID recognize the seriousness of their problem and are willing to consider positive steps that may be taken to stabilize and improve range and animal productivity in the area. To this end USAID in cooperation with the Director of de l'Elevage in early 1976 initiated a

range and livestock management project for Niger. One of the initial steps in their project was a survey of range and livestock resources in the area; this report reflects the findings of this survey.

IV. OBJECTIVE

The objective of carrying out this survey was to observe the present condition of grazing resources and range and animal management practices in an area representative of the grazing ranges of Niger. At the completion of the survey, where feasible, offer recommendations on the implementation of practices aimed at improving plant and animal productivity in the area.

V. LOCATION AND SIZE OF PROJECT AREA

The project area selected for study by the Range Resource inventory team is located on the grassland plains between Dakoro and Agadez, in north-central Niger. Specifically, the area is located between the 15° and 16° of north latitude and the 6° 40' and 7° 50' east longitude and contains some 1,164,800 hectares (2,912,000 acres). With reference to other locations, the area is located within a large square bounded by Aderbissant on the east, Gadabeji on the south, Abalak on the west and the Falaise de Tigidit rim on the north.

VI. PHYSICAL FEATURES

The principle physical features that determine the vegetational pattern of a grazing region are climate, topography and soil. Each of these features are dealt with in this section.

CLIMATIC FACTORS

A. Precipitation

In considering climatic factors that affect forage production, precipitation is the most important single consideration. The project area lies in what has been broadly classified as the Sahel-Saharan climatic zone. The mean annual precipitation for this zone ranges from 200-400 mm. Reliable precipitation (rainfall) records are unavailable for locations within the project area. However, long-term records for the period 1955-1975 are available for Agades, Tahoua, Zinder and Dakoro located 25-175 km from the project area.

The total annual rainfall for each of these four areas is presented in the following table.

ANNUAL PRECIPITATION AGADES, TAHOUA, ZINDER, DAKORO

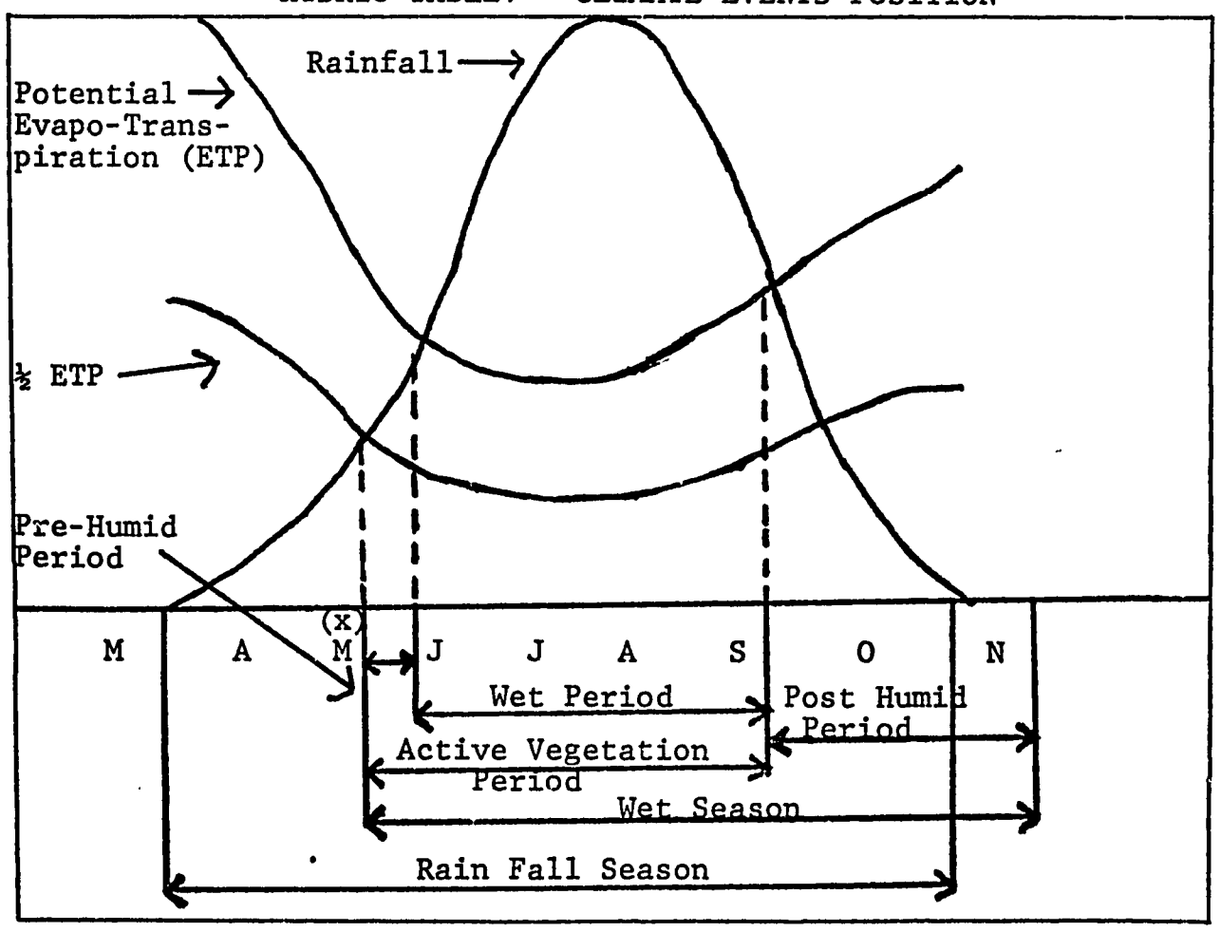
	LOCATION			
Year	Agades	Tahoua	Zinder	Dakoro
	PRECIPITATION			
1955	193 mm	468 mm	500 mm	342 mm
56	162	396	610	365
57	116	387	599	215
58	288	533	526	441
59	238	477	481	399
1960	147	315	583	574
61	216	582	577	454
62	151	555	467	281
63	174	342	362	267
64	128	440	658	584
1965	149	477	434	506
66	104	463	487	394
67	155	497	405	399
68	165	407	375	294
69	84	317	436	378
1970	39	421	354	328
71	92	267	352	336
72	73	267	302	207
73	76	244	297	110
74	136	421	480	451
1975	130	421	Missing	Missing
Annual Average	132 mm	414 mm	464 mm	366 mm

The mean average annual precipitation for these four locations varies from 132 mm at Agades on the north to 464 mm at Zinder some 175 km southeast of the project area. The only reasonable assumption that can be made here is that annual precipitation in the project area is somewhere near an average of these two extremes or approximately 280-300 mm of rainfall annually.

This figure places the area in the middle of the 200-400 mm limits indicated for the Sahel-Saharan climatic zone. Unlike many of the low desert regions of North America which are characterized by distinct summer and winter rainfall patterns, the deserts of western Africa and Niger normally receive rainfall during only one season, the period from early April through mid October.

The diagram which follows illustrates what is termed a "HYDRIC TABLE" and was taken from studies done by Dr. Pierre Granier. The illustration reveals some interesting facts on climatic events that occur during the rainfall season in Niger.

HYDRIC TABLE: CLIMATE EVENTS POSITION



(x)Rainfall = ½ ETP

Taken from Agrostological Study "Modernizaof Niger Pastoral Zone", Dr. Pierre Granier.

Storms during the rainfall season are usually heavy, accompanied with strong winds, but are of short duration. The average moisture receipt per storm is 6-10 mm.

B. TEMPERATURE

Temperature is probably the second most important climatic factor that influences range forage production. Unfortunately as with precipitation, accurate temperature data is not available for locations within the project area. However, reliable temperature data is available for three locations, Agades, Tahoua and Zinder, which are located 100, 150 and 175 kms respectively from the area. It is believed that the temperatures at these locations would be representative of most of the range sites in the project area. The following table shows the monthly and mean annual temperatures for these three locations:

Monthly and Annual Average Temperature - Agades, Tahoua and Zinder

degrees centigrade

Month	Location		
	Agades	Tahoua	Zinder
January	20.0	24.1	22.8
February	22.8	25.7	25.3
March	27.4	29.4	29.8
April	31.1	32.6	33.0
May	33.9	33.6	33.3
June	33.5	32.4	31.5
July	32.2	29.3	28.5
August	30.7	27.5	27.0
September	36.3	29.2	28.8
October	29.7	29.9	30.1
November	25.0	27.5	27.3
December	21.3	24.2	23.7
Annual Average	28.3	28.8	28.4

It can be seen from the temperature values shown in the table that average annual temperatures vary slightly from north to south and from east to west. It is also noted that monthly temperatures increase from January to June then stabilize and then decline progressively from November to January.

C. Evaporation-Transpiration

Research personnel involved with range and vegetation manipulation problems utilize ATMOMETERS or evaporation pans to measure evaporation under field conditions. It has been learned that plant transpiration and evaporation react similarly to atmospheric factors that affect the transfer of moisture from the

plant surface into the atmosphere. Thus for field measurement purposes, evaporation values are considered a good indication of potential for plant transpiration. Evaporation data is available for three locations Agades, Tahoua and Zinder located 100-175 kms from the project area.

The following table shows evaporation at these three locations.

Daily Average Evaporation - Agades, Tahoua & Zinder

MM of Water

Month	Location		
	Agades	Tahoua	Zinder
January	6.9	12.4	6.8
February	9.1	13.8	8.5
March	11.6	15.7	9.7
April	11.6	15.0	10.8
May	10.6	11.8	8.8
June	7.3	9.3	7.3
July	6.8	6.2	4.5
August	4.8	3.7	2.8
September	7.0	4.6	3.4
October	9.3	8.8	6.3
November	8.5	13.2	8.0
December	7.1	12.9	6.7
Monthly Average	8.4	10.6	7.0

Evaporation varies markedly from one location to another. During the 12 month period the warmest and driest months, February, March, April and May, have the highest daily evaporation. This is the case again during November and December.

D. Wind

Air masses move from regions of high barometric pressure to regions of low barometric pressure. Pressure differences at various locations within a region are usually due to unequal heating of the earth's atmosphere. The equatorial regions of the world including the Sahel-Saharan climatic zone of Niger regularly receive more heat than regions to the north or south. As a result lower atmospheric pressures are usually found at the lower latitudes. Because of this, global air movements are usually from the poles toward the equator. This pattern though generally true is often affected by temperature differences caused by large water and land masses and to a considerable extent by the deflecting action of the earths rotation.

This information is basic to an understanding of the physical forces at play with wind movements and may be helpful in utilizing wind data included in this section. Reliable wind information is available at three stations Agades, Tahoua and Zinder all of which are located 100-175 kms from the project area. Information on wind direction and velocity at each of these locations is presented in the following table.

MEAN MONTHLY WIND DIRECTION AND VELOCITY - AGADES, TAHOUA & ZINDER

1 mm/Sec = 2.237 MPH

LOCATION

	Agades		Tahoua		Zinder	
Month	Direction Degree	Velocity mm/sec	Direction Degree	Velocity mm/sec	Direction Degree	Velocity mm/sec
January	120	7	40	3	60	3
February	120	6	360	3	80	2
March	120	6	120	3	80	2
April	100	5	120	4	80	2
May	100	5	220	4	280	3
June	100	4	180	4	280	3
July	280	4	220	4	280	3
August	280	4	220	4	280	4
September	100	5	220	2	300	2
October	100	5	40	2	40	2
November	100	5	40	2	40	2
December	100	6	40	2	40	3
Averages	135	5.08	171	3.08	161	2.58

Distinct changes in wind direction can be seen at all locations as the summer rainfall season approaches. This rather abrupt change in direction is coupled with an increase in velocity at Tahoua and Zinder but with a decrease in velocity at Agades.

TOPOGRAPHY

Topography affects vegetation indirectly by modifying other factors of the environment; precipitation, temperature etc. Thus in areas where topographic variations are unimportant, other factors being equal, a uniform pattern of vegetation

may be expected. This was found to be the case in the project area.

The topography of the area can be characterized as a broken pattern of undulating plains and shallow drainages that flow generally in a north-south direction. The terrain is flat and often lays uninterrupted for many kilometers in any direction by anything except weakly defined hills and widely scattered sand dune ridges that rise only a few meters above the landscape.

Photos 50, 51, 52 and 53 show typical topographic characteristic described in the previous paragraph.

The photo site was located approximately 15° 15" north latitude and 6° 55" east longitude. Photo no. 50 was on a compass reading due west; photo 51 due south, photo 52 due east and photo 53 due north.

Elevations in the area vary from lows of 419-425 meters, found generally in the south to highs of 500-532 meters in the north. Strangely, for an area of this size, there are no dominant topographic features with the possible exception of widely scattered rocky outcroppings (malapai) in the northwest sector, to describe the area more dramatically.

The landscape of the project area is typical of adjacent lands for considerable distances in all directions. The only exception here might be the increase in cultivated land that begins approximately 25 kms beyond the south border of the project area. From this, it is reasonable to conclude that the project area is representative of much of the pastoral zone. Due to this fact, recommendations made for the project area would be applicable to most areas of the pastoral zone as well.

SOILS

Recognition of the fact that soils in the arid regions of the world must be managed differently from those of the humid regions has come very slowly and at great cost to the country of Niger. Wind erosion, water erosion, drought and lack of basic range management practices have created major problems for soil management in the pastoral zone.

No attempt will be made to discuss in detail the pedologic aspects (origin and nature) of soils in the project area rather concern is with Edaphic (soil as a foothold for plants) aspects of the soils of the area.

The destructive character of water erosion is accentuated where vegetative cover is sparse or denuded and where rains are brief but torrential. Soils formed under arid climates are typically alkaline and calcareous and because of the absence of leaching frequently are inherently fertile even though low in organic matter. Water and soil moisture are limiting factors so the conservation and judicious use of the available water supplies becomes of paramount importance for rangeland management in Niger.

Soil Description

The soils of the project area are mostly composed of coarse-limey and fine sands, with some traces of clays and silts. Sandy soils have high potential to absorb water readily during the rainy season but conversely have a low potential for water retention. All annual and perennial grasses and woody plant species will grow and develop normally in these soils. However, the longevity of plants is somewhat impaired due to the low moisture holding capacity of the soil.

Fine textured silts and clays are typically confined to river bottoms and waddies and to closed drainage basins where run-off accumulates from the higher areas. These alluvial and clay soils, however, are of rather minor consequence and represent a very small portion of the total area of the pastoral zone.

These bottomlands are almost always covered with large, deep rooted woody vegetation. Generally speaking, east of the 6° 41' meridian and north of the 15° 20' parallel, sandstone and coarse sands dominate soil structures. South of the 15° 20' parallel to the Tarka Valley, fine sands mixed with clays dominate soil structures.

For the purpose of range site description, soils in the Niger Project area will be classified by the following:

SY Pure sandy soils with no clay or silt particles and little or no organic matter. These soils are subject to gully erosion and will become duney when denuded of plant cover. These soils are characteristically deep and contain no profile.

SYC Sandy soils containing some clays that tend to bind soil particles. These soils are subject to sheet and gully erosion. The soils are relatively deep and contain no profile.

OV Sandy clay and silty clay loams make up this group of soils. They are the heaviest and the rarest in the project area. They are located mostly on the bottomland drainages and waddies. These contain a slight soil profile and some exhibit B - horizons.

Although sandy soils introduce problems of erosion their wide spread occurrence in these arid rangelands is fortunate. Studies of desert soils have shown that soil-water relationships of sandy soils are the key to their superiority in the arid rangelands of Niger. The efficient use of water is vital in this arid region both to conserve the

limited supply and to avoid water logging. Because most of the water in sandy soils is held at lower suction levels it is more easily removed by plants than is the water of clay soils. This property of sandy soils is important in arid rangeland conditions. Rapid absorption, deep penetration, and easy release of limited moisture by sandy soils contrast with the slow absorption, shallow penetration, and slow release of water by clay soils. Under normal rangeland conditions, where water application is not controlled, the greater water holding capacity of fine textured soils is of less significance than the ease of absorption and release by sandy soils.

The near complete absence of ground litter or cover in the majority of the project area presents serious problems with regard to deterioration and erosion of soils in the area. Plant residue left on the surface protects soil from the beating action of rain and slows the movement of water thus reducing runoff and water erosion. Sometimes terracing and contour tillage on rangeland is beneficial in reducing erosion. Runoff problems are generally similar in both humid and arid regions. The difference in the project area however are the intense storms that often deposit a years supply of rain within a few minutes or hours. Because of this, erosion and runoff control structures must be designed with this fact in mind. (See Section under Water Catchments).

Wind erosion control takes three forms; maintenance or development of the vegetative cover, reduction of wind force near the soil surface and tillage to avoid a loose finely divided soil surface.

The maintenance of a good vegetative cover is the best defense against wind erosion, unfortunately however many times this is difficult to achieve. This is especially true in Niger, where much of the plant cover has been disturbed by overgrazing, fire, erosion and drought. In such cases, where plant cover is incomplete, the surface roughness and stability of the soil become important management factors. Rough soil surfaces and well aggregated soils are less susceptible to wind forces than the smooth, sandy and poorly aggregated soils found in much of the project area.

Range fertilization, particularly the addition of nitrogen, is another tool of range improvement used in some range areas of the world. In Niger however the cost of fertilization in proportion to expected growth response would be impossible to justify.

From the soil information gathered during their inventory, no known soil problem exist that would interfere with the application of available "recipe knowledge" in the improvement of grazing ranges in the project area.

Three distinct types of landscape are seen in the project area. The northwestern portion is a low wooded plateau, where approximately two-thirds of the trees are dead and down. Most of the north, east and southern portions of the area is made up of stationary and mobil dunes which support varying stands of annual grasses and woody shrubs. The balance of the project area is characterized by heavily wooded drainage and swampy bottomland.

Soil Data Collection and Interpretation*

Twenty-three (23) soil samples were taken in the project area. (See overlay of transect site and soil samples). The transect sites were selected in such a manner as to obtain an even representative sampling of the entire project area.

All samples were analyzed for PH values, total soluble salts and exchangeable sodium status - (See Table 1).

*Appendix I

TABLE 1

Sample No.	Depth of Sample	PH Values	Soluble Salts Saturation Extract EC x 10	PPM	EDTA ML	
SS 1	30 cm	7.4	455	(.65)		
SS 2	15 cm	7.2	210	(.30)		
SS 2	60 cm	7.2	280	(.40)		
SS 3	15 cm	7.0	1190	(1.7)	3.2	Bottomland
SS 3	60 cm	7.2	1400	(2.0)	3.1	Waddie
SS 4	15 cm	7.2	105	(.15)		
SS 4	60 cm	7.2	105	(.15)		
SS 5	15 cm	7.2	455	(.65)		
SS 5	60 cm	7.4	840	(1.1)		
SS 6	15 cm	7.2	490	(.70)		
SS 6	60 cm	7.4	175	(.25)		
SS 7	45 cm	7.6	1960	(2.8)	2.5	Well
SS 8	15 cm	7.4	210	(.30)		
SS 8	60 cm	7.4	210	(.30)		
W 9	60 cm	7.6	455	(.65)		
W 10	60 cm	7.4	770	(1.1)		
W 12	60 cm	7.2	385	(.55)		
W 13	70 cm	7.4	385	(.55)		
W 14	60 cm	7.4	595	(.85)	3.1	
W 15	60 cm	7.2	210	(.30)		
W 16	60 cm	7.2	175	(.25)		
W 17	50 cm	7.2	420	(.60)		
W 6	15 cm	7.2	560	(.80)		

Only the heavier soils were titrated with EDTA to determine if exchangeable sodium problems exist. All tests on the potentially problem soils proved negative.

The results of soil tests shown in Table 1, reveal no mechanical soil conditions that might adversely affect plant growth.

The total soluble salts were analyzed by an electrical conductivity bridge test set. This instrument measures the

electrical conductivity of a saturated extract from the soil sample and the results are expressed as millimhos per centimeter at 25° C (see table 2 for relationships of conductivity to soil salinity and crop growth).

TABLE 2

EC x 10	Soil Salinity	Effects on Crop Growth
0	Very low	Salinity effects mostly negligible
2	Low	Yields of very sensitive crops may be restricted
4	Medium	Yields of many crops restricted
8	High	Only tolerant crops yield
16	Very high	Only very tolerant crops yield satisfactorily

Table No. 3 plots four (4) suspect soil samples on the sodium status diagram. Each of the four samples are well within the tolerances allowed for no exchangeable sodium problems.

TABLE 3

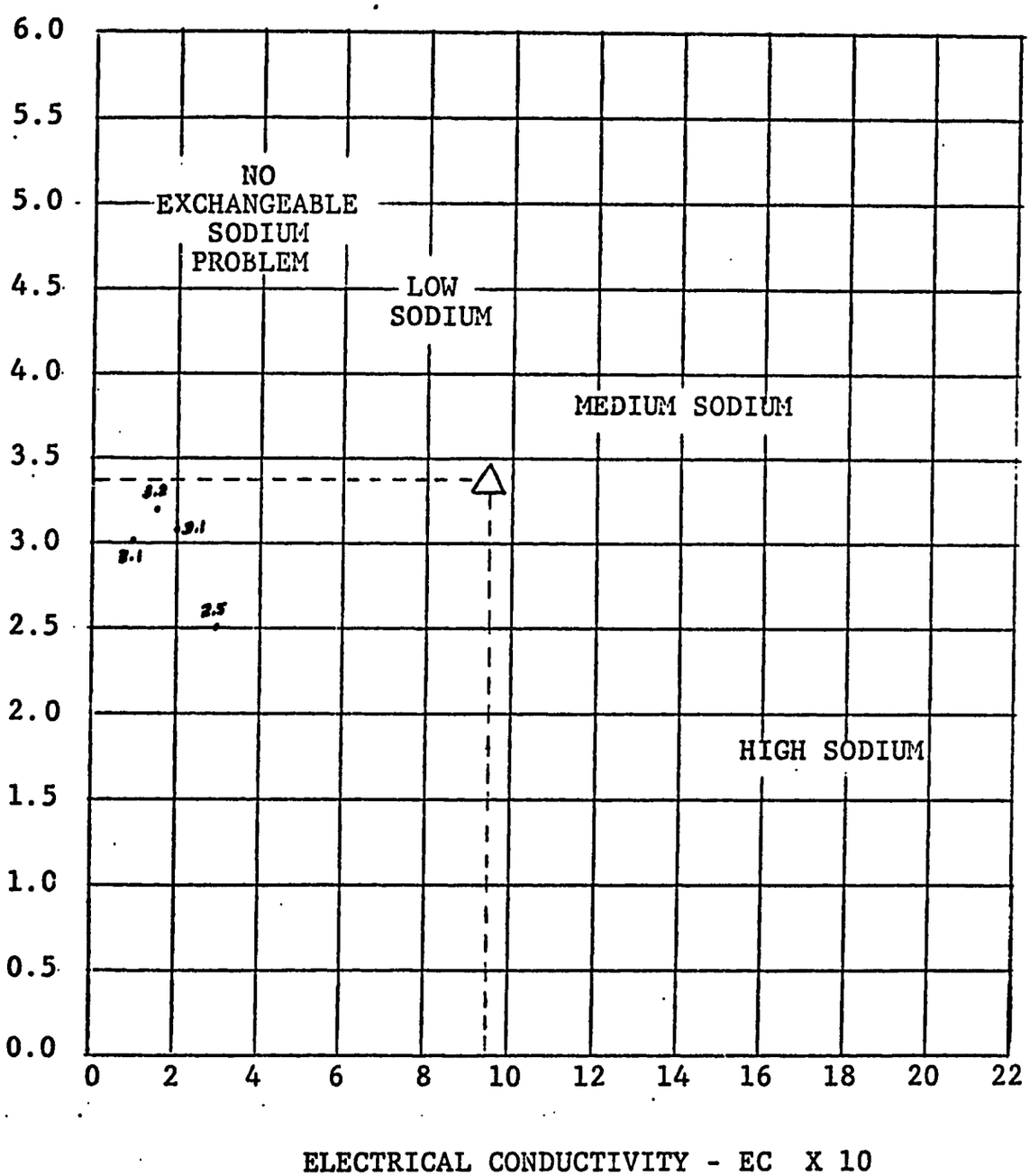


Figure 4. - Diagram for Classification of Sodium Status in Soils.

(Adapted from USDA Circ. 982, 1956)

USE EXCHANGEABLE SODIUM PERCENTAGE

ESP

PHYSICAL RESOURCES INTENTORY

FORAGE RESOURCES

Range Survey Methods and Data

The range survey method used in this study for grouping or dividing range areas is based on soil similarities or differences. These areas are referred to as "Range Sites". This method is used because plant communities and range potential are more likely determined by soil types, textures and depths, within a given climatic and elevation zone, than any other single factor. Of course, it also takes into consideration that plant communities can be modified by slope, exposure and management as well as various other factors.

Also taken into consideration for making judgment of range condition is the equilibrium of plant communities between itself and other related factors of its environment. In ecological terms, this equilibrium is termed climax.* Therefore, ranges in the early weed stage (annual grasses) are considered poor; those with climax vegetation are considered fair or good. The practicality of reaching a climax situation eventually becomes a management decision.

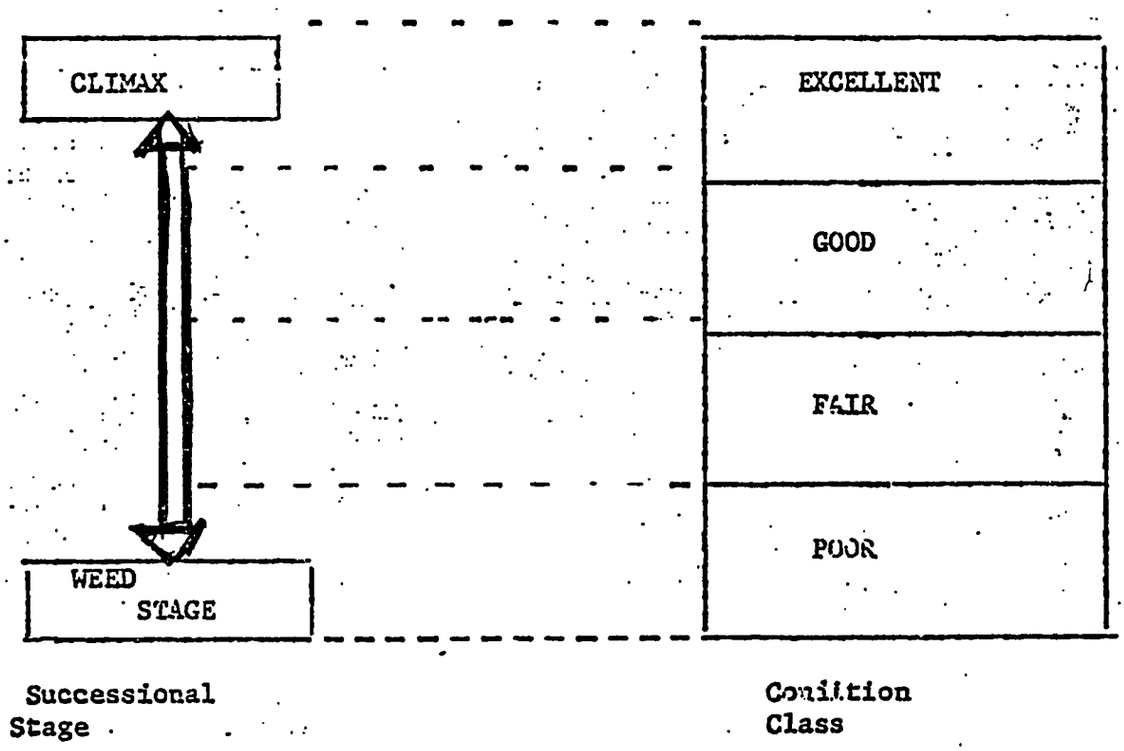
In this study we recognize that annual grass production plays an important role at the present time in the pastoral zone, even though the presence or absence of perennial grasses was used to determine range condition.

*Refer to chart following page

Annual grasses do not present a stable situation from year to year. This does not imply that we can reach a static relationship between the plant and animal community by re-establishing perennial plants. Far from it, nature is dynamic. But we can reduce the spread between the highs and lows and provide a dependable feed source from which realistic stocking rates can be based.

In this survey method range potential is described and any factors that will affect management are also noted.

Range Condition-Regressional Relationship



This chart shows approximate relationships between range conditions and degree of retrogression from climax conditions.

Range Site and Condition Inventory*

Successful range resource management is dependent upon an understanding of the interrelationships of soil, vegetations, climate, and physiography with its dependent biotic life. Many factors influencing soil resources (such as wind, water, topography) as well as those factors which have altered the climax vegetative cover (such as fire and grazing) have acted to produce complex patterns of distribution and composition. This ecological approach is based on the premise that climax vegetation, or as near to climax as practical will result in the highest practical returns from livestock, watershed or other legitimate uses and also provide the highest degree of soil stabilization.

There is an ever present need for the fullest and most accurate vegetation information practicable for use in the administration of the range and related resources for such purposes as livestock production, watershed protection, game conservation and other demands. It is for the purpose of obtaining these basic facts, analyzing the various problems and from them developing a comprehensive plan for managing the range resources that range inventories are conducted.

Many methods of survey have been and are being used to evaluate rangeland. Practically all of the methods involve

*Appendix I, Pg. 2-50

evaluation of "Range Condition". This term has many different meanings. These various interpretations can be divided into two major meanings: (1) Qualitative, where the density of ground cover occuppied by decreasers, increasers or invader plants is the primary criteria and (2) Quantitative, where the relative foliage production is the primary criteria. The quantitative system based on ecological principles was developed by E. J. Dyhsterhuis and is used here as a basic standard. This concept is based on the recognized assumption that usable forage production is highest where the vegetative cover is in close proximity to climax and lowest where the vegetation is most remote from climax. The application of this concept will provide for the maintenance and/or restoration of the ecological climax vegetative cover depending on whichever will provide the most practical and economical means of sustaining or improving the range resource.

The data obtained from the range resource inventory should provide a basis for examination and evaluation of the complex patterns of plant distribution and composition. This data is useful in the following:

(1) Identification of appropriate range sites and their respective condition class.

(2) Assignment of an initial stocking rate which will result in maintenance of the climax vegetative cover or provide for improvement of the vegetative

cover to its potential productivity.

(3) Provide technically sound data with which range management planning and practices can be implemented at the earliest practical date consistent with the maintenance of the range resource and economics of the livestock operation.

(4) Useful information to livestock operators on vegetative characteristics of individual range sites and the special requirements of key forage species, interpreted in terms of livestock use.

(5) Dissemination of information obtained from survey to various agencies and livestock operators concerned with the management of range resouces.

The results of this survey should be used as a flexible guide to aid livestock producers in making management decisions.

Climax Theory

One of the basic requirements of the climax theory is the designation of range sites. Range sites should be segregated depending upon different management practices that may be required or where significant variations in kinds or quantities of forage are produced.

1. Range Sites

   Range sites are range lands classified according to the soils or groups of soils they contain and

which have similar characteristics and capabilities to produce similar quantities and/or species of the climax vegetation. E. J. Dyhsterhuis[a] amplified the definition as follows: Range Sites are embodied within those areas where the soils and climatic environment sustain natural grass, forb, and shrub communities. Variation in soil (texture, depth, and permeability) and climate (precipitation, elevation, temperature, and exposure) determine measurable and important differences in the kind and amount of climax vegetation. Each specific complex of soil and climatic condition is called a "range site".

2. Identification and Characteristics of Range Sites

Range sites can be identified and range condition can be judged on the basis of vegetation alone. As range condition declines, as in the case of the project area, it becomes increasingly difficult and finally impossible to identify a site by vegetation alone. Consequently in the absence of the original plant cover, the permanent and hence applicable features of the site, that study and experience have shown to be associated with it, must be used as the identifying criteria. In this case plant communities and range potential are more likely to be determined by the kinds of soils within a climatic

(a) Condition and Management of Rangeland based on Quantitative Ecology. Journal of Range Management, Volume 2, No. 3.

zone or topographic classification.

Therefore climate, topography and soils must be consistently associated with the respective range site.

Range Sites are characterized by differences in the same area such as:

(a) Difference in soil (permeability, depth, texture, slope).
(b) Significant differences of climax plant composition.
(c) Similarity of climax plant composition but with a significant forage yield difference.
(d) Difference in elevation (precipitation).
(e) Difference in exposure (temperature).

A range site may be differentiated by considering any one or all of the above factors. It should be recognized that there may be small differences throughout an area delineated for management purposes. It is not feasible nor is it necessary to make fine separations because they would not be significant in terms of total production. With the exception of salt in toxic quantities, the principle factor limiting forage production on natural grassland, is the amount of available

moisture in the soil. The only significant differences in soil characteristics are those that effect available moisture. Differences in the amount of available moisture in soils is also affected by climate (precipitation, temperature) or by special factors that would increase the amount of the water available to the soil (such as overflow).

Range Site Description

Technical descriptions are developed for each range site to record:

(a) The actual or estimated composition of the climax vegetative cover.

(b) The significant topographic features and associated soil characteristics representative of the range site. Generally, detail of mapping allows for broad delineation of soil units that represent a range site, however, where more than one soil unit is included within each range site each should be identified.

(c) Climatic conditions (primarily precipitation).

(d) Guides to condition class, forage production and initial stocking rates.

Range site descriptions were developed by the Range Livestock Inventory Team. The technical descriptions were developed after the study of a given area.

The commonly used range site names of silty, clayey, sandy, etc., will be used in this description.

Range land in the project area is very homogeneous. It has been broken into three "Range Sites". Two of these range sites are sandy and differ very little. The only exception is that one site contains a small amount of clay that tends to bind the sand particles together and support a higher density of Acacia species than the other.

In order to avoid confusion the "Sandy Site" without clay will be referred to by the symbol SY; the other sandy site with the clay will be referred to by the symbol SYC. The overflow site containing clay accumulations will be designated by the symbol OV.

Range Sites

Sandy (SY) moderately deep to deep, coarse textured, rapidly permeable soils. The soils of this site contain little or no organic matter; there is no profile or structure. They are subject to sheet or gully erosion and can become duney when denuded by fire or overgrazing. This site is undulating to relatively flat. Productive potential is high when soil is stabilized.

Sandy (SYC) moderately deep to deep, coarse textured soils modified by the presence of fine particles. Soils are considered moderately to rapidly permeable. There is no structure or profile. Soils of this site contain some clay that trends to bind sand particles together. Water holding capacity is higher than that of SY site which probably accounts for the higher density of Acacia species.

Gully and sheet erosion are often found on this site. In cases with sheet erosion well developed erosion pavement is often seen. Wind erosion is seldom a problem on such sites. This site tends to be flatter than the SY site. It is a potentially highly productive site.

Overflow (OV) deep to moderately deep, medium and fine textured, very slowly permeable soils.

These sites occur in bottom locations and therefore are often flooded by runoff from the surrounding area during times of intense storms.

These soils are structured but show little profile development. Undistinguishable

horizons often occur down to parent shale material. This site is subject to compaction by livestock when wet, and gully erosion may be a problem where slope is a factor. The soils in overflow locations tend to seal and would make excellent sites for construction of pit charcos where runoff is sufficient. These sites have a very high production potential but are rather limited by total area.

Forage Availability

Perennial grasses are virtually non-existent throughout the study area. There are traces of Andropogon gayanus. Aristida funiculata and mutabilus are a little more common. The most common perennial grass found in the area is Cenchrus catharticus.

Annual grasses identified are: Ctenium elegan, Leptadenia arborea, Popalia lappaceu, Brachiaria ramosa.

Browse plants identified in the area are: Acacia raddiana, Acacia laeta, Acacia senegalensis, Balenites aegyptian, Boscia senegalensis, Calitropis procera, Commiphora africana, Maerua crassifolia, Popartia biriea, Ziziphus marritiaca, Cassia obovata.

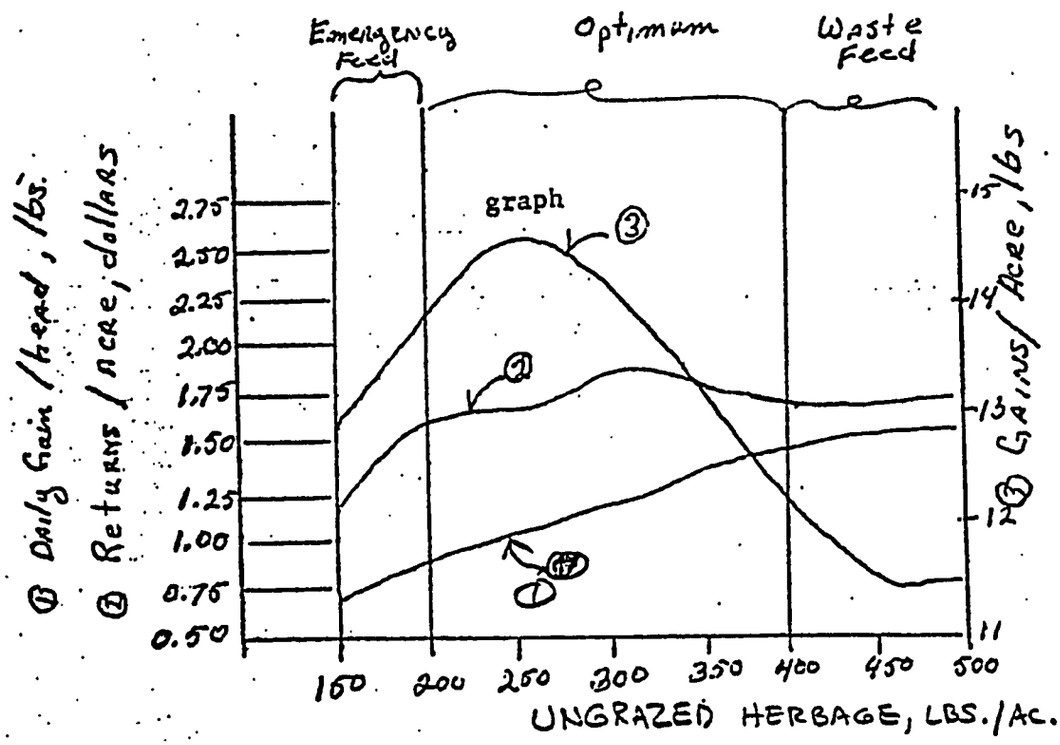
At the time of this survey the few perennial grass plants that exist had already begun to green up. Cenchrus catharticus in some areas had already achieved 20" (50 cm) of leaf growth whereas the annuals had not achieved much more than one inch (2.5 cm). Browse plants that play a major role in livestock forage and had also shown some signs of "greening up".

The availability of annual grasses as forage has a great variance. It appears that following a good rainy season it is lush and abundant. In dry years there is practically no production at all.

Browse plants are common in all areas and most always show the signs of severe hedging. The density of particularly the Acacias, Commiphora and Balenites is greater on overflow drainages but they are also found in other areas throughout the study area. Boscia senegalensis is in particularly overgrazed and in many areas killed out. Many trees and shrubs throughout the study area show the effects of severe grazing and drought. The mortality rate of trees and shrubs exceeds 50% in much of the project area.

Nutritional value varies greatly for grass and browse according to species and time of year. When green and growing forage plants are high in protein and carbohydrates; vitamin A levels are also high. When the same species are

in a dormant or dry state nutrient levels are significantly lower. In general perennial grasses cure fairly well and provide adequate protein especially for ruminants. Annuals tend to leach badly and protein levels are quite low. Trees and shrubs although high in protein during dormancy become woody, are unpalatable and can cause mechanical injury to the mouth and digestive system of animals. In areas where water is scarce, woody herbage is also a source for impaction problems. Vitamin A as well as most other vitamins and minerals are deficient during the dry season. Supplemental salt blocks would be a practical solution to this vitamin and mineral deficiency. Re-establishment of perennial grasses could help to solve the winter protein deficiency problem.



Optimum animal production is neither with maximum gains per unit area nor per head. Moderate stocking provides most returns in the short run and assures continued high yields of forage (adapted from Bement 1969).

Stocking Rates and Carrying Capacity

Grazing intensities can be evaluated from their effect on individual animals such as weight gains, weaning weights, calf or lamb crops and milk production. When a few animals are stocked on a range and their diet is not limited and gains are controlled by diseases, social behavior and factors other than nutrition. Grazing intensities can also be evaluated on a return per unit area which does not lead to the same conclusion as seen with individual animals. As the stocking rate is increased, forage becomes scarce and probably less nutritive, and less productivity results. This can be expressed in lower calf or lamb crops, lower weights and reduced milk production. Productivity per unit area on the other hand usually increases with increased stocking rates. One cannot have maximum animal production and maximum area yield concurrently. Animals tend to feed longer and travel more and food intake is usually lower as grazing intensities increase.

In short, stocking rate and carrying capacity are not synonymous. Stocking rate is flexible according to the type of management that is applied in an area. It is defined as number of animals grazed regardless of production. Carrying capacity is less flexible and varies with change in range condition and climatic factors. It is determined by actual production.

The stocking rates on the study area have exceeded the carrying capacity of the range for so long that a low nutritive value annual grass community has become the dominant source of food.

When possible the carrying capacity should be set on the perennial vegetation. Because a perennial situation does not exist and the area will and must be used, a carrying capacity based on annual production will be recommended.

Annual grass production from clipping studies varied from 8 lbs. of forage/acre to 2,000 lbs/acre. The high production sites are very rare but indicate the potential of the area. Clipping studies on several areas that showed little or no grazing average 1,200 lbs. feed/acre.

In order to allow the area to improve, organic matter and litter to accumulate and allow perennial grasses to become re-established only 50% of the annual grass production should be harvested.

Carrying capacity is expressed in animal unit months (AUM) or the area required to support a 1000# cow for one month. If we assume from our clipping studies that this area is capable of producing 1200 lbs. of grass and that the proper use factor is 50%, then 600 lbs. of useable forage is available per acre. It requires approximately 22.2 lbs. of air dry

forage to maintain 1 AU/day. Therefore, a range yielding 600# of available forage per acre will need 13.6 acres to support one 1000# cow one year.

In the past, in work done by Dr. Pierre Grenier, animal units in the Sahel were referred to as Tropical Bovine Units (TBU). In this designation a TBU is equivalent to a 250 kg (550 lb.) animal. The 250 kg TBU is significantly different than the 1000 pound value for 1 A.U. used in the United States.

Due to the fact that annual grasses are such an undependable feed source, yearly clipping studies should be made to determine the current carrying capacity and readjust stocking rates accordingly.

Water Resources

Two hundred seventy-seven (277) water wells were observed in the project area bounded by 6° 40' - 7° 50' east longitude and 15° 1' - 16° 0' north latitude.

Previous well excavations show (2) types of sandstones in the soil profiles.

1) Tegama type - this is a coarse sandy sandstone.
2) Farak type - a multicolored finer sandstone.

French geologists, to date, have not been able to arrange the Aquifer sandstone types into any coherent stratigraphic patterns - the only important observation is that clayish sandstones appear to be more abundant than sandy coarse sandstones.

The Tegama sandstones are shallower in the northern sections of the project area (approximately 200 m thick) and gradually thicken to about 600 m in the southern region of the area.

Most of the wells are located in the many valleys that generally flow from northeast to southwest through the entire zone and the area indicates a free water table.

The static water level for each individual well is noted

as a minus number (ie -32) on the overlay transparency included with this report.

There are presently two cased (borehole) wells with pumps located in the west and northwest section of the project area. One is located at Abouraya and the other at Al Mota. All the remaining wells are the traditional hand dug cement-ringed or dirt-lined wells. All the wells, with exception of the two bore holes, generally-speaking are located in an aquifer of fine clayish sandstone exhibiting low permeability and produce on an average $1m^3/h$ water supplies. The average depth to water in these wells is 30-40 meters except in the northern section where the average depth frequently drops to 50-60 meters.

French research has indicated that aquifers with higher permeability can be found at the 200-300 m depth and in some regions, artesian flow has been encountered.

Water quality from the traditional wells is poorly mineralized, aseptic, has varying degrees of sodium bicarbonate concentrations and test of dry extract of total solids rarely exceeds 250 mg/liter.

Contamination of the water from livestock, rodents and fecal residues is common because the wells are open and because of the method of pulling the water from the well.

Approximately one-half of all the traditional wells are 25 years old and many dry up during the seasonal dry period.

Estimates indicate that yields for a hand dug well with an ample aquifer can water 200 head of cattle per day. (Specific yield data for each individual well is incorporated in the transparent overlay legend).

Assumption: Average water consumption per head, per day including spillage -- 77 liters. Continuous pulling for 200 head

$$\frac{200 \times 77}{600 \text{ min.}} = 25.66 \text{ liter/min. capacity}$$

French topography maps show indications of many natural ponds. However, in reality, most of the natural ponds dry up in October and if any exist after November, it is a rarity.

The primary reason for the natural ponds short life is because they are all very shallow (average 30 cm depth or less) and they encompass a large surface area.

Most all of the natural ponds could be deepened, (by 5-10 meters) enlarged, and diked to substantially increase storage capacity. Most of the main drainage waterways

could have "pit" type water catchments constructed in them as is noted in the Water Development Section of this report.

It is realized that topography and soil structure dictate the type of water catchment basins; however, many sites are suitable for properly designed catchments.

All excess water storage would be available for limited irrigation uses, pumped and distributed to large storage tanks at higher elevations, for gravity flow to areas without adequate water, or stored for emergency use during the critical dry periods.

Permanent, dependable, potable water sources and supplies is a number one priority for both livestock and human needs.

A complete discussion of water harvesting methods both natural and artificially is presented in the Water Development Section.

WATER DEVELOPMENT*

The weather in Niger still remains an agricultural enigma. Probably greater annual losses have occurred in Niger in recent years as a result of the irregularity of rainfall

* Also see Appendix II

than from any other one factor. One solution of this problem has been the prospects of increased use of irrigation water but this of course has definite limitations.

The meteorological factors which combine to produce the phenomenon which we recognize as weather are still not fully understood. There have been attempts to induce rainfall in Niger with varying degrees of success but these attempts have been hampered by a limited understanding of cloud physics. It is conceivable that with more knowledge of the atmosphere and its components it may be possible to someday influence the distribution of rainfall to produce a much more effective pattern over the project area. More realistically, instead of relying upon a yet unproven science of cloud reseeding and weather modification to increase moisture, many other factors or ideas in water conservation and water harvesting can be put to immediate use in the project area.

The livestock industry of the southwestern United States and northern Sonora, Mexico was developed during the last century. Survival of the industry in arid and semi-arid zones has depended largely on available forage and water. As time passed, more consideration was given to the spacing needed for watering facilities in arid land regions. The original rule of providing water to keep animals alive

has been replaced by one of having sufficient water so spaced that all the range is properly utilized. Today proper utilization of the range has gained acceptance as the chief objective in range management. This necessitates placing livestock waters sufficiently close so that a minimum of forage is trampled in travel to and from water and the range is grazed as evenly as possible.

The location, utilization and limited numbers of water facilities in the project area has contributed to increased erosion and range depletion. Stockwatering places are too far apart and the traditional methods of hand pulling the water at each well is not satisfactory for proper livestock distribution. The development of permanent and dependable water storage supplies are necessary for any improvement in livestock production in the area.

In any type of surface water development the function of the watershed must be carefully considered. The amount of runoff from a given watershed area is so dependent on the many interrelated factors that no set rule can be given for its determination---

> Watershed characteristics such as slope, shape, size and cover and soil plus the amount, intensity, duration and the frequency of rainfall have a direct effect on the annual yield of

water from any given area.

- In areas where rainfall distribution is spotty the yield from watersheds in the same vicinity may differ greatly. It has been noted that with two similar reservoirs a short distance apart; one consistently fills with water and the other fills only occasionally. This is characteristic of the intensive type rainstorms in arid land regions. This can be accounted for partially by reason of rains occurring more consistently in certain areas than on others. Such local pecularities should be considered in planning the location of catchment structures. Experience indicates that local residents of an area usually have a good knowledge of the size and frequency of runoff from individual drainages.

WATER HARVESTING OPTIONS

In considering water harvesting options, harvesting methods will be separated into two basic categories--Natural and Artificial.

Natural Watersheds - included here are natural slopes and drainage-ways that move surface runoff from storms to bottomland areas where the water spreads out, percolates into the soil, is concentrated and stored, or runs off and is lost.

Such natural runoff can be controlled by the design of earthen collection basins where the water collected is utilized over an extended period of time.

Examples of such natural, earthen-type structures include:

Dugouts or dirt tanks

Deep Pit charcos

Rock-filled tanks

Sand-filled dams

The determination of the type structure to construct in a particular area is dependent upon the on-site topography, soil factors, and general precipitation pattern of the area.

Due to the fact that each type of dirt storage facility has its own unique application depending upon site, soil depth, etc., the Deep Pit charco will be singled out as the structure that has the most uniform application world-wide.

DEEP PIT CHARCO

The Deep Pit charco should be located in an area where forage is not fully utilized because of lack of water. Generally, it should be located in an area that is suitable for water spreading both above and below the pit in order

to help free the runoff of silt. If spreading is not needed for sediment control above the charco, the charco may be located on the upper end of the spreading area and the remainder of the runoff be used for increasing forage production through water spreaders and dikes. Sites such as this however, would be rare in the project area. With the majority of the water table in the project area being in the 30-50 meter class level, it appears that an impervious sandstone layer exists below the ground level and may be conducive to building deep pit charcos. The shape of charcos is unimportant, as they can be round, square or rectangular. Considerable water seepage immediately after the charco is first filled does not necessarily mean that it will be unsatisfactory for any given period of time. Frequently considerable time is necessary for the reservoir to seal itself naturally. This may require several months or perhaps a year depending on a variety of soil and water factors. It has been learned that natural puddling, solid saturation and sediment deposition tend to seal the soils of reservoirs that are somewhat pervious.

Charcos have been utilized extensively in southern Arizona and the southwestern United States for many years. They are extremely well adapted to relatively flat country where conventional dam sites are difficult to find. The present day charco is an improvement on the basic design that was

introduced into North America by the Spaniards. A properly designed and constructed charco when filled, will often hold water for 2 or more years even with almost no additional precipitation. Hundreds of these structures have been built in Arizona alone to stabilize the livestock industry.

The deep pit charco is one of the simplest type reservoirs to construct, and it is the only type of earthen reservoir that can be constructed economically in relatively flat terrain. Because a minimum of water surface is exposed in proportion to volume stored, losses through evaporation are substantially reduced. This is an important consideration in desert areas where evaporation losses are extremely high.

The ease with which charcos can be constructed, their compactness, their safety from flood-flow damage, their adaptability to most locations, and their low maintenance requirements--make them a most adaptable livestock water storage and use facility.

The basic design feature of the deep pit charco is the large desilting basin above the "full line" of the storage basin. Runoff water after dropping silt then pours through the inflow pipe into the deep storage basin.

Depending upon soil conditions etc. charcos are constructed to a depth of 20-45 feet. The deeper the charco, the greater the storage capacity and less water surface exposed. This results in significant savings in evaporation losses. The detention and settling basin should have a minimum capacity of at least twice as large as the reservoir. In cases where water flow habitually carries unusually large quantities of silt, the detention basin should have a capacity three times that of the storage basin.

Construction costs depend on the time and labor necessary in moving soil and shaping the storage and settling basins.

Track type crawler tractors are the most efficient equipment used in the construction of deep pit charcos. Track type tractors are used to construct charcos from 20-45 feet deep. If smaller wheel type tractors are used, difficulties in pushing dirt excavated from the bottom of the deep holes with slopes of more than 3:1 will be encountered. The dirt excavated from the pit is used to form the dike around the top of the charco, which in turn increases the overall storage depth of the basin as well as furnishing protection from wind. In deep pit charco construction the functional and operational design should be based on a long range, or structure life of 20-25 years. Protective measures taken at the time of construction will help assure this long life of the structure.

The deep pit charco should be of sufficient depth and volume to provide adequate storage for the needed consumption. That is, it must be engineered to handle the numbers of cattle or other livestock that will graze the area of range served by the facility during any single water storage season. Water storage facilities should be designed to provide adequate storage during anticipated drought periods. Most all charcos built in arid southwestern United States and northern Mexico are designed to hold sufficient stockwater for a two or three year period without any refilling. The advantages of the deep pit charco type reservoir for Niger are grouped as follows:

1. Universal Adaptability
   a. Minimum drainage area required, because small runoffs are effectively utilized and stored.
   b. Dam sites are not required. Water flows can be diverted or concentrated into sediment impoundment.
   c. Charcos can be located in open, relatively flat country near feed thus eliminating gullying of trails and steep slopes.
   d. Bypassed water can be spread and forage production increased near a water site.

2. Minimum Cost

   a. Charcos permit maximum water storage for minimal yardage of earth moved.

   b. Use of wide valley floor waterways eliminates costly drop structures and the hazards of elevated and constructed spillways common to the many of our dam type water reservoirs.

   c. Properly designed charcos require no riprapping or other protection against wave action. Wave action is virtually eliminated by the small water surface and the protective surrounding dikes.

   d. Practically all construction costs are for earth work, with very little other materials necessary except for construction of the concrete inlet abutment.

   e. It is not necessary to wet and pack fills as with other type dams. Little or no water is retained by the earth fills above the ground surface.

3. Long Life and Minimum Maintenance

   a. Minimal sedimentation; water spreading areas and desilting basins are utilized.

   b. Virtually no wave damage.

   c. No spillway failures.

d. The desilting area is easy to clean by bulldozer when it is silted full or the dikes may be extended and/or raised to give additional desilting capacity.

4. Reliable Supply of Relatively Pure Stock Water.

a. Silt settles before water flows into the tank.

b. The depth and coolness discourages plant growth and stagnation.

5. Minimal Loss of Water

a. Evaporation losses reduced to a minimum because of the small water surface area relative to the depth, and protection of water surface from the wind by surrounding dikes.

b. Percolation losses reduced to minimum because of the small water surface area.

c. Puddling of parent material by trampling of livestock is confined to a very small area, hence, more effective in the elimination of seepage losses.

6. No Bogging Down of Livestock

a. Sediment deltas at the upper end of the pond do not develop thus eliminating the hazard of livestock bogging down when the charco becomes low in water.

b. Livestock approach water and stand on puddled or undisturbed parent material to drink. There have been no losses reported from bogging and/or drowning in charcos.

The following contains schematics and illustrations describing the Deep Pit Charco.

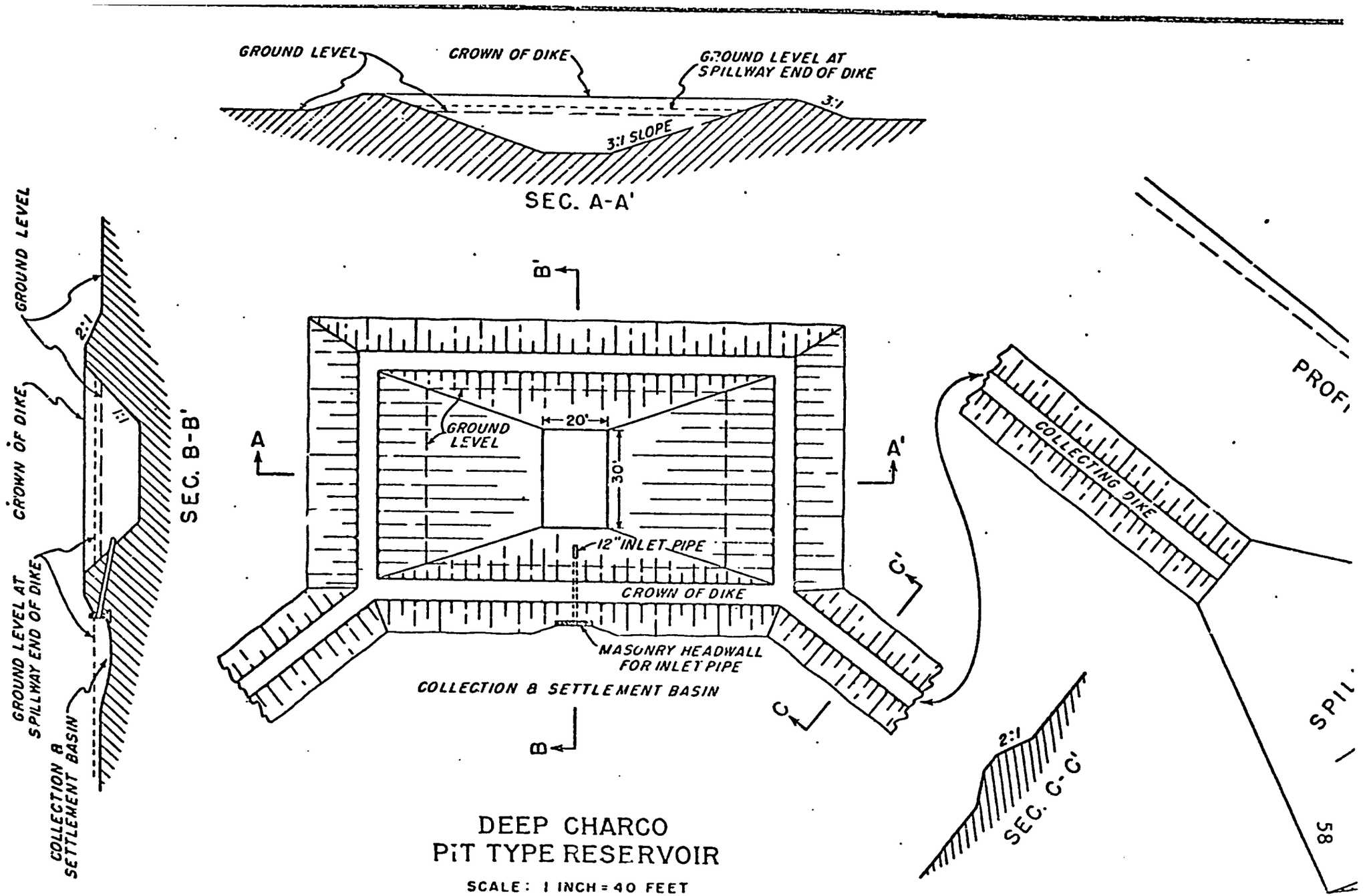
Figure 1. Schematic drawing showing completed deep pit type charco. Foreground shows desilting and sediment basin with inlet header and diversion dike on the right foreground.

Figures 2a & 2b

Line drawings depicting engineering specifications for typical rectangle pit charco.

Figures 3, 4, 5, 6

Figure 7. Completed and filled "charco" water reservoir in desert area of southern Arizona. Note inlet pipe from the desilting sediment area on the left of the photograph. This tank has a capacity of just over 3 acre ft. of water and a surface area of less than 1/2 acre.



DEEP CHARCO
PIT TYPE RESERVOIR

SCALE: 1 INCH = 40 FEET

Figure 2A

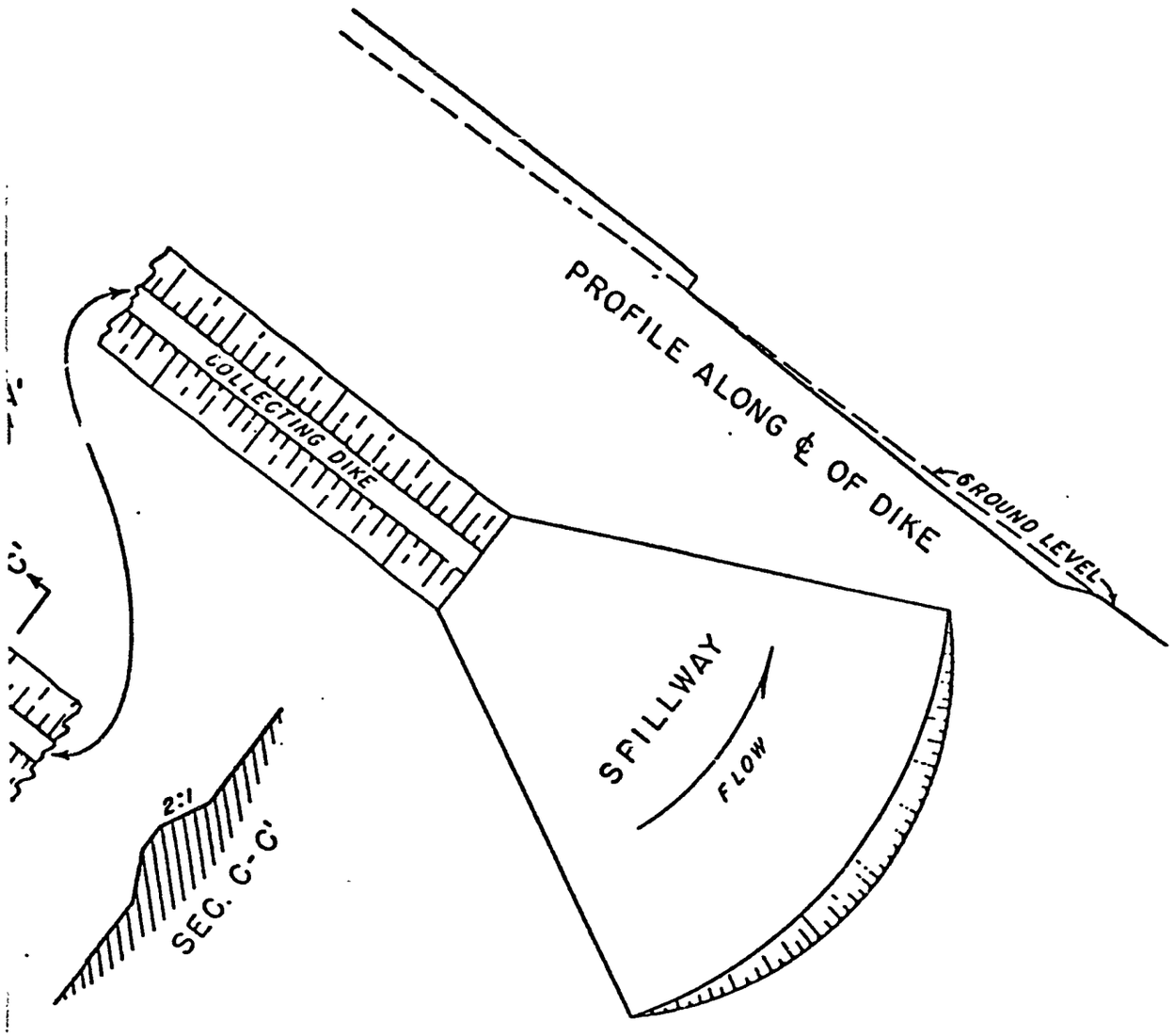


TABLE OF EXCAVATION AND CAPACITY OF A TANK HAVING A BOTTOM OF 20 X 30 FEET WITH SLOPES OF 3:1 ON THE LONG DIMENSION AND 1:1 ON THE SHORT DIMENSION

EXCAVATED DEPTH OF TANK IN FEET	EXCAVATION IN CUBIC YARDS	CAPACITY* IN GALLONS	CAPACITY* IN ACRE FEET
10	778	157,080	0.482
12	1,109	224,041	0.688
14	1,516	306,201	0.940
16	2,005	404,997	1.243
18	2,584	521,865	1.602
20	3,259	658,240	2.020
22	4,038	815,559	2.503
24	4,928	995,259	3.055

*CAPACITY SHOWN IS FOR WATER LEVEL AT GROUND LEVEL. IF FILLED 2 FEET ABOVE GROUND LEVEL, THE NEXT HIGHEST CAPACITY WILL BE POSSIBLE.

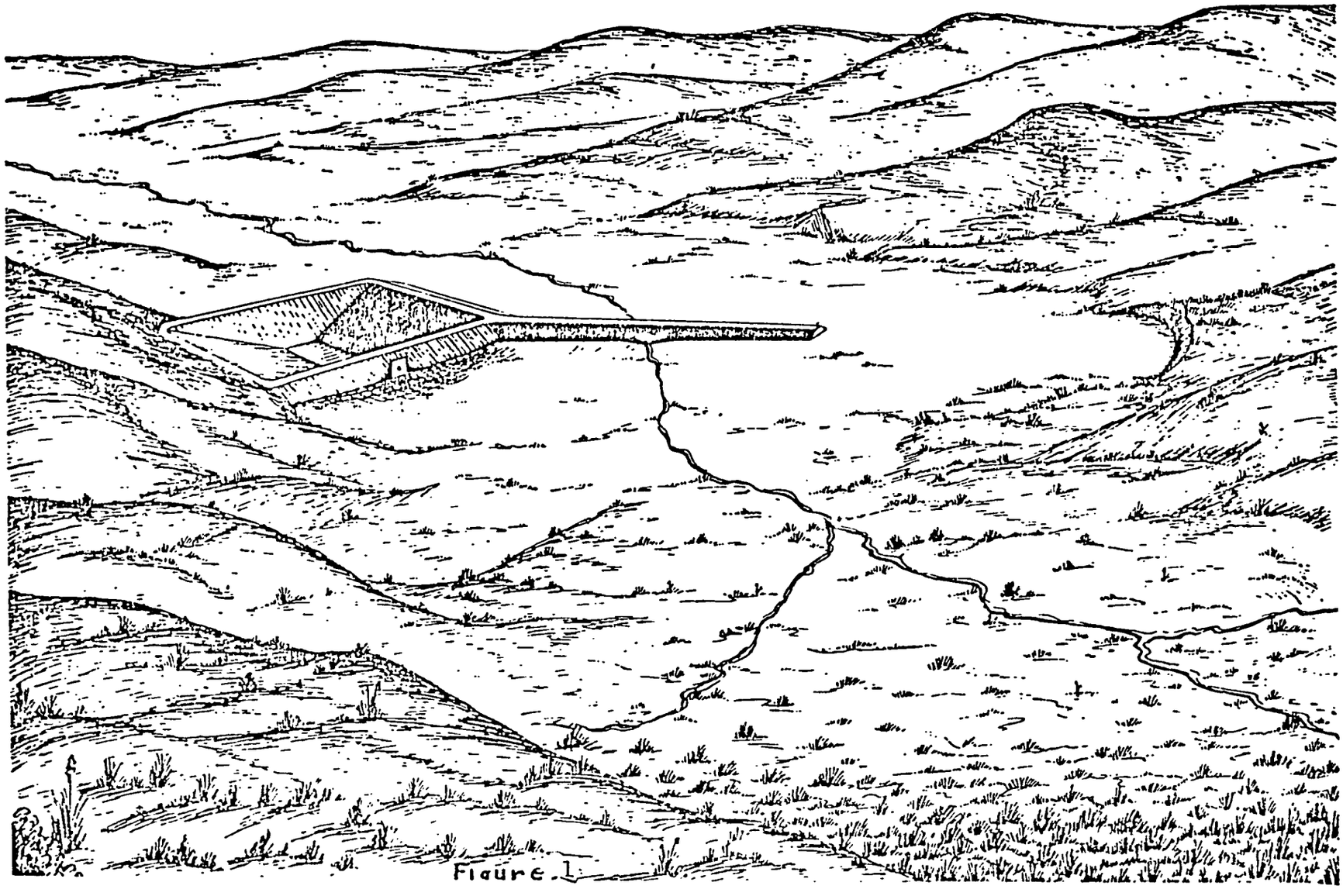


Figure 1

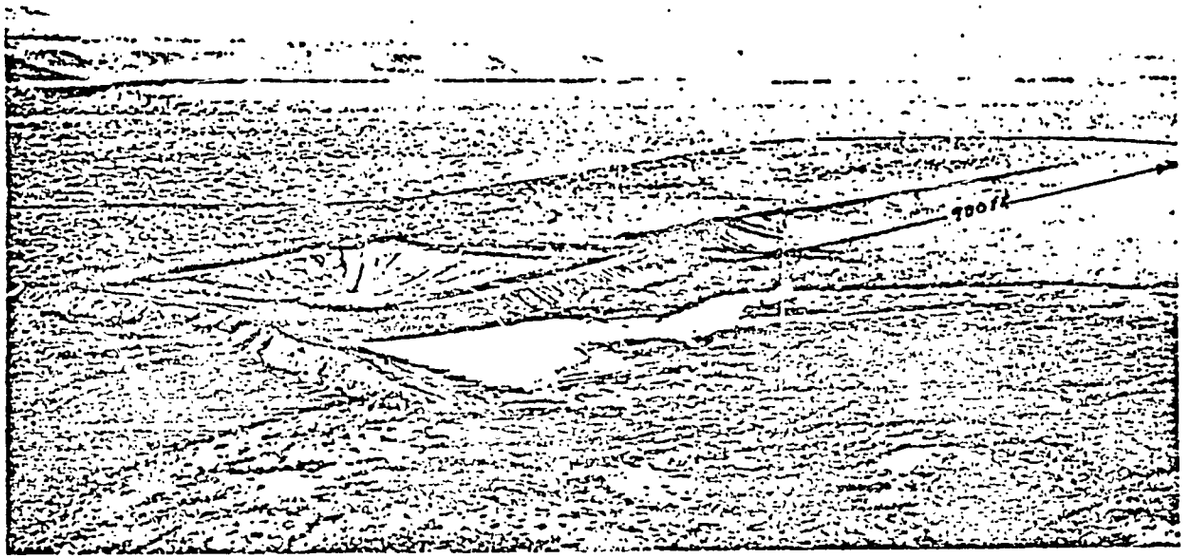


Figure 3. Deep charco before filling showing settling basin, diversion and retaining dikes. Range spreading area in light and center background.

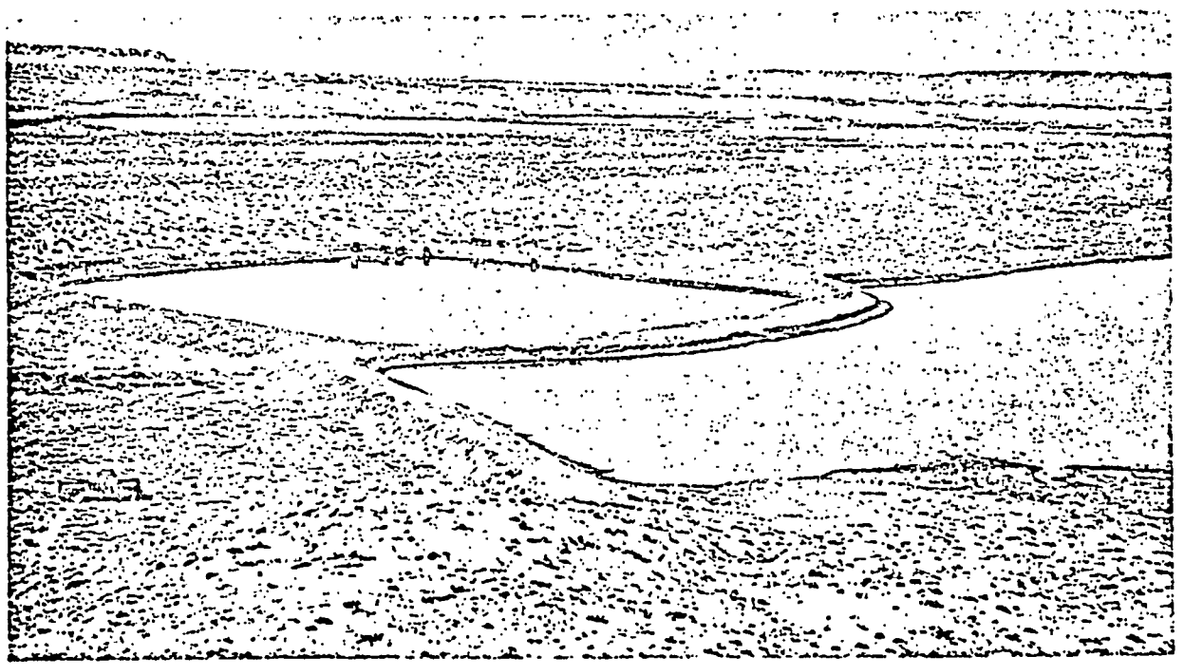


Figure 4 Same charco in process of filling. Water level in desilting basin still slightly above level in charco.

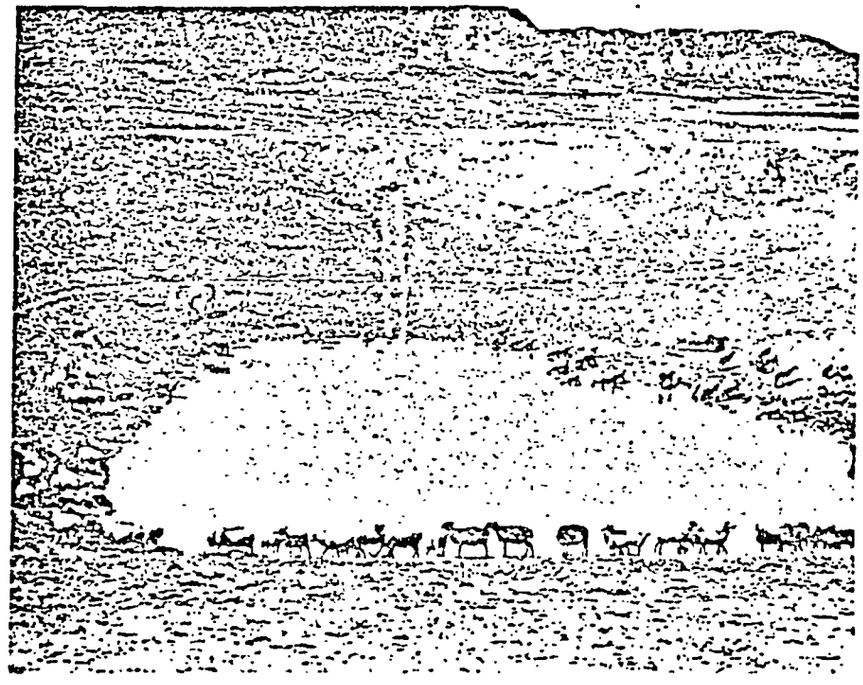


Figure 5. Charco in alluvial soil, round shape, 3:1 slopes showing masonry chute to conduct inflow to water surface without erosion.

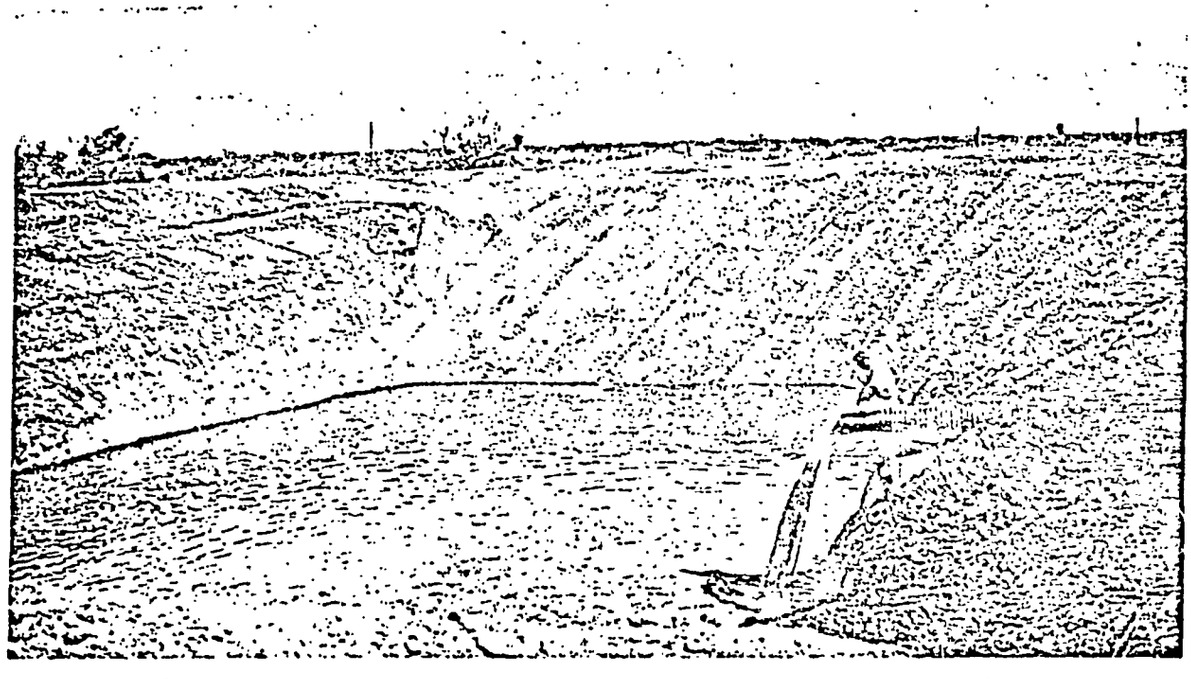


Figure 6. Charco in residual soil, rectangular shape, 3:1 slope on ends 1:1 slope on sides showing inflow directly into pond without erosion.

Figure 7. Surface catchment dirt tank that has been fenced to control livestock utilization in this area. If grazing pressure becomes too severe the water is closed off and livestock are forced to utilize another area.

ARTIFICIAL RAINFALL CATCHMENTS

In areas where natural watersheds are impractical or undesirable, artificial runoff aprons with water storage tanks may have application. The selection and design of the particular artificial catchment system will be dependent upon the site, the precipitation pattern of the area and the intended use of the water. A variety of artificial catchment materials that may be used are listed below.

Butyl Rubber Apron - with butyl rubber storage bag

Gravel-Covered-Plastic

Galvanized Steel

Asphalt-Plastic-Asphalt-Chipcoated

Asphalt (black top)

Cement and/or soil cement

Chemical soil treatments including Sodium Salts

Petroleum Product Treatments

Granulated Wax Coatings

A Water Harvest System can be defined as a system of catching and storing rainfall until it can be beneficially used. These principles are not new as treated catchments have been used since Biblical times - only the methods have been improved!

The primary limitation on the use of this technique has been the high cost per unit of water produced. However, since advances in modern technology in the field of water proofing chemicals, such as asphalts and plastics, the cost of water harvest systems has been greatly reduced.

The amount of water that can be harvested per square foot of collection area per inch of rainfall is rather astounding. A properly designed artificial water harvest system will collect 1.6 gallons of water per square foot of collection surface from one inch of precipitation.

The formula used to calculate water collected using runoff pavements is: Area of collection surface x 1.6 gal. water per sq. ft./1" precipitation x average annual rainfall x 85% efficiency factor for collection. Using this formula we see that a 1/2 acre (21,780 sq. ft.) collection surface with an assumed 8" annual rainfall has the capability of collecting 236,900 gal. of water per year.

COST ANALYSIS OF INSTALLATION OF 100,000 GALLON STORAGE TANK & PLASTIC, GRAVEL 1/2 ACRE CATCHMENT AREA

Type of Operation	Time & Rate	Total Costs
Surveying & layout of catchment site	2 man hrs. @ $8.00	$ 16.00
Surveying & layout of reservoir site	2 man hrs. @ $8.00	16.00
Excavation: For reservoir including operator (Gradall or backhole)	14 hrs. @ $35.00	490.00
Two dump trucks for removing soil from pit	14 hrs. @ $30.00	420.00
Shaping & trenching	20 man hrs. @ $3.00	60.00
Installation of liner including backfilling & compacting trench	20 man hrs. @ $3.00	60.00
Cost of plastic & gravel top dressing for catchment area (assuming 20 mile haul for gravel) $ .145/ft.^{2} x 21,780		980.00
Cost of material for catchment tank (FOB Tucson, Arizona)		1,350.00
	Total Cost	$ 3,392.00*

* Costs are computed at Southern Arizona cost for materials and labor.

Specialized machinery would not be necessary for the construction of this type of water harvesting unit in Niger and if

local labor were utilized, these units could be constructed very economically.

It is essential that each unit be completely fenced to prohibit livestock and wildlife from damaging the catchment surface via trespass. The cost of 1200 linear feet of a 6 wire barbwire fence would be approximately $ .55 per ft. or $660.00 for each unit.

Artificial runoff catchments (including shaped and compacted earth) are utilized to obtain potable water for human consumption and for livestock. The systems can also be utilized in small scale "runoff farming".

Because the particular type of artificial catchment designed and selected is "site specific"--that is designed during an on-site visitation, only three of the systems listed earlier will be described here.

Gravel-Covered-Plastic

Black polyethylene plastic (4 mil-8 mil) is one of the cheapest materials available with which to construct a runoff apron. However, when exposed directly to the desert sun, it will breakdown within one year. In order to utilize this cheap but efficient material it is necessary to in some way protect it from direct exposure to sunlight.

In an effort to increase the effective life of the plastic sheeting, pea-gravel is spread over the plastic to protect it from the ultra violet radiation of the sun and from wind damage. In storms where precipitation exceeds .06 inch measureable runoff is obtained (gravel absorbs the first .06 inch of moisture). Approximately 85 percent of the moisture that falls on this type of apron can be harvested. The depth of gravel used to cover the plastic apron should be 2 inches or less. Such aprons should be constructed on slopes preferably less than 5%. Gravel-covered-plastic catchments are ideally suited to providing water for the rock-filled tank storage reservoirs, with capacities of 50,000 gallons or less.

Salt-Treated Catchments

The basic concept in this system is to increase the exchangeable sodium concentration in the soil by applying sodium choride to the soil surface. When it rains, salt on the surface will go into solution and interact with the clay particles that are present. When the salt content of water is high, the initial infiltration rate is high. Thus the salt in solution moves into the soil and the sodium absorbed on the clays is greatly increased. When additional salt-free rain water enters the soil, the

sodium absorbed on the clays remain, but the concentration of the salts in the soil-solution becomes low. The clays become highly dispersed and block the water conducting channels present in the soil. Therefore, the infiltration rate is drastically cut, less water enters the soil and runoff is increased.

A procedure has been developed to predict the amount of sodium chloride which is required to raise the sodium percentage to any desired level in order to maximize surface runoff. Hence, by obtaining soil information on a potential site and then having it analyzed, it can be determined whether this salt treatment approach can be used or not. This system is not applicable to all soils, because the system depends on the presence of clay particles. However clay particles need not make up a particularly large part of the soil texture in order for the method to be considered.

Shaped Soil Beds for Runoff Farming

Properly designed and shaped runoff aprons constructed of compacted earth, compacted salt-treated earth, or perforated plastic--offer opportunities for harvesting water for use in irrigating farm crops. Such methods have been quite successful in growing orchard crops and grain sorghum in southern Arizona.

It is extremely important when considering artificial and natural water harvesting and collection projects for arid and semi-arid areas of the world, that an on-site observation be made by a watershed management specialist in order that the system or systems be designed for the specific site.

The following are examples of artificial water catchment systems.

1. A plastic lined water catchment tank without cover installed. This tank is located in an area receiving less than 7" annual rainfall per year. Note pipe located in center background used to bring water from catchment to the tank.

LIVESTOCK RESOURCES

The different species of livestock and associated breed-types found in the project area are listed below. They reflect both the nature of the environment and the background, traditional values, and expressed socio-economic needs of the herdsmen themselves.

Classes of Livestock:

- Cattle (Box Indicus)
  - Zebu or humped
    - Azwak
    - Bororo
    - Djilli
    - Crosses between the above
- Sheep
  - Long-legged desert eco-types
    - long tailed, woolless, mutton type
- Goats
  - Long-legges desert eco-types
    - Chevre Rousse
    - Chevre Sahelienne
- Camels (Dromedary)
  - Riding Camel - large white
  - Porter Camel - brown - brown & white
- Donkeys

DESCRIPTION OF THE DIFFERENT TYPES

The origin of the M'Bororo probably traces to Sango cattle (cross between longhorn humpless and zebu types) which migrated westward from upper Egypt in ancient times.

They can be further classified as long lyre-horned zebus. The Bororodiji tribe originally inhabitated an area east of the Niger River between Niamey (Niger) and Sokoto (Nigeria), but fled eastward in the early part of the nineteenth century to escape Islamization.

Hardiness, slowness, and the ability to walk long distances are among the characteristics looked for by the nomadic herdsmen in selecting M'Bororo breeding cattle.

The M'Bororo cattle are large framed animals with good height and long legs. Considering their uniformity of type, large size, dark red coat color, alert carriage, and long graceful horns, the M'Bororo is a most impressive animal. The hump is well developed, generally pyramidal in shape and thoracic in position. The dewlap is well developed and hangs in pendulous folds. The sheath and umbilical folds, in the case of males, are loose and pendulous. The head is long, narrow, and almost flat in profile.

The M'Bororo cattle are wild and of an intractable and nervous disposition, especially when not under the control of their chief tribal herder. They are poor milk producers, giving only some two liters per day during flush periods, with a rather short lactation of 5 or 6 months. Milk is necessary for the producers, and it is rather common to stint the male calves more than the female ones, resulting in higher mortality of males to one year of age.

The calf crop is estimated at 54 to 57% with an average calfhood mortality of 26%. The age at first calving is about four years, and the cows have an expected breeding life of some eight or more years. The sale of surplus males is around four years of age. The herd extraction rate is estimated at about 9% with a 2% herd increase.

The Azwak is also found throughout the production zone of Niger. In practice, the production norms between this type of cattle, and the cross-bred resulting from M'Bororo x Azwak mating, do not differ significantly.

The Azwak has been selected by the Niger Livestock Service as being the better animal for the country's purposes, because they are more suited as tri-purpose animals: work, meat, milk.

The Azwak are more traditionally kept by the Touareg tribe and sub-classes. Although mixtures of both types are seen, these mixtures usually indicate a herder that is not a Bororo.

The Azwak is characterized by a much shorter and thicker horn than the M'Bororo. The pure Azwak is reddish brown in color, although cross-bred are found in a variety of patterns from dark brown to speckled gray and white.

Average size for mature bulls is 1.20 m to 1.30 m in height, and 1.10 m to 1.20 m for mature cows. Weight for mature bulls is between 300 - 350 kg and for mature cows 200 - 250 kg.

Good five year old slaughter bulls may attain a weight of 500 kg, but seldom dress above 50% warm carcass weight. Females calve for the first time at 3½ to 4 years of age, and have a productive life of 6 to 8 years. They breed throughout the year and are fairly good milkers, giving over 1,000 kg in a 7 to 8 month lactation period.

The average calf crop is around 60% with calf mortality estimated at 30% largely due to internal and external parasites.

SHEEP

It is not clear where or when domesticated sheep (Ovis Aries) originated. They have many wild relatives, but it is possible that the Argali (Ovis Ammon) of Central Asia, the Uriel (Ovis Vignei) also of Asia, and the Mouflon (Ovis Musimon) of Asia Minor and Europe all contributed to present day races. Africa had no wild species except the Aberrant Arui (Ammotragus Lervia), which is closer to the goat than the ovine family. However, the ancient Egyptians knew two sheep species, ovis longipis and ovis platyura. The first species, with transverse horns spirally twisted and dropping ears, disappeared from Egypt soon after the beginning of the New Empire (1580 - 1350 B.C.) being replaced by the second type which had horns curving downward and forward. This later type first appeared in Egypt during the twelfth dynasty (2000 - 1788 B.C.). It is assumed that both of these types were of southwest Asian origin and would have contributed to the ancestral background of African sheep in general, although there would have been numerous other introductions over the centuries.

The establishment of sheep south of the Sahara no doubt faced many difficulties. The very process of domestication in sheep brings about a number of morphological and physiological alterations. For instance, the tail tends to lengthen and/or become a place of excess fat storage, manes disappear, wattles may or may not be developed, greater dependence is placed on water, and wool is replaced by hair coat.

Among the sheep found in the project zone, many wild and ancient traits are still to be seen today.

All of the sheep, where residents or outside transients of the pastoral zone, are haired animals and are commonly milked. While they may play some small part in wedding price, and their skins have some value, their primary purpose is for meat. It is also noted that sheep are not raised in their own right, but entirely subsidiary to cattle or as an adjunct to subsistence agriculture. They are always at their best during the dry season.

In their main habitat Niger sheep are usually herded with either cattle or camels and have a dry season watering interval capacity of three to four days.

Flock size varies, but 25 to 30 or more head of breeding ewes is normal. The ewes are milked according to tribal need, and in the flushing season 1/3 kg may be taken, apart from that allowed for lambs. Lambing is seasonal, chiefly during the early rainy season, and the drop is only some 70%.

SHEEP: Long-legged desert eco-types

GOATS: Long-legged desert eco-types

The sheep are long of leg and light of body, and are covered with hair as opposed to wool. Mature females stand 75 cm at the withers and weigh about 65 kg. The tail is long and thin, reaching to the hocks. Females are usually polled while rams are horned.

GOATS

The world population of goats numbers over 200 million; nearly half of them being in Africa. The majority of African goats, especially those in the project zone, owe their existence to the fact that they can thrive as meat producers under conditions in which it is difficult for other species of domestic livestock to live. Their unsurpassed ability to forage, their preference for browsing on a wide variety of vegetation, their catholic taste for any kind of edible material, and their power to withstand extremes of climate account for their widespread distribution throughout the project zone.

Although goats constitute the meat and milk supply of the pastoral nomades, further promotion of their numbers would be a questionable venture. This is because the normal activities of the species are detrimental to soil preservation, forestry, and settled agriculture. They are destructive of trees and shrubs and will strip the bark until such plants die. Thus, it is essential that goat husbandry should not be encouraged unless the goat can be kept under strict control.

CATTLE GRAZING PATTERNS

In the pastoral zone cattle grazing patterns are not only determined by seasonal and regional pasture conditions, but by water resources and their proximity to available forage. During the rainy season cattle disperse or go north near Agadez for the "Salt Cure", and can water themselves at ponds.

Progressively as the dry season approaches and surface water disappears, the animals begin to concentrate around wells and bore holes. Here they are completely dependent on man for drawing their water. As the animals graze out the areas around

these wells, they must continually walk further and further for grazing. As the temperatures get progressively higher, and the grass becomes scarce, the cattle are placed under a desperate stress.

The observations in Appendix III (graphs I, II, and III) made by this author (and confirmed by similar observations by Dr. Pierre Granier, a French veterinarian with a great deal of experience in the project area), were made during this stress period (May/June/July).

See Appendix III for movements of specific nomadic families.

DISEASES AND RECOMMENDED CONTROL

I. CATTLE DISEASES

A. Blackleg (Charbon Symptomatique)

1. Observations: Blackleg is considered the most important epidemic disease to occur in the area. It is more common in the wet season of the year than during the dry season. It affects primarily animals from birth to three to four years of age.

2. Recommendations: Dakar Hann Laboratory produces a vaccine for blackleg. All animals from birth to four years of age should be vaccinated annually. This vaccination should be given at the beginning of the rainy season and to all calves born throughout the rainy season. This procedure should adequately control this disease.

B. Rinderpest

Recommendations: It is recommended that all animals over six months of age entering the project area be vaccinated for Rinderpest. Calves should be vaccinated as soon as they reach six months of age and then re-vaccinated at two years of age. The vaccine should be repeated annually for animals in the area. The bivalent "Bissec" vaccine which combines Rinderpest with CBPP (Contagious Bovine Pleuropneumonia) should be used. The procedure of notching the ear as is now used to mark vaccinated animals should be followed for at least three vaccinations.

C. Contagious Bovine Pleuropneumonia (CBPP)

1. Observations: At the present time all cattle over six months of age are to be vaccinated annually.

2. Recommendations: It is recommended that all cattle over six months of age be vaccinated annually for CBPP using the "Bissec" bivalent vaccine.

The T_1 strain of the vaccine can be used on all animals in the project area.

D. Hemmorrhagic Septicemia (Pasteurellosis)

1. Observations: The disease occurs sporadically in the area during the rainy season. It occurs as both the throat and lung forms, and is somewhat more common in adult animals than in the young.

2. Recommendations: A survey should be made on the incidence of Pasteurellosis in the project area. Until the results of this survey are known, it is recommended that all animals six months of age and older be vaccinated annually one month prior to the beginning of the rainy season.

E. Botulism

1. Observations: During the drought this disease was a serious problem. It was caused by an animal eating the bones of dead animals for their mineral content. Since the drought the incidence of the diseases has lessened. A few suspected cases have been reported in the project area, but none have been reported recently.

2. Recommendations: A vaccine is available at Dakar Hann Laboratory. It is given annually in two doses, one month apart, during the middle and at the end of the dry season. At the present time it is not recommended to vaccinate animals in the project area, but in the case of another outbreak, the animals should be vaccinated. Mineral supplementation as proposed for the animals should also aid in preventing the disease.

F. Streptothricosis

1. Observations: This disease is thought to be associated with tick bites and possibly other skin conditions in cattle. Amblyomma and Hyalomma tick are thought to be the main ones involved. In the project

area the disease occurs sporadically in cattle during the wet season.

2. Recommendations: There is no specific control recommended for the disease at the present time. Treatment of animals as recommended for tick control should help to reduce the incidence of the disease. In addition, it is recommended that quaternary ammonium compound be used by adding to the pesticide spray during the rainy season to aid in controlling this disease.

G. Anthrax

1. Observations: Anthrax has not been diagnosed in the project area in recent years, but does occur sporadically.

2. Recommendations: Cattle should be vaccinated only at such time as an outbreak occurs and a vaccine is produced at Dakar Hann Laboratory

H. Piroplasmosis

1. Observations: To what extent this disease occurs in the area is not known. The disease is tick-transmitted, mostly by Boophilus ticks which are present on cattle in the area primarily during the rainy season.

2. Recommendations: The disease can be controlled only by controlling the tick vector and treating sick animals. One reason for recommending the tick control program is to aid in controlling this disease. Blood smears should be made from animals suspected of having the disease, and if they are positive, the animals should be treated. A new card test is available for testing animals for the disease and should be used by the diagnostic lab.

I. Anaplasmosis

1. Observations: There is no record of occurrence of this disease in the project area. However, it is reported to occur in Senegal, and

since the vector ticks are present in the area, the presence of the disease is suspected.

2. Recommendations: A relatively simple card test is available to detect carriers of this disease. Blood smears from cattle should also be examined to determine the incidence of the disease in the area. If a survey of animals in the area indicates the disease is present, some modifications of the tick control program may be required to control the tick vectors.

J. Internal Parasites

1. Observations: Internal parasites (roundworm, tapeworm and fluke) affect all livestock in the area. The most important, however, appears to be several of the roundworm parasites (flukes and tapeworms were reported to occur but were reported not a serious problem). The local livestock technicians attribute much of the death losses in younger animals to roundworm parasites. The livestock service do not have the equipment available for doing fecal examinations or necropsies on animals to confirm their diagnosis of internal parasites.

2. Recommendations: A diagnostic lab should be equipped to examine fecal samples for evidence of internal parasitism. The lab should also be equipped to do field necropsies and collect parasites for identification. A field survey should be done by the lab, and this survey should serve as the basis for developing the internal parasite control program. Until such time as this survey is completed, the following programs are recommended: All animals entering the project area will be wormed with broad-spectrum anthelmintics upon entry. All cattle will be wormed near the end of the dry season, in April, and all animals up to three years of age will be treated again early in the rainy season, either in July or August. All cattle will be treated again at the end of the rainy season in November or December.

K. Coccidiosis

1. Observations: Coccidiosis was mentioned several times as a problem in their animals. The management practices under which the calves are raised are ideal for the development of coccidiosis, as well as internal parasites. Again, the livestock technicians could only suspect that they were dealing with coccidiosis, as no equipment was available to confirm their observations.

2. Recommendations: Control of coccidiosis in cattle can be accomplished only by managing the animals in a way as to prevent the disease. The recommendation to remove the calves from the small enclosures during the day and away from the common bedding grounds is directed at controlling this disease as well as other enteric infections in the calves.

L. Ticks and Other External Parasites

1. Observations: Ticks can be found upon cattle any time of the year, but are most numerous during the rainy season. This is especially true for the Boophilus tick which transmits piroplasmosis and possibly other diseases. It is difficult to determine how serious the tick problem in the area is without better facilities to diagnose the diseases they transmit and surveying the animals for ticks.

There are numerous Tabanid flies in the area. In addition to the bites of these flies being very painful, they can also mechanically transmit diseases such as trypanosomiasis and anaplasmosis. In observing cattle in the area it is obvious how annoying these flies are to the animals.

Mange is said not to be a problem in the area, and it is not known if lice are a problem.

2. Recommendations: Ticks can only be controlled in livestock by use of pesticides applied to the animals. For this reason, spray races, as used successfully in East Africa, are recommended. These are recommended over

dips because they are easier to install and maintain. It is also easier to maintain the pesticide concentration at a proper strength in the spray race than in dips. It is recommended that all animals over two months of age be sprayed once a month during the rainy season and once during the middle of the dry season. It is recommended that toxophene be used for the pesticide in the spray and that it be carefully monitored for the development of resistance.

M. Reproductive Diseases

1. Observations: Almost no information is available regarding reproductive diseases such as brucellosis, vibriosis and trichomoniasis, in the area. The fact that most cows do not have their first calf until four or five years of age is suggestive of some reproductive disease.

Recommendations: It is relatively simple to check for these diseases. It is recommended that the area diagnostic lab with the help of Dakar Hann Laboratory, have the necessary facilities and equipment to diagnose these diseases and conduct a survey of cattle in the area for their presence. If vibriosis or brucellosis is present, a vaccine is available and it should be used. Bulls can be effectively treated for trichomoniasis, and there are programs for eliminating the disease organism from the cow.

N. Deficiency Disease

1. Observations: There is no question that various deficiencies in nutrition occur from birth throughout life. These include mineral deficiencies in all animals, protein deficiencies in young animals, and possibly vitamin and carbohydrate deficiencies in both the young and old animals. Any one of these deficiencies will greatly influence the weight gain of the animals, the age at which the animal reaches maturity and the fertility of the adult animals. If livestock production in the area is to be a successful enterprise, every effort must be made to

correct these deficiencies.

2. Recommendations: It is recommended that a laboratory be contracted to make a study of the animals and forage in the area to determine what deficiencies exist. They should then make recommendations as to how these can be corrected. Until such time as this study is completed, it is recommended that information already available from Dakar Hann Laboratory from other trials be used to formulate a temporary mineral, vitamin and possibly protein supplement for animals in the area.

O. Other Diseases

1. Observations: Other diseases such as heartwater, leptospirosis, and footrot or "pietin" occur sporadically in the cattle in the area. Again, reliable diagnosis of such diseases is difficult due to the lack of facilities.

2. Recommendations: More information must be made available through better diagnostic facilities before any control program can be proposed. In the case of heartwater, the controlling of ticks will help to prevent the disease. Disinfecting foot baths at the spray races may help in controlling footrot.

II. SHEEP AND GOAT DISEASES

A. Contagious Caprine Pleuropneumonia (CCPP)

1. Observations: This is one of the most serious diseases affecting goats in the area.

2. Recommendations: All goats and possibly all sheep over six months of age entering the project area should be vaccinated for CCPP. The vaccine, now produced by Dakar Hann Laboratory, is called "P 20". For the present, all goats and possibly all sheep in the project area should be vaccinated annually. At the same time more information regarding the incidence of

the disease in the area should be collected and evaluated before recommending a long range vaccination program.

B. Sheep Pox

1. Observations: This disease was brought in the area two years ago with sheep coming from Mauritania. At that time some of the sheep were vaccinated in the vaccination centers under a systematic program. Since that time the disease has occured sporadically in the area. A vaccine is produced at Dakar Hann Laboratory for the disease.

2. Recommendations: The incidence of the disease in the area should be studies more carefully. Until such time as this study is completed, it is recommended that no vaccination program be initiated for animals in the project area.

C. Internal Parasites

1. Observations: The information available on internal parasites in goats and sheep is very limited. One must naturally expect that they occur, but to what degree is purely a matter of speculation.

2. Recommendations: In the beginning a survey of the incidence and seasonal occurrence of parasitism in sheep and goats should be undertaken by a project diagnostic lab. The internal parasite control program can then be based on the findings of this survey. During the time required to conduct the survey, it is recommended that all sheep and goats be wormed twice a year, once at the beginning of and a second time one month after the rainy season. All sheep and goats should also be wormed at the time they enter a grazing unit.

D. Other Diseases

1. Observations: In the project area several other diseases of sheep and goats have been reported to occur sporadically. These include hemorrhagic septicemia, contagious pustular dermatitis, enterotoxemia and mange.

VACCINATION CENTERS AND MARKING POINTS

Vaccination centers will have to be built within the project area. These centers should contain facilities for branding, tagging, vaccinating, castrating, dehorning, applying pesticides, and weighing the animals.

It is suggested that facilities be constructed near established livestock marketing areas. In these locations they can be used both for treatment of animals during health campaigns and for weighing and separating of animals on market days.

The livestock handling corrals should have: one large entry holding facility leading to a long squeezing or crushing area. The crush shute should connect to at least two divided pens permitting the separation of animals. These should also contain a dipping vat for treatment against parasites and a connection for combined portable weigh scales and head catching shute for treatment of animals. They should be built in such a way as to enable the handling of all classes of livestock, including calves, sheep, and goats.

VETERINARY POST

It is recommended that three veterinary posts be established in the project area or demonstration area. These posts should be built in conjunction with a diagnostic laboratory, capable of examining slides for the presence of hemoprotozone parasites and examining fecal samples for evidence of internal parasitism. Some simple diagnostic test in the laboratory for brucellosis and leptospirosis, and the card test for anaplasmosis and piroplasmosis should also be available. The lab should have the capability to examine bull semen for fertility and culture for trichomoniasis. It should also be able to do simple bacterical isolations and antibiotic sensitivities.

In addition, the laboratory personnel should be able to perform field necropsies. This service is essential for more accurate and reliable information on the animal disease situation in the area.

The building should contain one laboratory room equipped with work benches, sinks and running water. There should be an office for files and keeping records of the animals in the project area. The building should also have a storeroom for drugs and other veterinary supplies.

It is suggested that the post be staffed by one technical agent (preferably a veterinarian), two nurses or lab technicians, and two technical assistants to the veterinarian.

During vaccination campaigns or when large numbers of animals are to be treated, the staff from Department de l'Elevage may supply additional help.

It is also recommended that the veterinary post be equipped with one four-wheel drive land rover pick-up. The vehicle should be equipped for field veterinary work, and a mobile radio.

MARKING OF ANIMALS

It is recommended that all animals be permanently identified before entering the project area. This can be done by hot iron branding or ear tagging of all cattle, including sheep and goats. Brands or tags should be coded so as to identify both the owner and the animals by a combination of letters and numbers. Individual animals can be identified by numbers. The final number of animal identification should be the last digit of the year of birth of the animal.

Example: 10E

1725

10E = owner identification number

172 = animal number

5 = born in 1975, 1985, etc.

The markings will serve as a means for owners to identify their animals and to enable the maintenance of individual health, vaccination and reproduction records for animals in the project zone.

The data in Appendix III reflects an approximation of herd production coefficients as seen by the author in the limited time allotted in the field. To obtain accurate and reliable data will require much time and help from many people. It was interesting to find, however, with the limited number of herders questioned, this data did not differ significantly from that collected by Dr. J. Coulomb.

SUMMARY OF PROJECT AREA CHARACTERISTICS

Because of low levels of purchasing power and the resulting low demand for meat, it is descriptive to speak of this project area as a "cattle exit" sector rather than a "cattle surplus zone". Major characteristics of the exit sector are:

I. The ecological conditions are arid. Stock water is almost entirely from hand pulled wells, and the extended dry season of 8 - 10 months favors a seasonal movement of livestock.

II. Disease and periodic drought take a high toll in death losses.

III. Nomadic, semi-nomadic production practices prevail under an Islamic system where wealth and family status are measured by herd size, living is maintained at a subsistance level, milk (at least until the previous drought) is used as a key element in daily diets, and beef is produced as a by-product, not primarily for profit.

IV. Although considerable improvement can be made, the nomadic system is currently the most economical way to harvest the grass cover. Many technical aspects of modernization are too costly to apply. In fact, full modern technology could only be utilized after displacing large numbers of the present inhabitants, who are poorly equipped to enter other occupations.

V. Traditionally, herd movement is northward to escape mud and biting insects, and to take advantage of accessible stock water and grass in the more remote areas during the rainy season. With the outset of the prolonged dry period, herds push slowly southward back into the project zone to utilize fixed water supplies and available forage.

VI. Cattle numbers have already peaked over much of the project area. Estimates of 25 percent total cattle offtake show that the herds will soon be depleted, if no improvements are made in production efficiency and local demands for meat rise with expected population increases and purchasing power.

VII. Uncontrolled fires, and agricultural encroachment on grazing lands are forcing the nomadic element to over-use and destroy the natural ranges upon which their existence depends.

VIII. Herdsmen are frequently criticized for delayed marketing of surplus stock. However, present practices are justifiable when considering that disease outbreaks, drought and the external need to walk are factors the nomad must continually endure. The situation described by a Bororo chief that follows was reported by Clare Oxby of the International African Institues Environmental Review Unit who recently spent a year living with the pastoral nomadic Touarez people:

Question: "If your cattle go on increasing and the grass gets finished what will you do?"

Bororo Herder: "I would still keep my cattle. I do not want them to die. I want to look after them. They are our life. As the government likes money, so we Nobaabe like cattle."

Question: "Would you rather have 300 fat cattle or 500 starving cattle?"

Bororo Chief: "I would rather have a thousand starving ones until God gives us grass, because if a man has lots of cattle, and some die, he still has some left, but if a man has a few cattle and they die, he has none left."

These are the kind of facts that any planner must take into account when considering a project concerned with herd size. Meanwhile, in the absence of any insurance policy against drought and bad years, it is clear that a <u>policy of herd maximization is the rational solution for the pastoral nomad</u>, and that given present conditions, no amount of persuasion from outsiders will alter this.

In order to remedy this a little, it is suggested that outsiders who are planning development for pastoral nomads stop and ask themselves: How do they justify their action? Who are they aiming to help? The pastoral nomads? The governments administering them? Their own governments? Their own institutions? If they think they are benefitting the pastoral nomads, have they gone out to ask the nomad leaders what they want (and not just a few destitute nomads who would welcome any alternative to their present situation)? What lessons are to be drawn from similar projects and their possible side-effects? ...The minimum requirement should be that planners be aware of all these questions, and have formulated their answers before taking on the enormous responsibility of interfering with the delicate mechanics of pastoral nomadism..

IX. Attempts to improve productivity efficiency include stock water development, vaccination programs to control major diseases, abattoirs, but to date only disease control has made a reasonable showing.

Everything that can be done to improve productive efficiency can be enumerated under five major phases or factors of production. These factors are:

a. Feeding or nutrition: Which covers the sum total of nutritive requirements including hand feeding and natural grazing.

b. Breeding: Changes to the genetic makeup of an animal or population which may be good or bad depending upon observed performance under a given set of environmental conditions.

c. Health: Includes all aspects of disease control and/or veterinary services.

d. Management: Relates to the daily care of animals, in complete confinement as well as under extensive range conditions.

e. Marketing: Implies the entire course of events - initial sale, transportation, processing, packaging, etc. - between the primary producer and the final consumer.

Feeding or nutrition and management: Would normally be discussed individually when considering the extent to which they are constraints on improving productivity. However, in the present circumstances, where the chief goal is to utilize cattle in harvesting natural forage under arid conditions, it is almost impossible to separate them.

There are two exceptions: the supplementation of range grasses with forages grown outside the project area, and the **addition** of salt, minerals and vitamins to the grazing animal's diet.

They are the most difficult, in terms of time required to initiate change, and high cost involved to effect manifest improvements, and should only be considered in long term projections. In the long view, judicious range use is more fundamental to a continuing cattle industry than any other issue because imprudent utilization will eventually destroy the ground cover and turn much of this project area into a barren desert.

In undertaking range management schemes, it should be kept in mind that not less than fifteen years are required to arrive at a point where realistic economic returns can be assessed, and such a production package program should involve all five production factors.

Breeding: Is not considered to be a significant deterrent to cattle development in this project zone at the present time. The local cattle have evolved over many years in direct response to climate, soil, water, vegetation, and disease. Each ecological niche has been occupied by a particular people or tribe group keeping animals best suited to the particular environment and the basic needs of tribal owners.

Marketing:

In approaching a marketing plan a large number of conditions outside the direct realm of animal resources development policy and technical guidelines must be minimally met before any action programs can hope to succeed. These prerequisites include:

1. A market for livestock and livestock products for which pastoral herders can produce at a profit. This market should be an expanding one and may be either a local market based on an increasing non-agricultural population with rising income, or an export market.

2. Political stability and continuity.

3. Minimal corps of administrative and organizational talent and competence.

Essentially, development in a country or region should first be viewed in terms of what makes sense from the market standpoint. This includes determining the nature and extent of the market and the type of product or products demanded.

Some recommendations for improving the present marketing system are:

1. Collect statistics and marketing intelligence.
2. Examine and license major livestock dealers and middlemen.
3. Control central markets.
4. Promote cattle sales by live weight or carcass weight.
5. Provide credit to buyers.

Organizational Recommendations:

There are presently no specific provisions within AID to retain, in a readily available form and place, the vast amount of valuable experience already acquired in sub-Sahara Africa. This circumstance, plus the exigency of learning from past successes and failures, prompts a number of general and specific recommendations:

a. Develop a working library of pertinent animal resources development experience and innovations within the above technical office.

b. The foregoing could lead to the development of specific, in-depth program guidelines and packages of information for field personnel that would assure the best possible planning, and permit relatively inexperienced livestock advisors to proceed immediately with approved programs. Hence, the chances of repeating past

mistakes would be minimized.

SUGGESTED LIVESTOCK PROJECTS FOR DEMONSTRATION RANCH AREA

In order to initiate the recommended livestock improvement program under controlled conditions, a demonstration ranch has been proposed. By implementing these programs on a small scale in an area that can be closely observed, the cost and specific effects can be accurately measured. This approach will reduce the future chances of oversights and will allow for more accurate cost estimates on a large scale implementation.

There are three specific livestock programs that should be initiated in conjunction with the range management development within the demonstration area:

1. An effective year-round vitamin, mineral, and salt supplementation program.
2. An economic supplemental feeding program to be used during periods of low forage availability and drought.
3. Herd health and selection program including: marking of all animals, vaccinations against indigenous diseases, treatment against internal and external parasites, selection and culling of animals to improve herd efficiency.

THE NEED FOR MINERAL AND VITAMIN SUPPLEMENTATION

Minerals and vitamins appear widespread throughout the project zone. It has long been known, for normal growth and function, inorganic minerals must be continuously available to all biological forms, and especially to ruminants grazing in arid or semi-arid areas during prolonged droughts.

Minerals make up only four to six percent of the body of the vertebrate animal, but because of their important role in body processes, they are important in the entire field of nutritional biochemistry. The indispensible elements needed for nutritional purposes by animals are usually divided into two groups. The first group, called major or maco elements include: calcium, phosphorus, potassium, sulfur, sodium, chlorine and magnesium. The remaining essential minerals are usually termed the trace minerals or trace elements because they are needed by the animal only in very small quantities. The elements usually included among the trace minerals for nutritional purposes are: iron, copper, maganese, zinc, cobalt and iodine. The list of essential elements is now usually expanded to include molybdenum and selenium.

Shortages of phosphorous in the soil and forages have been reported all over the sahelian region. The mixed desert grassland and shrub pastures are deficient 10 months of the year for all livestock, and it is this author's belief that phosphorus is deficient throughout the year for lactating cows.

Severe deficiencies of phosphorus in animals cause general weakness and loss of weight. Cattle on deficient grazing will continually lick each other and, while standing, will lash the tongue out to the side of the mouth. Low dietary intakes of phosphorus is associated with low breeding efficiency in cattle. Since calcium and phosphorus are closely interelated in metabolism, it is difficult to evaluate requirements and functions of one without the other. The most prominent function of calcium is for bone formation. Calcium constitutes approximately 2% of the

total weight of the animal's body, and about 99% of the total quantity of calcium is contained in the skeletal structure. The primary symptom of calcium deficiency is rickets. This condition was usually seen in young animals throughout the project zone, but was also observed in a few mature animals. Although a Ca:P ratio of 2:1 is recommended for ruminants, there may be some special requirements for the livestock in the project zone. Isolated incidences of deficiencies of several other minerals was suspected.

Vitamin A, D, and E deficiency are **usually** expected in cattle grazing arid lands and during prolonged periods of droughts. The severe vitamin A deficiencies of night blindness, muscular incoordination, and convulsive seizures were noted in the livestock throughout the project zone.

As vitamin D has the same deficiency symptoms as calcium, it is difficult to say whether the examples seen were one or the other. The author suspects both.

Faulty supplementation of minerals and vitamins is a significant factor in the poor performance of livestock in Niger, but inadequacies of feed energy intake mask identification of the problem. As there is no accurate information on amounts or levels of minerals available, a multi-element mixture for all livestock is recommended.

Salt

Non-lactating animals may need only limited amounts of salt. Also suckling young do not need extra salt, since milk is rich in salt. However, salt is extremely important for lactating animals. In fact, inadequate salt may be a significant factor in the loss of young and poor mothering ability. It appears wise, even in poor environments and where the cost of salt is high, to supplement the diets of lactating animals.

It is common practice to utilize salt as a means of supplying minerals. Such combinations are marketed as mineralized salts. A common formula (guaranteed analysis) on a percentage basis is:

Salt (NaCl) not more than 98.0%

Salt (NaCl) not less than 95.0%

Zinc (Zn) not less than 0.350%

Manganese (mn) not less than 0.280%

Iron (Fe) not less than 0.175%

Copper (Cu) not less than 0.035%

Iodine (I) not less than 0.007%

Cobalt (Co) not less than 0.007%

Mineralized salt may be prepared in block form to be used as lick or finely ground for compounding with other feed supplements. The amounts of mineralized salts needed depends on numerous factors, among them the age of the animal, stage of lactation, types and quantity of feed, and soil conditions. Due to the limited information on the mineral content of the forages and soil deficiencies, it is difficult at this time to determine the minerals and amounts needed for the project zone.

The cost of mineral supplements must be kept as low as possible. If the cost is high, either they will not be used at all or they will be used in such small amounts that in the end their use will be ineffective.

FEEDING SUPPLEMENTS

Often it is not economically feasible to provide significant improvements in forage production such as suggested earlier in this report. Pastures, even when well managed, more often than not fail to yield adequate supplies of protein - especially for young, growing livestock - if the sole forage are grasses. The best sustained rates of gain for cattle on grass alone averages no more than 0.5 kg per day. When gains are this low for cattle of 350 kg body weight or larger, the major portion of the energy from forages is used for maintenance. It then becomes desirable from an economic standpoint to provide animals rations having a higher energy content than is possible on grass alone. Development of feed supplies in addition to grazing is important as sources of both supplementary feeds for ruminants, and feeds for nonruminants, as well as to help make the most efficient use of the grass resources. If the animals lose weight or make no gains on the grazing, the grass is a lost resource.

Feedstuffs, other than forages, are generally referred to as supplements. These include by-products from plant and animal sources, synthetic supplements and waste products, as well as cereal grains, oil seeds, sorgum, and milo grain. The latter are the major suppliers of energy and protein for much of the livestock kept in arid and semi-arid zones. The most widely utilized products of this nature are rice bran, seed oil meals like peanut, cotton, and soybean, molasses, and bone meal.

This author is convinced that more use of plant residues and/or by-products of the peanut and cotton industries in Niger could be developed. However, technology and machinery will be needed to process these by-products if they are to be used effectively.

The following section describes several of the plant and animal by-products that might be used as supplementary sources of protein and energy or as roughages in Niger.

Peanut Meal

Peanut meal (ground nut meal) is an excellent source of protein. However, there have been reports of toxicity from afflatoxins produced by molding due to inappropriate storage. Even so, the production of peanuts might well be expanded to serve as a source of oil for human use and protein supplement for all classes of livestock.

Rice Products - Bran, Hulls, and Straw

Rice hulls are a popular feed in rural producing areas. It is produced in rice mills or in households by pounding with mortar and pestle to separate the polished rice from the bran and hulls. The quality of bran is influenced by the milling process and the type of rice used. Rice bran is a good source of energy for livestock.

Rice hulls are a very low quality roughage. Their main use is as a "filler" in feed mixtures. Rice straw is a fair quality roughage. It could be fed during the dry season with some augmentation by rice bran.

Animal By-Products

The most popular feed products from the preparation of meat for human use are blood and bone meals, and meat scraps. These are excellent sources of protein, and bone meal is an especially good source of calcium and phosphorus. Since these by-products are produced mainly in slaughterhouses or processing plants in urban centers, and not in large quantities, their use in rural areas is very limited.

Cottonseed Cake, Meal, and Gin Trash

Cottonseed cake and meal could be by-products of the cotton industry in Niger. They are included here because several countries are expanding their production of cotton with emphasis on the production of edible oil and protein supplements for livestock - even though the cotton fiber may be sold on the world market at a loss.

Either meal or whole cottonseed may serve as the chief protein source for all

classes of livestock. Extensive experiments have proved that cattle and sheep over 4 months of age may be safely fed cottonseed meal as the main source of protein. About 1 kg or slightly less per head per day is frequently sufficient protein supplement to carry adult cattle through the dry season if they are on fair grazing.

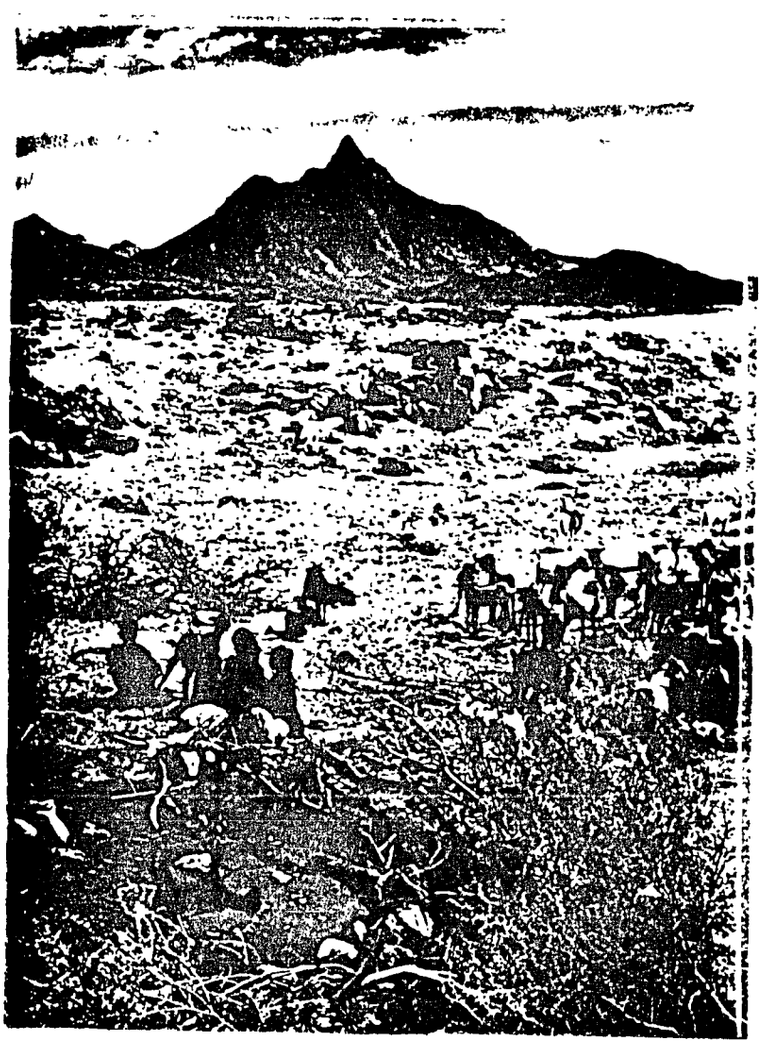
Gin trash, the residue consisting of the bole and stems, left after the cotton is processed in a gin, is often overlooked. Its value is exceedingly high in feeding cattle and may often have a protein analysis as high as alfalfa hay. It is also an excellent source of energy if it contains a sufficient amount of cotton boles.

Non-Protein Nitrogen Compounds

Urea and other non-protein nitrogen compounds (NPN) have been accalimed by many as important potential sources of nitrogen, which may be utilized by ruminants to replace protein from cereal grains or to make up deficiencies on grasslands.

There are flood and drouth
Over the eyes and in the mouth,
Dead water and dead sand
Contending for the upper hand.
The parched eviserated soil
Gapes at the vanity of toil,
Laughs without mirth.
This is the death of earth.

T. S. Eliot - Four Quartets



RANGE CONDITION AND TREND*

It is of great practical importance to know not only the present condition of a range but also whether that range is improving or deteriorating. In order to interpret factors responsible for the improvement in deterioration of a range, an understanding of the terms "range condition and range condition trend" is necessary. Range condition is defined as the state and health of the range, based on what that range is naturally capable of producing. A variety of criteria are considered in judging condition. Among these are plant vigor, species composition, species density, pattern stability, volume of forage production (biomass), reproduction, soil litter, soil erosion and insect and rodent activity.

Range condition trend is defined as the direction of change in range condition and soil. Factors which set trends in motion are grazing, fire, floods, introduction of alien plant species, disease, drought or short term climatic changes, manipulative management practices, and ecogenic effects (mutations).

Unmistakably, plant evidence in all sections of the project area indicate that the ranges of the project area once supported perennial grasses. Today these same ranges support only annual grasses. Based on the perennial grass

*** See appendix I for photos and detailed description.**

premise and the present grass population, the range condition of ranges in the project area is classed as poor.

Disuse is not normal for vegetation, and it is particularly not normal for members of the grass family. The physiological structure of the grass plant itself, indicates that it evolved under grazing pressure from large Herbivores. The type of plants and their density largely reflected the grazing habits and feed preference of the animals present. One can only reconstruct what probably caused the deterioration or retrogression of pastoral grasslands. Plant communities change in an orderly manner when grazed by a particular kind of animal at a rate greater than the ability of that plant species or community to sustain a constant yield.

Those plants most preferred by animals are first to show signs of grazing stress, in this case perennial grasses. They lose vigor, little annual growth is produced, and reproduction is almost absent. As grazing is continued, these palatable plants or (decreasers) as they are termed, die. With the death of the more palatable plants, the less palatable members of the plant community, in this case annuals or what is generally referred to as (INCREASERS) increase in abundance, resulting in a change in community composition. So with the passage of time plant populations

often change under the reduced pressure of native wildlife and the increased grazing pressure of domestic livestock. This most likely was the case in the project area of Niger. The plants that were most palatable, the perennials, declined in vigor and abundance to a point that they now play only a very minor role in the community.

The less palatable annual grasses have increased and now are dominant. Brush and other woody plants have increased in many areas of the project area as well. In such cases, these changes in plant community induced by cattle grazing improved the habitat for sheep and goats. As indicated earlier, the climax vegetation of the pastoral zone was most certainly perennial grasses. Any number of factors may have been responsible for disturbing this climax cover and liable for the pattern of regression, leading away from the climax. Drought, fire and grazing undoubtedly all played their part. In many cases, if these actions are temporary, a succession leading back to a climax community may follow, such was not the case in Niger. By far the most important of the factors that may cause regression on range is improper grazing. Unfortunately, with the weakening of the soil protecting vegetation (in this case the heavy deep root system of perennial grasses), soil deterioration also occurs. Deterioration here is seen in reduction in organic matter and minerals, less soil moisture and higher soil temperatures. In some cases water and wind may move (erode)

the surface soil to the point that the exposed subsoil is incapable of supporting climax plants. Evidence of these forms of erosion were seen in practically every sector of the project area. Intensive and poorly managed grazing in the area is undoubtedly the major cause of the disappearance of the preferred plants and those physiologically less resistant to grazing. Retrogression involves plant competition. The disappearance of climax grasses by abuse leaves growing space for other plants. The less preferred or more resistant plants may move into this space and thus are termed increasers; they increase under heavy grazing. This abuse of perennial, climax grass species paved the way for the regressional pattern to annual grasses in Niger. Though in many parts of the world these annuals would not be considered part of the climax vegetation, but rather invaders, the widespread take-over of project area ranges by annuals leaves some room for doubt. The stages of this retrogression in species composition probably was (a) physiological disturbance of climax plants, (b) plant species composition change in climax cover, (c) invasion of new species invaders (annuals and later woody perennials) and (d) near total disappearance of climax plants (perennial grasses). The last step, but one that has not generally occurred in the project area would be the decreased density of the invaders and the further invasion by shrubs of low palatability. In this situation the land approaches a totally unproductive state and soil

degradation is extensive. The soils of the project area have not been degraded to anything approaching this extreme. This would indicate that the trend at this time is neither up or down but has become somewhat stable.

Frequently a secondary plant succession may follow a retrogressional pattern if environmental factors plus grazing intensity are favorable. In this succession, climax plants (perennials) may reoccupy the range rather rapidly, though in the deserts of Niger this is unlikely. More often, invaders, in this case annual grasses appear to completely dominate the range (which indeed they do) and it's doubtful whether perennial grasses can ever reoccupy the range under the present type of grazing usage by local herdsmen. In this case the wisdom of attempting to plan the management of the project area for the re-entry of perennial grasses is highly questionable without the initiation of a comprehensive range educational program. If such a program is <u>not</u> adopted the practical feasibility of such range planning is baseless.

The invaders, here, the annuals are highly productive during at least part of the year and their use could be more profitable, if coupled with improved grazing management and animal husbandry practices. In spite of improved management with annual ranges, the greatest difficulty in their use lies in chances of extreme variations in production from year to year, due chiefly to precipitation fluctuation.

ANNUAL-TYPE VEGETATION

In review of the dominant role annual grasses play in forage production in the project area, a review of some of the characteristics of this type vegetation may be helpful in planning future range management programs in the area.

Annual grasses are simple plants as compared with other types of vegetation, ie. biennial or perennial. As the name implies, annual plants germinate, grow, flower and produce seed or otherwise complete their life cycle in a single season. They do not initiate regrowth in a successive year from roots or a plant crown. Annual plants are usually grouped into two main classifications: warm season or cool season growers. The latter group germinates during the fall or winter months as a result of precipitation at that time and completes its life cycle in the spring. Warm season growers on the other hand germinate as a result of summer moisture and complete their life in the fall. Summer annual grasses represent the dominant vegetation of the pastoral zone. The growth form of annuals is characterized by slender, erect above ground growth and a well developed lateral root system. This type root system enables the plant to absorb relatively large amounts of soil moisture in a short time. This characteris-

tic is particularly important with plants that must survive in regions with low annual precipitation.

Contrary to the opinion of many individuals responsible for the management of annual ranges, grazing philosophies such as "take it all" or "graze it to the ground" are totally wrong. The key to successful management of such ranges lies not in this concept but in the moderate utilization of the range. Moderate grazing as the term is used here implies a degree of use that will permit the more desirable forage plants to maintain or increase their abundance and yet be used from year to year. It's clear from their description that moderate or conservative grazing requires management of forage resources. Climatic variations, mainly precipitation, throughout a grazing region results in differences in the amount of forage and surface stockwater available. Because of this it is necessary for herdsmen and others who plan the use of such ranges to employ stocking and grazing practices that will promote moderate useage of the range. Again, contrary to the opinion of some range managers, livestock will not regulate forage utilization themselves; its through management alone that man regulate the proper utilization of ranges.

Moderate grazing should not be confused with light grazing. Range in good condition should not be grazed too lightly. To permit only light grazing of good productive range not

only results in a waste of forage that could be used to produce meat but also encourages the growth of less desirable plants. Light grazing, however, is desirable to encourage rapid improvement of range in poor or fair condition. It should be emphasized here that all annual grasses are not the same. Just as with perennial forage plants, annuals are considered as being high, medium or low in palatability and nutritional value. The productive condition or "health" of an annual range is likewise judged as excellent, good, fair or poor.

Soil fertility, an important consideration in the management of any range, including those of Niger, also improves with moderate grazing. Under moderate use, usually enough ungrazed plant growth is left on the ground each season to maintain and improve soil fertility when this organic matter is added to the soil. In addition, a cover of dry vegetation protects the soil surface from the direct action of rain, wind, sunshine and other forces that cause erosion or lower the fertility of the soils. Moderately grazed ranges produce new green forage 2-3 weeks earlier than those more closely grazed. This is true because the amount of plant residue left on the ground under moderate grazing protects the young plants from drying winds, making possible earlier growth. An additional advantage is that much of the old dry growth is eaten with the young green forage, providing additional roughage for animals during the green

feed season of the year. A useful guide in deciding whether an annual range has been moderately grazed is to observe the height of plant stubble left on the range. With moderate use, this stubble should appear about 2 inches tall when new green growth appears. On the range their stubble may appear patchy or mottled and vary from place to place but a general pattern of old low stubble should be present over the range.

If annual ranges are mismanaged and over-grazing or heavy use occurs, too much old plant growth will be removed. If this practice continues, the "stored" seed supply in the soil will be exhausted and the soil surface will be exposed to accelerated erosion. Such seed and soil losses will inevitably result in a reduced productive capacity of the range.*

*** See Appendix I for list of plants found in study area.**

EROSION

Soil erosion is a serious problem on many ranges in the project area. In some areas in fact the land has experienced more damage from wind erosion than would normally be expected from geologic causes. Erosion might be described as the slow dislodging and movement of soil particles by the action of wind and water. The amount of erosion that may occur is closely correlated with the protection and resistance soils possess to these forces. Very often the differences resulting from the actions of wind and water are difficult to detect. More often than not they interact and only on rare occasions is a soil affected by one force and not the other. In any case the causes, results and remedies for losses from wind or water are the same. Soil losses due to both forces but principally wind was observed in practically every portion of the study area. Geologic erosion, mentioned earlier, is normal wearing away of the earths surface, by forces not controllable by man. Accelerated erosion however is the unusual wearing of the surface due to the disturbances of man.

Vegetation is the most important single factor determining the rate of soil movement by wind. Not surprisingly then, soil losses from wind are greatest in arid regions where vegetation is more scattered and wind velocities are the

highest. Though erosion losses vary, they appear to be more serious on project area ranges where range fires are common and on unusually heavily utilized ranges where plant cover has been lost. Since wind velocities are always higher in areas with level terrain, wind has and always will present a challenge to vegetation management on the sandy plains of the project area. Unmistakable evidence of active erosion in the area was seen in pedestalled or hummocked plant crowns with exposed roots, subsoil exposure and the accumulation of fine plant debris around the perifery of barren denuded range sites. In addition, many examples of rill and sheet erosion due mainly to action of water were seen throughout the area.

The evidence of widespread active erosion in the project area reflects the level of abuse these grazing lands have and continue to sustain. It further emphasizes the need for the adoption of improved animal and plant management in the area.

FORESTS

The Sahel-Saharan climatic zone supports scattered stands of small trees. Acacia species including A. Radiana and A. Senegal plus Ballanites Aggyptiaca are typical of the sparse tree vegetation found in the project area.

The relationships that exist between tree reproduction and grazing animals in the area are not all harmful. Heavy utilization of grasses, even to the point of overgrazing may actually favor tree seed germination in some instances. This was often seen in bedgrounds and other areas where animals congregate. Trampling here may aid germination by reducing heavy litter and forcing seed into moist mineral soils. After the seeds have germinated, moderate grazing may again serve to aid seedling survival by reducing competition from herbaceous plants in these areas.

Though the presence of trees is important to the overall balance of the plant population, trees as such, play a minor role in the pastoral zone.

On many occasions evidence of tree cutting was observed. Though this may have been done for logical and seemingly worthwhile purposes, the practice should be controlled. The fact remains that livestock can survive on a diet of grass, annuals or otherwise, but all livestock cannot

survive on a diet of trees and brush. The project area must be managed for the production of grass, and trees, though necessary, are incidental. It is believed that an ample population of trees will reproduce and survive to meet the shade requirements of cattle and the browsing needs of some of the larger quadrupeds if some type of restriction is placed on indiscriminate cutting and harvesting.

The results of the survey indicates little evidence to support the need for a reforestation program in the project area or in the surrounding pastoral zone.

FIRE

The results of what apparently have been countless range fires over the years were seen at many locations in the project area. Most of these fire-denuded ranges were found in the west-central portion of the area bounded by the 6° 50'-7° 10' degrees of longitude. Man is believed to be the major cause of these fires. The fires and the waste of the valuable resource resulting from them are a glaring example of man's lack of understanding of his environment. The immediate economic loss from fire is matched by other less obvious losses. Such fires not only destroy much of the litter and plant accumulation on the ground, but they also promote leaching and soil erosion. It was also noted in many instances that unburned range adjacent to burned range supported some of the best stands of annual grasses seen anywhere in the project area. Though of course, this in itself is not surprising it does emphasize the fact that when fires burn and spread they often destroy some of the best animal feed as well. The end result of range fires are a tremendous loss not only to the present but to the future productivity of the range.

It should be pointed out here that although uncontrolled fires are a threat to the range, fire when used properly, can be a useful tool in range management.

One cannot help but suspect that much of the animal losses sustained in the recent drought were aggravated and probably substantially increased by starvation resulting from feed shortages caused by range fires.

It's obvious that the needless destruction of grass ranges in the area must be stopped. Though naturally caused fires will always be some threat, fires and losses resulting from the acts of careless herdsmen deserve serious attention. The solution to the problem of man caused fires lies somewhere in the education of man himself. Regardless however of successes gained in the reduction of man-caused fires, naturally caused fires will continue to be a reason for concern. Future planning for the management of the project area should include not only the education indicated above but the construction of physical structures as well. Such features might include strategically located fire look-out towers and a pattern of dual purpose road-fire breaks thoughout the area. The access to fire locations possible as a result of these roads might necessitate the training and equipping of volunteer fire fighting crews.

ACCESSIBILITY

ROADS

The project area and presumably much of the pastoral zone, though the latter was not included in this study, is virtually isolated from the rest of the country. The area is a mixed pattern of rolling plains and shallow valleys that is practically inaccessible except by animal or small 4-wheel drive vehicle. Indeed, in many places, the limitation of this type vehicle can be easily found.

A major factor in introducing improved range and animal management practices in the project area is the provision of improved access to the area. Increased accessibility here refers to accessibility by heavy two and three axel trucks.

Though the construction of such roads would be possible only after extensive planning and engineering, a modest network of north-south, east-west roads, some of which might junction with major routes of the country is sorely needed. Though desirable, these need not be graded, all-weather roads. Cleared trails, two bulldozer blades wide, would be sufficient. Once a "nucleus" of such north-south, east-west roads were established, in time a network of light-service trails, suitable for smaller 4-wheel drive vehicles could be cleared. This network of roads would

effectively "open" the area and serve a variety of purposes such as; (a) provide access for heavy trucks used in transport of market livestock, animal feeds and human food, (b) stock trails, (c) fire breaks to reduce spread of range fires, (d) access of extension education personnel and other personnel responsible for animal health, grazing schedule maintenance etc., and (e) emergency evacuation of sick and injured people and transport of medical personnel.

VIII. MANAGEMENT ALTERNATIVES IN THE PROJECT AREA

CONTROL is the key word in the sciences of range and animal management. If the meaning of the word control is coupled with management and applied in the field of agriculture together they signify the ability to direct and manipulate or otherwise influence positively the factors of production.

When the production factors of range forage and range livestock are being considered, its quite evident that management is impossible without the power to control the matters that influence these factors. This basic truth strikes at the heart of the animal production problem in the project area. There is no control of forage use or animal movement. Furthermore, with the situation as it exists today with nomadic herdsmen grazing excessive numbers of livestock in uncontrolled useage of grazing resources, there appears to be no opportunity to employ the known methods and practices of plant and animal improvement. This is true, because as was stated earlier, management requires control of the factors of production.

It is generally agreed by members of the survey team that until the Government of Niger (GON) takes whatever steps are necessary to slow and then stop the flow of people

and animals that are responsible for the uncontrolled use of the grazing resources of the project area, all attempts to employ range and animal improvement practices, on anything but a token scale, would be futile. There can be no real improvement in the grazing resources or the animal population of the area until measures to regulate the use of resources are available. To suggest that measurable progress in improvement of the productivity of the project area is possible under present circumstances is irresponsible. There is no alternative to the present situation in the project area that might result in long term improvement of productivity except major changes in the administration and regulation of the use of grazing lands in the area. If the situation continues as it is today, the level of productivity will remain essentially unchanged or it may worsen. On the otherhand if control of the use of these lands could be achieved, opportunities for improvement would be greatly increased.

It is understood that any decision to control or otherwise regulate the use of these lands will have strong economic, social or political repercussions. Regardless of this, if major changes in the administration of these grazing lands are possible, consideration to several basic needs of plants and animals would be needed.

Some of the important considerations that should be given attention are listed here.

1. Develop permanent and temporary livestock watering facilities in such a manner that it is unnecessary for an animal to travel more than 3 miles to water. This could be accomplished through the combined use of hand dug wells, drilled wells, metal and concrete storage tanks, windmills, pipelines, pit charcos, runoff pavement etc.
2. Delineation of all land into grazing units. The size of such units might be determined through the use of a formula, based on the economic needs of family units.
3. The establishment of physical bounderies of grazing units by the use of cement monuments, road-firebreak clearings, livestock waterings etc.
4. Assignment of herdsmen and their familiarity to specific units with permits. In time, some form of assessment for the use of the permit might be considered.
5. The development of some type of pasture and range management plan for each permit.
6. Determination of conservative carrying capacities for ranges in different regions. From this,

estimates of recommended yearly stocking rates could be determined based on range condition, precipitation, beneficial effects of pasture management programs etc.

7. Provision of basic animal mineral supplementation, ie. salt, phosphorus.
8. Establishment of some form of plant and animal continuing education program for herdsmen, such as a functional extension service.
9. Establishment of livestock health and management programs. In addition to basic animal disease and parasite control programs, consideration would be given to breeding improvement, identification, special practices such as dehorning and castration, replacement animal selection and many other herd and flock improvement practices.
10. Establishment of a system of surveillance of the land and permit holders. The purpose here would be to ascertain that grazing management plans were adhered to and that the best possible use be made of plant and animal resources.

IX. RESEARCH

Time spent by team members in reviewing the work and the reports of other individuals concerned with livestock and vegetation problems in the pastoral zone indicates clearly, that the problem has been research sufficiently.

Range and animal management problems in the zone in most cases are not unlike those faced by animal producers in other desert grazing areas of the world. Animal disease, nutrition, reproduction, forage utilization, water, erosion and marketing are but a few of the concerns shared by all producers. Information, expertise and recipe knowledge is readily available to deal with most aspects of plant and animal improvement in the zone. There is the possible need for the "fine tuning" or refinement of some recognized improvement techniques such as reseeding, water storage and livestock handling, but a lack of research data is not a major problem for the project area. There is however, at least one major difference in Niger that makes range and animal management more difficult than in many other grazing areas. The difference here of course is the nomadic or otherwise unsettled life style of the livestock producers themselves. It is believed by the team however, that the solution of forage and animal management problems associated with this situation, will not be found in further range and livestock research. The

problems and practices that hinder production and damage the resource are not agricultural, but rather they are sociological, cultural and people management problems. Such problems though related to the subject of this survey, are considered beyond the scope of this study.

X. RANGE AND RANGE MANAGEMENT PLANNING

Rangeland occupies approximately 48% of the earths surface. In Niger rangeland occupies a large percentage of the central portion of the country, known as the pastoral zone.

What is rangeland? The term range itself is generally described as land with a permanent cover of native or introduced grasses, shrubs and other forage plants and trees. Ranges are usually arid but other features such as sandy, saline soils and topography may also be limiting factors. Additionally, the term usually denotes vast, open, unfenced areas where animals roam at will.

It was the result of the need for wiser useage of such native resources that the term and science of range management evolved.

Range Management is a land discipline that skillfully employs biological sciences to renewable natural resource systems for purposes of protection and improvement of the range resource and the production of animal products. Although the major objective of range management is to maintain and improve forage productivity; focusing on natural range ecosystems, certain agronomic practices such as seeding and noxious plant control may also be included. The term range ecosystem as it is used here refers to the interacting

combinations of natural forces, management inputs, and organisms that make up a community environment.

Information collected in a physical inventory of plant and animal life in an area representative of a range unit under consideration constitutes the basis for a range management plan. A range management plan then is a predetermined course of action designed to secure the best practicable use of range. The plan is also designed to provide a word picture of the range resource, its condition and the actions and adjustments that may be necessary to maintain and improve the productivity of the grazing resource. A good plan should include a (a) statement of objectives or goals, (b) inventory of resources, (c) review of present usage of resources, (d) suggested adjustments for more efficient use of resources, and (e) monitoring of adjustments. The foundation of the plan is an accounting of not only present but potential productivity based on sound ecological principles.

The outline for a rangeland resource inventory and management plan is shown in the following.

<u>Rangeland Resource Inventory and Management Plan</u>

I. Introduction

II. Historical consideration

III. Current management

IV. Inventory - boundaries, physical improvements, land ownership, climate, geology, physiography, soils, vegetation.

V. Use by livestock, Range Condition and Grazing Capacity - mappping units and range sites, forage utilization, range condition and trend, livestock grazing capacity. (Procedures and results for each).

VI. Other Uses of the Rangeland - mining, cultivation, recreation, wildlife, watershed, forestry

VII. Management Alternatives

VIII. Evaluation of Alternatives - economic, impacts on the basic resources.

IX. Recommendations - management changes, improvements, procedures to evaluate improvements and management changes.

Range improvement generally involves the use of a sequence of management practices. The need for proper sequencing of the techniques involved, underlines the importance of timing and scheduling in improvement planning. There exists however in range improvement, probabilities of risk or failure. Unfortunately for the planner, the probability odds of success or failure are unknown. It's here that the hazards of scheduling or predicting completion results of range improvement practices in the field - become most apparent. The gamble here lies in the influence that uncontroll-

able factors have on the probability of success or failure of certain improvement practices. The reasoning here is that it is unwise for those responsible for the implementation of improvement programs to predict or otherwise indicate the time frame within which certain accomplishments will be made. Flexibility in timing and allowances for the expected and unexpected must be incorporated into the program. It's important that this fact be emphasized here because in discussions with team members in Niamey, USAID personnel indicated a desire to initiate a 2 year range improvement program followed by a 4 year improvement program.

This indicates that certain accomplishments will be expected within certain time intervals. Team members experienced in the planning and implementation of range improvement practices recommend that caution be exercised in predicting the accomplishments attainable in such short periods of time.

XI. PREREQUISITE FOR IMPROVEMENT IN THE PASTORAL ZONE

COMMUNICATION

Nomadic and semi-nomadic herdsmen play a vital role in opportunities for improvement of the pastoral zone. A failure to recognize this fact virtually dooms any program designed for the area, regardless of how well planned or conceived. It is the opinion of the survey team that a need exists for the development of a reliable and functional means of communication between the GON and/or other agencies and the nomadic and semi-nomadic people who use the land. The design and implementation of this liaison would contain new adaptation to a recognized and effective tool of rural communication, the "extension service". The type of extension service referred to here would utilize a positive, people to people, low profile approach and would differ markedly from the Extension Service that now exists in Niger. It should be noted here that if the recommendations described here were to be incorporated into the existing Extension Service, some noticeable changes in the existing service would be necessary.

The Peul, Tuareg and Fulani tribes are recognized as the people who constitute the main nomadic and semi-nomadic groups that graze the ranges of Niger (it is understood, too, that during the long seasonal migrations to the south, these people graze lands other than range land). The hope

for improvement of utilization and management of the pastoral zone lies in gaining the attention and cooperation of these people. It is believed that the best method of reaching these people is through a special arm of extension made up of a CADRE of Peul, Tuareg and Fulani extension aids, trained and guided by professional range and animal extension personnel. It should be indicated at this point that it is understood that grazing should be confined to the ranges of the pastoral zone of Niger and accordingly that management of these lands could best be obtained through sedentary stock growers rather than nomads. This would not apply to the small farm flocks of farmers in the agricultural area. However, the restriction of grazing to the pastoral zone, the termination of nomadic migrations or any other control of movement of people and animals forceable or otherwsie is not within the scope of this study.

The CADRE of native extension aids would come from specially selected, willing and interested local tribesmen. It is believed that although these are nomadic people and "on the move" most of the time, an ample number of trainees, could be found especially if the right incentives were offered ie. additional livestock.

Though certain requirements would be established for the

selection of these people, the underlying features would be that they were members of the community, they would be experienced and fellow herdsmen, and they would speak the same common language. In the field Peul extension aids would be selected to work with Peul herdmen, Tuareg aids with Tuaregs etc. It's believed that this approach would create a "low profile" and otherwise favorable atmosphere for the acceptance of new ideas and change on the part of the people. Stated another way, a Tuareg talking to a Tuareg probably offers the best way of getting a Tuaregs' attention and arousing his interest and curiosity. With this form of contact with herdsmen, native extension personnel (aids) would be in a good position to inform and earn the confidence of these people but most important of all, they'll be able to involve them in future range management planning.

It is realized that this type of education process will be slow, and that programs will be attempting to communicate with a moving clientele. However in time, with a well managed extension aid field program, it's reasonable to predict that an acceptance of the idea of the need for change in range and animal control, will be aroused in many of the people. With the losses of the recent drought still lingering with the people, this program may be surprisingly well timed!

The training of the cadre of extension aids need not be long or involved but deal only with the most basic factors of plant and animal management such as fire prevention and control, the use of increased stockwater facilities to improve range utilization and animal distribution, and nutrition (block salt and phosphorus). Regardless of what is included it must be extremely practical and involve the people in an "on-ground" approach to the things that affect them and their animals the most. This in reality is the basic concept of extension education.

The choice of the location to attempt the use of this extension technique is important. The logical place would be an area inhabited primarily by sedentary or semi-nomadic people. These herders because of their life styles might be the most receptive to ideas that would benefit them yet require minimal change from present management practices. A very slow approach involving the description of only the simpliest practices should be used. The use of well conceived illustrations or other "training aids" would be appropriate. Information should be presented in such a manner as to invite questions and promote discussion. It's this type of planned approach that will get the "people" involvement referred to earlier.

In actual use of this type education approach in the field,

it is believed that all non-tribal and professional extension personnel should remain in the background and as inconspicuous as possible. Otherwise the one to one, Peul to Peul relationship may be interferred with. If this technique is successful or at least indicates the right direction, it may be necessary to maintain this type of linkage between extension aids and professional extension personnel indefinitely. Assuming this is the case, the pinciple role of extension professionals would be (a) program organization and administration, (b) extension aid selection and training and (c) program maintenance. It's believed that this type of grass roots approach, modeled after the Cooperative Extension Service program in the United States but shaped to meet the needs of Niger, represents a workable method of opening the way toward a solution of some of the problems of the pastoral zone.

XII. ESTABLISHMENT OF PROJECT AREA DEMONSTRATION GRAZING UNIT

Demonstration grazing and animal management units are effective tools in introducing livestock producers to new production methods and practices.

With the use of the Demonstration Unit approach, producers have the opportunity to observe the application and results of new and better methods of plant and animal production which are applicable to their particular part of the world. Well designed demonstration practices leave the producers with little difficulty in identifying their particular problems with the possible solutions employed and illustrated in the demonstration unit. In view of this, the numerous livestock and grazing problems that exist in the project area suggest that a demonstration grazing unit may be a useful tool in educating the rural herdsmen of Niger. It is expected that such a demonstration unit would be particularly effective if used in conjunction with the rural extension education program outlined in section XI.

The plan of the demonstration unit should be simple and designed to deal with only the most basic plant and animal production problems of the desert grazing areas. This latter consideration is extremely important because too

often demonstration units are established in areas where the management practices studied have little or no application in areas where help is really needed. In Niger, a grazing demonstration unit in the agricultural region, where rainfall and other factors are substantially different than the project area, would be in a poor position to study and recommend grazing practices for the dry lands of the pastoral zone. In addition, the otherwise skeptical or resistant herdsmen would be even less impressed with grazing recommendations originating from areas distant from their own.

The following description contains what the survey team members believe would be a practical range and animal demonstration unit suited to the problems and needs of herdsmen in the project area.

Project Area Demonstration Grazing Unit

Purpose - To demonstrate the practical application of range and animal improvement practices recommended for the project area.

Location - The demonstration unit should be located near the watering sites of BIRMOU and BAMO in the southwest quadrant of the project area. Map coordinator 15° 10' north and 6° 50' east.

Area - Approximately 3,072 hectares (7,680 acres)

Administration - The management of the demonstration unit as well as the actual implementation of methods and practices should be under the direction of professional range and livestock personnel with USAID. Though certain levels of cooperation and/or participation would be expected from GON livestock personnel, the responsibility for directing the proper use of certain improvement practices should rest with USAID. USAID personnel responsible for the formation of the rural extension service described earlier in this report, should be especially familiar with the activities of the unit.

Delineation - Ideally the unit should be fenced to prevent trespass or interference with studies underway. If fencing is not possible perhaps some other method of segregating the unit from adjacent range could be devised. In this regard, the opinions and help of the French missionaries at the Birmou mission might be solicited. These people work closely with the tribesmen of the area, are trusted and their support for the demonstration unit would be advantageous.

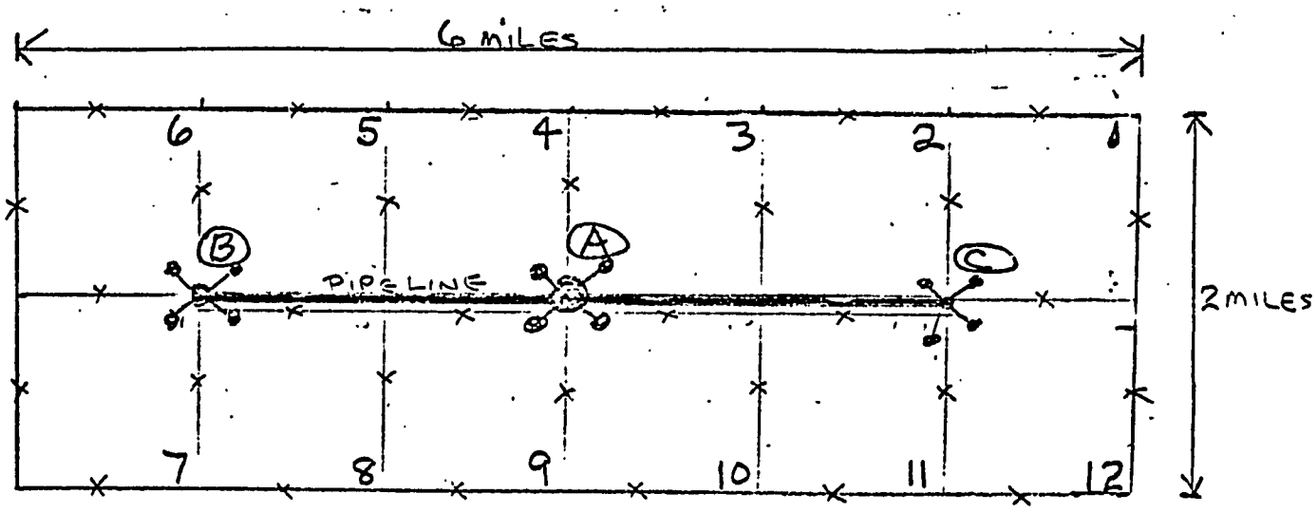
STEP I

(a) Establish a weather station at unit site and evaluate all old unofficial weather data that has been collected by the missionaries at Birmou during the last twenty years.

(b) Carry out an intensive range site survey and range improvement planning program. This should include areas to be reseeded, types and locations of soil conservation practices, stockwater development, cross fencing or other pasture segregation methods, pasture rotation and deferment patterns, stocking rates etc.

(c) Conduct a basic orientation and educational effort with herdsmen in and around the immediate vicinity of the demonstration unit. Note
It was learned that several of the tribesmen around the mission are sedentary and it is these people who would be expected to serve or prime cooperators with USAID in carrying out various studies. Also, it would be the livestock owned by these people, that would be utilized in grazing and animal studies.

STEP II. Example Of Demonstration Unit



(a) Fence or otherwise delineate boundary of unit. Cross fence unit into 12 equal size pastures each containing 257 hectares (640 acres).

(b) Construct roads within unit to reach waterings, serve as access for education and work activities and fire breaks.

(c) Drill well at point A for source of permanent water for entire unit. Construct storage tank at A. Construct pipelines east and west to storage tanks at B and C with drinkers as indicated. Windmill would be used at A with standby jack for use in calm weather.

(d) Develop grazing management system(s) for pastures nos. 1-11. A variety of rotation, deferred, and deferred-rotation systems can be studied with the pasture layout shown. With imagination and some innovation "local" systems can be also tried. The basic consideration of conservative stocking rates should be used in all early grazing system trials. Later, excessive numbers or other intentional short term abuses of the pastures could be allowed for educational purposes (to show damaging effects of over grazing, poor grazing timing etc.).

(e) An effective year round vitamin, mineral and salt supplementation program would be designed for all animals maintained in the unit. The opportunity

for various tests involving different types of supplementation, treatment and control animals etc., would be possible.

STEP III.

(a) Soil conservation practices. A variety of erosion control measures including water spreaders, soil pitting, basin forming, gully pulling, retention dams etc., could be constructed and tested. The types and methods used would be dependent on on-site observations.

(b) Water development. Special water storage and catchment structures such as dirt tanks, pit charcos, paved runoff surfaces and others could be constructed in the establishment phase of the unit in order to reduce water demands on the pipeline system.

(c) Range reseeding. Combinations of aerial and ground seeding techniques could be tested. In addition different seed varieties, seeding rates etc., could be evaluated. Pasture No. 12 might be set aside for use in reseeding trials.

(d) Supplemental feeding. A variety of supplemental feeding programs involving the use of many feeds available in Niger plus the use of feeds for breeding purposes, conditioning, stress and drought and other purposes could be tested.

(e) Herd Health and Animal Selection. Included here might be any number of management techniques including animal marking, vaccination against indigenous diseases, treatment against internal and external parasites, replacement male and female selection and culling programs to improve herd production efficiency.

The description offered here is intended only to provide an outline or check list of what might be included and accomplished by the establishment of a small scale demonstration grazing unit. Many facilities such as working chutes, corrals, loading chutes, gates etc. have been intentionally excluded. Such routine facilities would be included in on-ground planning at the unit location. USAID personnel assigned the responsibility of planning the use of plant and animal management practices at the unit would also be responsible for monitoring the conduct and the results of such field demonstration.

<u>Budget Estimate for Development of Demonstration Grazing Unit.</u>

Fencing	
16 miles perimeter @ $1,000/mile	$16,000
16 miles interior @ $1,000/mile	16,000
Windmill, total cost FOB port of shipment*	17,479
Windmill erection and installation crew*	14,600

Water storage tank, 20,000 gals.	$ 4,000
Well drilling (costs unknown) costs can best be obtained in Niger	
Plastic pipeline 2" Schedule 80 Black Plastic 4 miles @ $ .35/ft	7,500
Water Storage Tank, 5,000 gals. 2 tanks @$1200/each	2,400
Water troughs, miscellaneous plumbing equipment	1,600
Total	$79,579

*See special report entitled "Water Development & Water Harvesting Options for Arid and Semi-Arid Regions of the World", included as Appendix II.

APPENDIX I

PLANTS AND SOIL

	Page
Plant lists - generic and common names	1
Legend interpretation for selected sites	1A
Evaluation and representative photos of selected sites	2 - 40

Plant Lists, generic and common names, found in the Study area, Symbols used on writeup sheets.

PLANT LIST

Symbol	Grasses	Haoussa Name
Arfu	Aristida cuniculata	
Armu	Aristida mutabilis	
Anga	Andropogon gayanus	
Aris	Aristida species	
Ceca	Cenchaus catharticus	Karangiya
	Forbs	
Cao	Cassia obouata	Filasko
	Amaranthus viriclus	
	Trees & Shrubs	
Acla	Acacia lacta	Akovia
Acra	Acacia raddiana	Kamancha
Acse	Acacia senegalensis	Akawara
Baae	Balenites acgyptica	Adoua
Bose	Boscia senegalensis	Anza
Capr	Calitropis provera	Tumfafiya
Coaf	Commiphora Africana	Dashi
Euba	Euphorbia balsamifera	Agouaou
Guse	Guiera senegalensis	Sahara
Maer	Maerua crassifolia	Jiga
Pobi	Poupartia birrea spondias sp.	Danga
Zima	Ziziphus marritiaca	Magrias Koura

Legend Interpretation for the range data sheets used on the Sahel Project Study is as follows:

RANGE DATA SHEET

(LEGEND INTERPRETATION)

SOIL TEXTURE

1 - Clay
2 - Clay-loam
3 - Loam
4 - Sandy-loam
5 - Sand

SOIL CLASS

1 - Rocky, otherwise non-seedable
2 - Seedable only with difficulty
3 - Seedable with no major problems

COVER CLASS (SOIL)

1 - 0 to 5%
2 - 6 to 20%
3 - 21 to 50%
4 - 51 to 85%
5 - 86 to 100%

IMPROVEMENT POTENTIAL

1 - Could increase production 1½ to 2 X
2 - Could increase production 2 to 5 X
3 - Could increase production 5 to 10 X
4 - Could increase production 10 X or more

IMPROVEMENT METHOD

1 - Grazing management only
2 - Shrub control (chemical)
3 - Shrub control (mechanical)
4 - Shrub control and seed
5 - Plow and/or pit and seed

SLOPE CLASS

1 - 0 to 5%
2 - 6 to 15%
3 - 16 to 30%
4 - 31 to 45%
5 - 46 to 60%

CONDITION CLASSES

1 - Poor - few or no desirable species (0 to 25% of potential)
2 - Fair - few desirable perennials (producing 25 to 50% of potential)
3 - Good - at least ½ of vegetation desirable perennials (producing 50 to 75% of potential)
4 - Excellent - mostly desirable perennials (producing in excess of 75% of potential)

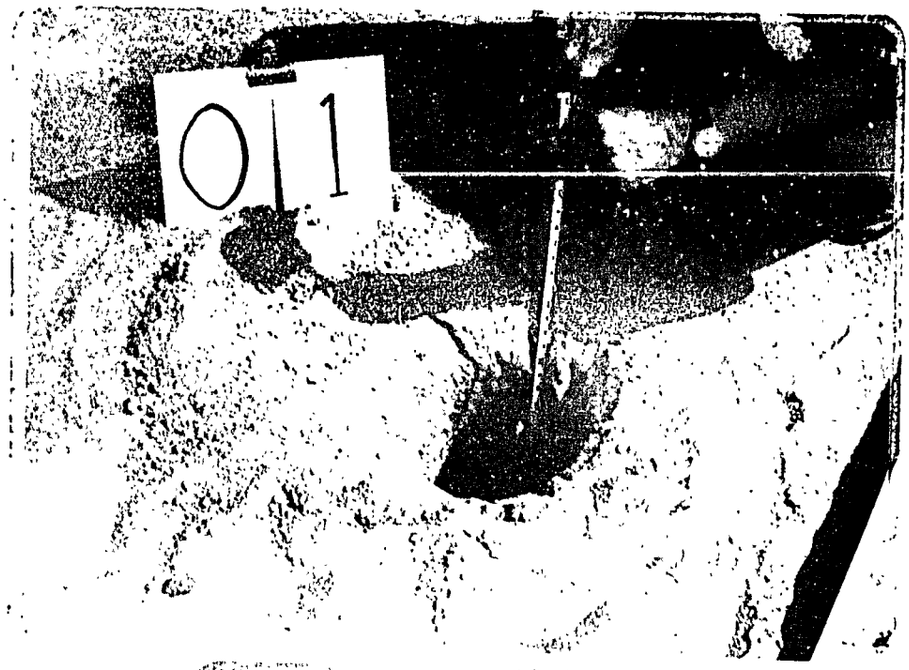
PROMINENCE RATING

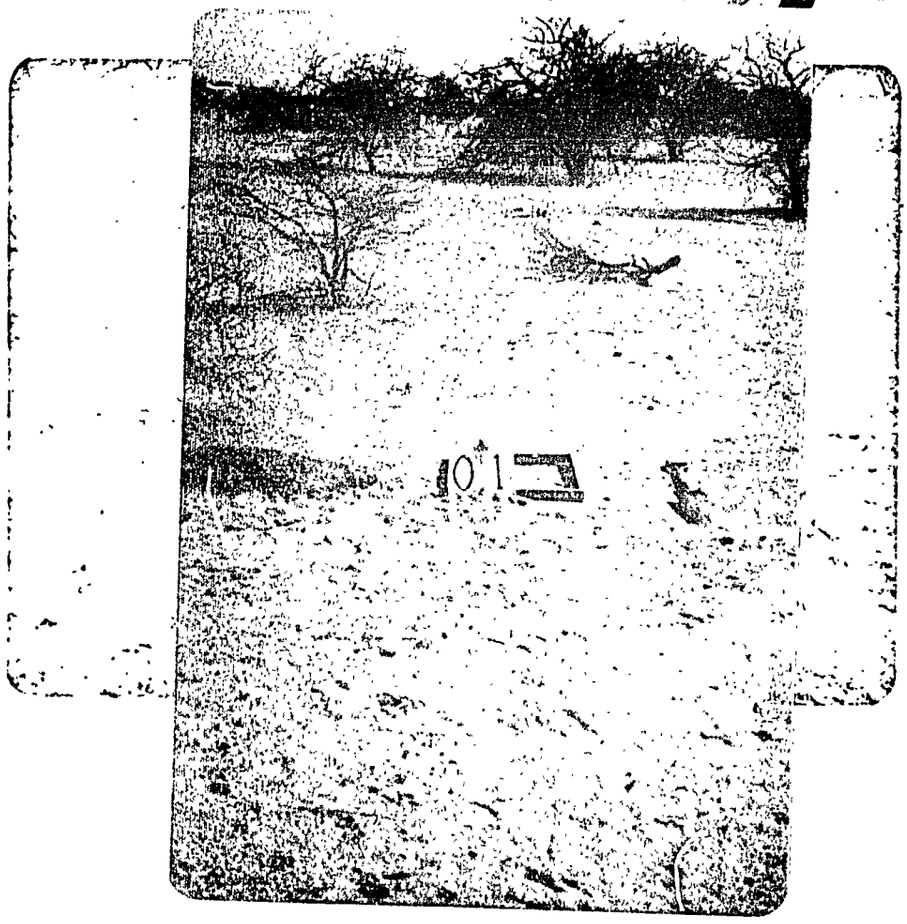
1 - Characterizes community
2 - Always very evident
3 - Usually evident
4 - Not easily seen
5 - Difficult to find

SOIL DEPTH

This should be measured to a point where it becomes difficult to dig; or to where there is a change in the soil profile between horizons.

Site number one





DATE 6/14/76

EVALUATOR Wheeler, LeVivess, Gerhart, Young

Write-up No. 01
Soil Depth 30"+
Soil Texture 5 (small amounts of Cl
Soil Class 3

Current Production 0 Lbs./A.
Condition Class 1
Slope Class 1
Cover Class 1 Soil

Improvement Potential
Rating 4
Improvement Method 1 + 5

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	15	30	50	70	90
Grasses								
Annuals	1	5						✓
Shrubs								
Acacias Sp	1	1			✓			
Ceanothus	1	1					✓	
Forbs								

PRODUCTION - 6 locations

	1	2	3	4	5	6
Erosion accelerated - Sheet + Gully	0	0	0	0	0	0

Site number two

DATE 6/14/76

EVALUATOR Wheeler LeVivess
Gerhart Young

Current Production 0 Lbs./A.
Condition Class 1
Slope Class 1
Cover Class 1 Soil

Write-up No. 02
Soil Depth 30"+
Soil Texture 5 (6% clay Barika)
Soil Class 3

Improvement Potential Rating 4
Improvement Method 1 + 5

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	1	4						✓
Geen	1	4						✓
Shrubs								
Acra	1	1					✓	
Acse	1	3					✓	
Base	1	3					✓	
Cona	1	1				✓		
Forbs								
Cacb								

This site represents a large homogeneous area near Eyde. Sandy soil has small amount of clay that ~~[illegible]~~ in small degree binds the sand particles together - Erosion rate is High

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number three

DATE 6/14/76

EVALUATOR Wheeler, LeVinness Gerhart, Young

Current Production 0 Lbs./A

Condition Class 1

Slope Class 1

Cover Class 1 Soil

Annual Production 600 lbs./Acre

Writeup No. 03

Soil Depth 30"+

Soil Texture 5

Soil Class 3

Improvement Potential Rating 4

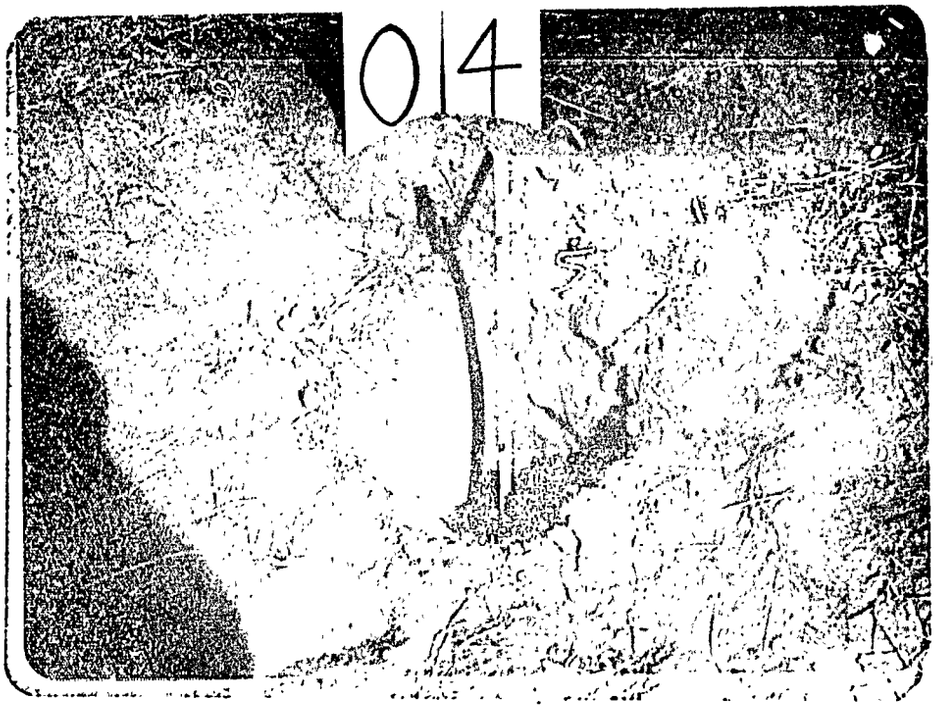
Improvement Method 1 & 5

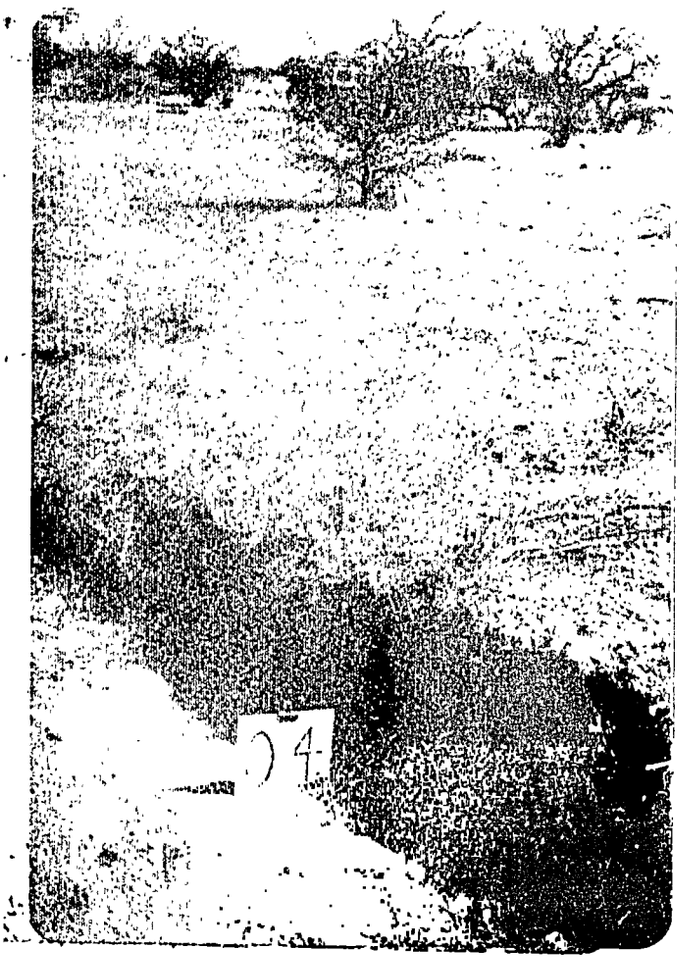
SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	3	1				✓		
Ceca	1	4						✓
Shrubs								
Boscia Bose	2	1			✓			
Cerc	1	3			✓			
Forbs								

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number four





DATE 6/15/76

EVALUATOR Wheeler - LeViness
Gerhart - Young

Current Production 0 Lbs./A.
Condition Class 1
Slope Class 2
Cover Class 2 Soil

Write-up No. 04
Soil Depth 8"+
Soil Texture 5
Soil Class 3

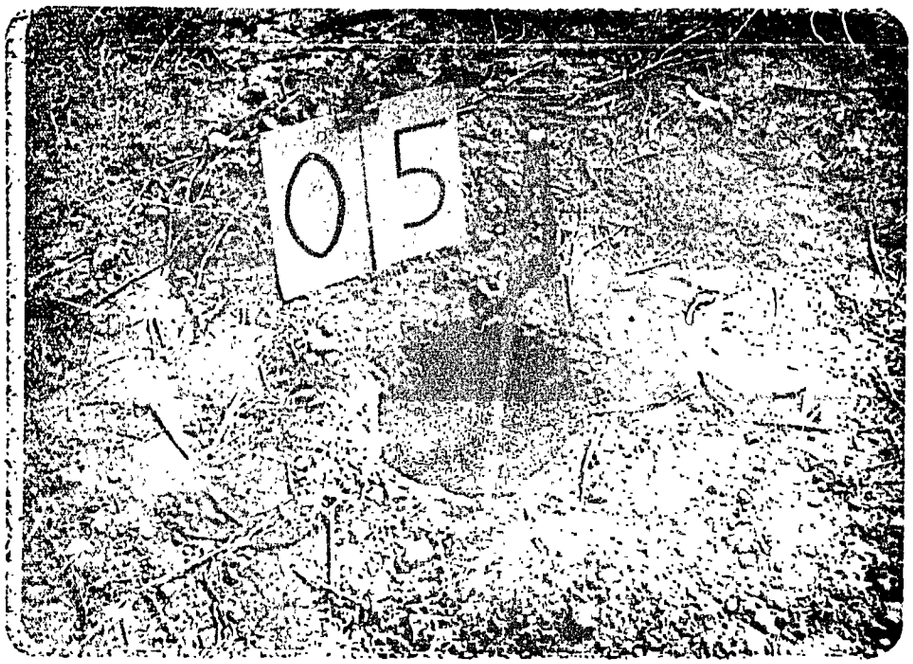
Improvement Potential
Rating 4
Improvement Method 1 + 5

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Avenuel	2	1						✓
Shrubs								
Cammiphora aquicanum	2	1			✓			
Acacia nig }	1	3			✓			
" sp. }								
Boscia sp.	1	3						✓
Forbs								
All production is from Avenuels - High potential site - Reseeding potential good								
Small amount of clay in sandy soil.								

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number five



DATE 6/15/76

EVALUATOR Wheeler, LeVivess Gerhart Young

Current Production 0 Lbs./A

Condition Class 1

Slope Class 1

Cover Class 3 Soil

Write-up No. 05

Soil Depth [illegible]

Soil Texture 2 Silty Clay Loam

Soil Class [illegible]

Improvement Potential Rating 4

Improvement Method 1, 2, 5

Annual Production 740 lbs./acre

SPECIES	COVER CLASS	PROD. Rtg	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annual	2	3						✓
Shrubs								
Acacia Spp.	3	1				✓		
Acacia Sp.	1	2				✓		
Bose	2	2						✓
Coaf	1	3					✓	
Forbs								

Bottom Land - overflow site

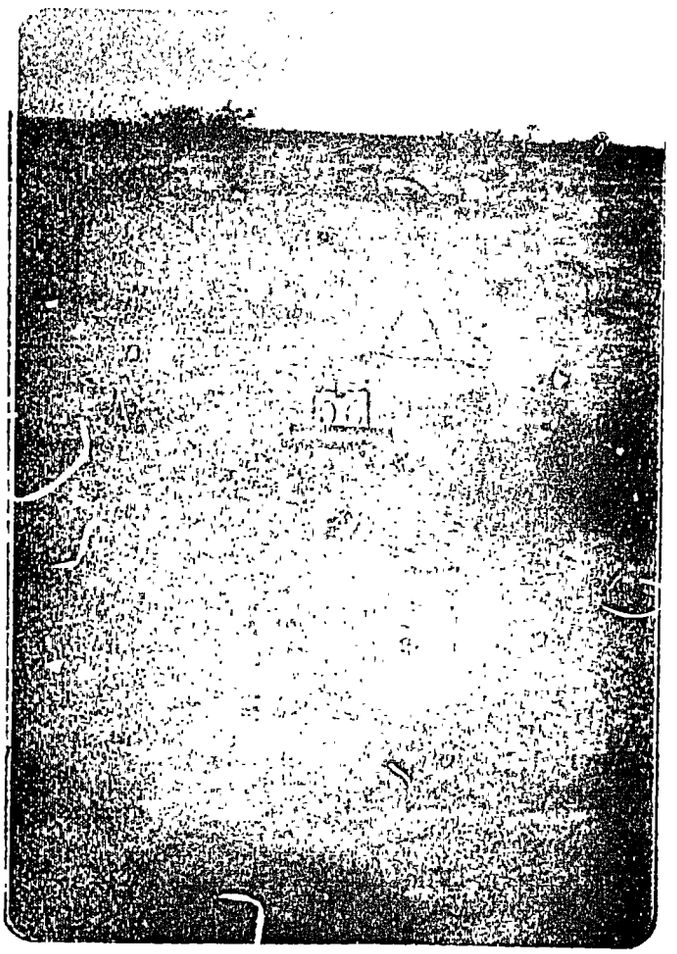
accelerated gully erosion

Trees dying out - grazing + drought

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number six



DATE 6/15/76

EVALUATOR Wheeler, Le Viness
Gerhart, Young

Current Production 0 lbs./A.
Condition Class 1
Slope Class 2
Cover Class 2 Soil

Write-up No. 06
Soil Depth 18" +
Soil Texture 5
Soil Class 3

Improvement Potential
Rating 4
Improvement Method 1 + 5

Annual Production 76#/acre

SPECIES	COVER CLASS	PROD. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	3	1				✓		
Shrubs								
Acacia RR	1	1						
Cor SF	1	2						
Forbs								

These sandy sites are all similar except for amount of grazing pressure on annual grasses

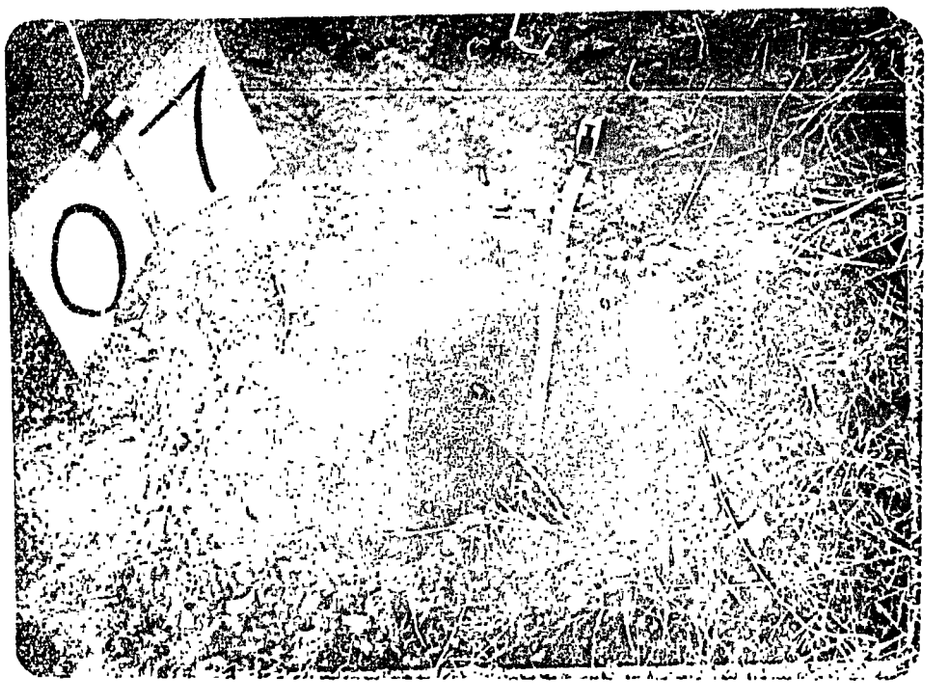
Trees have damaged or killed from excessive hedging

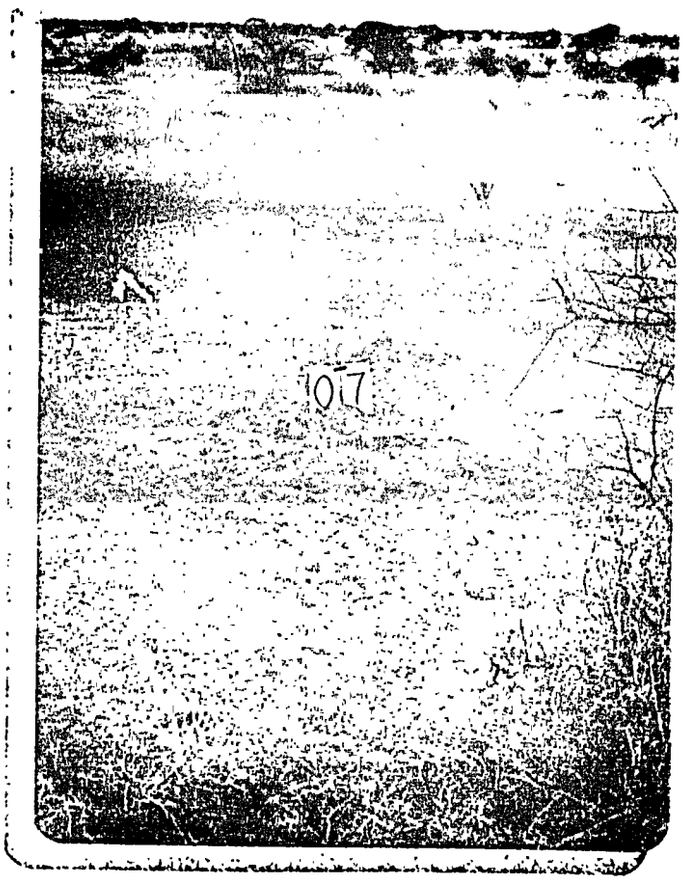
Wind & Water erosion is very active.

PRODUCTION - 6 locations

1	2	3	4	5	6
100	60	100	60	80	60

Site number seven





DATE 6/16/76

EVALUATOR Wheeler - Le Viness
Gerhart - Young

Current Production 40 Lbs./A
Condition Class 1
Slope Class 2
Cover Class 1 Soil

Write-up No. 07
Soil Depth 18"+
Soil Texture 5 + 3
Soil Class 3

Improvement Potential
Rating 4
Improvement Method 1 + 5

Annual Production 300#/acre

SPECIES	COVER CLASS	PROD. REG.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	3	1					✓	
Ce ca	1	3					✓	
Aristida	1	3					✓	
Shrubs								
Capr	1	2					✓	
Coaf	1	3				✓		
Bapa	1	3				✓		
Acacia ba	1	2			✓			
Forbs								
Croton								✓
Convolvulaceae	1	4	✓					

Same as most upland sites except annuals haven't been grazed as hard - Typical of south of Godembo Well

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number eight

DATE 6/16/76

EVALUATOR Wheeler - LeVineiss
Gerhart - Young

Current Production 200 Lbs./A.
Condition Class 2
Slope Class 2
Cover Class 4 Soil

Write-up No. 08
Soil Depth 12"+
Soil Texture 5
Soil Class 3

Improvement Potential Rating 4
Improvement Method 1 & 5

Annual Production 1600# to 2000#/acre

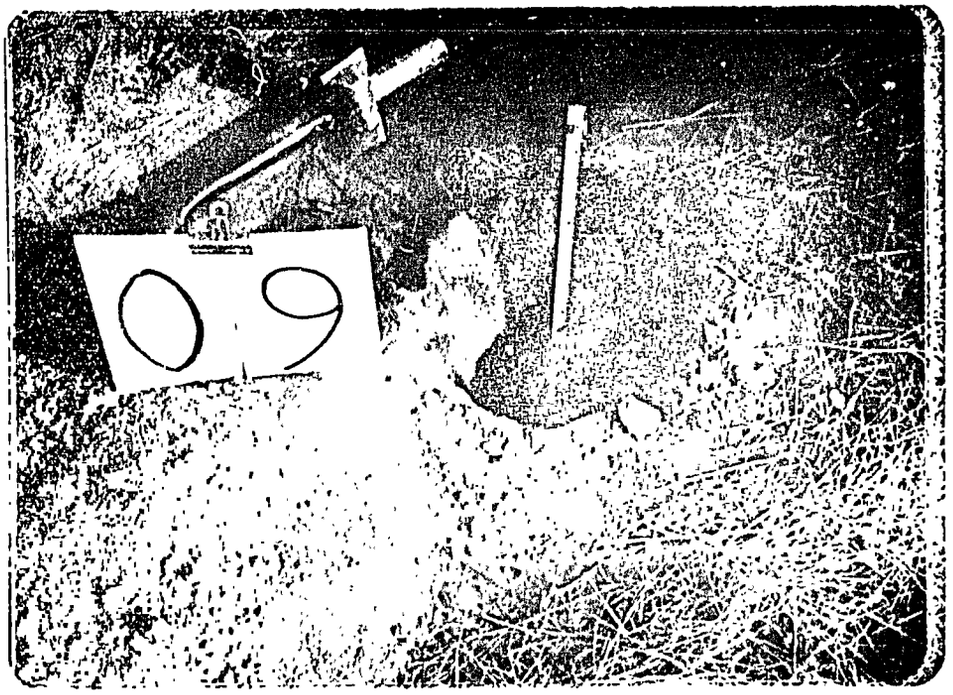
SPECIES	COVER CLASS	PROM. Rtg	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	3	1		✓				
Cesa	2	1		✓				
Aristida	1	2		✓				
Shrubs								
Coof	1	2		✓				
Bose	1	2		✓				
Bame	1	2			✓			
Acacia Spp	1	2		✓				
Forbs								
Pobi	1	2		✓				
Gusp	1	3	✓					

Same as most smudge sites except very little current grazing pressure on annuals - This area readily demonstrates site potential

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number nine



DATE 6/22/76

EVALUATOR Wheeler - Le Vivess
Gerhart - Young

Current Production 0 Lbs./A.
Condition Class 1
Slope Class 2
Cover Class 2 Soil

Write-up No. 09
Soil Depth 20" +
Soil Texture 5
Soil Class 3

Improvement Potential
Rating 4
Improvement Method 1 + 5

Annual Production 300# +

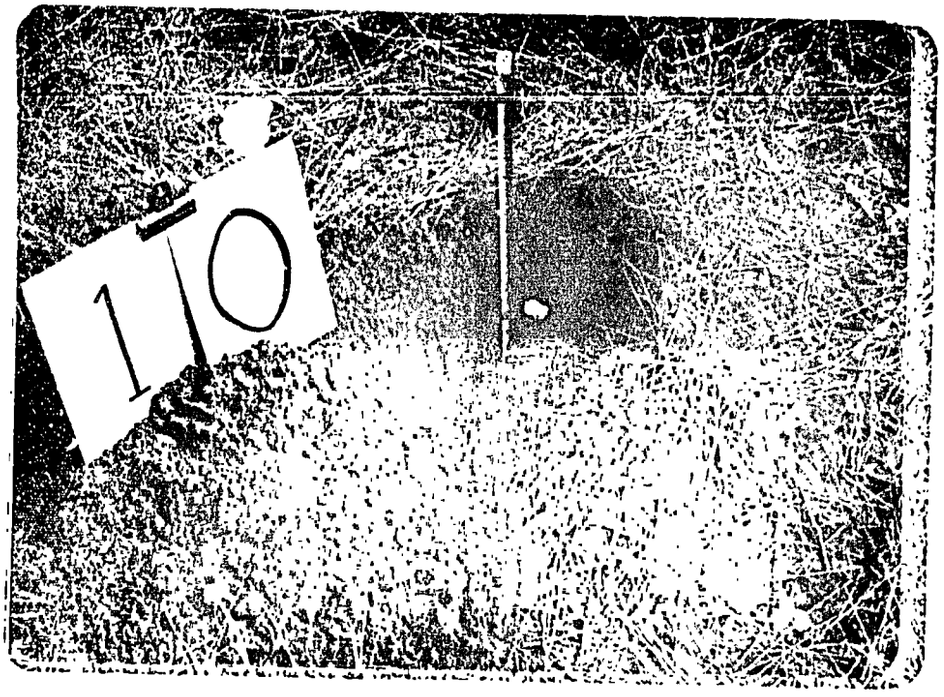
SPECIES	COVER CLASS	PROD. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	3	1						✓
Cr. ca	1	5						✓
Aristida	1	5						✓
Andropogon ?	1	5						✓
Shrubs								
Bare	1	1				✓		
Pobi	1	1						✓
Forbs								
Amaranthus viridis ?								
Cnob								

A very sandy soil - just North of Birmen Mission is typical of most sandy sites lots of annual growth - Good potential

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number ten



DATE 6/22/76

EVALUATOR Wheeler - LeVivess
Gerhart - Young

Current Production 20 Lbs./A.
Condition Class 1
Slope Class 2
Cover Class 2 Soil

Write-up No. 10
Soil Depth 20" +
Soil Texture 6
Soil Class 3

Improvement Potential Rating 4
Improvement Method 1 + 5

Annual Production 1600 #/acre

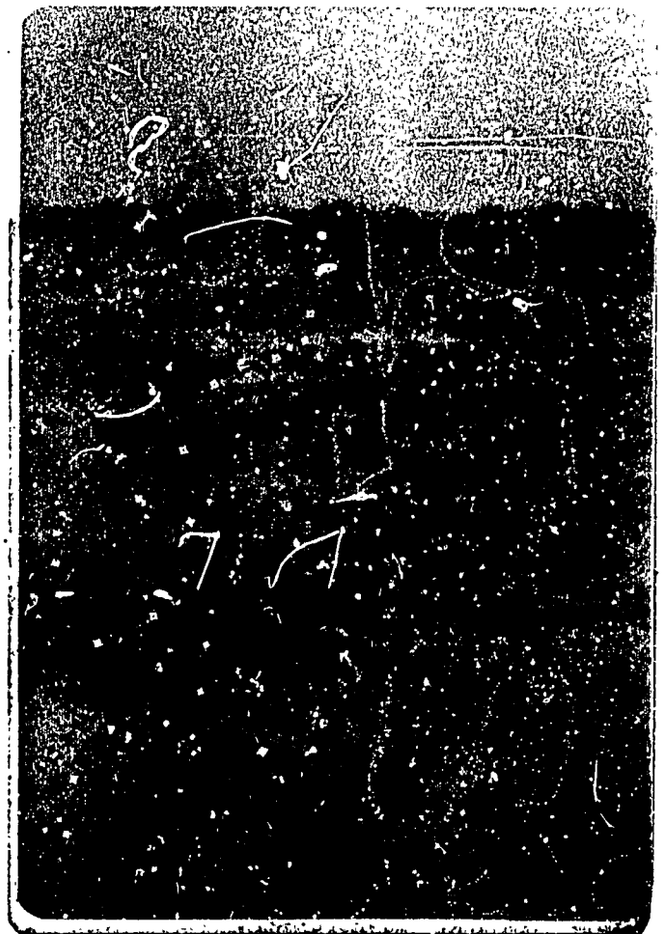
SPECIES	COVER CLASS	PROD. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	4	1			✓			
Aristidias	1	3		✓				
Cecn	1	3					✓	
Shrubs								
Bess	1	1			✓			
CapR	1	4		✓				
Ceanothus?	1	3					✓	
Cobf	1	2					✓	
Pobi	1	1					✓	
Forbs								
Gusc	1	3	✓					
Cach								

Picture #10 shows dead trees
Moisture was down 16"
High annual grass density -
A few perennials - show potential
of this site

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number twelve



DATE 6/22

EVALUATOR Wheeler -- Le Viness
Gerhart - Young

Current Production 15 Lbs./A.
Condition Class 1
Slope Class 2
Cover Class 2 Soil

Write-up No. 12
Soil Depth 20" +
Soil Texture 5 (Fine sandy clay)
Soil Class 3

Improvement Potential Rating 4
Improvement Method 1 + 5

Annual Production 500 lbs/acre

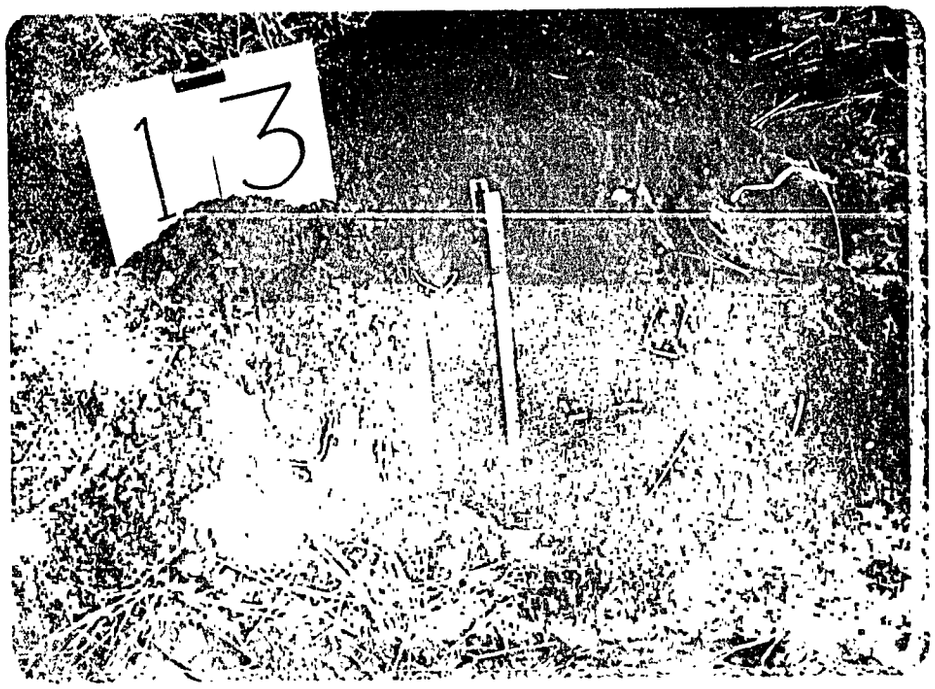
SPECIES	COVER CLASS	PROD. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	2	1					✓	
Cecr	1	4						
Aristida	1	4						
Shrubs								
Bace	1	1				✓		
CAPR	1	1				✓		
Ceanothus	1	3				✓	✓	
Pobi	1	2					✓	
Guse	1	3		✓				
~~Capf~~ **Forbs**	~~1~~	~~1~~					✓	
Coaf	1	1					✓	
Atriplex spp. ?	1	4			✓			

Basically same site as 10
Shows excessive grazing
Accelerated sheet + gully erosion

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number thirteen



DATE 6/23/76

EVALUATOR Wheeler Le Vineess
Gerhart Young

Current Production ~~20~~ 5 Lbs./A.
Condition Class 1
Slope Class 1
Cover Class ~~1~~ Soil

Write-up No. 13
Soil Depth 36" +
Soil Texture 5
Soil Class 3

Improvement Potential
Rating 4
Improvement Method 1 & 5

Annual Production (200#/acre)

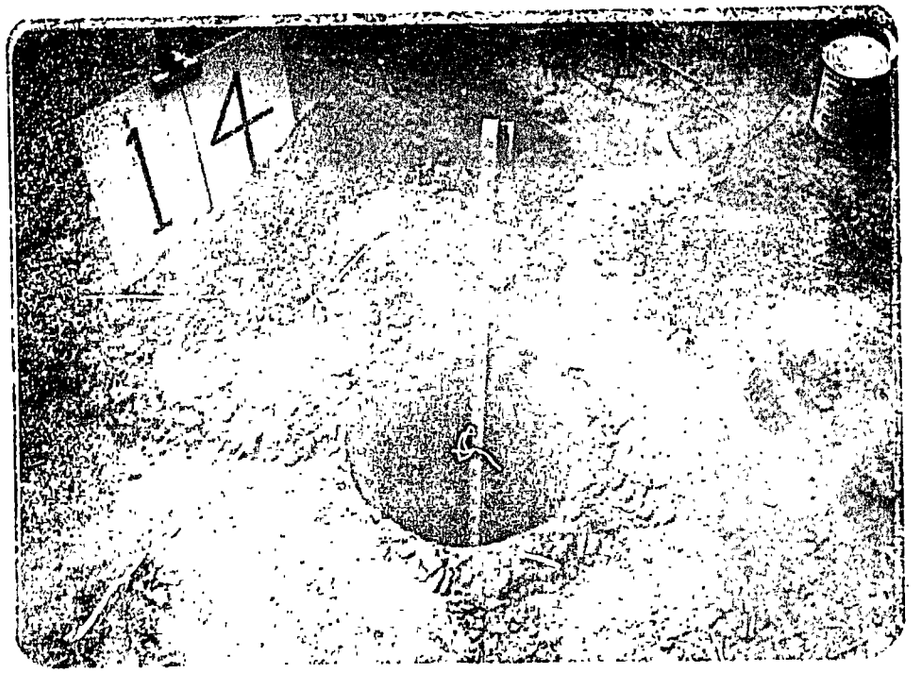
SPECIES	COVER CLASS	PROD. RTG.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Ceca	1	3					✓	
Annuals/s	3	1				✓		
Shrubs								
Ceof	1	1		✓				
Bose	1	1		✓				
Pobi	1	1		✓				
Forbs								

Sheet erosion excessive -
Soil Moisture to 36"

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number fourteen



DATE 6/23/76

EVALUATOR Wheeler - LeVivess
Gerhart - Young

Current Production 0 Lbs./A

Condition Class 1

Slope Class 1

Cover Class 4 Soil

Write-up No. 14

Soil Depth 25" +

Soil Texture Silty clay 3" - Sandy silt

Soil Class 4 Clay 3

Improvement Potential Rating 4

Improvement Method 1 - 3 - 5

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annual	1	3						✓
Shrubs								
Bace	2	1				✓		
Cang	2	1				✓		
Acacia Spp.	2	1			✓			
Forbs								

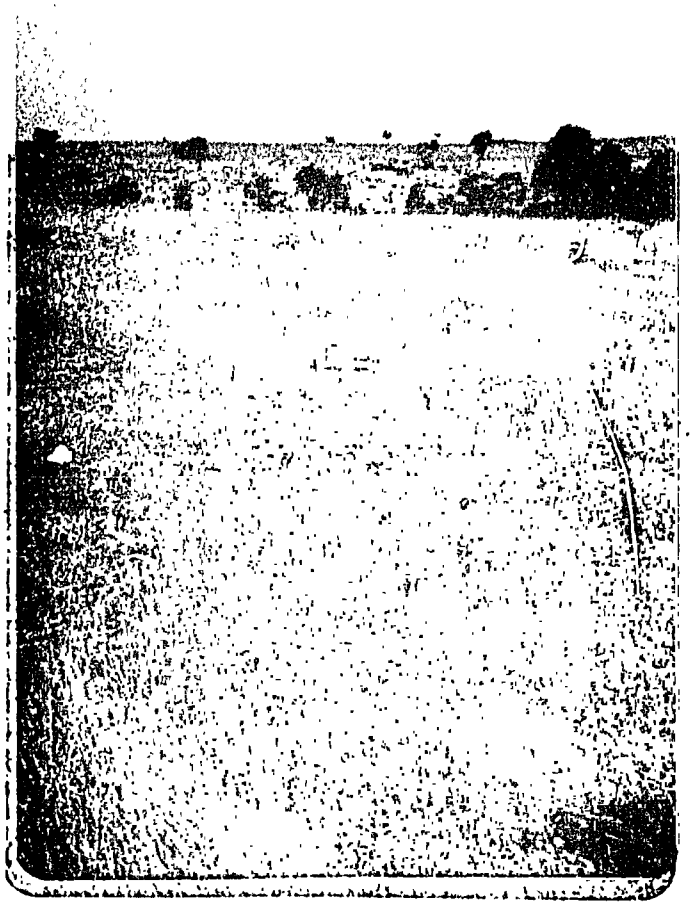
This typical overflow or Wildlife site - Silty layer over sandy or sandy clay underlain with clay

These areas show potential as charco sites

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number fifteen



DATE 6/24/76

EVALUATOR Wheeler - LeVivess
Gerhart - Young

Current Production 10 Lbs./A

Condition Class 1

Slope Class 2

Cover Class 1 Soil

Write-up No. 15
Soil Depth 2 c" +
Soil Texture 5
Soil Class 3

Improvement Potential Rating 4

Improvement Method 1 + 5

Annual Production 1200#/acre

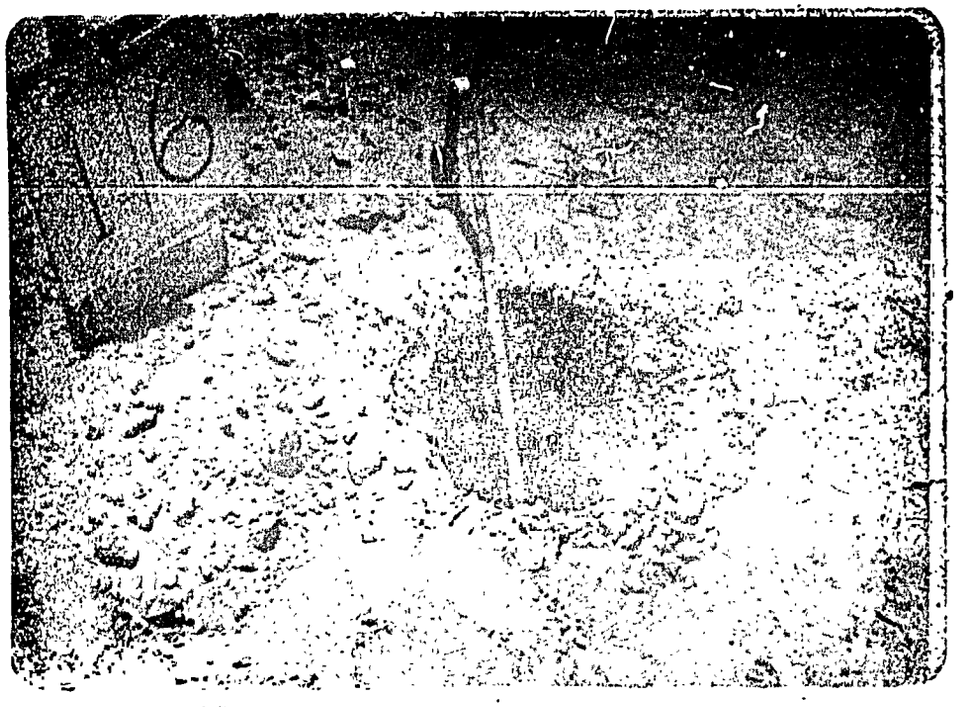
SPECIES	COVER CLASS	PROM. REG.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annual	4	1			✓			
Ceca	1	4			✓			
Aristida	1	5		✓				
Andropogon?	1	5			✓			
Shrubs								
Pebi	1	3			✓			
Bose	1	3			✓			
Bare	1	3						
Cang	1	3						
Forbs								

This site same as other Sandy site except shows little grazing this past year. Gives indication of potential as shown by the picture

PRODUCTION - 6 locations

1	2	3	4	5	6

Site number sixteen



DATE 6/29/76
EVALUATOR Wheeler - LeVivess
Gerhart - Young
Current Production 0 Lbs./A
Condition Class 1
Slope Class 1
Cover Class 1 Soil

Watershed No. 16
Soil Depth 20" +
Soil Texture 3
Soil Class 3

Improvement Potential
Rating 4
Improvement Method 1 - 3 - 5

SPECIES	COVER CLASS	PROM. REP.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Annuals	1	3						✓
Cecn	1	5						✓
Shrubs								
Acra	1	4		✓				
Crag	2	1			✓			
Bose	1	1			✓			
Eubu	1	1	✓					
Capa **Forbs**	2	2	✓					
Bame	2	2		✓				
Mucn	2	2		✓				
Similar to North & East of								
Eagle								

PRODUCTION - 6 locations

1	2	3	4	5	6

DATE 7/1/76

EVALUATOR Wheeler - LeVinness
Gerhart - Young

Current Production 30 Lbs./A
Condition Class 1
Slope Clas. 2
Cover Class 1 Soil

Write-up No. 17
Soil Depth 21+
Soil Texture 5
Soil Class 3

Improvement Potential Rating 4
Improvement Method 1 + 3

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90
Grasses								
Cecra	1	3						✓
Aristida	1	3						✓
Annuals	4	1					✓	
Shrubs								
~~Ceanothus? Unknown.~~	1	2					✓	
Cano	1	1						✓
Buse	1	1						✓
Acra	1	2			✓			
Bane **Forbs**	1	2				✓		
Euba	1	1						✓

PRODUCTION - 6 locations

1	2	3	4	5	6

Same Sandy site - Located East of Tolamanueca

Photo is on Ed's Camera

DATE 6-24-76

EVALUATOR WJ Tow EL

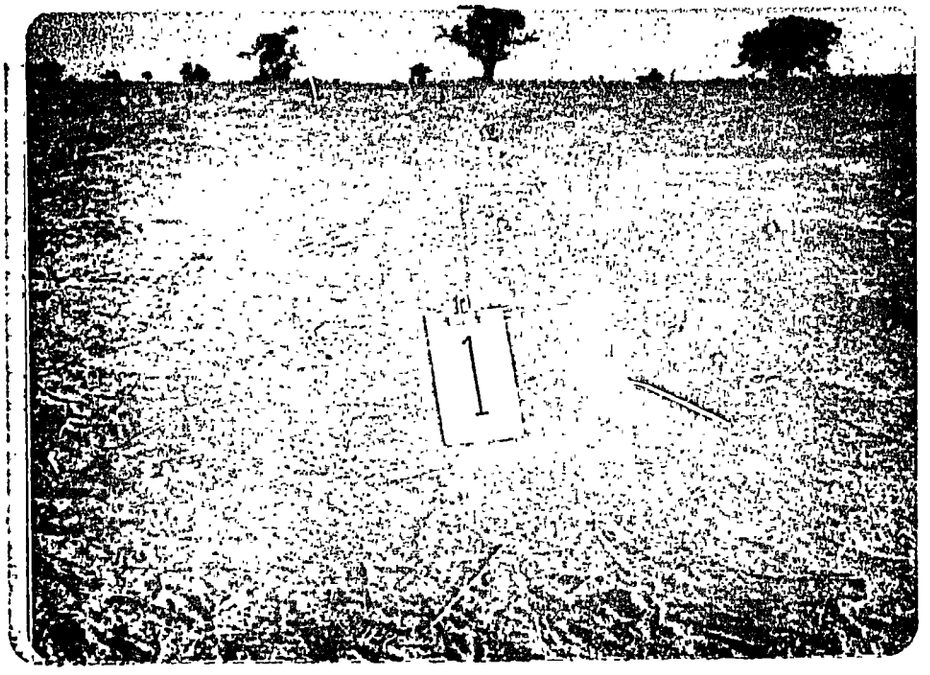
Writeup No. SS 1
Soil Depth 24" +
Soil Texture Sandy
Soil Class 3

Current Production _____ Lbs./A
Condition Class _____
Slope Class _____
Cover Class _____ Soil

Improvement Potential Rating _____
Improvement Method _____

Soil Sample only

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90



DATE 6-29-76

EVALUATOR NDB, Tolo, EL

Writeup No. SS 2
Soil Depth 15 cm
Soil Texture Sandy Clay
Soil Class 3

Current Production _____ Lbs./A
Condition Class _____
Slope Class _____
Cover Class _____ Soil

Improvement Potential Rating _____
Improvement Method _____

Soil Sample only

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90

DATE 6-29-76

EVALUATOR DAY, TOW, EL

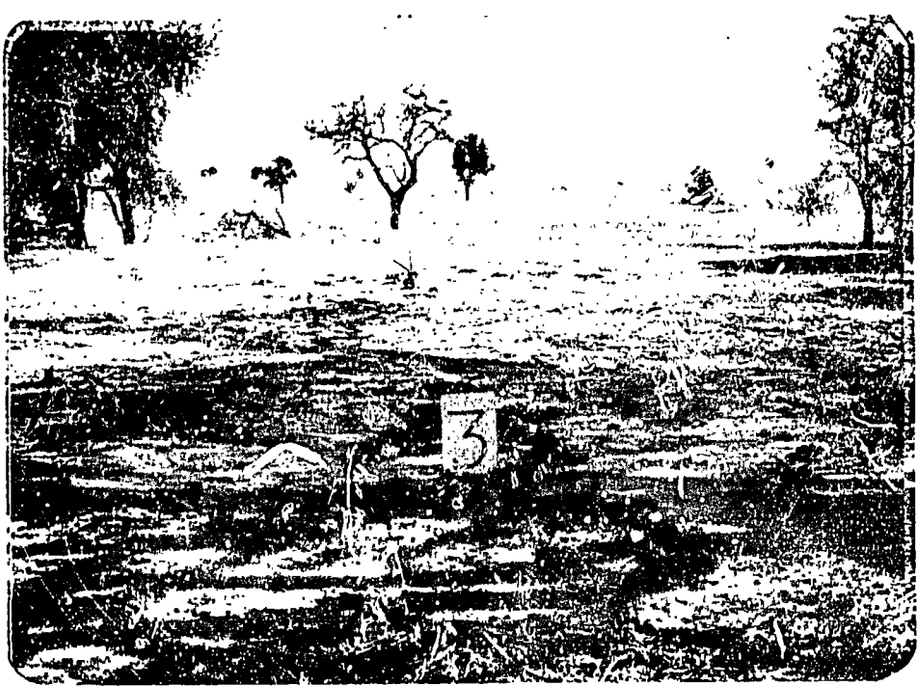
Writeup No. SS3
Soil Depth 15cm 60cm
Soil Texture Silty Clay
Soil Class 3

Current Production _____ Lbs./A
Condition Class _____
Slope Class _____
Cover Class _____ Soil

Improvement Potential Rating _____
Improvement Method _____

Soil Sample only Bottomland Position -

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90



DATE 6-24-76

EVALUATOR DDA Jay, EL

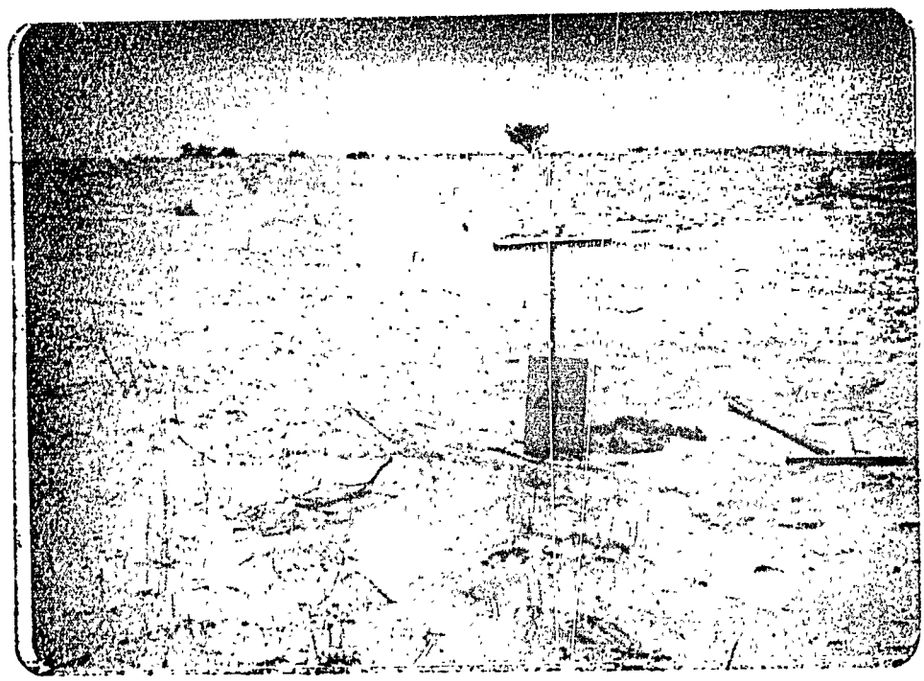
Writeup No. SS 4
Soil Depth [illegible]
Soil Texture Dirty Sand
Soil Class 2

Current Production _____ Lbs./A
Condition Class _____
Slope Class _____
Cover Class _____ Soil

Improvement Potential Rating _____
Improvement Method _____

Soil Sample only Blowout Area Very Sandy.

SPECIES	COVER CLASS	PROM. Rtg.	UTILIZATION CLASS 0	10	30	50	70	90



DATE 6-15-76

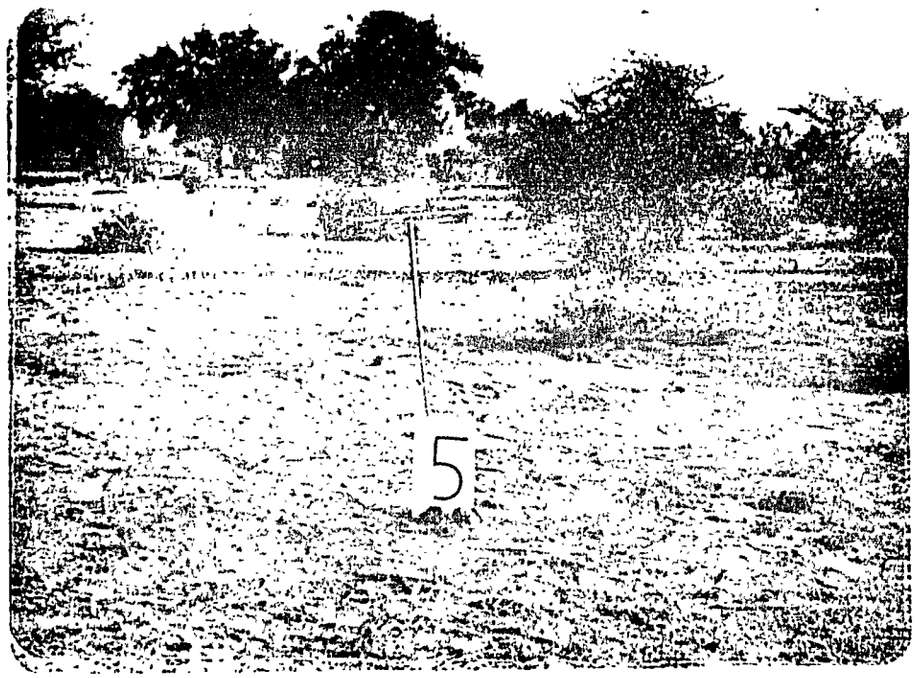
EVALUATOR SDH, TOW, EL

Writeup No. SS5
Soil Depth Deep 60 cm
Soil Texture Sandy Clay
Soil Class 3

Current Production _____ Lbs./A
Condition Class _____
Slope Class _____
Cover Class _____ Soil

Improvement Potential Rating _____
Improvement Method _____

Soil Sample only -



DATE 6-15-76

EVALUATOR SDG, Tow, EL

Writeup No. SS 8
Soil Depth 60 cm.
Soil Texture Sandy with Clay
Soil Class 3

Current Production _____ Lbs./A
Condition Class _____
Slope Class _____
Cover Class _____ Soil

Improvement Potential Rating _____
Improvement Method _____

Area Producing Fair Amount Browse Soil Sample Only.

DATE 6-15-76

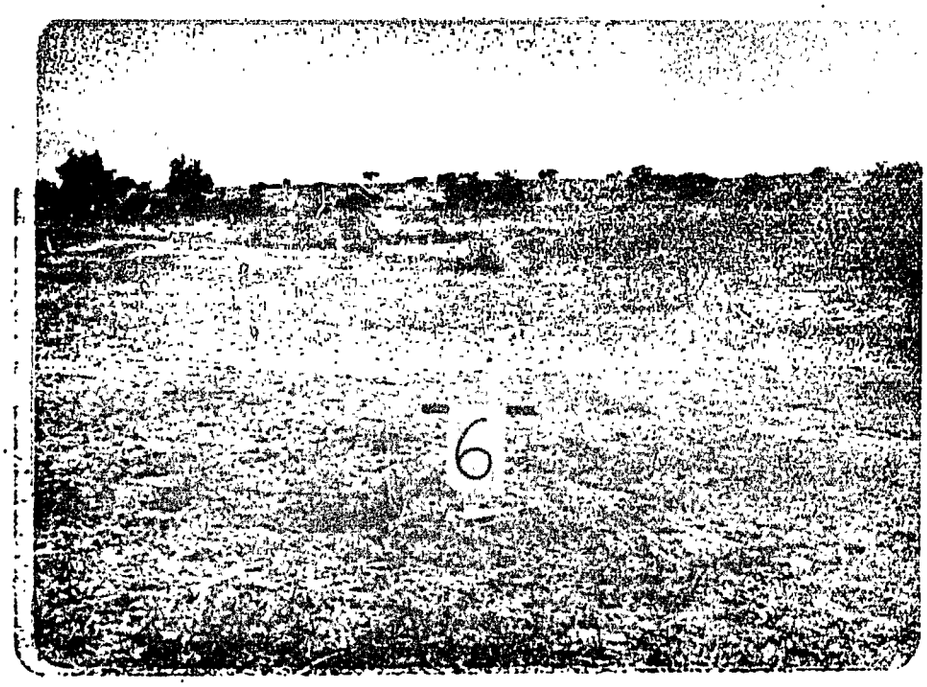
EVALUATOR NPS, Tom, EL

Writeup No. SS6
Soil Depth 15cm 60cm
Soil Texture Sandy
Soil Class 35

Current Production _____ Lbs./A
Condition Class _____
Slope Class _____
Cover Class _____ Soil

Improvement Potential Rating _____
Improvement Method _____

Soil Sample only



DATE 2-15-76

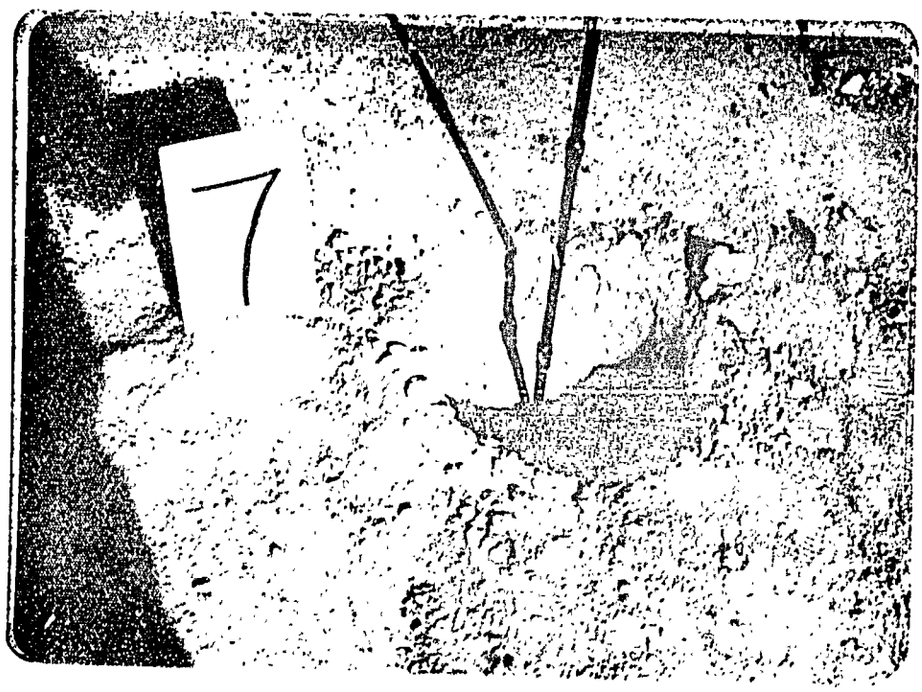
EVALUATOR DNR, TOW, FL

Writeup No. SS-7
Soil Depth 45 cm
Soil Texture Clay
Soil Class 2

Current Production _____ Lbs./A
Condition Class _____
Slope Class _____
Cover Class _____ Soil

Improvement Potential Rating _____
Improvement Method _____

Soil From Well Bottom & Profile



APPENDIX II

WATER RESOURCES

	Page
Water Development and Water Harvesting Options	1 - 8
Legend for water point overlays	9 - 10
List of observed water points	11 - 20

WATER DEVELOPMENT AND WATER HARVESTING OPTIONS FOR ARID AND SEMI-ARID REGIONS OF THE WORLD

Low Cost Pumping (Windmills)

Following well development, there exists the opportunity of installing inexpensive pumping equipment (windmills) for many areas of the world. The choice of the pumping methodology will be correlated closely with the volumes of water that must be raised to fulfill the needs of the specific installation.

A. Where the intended use of the well is for irrigation, then the wells must be deep, of a large diameter, and fitted with high volume pumps in order to pump out a large volume of water to meet the irrigated crop requirements. The same high volume pumping requirements are necessary when the use of the wells is to supply large domestic water systems.

B. However, when the need is for minimal water supplies such as for livestock and limited domestic use (several families -vs- cities); windmills can fulfill the pumping needs at a relatively low cost and with a minimum of maintenance.

In selection of windmills, there is an economical limit to the size of the windmill wheel. Pumping depth and volume pumped is directly proportionate to the size of the windmill wheel. To pump deeper depths, it is necessary to have a larger mill. Also to pump from deep depths (500 feet to 1,000 feet) the size of the pump cylinder must be less, hence pumping capacity is dramatically reduced.

Windmill installations of necessity require considerable storage capacity at the site. This is necessary to take advantage of low pumping capacity for deeper wells, plus it is essential to have storage for those periods of time when the wind velocity is inadequate to pump at a rate equal to water consumption. See Figures 1, 2 and 3.

Explanation of Ferrocement Construction Procedures

Ferrocement is a highly versatile form of reinforced concrete made of wire mesh, sand, water and cement, which possesses unique qualities of strength and serviceability. It can be constructed with a minimum of skilled labor and utilizes readily available materials. The system has been proven suitable for a variety of applications in agriculture, industry and housing.

Ferrocement is particularly suited to Niger for the following reasons:

1. The basic raw materials (sand) are available in ready supply.

2. The Ferrocement process can be fabricated into almost any shape to meet the user's needs. Properly fabricated, the processes are more durable than wood and much cheaper than imported steel construction.

3. The skills for Ferrocement construction can be quickly acquired and include many traditional skills already familiar with the people of Niger. Ferrocement construction does not need a complement of heavy machinery; it is labor intensive. A trained supervisor can achieve quality construction techniques with unskilled labor in a short period of time.

Following the construction of the windmill and the water storage tank, a system of distribution from the water storage tank to the actual point of us is essential.

Low cost, easily installed PVC plastic pipe should be used to convey the water from the storage tank to the drinking system.

Figures 4 and 5 show Ferrocement constructed water boxes with float control water valves. Float controlled valves are as dependable a system that there is designed. This process uses water upon demand only and keeps a constant level of water in the drinker for livestock use.

Windmills must be installed by skilled workmen. It is critical that all moving parts are properly adjusted and that the vertical and horizontal axes are accurately aligned when the tower and windmill are installed.

Wind velocity is reduced and less uniform near the ground, consequently the tower must be high enough to elevate the windmill wheel above any nearby obstructions such as buildings, hills, trees etc.

After proper installation, long life is assured by minimal basic maintenance which includes proper lubrication of all moving parts and periodic tightening of all tower bolts etc.

With the introduction of windmills into new arid land regions of the world, it is important to provide a basic spare parts inventory of critical parts to assure proper functioning for an extended period of time. Hence, in any proposal that lists the complete windmill, essential component parts and tools should also be listed. It is important to realize that wells set up and well pulling tools, plus the plumbing tools, need not be included with each complete windmill installation. As these tools can be used by the windmill setup crew for innumerable windmill installations. The same tools would then be used by the maintenance crews thereafter.

It should also be realized that the proportionate cost of windmill installations are relative to the depth of the static water level of the well and the quantities of well casing, column pipe and sucker rod necessary to pump the water to the surface.

Following is a listing of a complete windmill with component spare parts including well set up and well pulling tools, and plumbing tools for an installation that will lift approximately 5 gallons per minute, 200 feet to an on-site storage tank.

Itemized List of a 14' Aermotor Windmill Complete with Component Spare Parts and Well Setup and Well Pulling Tools Etc.

Units	Item	Cost
1	Model 702-14 Foot Aermotor Windmill complete	$3,462.00
1	33 Foot Tower (wide spread) EDP 02033	1,806.00
2	2-inch Deep Well Cylinders @ 93.60 ea.	187.20
1	2-inch Stainless Steel Strainer	120.00
320 ft.	2-inch Standard Column Pipe @ 1.74 per ft.	556.80
250 ft.	6-inch Screw Joint Wellcasing @ 9.60 per ft.	2,400.00
16	(16 lengths 5-8") Sucker Rod with couplings @ 141.90 ea.	2,270.40
10	Extra 5/8" Sucker Rod Couplings @ 2.40 ea.	24.00

Units	Item	Cost
1	Stuffing Box and Packing	$ 90.00
2	Boxes Extra Tower Bolts @ 34.80 ea.	69.60
1	Set (4 ea.) Anchor Bolts @ 42.00 ea.	168.00
1	55-gallon drum Windmill Oil	165.60
1	Large Gear and Pin Assembly	453.60
4	2-inch Unions @ 5.34 ea.	21.36
6	2-inch Tees @ 4.80 ea.	28.80
6	2-inch Ells @ 3.36 ea.	20.16
6	2-inch x 6-inch Nipples @ 3.36 ea.	20.16
2	2-inch Gate Valves @ 11.82 ea.	23.64
1	Complete Set of Well Pulling Tools - cables, slips, clamps etc.	540.00
1	Set Pipe Tools, Threaders, Wrenches etc.	1,440.00
	TOTALS	$13,867.32
	10% Export Preparation (including crating) -	1,386.73
	Inland Freight - from Dealer Warehouse to Charleston, S.C. -	2,225.00
	GRAND TOTAL SELL PRICE COMPLETE CHARLESTON, SOUTH CAROLINA -	$17,479.05

PERSONNEL REQUIREMENTS FOR DEMONSTRATION INSTALLATION, ERECTION, AND FABRICATION OF THE AERMOTOR WINDMILL AND THE WATER STORAGE TANK

In order to properly introduce the windmill plus storage concept into an area where it is totally new---requires the utilization of skilled workmen to install the initial unit so that its proper operation is assured.

3-man Team for 20 days @ $580 per day =	$11,600.00
Per Diem - 3 men for 20 days each @ $50.00 per day =	$ 3,000.00
Total Personnel Cost =	$14,600.00*

* Does not include round trip air fare from the States to host country, nor internal transportation within the host country.

During the installation of the demonstration unit, the windmill crew would train a selected national crew in the process of proper erection, well setup and storage fabrication. The windmill crew would also train the national crew in basic maintenance of an operating windmill.

With the introduction of a number of windmill units into a country, a trained national windmill crew (possibly more than one) would be in a position to assume the role of windmill and storage installation and maintenance. It is reasonable at the initiation of a large project involving a number of machines, to include within the project proposal some supervisory personnel for a limited period of time to assure that the locally trained windmill crew is competent and confident in their new role. Hence, expatriot personnel needs would have to be determined on the basis of individual projects.

LEGEND FOR WATER POINT OVERLAYS

●	Permanent cement well
■	Traditional permanent well
⊘ ⊘	Permanent and traditional well temporarily dry in February
○	Cement well under construction
□	Traditional well under construction
∪	Group of permanent piusards
∪ 12	Group of temporary piusards dry in December
	Permanent marsh
1	Temporary marsh dry in January
	Permanent water source
4	Temporary water source dry in April
	Cased well on free water table
	Cased well on rising water table
	Cased well on artesian water table
-46	Static water level

		Dry or unusable water catchment area
12071		Well registration numbers
12071	A	Well registration number with well capacity designated by Letter (A)
	A	Well capacity to accommodate 1000 hds/day
	B	Well capacity to accommodate several hundred hds/day
	C	Well capacity to accommodate 100-200 hds/day
	D	Well capacity to accommodate few dozen hds/day
	E	Well capacity to accommodate only goats, sheep & domestic use
	F	Water area unusable and of no practical interest

WATER POINTS ADERBISSINAT 16

LIST OF OBSERVED WATER POINTS

Registration Number	Name	Longitude W	Latitude N	State Water Level
	Category B			
991	Tadélaka Sud	7°58'55"	15°30'30"	- 39,90
1346	Toumbélaga Sud	7°50'10"	15°48'40"	- 32,10
7854	Anfénitan	7°56'35"	15°26'30"	- 44,30
8003	Emoulas	7°01'25"	15°08'45"	- 36,15
8011	Bakoba	7°17'30"	15°05'35"	- 28,65
8015	Amazagarni	7°05'30"	15°37'00"	- 77,40
8021	Tadèni	7°26'50"	15°16'40"	- 28,65
8028	Barajé ou Tardé	7°44'40"	15°06'30"	- 34,35
8036	Ténaou ou Bey	7°42'40"	15°51'00"	- 38,00
8575	Lamido	7°16'40"	15°31'55"	- 50,00
8605	Déra	7°25'00"	15°03'20"	- 38,30
8613	Gadambo	7°23'35"	15°17'55"	- 33,00
10657	Assader ou Bengou	7°02'05"	15°23'10"	mare - 6,00
11140	In Tilli	7°20'00"	15°59'30"	- 35,00
	Category C			
990	Echia	7°53'35"	15°38'25"	- 31,40
1345	Gala Dima	7°50'45"	15°58'30"	- 37,00
7852	Takado	7°41'10"	15°15'00"	- 31,25
7853	Egadé	7°30'10"	15°31'50"	- 26,85
7855	Abori	7°29'40"	15°46'40"	- 33,50
7857	Ekaouïl	7°05'10"	15°55'25"	- 31,65
7858	Anou Moulèn	7°43'10"	15°55'10"	- 36,65
7996	Téguénziguit	7°20'20"	15°55'30"	- 43,00?
7997	Bassar	7°16'30"	15°54'20"	- 37,00?
8000	Akèrinjèd Ouest	7°44'30"	15°45'00"	- 29,50
8001	Samarila	7°41'00"	15°47'10"	- 31,00
8002	Antofèrkit	7°38'15"	15°50'40"	- 32,60
8007	Taoua	7°54'10"	15°56'50"	- 32,70
8014	Oli	7°11'55"	15°34'50"	- 57,00
8016	Kouloua	7°19'30"	15°22'50"	- 43,35
8019	Bama	7°06'30"	15°12'50"	- 26,00?
8020	Jola ou Diola	7°25'50"	15°13'35"	- 25,95
8022	Tanko	7°54'20"	15°24'05"	- 38,80
8025	Arhmèd ou Mékamadouli	7°42'05"	15°01'05"	- 33,40
8037	Boulay	7°35'30"	15°52'30"	- 45,00?
8040	Eudour	7°31'40"	15°48'00"	- 33,45
8049	Tari	7°44'50"	15°57'20"	- 45,40?
8057	Gaourarou	7°13'35"	15°01'15"	- 32,90
8066	Akenzigui	7°25'25"	15°55'50"	- 45,00?
8565	Maïkaoua	7°02'35"	15°09'20"	- 32,60
8568	Hamada	7°05'40"	15°15'15"	- 28,40
8569	Bamo	7°05'05"	15°18'30"	- 33,60
8570	Danga	7°06'35"	15°19'55"	- 38,15

Category C (cont.)

8571	Bilanga	7°15'20"	15°22'15"	- 36,45
8572	Agalé	7°17'05"	15°24'05"	- 38,20
8574	Jahé	7°17'30"	15°29'25"	- 49,20
8576	Gambo	7°16'40"	15°33'00"	- 62,30
8577	Rhamadi	7°11'05"	15°36'00"	- 55,90
8578	Choubba	7°10'20"	15°32'10"	- 53,40
8579	Bourhtourou	7°10'05"	15°30'50"	- 50,75
8580	Morhamadin	7°09'55"	15°30'15"	- 49,20
8581	Kassohoussaoua	7°08'20"	15°27'55"	- 47,15
8582	Tairart	7°06'35"	15°27'25"	- 42,35
8584	Amatann ou Mazababou Sud	7°02'35"	15°31'10"	- 55,85
8585	Mazababou Nord	7°02'55"	15°33'45"	- 63,90
8586	Anntouchoukouk	7°10'40"	15°57'55"	- 30,25
8587	Rholou Ouest	7°11'00"	15°53'05"	- 61,50
8588	Rholou Est	7°12'30"	15°53'15"	en cours
8589	Téguénziguit 2	7°16'40"	15°54'15"	- 47,90
8590	Rhidale	7°20'00"	15°57'10"	- 53,90
8591	Manèji 2 ou Rhéchid	7°23'50"	15°49'40"	- 46,40
8592	Téjiguèlt Afféroko	7°29'45"	15°54'45"	- 62,40
8600	Sabonkori	7°37'10"	15°09'05"	- 42,35
8601	Jémari	7°30'15"	15°09'10"	- 53,15
8602	Rhalissou	7°29'15"	15°06'30"	- 46,50
8606	Godé	7°22'30"	15°01'15"	- 36,00
8607	Gora	7°15'35"	15°02'50"	- 34,60
8609	Dogo	7°17'45"	15°09'20"	- 37,90
8611	Gora	7°13'50"	15°13'15"	- 49,50
8614	Hama ou Oroga	7°24'15"	15°20'00"	- 28,85
8615	Ebélakan	7°25'15"	15°23'10"	- 25,35
8617	Rafir	7°28'40"	15°27'10"	- 23,00
8618	Ténarou Folgo	7°32'10"	15°31'15"	- 42,00
8620	Tongoutman	7°26'05"	15°34'10"	- 33,40
8633	Akérinjèd Est	7°45'00"	15°45'25"	- 32,75
8635	Katkataoua	7°42'45"	15°39'45"	- 33,85
8636	Eknaouan 1 Intili	7°39'40"	15°35'50"	- 24,45
8637	Eknaouan 2 Sud-Ouest	7°38'20"	15°35'10"	- 19,35
8638	Tagama	7°31'50"	15°33'20"	- 26,35
8639	Maygochi	7°37'35"	15°25'45"	- 54,00
8640	Alla	7°38'10"	15°23'05"	- 51,15
8641	Sèyidi	7°38'35"	15°19'25"	- 42,80
8646	Labi	7°46'50"	15°23'30"	- 37,10
8647	Gahido	7°44'50"	15°26'50"	- 41,70
8650	Arouna	7°50'40"	15°26'30"	- 27,65
8651	Tchinaboro	7°51'20"	15°27'55"	- 30,40
8652	Toukbalana	7°50'00"	15°31'05"	- 24,50
8653	Ambogotan	7°50'55"	15°33'25"	- 24,50
8654	Tarsat	7°48'10"	15°36'50"	- 41,60
8656	Malan Ouest	7°50'25"	15°40'45"	- 22,00
8660	Oumarou Tanko	7°58'25"	15°43'45"	- 38,70
8664	Edoualèn	7°59'30"	15°11'55"	- 40,70
8665	Samoro	7°59'45"	15°07'40"	- 27,20
8667	Baka	7°58'25"	15°03'25"	- 39,45

	Category C (cont.)			
8668	Bouza	7°51'50"	15°02'40"	- 47,60
8672	Korgam	7°52'55"	15°10'05"	- 58,45
8673	Abousza	7°39'40"	15°02'15"	- 43,15
10553	Sala	7°01'05"	15°10'55"	- 42,90
10560	Mata	7°00'30"	15°03'20"	- 36,40
11118	Djado	7°54'00"	15°59'30"	- 38,50
11119	Mati	7°57'40"	15°59'10"	- 22,40
11122	Abdem	7°57'10"	15°52'00"	- 36,30
11125	Tama	7°47'40"	15°56'50"	- 41,60
11126	Gayldi	7°25'40"	15°13'00"	- 29,30
11127	Adouma	7°28'55"	15°17'45"	- 33,10
11128	Mohamsai	7°31'50"	15°18'50"	- 46,10
11129	Mohamdi	7°32'20"	15°18'20"	- 46,00
11130	Zarbemdet	7°31'00"	15°22'35"	- 60,00
11131	Hangasi	7°32'00"	15°23'00"	- 43,40
11132	Mandaidant	7°53'10"	15°37'00"	- 13,20
11134	[illegible]	7°37'20"	15°55'00"	- 50,70
11135	[illegible]	7°30'00"	15°50'50"	- 41,00
11136	[illegible]	7°32'15"	15°53'10"	- 00,00
11137	Tibedi Bleimbert	7°24'15"	15°57'43"	- 50,70
11138	Mina	7°12'55"	15°53'55"	- 7,70
11141	Tamaat Ouest Est	7°12'35"	15°50'50"	- 10,70
11142	Tamaat Centre			
11143	Tamaat Centre Ouest	7°12'10"	15°58'30"	- 28,00
	Category D			
7999	Tonin ou Amatuhs	7°37'05"	15°35'40"	- 27,00
8008	Ilemi	7°56'15"	15°53'20"	- 29,00
8023	Mangaia	7°51'30"	15°05'20"	- 39,00
8024	Ilm Gure	7°49'35"	15°01'40"	- 34,43
8032	Hamamat ou Mata	7°35'40"	15°40'15"	- 35,43
8043	Ilem Dagoma	7°04'55"	15°47'55"	- 39,33
8045	Tamaat 2	7°07'10"	15°56'20"	- 23,00
8054	Lamhalidi ou Abouel	7°50'20"	15°32'20"	- 23,50
8058	Mamangamin ou Hamar	7°52'00"	15°18'30"	- 20,10
8059	Mazzapori	7°50'35"	15°15'30"	- 23,20
8061	Zahlamdjaqu ou Hamd	7°43'30"	15°05'20"	- [illegible]
8068	Demoffir	7°03'40"	15°10'50"	- 30,03
8373	Sijji	7°17'55"	15°27'20"	- 20,[illegible]
8383	Bisar Nord	7°01'35"	15°26'45"	- 43,35
8393	Kobobi	7°32'25"	15°49'30"	- 36,80
8394	Tahlamdjaqu	7°45'45"	15°50'35"	- 33,43
8395	Sidi	7°52'30"	15°22'40"	- 33,50
8396	Hadiaya	7°48'30"	15°14'05"	- 43,23
8397	Antchamaout	7°45'15"	15°12'20"	- 32,75
8398	Agnajil	7°44'40"	15°10'55"	- 39,60
8399	Didrou	7°41'30"	15°08'10"	- 34,45
8603	Kitchou	7°28'00"	15°05'15"	- 37,20
8604	Afagag	7°26'45"	15°04'25"	- 60,10
8608	Dehama	7°16'35"	15°04'15"	- 20,50
8612	Ryandé	7°22'45"	15°10'20"	- 34,40
8616	Jabar	7°26'45"	15°25'35"	- 26,80
8619	Rabidin 2	7°29'15"	15°30'45"	- 26,15

	Category D (cont.)			
8621	Guêrmaouan	7°20'45"	15°38'05"	- 42,00
8624	Nêkaka	7°22'40"	15°44'20"	- 34,00
8628	Touèndiguit	7°33'50"	15°42'15"	- 39,15
8629	Toumkou	7°34'40"	15°45'15"	- 33,85
8630	Samarila Ouest	7°39'20"	15°46'45"	- 37,15
8631	Tênaou Sud +	7°42'00"	15°48'30"	- 29,90
8632	Yobi	7°46'00"	15°53'25"	- 36,45
8634	Akarh	7°43'05"	15°41'25"	- 29,25
8642	Konchi	7°39'20"	15°16'20"	- 46,00
8643	Jaoura	7°40'25"	15°15'20"	- 42,40
8648	Ambora	7°43'40"	15°28'55"	- 49,00
8649	Abèz	7°49'50"	15°22'55"	- 35,80
8657	Malan	7°51'35"	15°40'25"	- 25,55
8658	In Zornan	7°53"15"	15°42'30"	- 22,15
8659	Edoubouk	7°54'25"	15°43'50"	- 29,50
8661	Tizoum 2	7°57'05"	15°48'50"	- 41,50
8663	Gorssé	7°57'50"	15°12'25"	- 44,45
8666	Daora	7°59'40"	15°07'00"	- 28,10
8669	Boubakar	7°51'45"	15°03'55"	- 43,85
8674	Magaria	7°36'50"	15°01'55"	- 51,80
8675	Jêmari	7°31'35"	15°02'40"	- 58,20
10260	Teurben Hamadou	7°41'50"	15°58'45"	- 52,95
11120	Abdeul	7°59'30"	15°56'20"	- 23,20
11121	Agtiouban	7°55'10"	15°54'30"	- 26,50
11123	Tanko	7°56'30"	15°45'30"	- 24,00
11124	Arhmed Lamine	7°56'45"	15°39'30"	- 34,10
11133	Anntazoalèn	7°38'50"	15°21'45"	- 47,50
11139	Elimane ou Bazo	7°24'00"	15°57'00"	- 57,40
	Category E			
1017	Aderbinsinat 2	7°53'35"	15°37'05"	- 27,60
	Category F			
8010	Gajiri	7°42'40"	15°29'40"	- 51,75
8026	Sabonkori	7°36'30"	15°09'00"	- 40,00 ?
8041	Matafé	7°13'25"	15°53'30"	- 41,00 ?
8048	Jiji Ouest ou Ajékourou	7°17'40"	15°27'10"	- 36,00 ?
8062	Amadou Moussa	7°24'55"	15°35'05"	effondré
8063	Tchin Garsama	7°26'10"	15°43'05"	effondré
8610	Dogo Nord	7°17'40"	15°10'35"	sec. /dy
8623	Tiantoubarak	7°22'20"	15°39'30"	env.- 6,00
8655	Erhadi	7°48'45"	15°41'25"	effondré
11130	Dangui	7°30'50"	15°21'50"	effondré
982	Ehèli	7°59'15"	15°05'25"	- 35,50
992	Tadélaka Nord	7°58'55"	15°30'30"	- 38,40
1016	Aderbissinat 1	7°53'30"	15°37'15"	- 9,90 ?

1347	Toumbélaga 2	7°50'20"	15°48'40"	- 29,80
1348	Aderbissinat 3	7°53'40"	15°37'05"	mare
7856	Manèji	7°23'20"	15°49'35"	- 51,50
7995	Maoudé	7°33'20"	15°09'55"	- 58,75 ?
7998	Adam	7°33'45"	15°33'35"	- 27,00 ?
8004	Rabidin 1	7°29'05"	15°30'50"	- 18,80 ?
8005	Baki	7°20'45"	15°30'00"	- 38,50 ?
8006	Bouzou	7°19'20"	15°29'30"	- 37,55
8009	Tizoum	7°57'30"	15°49'00"	- 24,70
8012	Tougoutaou	7°15'25"	15°21'25"	- 33,80 ?
8013	Assadèr	7°16'10"	15°24'40"	- 49,15
8017	Okoualèy ou Rabo	7°13'20"	15°19'20"	- 36,60 ?
8018	Animata	7°09'35"	15°15'10"	- 34,00 ?
8027	Toujé	7°40'45"	15°08'20"	- 34,00 ?
8029	Balèri	7°25'00"	15°50'00"	- 46,00 ?
8030	Ekènan ou Aramadou	7°32'50"	15°34'00"	- 46,00 ?
8031	Toula	7°36'45"	15°34'15"	- 26,45 ?
8033	Infelki	7°37'10"	15°46'20"	- 32,00 ?
8034	Kartchella Mati	7°41'00"	15°45'30"	- 42,60 ?
8035	Moutia	7°44'30"	15°48'30"	- 35,00 ?
8038	Siliman ou Fouta	7°35'40"	15°49'30"	- 51,00 ?
8039	Djano	7°34'10"	15°50'00"	- 51,00 ?
8042	Rholou ou Takénziguit	7°10'30"	15°52'50"	- 59,00 ?
8044	Feydou	7°25'30"	15°34'10"	- 25,00 ?
8046	Tanout 3	7°09'30"	15°58'20"	- 15,00 ?
8047	Bininèn	7°21'00"	15°30'05"	- 40,00 ?
8050	Mati	7°57'40"	15°58'20"	- 29,00 ?
8051	Anóu Tagas	7°58'45"	15°55'50"	- 23,00 ?
8052	Insa Tafat ou In Mota	7°54'00"	15°49'55"	- 23,30 ?
8053	Taral	7°53'00"	15°42'00"	- 19,00 ?
8055	Léko	7°15'25"	15°29'00"	- 36,00 ?
8056	Mahana ou Agali	7°16'05"	15°26'10"	- 36,00 ?
8060	Méguémá	7°57'20"	15°29'10"	- 34,70 ?
8065	M'Bolondou	7°27'40"	15°44'40"	- 36,00 ?
8067	Tamèsguine	7°34'10"	15°44'40"	- 31,00 ?
8567	Bama 2	7°06'25"	15°12'50"	- 26,15
8622	Jaho	7°14'50"	15°39'25"	- 53,80
8625	Sanda	7°28'10"	15°39'05"	- 33,15
8626	Azohor	7°29'20"	15°37'00"	- 28,60
8627	Bulbul	7°30'15"	15°38'10"	- 30,05
8644	Hodi	7°46'10"	15°16'55"	- 51,50
8645	Akoutan	7°45'00"	15°17'40"	- 46,60
8670	Mamajam 2	7°51'40"	15°05'00"	- 41,35
8671	Gaènaga	7°52'15"	15°07'40"	- ?

WATER POINTS ABALAK 12

LIST OF OBSERVED WATER POINTS

Registration Number	Name	Longitude W	Latitude N	State Water Level
	Category A			
4 882	Eras	6°11'50"	15°03'20"	- 4,65
4 895	Akoko	6°17'20"	15°06'20"	- 9,50
4 900	In Kokan	6°20'05"	15°08'25"	- 9,40
4 909	Tédèz 2	6°14'45"	15°13'35"	- 7,10
4 987	Abouraya	6°42'35"	15°22'25"	Forage
4 998	Al Mota Tamaya	6°46'55"	15°47'40"	Forage
5 006	Abalak	6°17'10"	15°27'30"	- 76,80
5 010	Tofamanèr	6°33'00"	15°50'15"	Forage
10 648	Akibénou Tatawassèn	6°05'40"	15°20'55"	Forage ?
	Category B			
4 883	Chadawanka	6°07'35"	15°02'15"	- 3,05
4 890	Wassamaman	6°08'55"	15°05'45"	- 7,30
4 908	Tédèz 1	6°14'45"	15°13'35"	?
4 914	Mécharou	6°20'00"	15°17'50"	- 3,50
4 940	Chin Tébagot	6°08'00"	15°38'45"	Mare
4 943	Ekisman	6°25'30"	15°37'30"	- 84,00
4 979	Birmou	6°48'50"	15°08'50"	- 42,95
4 980	In Talak Est	6°46'00"	15°14'25"	- 47,15
4 996	Marékini 2	6°41'30"	15°37'45"	- 5,25
10 649	In Talak Ouest	6°45'55"	15°14'25"	- 48,80
11 012	Tanabak	6°18'55"	15°10'55"	Mare et - 3,20
11 015	Sanfitajet	6°05'10"	15°07'35"	- 7,15
	Category C			
4 902	Tamanokal	6°13'50"	15°20'40"	Mare
4 916	Assarara 2	6°21'10"	15°24'10"	Mare
4 941	Tchin Gari 1	6°09'20"	15°34'00"	Mare
4 947	Alambatou	6°16'20"	15°40'00"	Mare
4 948	Bonkar Mèklan 1	6°14'50"	15°46'00"	Mare
4 949	Bonkar Mèklan 2	6°14'50"	15°46'00"	- 9,05
4 953	Taramtaguèy	6°07'20"	15°58'40"	Mare
4 958	Guirmawan	6°25'45"	15°45'45"	- 77,[illegible]
4 966	Aliou In Ifi	6°50'00"	15°02'10"	- 60,[illegible]
4 968	Gagui	6°49'00"	15°04'20"	- 37,40
4 970	Tambaya	6°53'50"	15°00'10"	
4 971	Bougaou	6°56'00"	15°02'10"	
4 972	Efèrèd	6°57'25"	15°02'20"	- 31,20
4 973	Aliou	6°57'40"	15°04'50"	- 36,40
4 975	Bada	6°58'10"	15°07'20"	- 37,50
4 976	Moussalkam	6°59'45"	15°08'20"	- 39,60
4 978	Al Moujtafa	6°49'10"	15°07'00"	- 42,60
4 981	Magaida	6°48'20"	15°15'40"	- 39,70
4 982	Woénésséli	6°43'05"	15°17'15"	- 49,80

4 985	Afalinjét	6°38'05"	15°18'30"	- 66,40
4 986	Souminti	6°39'45"	15°19'00"	- 55,50
4 988	Adérnatsan	6°39'40"	15°27'30"	- 70,05
4 989	Koutou	6°50'50"	15°24'20"	- 68,00
4 990	Raye Séye	6°48'25"	15°22'40"	- 69,40
4 991	Doda	6°51'40"	15°28'00"	- 69,70
4 992	Al Hadji	6°47'20"	15°34'45"	- 77,80
4 995	Marékini	6°41'30"	15°36'55"	> - 50,00
4 997	Al Mota Tamaya 1	6°46'45"	15°47'35"	- 84,90
5 000	Issoufa	6°54'55"	15°49'30"	Mare
5 003	Tankarchwèn	6°39'55"	15°51'15"	- 76,95
5 004	Tofamanèr	6°32'50"	15°50'20"	- 75,75
5 005	In Tézégaret	6°29'00"	15°35'20"	-100,50
5 008	Akibénou Tatawassèn	6°05'30"	15°20'25"	- 54,80
9 718	Chin Fangala	6°07'40"	15°36'35"	- 3,75
9 733	In Kiritiribón	6°00'10"	15°34'15"	- 6,00
10 643	Mboraga ou Barhgadji 2	6°57'30"	15°51'40"	?
10 651	Djobari	6°47'20"	15°12'30"	- 43,40
10 652	Gabadirou ou Oumarou	6°48'40"	15°09'25"	- 43,60
10 653	Zoumou	6°47'55"	15°11'20"	- 42,95
10 659	Korôn Dakari	6°58'35"	15°13'00"	- 54,20
10 662	Sala	6°57'35"	15°03'15"	- 31,50
10 977	Tagadayat	6°22'15"	15°23'45"	Mare
10 988	Chiramane Nord-Est	6°21'00"	15°15'55"	Mare
10 989	Chiramane Sud-Ouest	6°19'50"	15°14'55"	Mare et >- 3,70
10 992	Ténékart	6°27'30"	15°16'15"	- 5,50
10 999	Rhantarho	6°21'50"	15°11'50"	- 8,50
11 001	Daoulâlân	6°33'00"	15°14'55"	- 3,50
11 003	Tatis In Nâjein	6°34'05"	15°14'25"	> - 5,00
10 005	Anou Zâgré	6°15'40"	15°17'20"	Env. - 8,00
11 019	Akarkar	6°14'40"	15°09'00"	Mare
11 021	In Karagada	6°16'05"	15°06'15"	Mare et - 3,00
				env.
11 024	Maydoubou Sud	6°19'30"	15°06'40"	Env. - 4,00
11 025	Hanga	6°13'45"	15°03'55"	Mare env. - 4,50
	Category D			
4 885	Alagaza	6°06'35"	15°02'50"	- 7,[illegible]
4 886	Guirbat	6°01'00"	15°02'30"	- 4,[illegible]
4 889	Tabafacut	6°01'25"	15°06'15"	- 3,[illegible]
4 899	Maydoubou Nord	6°19'00"	15°07'30"	- 5,[illegible]
4 903	Assoe 1	6°12'30"	15°19'20"	Mare
4 904	Assoe 2	6°12'20"	15°19'20"	- [illegible]
4 912	Fokayat	6°23'05"	15°12'45"	- 3,[illegible]
4 918	Afénatna	6°19'30"	15°28'45"	Mare
4 919	Tilicât	6°16'30"	15°30'15"	Mare
4 925	In Wara	6°05'50"	15°30'15"	- 3,[illegible]
4 931	In Taséf	6°00'20"	15°41'50"	- [illegible]
4 934	In Tallat	6°04'30"	15°52'05"	- 12,35

Category D (cont.)

4 935	Tazét	6°08'10"	15°51'30"	- 9,75
4 937	Chin Adéraran ou Doway	6°09'30"	15°[illegible]	- 12,10
4 942	Tchin Gari 2	6°09'10"	15°33'55"	- 5,00
4 946	Chin Wala	6°19'20"	15°39'50"	- 9,40
4 950	Amalaoula	6°14'00"	15°50'10"	mare
4 951	Akoko	6°13'00"	15°53'10"	mare
4 952	Abilétèn	6°15'40"	15°57'30"	mare
4 954	Chin Lémos	6°06'30"	15°59'40"	- 11,40
4 955	Bagotèn	6°22'00"	15°55'20"	- 94,20
4 957	Tazzéité	6°24'10"	15°50'35"	- 5,05
4 960	In Tazét	6°24'50"	15°42'05"	- 10,60
4 961	Bagam	6°29'50"	15°44'00"	mare
4 967	Taféskén	6°49'00"	15°02'45"	- 50,20
4 969	Bello	6°50'[illegible]"	15°01'50"	- 37,60
4 974	Dirka	6°57'25"	15°06'00"	- 36,00
4 983	Maikordi	6°42'25"	15°17'45"	- 49,60
4 993	Agourdoubé I	6°41'40"	15°33'15"	- 6,10
9 708	In Faladén	6°01'30"	15°54'10"	- 10,05
9 709	In Taboulé	6°05'10"	15°53'30"	mare
9 710	In Ifay ou In Néjéin	6°05'35"	15°48'20"	- 6,20
9 713	In Témézour	6°04'15"	15°45'20"	env. - 8,00
9 714	In Tagay	6°06'10"	15°42'45"	- ?
9 715	Tihirit	6°04'05"	15°33'25"	- 5,25
9 719	Toubbeur Kounoult	6°04'50"	15°36'35"	- 4,20
10 661	Imouésséli	6°18'55"	15°21'55"	> - 11,15
10 669	Ekoukou	6°35'40"	15°03'40"	env. - 3,00
10 670	Takakot	6°36'05"	15°02'45"	env. - 3,30
10 973	Ebagey	6°21'15"	15°26'00"	env. - 6,00
10 974	Chin Samatan	6°24'10"	15°27'40"	mare
10 975	Tadagalt In Zorien	6°24'20"	15°24'35"	env. - 7,00
10 976	Zorien	6°25'10"	15°24'15"	- 8,40
10 985	Azizit	6°25'45"	15°17'10"	mare
10 986	Tizizat	6°27'40"	15°17'15"	- 10,70
10 998	In Somia	6°22'45"	15°11'20"	> - 4,00
11 006	In Tanérwat	6°16'10"	15°15'30"	env. - 5,00
11 007	Touboudéni	6°14'35"	15°14'35"	- 5,85
11 008	Tamananat	6°09'55"	15°13'20"	- ?
11 017	Taboutout ou In Akeur	6°07'20"	15°07'00"	- 5,90
11 018	In Garat	6°08'30"	15°07'45"	- 3,90
11 022	Tambadan	6°18'30"	15°04'05"	- 9,00

Category E

4 878	Safiratou	6°03'30"	15°16'00"	- 6,00
4 880	Bakr	6°09'00"	15°13'50"	- 8,65
4 891	Akouya	6°10'10"	15°01'00"	- 6,35
4 892	Tafobayo	6°10'45"	15°01'55"	- 3,90
4 894	Sabouli Abancoursé	6°16'00"	15°01'55"	- ?
4 897	Télinguidit	6°20'30"	15°06'00"	- 6,90
4 898	Abilbé	6°24'00"	15°07'00"	- 17,25
4 901	Azéguéiley	6°15'00"	15°24'10"	- ?
4 905	Tazak I	6°13'10"	15°17'35"	mare

	Category E (cont.)			
4 906	Tazak 2	6°13'05"	15°17'40"	- 3,65
4 907	In Térawa	6°15'40"	15°18'15"	- 8,60
4 910	Chin Arhmat	6°15'45"	15°10'20"	- 8,10
4 915	Assarara 1	6°21'10"	15°24'10"	- 3,45
4 917	Zorian	6°25'45"	15°22'40"	- 9,30
4 920	Tazak	6°16'25"	15°33'00"	- 10,60
4 923	Tabalar	6°09'25"	15°27'55"	- 5,05
4 924	In Afissaouan	6°11'50"	15°25'15"	- 10,50
4 926	In Kéla	6°07'10"	15°31'30"	- 5,50
4 932	In Titoungour	6°02'00"	15°43'40"	- 5,65
4 933	Elamamad	6°04'30"	15°47'00"	- 9,30
4 936	Chin Adéraran	6°08'20"	15°48'05"	- 8,35
4 938	Batelbakam	6°09'20"	15°41'45"	- 3,15
4 939	Azoumbalar	6°11'00"	15°40'30"	- 4,45
4 944	Tagalalt	6°21'25"	15°39'55"	- 7,60
4 956	Tzéyt	6°26'20"	15°53'30"	- 6,40
4 959	In Béroukèn	6°24'40"	15°43'00"	- 6,85
4 962	Bagam	6°29'40"	15°43'55"	- 5,10
4 964	Siguiril	6°34'00"	15°01'30"	- 10,15
4 994	Agourdoubé 2	6°41'20"	15°34'35"	- 6,85
9 711	Sarsadén	6°00'40"	15°48'20"	- 5,45
9 712	In Tada	6°02'55"	15°47'40"	- ?
9 716	In Tinganbèt	6°02'10"	15°32'25"	env. - 6,00
9 717	Takanzért	6°02'10"	15°31'15"	env. - 4,00
10 646	Akokou	6°42'30"	15°32'30"	mare - 4,90
10 647	Wan Chéférou	6°40'45"	15°30'40"	- 9,60
10 650	Souloumakabar	6°08'00"	15°20'10"	- 5,50
10 671	Igadou	6°03'20"	15°16'25"	- 6,10
10 978	Tofagat	6°23'10"	15°22'10"	> - 3,15
10 983	Malakrouden Est	6°29'25"	15°19'45"	- 4,50
10 984	Abdélafata	6°24'20"	15°18'15"	- 5,10
10 991	Touzouzét	6°26'45"	15°16'05"	env. - 5,00
11 004	Tazak	6°12'10"	15°17'40"	- 6,25
	Category F			
4 879	Anamanas	6°03'15"	15°14'25"	- 6,35
4 881	Tiggar	6°13'00"	15°07'10"	mare
4 896	Meydoubou Nord	6°19'50"	15°07'25"	env. - 7,00
4 927	Tabardot	6°06'35"	15°33'40"	- 5,00
4 963	Tatis ou Tamat	6°33'40"	15°14'00"	- 5,40
4 977	Bamo	6°54'30"	15°08'45"	effondré
5 001	Mboraga ou Barhgadji 1	6°57'25"	15°51'30"	effondré
5 002	Rijya Fourdou	6°54'10"	15°58'15"	- 52,60
10 645	Dakari	6°53'35"	15°44'55"	- 71,40
10 655	Dakari	6°56'25"	15°16'10"	effondré? > 80,00
10 656	Dakari	6°56'40"	15°16'35"	effondré
10 979	Ténèm	6°23'40"	15°20'50"	- ?
10 980	Tourgui	6°20'25"	15°19'05"	env. - 5,00
10 981	Tazoubarat	6°25'10"	15°19'20"	?
10 982	Malakrhoudèn Ouest	6°28'35"	15°19'35"	env. - 11,00
10 987	In Tatébèn	6°28'40"	15°17'40"	> - 6,00
10 990	Tan Rhawil	6°26'00"	15°16'15"	- ?

	Category F (cont.)				
10 993	Tan Alrhalès	6°27'30"	15°15'50"		- ?
10 994	Tamama	6°27'15"	15°15'30"		- ?
10 995	Aouchinan	6°25'05"	15°14'40"	env.	- 7,00
10 996	In Néjein	6°25'15"	15°13'20"	env.	- 7,50
10 997	Fakayat In Rharhilé	6°22'30"	15°12'45"	env.	- 7,00
11 000	Takadagout	6°31'15"	15°17'05"		- ?
11 002	Fak ou Téguélgamarhit	6°32'05"	15°14'25"		- ?
11 010	In Tijijwin	6°14'15"	15°11'35"		- 5,00
11 011	In Waggar	6°19'35"	15°12'10"	env.	- 6,00
11 013	Daoulalan	6°03'05"	15°08'30"		- 5,80
11 014	Chin Fakalawa	6°07'25"	15°09'45"		- ?
11 016	Taboutout	6°07'00"	15°07'05"		> - 5,50
11 020	Akaekar	6°14'55"	15°08'40"		> - 6,15
4 921	Tichawa 1	6°10'55"	15°31'55"		- 5,70
4 922	Tichawa 2	6°11'00"	15°32'05"	mare	
4 928	Tihirit	6°04'05"	15°33'25"		- 4,40
4 965	Hama Séoundou	6°42'40"	15°00'40"		- 69,30
4 999	Tamaya	6°49'35"	15°48'00"	mare	
10 644	Jadéri	6°50'25"	15°46'10"	en cours	-?
10 654	Birmou	6°48'45"	15°08'55"	en cours	-43,80
11 009	In Téyétaft	6°17'40"	15°14'10"		- 5,65

APPENDIX III

LIVESTOCK IN THE PROJECT ZONE, NIGER, WEST AFRICA

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Introduction	1 - 2
Graphic presentations of the Sahel problems	3 - 5
Grazing and watering patterns	6 - 13
Cattle movement - overlay narrative	14 - 31
Reproductive efficiency and herd composition	32 - 43

INTRODUCTION

The pastoral region of Niger is a place of long human history. The channels of thought of the nomadic Fulani and Touareg have been cut deeply, and one can not separate the continuousness of these people from their land or from their livestock. All are inextricably bound together. In this study it should be remembered that herders are the subjects of our interest, and not just objects of some developmental project. All too often in the quantitative approach of how many cattle and how much grass, one loses the perspective of just how much our interests will improve the quality of life.

In order to be quite clear about the subjects covered by this report, a few definitions are necessary.

Pastoral Zone: refers to a definable area where the main livelihood of the people is herding.

Nomads: these are taken to be the people for whom constant mobility is an integral part of making a livelihood in areas where there are not enough resources to stay in one place.

The focus of this report is on the pastoral nomads, their livestock, and their adaptation or reaction to their changing environment. There is a need to emphasize several points: pastoral nomads are not as remote and out of touch with other populations as their geographical location might suggest. Most pastoral nomads make regular trips to markets in the settled agricultural zone, where they sell their animals, and buy grain and other commodities.

For many pastoral nomads, cereals, and not dairy products, are their staple food, particularly now after the drought. Recurrent drought has always been a hazard for many groups of pastoral nomads, and their social structure can easily be seen in terms of an adaptation to drought risks; for example, political units among

pastoral nomads are typically small and flexible (the settlement, the camp), so that they can unite and disperse according to the availability of pasture and water.

From time to time, there are exceptional droughts, and pastoral nomads resort to a set of strategies, most of which exploit their ability to move away from the worst affected areas to areas which have, relatively, been spared (see Johnson, D. 1973, Special Sahelian Office, UN, New York. 23 pp).

Figures 1 and 2 taken from Picardi, A. 1974, A Systems Analysis of Pastoralism in the West Africa Sahel, illustrates the suddeness and relative magnitude of this human and ecological catastrophe.

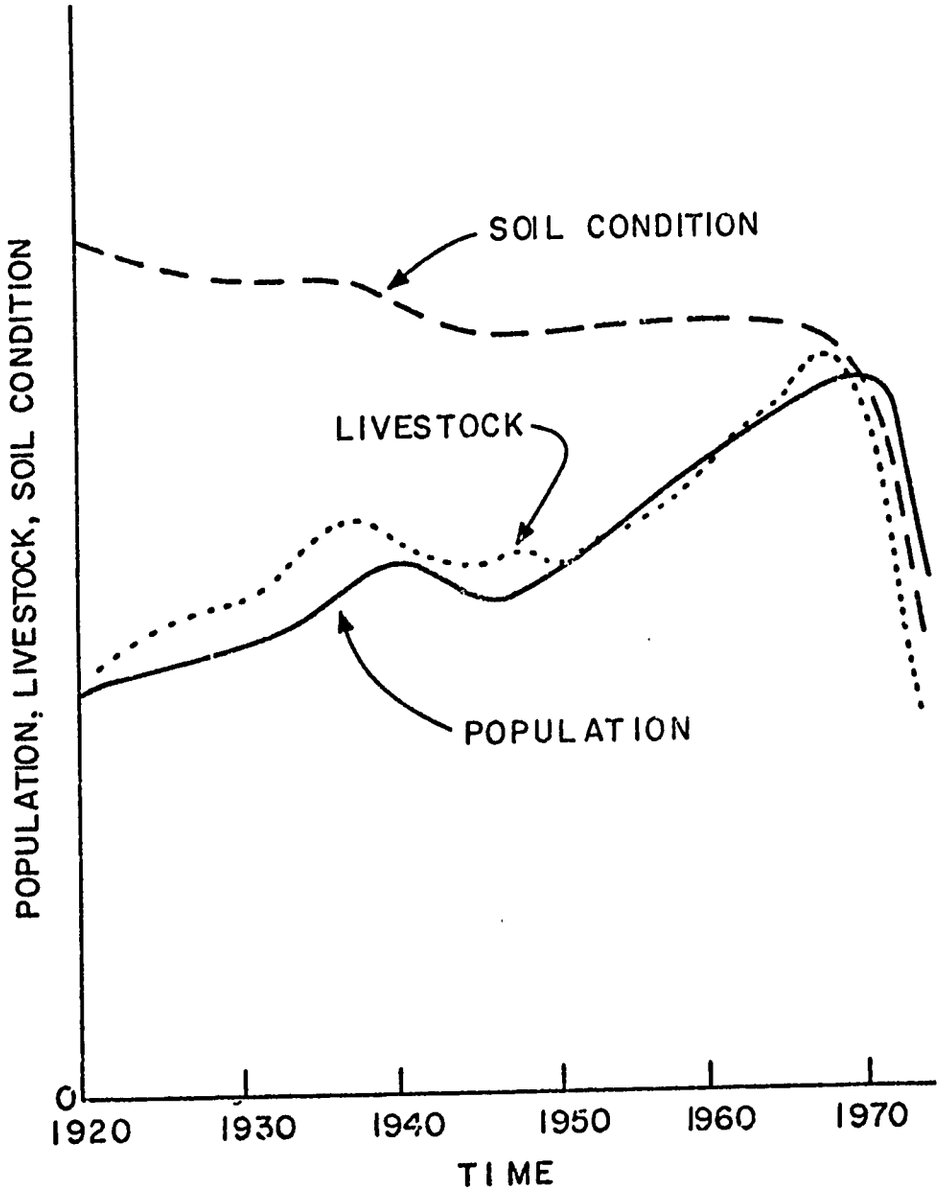


FIGURE 1: A Graphic Representation of the Problem in the Sahel

The possibility that the human catastrophe shown in Figure 1 will recur and that the ecological disaster will be total and irreparable is a long term problem. It is a long term problem for the pastoralists who will face starvation and the loss of a way of life. It is a problem for the Francophone West African national economies which contain sahel and subdesert regions and which depend on export livestock for a large share of their foreign exchange earnings. Finally, it is a problem for the developed countries whose moral and financial resources will be increasingly summoned to forestall the misery and repair the damage.

Figure 2, is a model showing the most important interactions that determine the long term behavior of the ecological-pastoral system. They are perceived as dynamic feedback processes. This means that the behavior of the individual system elements causes changes in the rest of the system, which in turn cause the original system elements to behave differently. For example, livestock cause changes in the range condition by their grazing intensity. The condition of the range then affects the livestock through the amount of forage that is produced each year. These feedback processes typically proceed at different rates --- some happening almost immediately, and some taking as much as 100 years.

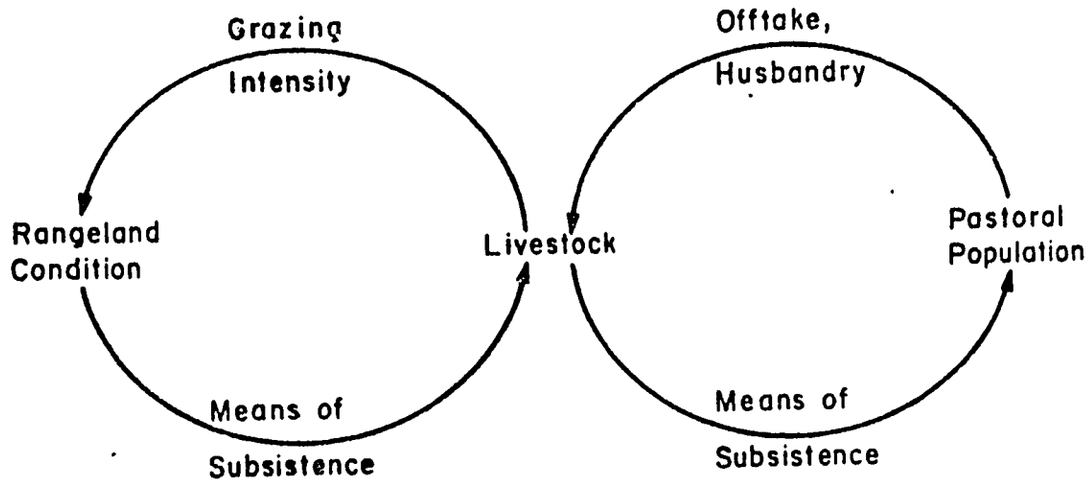


FIGURE 2: A Simplified Representation of the Sahel Ecological-Pastoral System Showing Some Dynamic Feedback interactions.

Two modes of grazing and watering were observed using several different Fulani Bororo herds.

Graph I Watering every day

Pasture with trees and shrubs.

Graph II Watering every day

Pasture without trees and shrubs.

Graph III Watering every two days

Pasture with few trees and shrubs.

DISCUSSION OF GRAPH I

It was established that the principal activities of walking and grazing were done during the day. The night is left for rest and rumination. Watering is done once a day by drawing water from a well. Although the watering process often takes at least 2 hours, each animal only drinks for approximately 5 minutes followed by a rest period.

The actual grazing is done during the afternoon and is often broken by a rest period. It should also be noted that the grazing time of 5 hours 30 minutes is relatively short compared to a grazing time of about 8 hours in the United States.

Time established for resting is very important (10 hours 15 minutes). The time seems inordinately long, but may indicate one way in which the animals conserve energy during these stress periods.

Energy Requirements:

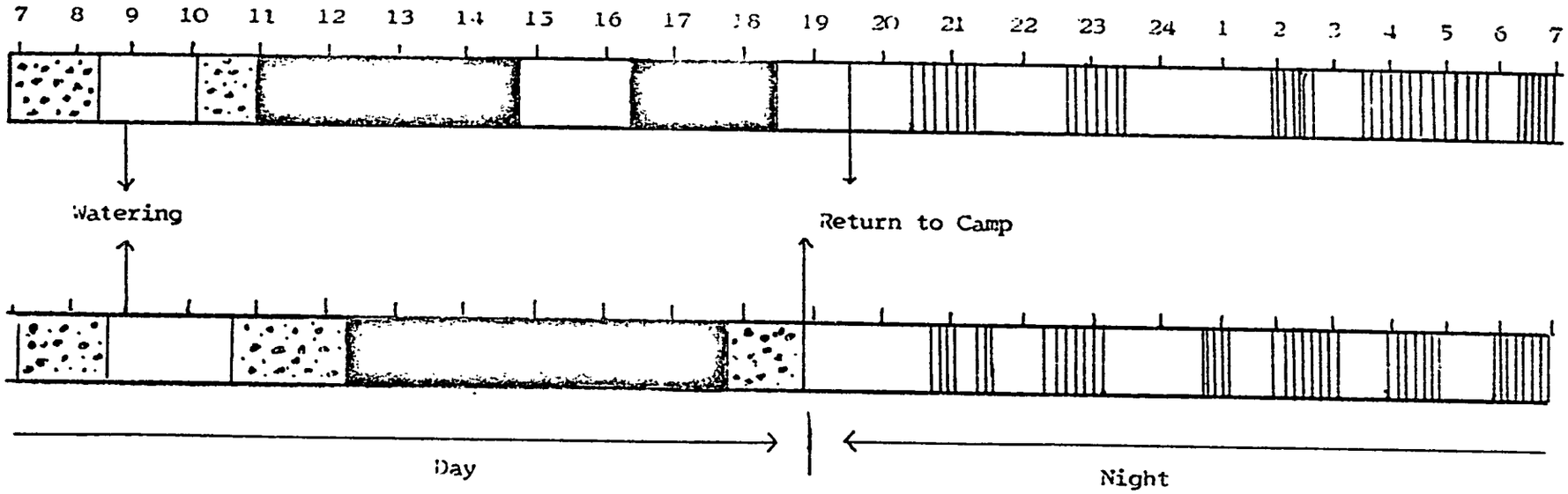
Although cattle graze for shorter periods than expected because of the composition of the local grasses, the animal can ingest a sufficient quantity of dry matter.

Note: See grass analysis section for types of grasses and protein dry matter analysis.

It should also be pointed out that cattle grazing on pasture with shrubs and trees can supplement their diet with a variety of plants.

GRAPH I: PASTURE WITH TREES AND SHRUBS

WATERING EVERY DAY



	Grazing	5 h 30 min
	Walking	3 h 40 min
	Rumination	4 h 30 min
	Rest	10 h 15 min
	Watering	5 min

Available plants

Maerua crassfolia
Balanites aegyptiaca
Acacia laefe
Acacia raddiana
Boscia senegalensis
Cadaba farinosa

Graph II describes a daily watering situation in a pasture area without trees and shrubs to supplement the forage intake of the cattle. The Bororo camp is situated about 3 km from the grazing area and 12 km from the water source. It takes the cattle over 3 hours traveling to water, and 3 hours to return to the grazing area.

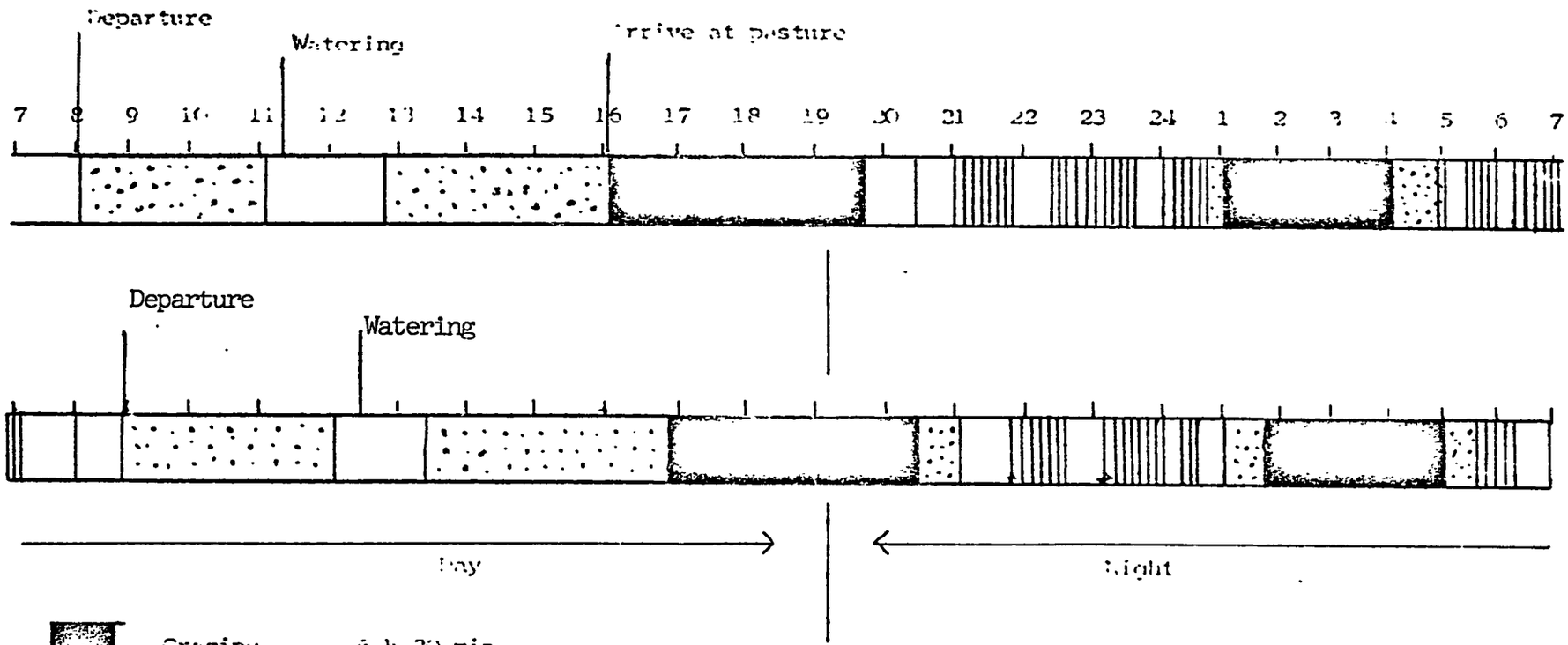
Without trees and shrubs with higher protein values to supplement the herd's diet, they are forced to graze at night in order to meet their minimum maintenance requirements.

Because of the 6 hours required for going to and from water, the night grazing period is longer than the day grazing period. Although grazing is interrupted by frequent rests and rumination periods, the total time appears insufficient. Especially when considering that the cattle must walk 24 kms a day for water plus 6 kms more to the pasture on top of the walking required for foraging iteself.

Needless to say, these cattle were in extremely poor condition, covered with ticks and lice, and several showing the vitamin A & D deficiency of partial to complete blindness.

It is obvious that these cattle cannot meet their basal metabolic needs on this kind of a regime where energy intake is less than the energy output.

Graph II - Pasture without trees and shrubs - Watering every day



	Grazing	6 h 30 min
	Walking	6 h 30 min
	Rumination	3 h 30 min
	Rest	5 h 20 min
	Watering	10 min

Predominant pasture

Cenchrus biflorus
Aristida mutabilis
Brachiaria hagerupii
Gisekia pharnacoides

GRAPH III - WATERING EVERY TWO DAYS

As the forage around a given water source retreats further and further away, the herds are forced to walk their cattle over longer distance to graze, and consequently return longer distances to water. This regime ultimately results in watering the animals every other day.

The observations in preceeding graph were made by this author while following a Bororo herd watering at Birmou. The camp was situated 12 km from the well, and the pasture was another 4 km beyond the camp.

Although the distances covered in this observation (Graph III) were similar to the previous observations (Graph II), the total grazing times were longer on both the first and second day. The cattle also appeared to be in better condition. In fact, other than going without water, the animals grazed longer on the second day than is expected under accepted animal husbandry practices.

The animals are always moved at a slow leisurely pace, and are allowed to graze as much as possible while walking to and from water. The average grazing time for the two days is 7 hours 50 minutes which is quite satisfactory, although usually close to half of that time is night grazing.

On the second day only two hours were needed to go and return from the pasture. Watering is done twice, separated by approximately a 3/4 to 1 hour rest period.

It would be interesting to continue these studies to see if the reason for the improved condition of the animals under observation is due to the time space between waterings which allows for more grazing or due to the reduction of fatigue and energy used for transportation.

Summary:

It should be noted that the rumination periods which are normally rather constant, in all three observations were variable to adjust to grazing patterns (3.30 - 4.30 -

4.50 - 5.40). These periods are extremely important for food digestion and absorption.

This study of cattle behavior, done at the end of the dry period, should give some indication as to animal and herder behavior at a time when they are at their "peak stress".

The comparisons between herds I and II should indicate the importance of shrubs and trees, (which the goats are destroying) to supplement the protein intake in the animals' diet. They are a definite enrichment to the pastures, and reduce the time needed for grazing. Thus, more time can be devoted to rest and rumination.

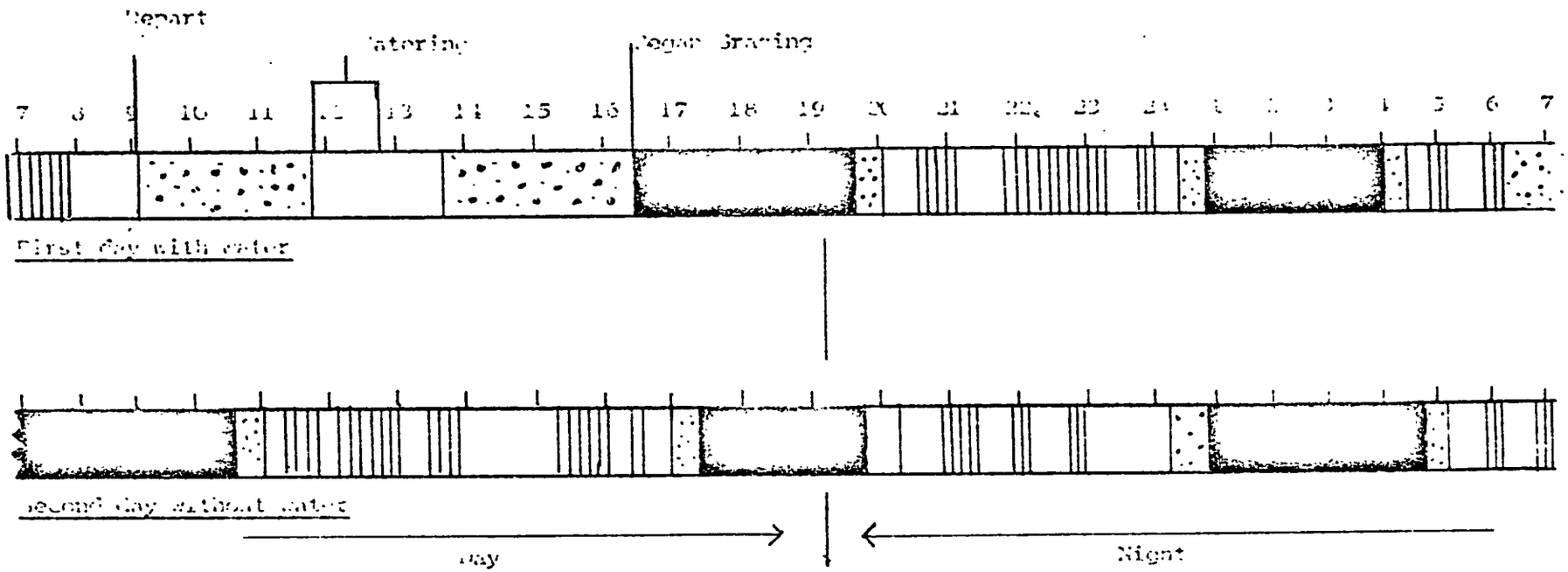
The comparison between herds II and III show that by reducing walking periods, and allowing for more grazing, resting and ruminating periods will result in better animal conditions.

In spite of the extremely harsh conditions in which these animals must live, it is possible to maintain them in relatively good shape if the pastures can be protected to give a variety of plants such as trees and shrubs.

It would be advised to leave a pasture in reserve next to a water source so that at the end of the dry season when the environment is under its greatest stress, the animals will not be required to walk such great distances. Thus, the energy contribution of the pasture can be used to a greater extent.

Cattle adapted to the environment may succeed in gathering a sufficient amount of feed, but in order to do so are forced to walk great distances which greatly increase their energy requirement for growth, maintenance and reproduction.

Graph III - Pasture with few trees and shrubs - watering every 2 days



	1st day	2nd day
Grazing	6 h 4 min	9 h
Walking	7 h	2 h
Rumination	1 h 30 min	3 h 40 min
Rest	3 h 8 min	7 h 20 min
Watering	10 min	-

CATTLE MOVEMENT - OVERLAY NARRATIVE

Estimates of cattle movements can only be given as generalizations at the present time. This is because there exist too many lacunae in our knowledge of precise family movements among the Sahelian nomads, and secondly, for the casual observer without any understanding of the terrain and pastoral conditions, anything more than general ideas would be simply non-informative.

The fundamental migration in the project area is an annual visit to IN GALL and outlying areas for the SALT CURE, which would last approximately from August 15 - September 15. The rain season brings up the high salt content in the soil (there is a salt mine at Tegguidam Tessoum) which the animals use to great advantage as there is very little salt available in the southern regions during the rest of the year. Traditionally, the time of the Salt Cure is also equally important as a social event, for regrouping a family, for meeting friends one hasn't met since the last rains, for weddings and celebrations.

It appears to be the case that a family will move each year to a chosen area, which may possibly be the same for several years. With some knowledge of these movements, one can almost forecast with some certainty that, by late August, a family X will be in or around place Y.

What is by no means clear is the route taken to arrive there. This may well change from year to year, and this makes it very difficult to trace nomadic movements within the study area. There are a number of contitional factors:

i. Availability of water: marshes en route which may be usable even early in the rain season.
Pumping stations which have to be avoided because the moteur is unreliable.

ii. Availability of pasture: the area around certain wells tends to be periodically overgrazed. eg. 1976 Tofamaner.
Bush fires destroy many acres of pasture

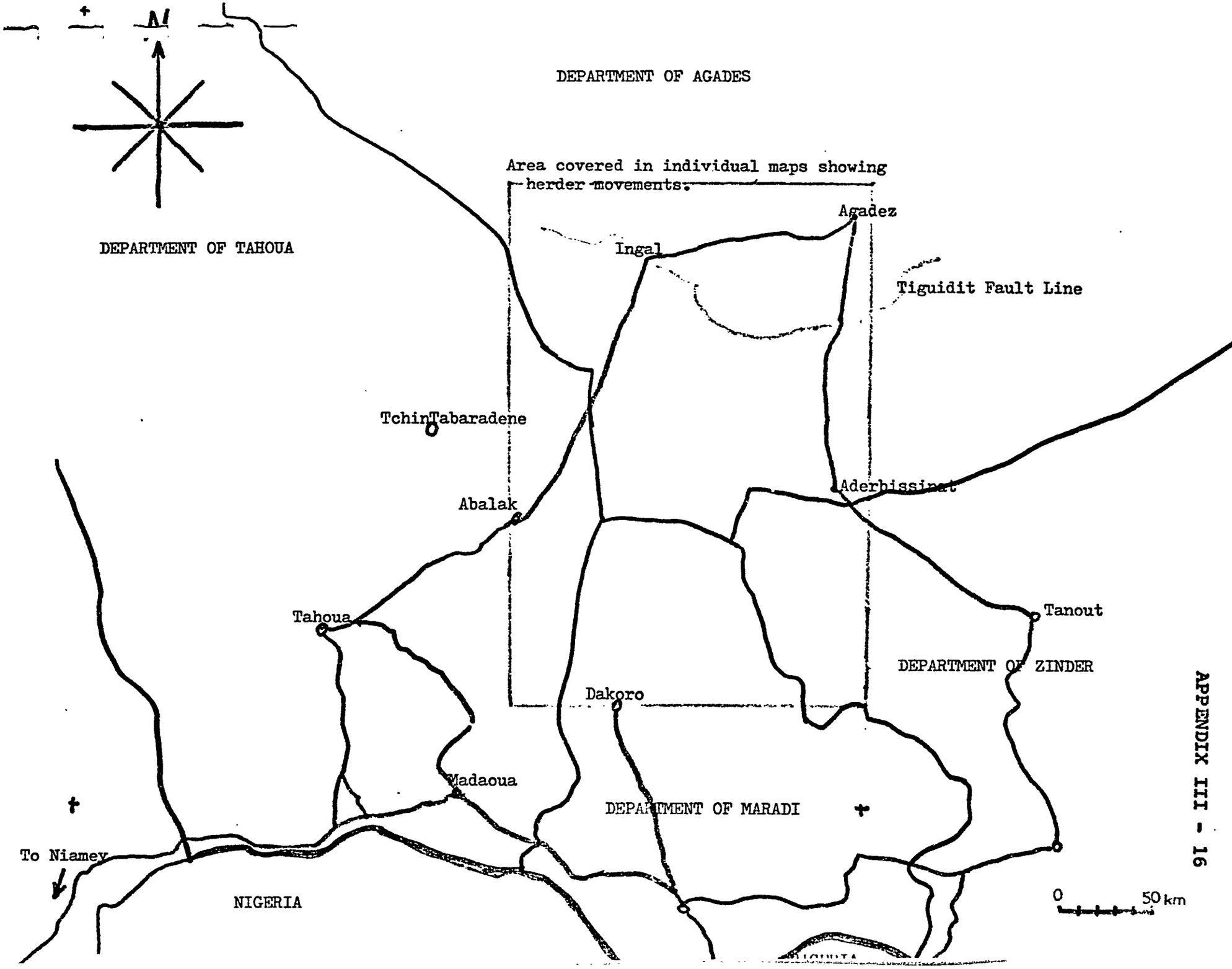
iii. The presence of other nomads in the area: there is a very fine and complicated modus vivendi maintained between different tribal and racial groups in the pastoral zone.

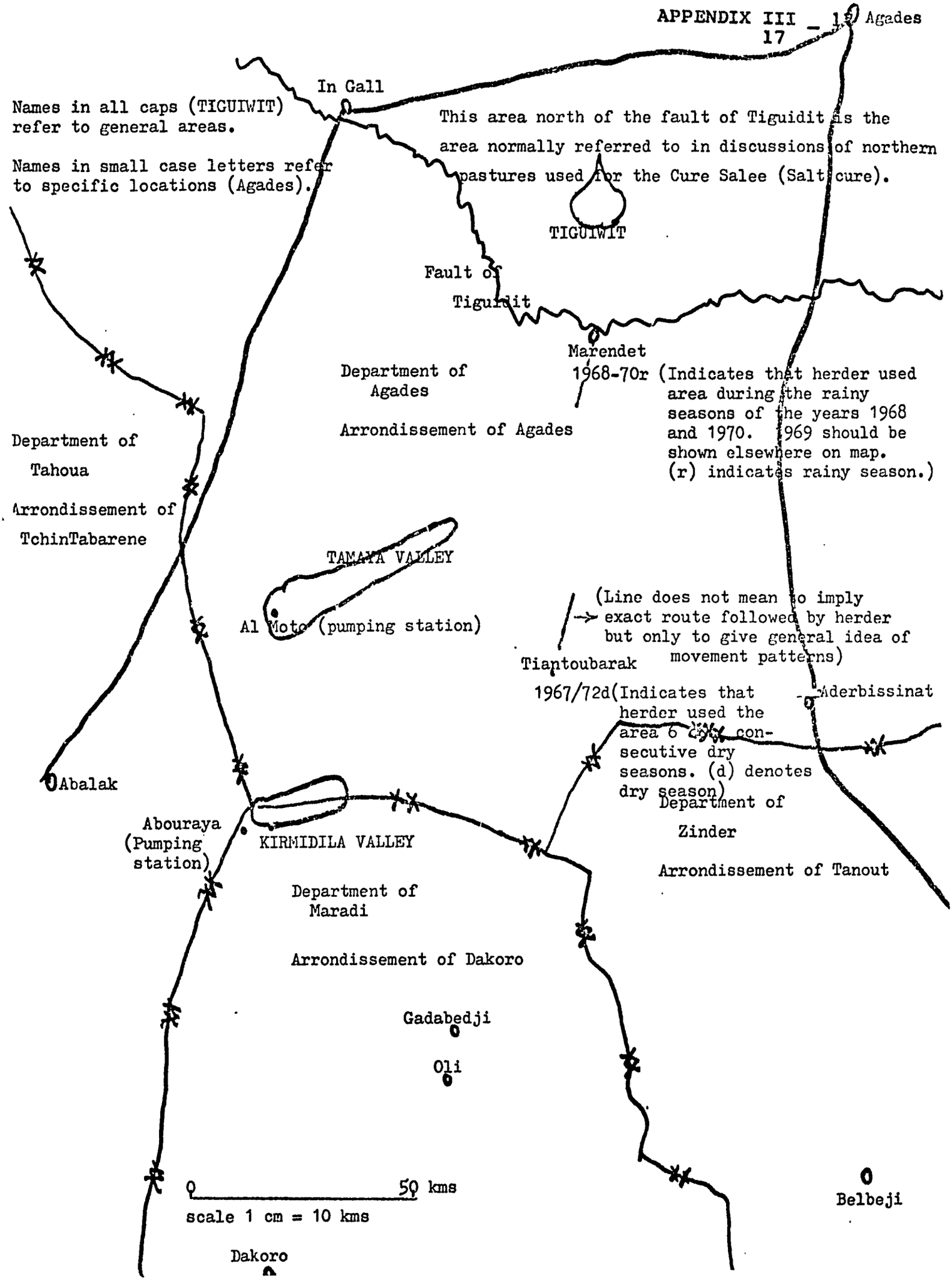
The chart shows the approximate location (chart-green) of peoples around INGALL, from the project study region. Those from Tahoua/Tchin Tabaraden will be found at INGALL and West, into the Irhazel Valley; those from Dakoro/Gadabeji at E of INGALL and Assouas; those from Tanout and Aderbissinat go as far as the falaise some 70 dilometres from Agades, and then turn W to Assouas and the routes NE to Agadez itself.

This basic pattern is complicated by two nomadic movements about which there is very little information (chart-red) a) from Balbeji/Gangara to some area N and W of Aderbissinat. b) groups returning from Nigeria.

This last group may consist of about 10,000 people, some 30% of the nomadic population of the Dakoro arronde. Possibly most of these will stay in the project area, but a certain number of groups (a) and b)) will continue northwards for the Salt Cure. The fact that this year some 150,000 hectares N of Gadabeji have been severely burnt will presumably mean that, at least for the next two seasons, only the western routes from Dakoro will be used.

Finally, it may no longer be possible to talk about traditional nomadic movements. Already it is quite clear that the extended migrations have become part of the legends of the past. It is still possible to meet a family who are about to set out for Senegal and the rich markets, but such people are few and far between. The emerging pattern seems to show that the modern nomad has a "home" area, a definite location within which he will circulate, and over which he would want to establish some territorial rights.


N
DEPARTMENT OF AGADES
Area covered in individual maps showing herder movements.
Agadez
Ingal
Tiguidit Fault Line
DEPARTMENT OF TAHOUA
TchinTabaradene
Aderbissinat
Abalak
Tahoua
Tanout
DEPARTMENT OF ZINDER
Dakoro
Madaoua
DEPARTMENT OF MARADI
To Niamey
NIGERIA
0
50 km

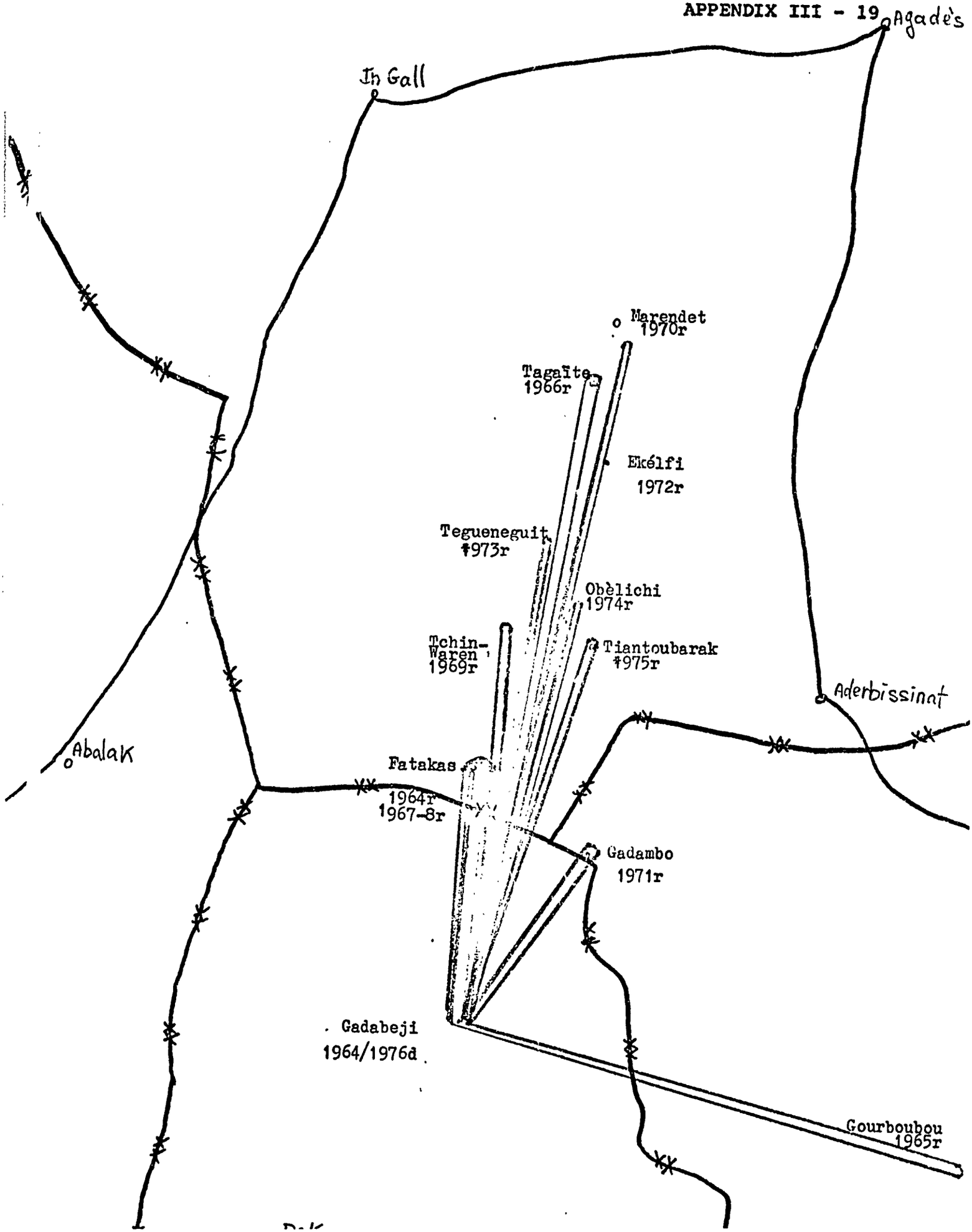

Agades
In Gall
Names in all caps (TIGUIWIT) refer to general areas.
Names in small case letters refer to specific locations (Agades).
This area north of the fault of Tiguidit is the area normally referred to in discussions of northern pastures used for the Cure Salee (Salt cure).
TIGUIWIT
Fault of Tiguidit
Marendet
1968-70r (Indicates that herder used area during the rainy seasons of the years 1968 and 1970. 1969 should be shown elsewhere on map. (r) indicates rainy season.)
Department of Agades
Arrondissement of Agades
Department of Tahoua
Arrondissement of TchinTabarene
TAMAYA VALLEY
Al Moto (pumping station)
(Line does not mean to imply exact route followed by herder but only to give general idea of movement patterns)
Tiantoubarak
1967/72d (Indicates that herder used the area 6 consecutive dry seasons. (d) denotes dry season)
Aderbissinat
Abalak
Abouraya (Pumping station)
KIRMIDILA VALLEY
Department of Zinder
Arrondissement of Tanout
Department of Maradi
Arrondissement of Dakoro
Gadabedji
Oli
0 50 kms
scale 1 cm = 10 kms
Belbeji
Dakoro

EXAMPLE #1

Touareg chief in the zone having a sizeable herd of camels, plus some cattle, sheep and goats. The chief owns three wells in the area of Gadabeji and in addition, uses several OFEDES wells in the region. The chief, because of the size of his camp, has settled permanently since 1970 in the region of Gadabeji. His animals are usually divided between his herders (Bellas) and his sons. Often they are scattered over the entire region in several different camps. This fractional group of Touaregs originated from the North of Agades, but probably has been in the area for at least fifty years.

The movements of the chief rarely reach the preferred rainy season pastures which are in the area north of Marendet. The areas he frequently uses as rainy season pastures are used in common with other Touareg tribes of the same fraction. (Mostly, these tribes are located around Tiantoubarak and Aderbissinat.) The direction of the seasonal movements of the chief has remained almost unchanged for the past twelve years. Where the largest part of his herd actually stops depends on the availability of water and abundant pasture. The unexplained exception is the 1965 rainy season deviation to Gourboubou.

It should be noted that the drought didn't affect the migratory movements of the chief's herd. The distance traveled to arrive in the region of the rainy season pastures varies between 80 and 100 kms. The average for the twelve years of information is 120 kms.

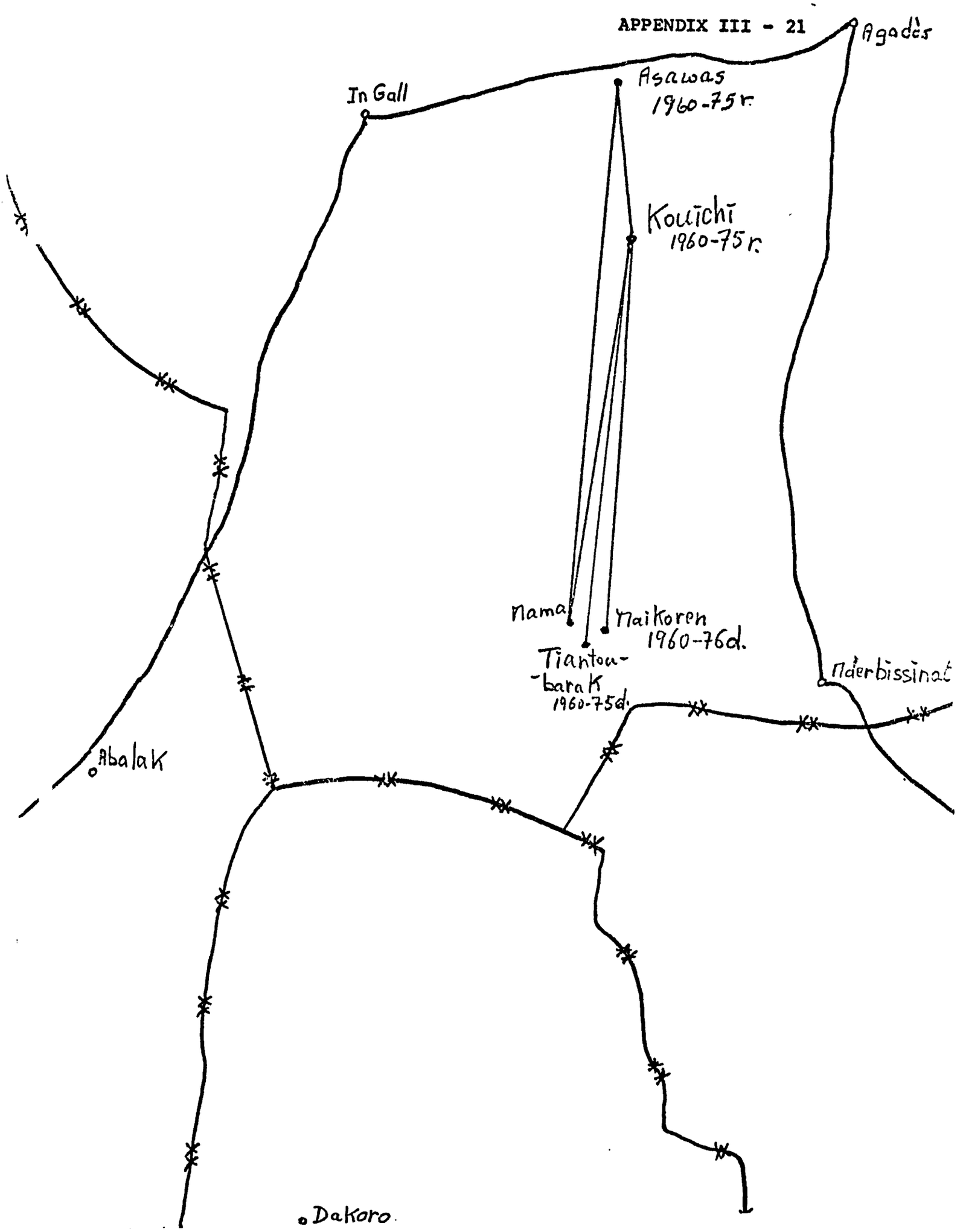

Agadès
In Gall
Marendet
1970r
Tagaïte
1966r
Ekélfi
1972r
Tegueneguit
1973r
Obèlichi
1974r
Tchin-
Waren
1969r
Tiantoubarak
1975r
Aderbissinat
Abalak
Fatakas
1964r
1967-8r
Gadambo
1971r
Gadabeji
1964/1976d
Gourboubou
1965r

EXAMPLE #2

Touareg herder having herd of primarily camels with some goats and several donkeys. The herder has two wells in the region, which he habitually uses during the dry season. He also uses the temporary or permanent lakes in the area until the quality of the water becomes bad. One of his two wells caved in several years ago and he has just replaced it with a second well. He chose to put the well back in the same region as the one that fell in because he thinks the water and grass are good in the area.

The herder also likes having several wells in the area. By having several sources of water, he can divide up his herd among his wells if the quality of pasture is poor. If the pasture is good and he doesn't use both wells, he allows friends or relatives to use his second well.

The herder stated that for the past ten years he has not deviated from his stable movement pattern. Before digging his wells in the mid-sixties, the herder was reliant on the lake at Tiantoubarak for his water supply during the dry season. Even so, his movements prior to the installation of his wells were similar to his current grazing patterns. Because he was reliant on a more variable water supply, the herder used numerous small lakes and at times the wells of friends and tribal members in the Tiantoubarak-Aderbissinat region. During the rainy season, the herder usually went north somewhere between Marendet and Asawas. Each year he hopes to get to Asawas, but some years the quality of grass doesn't permit him. The average distance traveled to reach his habitual rainy season pastures is about 150 kms.


Agadès
Asawas
1960-75r.
In Gall
Kouichi
1960-75r.
Nama
Naikoren
1960-76d.
Tiantou-
-barak
1960-75d.
Nderbissinat
Abalak
Dakoro

EXAMPLE #3

Prominent Touareg herder in the area having a sizeable family and herd of camels. He also has goats, donkeys and a few cattle. The family is currently using a region served by a pumping station (Abouraya), a temporary lake and numerous shallow seepage wells (KIRMIDILA). Camels are watered at the pumping station; the other animals are usually watered at the shallow wells. The family currently does not own any wells in the region although, they express interest in digging a new well in the near future. The herder dug a well in the late fifties and used it until the mid-sixties (well Maigaida). He found that the well couldn't supply sufficient water for his herd and it required a considerable amount of upkeep. He sold the well and has been using wells of friends (Risse) or public wells since.

The herder historically goes far north to take advantage of the seasonal northern pastures. At times, he crosses the Agades - In Gall road. He has continually used the same area in the north for over thirty years.

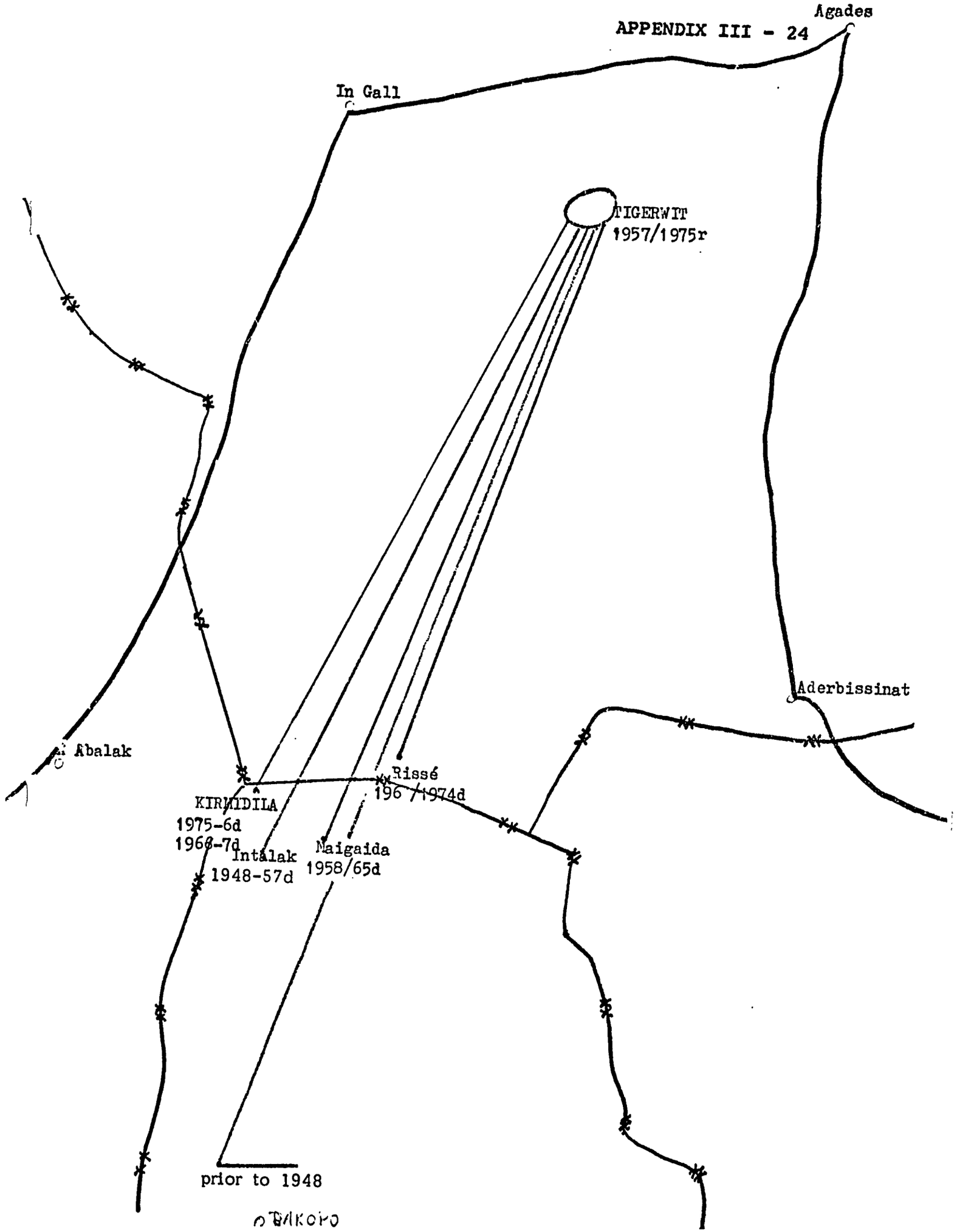
The herder expressed that he felt he could stay in one region (dry season pastures) for about ten years. After that length of time, he stated that the land and water were tired and a herder should move on to a new area. His movements over the past thirty years indicate that he practices such long term movements. The well he first remembers using steadily was located north of Dakoro and east of Iniwila. He didn't state specifically the time spent there, but estimated it was between fifteen and twenty years. They moved north to a public well, Intalak, starting to use it in about 1948 and using it for about ten years. The herder said that Intalak finally became too crowded and he dug a well for himself in the region which he then used for seven or eight years. He then sold it to a Fulani herder. After selling his own well, he used one of a fellow tribesman through the drought. Currently, he is using public water facilities while trying to dig his own well.

His migratory movements are steady and predictable. The average distance traveled

EXAMPLE #3

(Page 2)

one way between his pastures is 30 kms. It is interesting to note no deviation during the recent drought.

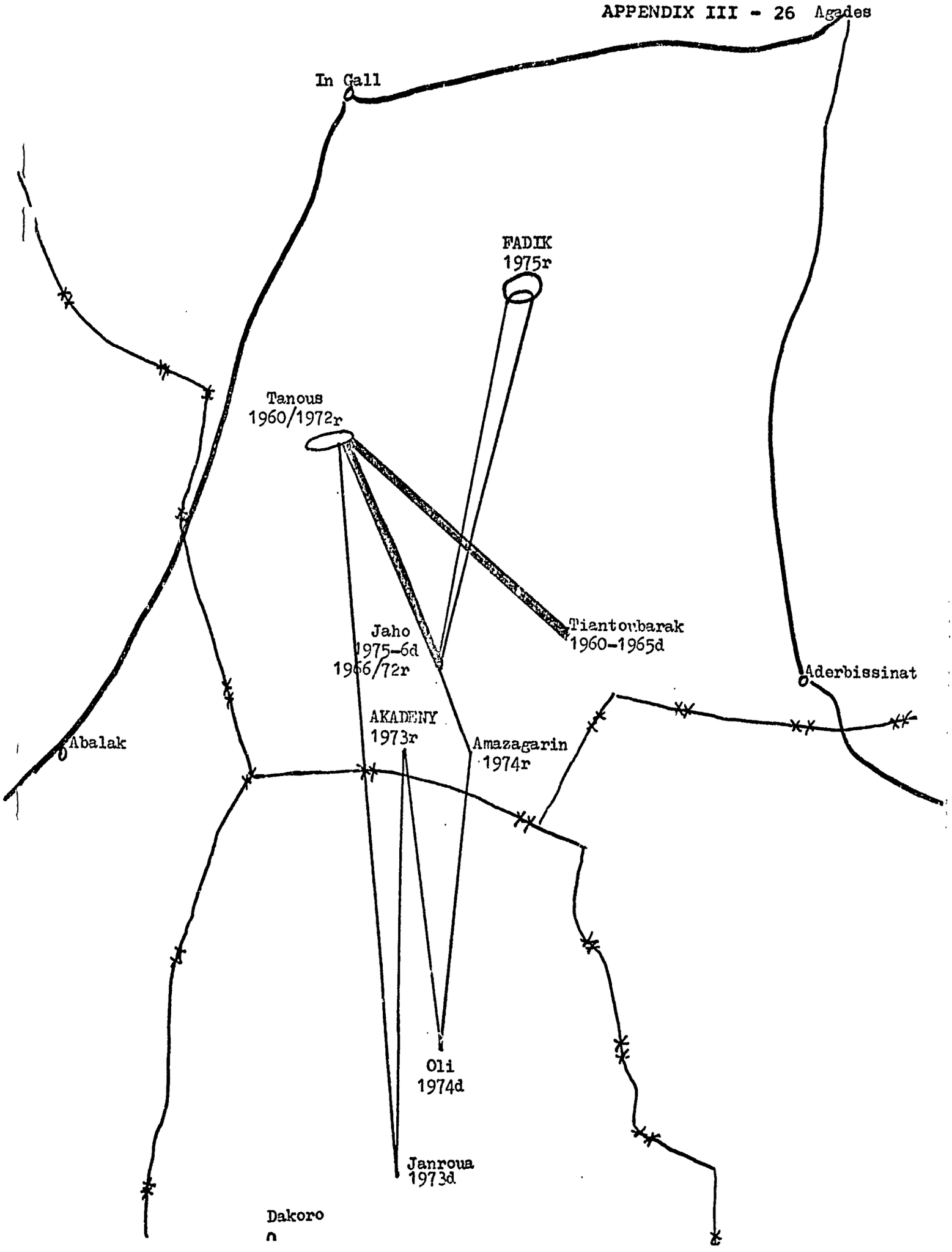

Agades
In Gall
TIGERWIT
1957/1975r
Aderbissinat
Abalak
Rissé
196 /1974d
KIRMIDILA
1975-6d
1968-7d
Intalak
1948-57d
Maigaida
1958/65d
prior to 1948
TAKORO

EXAMPLE #4

Peuhl (Fulani) Bororo having herd consisting almost totally of cattle. The herder seemingly has no sheep or goats, one camel for transportation and several donkeys as draft and pack animals. The father of the young herder interviewed had purchased the well "Jaho" eleven years ago from a Touareg. Before purchasing the well, the family used the nearly permanent lake in the same region. The herder noted that last year they didn't start using the well until December (Month of Tabaski) which is about a month later than normal for the region. The main source of water in the interval after the rains had stopped and when they began to use their well was melons having a high water content and occasionally pond water remaining several months after the rains. The herder also stated a preference for using the well over using the lake, where physically it is much less work to water the animals. The herder said there were too many people and animals around the lake.

This herder shows fairly constant migratory movements. During the dry season, they used the lake constantly until they purchased the well. The well was used constantly afterwards until they were forced out late during the drought (1973). Thus, they deviated from their traditional water source (lake 1960-5; well 1966-76) only two out of sixteen years. This deviation, we assume, was drought related. Their rainy season grazing patterns also are fairly constant. Out of the sixteen, only three were spent outside of their traditional grazing area. At least one and probably two years of this deviation can be explained by the drought. The remaining deviation (1975) was perhaps due to excellent pasture conditions in the north that year coupled with a desire on the part of the herder to use that pasture if possible.

This group holds their "worso" during the rainy season, usually in the TANOUS area. It was noted that in 1975 they did not participate in this festivity.

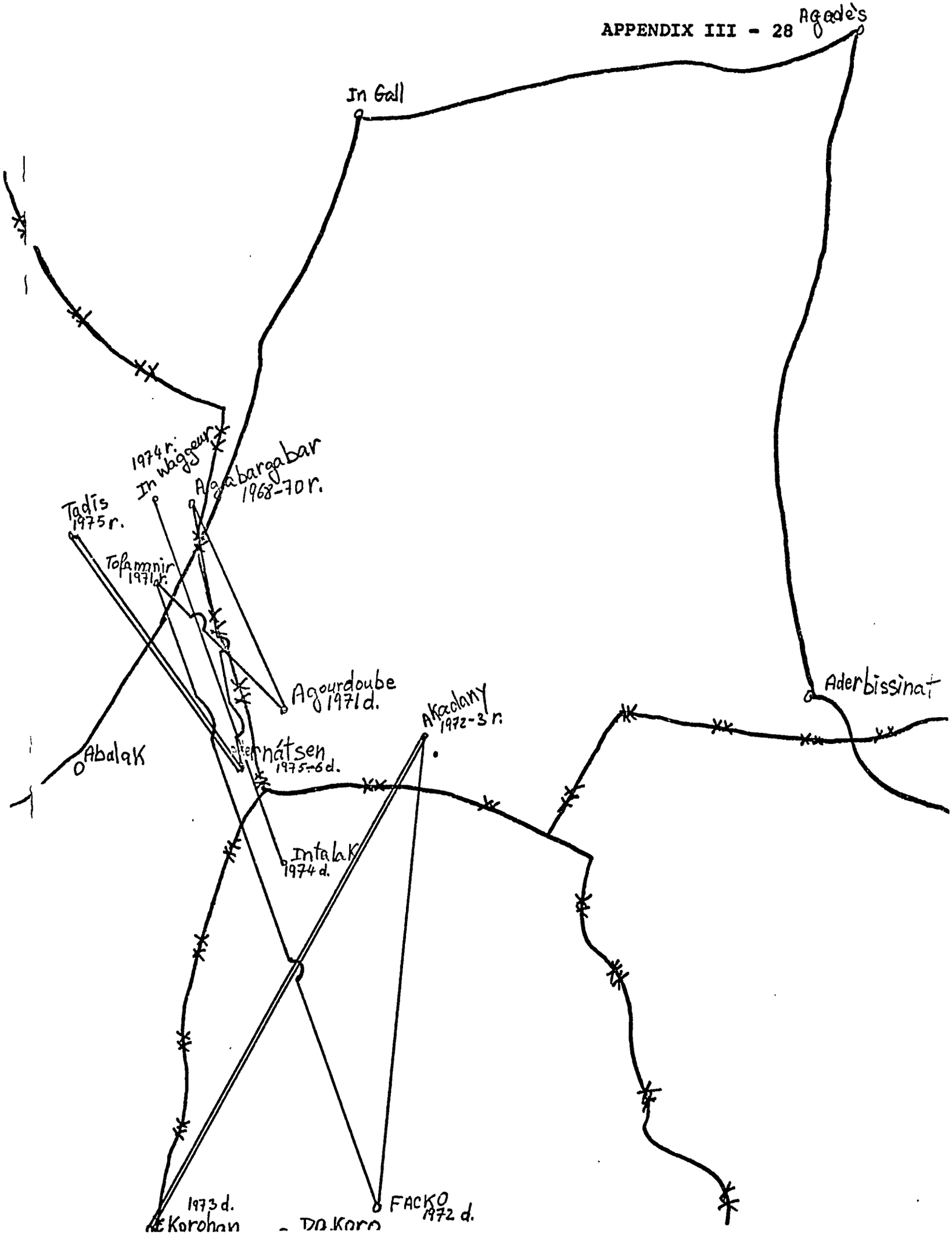

Agades
In Gall
FADIK
1975r
Tanous
1960/1972r
Tiantoubarak
1960-1965d
Jaho
1975-6d
1966/72r
Aderbissinat
AKADENY
1973r
Amazagarin
1974r
Abalak
Oli
1974d
Janroua
1973d
Dakoro

EXAMPLE #5

Peuhl (Fulani non Bororo) herder having a herd consisting almost entirely of cattle and using a public well. Herder uses pumping station (Abouraya), OFEDES wells and shallow seepage wells in the area. The herder has no history of owning wells in the area.

The herder moved fairly steadily between the AGOURDOUBE area and the InWaggeur-Tofamanir area before the drought. During the drought, he moved southward into or slightly south of the Dakoro region. The herder seems to have re-established his normal movement pattern after the drought. The "worso" of this fraction of people is held during the rainy season -- usually near Axilik (east of InWaggeur).

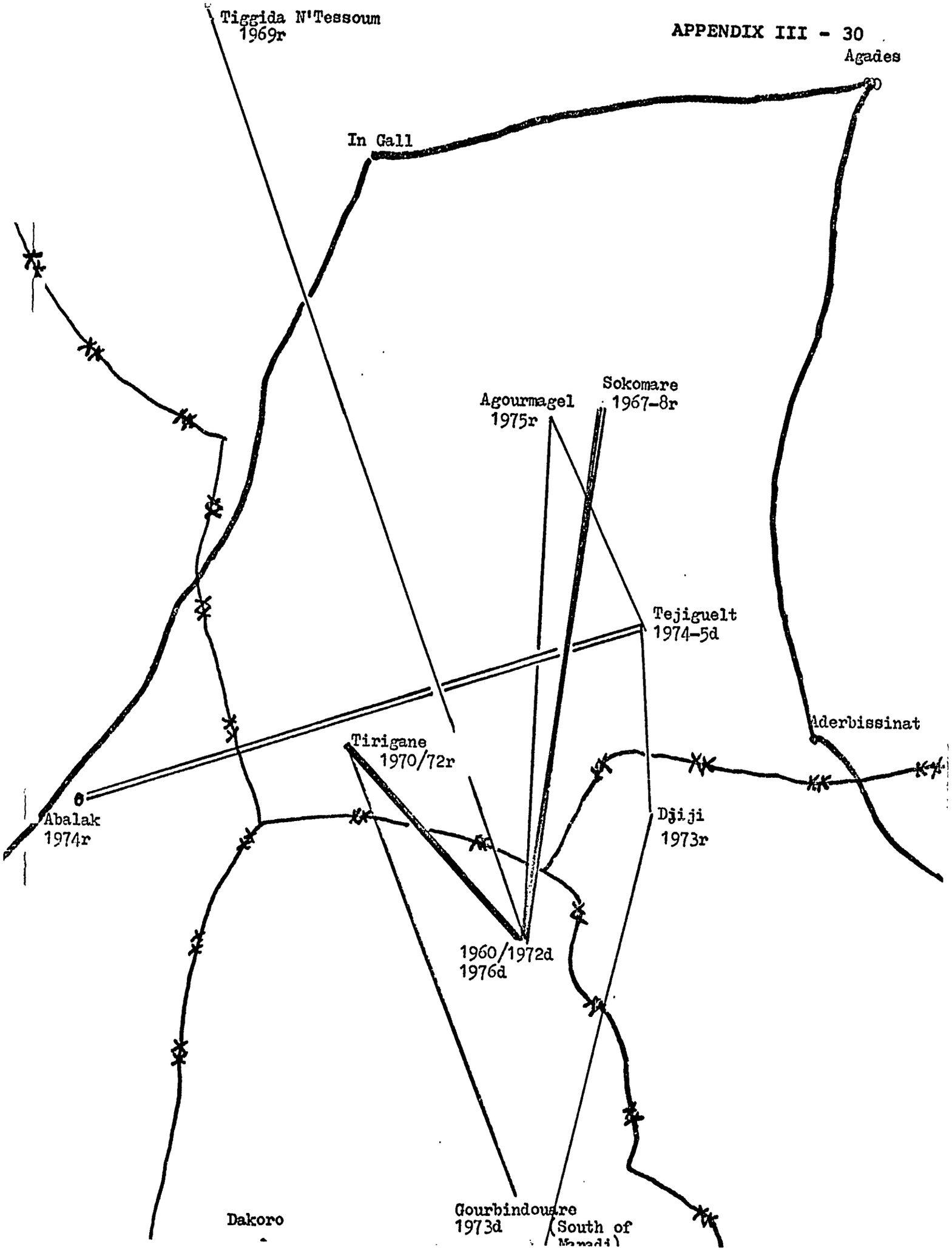
The average distance separating normal rainy season pastures and his normal dry season pastures is seventy kilometers. It is interesting to note that no importance was stated during the interview of reaching northern pastures during the rainy season.

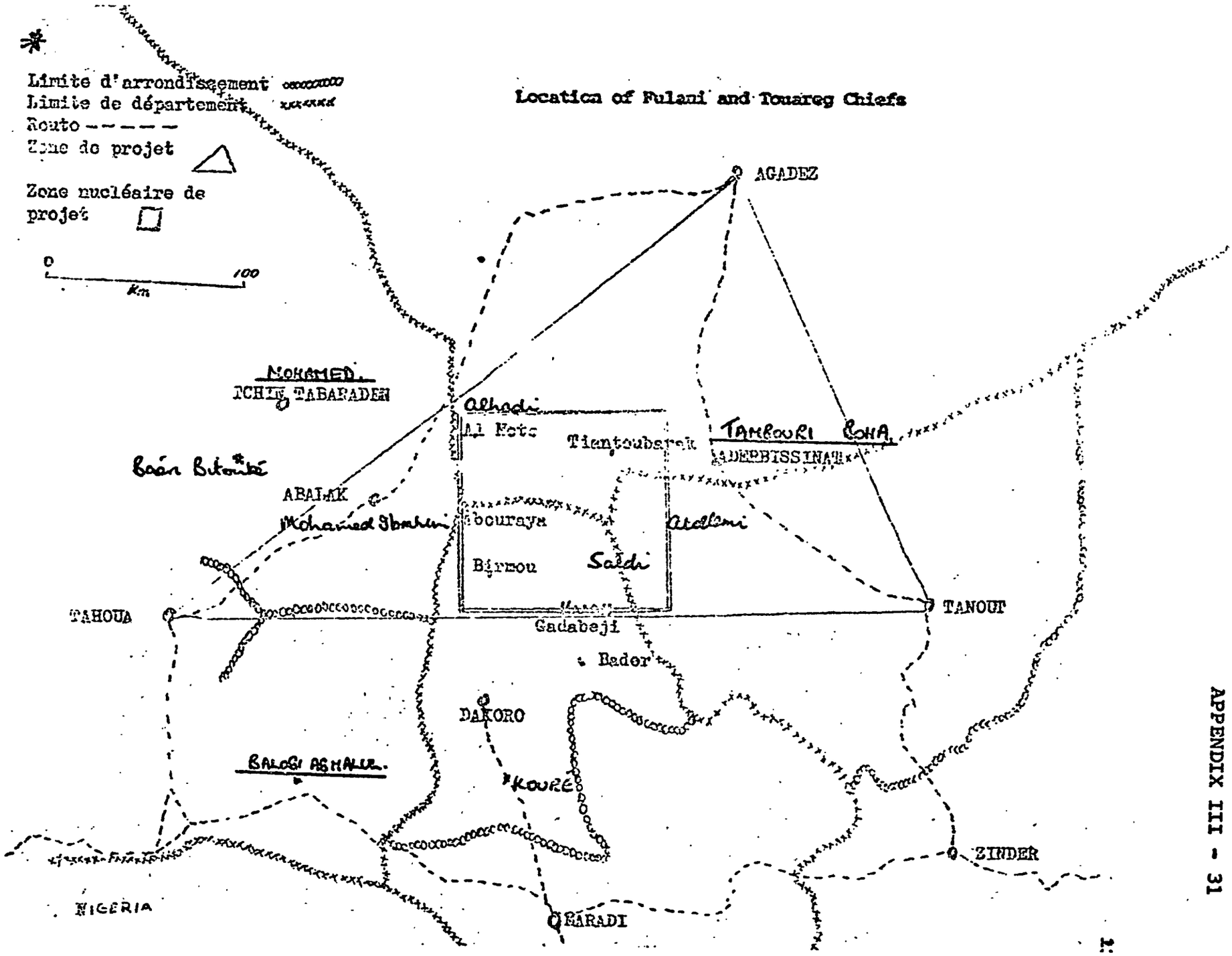

Agadès
In Gall
1974 r.
In Waggeur
Agabargabar
1968-70 r.
Tadis
1975 r.
Tofammir
1971 r.
Agourdoube
1971 d.
Akadany
1972-3 r.
Aderbissinat
Abalak
Intalak
1974 d.
1973 d.
Korohan
FACKO
1972 d.

EXAMPLE #6

Peuhl (Fulani) herder having a herd consisting primarily of cattle with some sheep, goats, and donkeys. The family has been in the region for at least twenty-five years. The well most frequently used by the herder (Dogo) was dug approximately twenty-five years ago by a family member and an older brother of the herder has inherited the well. The two brothers continue to use the well jointly. He and his brother recently hired some Haussas to repair the well which gave the herder a second means to claim some interest in the well. Cost of the recent reparation was 26,000 FCFA. The "Worso" or annual festivity reuniting all members of the fraction usually takes place in late fall on the area of Gadabeji.

The drought interrupted the herder's pre-drought grazing patterns. This year, he returned to the traditional well because the grass was better there than where they had passed the 1975 dry season. Before using the well it had to be repaired. The herder seems to have a fairly fixed pattern for using a particular well during the dey season. (Thirteen out of sixteen dry seasons were spent at well "Dogo".) The herder has no fixed pattern for using rainy season pastures and will go where the best grass is found. The herder also expressed a desire to each year go as far north as the grass would permit him. Average distance traveled annually in search of rainy season pastures was slightly over 100 kms given our nine years of data.


Tiggida N'Tessoum
1969r
Agades
In Gall
Sokomare
1967-8r
Agourmagel
1975r
Tejiguelt
1974-5d
Aderbissinat
Tirigane
1970/72r
Abalak
1974r
Djiji
1973r
1960/1972d
1976d
Gourbindouare
1973d
(South of
Dakoro


Location of Fulani and Touareg Chiefs
Limite d'arrondissement
Limite de département
Route
Zone de projet
Zone nucléaire de projet
0
100
Km
AGADEZ
MOHAMED
ICHIY TABARADEN
Alhadi
Al Fotc
Tiantoubarak
TAMBOURI
BOHA
ADERBISSINAT
Baán Bitouré
ABALAK
Mohamed Ibrahim
bouraya
Arabani
Birmou
Saidi
TAHOUA
TANOUT
Gadabeji
Bador
DAKORO
BALOGI ASMALLE
KOURE
ZINDER
NIGERIA
BARADI

HERD PRODUCTION COEFFICIENTS AND HERD COMPOSITION

BORORO CATTLE: (Nomadic/Semi-Nomadic)

Bull to cow ratio:	1 to 20
Calf crop:	56%
Effective calving rate:	41.2%
Cow replacement rate:	13%
Bull replacement rate:	15%
Age at first breeding:	3½ to 4 years
Herd offtake:	9.1%
Herd inventory change:	+1.9%
Herd offtake plus herd increase:	11%
Average age/weight of slaughter males:	3½ years/275 kg.

TOUAREG CATTLE: (Nomadic/Semi-Nomadic)

Bull to cow ratio:	1 to 20
Calf crop:	60%
Effective calving rate:	45%
Cow replacement rate:	14%
Bull replacement rate:	15%
Age at first breeding:	3½ to 4 years
Herd afftake:	9.2%
Herd inventory change:	+2.0%
Herd afftake plus herd increase:	12%
Average age/weight of slaughter males:	3½ years/200 kg.

SHEEP: (Mainly Touareg)*

Ram to ewe ratio:	1 to 25
Lamb chop:	90%
Effective lambing rate:	70%
Ewe replacement rate:	25%
Ram:	25%
Age at first breeding:	16 months
Flock afftake:	37.4%
Flock inventory change:	+2.8%
Flock afftake plus flock increase:	40.2%
Average weight/age slaughtered animal:	?

GOATS: (Mainly Touareg)

Buck to doe ratio:	1 to 25
Kid drop:	120%
Effective kidding rate:	115%
Doe replacement:	25%
Buck replacement rate:	25%
Age at first breeding:	8 - 12 months

Flock afftake:	5.5%
Flock inventory change:	+8.5%
Flock afftake plus flock increase:	63.5%

HERD COMPOSITION

The following herd data was collected by Dr. J. Coulomb DVM, Service de Zootechnic, Institute d'Elevage et de Medecine Veterinaire des Pays Tropical. He was assisted by G. Lamarque, Photo-Interpretateur-Gartograph Charge de la Realization de la carte, and member of the Service de l'Elevate et des Industries Animal du Niger.

It was completedin 1970-71, and reflects herd composition before the drought. However, after some observation, this author concludes that the percentages remain basically the same as of July, 1976. The changes which have occurred will be noted at the end of this section. Touareg Herd Composition is reflected as follows:

TOUAREG HERD COMPOSITION
(BELLA AND BUZU) - DAKARO

	Males		Castrate		Total		Female		Total*	
Classes	No.	%	No.	%	No.	%	No.	%	No.	%
Milk teeth	8	11.3			8	11.3	11	15.5	19	26.8
Two teeth							6	8.5	6	8.5
Four teeth							5	7.0	5	7.0
Six teeth	1	1.4	2	2.8	3	4.2	14	19.7	17	23.9
Eight teeth							19	26.8	19	26.8
Mautre +							5	7.0	5	7.0
TOTAL	9	12.7	2	2.8	11	15.5	60	84.5	71	100.0

BORORO HERD COMPOSITION (NEAR DAKARO)

	Males		Castrates		Total		Female		Total	
Classes	No.	%	No.	%	No.	%	No.	%	No.	%
Milk teeth	242	9.0			242	9.0	494	18.5	736	27.5
Two teeth	32	1.2	4	0.1	36	1.3	201	7.5	237	8.8
Four teeth	34	1.3	10	0.4	44	1.6	234	8.7	278	10.4
Six teeth	29	1.1	9	1.3	38	1.4	311	11.6	349	13.0
Eight teeth	46	1.7	43	1.6	89	3.3	959	35.8	1048	39.1
Mature +	1	+	1	+	2	.1	29	1.1	31	1.2
TOTAL	384	14.3	67	2.5	451	16.8	2228	83.2	2679	100.0

- Age Classification as c[illegible]ared by herder

Class by age	Number of Calves											Total	
	0	1	2	3	4	5	6	7	8	9	10	Female	Calves
0 - 1 year	225											225	
1 - 2 years	436											436	
2 - 3 years	229	5										234	5
3 - 4 years	201	27	3									231	33
4 - 5 years	97	115	18	3								233	160
5 - 6 years	34	119	52	29	5							239	330
6 - 7 years	47	96	118	54	20	1						336	579
7 - 8 years	3	15	49	43	25	7	1					143	383
8 - 9 years	3	5	21	19	21	7	3					79	241
9 -10 years			6	6	8	2	2	1				25	91
10 years +		1	7	15	7	10	4	3				47	183
Total	1275	383	274	169	86	27	10	4				2.228	2.005

- Age Classification as determined by teeth

Class by age	Number of Calves											Total	
	0	1	2	3	4	5	6	7	8	9	10	Female	Calves
milk teeth	494											494	
2 teeth	201											201	
4 teeth	228	6										234	6
6 teeth	241	56	12	2								311	86
8 teeth +	111	321	262	167	86	27	10	4				988	1.913
Total	1275	383	274	169	86	27	10	4				2.228	2.005

- Age classification as declared by herder

Class by age	Number of Calves											Total	
	0	1	2	3	4	5	6	7	8	9	10	Female	Calves
0 - 1 year	5											5	
1 - 2 years	8											8	
2 - 3 years	9											9	
3 - 4 years	4		1									5	2
4 - 5 years		2		1								3	5
5 - 6 years		4	1	1								6	9
6 - 7 years			7									7	14
7 - 8 years		1	8	1								10	20
8 - 9 years				1								1	3
9 -10 years													
10 years +			1	2	3							6	20
Total	26	7	18	6	3							60	73

- Age classification as determined by teeth

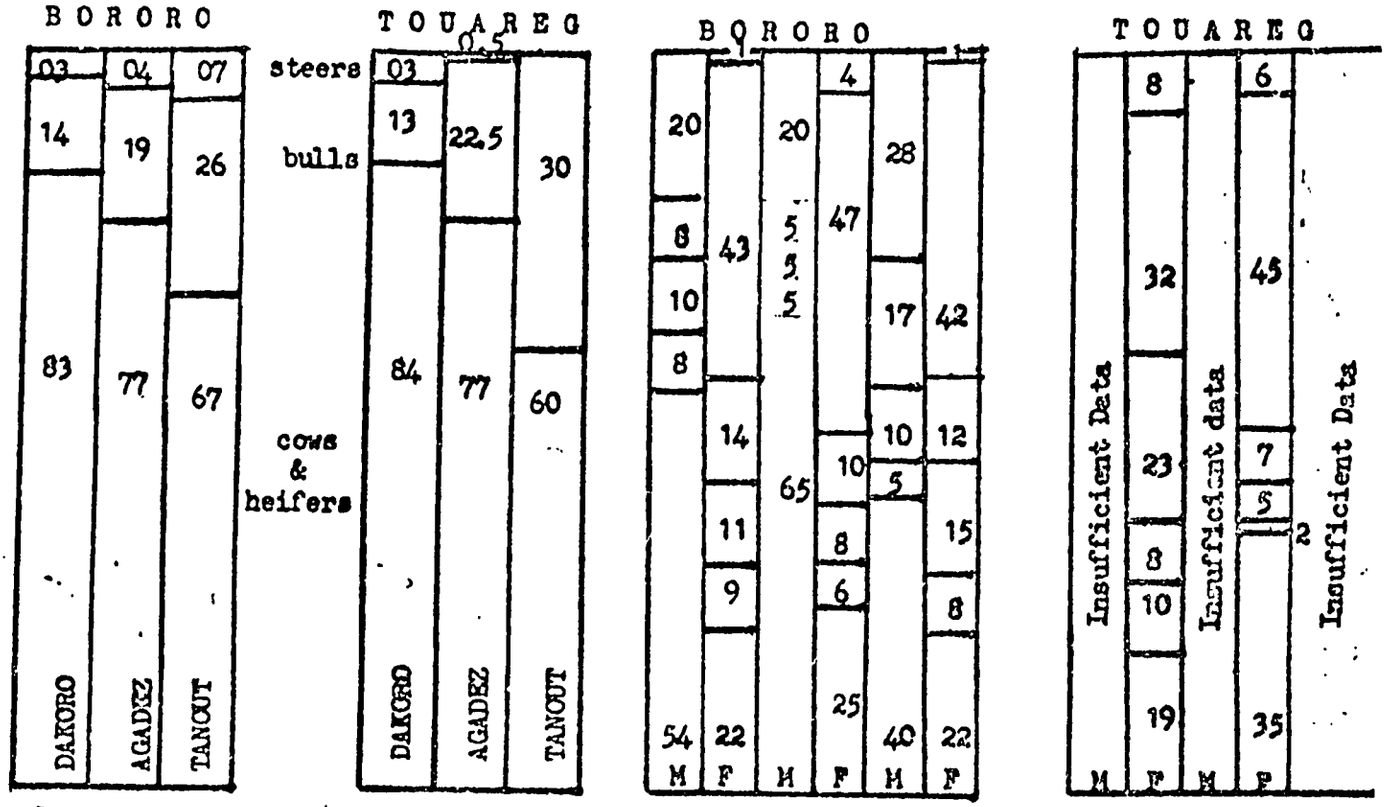
Class by age	Number of Calves											Total	
	0	1	2	3	4	5	6	7	8	9	10	Females	Calves
milk teeth	11											11	
2 Teeth	6											6	
4 teeth	5											5	
6 teeth	4	5	5									14	15
8 teeth +		2	13	6	3							24	58
Total	26	7	18	6	3							60	73

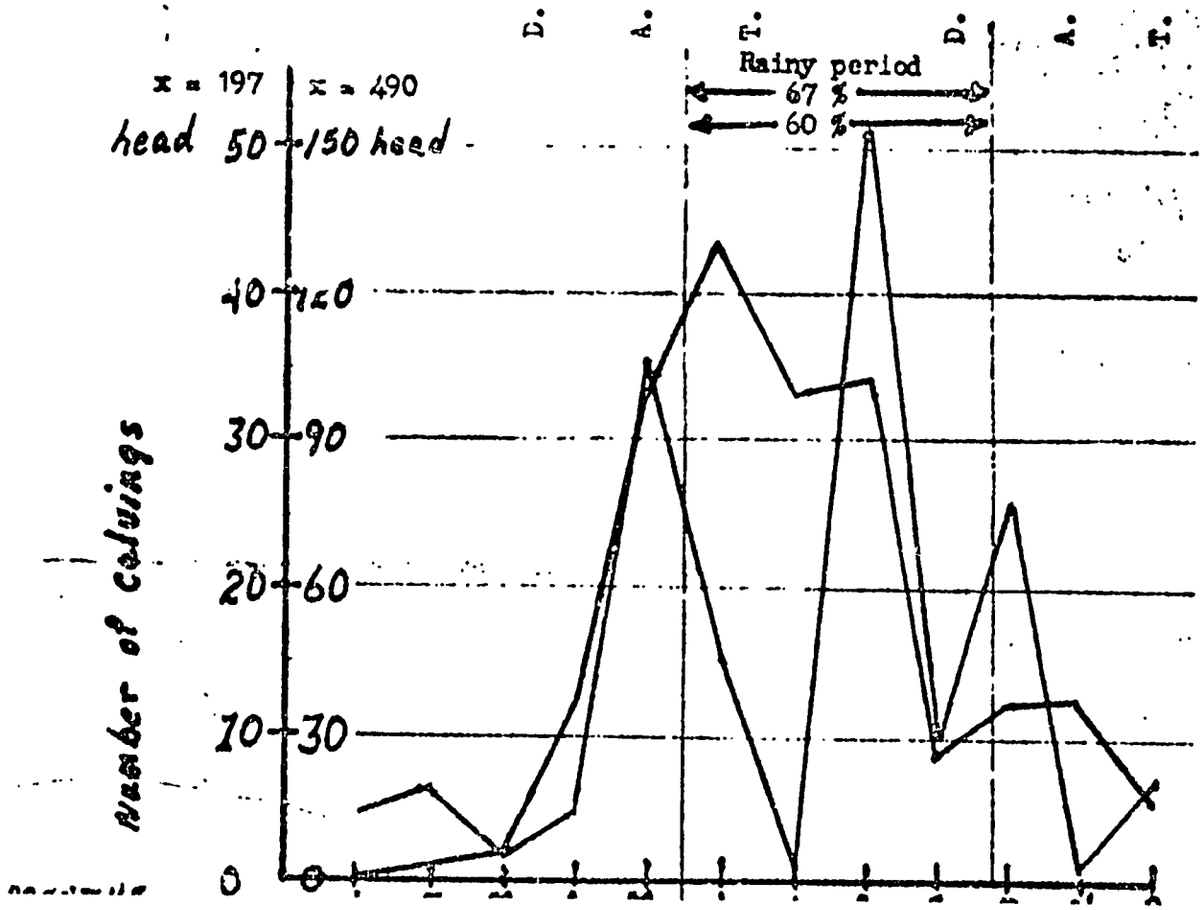
Comparison of herd composit : by sex, ethnic group and arrondissement.

(figures show % each group of total herd)

Age structu of herds by sex, ethnic groups and arrondissement.

(age determined milk teeth or number of permanent adult teeth)





BIRTH RATE FREQUENCY FOR 197 MOTHER COWS

January	0	0
February	1	.5
March	2	1.0
April	13	6.6
May	33	16.7
June	43	21.8
July	33	16.7
August	34	17.3
September	9	4.6
October	12	6.1
November	12	6.1
December	5	2.5
Total	197	

GROUPED BY QUARTERS

		No.	%
Cool dry season	Jan., Feb., Mar.	3	1.5
Hot dry-stress period	Apr., May, Jun.	89	45.1
Rain (move to Salt Cure)	Jul., Aug., Sept.	76	38.6
Hot dry	Oct., Nov., Dec.	29	14.7

NUMBER OF CATTLE EXPORTED FOR SLAUGHTER
CHAD, MALI, MAURITANIA, NIGER, UPPER VOLTA
1966-1972

	1966	1967	1968	1969	1970	1971	1972
Chad	9,150	8,840	7,550	9,380	13,630	13,350	13,060
Mali	12,010	14,280	10,800	20,600	19,880	17,530	16,150
Mauritania	14,700	15,000	14,670	14,690	14,400	14,500	14,600
Niger	13,490	13,850	14,470	15,060	15,630	16,160	16,680
Upper Volta	10,790	11,680	12,840	10,010	7,370	9,530	8,760
Total	60,140	63,650	60,330	69,690	70,910	71,070	68,750
Index		106	100	116	118	118	115
Percentage Change		+6	-6	+16	+2	+/-0	-3

The following table, prepared by Dr. George B. McLeroy after many years of experience in West Africa, helps bring some important facts to attention.

The project zone in Niger, because of its low calf drop and high calf mortality falls within the subsistance stage of development. Assuming all seven of the explanatory notes to be constant, the generation interval (the number of years between the time an animal conceives a calf, and that calf is grown and old enough to conceive) is between 7.0 and 7.5 years.

This number should be kept in mind when planning any development programs for livestock. Assuming any program initiated within the next two years can only yield measurable results when the present animal population has improved enough to pass those advantages on to the next generation, it will take at least two 7.0 year generation intervals to yield a measurable response.

AVERAGE DYNAMIC PARAMETERS AND THEIR RELATIONSHIP IN A CONSTANT-SIZED CATTLE POPULATION AT DIFFERENT STAGES OF DEVELOPMENT

Stage of Development	Reproductive Rate-%			Offspring Needed as Breeding Replacements-%		Age at First Breeding in Years	Generation Interval in Years	Required Annual Offtake-%	% of Required Total Annual Offtake by Sex and Relative Age					
									Male			Female		
	Calf Drop	Calf Mortality	Effective Rate	Male	Female				Young	Old	Total	Young	Old	T l
Highly Developed	90	5.0	86	3.0	45	1.50	4.5	37	57	3	60	20	20	40
	85	6.0	80	4.0	50	2.00	5.0	28	31	31	62	16	20	38
Developed	76	8.0	70	5.0	60	2.50	5.5	21	21	44	65	16	19	35
	68	12.0	60	6.0	70	3.00	6.0	16	13	56	69	13	18	31
Developing	60	17.0	50	7.0	80	3.25	6.5	12	8	66	74	9	17	26
Subsistence	55	28.0	40	9.0	90	3.50	7.0	10	4	76	80	5	15	20
	45	35.0	29	12.0	100	3.75	7.5	8	1	86	87	0	13	13

EXPLANATORY NOTES:

1. Sex ratio at birth assumed to be 50:50.
2. Calf drop expressed as a percent of total breeding age females in the breeding herd during the breeding season.
3. Effective calving rate equals calf drop minus calf mortality to one year, expressed as a percent.
4. Offspring needed as breeding replacements based on effective calving rate.
5. Generation interval is the average age of parents when their offspring are born.
6. Required annual offtake (exclusive of all losses) or extraction rate (based on average herd size during the year) if herd size is to remain constant.
7. A higher or lower annual offtake at a given stage of development would be reflected in a reduced or expanded total population, as the case might be.

APPENDIX IV

MISCELLANEOUS INFORMATION

	Page
Composition of animal and plant by-product feeds	1
Location of wells and villages used as vaccination centers and available corrals	2
Basic values of livestock	3
Analysis of local salt resources	4 - 5
Daily nutrient requirements of beef cattle	6 - 7
Alternative range management plans	8 - 9

COMPOSITION OF THE ANIMAL AND PLANT
BY-PRODUCTS LISTED BELOW

Feedstuff	Dry Matter	Dig. Crude Protein	TDN	Calcium	Phosphorus
	%				
High Protein Feeds					
Blood meal, dried	89.5	72.7	60.0	.32	.25
Bone meal, steamed	87.9	26.2	65.0	30.53	10.02
Cottonseed cake	89.1	17.2	48.9	.23	1.12
Cottonseed meal	90.5	31.1	79.2	.17	.58
Meat & bone scraps	91.8	46.3	64.5	10.44	4.89
Peanut oil meal,39% protein	90.2	36.7	80.3	.14	.50
Peanut screenings	92.0	19.0	70.1	1.18	.05
High-Carbohydrate Feeds					
Cottonseed, whole	92.5	10.7	75.8	.24	.68
Rice bran	90.1	6.5	55.1	.11	.65
Sorghum, grain	89.6	8.4	78.4	.02	.32
Roughages					
Millet stalks	92.3	1.7	39.9	.30	.21
Cottonseed hulls	88.4	.3	38.1	.13	.07
Peanut shells	92.3	1.6	19.0	.23	.04
Rice hulls	92.0	.8	15.0	.09	.06
Rice straw	91.5	.1	44.2	.20	.08
Sorghum fodder, dried	88.2	2.2	54.4	.29	.15

Appendix of Miscellaneous Information

Wells and villages used as vaccination centers in Dakoro area

1. Guidan Amadou
2. Mayoki
3. Agikoria
4. Mai Wasa
5. Issou
6. Guirka
7. Amouless
8. Sadoni
9. Dan Binta
10. Korahan
11. In Touilla *
12. Hama
13. In Talak *
14. Akadanil
15. Guidan Galadima
16. Para Amadodo
17. G Kané Bango
18. Dalla
19. Mai Janroua
20. Koren Mota
21. Olli
22. Markaon
23. Sansani
24. Sabou Machi
25. Jaja
26. Talewa
27. Kouka Goma
28. Kougou
29. Mai Koulaki
30. Gadabedji *
31. Tougouto
32. Gadambo *
33. Gangara
34. Sakawa
35. Dan Mallum
36. Dan Boka
37. Illo
38. Goula
39. Bodu
40. Koudou
41. Samia Andi

Location of Available vaccination corrals

Dakoro
Dakoro villa
Intuila
Goula
Abouraya

Tanout
Tanout villa
Belbeji
Tchin Taraguen

Agades
In Gall
Aderbissinat
Tamaya (Al Mota)
Marandet

Tahoua
Abalak
Tofamaner
In Waggeur

Basic values of indivual animals in project area

Camel

Riding Camel (white)	: 60,000 - 70,000 CFA
Porter Camel (brown etc.)	: 40,000 - 45,000 CFA
Small Camel	: 30,000 CFA
Old & thin camel	: 15,000 CFA

Cattle

Brood Cow (4 yrs to 7 yrs)	: 60,000 CFA
Herd Bull (4 yrs to 7 yrs)	: 60,000 - 70,000 CFA
Replacement Heifers	: 45,000 - 50,000 CFA
Young Bull	: 47,000 CFA
Steers ($3\frac{1}{2}$ - 4 yrs)	: ?

Goats

Female goat	: 2,000 - 3, 000 CFA
Large & fat both sexes	: 5,000 CFA
Billys	: 3,000 CFA

Sheep

Female Ewe	: 2,000 - 3, 000 CFA
Large & fat both sexes	: 5,000 CFA
Rams	: 3,000 CFA

Donkey

Mature good donkey (both sexes)	: 10,000 CFA
Small or poor donkey	: 5,000 CFA

Horse

Stallion (good)	: 70,000 CFA +
Mare (good)	: 70,000 CFA +
all others	: 40,000 CFA +

October 4, 1976 SALT ANALYSIS

SAMPLE 1, FACHI, NIGER SAMPLE 2, GOURE, NIGER SAMPLE 3, GOURE, NIGER

SAMPLE #	%N	%P	%K	%CA	%MG	%NA
1	0.29	.012	1.53	0.12	.644	0.33
2	0.31	.082	2.75	1.16	.644	0.43
3	0.23	.043	1.38	0.50	.197	0.52

SAMPLE #	PPM CU	PPM ZN	PPM MN	PPM FE	PPM BORON
1	2	16	25	774	8
2	7	21	67	890	50
3	14	48	50	1455	29

Sample #1

Sample of salt block coming originally from deposits in the region of FACHI. Vendor stated that the salt came from FACHI and several herders verified this, judging by a) the pinkish color of the block of salt, and b) the size of the salt granules.

Salt is found suspended in water which is evaporated and the remaining slush is emptied into rock lined holes dug in the ground. The holes are filled with the slush and the remaining water is allowed to drain away. When the block is fully solidified, the salt is taken out of the mold and ready for shipment.

The salt is purchased by herdsmen for distribution in limited quantities to their animals during the cool, dry season (late November to mid-March). Animals are supplied salt at monthly or forty-five day intervals. This salt is given most frequently to large animals (cattle and camels) usually in a dry form and alone. However other herders give the salt to all types of animals, goats and sheep included.

Sample was taken at Intwila market in late June by Baker.

Sample #2

Sample of salt (alkaline ?) matter originating from GOURE region. Vendor stated that matter did originally come from the GOURE region and herders verified samples as what is usually referred to in French as GOURE natron (naturally hydrated sodium carbonate).

The subject matter apparently is found near the surface (or on the surface) and is excavated with simple hand tools, packaged and sold without any further refinement. (This suggests the natron comes from a heavy alkaline area.)

The salt matter is purchased by herders for distribution in limited quantities to their animals during the hot season (mid March to June). Animals are supplied this supplement usually at monthly or month-and-a-half intervals. This salt supplement is given to all types of animals (sheep and goats as well as cattle and camels). It is usually given in a dry form and alone.

Sample taken at the Intwila market in late June by Baker.

Sample #3

Sample of salt (alkaline ?) matter found in the region of GOURE. Same basic description applies for this sample as was given for Sample #2.

Price paid for similar quantities of natron did not vary substantially from one market to another, nor for one sample product as opposed to the second sample product. It would appear that users of this natron consider samples two and three as like products.

Herders in the area claim that the salt matter similar to sample one is more concentrated and is too concentrated a salt ration for animals during the hot season. For this reason, they prefer to give animals GOURE natron during the hot season.

Sample was taken at the SAKABAL market in late June by Baker.

TABLE 1 Nutrient Requirements of Beef Cattle (Daily Nutrients per Animal) – Continued

Body Weight (kg)	Average Daily Gain (kg)	Daily Dry Matter per Animal[a] (kg)	Total Protein (kg)	Digestible Protein (kg)	Energy ME[b] (Mcal)	Energy TDN[c] (kg)	Ca (g)	P (g)	Carotene (mg)	Vitamin A (Thousands IU)
300	0.00	4.5	0.35	0.19	9.3	2.6	8	8	25.0	10.0
	0.25	6.1	0.54	0.32	12.6	3.5	11	11	34.0	13.6
	0.50	7.7	0.77	0.47	15.9	4.4	14	14	43.5	17.4
	0.75	8.0	0.89	0.57	18.2	5.0	17	15	44.5	17.8
400	0.00	5.6	0.44	0.24	11.5	3.2	10	10	31.0	12.4
	0.25	7.7	0.64	0.35	15.9	4.4	14	14	43.0	17.2
	0.50	9.7	0.86	0.50	20.0	5.5	17	17	54.0	21.6
	0.75	9.9	0.88	0.51	22.6	6.3	18	18	55.0	22.0
Growing Heifers										
150	0.00	2.7	0.21	0.11	5.6	1.5	5	5	15.0	6.0
	0.25	3.2	0.36	0.23	7.3	2.0	8	7	17.5	7.0
	0.50	3.2	0.39	0.26	8.4	2.3	12	10	18.0	7.2
	0.75	3.3	0.44	0.30	9.3	2.6	17	13	18.5	7.4
200	0.00	3.3	0.26	0.14	6.8	1.9	6	6	18.5	7.4
	0.25	4.6	0.46	0.28	9.5	2.6	8	8	25.5	10.2
	0.50	5.0	0.56	0.36	11.4	3.2	13	10	28.0	11.2
	0.75	5.4	0.60	0.38	13.5	3.7	18	14	30.0	12.0
300	0.00	4.5	0.35	0.19	9.3	2.6	8	8	25.0	10.0
	0.25	6.2	0.55	0.32	12.8	3.5	11	11	34.5	13.8
	0.50	8.2	0.82	0.50	16.9	4.7	15	15	45.5	18.2
	0.75	8.6	0.95	0.61	19.6	5.4	17	15	47.5	19.0
400	0.00	5.6	0.44	0.24	11.5	3.2	10	10	31.0	12.4
	0.25	7.7	0.64	0.35	15.9	4.4	14	14	43.0	17.2
	0.50	10.2	0.91	0.53	21.0	5.8	18	18	56.5	22.6
	0.75	10.6	0.94	0.55	24.2	6.7	19	19	59.0	23.6
Dry Pregnant Mature Cows										
350	—	5.8	0.34	0.16	10.3	2.8	9	9	35.0	14.0
400	—	6.4	0.38	0.18	11.5	3.2	10	10	38.8	15.5
450	—	6.8	0.40	0.19	12.4	3.4	12	12	42.0	16.8
500	—	7.6	0.44	0.21	13.6	3.8	12	12	45.5	18.2
550	—	8.0	0.47	0.22	14.4	4.0	12	12	48.8	19.5
600	—	8.6	0.50	0.24	15.5	4.3	13	13	52.0	20.8
Cows Nursing Calves, First 3–4 Months Postpartum										
350	—	8.6	0.79	0.46	17.7	4.9	25	20	83.0	33.2
400	—	9.3	0.86	0.50	19.2	5.3	26	21	90.0	36.0
450	—	9.9	0.91	0.53	20.4	5.6	28	22	96.2	38.5
500	—	10.5	0.97	0.57	21.6	6.0	28	23	102.5	41.0
Bulls, Growth and Maintenance (Moderate Activity)										
300	1.00	8.7	1.21	0.84	20.4	5.6	23	18	85.0	34.0
400	0.90	10.0	1.33	0.90	23.5	6.5	19	18	97.0	38.8
500	0.70	12.0	1.60	1.08	25.8	7.1	21	21	116.5	46.6
600	0.50	11.6	1.42	0.94	24.9	6.9	21	21	113.0	45.2
700	0.30	12.7	1.41	0.90	26.2	7.2	23	23	123.5	49.4
800	0.00	9.9	0.99	0.60	20.4	5.6	18	18	96.2	38.5
900	0.00	10.7	1.07	0.65	22.0	6.1	19	19	104.0	41.6

[a] Feed intake was calculated from the NE requirements and average NE values for the kind of ration being fed.
[b] ME requirements for growing and finishing cattle were calculated from the NE_m and NE_{gain} requirements for weights and rates of gain (see page 3).
[c] TDN was calculated from ME by assuming 3.6155 kcal of ME per g of TDN.

TABLES

TABLE 1 Nutrient Requirements of Beef Cattle (Daily Nutrients per Animal)

Body Weight (kg)	Average Daily Gain (kg)	Daily Dry Matter per Animal[a] (kg)	Total Protein (kg)	Digestible Protein (kg)	Energy ME[b] (Mcal)	Energy TDN[c] (kg)	Ca (g)	P (g)	Carotene (mg)	Vitamin A (Thousands IU)
Finishing Steer Calves										
150	0.90	3.5	0.45	0.30	9.9	2.7	21	15	19.5	7.8
200	1.00	5.0	0.61	0.41	13.4	3.7	23	17	27.5	11.0
300	1.10	7.1	0.87	0.58	19.0	5.3	26	19	39.5	15.8
400	1.10	8.8	0.98	0.62	23.5	6.5	25	20	49.0	19.6
450	1.05	9.4	1.04	0.67	25.1	6.9	21	21	52.0	20.8
Finishing Yearling Steers										
250	1.30	7.2	0.80	0.51	18.8	5.2	29	20	40.0	16.0
300	1.30	8.3	0.92	0.92	21.7	6.0	29	21	46.0	18.4
400	1.30	10.3	1.14	0.73	26.9	7.4	28	23	57.0	22.8
500	1.20	11.5	1.28	0.82	30.0	8.3	26	26	64.0	25.6
Finishing Two-Year-Old Steers										
350	1.40	10.3	1.14	0.73	26.4	7.3	30	24	57.0	22.8
400	1.40	11.3	1.25	0.80	28.9	8.0	30	25	63.0	25.2
500	1.40	13.4	1.49	0.95	34.3	9.5	30	30	74.5	29.8
550	1.30	13.7	1.52	0.97	35.1	9.7	30	30	76.0	30.4
Finishing Heifer Calves										
150	0.80	3.5	0.45	0.30	9.9	2.7	18	13	19.5	7.8
200	0.90	5.0	0.61	0.41	13.4	3.7	21	15	27.5	11.0
300	1.00	7.3	0.89	0.59	19.5	5.4	23	18	40.5	16.2
400	0.95	8.7	0.97	0.62	23.2	6.4	23	19	48.5	19.4
Finishing Yearling Heifers										
250	1.20	7.6	0.84	0.54	19.8	5.5	27	20	42.0	16.8
300	1.20	8.6	0.95	0.61	22.4	6.2	27	20	48.0	19.2
400	1.20	10.7	1.19	0.76	27.9	7.7	30	24	59.5	23.8
450	1.10	11.0	1.22	0.78	28.7	7.9	24	24	61.0	24.4
Growing Steers										
150	0.00	2.7	0.21	0.11	5.6	1.5	5	5	15.0	6.0
	0.25	3.1	0.34	0.22	7.1	2.0	8	7	17.0	6.8
	0.50	3.2	0.39	0.26	8.4	2.3	12	10	17.5	7.0
	0.75	3.2	0.43	0.29	9.0	2.5	17	13	17.5	7.0
200	0.00	3.3	0.26	0.14	6.8	1.9	6	6	18.5	7.4
	0.25	4.5	0.45	0.27	9.3	2.6	8	8	25.0	10.0
	0.50	4.9	0.54	0.35	11.2	3.1	13	10	27.0	10.8
	0.75	5.0	0.56	0.36	12.5	3.5	18	14	28.0	11.2

ALTERNATIVE RANGE MANAGEMENT PLANS

The following outline shows three possible management plans using the 3 year, 3 pasture rotation grazing system. The study area is divided into the three Prefet districts that make up the area. A certain number of families or family groups are assigned to graze within a certain Prefet District.

Maradi District - Broken into three pastures. Pasture 1 is grazed July-November. Pasture 2 is grazed November-March. Pasture 3 is then grazed in growing season July-November the second year and the cycle continues according to example.

Agadez District - Broken in three separate grazing areas of 3 pastures each. Herdsmen would be assigned to one of the three large areas and follow a 3 pasture rotation system within his particular area. This system can be accomplished without the use of fence if herding can be confined to arbitrary marked but unfenced boundary.

Zinder District - The Zinder District grazing pattern would be a simple rotation grazing program not contingent on marked areas. Herdmen would refrain from summering or wintering in the same area two years in succession.

ADDENDUM

RANGE REVEGETATION CONSIDERATIONS FOR NIGER RANGE

ADDENDUM TO NIGER RANGE LIVESTOCK INVENTORY TEAM REPORT

Range Revegetation Considerations For Niger Range

General

Range Reseeding of selected sites with high potential for response, fullfills the goal of soil retention (prevents abnormal soil and water losses) and increases forage production.

Range seeding should be practiced only on lands that have the potential for supporting a satisfactory stand of adapted species once established.

The key to successful range seeding is that it should only be done where it can be anticipated that there will be management following seeding. Management is essential to insure seeding establishment and subsequent maintenance of the stand.

The Methodology to be considered for rangeland seeding presents no major problems. Specialized rangeland seeding equipment, seed of desirable grass species and the technical expertise to accomplish the job are all available. The mechanics of the specialized equipment and the

"Recipe" knowledge has been proven and tested with great success. The major deterent factors for the success of revegetation projects in Niger are social, economical and managerial.

It is important to allow for a minimum of two growing seasons of complete non-use of sites that are seeded. Hence it is important to have control of the seeded sites so that livestock do not have access until the seeding is well established. Deferment for two seasons, does not necessarily mean two years---it would imply a period of 18 months from the original seeding dates, (but include two growing seasons.)

Seeding Methodology would include (depending upon site selection) plowing, drilling and/or pitting and drilling and Aerial Reseeding. In many instances it would be necessary to broadcast the seed in deference to drilling. Slope, position, soil composition and plant competition, would influence the seedbed preparation and seeding methods.

Some species that could be recommended for trial plantings are:

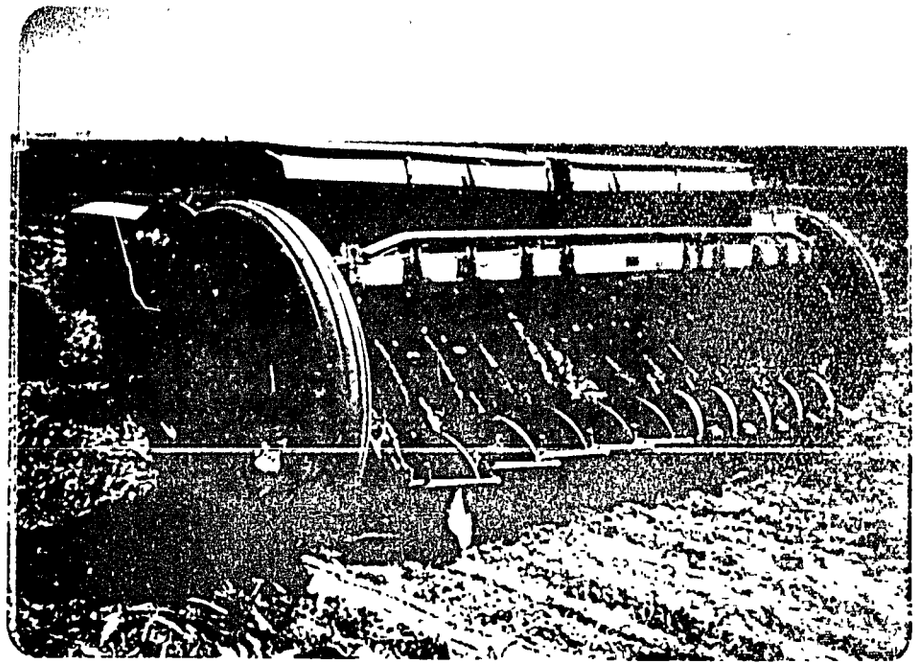
1.	Cenchrus Catharticus	Native to the Sahel
2.	Andropogon Gayanus	Native to the Sahel
3.	Cenchrus Ciliaris	(Buffelgrass) Exotic
4.	Sporobolus Crytandrus	(Sand Dropseed) Exotic
5.	Sporobolus Wrightii	(Sacaton) Exotic
6.	Sporobolus Airoides	(Alkali Sacaton) Exotic

7. Eragrostis Chloromelas (Boers Lovegrass) Exotic
8. Eragrostis Intermedia (Plains Lovegrass) Exotic
9. Eragrostis Superba (Wilman Lovegrass) Exotic
10. Panicum Antidotale (Blue Panicgrass) Exotic
11. Oryzopsis Hymenoides (Indian Ricegrass) Exotic

Drilling Seed

Utilization of a rangeland drill and medium size wheel tractors (65-80 Hp) would be the most practical method for reseeding the majority of the Pastoral Zone.

Drilling seed has advantages over Broadcasting and Aerial Seeding. Drilled seed can be accurately placed at the desired planting depth and the seeding rate can be accurately measured. The resulting new grass stands are generally dense and uniform. The majority of the range sites would respond to drilling alone with no land preparation as the drill would disturb the light soils sufficiently to allow proper moisture penetration for germination.



Specially designed rangeland drill. Extra large wheels and heavy duty construction design allows this machinery to operate in a variety of brush and terrain environments.

Pitting and drilling will have limited application in specialized areas such as those exhibiting high runoff and areas with rough terrain occupied by undesirable vegetation.

The "Jordan Pitter" creates small pits in the soil that trap precipitation and concentrates the moisture in the pits creating a more favorable site for seed germination and growth.

The soil disturbance and pits also retards water runoff on hillside and sloping topography.

A well trained two man crew, utilizing a 65-80 Hp tractor, 14 ft. rangeland drill, and support two man crew should be able to seed 12-16 acres per hour at an average cost of U.S. $10.00/acre. This cost includes gas, oil, grease, maintenance, labor and seed.

Cost does not include purchase of equipment, depreciation, overseas shipment, duties, insurance or profit for the contractor.

Note - Special steel cleated wheels should be considered for use on the tractor and drills while seeding, because the ever present Camel Thorn punctoring pneumatic tires would be a tremendous deterent to an efficient reseeding operation.

Aerial Reseeding

Aerial Reseeding is a realistic seeding method that should be given consideration in the revegetation planning for large range areas in the pastoral zone. However, before aerial reseeding could commence certain support infrastructures must be considered.

1. Landing Strips - These must be constructed at 25-30 mile intervals and should be compacted dirt strips at least 4,000 ft. long. Wind socks should also be installed at each strip.

2. A network of roads will be needed to connect each strip so a dependable supply of fuel and seed could be trucked into that strip when in use.

3. Support crews must be trained. A three man flagging, fueling and loading team is required for each operating aircraft, plus one pilot.

4. Aircraft commonly used in this type operation are 600 Hp. types with hopper capacities for 3,500-4,000 pounds seed. This quantity is generally sufficient to seed 600-700 acres at one filling depending upon the seeding rate. Fuel consumption for these type aircraft generally is 25-30 gallon/hr.

Assuming all logistical support (fuel, seed, crew, etc.) systems were operating normally; a single aircraft with a four man crew could seed up to 10,000 acres/day at a U.S. cost of $10.00/acre. This $10.00/acre cost figure would include seed, labor, fuel, aircraft and maintenance.*

*Note - It is important to emphasize that cost figures as expressed in the seeding addendum are relative and are not specific figures that might be expressed

by a contract proposal. These figures basically would cover seed costs and basic application costs as might be expressed Stateside.

Aerial reseeding alone is not the answer for revegetation in the pastoral zone. It is another method of seed application to be considered along with other seeding techniques. The inherent factors of soil moisture, precipitation patterns, temperature and soil condition must be optimum for any chance of reasonably success in obtaining germination and a grass stand.