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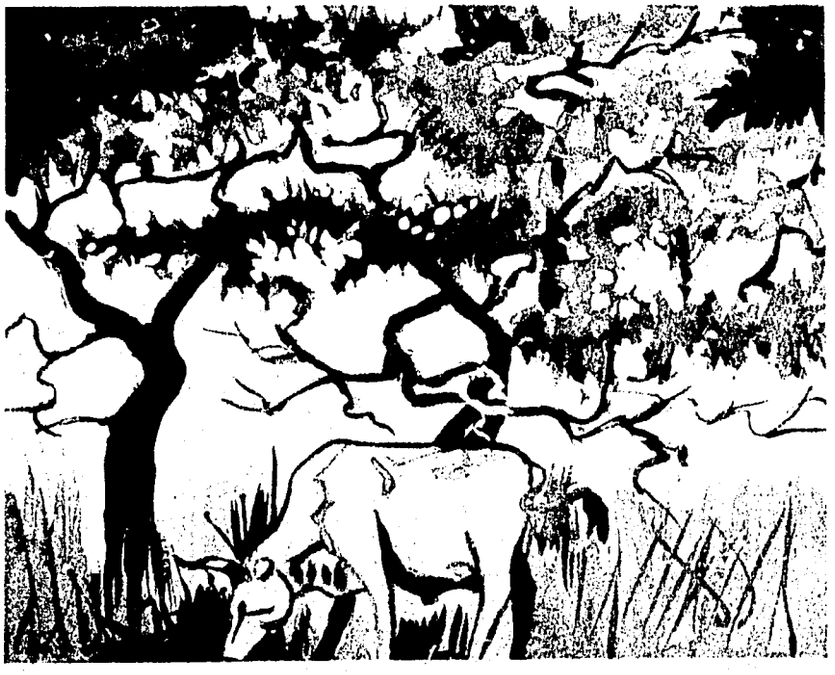

FINAL DESIGN REPORT

BAKEL RANGE LIVESTOCK PROJECT
EASTERN SENEGAL

Prepared for the
Agency for International Development
Department of State

Consortium for International Development
Utah State University
Logan, Utah 84322

LETTER OF TRANSMITTAL

Mr. Lloyd Clyburn
Office of Central and West Africa
Regional Affairs
New State Building
Washington, D.C. 20523

Dear Mr. Clyburn,

This final report contains the observations and recommendations of the C.I.D. Bakel Range Livestock Design Team members. The final design report contains additional information not included in the interim report, therefore the interim report as well as other individual reports should be discarded at this time.

The design team members were initially in Senegal from June 8, 1975 through July 31, 1975 at which time an extensive survey of the project area in Eastern Senegal was conducted. The time of the initial visit to the project area was at the end of the dry season and much of the area was either burned or overgrazed. As a result it was not possible for the team members to obtain forage production for the purpose of determining range carrying capacity. To obtain this information, two team members returned to the project area in late November following the rains to collect this information and additional information to finalize the economist report.

Many organizations and individuals have greatly assisted the design team in making this report possible. The design team would especially like to thank the staff at the AID offices in Washington, D.C. and in Dakar; Dr. Souleymane Diallo, Director of Livestock Services for Senegal, and his staff in Dakar, Tambacounda and Bakel; Mr. Mabaye Niang, the Prefet of Bakel and his staff; Mr. Sekou, the Deputy Prefet of Bakel; and the many individuals at Dakar Hann Laboratories. The design team's task would have been much more difficult if it had not been for our interpretor, Mr. Kent Salter, whose knowledge of the country and of the individuals to contact made it much easier. The team members are especially thankful to him.

Sincerely yours,

John M. Cheney DVM.

John M. Cheney, DVM
Chief of Party
Bakel Range Livestock Design Team

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BAKEL RANGE LIVESTOCK PROJECT
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CHAPTER 1

PROJECT ORGANIZATION

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I. SUMMARY

This report contains the observations and recommendations of the range-livestock design team that made an extensive analysis of the Eastern Senegal Livestock Project Area of Bakel, Senegal. This project is of high priority to the government of Senegal (GOS) for several reasons. (1) The project is a response to the problems caused by the drought, especially those related to livestock losses. (2) The GOS is interested in controlling grazing on rangelands which have been overgrazed. (3) The project area is within a sector of Senegal which needs attention in rural development efforts. (4) The project is within the long range strategy of livestock development programs of the GOS.

In general, the proposed project intends to assist in the development of the livestock sector of the eastern Senegalese economy. Yet, the development of the range livestock industry for the project area is also to prevent further degradation of rangelands which has occurred in the past. Therefore, a system approach was used in the development of the area by including information on livestock, vegetation resources, water resources, land capability, human needs and desires, availability of technical assistance, transportation needs, marketing opportunities, and climatic characteristics.

The GOS realizes the need to produce quality rather than quantity of livestock from the project area. Furthermore, the GOS

recognizes that this goal of quality must be attained without further deteriorating the overgrazed rangelands of the area. Already, the Ministry of Rural Development officials in Dakar have designated the northern geographical zone, which includes the Bakel and project area, as a breeding zone for a cow-calf operation. This area is to provide yearling animals which will be sent to the peanut growing regions of central and western Senegal. The latter regions are now being planned for irrigation of peanuts, sorghum, and other forage crops. The forage produced in this region will be used for the growing and fattening of the yearling animals.

The design efforts of the team considered the strategies formulated by the GOS in development of the range-livestock project. Improvement in beef production and marketing while applying proper range management strategies was a stated goal of the GOS. Although this goal will be a long-term realization, the Bakel project will directly assist in attaining that goal in medium-term strategies. Furthermore, the GOS officials have made committments to repeat the project design on a large scale basis throughout eastern Senegal as success is obtained on the project.

The particular design of this project for range and livestock management was based on multidisciplinary characteristics of the selected area. Livestock consideration included type of animals, size of herds, animal health, calving season, marketing patterns, and herd management during drought years. The range management plan

development was based on an integrated vegetation-soil survey to obtain range site information. Utilization of the available forage by livestock grazing was estimated as well as total forage production, percent area burned over by recent fires, canopy cover of woody vegetation, condition and carrying capacities of the rangelands.

Livestock distribution for proper grazing was planned by water development and through division of the area into pastures.

Socio-economic information was utilized in developing the range and livestock management program. Herding practices, traditional areas of grazing, size of villages, and transhumance patterns were integrated into the plan for management of the project area. Water for the people was a significant factor for consideration in the design of the overall plan in that development of water for livestock management also considered water for human use and consumption.

Baseline information was obtained in all disciplines so that the project design could be evaluated as to effectiveness after an initial time period of three years. It was assumed that a full implementation program would be underway in the area for a period of three years.

Economic analyses were carried out on baseline information that was obtained from the project area and from relevant literature.

The two initial planning zones included 110,000 hectares, but boundaries were changed in both zones to correspond more closely with natural phenomena and to homogenize the interior of each zone. These new boundaries include 87,338.6 ha. in the Toulekedi zone and

42,977 ha. in the Sarre zone for combined total of 130,316 ha. The Toulekedi zone was planned for a complete range management livestock program while the Sarre zone was treated in a general way. Much more intensive information will be needed from the Sarre zone for detailed planning as explained in the report.

II. DESIGN TEAM CONTACTS

A. USAID, Washington

1. Mr. Lloyd Clyburn, AFR/CWR
2. Mr. Robert Shoemaker, AFR/DS
3. Mr. Stan Peek, AFR/CWR
4. Mr. David Shear, AFR/CWR
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11. Mr. Jim Black, Peace Corps, Washington

B. Embassy and Regional Office Staff

1. Mr. O. Rudolph Aggrey, Ambassador to Senegal
2. Mr. Allan C. Davis, Deputy Chief of Missions
3. Mr. Norman Schoonover, Regional Development Officer
4. Mr. Phillip Amos, Regional Controller
5. Mr. Walch, Mission Program Officer
6. Mr. Procopus, Mission Assistant Program Officer

7. Mr. Tom Stammer, Peace Corps, Senegal

8. Mr. Labat, Peace Corps Director, Senegal

C. Government of Senegal

1. Dr. Souleymane Diallo, Director of Livestock Services

2. Dr. Derneville, Assistant Director of Livestock Services

3. Mr. Youssou Diop, Assistant Governor for Development
   Senegal Oriental (Eastern) Region

4. Mr. Mbaye Niang, Prefet of Bakel

5. Mr. Sekou Sonko, Deputy Prefet of Bakel

6. Mr. Ochs, World Bank

7. Dr. H. LePissier, Ministry of Rural Development

8. Mr. Lakh, Director of Hydraulics

9. Mr. Sene, Director of Water and Forestry

10. Dr. Gueye, Fonds European de Development
    FED Ferlo Project

D. Technical Staff, Senegal

1. Mr. L. Calves, Institute Geographique National

2. Mr. Youssoupha N'Doye, Cartographe, Bureau de Recherches
   Geologique et Minieres

3. Dr. Valenza, Institute d'Etudes Medicules et Veterinares
   Tropicales--Botanist

4. Dr. Buckstein, Bureau des Recherches Geographique et Minieres

5. Mr. C. Feller, Organization de Recherches Scientifique et
   Technique d'Outre-Mer--Pedoloque

6. Dr. Moussu, Bureau des Recherches Geographique et Minieres

7. Mr. Paul Coly, Ingenieur du Genie Rural, Parc de Hann
8. Dr. S. M. Toure, Parasitologist, Dakar Hann
9. Dr. Martin, Parasitologist, Dakar Hann
10. Dr. J. P. Denis, Veterinarian, Dakar Hann
11. Dr. Bathily, Economist, University of Dakar
12. Dr. Lopez, Economist, University of Dakar
13. Dr. Cadot, Forage Cultivation, Dakar Hann
14. Dr. Girand, ASECNA Meterology
15. Tidiane Kane, Ingenieur Travau Elevage, Bakel
16. Mansour Seck, Meteorologist, National Service Building
17. Ibrahima Sane, Regional Director, Promotion Humaine
18. Dr. Dieme, Regional Director, Livestock Service
19. Mr. Mbenque, Regional Director, Agriculture
20. Mr. Fall, Regional Director, Water and Forests
21. Mr. Diop, Regional Director, Rural Engineering
22. Mr. Cheikh Tidiane Kane, Promotion Humaine, Dakar
23. Mr. Papa Abdou Sylla, Promotion Humaine, Bakel

E. Companies

1. Mr. Rolf Lepreuost, IBM
2. Mr. J. Mesmil, Caterpiller Tractor
3. Mr. Le Bois, La Scierie Dakar Lumber
4. Mr. M. N'Diaye, Caterpiller Tractor Garage
5. Mr. Reyraret, Mercedes-Bentz, Unimog, and Trucks

6. Mr. Virmand, Fire Towers

7. Merck, Sharpe and Dohm, Veterinary Drugs

8. Hoerchst Pharmaceuticals, Veterinary Drugs

9. Bayer Chemical, Veterinary Drugs

III. PURPOSE OF PROJECT

Collect and analyze pertinent baseline data from within and without the project area in, but not restricted to, the following subject matter areas:

1. Climate
2. Soils
3. Geology
4. Water Resources
5. Wildlife
6. Forestry
7. Forage Resources
8. Livestock
9. Animal Health
10. Extension-Education Training
11. Human Resources
12. Economics

Based upon an analysis of the assembled data, prepare a detailed design of an integrated range-livestock management project.

Identify key indicators and develop a system for measuring impact of the range livestock management projects over time.

IV. PROJECT DESCRIPTION

A. GEOGRAPHIC DESCRIPTION AND BOUNDARIES

The proposed project is located in eastern Senegal near the confluence of the Senegal and Faleme Rivers and thus adjacent to the countries of Mauritania and Mali. Boundaries are natural features to the east and west of a geological outcropping which divides the project into two zones, namely Toulekedi and Sarre. These two zones comprise 87,339 and 42,977 hectares respectively. Access is difficult, requiring one and one-half days travel by road over 700 kilometers of nearly equal portions of paved and unpaved surfaces. Rail, air and, in season, water transportation also serve nearby towns.

B. SOCIO-ECONOMIC SETTING

The area chosen for this development project is called the Diery, i.e. drylands, of the Bakel region of eastern Senegal. The range perimeter this team has designed includes within its confines and on its periphery a recently sedentarized population of some 35 villages. The people engage primarily in livestock raising for their livelihood and also cultivate dryland cereal crops. These village communities are small, ranging in size from less than ten individuals to a maximum of over three hundred. They have many links to the inhabitants of the

surrounding countryside, to the administrative-market towns and beyond into the rest of Senegal, as well as across the Senegal River into Mauritania. Their husbandry practices concentrate on ruminant animals, grazing primarily cattle and goats. They also raise a few sheep, courtyard poultry, and use donkeys and horses as beasts of burden.

The concentrations of population increase toward the east where land is more fertile and water less scarce. Also, to the east interaction with riveraine communities along the Senegal and Faleme rivers is more concentrated, the villages are older, and they are more oriented toward cultivation.

C. INTERVENTIONS

1. Range Improvements

Since range management is a term and concept not understood or comprehended in Senegal, it was necessary to define range management and proper use of the forage resource. Participant training will be an important aspect of the proposed project to correct this deficiency. Carrying capacity and its complexities are explained and tentative figures estimated for the eight management units proposed. These management units were designed on the basis of traditional use areas and on natural watershed boundaries as nearly as possible. A grazing system of moderate yearlong grazing is proposed to utilize the dominant annual grass forage most efficiently.

Surface ponds have been planned to supply water to the beef herd, which will be kept out of the village areas and in the grazing unit, while a village milk herd will be kept near the village and improved pastures developed for this herd.

Badly overutilized areas have been identified and suggestions made for their management.

Procedures have been laid down for the use of water facilities, herder organization, herding methods, yearly herding plans, night corral location and supplemental feed grounds.

The control of fire, as well as its use as a management tool, is discussed and the necessary infrastructure described.

Methods of assessing forage utilization and production as well as condition and trend are recommended.

The range development plan designates a schedule of construction for water facilities, fire lines, vaccination parks, livestock markets, fencing and reseeding trials.

Since a complete land-use plan will be necessary in the Sarre zone, as well as the drainage systems in the Toulekedi zone, before any range livestock program can be fully operative, a new aerial flight has been requested for the area.

2. Livestock Management

Livestock in the Bakel Range Livestock Project area are comprised of three breeds, most of which contain considerable Zebu

breeding. The cattle production of the area has possibilities for improvement through improved programs of breeding, nutrition and management. Numerous social changes will be necessary to achieve livestock improvement since livestock, and especially cattle, are closely associated with and managed according to social custom.

Livestock will need to be managed in an entirely different manner than is now present since they will be kept away from the village at all times and managed for calf production. A milk herd will be kept at the village to supply the people with a source of milk. Other animals such as goats and sheep will be evaluated for their use in providing milk for both calves' and human consumption.

Demonstration livestock herds will be established to demonstrate proper techniques of livestock management to the herders. These demonstrations will be conducted by the Animal Scientist/Animal Health Specialist, the Extension Education Specialist and personnel from Promotion Humaine.

Livestock marketing systems for the sale of animals and hides will need to be established to guarantee the recommended off-take of animals.

3. Extension Education

An extension education program will be coordinated by the Extension Education Specialist assigned to the project. This specialist will work in cooperation with other project specialists and the

personnel of Promotion Humaine to conduct a series of meaningful demonstrations of applied technology in order to achieve adaptation of the suggested practices by the local herders.

While the demonstration programs will be a major thrust of the educational effort, other activities will include field days, seminars, short courses and special committee organization for gaining local acceptance of the project goals and activities.

The extension education program will include all phases of education dealing with technical subject matter. Complimentary educational programs such as literacy training, sensitization of the people, health training and organization of cooperatives would be handled by Promotion Humaine and coordinated with the Extension Education Specialist. The overall educational effort should receive full cooperation by the subject matter specialists, the Extension Education specialist, and the personnel from Promotion Humaine.

4. Animal Health

Chapter 5 contains the finding and recommendation on animal health. Each of the major cattle, sheep and goat diseases known to occur in the area have been reviewed. Vaccination programs have been recommended for controlling rinderpest, contagious bovine and caprine pleuropneumonia, blackleg, and haemorrhagic septicemia. A program for controlling internal parasites in cattle, sheep and goats,

and a program for controlling some of the important external parasites of cattle have been recommended.

Vaccination parks have been included in the project design. These parks are to be equipped with weigh scales to be used in the overall livestock improvement program. A spray race has also been included in each of the vaccination parks. The parks can also be used as market points for livestock.

Only one veterinary post is recommended for the project. The post will be located at the project headquarters in the proposed diagnostic laboratory.

Very little information is available regarding many of the animal diseases thought to occur in the area. For this reason it is recommended that the implementing team conduct several surveys in an effort to obtain a better understanding of the animal disease situation in the area. Once this is done, the animal health program can be further strengthened.

If additional information on animal diseases in the area is to be forthcoming, it will be necessary to construct a small diagnostic laboratory for the project. The laboratory will be capable of conducting routine diagnostic tests as required to maintain the health of the animals.

V. PROJECT PERSONNEL

A. IMPLEMENTATION

1. Proposal

Due to the complexity of problems associated with remoteness, living conditions, and medical and educational facilities' nonexistance at the Baniou Project Headquarters, it is proposed that the project be staffed by relatively young people, without children, and who have some practical experience in their professions. In the fields of range management, agronomy, animal science/animal health, extension education, and agricultural engineering, numerous possibilities exist for applied research to be conducted in conjunction with implementation of the project and it is therefore suggested that these positions be staffed by graduate students with consultation from their major professors. The remaining positions of fire control/radio repair and equipment maintenance will be filled by Peace Corps technicians.

2. U.S. Personnel

To administer and implement such a project the following personnel will be required.

a. U.S. Project Coordinator--44 man months

To implement the project, USAID will contract a U.S. university or other institution. The U.S. contractor will be responsible for recruiting the U.S. field staff and their advisors. For administration of the project the contractor will maintain a project office at the university or institution. This office will be staffed by a part-time project coordinator and a full-time secretary. The project coordinator will devote one-fourth of his or her time to the project. He will need an operating budget to communicate with the participating universities, Peace Corps, Washington, AID/Dakar, and the Project Headquarters in Baniou. He must be available eight months prior to personnel arriving at Project Headquarters in order that he may order equipment, locate personnel and make all necessary arrangements for project implementation.

b. Graduate Student Specialists--72 man months per specialty

The U.S. contractor field staff will consist of the following:

(1) One (1) Range Management Specialist

(2) One (1) Agronomy Specialist

(3) One (1) Extension Education Specialist

(4) One (1) Animal Scientist/Animal Health Specialist

(5) One (1) Agricultural Engineer Specialist

The field technicians will be recruited from graduate students under supervision of their major advisors and in cooperation with the

project coordinator. Each graduate student will be funded for a minimum of 18 months in the field and from 12 to 18 months on campus to complete his course work, obtain his language training in French, and write his thesis/dissertation. Each specialty will have two graduate students as field technicians with their time in the project area to run consecutively. Field staff will therefore be in the project area for the three year duration of the contract. One of the U.S. field staff members will be Chief of Party. This individual will be responsible to the contractor for the daily operation of the project and staff in the field.

(1) Range Management Specialist

The Range Management Specialist must have a minimum of a B.S. in Range Management from a western U.S. university, preferably in an arid to semi-arid environment, and be acceptable to a graduate program of a participating university. The person must have a practical background, training and/or interest in livestock production. Requirements will be to develop and implement grazing management systems, determine needs and locate sites for stock water development, map vegetation types from aerial photos, help develop land use plans for mixed cultivation/grazing lands, determine forage production and carrying capacity of grazing units, conduct condition and trend studies, determine areas and methods for bush control, establish and evaluate reseeding trials, assist in livestock production, animal health, fire control, engineering construction of ponds and firebreaks, and help develop range management training programs with

the extension specialist and Promotion Humaine. Primary responsibility will be to train the Senegalese Range Management Counterpart in range management techniques.

(2) Agronomy Specialist

The agronomist must have a minimum of a B.S. in Agronomy with strong emphasis on soils and land use planning, and be acceptable to a graduate program of a participating university. The person must have had practical experience that will enable the development of detailed land use plans for a mixed farming/grazing situation in the Sarre zone, as well as intensive land use plans on the main drainage areas in the Toulekedi zone. The person must conduct studies and recommend areas suitable or non-suitable to cultivation, crops adapted to these areas, proper cultivation methods, tilling methods, harvesting time and methods, crop storage facilities, fertilizer needs and application procedures, crop rotation plans, assist in range forage crop trials, firelane and dam location, and help develop agronomy training programs with the extension specialist and Promotion Humaine. Primary responsibility will be to train the Senegalese Agronomy Counterpart in agronomic techniques.

(3) Extension Education Specialist

This U.S. technician will be responsible for planning, conducting, evaluating and reporting an educational program on the theoretical and applied subject matter necessary to support the Bakel Range Livestock Project. Subject matter emphasis will be placed on range

management, animal husbandry, and agronomy, and subject matter specialists in these fields will be available to the extension specialist.

Required: (1) Three or more years of employment with the Cooperative Extension Service at a county or area level; (2) B.S. degree in range management, animal science, or agronomy; (3) a demonstrated competency in program planning and organization, including a proven record of field demonstrations conducted and evaluated; (4) acceptable to a graduate program of a participating university.

Desirable: (1) 4-H or FFA experience as a youth; (2) a rural background; (3) working experience in a southwestern or western U.S. county where range-livestock management in practiced; (4) an ability to work as a team member under primative living conditions, minimal health care and tropical climatic conditions.

(4) Animal Scientist/Animal Health Specialist

The U.S. staff technician in this position must have a minimum of a B.S. in animal production and be acceptable to a graduate program of a participating university. The individual should also have a working knowledge of the routine health care for range livestock. In addition to the professional training the individual must have at least three and preferable more years of practical experience in cattle ranching. The individual should have a working knowledge of animal nutrition, be able to set up a livestock breeding program, and recommend proper offtake and market procedures at the village level.

(5) Agricultural Engineer Specialist

The engineer must have a minimum of a B.S. in agricultural engineering and be acceptable to a graduate program of a participating university. The person must have experience and will be expected to locate, design and construct ponds for livestock water in close cooperation with the range management specialist and in agreement with the range development plan. Additionally, fire lines/pasture boundaries/access roads will be located and constructed. Construction of vaccination parks, market centers, fire towers, project headquarters shop, office, diagnostic laboratory and living quarters will be required. Yearly maintenance of the above facilities will be a must.

c. Major Professors for Graduate Students--15 man months

The major professor for the field staff member will act as the senior advisor to the field staff member. The advisor will make one or two trips as needed to the project area each year to consult and advise the field staff member. These trips will be for a two-week duration. A semi-annual report submitted through the contractor to USAID will be the responsibility of the senior advisor. The senior advisor will also be responsible to the contractor for implementation of their part of the program.

d. Peace Corps Specialists--96 man months

Two specialties will be involved requiring two people per specialty, each for a two-year period at Baniou project headquarters.

This will mean that the specialist serving the second two-year tour in both specialties will remain on the project one year after the U.S. graduate students have completed the three year project.

The Peace Corps will furnish staff members to the project in the following specialties:

(a) fire control and radio technician

(b) equipment maintenance technician

These two staff members will be responsible to the U.S. Chief of Party.

(1) Fire control/radio technician

The technician for this position should have some experience and training in fire control and organization. He should be able to organize fire crews and train them in the art of fire fighting and protection.

He will also need a knowledge of radio communication and how to make minor repairs to radios and receivers, and how to direct fire crews from a central control point. He should have a knowledge of how to locate a fire on a map from a control tower and be able to direct the fire crew to the fire. He will work with the engineer on all fire lanes and arrange for clearance or back firing to maintain them in good operation.

All fire equipment will be supervised and maintained in good condition.

(2) Equipment maintenance technician

The technician for the position should have had several years of diesel equipment maintenance. He will supervise the repair of all project equipment and see that the necessary precautionary measures are taken to keep it in good repair. He will supervise the project repair shop and be responsible for maintaining an adequate parts supply to avoid long delays in the repair of equipment. He will set schedules for equipment checks and see that all equipment is not abused by project people. He will train counterparts so they are acquainted with all of the operation and maintenance procedures.

3. Senegalese Staff

a. Project Director (1)

The Senegalese government will select a project director. In cooperation with the U.S. Chief of Party and the project coordinator, this individual will have overall responsibility for the operation of the project. The individual will be the liasion between the Senegalese government and the U.S. project personnel through the U.S. Chief of Party. Following training in the U.S. (see 'Participant Training') he will assume directorship of the project.

b. Zone Administrators (2)

Following training (see 'Participant Training'), one will administer the Toulekedi zone and one will administer the Sarre zone, both being responsible to the Senegalese project director.

c. Counterparts

The Senegalese government will have one counterpart in each of the following specialties:

(1) Range Management Specialist

(2) Agronomy Specialist

(3) Animal Scientist/Animal Health Specialist

(4) Extension Education Specialist

(5) Agricultural Engineer Specialist

(6) Fire Control Technician

(7) Equipment Maintenance Technician

These individuals will work directly with their U.S. counterparts in their specialty. They will be responsible to the Senegalese project director.

(1) Senegalese counterpart to range management specialist

Prior training in botany and soils at a diploma level is essential. He must have experience either in forestry or livestock management.

(2) Senegalese counterpart to agronomy specialist

Prior training in agronomy at a diploma level is necessary. He must have experience in agronomy and should be familiar with land use planning.

(3) Senegalese counterpart to the animal scientist/animal health specialist

This individual must be trained at the level of an Ingenieur des travaux d'elevage.

(4) Senegalese counterpart to the extension education specialist

This person must be trained at the level of Ingenieur des travaux d'elevage.

(5) Senegalese counterpart to the agriculture engineer

The technician for this position does not need a college degree in engineering but he should have some technical training in engineering. He should be able to run a plane table and transit and assist in figuring the construction requirements of earth dams, road construction, fire lane construction, house and small building construction. He should be able to direct and give instruction to crews as directed by the engineer. He should have had several years of practical experience in the field of engineering.

(6) Senegalese counterpart to the fire control/radio technician

This position requires training in fire control through the Division of Water and Forests, and experience with and capability of radio repair.

(7) Senegalese counterpart to the equipment maintenance technician

He should be trained and experienced in equipment maintenance of small engines, gas and diesel engines and heavy equipment.

d. Full-Time Staff

(1) Accountant (1)

(2) Business manager (1)

(3) Typist (1)

(4) Drivers (2)

(5) Heavy equipment operator (1)

(6) Medical dresser (1)

e. Part-Time Labor

It will be the responsibility of the Senegalese project director to employ and organize the labor and other staff for the fire lookouts, fire control teams, veterinary assistants, engineering assistants and other Senegalese labor and staff as required by the project. To coordinate this staff he will work directly with the zone administrators and the U.S. Chief of Party.

(1) Lookouts (3)

Each for the nine-month dry season, these people will serve as assistants to the engineer during the rainy season when construction is possible.

(2) Engineering assistant (1)

(3) Veterinary assistants (diagnostic laboratory)

(a) Technical agent (1)

(b) Nurses (2)

(c) Laborers (2)

4. Alternatives in U.S. Staffing

a. Peace Corps

The difficulty in staffing the entire implementation team with Peace Corps volunteers is two-fold. It would be difficult to find highly qualified people in these technical specialties who were all available at the same time. If they were graduate students or of that caliber, the chances of finding all seven at one time is remote. This is particularly true in the fields of Range Management and Animal Science/ Animal Health. Secondly, there would be the problem of adequate supervision over seven highly technical specialties. In addition to recruiting new volunteers , the possibility exists of transferring present volunteers or contacting ex-volunteers who have this specialized training.

b. Outside Professional Contractor

The problems connected with this alternative are the reverse of the Peace Corps option and much more severe. A contractor will have comparatively little trouble finding qualified people but these people are generally going to be older, married and with children. There are few in this category who would be willing to live 18 to 24 months in Baniou. Living in Dakar is simply not possible due to the remoteness of the Project area and the consequent cost of frequent trips to and from Dakar for family visits. Any people living in Dakar

would spend little time in the Project area, would not be familiar with day to day problems, and would therefore be ineffective in their jobs.

B. PARTICIPANT TRAINING

Three Senegalese are to be trained in the U.S.--one project director and two zone administrators. The proposed schedule is:

a. Arrive for training on May 15

b. Three months language training

c. Nine months academic training to include the following courses (participants must have a solid background in basic botany and soils):

1. Range Forage Plants
2. Introductory Ecology
3. Principles of Range Management
4. Plant Physiology
5. Forest and Range Ecology
6. Watershed Management
7. Rangeland Evaluation
8. Animal Nutrition
9. Range Improvement Practices
10. Natural Resource Management Planning
11. Photointerpretation
12. Range Seminar
13. Beef Cattle Production

d. One each trained at

1. Utah State University

2. Texas A & M

3. University of Arizona

e. Three month academic/practical experience in Colorado State University summer Range Program for foreign students.

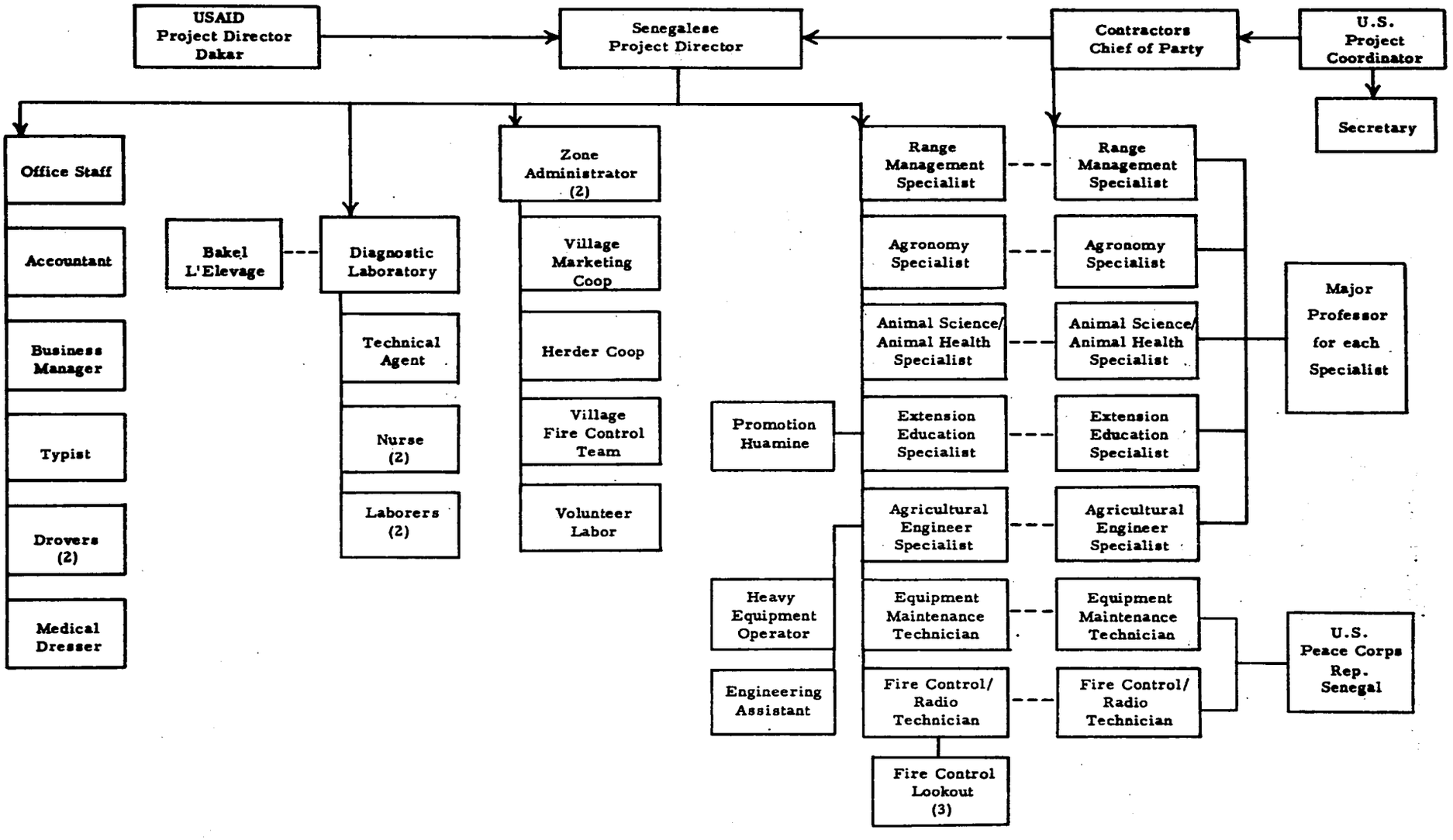
f. Two months travel in East Africa, visiting existing range management projects: Kenya, Tanzania, Ethiopia, Botswana.

g. Total of 17 months per participant.

C. OBSERVATIONAL TRAINING

At the outset of the project the Directors and Tambacounda Regional Chiefs of Livestock, Hydraulic, Water and Forest, and Rural Development Services (eight people in all) will be given an observational training tour of western U.S. range and livestock management operations. This should include work of governmental agencies in management and research as well as progressive private ranching operations. A one-month period should be sufficient for these people to gain a feeling for the art and science of range management.

PROJECT ORGANIZATION



VI. PROJECT BUDGET

A. INFRASTRUCTURES		$ 937,510.00
1. Reservoirs		
a. Toulekedi zone (31)	$467,000.00	
b. Sarre zone		
Total	$467,000.00	
2. Fire		
a. Fire breaks		
(1) Major (323 km @ $300.00/km)	$ 96,900.00	
(2) Internal (132 km @ $230.00/km)	30,360.00	
b. Fire towers (3 @ $10,500.00)	31,500.00	
Total	$158,760.00	
3. Vaccination and Quarantine Parks		
a. Vaccination parks (4 @ $10,000.00)	$ 40,000.00	
b. Quarantine pens (1 @ $2,000.00)	2,000.00	
Total	$ 42,000.00	
4. Buildings--Project Headquarters		
a. Director's house and office (1)	$ 20,000.00	
b. Zone chiefs' houses (2 @ $10,000.00)	20,000.00	
c. Counterparts' houses (7 @ $10,000.00)	70,000.00	
d. U.S. technicians' Winnebagos (6 @ $15,000.00)	90,000.00	
e. Diagnostic lab (1)	11,750.00	
f. Garage and tool storage (1)	25,000.00	
g. Storage building and bulk gas storage (1)	18,000.00	
h. Training and office buildings (2 @ $7,500.00)	15,000.00	
Total	$269,750.00	
B. EQUIPMENT		$ 321,111.00
1. Vehicles, Engineering, Fire Control		
a. Land rover (all diesel)		
(1) Station wagons (2)	$ 16,000.00	
(2) Pickups (3)	21,000.00	
b. Motor bikes (5)	1,200.00	
c. Stake trucks, 3-ton (2)	20,200.00	
d. Unimog with scraper and dozer blade (1)	35,000.00	
e. D-7 cat (1)	110,500.00	
f. Trailer units for fire fighting including equipment (3)	6,000.00	
g. Spare vehicle and equipment parts	8,000.00	
h. Hoist, 5-ton (1)	5,000.00	
i. Generator	5,000.00	
j. Arc welder	2,000.00	
k. Radio equipment	17,200.00	
(1) Base station (1 @ $2,500.00)		
(2) Mobile units (7 @ $2,100.00)		

B. EQUIPMENT (continued)

1. Vehicles, Engineering, Fire Control (continued)

l. Pump (small) (4)		$ 500.00
m. Wheel barrows, shovels, mattacks, axes, saws		2,500.00
n. Transit, alivade, plane table, drafting table, rods and drafting supplies		5,000.00
o. Binoculars (4)		200.00
Total		$255,300.00

2. Animal Health

a. Diagnostic Lab		
(1) Electrolux kerosene refrigerator (2)	$1,400.00	
(2) Clinical centrifuge (1)	300.00	
(3) Timer (1)	5.00	
(4) Differential counter (1)	100.00	
(5) Agglutination test plate (1)	50.00	
(6) Incubator (1)	250.00	
(7) Microscope (1)	900.00	
(8) Stereomicroscope (1)	500.00	
(9) Glassware, racks, slides	750.00	
(10) Stains and reagents	500.00	
(11) Fecal exam supplies	200.00	
(12) Diagnostic test kits	400.00	
(13) Miscellaneous supplies and equipment	1,500.00	
Subtotal		$ 6,855.00
b. Vaccination Parks		
(1) Portable weigh scales (1)	$1,000.00	
(2) Ranger ranch head gates (4)	720.00	
(3) Spray races (4)	4,600.00	
(4) Pump, portable gas for spray race (1)	350.00	
Subtotal		6,670.00
Total		$ 13,525.00

3. Veterinary

a. Necropsy equipment (2 sets)		$ 150.00
b. Serum and instrument cases (6)		200.00
c. Dose syringes, 6 oz. (6)		40.00
d. Frick mouth speculum (3)		15.00
e. Stomach pump (3)		40.00
f. Balling guns		
(1) cow (12)		50.00
(2) calf and sheep (12)		50.00
g. Automatic anthelmintic drenching sets (3)		150.00
h. Obstetrical		
(1) OB wire, 10 rolls	$ 50.00	
(2) OB saw handles, 5 pr.	10.00	
(3) Fetatome (1)	30.00	
(4) OB chains (10)	16.00	
(5) OB chain handles, 5 pr	19.00	
(6) Calf puller	100.00	
Subtotal		225.00

B. EQUIPMENT (continued)

3. Veterinary (continued)

i. Dehorning saw and extra blades	24.00
j. Restraint supplies	50.00
k. Burdizzo emasculators	
(1) small (6)	210.00
(2) large (6)	210.00
l. White emasculators (5)	180.00
m. Gravity IV sets (10)	30.00
n. Portable ice chest (4)	180.00
o. Thermometers (20)	75.00
p. Surgical instruments	300.00
q. Shoulder length gloves, 20 rolls	300.00
r. Syringes	
(1) Hayptner automatic, 50 cc (4)	140.00
(2) Ranch record, 50 cc (2)	20.00
(3) Ranch record, 20 cc (4)	16.00
(4) Disposable, 12 cc (1,000)	175.00
s. Needles	
(1) 16 ga. 1" (1,000)	90.00
(2) 18 ga. 1" (1,000)	50.00
t. B-D Vacutainers	
(1) Plain (10 boxes)	250.00
(2) EDTA (10 boxes)	250.00
u. Miscellaneous equipment	1,000.00
Total	$ 4,470.00

4. Livestock

a. Branding iron letters (4 sets)	$ 1,440.00
b. Branding iron numbers (4 sets)	320.00
c. Ear tags (8,000)	1,080.00
d. Tag pliers (6)	24.00
e. All-weather marking sticks	50.00
f. Rope	
(1) cotton	75.00
(2) sisal	90.00
(3) nylon	120.00
g. Hoof equipment	150.00
h. Hand sprays	1,200.00
i. Miscellaneous supplies	1,230.00
Total	$ 5,779.00

5. Range Management

a. Stereoscopes (4)	$ 100.00
b. Drafting equipment (2 sets): pens, drawing board, T-square, ink, triangles, protractor, compass, light table, etc.	400.00
c. Gram scales (4)	60.00
d. Planimeters (4)	250.00
e. Dot grids (4)	10.00
f. Grass clippers (4)	20.00
g. Backpack herbicide sprayer (2)	100.00
h. Hand lens (4)	20.00

B. EQUIPMENT (continued)

5. Range Management (continued)

i. Soils/plants analysis kit (2)	$ 100.00
j. Reference material (statistics, range management, soils, agronomy, etc.)	100.00
k. 50 meter tape (2)	40.00
l. Cyclone seeders (4)	60.00
m. Grass seed (± 50 lbs.)	500.00
n. Acetate (photo overlay material) (200 sq. ft.)	30.00
o. Small drying oven (1)	75.00
p. Balance (1)	30.00
q. Plant mounting material	50.00
r. Saddle, bridle, blanket, halter, etc. (2 each)	400.00
s. Horse (2)	400.00
Total	$ 2,745.00

6. Educational

a. Kodak carosel projectors (35 mm slides) (2 @ $275.00)	$ 550.00
b. Portable projection screens (2 @ $150.00)	300.00
c. Overhead projectors (2 @ $195.00)	390.00
d. Extension cords (heavy duty, 100') (10 @ $20.00)	200.00
e. Portable 110 v generators (2 @ $350.00)	700.00
f. Motion picture projector, 16 mm (1)	750.00
g. Motion picture projector, 8 mm (1)	250.00
h. 35 mm camera SLR (1)	450.00
(1) 85-210 mm zoom lens (1)	350.00
(2) strobe flash attachment (1)	125.00
(3) 28 mm wide angle lens (1)	175.00
(4) set of lens filters for 55 mm lens (1)	50.00
i. 8 mm motion picture camera (1)	350.00
j. Waterproof/dustproof carrying case for cameras (2)	100.00
k. Extra slide trays for carosel projectors (20 @ $4.00)	80.00
l. Extra reels for 16 mm and 8 mm projectors (5 @ $5.00)	25.00
m. Cassette tape recorder (2 @ 175.00)	350.00
n. Tripod for cameras (1)	35.00
o. 35 mm slide viewer (1)	35.00
p. 35 mm slide editor (2 @ $5.00)	10.00
q. 8 mm editor (1)	125.00
r. Film, 8 mm and 35 mm	1,000.00
s. Books	1,200.00
t. Films	2,500.00
Total	$ 10,100.00

7. Shipping charges (10% of total)* . . . . . $ 29,192.00

*Shipping charges are figured at 10% rather than 25% because cost of heavy equipment is based on Dakar delivery prices.

C. EDUCATIONAL			$ 115,000.00
1. In-service and special training in range and livestock management for technicians		$ 35,000.00	
2. Demonstration materials for range management, livestock management, and crop production result and method demonstrations, implementation and evaluation		25,000.00	
3. Publications purchase and development in support of adult and youth programs in range management, animal husbandry, and agronomy		15,000.00	
4. Co-op funding		40,000.00	
Total		$115,000.00	
D. DESIGN AND EVALUATION			136,000.00
1. Design study		$106,000.00	
2. End of project evaluation		30,000.00	
Total		$136,000.00	
E. TECHNICAL ASSISTANCE			698,800.00
1. TDY Assistance			
a. Range management specialist 2 two-week trips/year 6 trips @ $3,600.00	$ 21,600.00		
b. Livestock and animal health specialist 2 two-week trips/year 6 trips @ $3,600.00	21,600.00		
c. Agricultural extension specialist 1.5 two-week trips/year 4 trips @ $3,600.00	14,400.00		
d. Agricultural engineer 1.5 two-week trips/year 4 trips @ $3,600.00	14,400.00		
e. Agronomist 1 two-week trip/year 3 trips @ $3,600.00	10,800.00		
Subtotal		$ 82,800.00	
2. U.S. Field Technicians			
a. Range management graduate student (2) 36 man-months per person	$110,000.00		
b. Livestock and animal health graduate student (2) 36 man-months per person	110,000.00		
c. Agricultural extension graduate student (2) 36 man-months per person	110,000.00		
d. Agricultural engineer graduate student (2) 36 man-months per person	110,000.00		
e. Agronomist graduate student (2) 36 man-months per person	110,000.00		
Subtotal		550,000.00	
3. U.S. Project Office			
a. Project Coordinator--4 months/year 12 man-months	$ 36,000.00		
b. Project Secretary 36 man-months	30,000.00		
Subtotal		66,000.00	
Total		$698,800.00	

F. PARTICIPANT TRAINING		$ 77,500.00
1. Project personnel		
a. Project director (1)--17 months	$ 14,000.00	
b. Zone chiefs (2)--17 months each	28,000.00	
c. Materials for training	7,500.00	
Total	$ 49,500.00	
2. Observational Training		
a. Director and Tambacounda Regional Chief of Livestock Service	4,500.00	
b. Director and Tambacounda Regional Chief of Hydraulic Service	4,500.00	
c. Director and Tambacounda Regional Chief of Water and Forest Service	4,500.00	
d. Director and Tambacounda Regional Chief of the Rural Development Service	4,500.00	
e. Interpreter for observational training tour	10,000.00	
Total	$ 28,000.00	
G. SARRE ZONE DEVELOPMENT		30,000.00
1. Aerial mapping	$ 30,000.00	
H. OPERATION COST		330,589.00

	First Year	Second Year	Third Year
1. Animal Health*			
Vaccines:			
Rinderpest: CBPP	$ 195.00	$ 585.00	$ 780.00
Blackleg	90.00	270.00	360.00
Pasteurellosis	90.00	270.00	360.00
CCPP	45.00	135.00	180.00
Pesticides:			
Toxophene	1,800.00	5,400.00	7,200.00
Anthelmintics:			
TBZ or Niluerm			
Calves	1,500.00	4,500.00	6,000.00
Cows	2,250.00	6,750.00	9,000.00
Lambs	150.00	400.00	600.00
Ewes	225.00	600.00	900.00
Trypanocides:	1,125.00	3,490.00	4,330.00
Antibiotics; Misc. drugs:	2,000.00	4,500.00	6,000.00
Mineral supplement:	9,000.00	27,000.00	36,000.00
Diagnostic supplies:	0	1,500.00	2,000.00
2. Project Office	20,000.00	25,000.00	30,000.00
3. Vehicles; Equipment	28,000.00	35,000.00	45,000.00
Total	$66,470.00	$115,400.00	$148,719.00

TOTAL BUDGET $2,498,921.00

*Drug costs are based on the following cattle number: 1st year--3,000; 2nd year--9,000; 3rd year--12,000. Drugs for sheep and goats are based on: 1st year--1,500; 2nd year--4,000; 3rd year--6,000.

VII. TIME SCHEDULE

A. Final design team report complete February 1, 1976.

B. Months shown below are number of months after the project has been reviewed and accepted by CID, AID Washington, AID Dakar, GOS, and after the cooperating universities have been identified and services contracted.

	Months
1. Identify U.S. Project Coordinator.	1
2. Order equipment.	2
3. Begin project headquarters building construction.	2
4. Identify graduate students.	2
5. Identify Peace Corps volunteers.	2
6. Participants to U.S. for 17 month training.	2
7. National and Regional personnel to U.S. for observational training.	2
8. Graduate students to project headquarters.	8
9. Equipment arrives at project headquarters.	11
10. Begin construction of first management unit (fire lines, ponds, vaccination parks, fire towers, etc.). This must occur partly during or immediately after the rainy season.	11
11. First management unit construction complete.	18
12. Participants return from U.S. to assume direction of project.	19

	Months
13. U.S. technicians depart project.	44
14. Evaluation of project.	44

VIII. ISSUES

Within the country of Senegal there certainly are other areas of similar type vegetation, similar land use practices and the need to improve both of these factors. A number of areas could be selected that, because of their location, would not involve the serious personnel and access problems anticipated in this project. These alternative locations would have a much higher probability of success and would provide an affirmative demonstration of improved range and livestock management practices. Following are the major problem areas to be encountered.

A. STAFFING

Numerous obstacles are anticipated in the staffing of the Bakel Range Livestock Project. Most of the problems anticipated stem from the remoteness of the area and the total lack of supplies and housing in the area to accommodate a team of scientists and technicians for the duration of the project.

A major problem to be encountered will be the recruitment of qualified personnel to serve in the project. The lack of schools, medical facilities and other amenities basically accepted as necessary by most Westerners will probably eliminate the possibility of a technician having his family with him. This possibility will reduce the number

of qualified personnel who would be willing to serve in the project area for an extended period of time.

Unless they are properly oriented and truthfully informed as to the actual conditions in the project area, technicians may become dissatisfied and abandon the project, thus necessitating additional expenses for transportation and recruitment of additional personnel. The greatest cost of this possibility is the loss of time in achieving meaningful implementation of the project.

A multi-disciplinary effort is a necessity for successful implementation that would be lost if only a few qualified technicians are present at any one time rather than the entire staff of suggested personnel.

Participants trained in U.S. range management programs will not be present on the project to become familiar with many aspects of the project in the initial stages of development if U.S. technicians are sent immediately into the area. Therefore, there will be a necessity to concentrate on in-service training for participants in order that they are capable of extending the project to other regions of the country.

Another problem relating to participants and counterparts will be the fact that these personnel will be transferred to other parts of the country, thus requiring continual training of new personnel.

B. EQUIPMENT, HOUSING AND SUPPLIES

The problems to be anticipated in providing equipment, housing and supplies are more related to the availability and time required to acquire items than any other factor. Most major items such as housing facilities, vehicles and office equipment should be ordered or constructed well in advance of the fielding of personnel. The problems of housing are especially critical and owing to the time and finances required for construction it is suggested that U.S. technicians be housed in mobil units for the duration of U.S. involvement in the project.

Transportation of supplies and equipment into the project area must be either by train and/or over unimproved roads which become impassable during the rainy season. This may necessitate the stocking of a commissary at Baniou to provide supplies for the project personnel.

Gasoline and fuel are available only part of the time and must be stored in a project compound. Vehicle repair and especially the stocking and acquisition of replacement parts will be a major constraint of maintaining an effective vehicle motor pool. It would be helpful to the project implementation if the government of Senegal could grade and maintain the road from the towns of Bakel and Goudiry to the project boundary.

C. COOPERATION BETWEEN ORGANIZATIONS AND PERSONNEL

The greatest strength of the project is the combined talents of the various personnel involved in the project. However, this factor could also be a potential problem for the project if less than adequate administrative ability is utilized in dealing with personnel and organizational problems. The personal projects of individuals should not take precedence over Project goals, and each individual should be urged to cooperate in a team spirit.

The personnel of Promotion Humaine must be willing to leave technical education to the Extension Education specialist. In turn, the Extension specialist should leave the sensitization and organization of villagers into cooperatives for Promotion Humaine personnel. Both educational organizations should cooperate and support the programs of the other and work cooperatively for successful program implementation. Subject matter specialists and their counterparts should work cooperatively among themselves and with Promotion Humaine.

D. SOCIOLOGICAL PROBLEMS ANTICIPATED

Numerous technical problems are expected to be encountered by the project personnel; however, most of these problems have reasonably defined technical solutions. The most difficult task will be to change a number of social constraints in order to implement the technical knowledge. The fact that livestock ownership is deeply entwined

into the social patterns and lifestyles emphasizes the need to understand and plan meaningful educational programs. This important function will rely heavily on the services of Promotion Humaine to sensitize the villagers to the project goals and objectives. Likewise, the Extension Education program must demonstrate the benefits accrued to the villagers from improved range and livestock management together with other important technical subject matter.

CHAPTER 2

LAND RESOURCE BASE--TOULEKEDI ZONE

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I. LOCATION

Situated on the eastern edge of the Continental Terminal, between 14° and 15° North latitude and 12° and 13° West longitude, the Toulekedi zone is extremely flat, broken only by relatively shallow drainages running to the southwest, and by the outcroppings of a laterite layer, referred to hereafter as the rim, which forms an escarpment as the eastern boundary of the zone. The main access road into the area runs along the northwest side of the zone and connects Bakel with Goudiry to the south. Although only 26 kilometers from Bakel to the northernmost tip of the zone, this requires approximately 1.5 hours travel time. Distance and travel time are approximately double this from Baniou, in the southwestern tip, to Goudiry on the Dakar-Bamako road. Refer to the enclosed Bakel Range Livestock Project map and the Toulekedi Zone-Bakel Range Livestock Project map (back pocket).

II. CLIMATOLOGICAL DESCRIPTION OF THE AREA

Rainfall records for Bakel for the years 1919-1974 were obtained from the ASECNA office in Dakar. There records were the only meteorological records available from the Bakel area. Rainfall amounts by month and number of days receiving precipitation were recorded. Appendix A contains this information. A significant amount of precipitation can occur during the dry months of some years. For example,

significant amount of rain occurred in the month of December for several years (12.5 percent of the years). Occasionally, rain came in January (7 out of 56 years, or 12.5 percent of the years). The average annual precipitation for the Bakel station is 502.9 mm (19.8 inches) for the 56-year period. The concentration of precipitation generally occurs during the months of June, July, August, September and October while the beginning and ending periods vary from one year to the next. During this period, 5.5 to 21 days have a measurable amount of rain. The minimum amount for a given year was 233.5 mm (9.2 inches) in 1921, while the maximum rainfall occurred in 1967 (902.5 mm or 35.5 inches).

The chance that the average rainfall will be exceeded is 52 percent based on past records. The chance that less than 15 inches (381 mm) of rain will occur during a given year is 14.3 percent, while the chance of receiving 10 inches or less (254 mm) is 3.6 percent. This information will be useful in planning for reseeding of rangeland and the construction of watering ponds for livestock.

Evaporation rates from open surface water was also obtained from the ASECNA office in Dakar. However, since records were not kept at the Bakel station, those from Matam were used (Appendix B). Only the years from 1951-1970 were available. (Since values were missing, no analysis was attempted for this report. An analysis, however, should be completed for use in livestock water development planning at the time of project implementation.)

III. SOILS

Four basic soils are present in the Toulekedi zone (Maignien, 1965). These are:

1. Non-climatic, undeveloped, erosion, mineral soils which are lithic with ferrugenous armor coatings on clayey sandstones. They are found in the NW corner of the zone and are useful as grazing land.

2. Non-climatic, undeveloped, erosion, mineral soils which are regolithic and found on clayey sandstone. They are also found in the NW corner of the zone but are thought to be practically unusable.

3. Poorly developed, non-climatic, erosion soils which are lithic (< 50 cm thick), gravelly soils on ferrugenous coatings over clayey sandstones. Surface horizon is sandy-clayey with 2-3% organic matter. Found over the entire zone except in the NW corner and the drainage ways, they are good for cattle grazing but unsuitable for cultivation. These could be Plinthoxeralfs (Alfisol order) in the U.S. Soil Classification system.

4. Sesquioxide, tropical ferrugenous soils with profile development. Deep (200-250 cm), they may have iron oxide armor coating deep down, sandy surface, clay accumulation layer, low organic matter, pH 6.0-6.5, base saturation 70-90% in accumulation layer, high in kaolinite, 50-60% free iron, on sandy clayey sandstone. They could be natrixeralfs, rhodoxeralfs, or palexeralfs (Alfisol order) in the U.S. Soil Classification system. Only found on the drainage ways,

they are widely used for cultivation and the only soils so suited in the entire zone.

See Appendix C for a more detailed description of these four basic soil types.

IV. CONTROLLING GEOLOGIC CONDITIONS FOR WATER

The geology of the area controls the movement of the people and the amount of water, both surface and subsurface, that is available for their use. The two zones have a common boundary, which is a geologic escarpment that largely separates the movement of cattle, people and water.

On the Toulekedi side of the rim, the geology consists of old iron lateritic areas, which form continuous surface outcroppings along the rim, that are largely impermeable to water. These outcrops were formed on the old primary terrain.

Overlying these areas are the more recent sediments of the continental terminal formation which are much younger in age. This material occupies most of the western part of the zone. It is in these sediments that deep sands may be encountered for deep wells. These are sands that have produced deep wells in other areas, but they have not been tested in this zone. These sediments slope gently to the southwest and all of the major stream patterns are cut into these sediments.

The wells in the area are found largely in the shallow sands. How deep these sediments are in this area has not been determined as

none of the wells are over 47 meters deep. Indications from a large scale hydrologic map of Senegal indicate they may be 100-200 feet thick before crystalline rocks are encountered.

Table 1 shows the existing wells that were examined in the zone. The wells that have water yearlong and water for people only are located on the map for the Toulekedi zone.

From the table for the Toulekedi area it is quite apparent that the old wells are becoming less productive. Where these older wells occur, villages related several situations where the bottom cement was breaking up which allows sand to filter into the well, thus reducing the amount of water that can be recovered. Where these conditions exist it will only be a matter of time until the well will not yield enough water to supply the people's needs and will be abandoned.

The wells in this area are located in what is called the continental terminal formation sands. At the depth where water is encountered for the dug wells, it is questionable if they are tapping a high water yielding sand. It appears it is largely surface seepage. It is quite possible that deeper water-bearing sands could be located by deeper drilling. Before this is recommended, test holes should be made to determine if there are water-bearing sands and the depth of these higher producing water strata.

Many of these wells are poorly constructed by present well-digging methods and it would be too dangerous to try to repair them or dig them deeper. If it is determined later in the project development

Table 1. Village wells in Toulekedi area.

Village	Wells	Estimated Depth (meters)	Dry or Seasonal	Yearlong	Temp.	Condition of Casing	General Conditions and Comments
Toulekedi	1	30-40		for people		good all way	Well in good condition. Can draw water 2-3 hours and wait 5-6 hours before they can draw water again.
Boulel	1	20-30	old dry	-	-	broken; do not use	Abandoned; not had water for 10 years.
	1	40		for people dry season	-	breaking at bottom	Can draw well dry in 1 hr. Have to wait 4 hrs to draw water again. Well 10 yrs old. Cannot deepen.
Ndia	1	40		for people	30°	not cased; breaking at bottom	Dug 1937. Had to repair twice this year. Poor drainage at top of well. Some cattle water year long.
Ndiakone	1	20		old well		not cased	Very old well in bottom of drainage; wood frame. Surplus water drains into well.
Diare Mbolo	1	40		yes		fair	Poor drainage around top of well.
Baniou	1	30	not used				Dry.
	1	30		not used		poor	Water in bottom but covering so they don't use during rainy season.
	1	47		for people	28°	good; poor drainage	Well 3 yrs old. Can dry well in 3 hrs. Requires 3-4 hrs before can draw water again. Est. 70 people use well.

that additional water is required for village use, new well sites should be located.

V. WILDLIFE

Being situated in a remote area in the country and relatively close to Niokolo Koba National Park (150 km south), the zone is comparatively important as wildlife habitat, although present numbers are quite low. As water is developed in the area it is anticipated that small buildups in numbers may occur.

Following is a list of species, either wholly protected or partially protected, which are known to occur in the area.

Wholly Protected

Guepard	Cheetah
Elephant	Elephant
Hippopotame	Hippopotomus
Crycterope	Aardvark
Autruches	Ostrich
Les Rapaces	Birds of Prey
Vautours	Vultures
Marabout	Marabout Stork
Effraie	Owl
Messager Serpentaire	Secretary Bird
Pelican	Pelican
Flamant Rose	Flamingo
Jabiru	Jabiru
Grand Calao d'Abyssinie	Great Abyssinia Hornbill
Petit Calao a Bec Rouge	Little Red Beaked Hornbill
Garde-Boeufs	Cattle Egret

Partially Protected

Panthere	Panther
Grue Couronee	Crowned Crane
Outarde Naine	Dwarf Bustard
Grandes Outardes	Greater Bustard
Gazelle a Front Roux	Red Faced Gazelle
Guib-harnache ou Mina	Bushback
Antilope-Cheval ou Koba	Koba Antelope
Buffle	Buffalo
Lion	Lion
Cephalophe de Grimm	Grimm's Antelope

Warthogs are common in the area, do extensive crop damage, and are therefore not protected. They are not hunted for meat because of the lack of pork in the Moslem diet.

Second only to water needs is the people's concern over the predator problem. Individual villages report from 20-60 animals killed per month by "tigers", which can mean hyena, jackal, lion, panther, cheetah, leopard, or wild dog. Sheep and goats are the main prey due to the fact that native game prey is practically non-existent. The village of Diare Mbolo expressed the desire to have poison supplied to them that they might use in meat baits. The wild animal problem is one cause for stock being gathered and guarded at night and therefore restricts 24-hour grazing and potential livestock weight gains. The gathering of animals also results in concentrations of livestock with consequent overuse areas. It also necessitates constant trailing of livestock to

and from protection, water and forage with a high percentage of the grazing areas being denuded due to trails alone.

Ten people are presently assigned to the Department of Bakel in the Division of Water and Forests, which also handles wildlife. They seldom see the area included in the Toulekedi zone due to transportation problems.

VI. PRESENT LAND USE

A. CROPLAND

Although cultivation occupies a relatively small total area (542.6 hectares) in the zone, it is an important activity and demands considerable time of the people during certain periods of the year. Area in cultivation varies from village to village and from one management unit to another, as seen in Table 2, but in all cases is centered around active villages and does not occur in isolated areas.

Fields are cultivated by hand hoe and/or oxen with metal plows immediately at the outset of the rains which may be in June or July. Following a rain, a small area is plowed, rows of small holes are dug with a hand hoe, seed dropped in the hole by hand and the hole filled and lightly tamped with the foot. If the ground has sufficient moisture, another small area is then plowed and planted the following day. If it does not have enough moisture, plowing does not proceed until another rain occurs. Work is done early in the morning and generally is

Table 2. Area in cultivation by management unit and village in the Toulekedi zone.

Management Unit	Village	Hectares Cultivated
I	Baniou	41.3
II	Ndia	52.7
III	Boulel	28.7
IV	Toulekedi	66.3
V	Guanade	29.0
	Garala	27.8
	Medina Geri	32.5
	Ndiakone	56.3
VI	Diare Mbolo	70.9
	Diare Mabobe	137.1
VII	-	-
VIII	-	-
Veterinary holding ground	-	-
Total		542.6

completed by noon. Very little land is in fallow during the rainy season and go-back or abandoned farmland is practically non-existent in this zone.

Cultivation is limited in the zone to the drainages, which are deep, leached, tropical ferrugenous, sesquioxide soils, but by no means occupy all the soils of this type. Little, if any, attempt has been made by the people to cultivate any of the other three soils, which are unsuitable for cultivation. The fact that these people are primarily interested in livestock raising is probably the main limiting factor on cultivation, since considerably more area of suitable soils are available for this type of land use within the zone.

Livestock are herded away from the cultivated areas surrounding the village at the first breaking of ground after the initiation of the rains. They are kept off of these areas until after the crop is harvested, which is generally in late November to early December. Animals are then allowed on the fields to consume the crop aftermath. From this period until the start of the next rains in June or July, herds are held on the croplands overnight so that the fields might be fertilized, as well as for previously mentioned protection reasons. Night camps are rotated in such a manner that all cultivated land is manured. Crops grown are primarily maize, millet and sorghum.

B. RANGELAND

Grazing land in the Toulekedi zone is shown in Table 3 for each management unit. Valenza (1972) describes the area as being in the sudano-angolan region of the paleo-tropical floral empire and in the sahelo-sudanian sector which is part of the sahelian domain. It appears to him that the present physiogomy is much more the reflection of dense human activity and a semi-aridity having followed a damper period. He finds, over the whole area, woody species much more mesophytic of sudanese nature which are leftovers from a cleared forest of a damper period. Following a mesophytic vegetation there was a xerophytic type based on selective arid climatic conditions.

The sahelo-sudanese sector is marked by the appearance of an often great quantity of Combretum glutinosum. In the eastern subsector, it corresponds to the sandstone-clay formation of the continental terminal. It is marked by:

(1) the absence of Acacia raddiana except on the plateau bordering the Ferlo Valley.

(2) the frequency of residual stations around temporary ponds whose existence is connected with the outcroppings of impermeable terrain. . .the development of a large heterogeneous vegetal growth in which Combretum glutinosum and Acacia seyal predominate. This group can be split into two pseudo-climaxes which are most often superimposed at the same station: one pseudo-climax of Combretum

Table 3. Grazing land by management unit and total for the Toulekedi zone.

Management Unit	Hectares Rangeland	Total Hectares
I	7,203.9	7,245.2
II	6,091.5	6,144.2
III	7,748.7	7,777.4
IV	9,648.7	9,715.0
V	14,093.9	14,239.5
VI	19,570.0	19,778.0
VII	9,784.3	9,784.3
VIII	11,893.3	11,893.3
Veterinary holding ground	761.7	761.7
Total	86,796.0	87,338.6

glutinosum and Aristida mutabilis, and a pseudo-climax of Acacia seyal and Chloris prieurii in the clayey zones. These two pseudo-climaxes are most frequently associated with each other.

In the east of this subsector there are dense and sometimes monospecific growths of Pterocarpus lucens, accompanying the ferrugenous coatings, either in the form of outcroppings or at a shallow depth.

Because of the climatic and edaphic conditions, phytogeographic factors among the woody vegetation, and human elements, the types of natural grazing lands of the zones are numerous and varied.

Draws in general have deeper soils, have greater variety of plant species, greater canopy cover and sometimes less woody stems per acre, although the latter depends upon the past effects of burning, grazing, trailing, etc. The past effects of fire seem to determine the plant density of woody species on ridge areas.

The majority of the Toulekedi zone is best suited to grazing by livestock and is used yearlong for this purpose. Forage produced is primarily annual grasses which complete their growth cycle during the rainy season or shortly thereafter, from about June to November. They are most nutritious during this period, cure rapidly, and have relatively low value during the remainder of the year. Water resources are numerous during the rainy season in natural ponds and drainage ways, but by January are limited to wells in the villages. During the rainy season, livestock are kept out away from the village for

grazing, as well as at night in temporary, loosely constructed bush corrals, so that they might utilize the temporary water available. They are then kept on the cultivated fields at night, following harvest, and trail out daily to forage. They are generally accompanied by a herder during the rainy season for two reasons. One is to keep livestock out of the fields and the second is to keep animals from straying into dense vegetation where they are excellent predator prey. Once the tall grass has been trampled, grazed or burnt down, it is no longer necessary to accompany the animals daily and thus they may or may not be herded during the dry season. They do, however, return to the village nightly in the dry season, on their own, in search of water and to be milked.

In addition to the problem of a lack of permanent, evenly distributed watering points throughout the grazing areas, fire is a serious limiting factor. Approximately 80% of the land area of Senegal, and closer to 90% of the land area of the Toulekedi zone is burned off annually. There is little question that fire has caused great damage in the two study zones. There is any amount of evidence that indicates fire has burned large areas during the past dry season. This has resulted in feed shortages for livestock, especially close to the villages where the cattle are kept close to water. Out beyond the water supplies fires have occurred but have not had as serious an impact.

Fires are quite possibly the most awesome problem due to the fact that it is a social problem and not a strict technical problem. On

December 1, 1975, only one and one-half months into a seven- to nine-month dry season, approximately 75% of the zone had already been burned to one extent or another. This varied from very light burns which had occurred immediately after the rains, burning the slender drier grasses and leaving the more coarse plants which had moisture remaining in them, to burns that had occurred only a few days before in which 100% of the grasses and forbs were destroyed. At the end of the dry season (July, 1975) it is estimated that close to 90% of the zone had been burned to the point of 80-90% removal of grasses and forbs. Reported causes of these fires ranged from intentional burning to remove coarse forage or to open up tall grassy areas to prevent predators from sneaking up on livestock, to accidental burning in instances where the original fire was intended for another purpose, such as smoking out bees, burning brush piles, or clearing fields of uneaten crop aftermath prior to planting and then disregard for what happened to the fire once it had served their immediate purpose. A most challenging cause was also reported to be one of superstition that, even though perhaps a livestock owner, good luck and safekeeping will follow those among the first to start a range fire following the rainy season. It was reported by the Division of Water and Forests that they considered all fires man-caused. This may or may not be entirely true because some highly intensive electrical storms were witnessed that could have caused serious fires. Fortunately, rain followed most of these frontal storms.

C. AREAS OF NON-USABLE LAND

Non-usable land can be either natural or man-made. In the zone the principal areas that are non-usable are man-made, these being the heavily overused drainage ways from the villages of Diare Mbolo and Toulekedi to the southwest corner of the zone. The continued degradation of these areas is due to overgrazing and trailing. Natural mineral licks also occur on the eroded slopes into the drainages, which adds to the livestock concentration problem. See Table 4 for area, by management unit, of this type of non-usable land.

Table 4. Non-usable land which is highly eroded along drainage ways, shown by management unit, in the Toulekedi zone.

Management Unit	Hectares Non-Usable
I	686.9
II	721.3
III	408.3
IV	58.9
V	2250.5
VI	624.5
VII	-
VIII	-
Veterinary holding ground	-
Total	4760.4

There is a sizable amount of land presently in low production that exists in areas at the head of drainages along the continental

terminal. These are slight depressions in extremely flat terrain in which water collects during the rainy season. Existing annual grasses are not adaptable to this flooded condition and produce only a very slight cover when the ponds dry up. Clay content of the soils is slightly higher in the ponds than on adjacent soils resulting in slight crusting and cracking when dry, and swelling and sealing when wet. Since these areas do hold wet season livestock water, they are heavily used during that period. Due to adjacent heavy brush vegetation they are favorite trail routes. As are all areas, they too are subject to fires.

Rock outcrops are a factor only along the eastern boundary of the zone where the laterite layer surfaces and forms an escarpment from north to south. This does not pose a non-use problem since it can be an effective boundary and firebreak.

Areas occupied by villages are insignificant, since cultivation occurs around and within the village area, and has been included in Table 2 as cultivated land. Non-usable land due to road right-of-ways is also insignificant at this time and can be disregarded for all practical purposes. The main route through the zone follows the eroded, non-usable areas shown in Table 4 and, for the most part, is included in them.

D. POTENTIALLY USABLE LAND NOT NOW IN USE

Potential cropland not now is use exists along all main drainages in the zone. Present villages are located along these drainages, but

due to the people's prime interest in livestock raising, these areas of cultivation have not spread to any great extent. A more detailed land use plan would be necessary to identify these potential sites and arrive at a figure of hectares. As witnessed by the fact that the three villages of Guanade, Garala, and Medina Geri are relatively new villages, some pressure does exist for expanding the area now in cultivation and such a land use plan is necessary.

Management unit VII and part of unit VIII are not presently usable year-long as grazing land, due to the lack of permanent water and distance from existing water sources in villages. They are, however, used as wet season grazing. These areas are also the only extensive areas in the zone that have not been burned as extensively or regularly as the majority of the rangeland. Forage production, but also bush density, therefore, is highest in these units.

VII. LAND RESOURCE MANAGEMENT AND DEVELOPMENT PLAN

A. CROPLAND

Without expertise to analyze adequately the agronomic situation in the zone, few concrete recommendations can be made at this time. However, the following points might well be problems that need correcting.

1. Constant use of the same area for growing of the same crops year after year has undoubtedly led to soils being low in fertility. A

greater variety of crops might be encouraged along with rotation of these crops.

2. Improved varieties might be studied.

3. Present plowing methods, especially by oxen and a metal plow, may well be resulting in a plow sole developing in the soil. It was observed that plowing in this manner seldom exceeds 10 cm and is consistently at the same depth over the entire field. It might be necessary to break this plow sole occasionally with heavier equipment. It has been shown that detachment of soil particles by rainfall is decreased by increasing plowing depth from 10 to 30 cm (Mazurak et al., 1975).

4. In some cases contour plowing is necessary to prevent water erosion in the fields. This is not a serious problem since most areas are extremely flat, but occasional situations were encountered where it would be beneficial.

5. Harvest should be conducted at a time when the crop is most nutritious not only to humans, but as aftermath for livestock. This optimum harvest date is often passed due to ease of harvest at a later date.

6. Storage facilities could be improved to prevent loss due to spoilage, rat and insect damage, etc.

The following points are recommendations necessary to coordinate crop production with the range management program:

7. Crop aftermath could be consumed in place by the village milk herd or stored as silage (necessitating alterations of present harvesting techniques) for use later in the dry season when the demand for feed is more critical, but at no time should the beef herd be brought back to the village for this purpose. If is is desirable to supplement the beef herd with crop aftermath, the supplement should be taken into the underutilized portions of the grazing area for these animals and never should the same feeding site be used twice within a two-year period nor more than two days in a row. Transport of these small quantities, rationed out daily, could be easily handled on the horse drawn carts present in most of the villages.

8. Since the beef herd will no longer be brought back to the village on a nightly basis, commercial fertilizers will have to be purchased to replace traditional manuring practices. After an analysis is made of each field's individual needs, it is believed that crop requirements can be met as satisfactorily with commercial fertilizers (Rothamsted Experimental Station, 1970). If nitrogen is the limiting factor, inorganic fertilizers would be preferable since nearly 90% of the nitrogen is immediately available while phosphorus is only moderately available. Organic fertilizers (manure), on the other hand, lose about half of their nitrogen by denitrification while phosphorus is almost completely available. Mazurak et al. (1975) also found that there was more soil detachment due to rainfall on manured as opposed to non-manured fields that were disced to 10 cm. Senegalese officials

mentioned that inorganic phosphorus fertilizers are free to the farmer from the government while inorganic nitrogen will be supplied to them on a cost share basis with the farmers' cost being 12 CFA per kilogram. The agronomist should design, implement and evaluate fertilizer trials in order that proper recommendations might be given to village farmers in this area. This should be done immediately in order that demonstrations can be set up to convince the farmers of the need to use inorganic fertilizers rather than manure.

9. Individual village milk needs must be determined and, as a result, the size of the milk herd kept at the village will be established. Seeding trials are being recommended for the project and when sufficient information has been gained on adaptable forage species, areas near the villages should be set aside for planting to permanent pasture for this milk herd.

10. A more detailed land use plan must be written on the land suitable for cultivation, which is adjacent to the main drainages in the zone. This will be necessary, not only to prepare for expansion of existing food crop production, but to identify sites capable of producing a yearlong standing forage crop for the village milk herds. Care must be taken in selecting these sites, since they will border existing badly eroded areas that, of necessity, must receive no use for an underdetermined number of years to allow for revegetation of these areas.

B. RANGE LAND

1. Range Survey Data by Management Unit

a. Vegetation

Refer to the enclosed Toulekedi Zone-Bakel Range Livestock Project map as well as Table 5 for vegetation types and particular species information. The perennial grass Andropogon gayanus is found primarily in the bottoms but is also present in scattered patches on ridges in the southeastern portion which have not been burned as extensively. Annuals dominate the forage plant community.

b. Overstory Characteristics

Table 6 lists overstory canopy cover classes by management unit. Overstory, in this case, refers to all woody species including both shrubs and trees.

Distance between woody species, as seen from the Toulekedi Zone-Bakel Range Livestock Project map, in general indicates that woody plants are more closely spaced on the downstream portions of the drainages and in the pond areas along the rim where woody plants tend to be in clumps with open areas between clumps. In the case of the pond areas, the clumps occur around and between ponds. Along the entire rim on the eastern half of the project area, the situation is reversed with spacing closer on the ridges than in the drainages. This is particularly true in the southeast corner where fires have not been as frequent.

Table 5. Dominant plant species found in the Toulekedi zone.

Map Symbol	Name[1]	Tree	Shrub	Forb	Grass
Ascen	*Acacia senegal*	X			
Acsey	*Acacia seyal*	X			
Addi	*Adansonia digitata*	X			
ALBI	*Albizzia* sp.		X		
Anga	*Andropogon gayanus*				X[2] perennial
Anps	*Andropogon pseudapricus*[3]				X
ARIS	*Aristida* spp.				X
AVIC	*Avicennia* sp.		X		
Baeg	*Balanites aegyptiaca*		X		
Boca	*Bombax costatum*	X			
BORR	*Borreria* spp.[4]			X	
Caob	*Cassia obtusifolia*[5]			X	
Cein	*Celtis integrifolia*	X			
COMB	*Combretum* spp.	X			
Diha	*Diheteropogon hagerupii*[3]				X
Elel	*Elionurus elegans*				X
Guse	*Guiera senegalensis*		X		
HIBI	*Hibiscus* spp.[6]			X	
Loto	*Loudetia togoensis*[3]				X

Table 5. Continued.

Map Symbol	Name[1]	Tree	Shrub	Forb	Grass
Miin	Michrochloa indica[7]				X
Pepe	Pennisetum pedicellatum[8]				X
Scgr	Schoenefeldia gracilis[7]				X

[1]Grasses and forbs identified using Bartha (1970) along with notes, photographs and checking by Dr. Valenza, Institue d'Etudes Medicules et Veterinares Tropicales, Dakar-Hann, Senegal.

[2]Grasses are annuals unless otherwise noted.

[3]Primary forage species.

[4]Some are forage species but not highly desirable.

[5]Non-forage. Found primarily in overused areas.

[6]Unpalatable, irritating burrs.

[7]Found on tight soils (high clay, extremely low infiltration) which have been severely overused to the point that advanced sheet and gully erosion is occurring. Quite possibly would provide an initial secondary succession cover crop if these areas were allowed to receive non-use for a period of several years.

[8]Indicator of overuse or disturbance on all sites.

Table 6. Overstory canopy cover by management unit in hectares.

Management Unit	Area in Hectares							
	Canopy Cover in Percent						Village Cultivation	Totals
	<30	30-39	40-49	50-59	60-69	70+		
I	-	6,389.3	814.6	-	-	-	41.3	7,245.2
II	-	3,067.4	3,024.1	-	-	-	52.7	6,144.2
III	-	1,693.0	6,055.7	-	-	-	28.7	7,777.4
IV	32.0	3,035.1	4,981.8	505.6	1,001.2	93.0	66.3	9,715.0
V	-	415.2	13,678.7	-	-	-	145.6	14,239.5
VI	-	11,191.4	8,378.6	-	-	-	208.0	19,778.0
VII	-	5,357.6	4,426.7	-	-	-	-	9,784.3
VIII	169.3	7,827.0	1,426.4	1,315.5	860.1	295.0	-	11,893.3
Veterinary holding ground	-	761.7	-	-	-	-	-	761.7
Total	201.3	39,737.7	42,786.6	1,821.1	1,861.3	388.0	542.6	87,338.6

c. Soils, Slopes and Erosion

Soil descriptive terms used here apply to surface characteristics. Table 7 shows soil types by management unit. Deep, grey, silty loam soils are those found in drainages which have cultivation potential. Thin, red, gravelly laterite soils are ridge type soils which should not be tilled. Shallow, grey, sandy or silty loam soils are found primarily along the eastern edge of the continental terminal where drainage is very slow due to nearly level topography and thus poorly vegetated pond areas have formed. Areas of severe sheet and gully erosion are occurring on the drainages downstream from villages and, as shown in Table 7, are on the cultivatable soils. Slopes are all in the 0-3% class, reflecting the extreme flatness of the terrain.

d. Range Condition

Areas in poor condition are restricted to two situations. The first is in the highly eroded drainage ways as a result of total overuse and the second is in the pond areas along the rim (on deep, grey, silty and sandy loams) where the annual grasses are not adapted to flooded conditions and overuse is occurring as well (see Table 8). One minor exception is in the northwest corner of management unit VIII where the drainage is not a major one but has a fairly dependable rainy-season water hole in it, thus resulting in overuse and a poor condition. It must be admitted that the rating system used could be in error due to uncertainty as to what the climax species might be in this area.

Table 7. Soil type by management unit in hectares.

Management Unit	Area in Hectares						
	Thin, red gravelly laterite	Deep, grey silty loam; highly eroded	Deep, grey silty loam	Shallow, grey, sandy loam	Shallow, grey, silty loam	Village Cultivation	Totals
I	6,517.0	686.9	-	-	-	41.3	7,245.2
II	5,370.2	721.3	-	-	-	52.7	6,144.2
III	7,340.4	408.3	-	-	-	28.7	7,777.4
IV	8,432.2	58.9	1,125.6	32.0	-	66.3	9,715.0
V	11,644.5	2,250.5	198.9	-	-	145.6	14,239.5
VI	12,899.2	624.5	6,046.3	-	-	208.0	19,778.0
VII	5,642.5	-	4,141.8	-	-	-	9,784.3
VIII	7,307.3	-	1,207.2	169.3	3,209.5	-	11,893.3
Veterinary holding ground	761.7	-	-	-	-	-	761.7
Total	65,915.0	4,750.4	12,719.8	201.3	3,209.5	542.6	87,338.6

Table 8. Range condition by management unit in hectares.

Management Unit	Area in Hectares					
	Excellent	Good	Fair	Poor	Village Cultivation	Totals
I	-	-	6,517.0	686.9	41.3	7,245.2
II	-	-	5,370.2	721.3	52.7	6,144.2
III	-	-	7,340.4	408.3	28.7	7,777.4
IV	-	-	9,464.8	183.9	66.3	9,715.0
V	-	-	11,843.4	2,250.5	145.6	14,239.5
VI	-	-	18,945.5	624.5	208.0	19,778.0
VII	-	-	9,784.3	-	-	9,784.3
VIII	-	-	8,219.5	3,673.8	-	11,893.3
Veterinary holding ground	-	-	761.7	-	-	761.7
Total	-	-	78,246.8	8,549.2	542.6	87,338.6

However, due to the heavy grazing and trailing pressures and excessive occurrence of fires, it is probably not far wrong.

e. Current Year's Forage Production, Forage Utilization and Carrying Capacity

Production of forage species following the rainy season of 1975 ranged from 800 to 2500 kilograms per hectare which, after corrections for unavailable forage and percent moisture content, were from 593 to 2041. As can be seen from Table 9 and on the Toulekedi Zone-Bakel Range Livestock Project map, the least productive areas are those in poor condition along drainage ways and in the rim pond areas. The most productive are those in both drainages and on ridges in the southeast side and center of the Toulekedi zone that are both remote from villages and receive less frequent burns.

Utilization figures shown on the map are those at the end of the dry season (July) of 1975. Except for the southeast corner they represent total use, including fire. In fact it was impossible to separate livestock use from the effects of fire, except in the southeast corner, since so few unburned patches could be found.

It must be stressed at this point that the carrying capacity figures as shown in Table 9 are a reflection of the current year's rainfall, which was 667.1 mm. Since the long term average precipitation is 503 mm, and only five years in the last 56 years have exceeded the 1975 amount, production was undoubtedly above average this year. This topic is discussed further later under Range Management Plan

Table 9. 1975 forage production and carrying capacities by management unit for the Toulekedi zone.

Management Unit		Forage Available on Oven Dry Basis (kg/ha)	Carrying Capacity of Type (ha/AU/yr)	Hectares in Type	Carrying Capacity of Type (AU/yr)
I		1,613	5.7	6,38[illegible].3	1,120.9
		1,929	4.7	1[illegible]7.7	27.2
		841	10.9	[illegible]6.9	-[a]
	Village area			41.3	-
	Totals			7,245.2	1,148.1
II		2,041	4.5	2,302.8	511.7
		1,028	8.9	398.8	-[a]
		841	10.9	322.5	-[a]
		1,613	5.7	3,067.4	538.1
	Village area			52.7	-
	Totals			6,144.2	1,049.8
III		2,041	4.5	5,647.4	1,255.0
		1,613	5.7	1,693.0	297.0
		1,028	8.9	408.3	-[a]
	Village area			28.7	-
	Totals			7,777.4	1,552.0
IV		1,929	4.7	31.4	6.7
		2,041	4.5	4,891.5	1,087.0
		1,779	5.1	1,001.2	196.3
		1,977	4.6	505.6	109.9
		593	15.4	32.0[b]	2.1
		1,028	8.9	58.9	-[a]
		1,613	5.7	3,035.1	532.5
		949	9.6	93.0[b]	9.7
	Village area			66.3	-
	Totals			9,715.0	1,944.2
V		1,833	5.0	63.0	12.6
		1,929	4.7	198.9	42.3
		841	10.9	2,250.5	-[a]
		2,041	4.5	4,364.2	969.8
		1,929	4.7	6,865.1	1,460.7
		1,613	5.7	352.2	61.8
	Village area			145.6	-
	Totals			14,239.5	2,547.2
VI		1,833	5.0	8,251.4	1,650.3
		1,929	4.7	2,110.9	661.9
		841	10.9	624.5	-[a]
		1,929	4.7	6,046.3	1,286.4
		1,613	5.7	5.0	0.9
		2,041	4.5	1,531.9	340.4
	Village area			208.0	-
	Totals			19,778.0	3,939.9

Table 9. Continued.

Management Unit	Forage Available on Oven Dry Basis (kg/ha)	Carrying Capacity of Type (ha/AU/yr)	Hectares in Type	Carrying Capacity of Type (AU/yr)
VII	1,833	5.0	4,135.2	827.0
	1,929	4.7	4,141.8	881.2
	2,041	4.5	284.9	63.3
	1,613	5.7	1,222.4	214.5
Totals			9,784.3	1,986.0
VIII	2,041	4.5	907.4	201.6
	1,929	4.7	52.1	11.1
	1,285	7.1	2,742.6[b]	386.3
	593	15.4	169.3[b]	11.0
	1,779	5.1	860.1	168.6
	1,613	5.7	571.5	100.3
	949	9.6	295.0[b]	30.7
	1,613	5.7	4,512.9	791.7
	1,898	4.8	466.9	97.3
	1,977	4.6	1,315.5	286.0
Totals			11,893.3	2,084.6
Veterinary holding ground	1,423	6.4	761.7	119.0
TOTAL				16,370.8

[a]Highly eroded drainageways need to be excluded from use until such time as they are revegetated and are providing protection from water erosion and are therefore not included in available carrying capacity at this time.

[b]Areas in poor condition, other than the highly eroded drainage ways, warrant close attention. They are included in available carrying capacity at this time, but if they do not improve under the proposed management they should also be excluded from available carrying capacity and the management unit carrying capacities should be reduced accordingly, and management adjusted to allow non-use of these areas.

b (Carrying Capacity) and c (Grazing Plan). It is important to note, then, that these carrying capacity figures are overestimates; that the figures for livestock water needs per pond in Tables 11 and 12 are overestimates, and that all of these tables will need to be adjusted as more information is collected.

The following is an example of the procedures used in estimating carrying capacities.

Forage produced in kilograms/hectare[1]	2000
Minus forage inaccessible[2] (or 10% of 2000)	- 200
	1800 kg/ha
Minus moisture content[3] (or 1.15% of 1800)	- 21
Kilograms forage production/hectare (figure shown on map)	1779 kg/ha
Multiplied by desired percent use of forage crop	x .60
Forage available for livestock use =	1067.4 kg/ha
Forage available for livestock use / Forage needs per day per animal unit (AU)	1067.4 kg/ha / 15 kg/day[4]
	= 71.2 days/ha/AU
Days/year / Days/ha/AU	365 / 71.2
Carrying capacity	= 5.1 ha/AU/yr[5]

[1] Average for vegetation type.

[2] Under thorn trees, etc.

[3] Samples were collected and oven dried for 24 hours at 40.6° C. Moisture contents for these grasses, even though only 30 days since the end of the rains, were extremely low. Samples collected in the morning averaged close to 6% moisture while afternoon samples contained about 1.5% moisture. One sample collected in the afternoon but in an extremely dense forage stand and in a shaded area still held 11.25% moisture.

[4] Due to the extremely low quality of forage available and also due to the loss that will occur in trampling when forage is as dry as was found in 1975, needs per day are necessarily high. Samples collected in late November, 1975, and analyzed at the University of Arizona revealed that composite samples of annual grasses which have lost most of their seed heads and also some fine material average 1.6% crude protein and 53.9% crude fiber on an air dry basis. A composite sample of annual grasses, including seed and fine material which had fallen to the ground, gave a crude protein percentage of 5.0 and 50.4% crude fiber on an air dry basis while fresh green leaves of the same plant showed 11.4% crude protein and 38.0% crude fiber on an air dry basis.

In California studies by Hart et al. (1932) annual grasses, while valuable early feed, have a comparatively short period when they furnish adequate nutrition. When these species mature and dry, the seeds are largely unavailable and the remaining stems and leaves are deficient in protein and minerals, particularly phosphorus. Values of crude protein of oven-dried and silica-free samples varied from 1.81 for dry, leached, wild oats (Avena sp.) to 17.2 for green soft chess (Bromos hordeaceus) while crude fiber was 36.7 and 28.6, respectively.

Gordon and Sampson (1939) found that in most of the graminaceous, grasslike, and broad-leaved herbaceous species in the California annual type there is a continuous and rather orderly decline in the crude protein, silica-free ash, calcium, phosphorus, and potassium from the earliest appearance of leaf blades to plant maturity. The percentage of crude fiber in these plant groups, on the other hand, increases with the advance of the season. The most rapid changes in constituents take place from the early leaf development to the period of full bloom. Values of crude protein varied from 1.26 for straw only, heads clipped, Bromus mollis to 34.5 for early leaf stage, manured Bromus rigidus while crude fiber was 42.6 and 14.9, respectively. Shortening of the growing season apparently results in a decrease in phosphorus, and in some species in calcium, but it does not influence quantitatively the protein and potassium contents.

As Heady (1961) points out, animals are likely to be improperly nourished during periods of wet weather when the forage is young because the high moisture content in the feed prevents them from consuming enough bulk to get the daily requirement of total digestible nutrients. In the dry season sufficient bulk will be consumed but it may not contain adequate nutrients.

Studies by Valenza (1965) in Andropogon pseudapricus and Andropogon amplectens vegetation in the Dara-Djoloff area of Senegal show digestible crude protein (N x 6.25) to range from

2.68 with 94% dry matter to 11.52 with 25.5% dry matter. Calcium (.284) and phosphorus (.027) were again lowest at 94% dry matter and highest (.870 for calcium and .097 for phosphorus) at 25.57% dry matter. He found that male gobra zebus put on weight from October to December, lost weight from January to July (July was back down to October weights) and put on weight in August and September. This was under continuous grazing at 3.5 hectares per animal unit per year, which he admits was too heavy as forage was depleted five weeks before the rainy season. As can be seen, then, animals showed a net gain in weight for two months during the year even under extremely heavy stocking rates and in years which he reports were far below the average rainfall of 520 mm. (Studies were run in 1962 and 1963 when 335.7 mm and 494.0 mm respectively were received.)

(5) Carrying capacity as shown on the Toulekedi Zone-Bakel Range Livestock Project map.

f. Plant Vigor and Reproduction

Plant vigor was not a limiting factor in 1975 nor was reproduction. Even though the zone was extensively burned prior to the rains, there was more than adequate seed remaining in the soil exclusive of the highly eroded drainages, to provide a dense stand of understory species.

g. Water Availability

On December 1, 1975, only one and one-half months following the rainy season, temporary ponds were beginning to go dry and the best of them were expected to last no longer than one more month. This means that under the very best of conditions, animals will be watering at the village wells from January 1 until June 1, 1976, or for a period of five months. Most livestock owners will be watering at the village wells much longer, even up to nine months, depending upon

temporary water available to them and the beginning date of next year's rainy season. These temporary ponds, even though reasonably well sealed by natural clay deposits, cannot be expected to last long since they are seldom over 2 meters deep. This shallow water spread over areas one-half hectare in size amounts to a sizeable quantity but is largely spoiled by animals milling in it. It appears quite likely from the amount of clay presently on the bottoms of these temporary ponds and due to the fact that most of the soils are Alfisols, with high clay contents in the profile, that some of the existing ponds could be deepened and small stock ponds constructed in areas presently lacking livestock water.

h. Other Limiting Factors

The Toulekedi zone is in a transition zone between tsetse fly areas to the south and tsetse fly-free areas to the north. Problems associated with this as well as other livestock problems are discussed under Animal Health and under Livestock.

Heat can be a real problem, not just for livestock but for man as well. Near the end of the dry season it will be difficult to accomplish work objectives and, in fact, could be very dangerous unless one is fully prepared with water, food, medical supplies, a compass, and a trustworthy vehicle.

2. Range Management Plan

a. Definition

Range management is the science and art of planning and directing range use to obtain the maximum livestock production consistent with conservation of the range resources. It implies a sustained yield of livestock over a long period of time (Abercrombie, 1974). Range management is sometimes defined as the art of manipulating vegetational changes for greatest livestock production (Heady, 1960). Herbel et al. (1974) do not limit production from rangeland to livestock products alone but describe it as producing the highest possible net return. This might include wildlife, recreation, wood products, water and clean air.

It is evident from the definition that range management is closely related to animal husbandry, plant ecology, game management, forestry, engineering, agronomy, soil science and economics. Not to be overlooked is the importance of the social sciences, especially in the African situation.

Rangelands are not necessarily responsive to the agricultural practices used on ley pastures, including cultivation, intense rotations with crops or with livestock, and other general farming techniques. The plant species are different, the growing periods are often short, rainfall is low and erratic, the weed species are different, and production per acre is inherently low. In these semi-arid areas,

management must be geared to the natural complex of vegetation, soil, animals and climate. In short, rangelands present greatly different problems and techniques in management from the cultivated pasture (Heady, 1960).

The purpose of proper utilization of rangeland is to obtain maximum production of desirable forage while maintaining or improving the range resource. Proper range use is the highest degree of use that the current available forage can be grazed by livestock, game, and other animals and still leave adequate cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation over the maximum area of a given range unit, and when the most practical uniformity of grazing and other land uses are given due consideration. Excellent range condition is usually the management objective. However, there are times when excellent range condition will not be the goal. In some cases, the goal may be a lower range condition that will provide a certain kind of forage during a particular season or for a specific kind of livestock or wildlife. Improvements in the range resource include increased production of desirable forage species, greater plant density and vigor, increased mulch cover, greater rainfall infiltration, reduced soil-surface evaporation, and reduced soil erosion (Arizona Interagency Range Technical Subcommittee, 1973).

b. Carrying Capacity

Management units have been established for the Toulekedi zone based on traditional use patterns and natural ecological boundaries on a best fit basis with the information available. Table 9 shows total carrying capacity, by management unit, as determined following the rainy season of 1975. One animal unit (AU) refers to one mature zebu or ndama cow with or without an unweaned calf at her side. Five sheep, 5.9 goats, 0.8 horses, 0.8 mature bulls, 0.8 donkeys, and 1.7-1.9 immature cattle (depending on age) are equivalent to one animal unit.

Carrying capacities are extremely difficult, if not impossible, to accurately determine. Great variation in forage production from one year to another on rangelands is an established fact. The grazing pressure that a range can withstand in drought is much different than in years of high rainfall. To stock a range at an average of these leads to alternate damage and improvement and to poor and good animal responses. In semi-arid areas, years of below-normal forage production are likely to outnumber the above average years. Hence stocking at the average is likely to lead to deterioration in the long run. Many ranges have been adequately managed by stocking at about 80% of the average carrying capacity. Obviously, it will be a number of years before an "average" carrying capacity can be determined for these management units, and thus it is not possible at present to apply such a factor, but may be more meaningful as experience is gained.

Heady states that another approach to proper stocking is to adjust stocking rates to the amount of forage produced each year. This, too, is difficult because it entails continual buying or selling animals at a time when the neighbors are doing the same. It also requires an extensive system of markets and transportation and a willingness to buy and sell. These items do not exist in Africa to any great extent. Until they do, even the restriction of animal numbers to any reasonable balance with the forage resource will be difficult to attain. Until such facilities and attitudes exist, improvement of African ranges as a whole will be next to impossible to obtain.

Control of livestock numbers, often the most difficult part of the whole program, must be accomplished as soon as possible. If this cannot be done, there is no point in starting the scheme in the first place. The longer an area goes without livestock control the more difficult range management becomes. A conservative attitude toward raising stocking rates in good years with resulting range improvement and a drastic attitude during poor years when deterioration may occur is commended. A drought is not as severe if a husbandman goes into it with abundant, excellent range, nor is it as long (Heady, 1960).

An agreement should be drawn up between the Project/Senegalese Government and the grazing associations which will state that in return for provision of water, fire control, etc., the grazing association will abide by the carrying capacity limitations set for each management unit and will pay a grazing fee, based on number of animals

grazed, for service rendered. At the same time, user rights should be granted the grazing associations to insure them grazing rights to their management unit should they follow the regulations established. The individual grazing association will then allocate the total carrying capacity of their management unit to the members of that association and provide their own internal management as concerns the hiring of herders, bookkeeping, etc.

c. Grazing Plan

(1) Moderate Continuous Grazing

Forage species in the Toulekedi zone are primarily annual grasses. Dr. Valenza, Botanist, Dakar-Hann Labs (personal communication) does not believe that perennial grasses would introduce themselves even under total non-use by livestock, fire, etc. Heady (1961) found in the annual grasslands of California that the size of the forage crop is related to weather conditions and may differ over 100% between years. The species composition also varies widely from year to year. The various species mature at different times during the spring. In planning a grazing strategy, therefore, several points are important: the short and variable time when species mature, variable maturation dates of desirable and undesirable plants, a wide difference in forage quality as related to available moisture and stage of maturity, and fluctuations in stage of maturity due to site. Of course, the more complicated a grazing scheme is the more managerial ability is needed to operate it.

Based on experience gained in the California annual type, the management units in the Toulekedi zone should follow a system of yearlong grazing at a moderate stocking rate. Duncan and Heady (1969) report that yearlong continuous grazing is advantageous over the various specialized grazing systems in terms of animal and plant response to grazing treatment. Moderate use is the basis for carrying capacity estimations shown previously for each management unit. This grazing system pays primary attention to the day-by-day animal needs and amounts to a partial deferment every year. Enough forage must remain at the end of the forage growth period so that the animals have ample feed to last them until the new crop is produced eight to nine months later. This amounts to a very light grazing on all the range during the growing season every year.

Unless the grazing pressure is extremely heavy, sufficient seed will be produced for the next crop and rest from grazing during the fast growth period is not needed. Also, systems of grazing which give pastures a growing season rest every three or four years in order to allow for range improvement would seem to be ineffective on annual ranges because any gain in one year can be wiped out the next year by weather alone. In the California studies roughly twice as much herbage was produced with all the plant material left in place than when all was removed. Intermediate amounts of mulch resulted in intermediate herbage production. Proper use then, as defined earlier, for annual type ranges is moderate use where this intermediate mulch/herbage

production situation exists. A general rule of 60% use by weight might be followed initially until results indicate a need to modify the rule. According to Heady (1961) it would seem wise to leave the least nutritious plant material as mulch and to encourage as much animal selectivity of the better plant parts as possible. Animals should be widely spread and allowed to graze for long periods to accomplish these conditions most efficiently. Since forage will be remaining at the end of the dry season when proper use has been obtained, it is obvious that forage available cannot be a limiting factor on controlling animal numbers in a management unit. With forage available on the ground, this factor will not prevent animals from being able to survive in the unit. Water, then, must be this limiting factor and the quantity of it supplied carefully balanced with the percent of forage that should be removed. When water has been exhausted at or near the degree of forage use desirable, animals will be forced to leave the area if overstocking has occurred. However, if stocking follows recommended levels, water, as planned, will be adequate for the entire dry season. Thus proper use will be obtained.

(2) Water Development

It is extremely important that grazing control and water development come together or very near the same time. Development of more water without limitation of livestock numbers lead to new areas being damaged by overuse. To obtain better distribution of livestock throughout the management units it is recommended that several

relatively small surface ponds be developed in each unit to enable all parts of the unit to be grazed without excessive trailing distances to and from water. Wherever possible pond locations have been recommended that will require animals to walk no more than six kilometers between forage and water. High evaporation rates are recognized and will be built into storage capacity. Ponds will be fenced with bush fencing to prevent spoiling of the total pond area by livestock trampling with access allowed only at specified points. Quantities of water that will be available for livestock use have been calculated according to the carrying capacity of the units and, therefore, is in balance with utilizable forage. As is pointed out by Heady (1961), surface water development losses are more for two smaller developments and the construction costs may be more than for one large development, but better forage production soon makes up the difference.

(3) Milk Herd Water

With the beef herd no longer watering at the village wells, the production of these sources can be determined, the water needs of the people and small milk herd assessed and additional well water provided for this purpose if a deficiency still exists. Before deep wells are drilled several test holes should be drilled to locate sand strata that will provide the necessary water. Wells can then be recommended on a firmer basis than at present. Any recommendation for deep wells at this stage of development would not be realistic. Consequently no deep wells are recommended to be drilled at this time. Deep wells

should be considered only as the last resort. Before deep wells are considered, a hydrogeologist should make a more thorough search of the literature and available data to determine the probability of the success of deep bored wells. As pointed out earlier, the only animals to be watered from village wells will be the village milk herd. In some cases (Toulekedi, Boulel, Garala and perhaps Ndiakone and Diare Mabobe) this will not even be necessary since the milk herd can be watered at the pond located within a short distance from the village.

(4) Use of Water Facilities

It is essential that fences be maintained around ponds and that herders prevent animals loitering around these water points. Access to ponds should be closed during the rainy season and as long as adequate water exists in temporary pools throughout the management unit. Pond storage will then be available for the dry season and the access areas to ponds will have had a deferment and chance to recover from the heavy use during the past dry season.

(5) Non-Use Areas

Badly eroded areas that presently exist along main drainage ways have been shown earlier as non-usable land and should be treated as such for a sufficient period of time to allow revegetation by native or introduced forage species. As is recommended in the range development plan, a small plot will be established on this type area to evaluate forage species that might be established in the area. Only when these eroded areas have developed adequate forage cover, either

by natural or artificial means, should the project manager change the status of these areas to usable rangelands.

(6) Herding

The village livestock organization will need to designate or hire herders who will be responsible for daily care and supervision of the livestock. Number of required herders will vary according to the carrying capacity of the management unit with each herder responsible for no more than 200 animals. The more small herds distributed evenly throughout the unit the better for optimum use of the forage supply, minimizing damage due to trailing, less pressure on watering areas at any one time, and controlling livestock disease through closer observation of animals.

Animals will be kept in the grazing areas at night and not returned to the village. These night camps should include only the animals of one herder (i.e. not more than 200 animals). They should be distributed evenly throughout the unit and should be moved frequently to avoid heavy use of any one given camp site. As much as possible, herders should allow animals to graze freely and travel to and from water at their own free will, thus avoiding bunching of animals which will result in uneven use of the forage supply and excessive trailing damage. Loitering of animals around water should be discouraged, however. Better livestock performance will be noticed when forage and water are constantly available than when alternating periods of feast and famine occur. A well layed-out herder distribution plan

should be prepared, herders should be informed as to the need and advantages of following this plan, and constant field checking and supervision will be necessary to adapt the herders and his herd to these procedures. Livestock owners should have the privilege and responsibility of seeing that their animals are being properly cared for by the herder and that plans are being followed.

Herders must avoid using the same trails to and from water, forage, night corrals and vaccination parks but should rather allow animals to drift into these areas in a loosely organized fashion, gathering them, when necessary, only immediately at the site being traveled to. When health treatment is necessary, only the specific animals requiring this care should be trailed to the vaccination park, and not the entire herd. Assistance should be available for the herders to enable them to handle this problem of a split herd when it exists. Travel by the animals of one management unit should never cross over into another management unit, and should never be required since all necessary facilities are available within or on the boundary of each management unit.

Animals trailed to market, if leaving the zone, will travel only on the grazing unit boundaries, which are also major firebreaks and access roads, and never cross through another management unit. Better communication between buyer and seller would encourage marketing practices which would avoid trailing large herds to market and

then back home when a buyer is not available or demand is not sufficient.

(7) Trailing

Since one of the greatest overuse factors present is trailing damage to and from water, forage, night corrals, health facilities and markets, every effort should be made to minimize this problem.

(8) Supplemental Feed Grounds

Supplemental feed grounds, including salt grounds, should be in areas remote from water where light use may be occurring and should be rotated so that no one site is used more than once in a two-year period nor for an extended period of time in any one grazing season.

d. Fire Control

(1) The Problem

One of the big problems to be overcome will be to get the people to recognize that fire is not good for most situations and that extreme care must be taken to prevent the spread of fire. The villagers must be made aware that fire danger in its simplest form is the prediction of the behavior of a potential fire. They should not do burning when there is a high risk that the fire will get out of control. People need to understand that the principal determinants of fire behavior consist of a few simple things. Some are constant with time and others are weather dependent. Weather dependent things are wind,

fuel moisture and fuel temperature. The more constant determinants are topography and the amount of fuel available.

Wind is the one factor that causes most fires to spread because it increases the flow of oxygen to the fire. Also wind bends the flames over the unburned fuel which increases the flow of hot gases to the combustion zone; both processes contribute to the preheating of unburned fuels. Also, the higher the temperature the less energy is required to raise the fuel to the combustion point. All of these factors are at the critical point particularly during the latter part of the dry season before the rains start.

Also, in the Sarre zone, the steeper slopes accelerate burning. This seems quite evident as more areas seem to be burned in this area. The steeper the slope the closer the flames are to the unburned fuels, with the result that drying and preheating is more efficient causing the fire to spread much faster. A considerable amount of education work will be required to teach the village people the damage fire does to their resources and the value of good fire control practices.

Since most fires can be readily controlled if attacked soon enough, prompt action is of primary importance. Effective initial attack is equally important. If fires are controlled within the first one or two hours chances are they will not get out of control. This has been the problem of controlling fires in the project area in the past. No one was responsible for organizing an action program that could combat the fire once it began to run.

In addition to fire control, there is need for better fire prevention. To put fires out is not enough. As far as possible, they should be kept from starting. This means that villagers must become fire conscious to a degree that care with fire becomes a second nature, particularly as they burn crop residue and excess grass for insect control. Education and publicity of the values of fire control, and stricter enforcement of fire regulations will be needed to accomplish these goals. As the project is developed, the increasing values will call for increased handling of fire suppression in order to reduce the number and size of large fires that occur each season. The long hot dry season after the summer rains creates a seasonal occurrence of fires which presents peak periods and emergency conditions which will require a major fire organization if this problem is to be controlled. It will require the combining of fire control with other activities in order to provide an adequate emergency reserve of trained fire personnel. This approach will fail, however, if other activities are allowed to interfere when the services of trained people are required for fire suppression. To be effective in protecting the large investment in the project, fire control will require top priority from not only those assigned to the actual fire fighting, but from all villagers as well. Fire protection will need to become a village responsibility and cooperation will need to be coordinated at the local level with the overall efforts of the project control program if it is to be successful. As experience is gained in controlling new fires, new hazards, new needs

and new techniques will change the picture of how to meet this urgent problem, but the need for an organized fire control program will remain. Experience elsewhere in Senegal has demonstrated that forest and grass fires can be controlled when people understand the need for fire suppression and the organization required to meet this urgent problem.

(2) The Plan

The key to fire suppression is the detection of fire as soon as possible. The eyes of the protection plan are fire towers which have been strategically located throughout the zones. These towers are manned by radio communication which can alert the central control station so all effort can be centered and focused on the fire in the shortest possible time. They can radio the location of the fire, the land description, land marks and distances so that all efforts can be quickly brought to focus on the suppression problem. The towers will be equipped to estimate the size of the fire and how fast it is spreading. They will be able to tell if it is just creeping along and spreading slowly or if it is burning briskly. What the wind conditions are and from which direction it is blowing are only some of the things fire towers can report to the ground fire control units.

The ground control equipment will be centered around the Unimog which will be equiped to carry 1000 liters of water and three spray nozzels. This should provide a quick attack on the fire line. In addition, each village should organize a fire suppression crew which would

be trained in the art of fire suppression. Each crew should have five to eight members and a back up crew should be trained in case of need. How these crews are organized in the villages will depend on the village leaders and the educational leaders. It will be particularly important to have crews in the villages close to the towers where they have radio communication. In addition to the Unimog, two mobil trailers which can be pulled behind a land rover pickup will be equipped with fire fighting equipment and will be located one on each side of the project. They can serve as first attack units before the Unimog arrives and will be equipped with axes, back pumps, small water tanks, saws, shovels, and first aid kits. These units will be under the direct supervision of the fire boss and will only be used under his supervision.

(3) Fire Fighting

The most important factor to remember in fire suppression is that a small fire is easily put out by one to five men, but it is necessary to discover and get to the fire quickly if it is to be put out while it is small. The drier the fire fuels, the higher the wind, the warmer the day and the lower the relative humidity, the more important it is to get to the fire quickly, since it is under these conditions that fire spreads most rapidly and becomes a roaring inferno in a very short time.

Large fires may require several hundred men and several days to clean up completely. When they do occur it is necessary to have an

organization to control them or they can easily get out of control and destroy large acreages of valuable feed, as well as other property. Consequently, fire suppression must be considered in two separate operations: (1) the controlling or checking the spread of the fire, and (2) mopping up or seeing that smoldering stumps and brush are completely extinguished to prevent further blowups after the suppression job is completed. This last operation is often overlooked and serious fires can be caused by this neglect. This operation must be considered as part of the fire suppression plan.

(4) Fire Organization and Plan

To carry out effectively a fire suppression program for the project area, an organization plan should be developed which would include the various groups that will participate in the control of fires. Such a plan should be developed so that people know and understand the chain of command and who directs the various activities in times of need. The organization and plan should not be complicated but should cover the essential operations when fire suppression becomes necessary. There are several ways of setting up such an organization and plan depending on the people to be involved. The following plan is suggestive and should be developed and modified as esperience is gained and new conditions warrant.

The fire technician should be the fire coordinator. He will have as his counterpart a Senegalese. Together they will develop a coordinated fire operation plan for the project. Such a plan should include

such items as manpower and equipment available, its location and who will be in charge of its maintenance. The plan should include a review board which would help in obtaining village cooperation. Who will be called first to help in fire emergencies is also paramount. A history of the fires that occur should be provided for reference in determining preventative measures for future fire control.

The fire technician will be responsible for organizing crews for fire lane maintenance, and calling additional fire fighters in times of emergency. The plan should include the maintenance and replacement of equipment and how personnel will be compensated for service rendered. It should be designed to implement all types of fire education and assistance from the villages and will be used as an action plan to provide an orderly and efficient means of using fire suppression assistance in emergency situations. It should also outline and plan the type of help that will be needed and how this help will be trained to do the fire suppression job. No personnel should be used on a fire line on a regular basis until they have been given the basic essentials of how to protect themselves and those with them when cut off by a fire. Training in fire control is a must for all people used on the fire line.

The plan should provide a list of tools available for each fire fighter and they should be given training in how the tools should be used. The tools kept in the villages should be under the strict supervision of one man and should not be used for any other purpose than

fire suppression. A good organization can be summed up in a few general topics. A good plan should:

a. provide a plan for coordinated action;

b. insure against duplication of effort;

c. eliminate conflicting activity;

d. promote team work;

e. insure that the task at hand is completed in the minimum of time and with the minimum of effort.

Efficient fire suppression demands a maximum of accomplishment and a minimum of time, utilizing the resources at hand. Experience has demonstrated that the attainment of these objectives is best assured if the suppression action adheres to the principles of good organization.

(5) The Fire Suppression Job

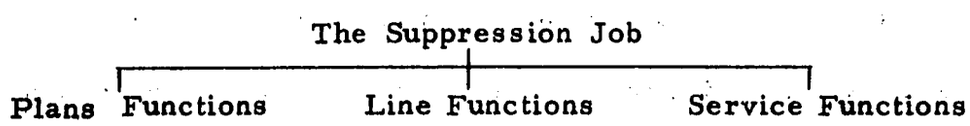
The jobs which make up the task of handling the suppression of a fire fall into three general groups or activities. They are:

a. line functions

b. plans functions

c. service functions

The relation of these groups to each other and the overall job of controlling a fire can be illustrated by the following diagram.



The plans functions are those of collection and evaluation of information pertaining to the fire factors which may influence the future action, development of plans of control, maintenance of proper records of fire and the control action, operation of the communication center in coordinating the fire suppression, and village cooperation.

The line functions are those of controlling manpower, tools and equipment and how they are to be used on the fire in accordance with the overall plan of fire suppression action.

The service functions are those required to provide the feeding, supply, communication, transportation and maintenance needs of the entire fire crew on the fire line.

To coordinate properly the work of the fire organization it is necessary that one individual be given complete authority over, and responsibility for the entire fire suppression job. This individual can be termed the Fire Boss. The other divisions can carry the title of Plans Boss, Line Boss and Service Boss. These three units make up the top staff of the board of strategy for the Fire Boss. Under normal operating conditions, the Fire Boss will handle the business of directing the fire organization through one or more of these unit bosses. They, together, would have full responsibility for handling the fire suppression job with complete authority over all personnel, equipment and other resources assigned to the fire suppression operation.

In general, the objectives of the fire suppression organization should be to secure basic protection of land, water and people by:

a. stimulating and planning fire protection efforts on the part of both the project and the villages;

b. encouraging and developing local interest and participation in fire protection;

c. bringing about a definite reduction in the number of man-caused fires through education work, demonstration and publicity;

d. increasing the efficiency of fire fighting through training in fire suppression techniques and methods, and the use of the modern fire fighting equipment and methods.

e. Use of Fire

Due to the present devastation of grazing lands by fire, it will be essential during the early years of the project to insist on and convince the people through educational programs of the need for complete discontinuation of burning. This will result in an increase in quantity and quality of forage available but, at the same time, will bring about an increase in woody plant densities. It is foreseen that, after a period of three to five years with no fire, many areas will have produced dense bush thickets and it may be necessary at that time to initiate controlled burning for brush control. For a review of the use of fire as a management tool, see Heady (1961, pp. 53-67).

f. Charcoal Production

Prior to, or in coordination with, a burning program it might be desirable to open up bush areas by hand cutting while leaving sufficient large trees for shade. The woody material removed might be utilized

as fence material or converted to charcoal. Management objectives must be clearly defined before selecting a brush control program.

g. Annual Range Utilization Checks

In addition to day-to-day monitoring of the forage resources, detailed utilization checks should be made in April-May of each year to determine what adjustments will be necessary, if any, to obtain optimum use of the forage crop. Animals must be removed and sold if the forage supply is inadequate or animals might be conservatively added if the feed is above normal. Where and when possible these checks should be made by horseback in order that a more close-at-hand picture of the situation be obtained.

Determination of carrying capacity (CC) will require a statistical sample from the project area. Small sampling units will be used to clip the forage and from this an estimate will be made of the total available forage for livestock use during the year. Since the Toulekedi zone contains a relatively large area, it will be divided into strata for sampling purposes. Either vegetation types based on dominant species or range site classes will be used as strata. A general survey is one in which the measured units (kg/ha) are evenly distributed over the region (in this case the Toulekedi zone). Since this is probably not the case, and it seldom is in vegetation biomass, the stratified sampling approach is recommended for carrying capacity determination. A preliminary sample will be obtained from each stratum and this information will be used to determine sample size necessary to describe

adequately the forage availability and distribution in the grazing zone. The preliminary sample will be used to obtain information needed in the following formula for final sample size used in each stratum:

$$n_i = t_1^2 s_i^2 / d_i^2$$

If the first sample from the stratum (vegetation type) is equal to 10, then $t_1 = 2.26$ with a confidence level of five percent that the true value of the average forage production per hectare will be included in the confidence interval. An initial estimate of the variation occurring in forage kg/ha will be obtained from the preliminary sample data. This estimate is in the formula and is calculated in the usual manner. If a need exists to be within a specified percentage of the mean, say ±10%, then $d_i^2 = (.10\bar{x})^2$ where $\bar{x}_i$ is the average of the preliminary sample data. The information given above then determines the size of sample to be taken to describe adequately the carrying capacity of each management unit, vegetation type or range site present in the zone.

Let $k\bar{x}_i = \bar{\bar{x}}_i$, where k is a constant to convert the weight of forage in kg/sample plot area to kg/ha; $\bar{x}_i$ is the mean weight of forage in stratum i as determined by sampling; and $\bar{\bar{x}}_i$ is the average forage in kg/ha for the ith stratum. Assuming that an animal consumes a constant amount each day, the carrying capacity of each stratum will be determined by dividing $\bar{\bar{x}}_i$ by the amount consumed in one animal time period (year, month, etc.) and multiplying by the number of

hectares (H) in the management unit. A level of confidence can be set on the estimated CC by the following relations:

$$CC = H_i(\bar{\bar{x}}_i \text{ / consumption for time t})$$

For convenience, let $(H_i/\text{consumption for time t}) = A_i^2$. Then the variance for CC is

$$V(CC) = A_i^2 S_i^2$$

Therefore, the confidence interval for CC for a given strata i is:

$$\sqrt{(A_i^2 S^2/n)}\ t_\sigma - \bar{\bar{x}}_i \quad \langle CC \rangle \quad \bar{\bar{x}}_i + t_\sigma \ \sqrt{A_i^2 S^2/n}$$

where t is obtained from the t-table at a specified probability level (σ) of not including CC, the true mean carrying capacity for the stratum (management unit). A conservative estimate of carrying capacity will use the lower value while a liberal estimate will be obtained using the larger value. From the range management viewpoint, particularly for the overgrazed areas, the lower value should be used initially. If future monitoring of the forage produced in a pasture verifies understocking, then adjustments in stocking rates should be made. It is far easier for management to adjust livestock numbers upward after an initial time period than it is to adjust numbers downward.

No attempt is made here to present detailed information on stratified sampling. However, in light of the previous recommendation that the range forage production be stratified for sampling, a few comments are in order. Additionally, any monitoring of a socio-economic

change occurring as the project developes should include stratified sampling techniques.

In stratified sampling, the statistical population is divided into subpopulations. Together the subpopulations make up the entire population. Reasons for this subdivision include:

a. If data are ever needed for a subpopulation alone, it is available and the data is of known precision.

b. It may be convenient administratively to work with subdivisions of the overfull population such as management units, herds of livestock, or villages.

c. Problems encountered in sampling may vary (and probably do) from one subpopulation (management or village, for example) to another. Thus differing sampling approaches may have to be used in each stratum.

d. Since heterogeneous populations often exist, subpopulations can be described which will permit homogeneity within each. This latter reason is justification alone for using stratified sampling.

h. Permanent Photo Points/Line Transects

At the time of initiation of the project, permanent photopoint/line transect locations should be selected in each major vegetation/soil type within each management unit. Location of these key areas should be located on aerial photos and the management map, and should

be marked on the ground by digging a pit one meter square and one meter deep. Stakes, cement markers and the like are not satisfactory since curiosity or the desire for that material by local people will usurp its purpose. These transects should be read yearly, with photos taken of a photogrid plot as well as a general shot along the length of the transect from the beginning towards the end of the transect. This condition and trend information will aid in determining more precise carrying capacity figures and its confidence interval. Pits are in existence along the Ololdou-Toulekedi road which were dug for the purpose of conducting a soil survey and mapping of soils from the Continental Terminal to the Senegal/Faleme Rivers by Dr. Feller of ORSTOM, Dakar-Hann, in 1975. This survey was completed and information should be available shortly. Although only one of the 14 pits is in the actual project area, they might serve as monitoring photo locations in an area adjacent to the project. Photos were taken from these pits in June-July 1975 whose locations are shown in Table 10. These points need to be located on aerial photographs and ground photos taken yearly in both the wet and dry season in order that permanent trend records be established.

3. Range Development Plan

a. Water

During the first part of the rainy season, rainfall distribution is spotty and the water yield from watersheds in the same vicinity may

Table 10. Photo points from soil pits located from Ololdou to Toulekedi.

Pit No.	Km. from Ololdou	Direction from Road	Direction Photos Taken	Date Photos Taken
- - - - - - - - -Points East of Continental Terminal- - - - - - - -				
1	2.5	S	Mag. N+S	July 6, 1975
2	3.2	N	"	"
3	3.7	N	"	"
4	4.4	S	"	"
5	4.6	S	"	"
6	4.8	N	"	"
7	7.5	S	"	"
8	7.8	S	"	"
9	8.3	S	"	"
10	9.1	S	"	"
11	10.7	N	"	"
12	11.8	S	"	"
13	12.65	N	"	July 10, 1975
- - - - - - - - - -Points West of Continental Terminal - - - - - - -				
14	15.4	N	Mag N+S	July 10, 1975

vary greatly and not all small water holes will carry water yearlong. Watersheds with the same size drainage may not always produce the same amount of runoff. Because of these variances and many others, the probability of filling all stock water developments cannot always be assured. Consequently, it is necessary to develop storage tanks on drainages of sufficient size and runoff to assure year long water.

In planning water needs, only consumption by livestock has been calculated at this time. By moving the beef herd out of the village area and supplying water for them within the grazing areas, present wells in the village will be available for human use and the milk herd needs.

A figure of 32 liters per day per animal unit has been used here in determining livestock water needs. Since animals will not water at the tanks during the wet season but rather obtain water needs from temporary pools, water storage needs are based on a 240 day period which amounts to 7680 liters of water needed per year per animal unit. Table 11 shows the amount of available water needed per management unit and the number of ponds proposed in the unit. It should be pointed out that these are available water needs and does not account for surface evaporation or seepage. Tank capacities must be based on all of these considerations. (See Appendix D for details of pond construction.)

After the completion of the tank, a stake thorn fence should be constructed around the entire facility so that cattle only have access to

Table 11. Livestock water needs by management unit.

Management Unit	Carrying Capacity (AU/yr)	Available Water Needs (liters/yr)	No. of Tanks
I	1,148	8,816,640	3 (1)[a]
II	1,050	8,064,000	4 (4)
III	1,552	11,919,360	4 (2)
IV	1,944	14,929,920	5 (3)
V	2,547	19,560,960	8 (3)
VI	3,940	30,259,200	7 (3)
VII	1,986	15,252,480	6 (3)
VIII	2,085	16,012,800	7 (5)
Veterinary holding ground	119	913,920	1 (1)
Total	16,371	125,729,280	

[a]Number in parantheses indicates number of ponds in a management unit that also serve another management unit.

the water at one specific point. It should be wide enough so that they can get in and out without congestion.

Many dams will serve more than one management unit, as can be seen from Tables 11 and 12, and the map. Table 12 shows the available water needed, by dam number in the entire zone. Ndia Lake is a natural body of water that needs access improvement in order for it to serve as a year around water source.

Unit IV has been selected as the first to be developed which will mean constructing five dams the first year. With the establishment of the veterinary holding ground the first year, dam number 29 will also need to be constructed following the completion of construction on unit IV facilities.

b. Grazing Unit Boundaries, Fire Control, Access Roads

Total length of major firebreaks which also serve as grazing unit boundaries, is 254 kilometers with 132 kilometers of interior firebreaks. Unit IV, to be developed the first year, has 45.75 kilometers of major firebreaks and 16.5 kilometers of internal firebreaks.

A system of firebreaks has been designed (see Toulekedi Zone map) for the outside boundaries of the management units. These firebreaks should be cleared of all vegetation for a width of 12 meters. The brush that is removed by volunteer hand labor should be stacked on the outside boundary to serve as a fence for the project. All stumps should be pushed by dozer to the outside, then the middle should be

Table 12. Available water needs for 31 tanks in the Toulekedi zone.

Tank No.	Management Unit	Available Water Needs (liters)
1	I	3,526,656
2	I	3,526,656
3	I, II	3,779,328
4	II, III	4,995,840
5	II, III, V	3,720,480
Ndia Lake	II, V	4,246,560
6	III	4,469,760
7	III	2,979,840
8	IV	3,732,480
9	IV	3,732,480
10	IV, VIII	6,734,880
11	IV, VIII	4,368,240
12	IV, VIII	2,867,040
13	V	2,445,120
14	V	4,890,240
15	V	2,445,120
16	V	2,445,120
17	V, VI	6,227,520
18	V	2,445,120
19	VI	7,564,800
20	VI	5,673,600
21	VI	5,673,600
22	VI	3,782,400
23	VI, VII	4,664,378
24	VI, VII	4,664,378
25	VII	2,773,178
26	VII	2,773,178
27	VII	2,773,178
28	VII, VIII	2,887,790
29	VIII, Vet hldg grnd	3,916,320
30	VIII	2,502,000
31	VIII	2,502,000
Total		125,729,280

graded, leveled and drained to provide an access road around the outside of the project as well as to the various pastures in the project. In providing drainage for the road no water should stand on the road surface and water collected in the barrow pit should be drained away by short cross dykes. Water should not be allowed to run in the barrow pit over 20-25 meter distances. It should be diverted onto the land so that it does not cause erosion or gully cutting.

The firebreaks must be kept clean of vegetation to be effective. A scraper and dozer have been provided for the Unimog to do this maintenance. Work should commence to clear the vegetation as soon as the rainy season is over. Grass and weeds that will grow during the rainy season must be removed for the fire lanes to be effective.

The internal fire lanes should be cleared, to 10 meters, of brush by cutting the brush using volunteer hand labor and piling it in the center of the lane and burning it. The larger pieces could be used for fuel or made into charcoal if there is a demand for this type of product. After the brush has been burned, the dozer should push the stumps into piles so they can be burned. The lane should then be leveled so a road bed can be constructed in the center and the grader can keep the fire lane clear of vegetation.

All fire breaks, either major or internal, could be made more effective by clearing a strip approximately three to four meters wide at a distance of 100 meters parallel to the firebreak access road and burning off the vegetative cover of this 100 meter strip immediately

following the rainy season. Extension education programs should be conducted on site at the time of this burning to point out the use of fire in a fire control program.

Three fire towers for the project are to be constructed the first year and are shown on the Toulekedi Zone map. They are to be constructed of angle iron, the dimensions to be worked out by the contractor. (Virmund, Sodacom Shaller Co. in Dakar have prepared specifications and weight of steel to be used in this height tower.) The towers are to be 22 meters high, 12 meters at the bottom, anchored in concrete footings. A three meter square lightning-shielded cabin is to be at the top. The entire tower should be well grounded, and contain a ladder to reach the top.

Each tower is to be equipped with a two-way radio that can communicate with the other towers and the central ground station, Unimog, landrovers and pickups.

The fire towers should be manned by at least two observers who have had training, or at least a short course in radio communication. During the heavy fire season the towers should be manned 24 hours a day. Figure 1 gives the general plan for the fire towers.

c. Vaccination Parks, Livestock Markets

If construction of vaccination parks/livestock markets is contracted and it is found less expensive to do all four parks at one time, four such facilities will be constructed the first year. If done one at a

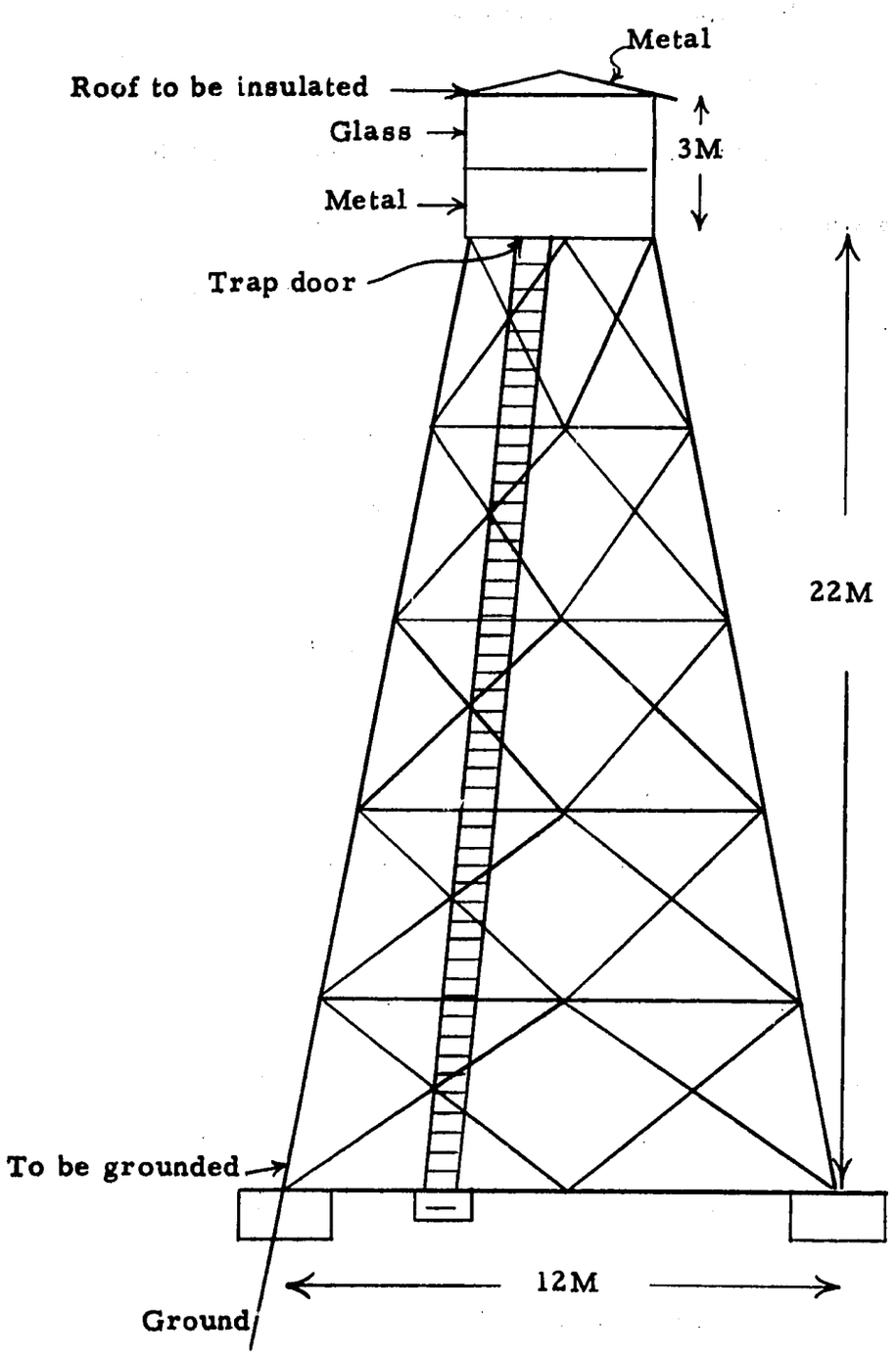


Figure 1. Fire tower plan.

time as the project progresses, park numbers one and two will be completed the first year.

d. Fencing

Fences around dams will be accomplished with volunteer labor from the villages and will immediately follow completion of each dam. These fences will be constructed of native materials as a result of the site clearing and additional local material as necessary.

Approximately 3.5 kilometers of fencing will be necessary on the southwest and northwest sides of the veterinary holding ground to tie in with natural features which will form the remaining fence. This will also be done by volunteer labor and should be constructed within the first year.

All fences must be maintained constantly to insure their effectiveness.

e. Reseeding

Small plot reseeding trials should be established immediately after the range management specialist arrives at the beginning of the first rainy season.

Three sites are recommended for such trials: (1) badly eroded areas along main drainage systems; (2) land in the main drainage system that is not presently badly eroded and which is suitable for forage crop production to be utilized by village milk herds; and (3) pond areas near the rim which have very slight drainage and are presently nearly bare.

At each site one hectare should be fenced with bush fencing. One-half the area will be seeded to various species combinations while leaving one-half to see what changes might occur from protection alone. See Appendix E for suggestions on adaptable species.

When sufficient information is gained, larger areas of seeding could be considered.

f. Aerial Photographs

More recent aerial coverage will be necessary to enable a more detailed land use survey of the main drainages in the Toulekedi zone. This should be accomplished at the outset of the project in coordination with a new flight of the Sarre zone and the proposed AID irrigation project on the Senegal/Faleme River areas near Bakel.

g. Horse Facilities

Corral and feed storage facilities should be constructed at the Baniou Project Headquarters for two horses used in range management field checks. Medication, including African horse sickness vaccine, should be available in connection with the veterinary diagnostic laboratory.

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APPENDIX A

RAINFALL

Table A-1. Rainfall in millimeters and tenths, for Bakel.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1919													
Amount	X	X	X	X	X	X	844	2229	1280	625	.	.	4978
No. of days													
1920													
Amount	TR	.	X	X	X	1945	695	2875	475	20	X	X	6010
No. of days	.	.	X	X	X	6	5	8	4	1	X	X	24
1921													
Amount	X	X	X	X	X	310	155	1355	395	120	.	X	2335
No. of days	X	X	X	X	X	5	5	17	8	2	.	X	37
1922													
Amount	X	X	X	X	X	X	1377	2075	1140	340	155	35	5122
No. of days	X	X	X	X	X	X	10	9	10	9	1	1	34
1923													
Amount	.	.	.	.	.	65	1948	961	1793	269	45	60	5141
No. of days	.	.	.	.	.	1	12	9	15	4	1	1	43
1924													
Amount	245	.	.	.	35	820	1925	1485	765	80	20	.	5375
No. of days	1	.	.	.	1	7	13	6	10	1	1	.	40
1925													
Amount	.	.	.	.	TR	330	780	2330	1260	205	.	.	4905
No. of days	.	.	.	.	.	4	6	10	4	1	.	.	27
1926													
Amount	.	TR	.	.	.	270	535	940	1155	100	.	.	3000
No. of days	.	.	.	.	.	3	5	6	6	1	.	.	21
1927													
Amount	.	TR	.	.	320	150	690	1940	1400	515	180	120	5315
No. of days	.	.	.	.	2	3	8	13	8	4	1	1	40
1928													
Amount	.	.	.	TR	130	545	910	2802	667	505	.	X	5969
No. of days	.	.	.	.	2	6	4	11	5	2	.	X	30
1929													
Amount	X	X	X	X	.	615	400	2570	650	285	X	X	4520
No. of days	X	X	X	X	.	8	5	19	6	4	X	X	33
1930													
Amount	45	.	.	.	190	190	1822	2739	510	20	.	.	5516
No. of days	1	.	.	.	1	3	7	14	5	1	.	.	32
1931													
Amount	.	TR	.	25	135	400	1300	585	1995	X	X	X	4440
No. of days	.	.	.	1	1	5	8	3	10	X	X	X	28
1932													
Amount	15	.	.	.	20	400	1755	1115	640	.	.	.	3945
No. of days	1	.	.	.	1	3	7	6	6	.	.	.	24
1933													
Amount	.	.	.	.	20	636	1605	1265	1122	335	155	220	5358
No. of days	.	.	.	.	1	4	16	7	5	1	2	X	X
1934													
Amount	.	.	.	.	TR	550	845	3031	625	190	.	.	5241
No. of days	.	.	.	.	.	7	7	15	9	1	.	.	39
1935													
Amount	.	.	.	.	.	775	890	1625	1120	198	.	.	4608
No. of days	.	.	.	.	.	7	6	10	9	2	.	.	34
1936													
Amount	.	.	.	.	370	945	1115	2405	1530	200	.	.	6565
No. of days	.	.	.	.	2	6	7	11	8	2	.	.	36
1937													
Amount	.	.	.	.	.	314	840	3168	1284	.	30	.	5636
No. of days	.	.	.	.	.	4	7	11	9	7	1	.	32
1938													
Amount	.	.	.	.	.	460	595	1180	2600	470	.	.	5305
No. of days	.	.	.	.	.	4	5	5	8	3	.	.	25
1939													
Amount	.	.	.	.	15	166	707	1850	1389	142	.	2	4271
No. of days	.	.	.	.	1	4	6	9	11	2	.	1	34
1940													
Amount	.	.	.	.	28	237	648	1804	1062	1226	.	TR	5005
No. of days	.	.	.	.	2	2	7	15	8	9	.	.	43
1941													
Amount	.	.	.	.	164	327	1546	1535	1670	12	.	.	5254
No. of days	.	.	.	.	2	4	8	12	14	1	.	.	41
1942													
Amount	.	.	.	.	165	135	980	1466	780	187	TR	.	3713
No. of days	.	.	.	.	2	4	4	10	9	2	.	.	31

Table A-1. Continued.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1943													
Amount	.	.	.	TR	.	350	1820	1400	400	100	.	.	4070
No. of days	.	.	.	.	.	6	9	14	7	3	.	.	39
1944													
Amount	.	.	.	.	TR	168	1023	899	1067	294	.	.	3451
No. of days	.	.	.	.	.	3	9	9	9	5	.	.	35
1945													
Amount	.	TR	TR	TR	18	558	2049	1863	972	381	26	.	5867
No. of days	.	.	.	.	1	4	13	13	9	6	1	.	47
1946													
Amount	.	.	.	.	TR	363	1104	2880	1202	562	.	TR	6111
No. of days	.	.	.	.	.	6	8	11	9	5	.	.	39
1947													
Amount	12	.	.	.	TR	454	1499	2311	1177	74	TR	TR	5527
No. of days	1	.	.	.	.	6	8	14	8	1	.	.	38
1948													
Amount	TR	.	.	TR	.	1011	2124	1846	675	93	.	.	5749
No. of days	.	.	.	.	.	7	6	9	6	1	.	.	29
1949													
Amount	.	.	.	.	76	442	1498	3151	423	.	.	.	5590
No. of days	.	.	.	.	1	4	7	13	3	.	.	.	28
1950													
Amount	.	.	.	.	80	360	850	2050	2370	610	.	.	6320
No. of days	.	.	.	.	2	3	6	10	10	3	.	.	34
1951													
Amount	.	.	24	.	150	40	1360	1610	545	1111	134	X	4974
No. of days	.	.	1	.	2	2	8	13	5	14	2	X	47
1952													
Amount	.	.	.	.	234	519	688	710	2035	383	.	11	4580
No. of days	.	.	.	.	3	10	7	6	15	5	.	1	47
1953													
Amount	.	.	.	.	133	392	795	1770	942	236	.	.	4268
No. of days	.	.	.	.	2	5	8	14	9	2	.	.	40
1954													
Amount	.	50	.	.	TR	701	524	1112	454	232	499	.	3572
No. of days	.	1	.	.	.	8	7	12	5	2	2	.	37
1955													
Amount	.	.	.	10	25	451	1539	1320	1718	76	.	.	5139
No. of days	.	.	.	1	1	9	13	13	9	2	.	.	48
1956													
Amount	.	.	.	TR	40	752	932	2062	985	433	.	TR	5204
No. of days	.	.	.	.	2	4	8	11	15	3	.	.	43
1957													
Amount	30	.	.	.	14	353	437	1401	2387	218	.	.	4840
No. of days	1	.	.	.	1	8	10	13	14	5	.	.	52
1958													
Amount	.	06	.	.	09	615	235	720	428	167	166	.	2346
No. of days	.	1	.	.	1	2	4	3	7	3	2	.	23
1959													
Amount	.	.	.	.	10	645	902	1579	3582	170	.	.	6888
No. of days	.	.	.	.	1	5	8	12	8	1	.	.	35
1960													
Amount	.	.	.	.	60	165	765	2299	665	X	.	.	3954
No. of days	.	.	.	.	2	2	6	13	10	X	.	.	X
1961													
Amount	.	.	.	.	50	330	1525	785	965	.	.	.	3655
No. of days	.	.	.	.	1	4	11	6	5	.	.	.	27
1962													
Amount	.	.	.	.	.	120	980	1400	300	370	.	.	3170
No. of days	.	.	.	.	.	3	6	10	4	5	.	.	28
1963													
Amount	.	.	.	.	.	414	2425	1392	511	542	.	.	5284
No. of days	.	.	.	.	.	2	12	8	4	2	.	.	28
1964													
Amount	.	.	.	.	110	922	1078	1441	1079	57	.	.	4687
No. of days	.	.	.	.	1	7	8	7	7	1	.	.	31
1965													
Amount	20	.	.	.	05	746	992	3622	1521	601	.	.	7507
No. of days	1	.	.	.	1	8	7	12	10	2	.	.	41
1966													
Amount	.	.	.	.	.	1118	1205	1531	2185	926	36	.	7001
No. of days	.	.	.	.	.	10	5	8	15	6	1	.	45

Table A-1. Continued.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1967													
Amount	.	.	.	.	69	919	1687	3848	2277	199	.	26	9025
No. of days	.	.	.	.	3	6	10	10	13	3	.	2	47
1968													
Amount	.	102	.	33	TR	367	2506	960	796	53	20	.	4837
No. of days	.	2	.	1	.	6	7	9	9	2	1	.	37
1969													
Amount	.	.	.	.	08	414	1564	1669	848	1316	.	.	5819
No. of days	.	.	.	.	1	4	12	14	10	9	.	.	50
1970													
Amount	.	.	TR	02	02	828	961	1880	889	05	TR	.	4567
No. of days	.	.	.	1	1	4	9	14	7	1	.	.	37
1971													
Amount	.	.	TR	TR	TR	474	1334	1967	1514	57	60	.	5406
No. of days	.	.	.	.	.	3	10	16	13	2	1	.	45
1972													
Amount	24	.	TR	TR	338	437	454	1300	1237	151	TR	.	3941
No. of days	1	.	.	.	2	5	5	8	8	4	.	.	33
1973													
Amount	.	.	.	.	10	370	1479	1462	560	75	.	.	3956
No. of days	.	.	.	.	1	5	10	11	4	1	.	.	32
1974													
Amount	.	.	.	.	.	490	1829	2734	1140	622	.	.	6815
No. of days	.	.	.	.	.	1	13	15	6	4	.	..	39
1975													
Amount	.	.	.	.	03	213	3497	1388	1007	563	.		6671
No. of days	.	.	.	.	1	3	16	10	7	3	.		40

. = no rain

X = bad data; not used

REPUBLIQUE DU SENEGAL

CARTE D'ISOHYETES EN MM.

DU 1er MAI AU 31 AOUT

1931-1960

1974

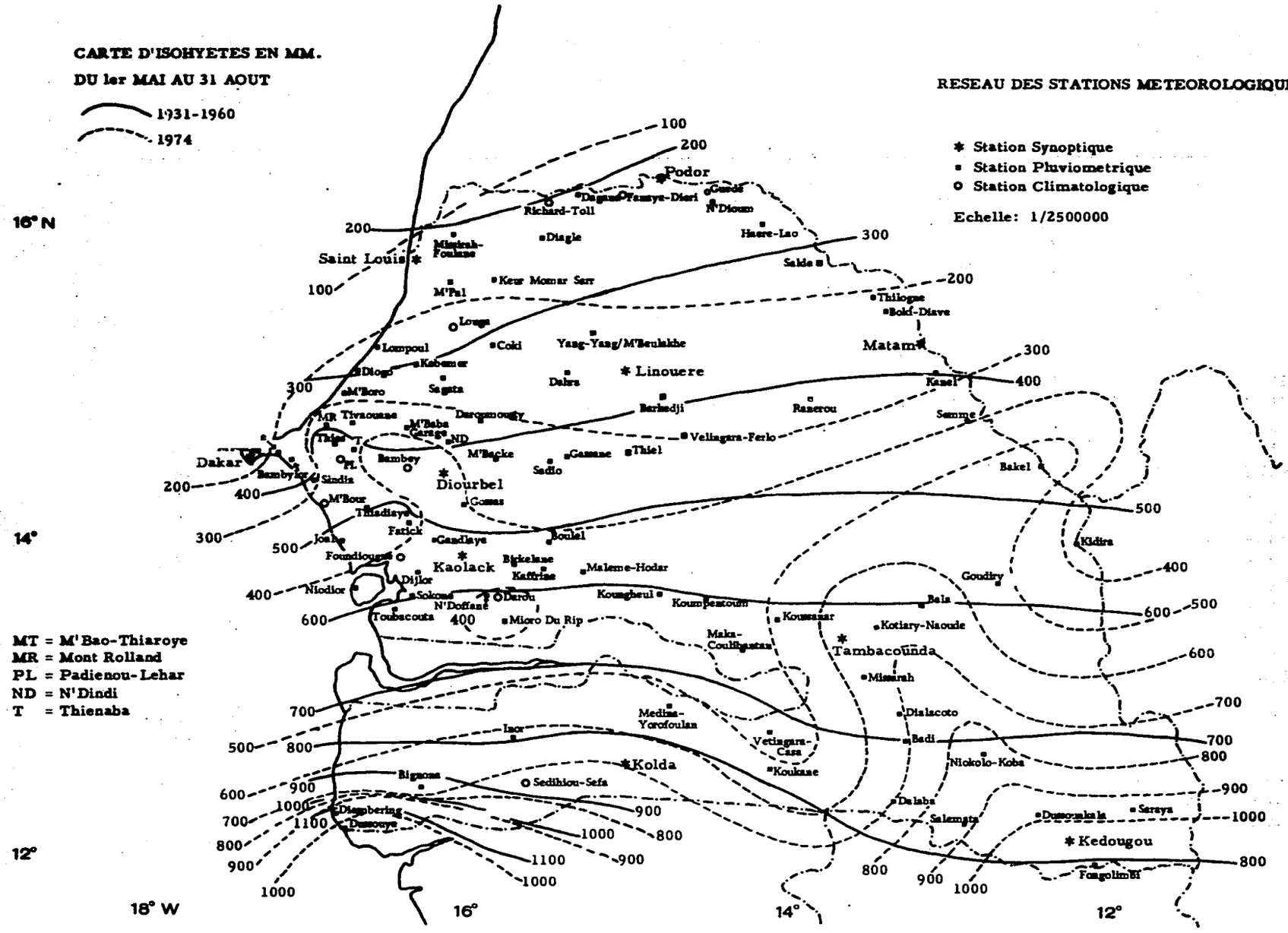
RESEAU DES STATIONS METEOROLOGIQUES

✱ Station Synoptique

▪ Station Pluviometrique

○ Station Climatologique

Echelle: 1/2500000



MT = M'Bao-Thiaroye
MR = Mont Rolland
PL = Padienou-Lehar
ND = N'Dindi
T = Thienaba

NOTE: Les donnees pour 1974 sont provisoires parce qu'incompletes.

APPENDIX B

EVAPORATION

Table B-1. Average amounts of evaporation in millimeters and tenths for Matam.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg
1951	86	98	118	142	XX	132	67	26	40	42	76	90	83
1952	96	111	128	136	162	139	85	59	37	56	69	85	97
1953	85	105	127	138	134	120	77	62	53	60	83	82	94
1954	92	89	128	126	XX	XX	XX	25	39	63	37	68	XX
1955	72	89	108	117	143	128	70	36	44	56	58	82	84
1956	80	95	133	154	163	146	84	62	38	53	71	67	95
1957	93	92	129	152	174	141	98	79	40	58	79	74	101
1958	87	104	119	160	158	130	72	25	XX	47	59	64	93
1959	77	88	107	127	143	120	72	47	37	58	64	78	85
1960	83	102	105	124	138	132	75	38	35	63	84	77	88
Average	86	97	120	138	152	132	78	46	40	56	68	74	91
1961	93	113	128	139	150	119	77	50	39	59	72	83	94
1962	84	99	118	125	139	129	87	36	46	50	68	81	89
1963	79	94	140	110	131	120	57	39	52	49	94	76	87
1964	93	112	117	121	138	126	74	33	80	52	71	62	90
1965	79	94	132	136	153	127	79	43	74	51	70	83	93
1966	82	122	122	130	147	124	85	52	33	40	67	73	90
1967	105	88	113	121	147	119	76	59	36	55	67	74	88
1968	90	67	103	122	148	132	73	82	62	80	86	89	95
1969	99	129	144	160	163	152	70	36	41	58	83	84	102
1970	95	115	128	142	147	134	97	47	53	90	101	93	104
Average	90	103	125	131	146	128	78	48	52	58	78	80	93

APPENDIX C

FOUR BASIC SOILS OF THE TOULEKEDI ZONE

FOUR BASIC SOILS OF THE TOULEKEDI ZONE

The following is a description of the four basic soils found in the Toulekedi zone as reported by R. Maignien in the Notice Explicative--Carte Pedologique du Senegal, 1965.

In Senegal, the Sahelian regions are characterized by the presence of subarid soils, the sudanese regions by tropical ferrugenous soils and the guinean regions by ferrallitic soils. This distribution shows the dominant influence of climate and vegetation on the development of these soils. However, variations due to other factors were observed, mainly: (1) the nature of the original material; (2) drainage; and (3) various recent or ancient influences.

At the northwestern tip of the zone along the edge of the Continental Terminal, are found two soil types classed as undeveloped mineral soils. These soils have a profile presenting the beginning of the horizon A made up essentially of slightly decomposed rock debris, with no practical trace of organic matter. These soils are often called skeletal soils. Their very slight degree of evolution is the result of too cold or dry a climate, or of particular conditions of the setting, such as extreme youth, very resistant material, etc.

The non-climatic undeveloped mineral soils in Senegal are divided into undeveloped erosion soils and undeveloped alluvial soils. Undeveloped erosion soils include soils whose altered materials are

permanently swept away either by winds or by water. The original material is thus found continually as outcroppings. According to the texture of this material, groups of lithic soils with coarse debris and regolithic soils composed of fine substances are distinguishable.

Among the lithic soils, which are found along the northwestern boundary of the zone, is the family of ferrugenous armor coatings on clayey sandstones, which covers a large part of the Eastern Ferlo. They are shallow (maximum 100 cm), subhorizontal, rich in iron, pisolithic in their upper part, more massive lower down, often lamellar when along collatures and which lie on formations of the Continental Terminal. This type of soil is really just successive appearance of the change from leached tropical ferrugenous soils into ferrugenous armor coating whose surface horizons have been more or less swept away by water erosion.

On these coatings grow a very degraded and open shrub and tree savanna. At the most, this first type can be used as grazing land for cattle in the rainy season, according to Maignien (1965).

Among the regolithic soils which are found in the northwest tip of the zone along the edge of the Continental Terminal, is the family on clayey sandstone. Here the outcropping of the Continental Terminal border the armor coated "cuesto" of the Eastern Ferlo. The sandy-clayey materials have been greatly altered by water erosion and this second type is practically unusable (Maignien, 1965).

Poorly developed soils in Senegal have a horizon of organic matter which is only slightly decomposed on the surface. This is in direct contact with an original material that is only slightly altered. This low degree of evolution is non-climatic in origin and is found in either (1) erosion soils, or (2) poorly developed alluvial soils.

Erosion soils of this nature are soils whose fine altered materials have been more or less swept away by the processes of erosion. This has increased the proportion of coarse material. The lithic soils found are of coarse, stoney or pebbly texture and include gravelly soils on ferrugenous armor coating. These are connected with the skeletal soils of the ferrugenous coating over clayey sandstone of the Continental Terminal, which occur over the entire zone with the exception of drainage ways. They are mostly old, leached, tropical ferrugenous soils with concretions or armor coatings whose shallow horizons have been removed by water erosion. They are rarely more than 50 cm in thickness. The surface horizon, which is grey-black and average humus-bearing (2-3% organic matter), is of a sandy-clayey texture with mixed in ferrugenous gravels resulting from the partial dissolution of the cements of the underlying pisolithic armor coating. They are saturated with water during the rainy season. In the most marked cases, when horizon A is relatively deep, there is seen deep down the start of whitening with rust colored ferrugenous seams. These soils are probably very susceptible to oblic leaching, this contributing to the evolution of the ferrugenous armor coating

border the collatures. Maignien (1965) reports that these shallow soils of the third type are unsuitable for crop growing, but can be good land for cattle grazing. They are mostly covered with a tree savanna.

In Senegal, sesquioxide soils include tropical ferrugenous soils representative of the sudanese climates. Morphologically, the tropical ferrugenous soils are soils with A, B and C profiles with clear-cut boundaries between horizons. The surface horizon is of a dark color, grey to grey-black (10 Y R 4-3/1-2). It gets even darker when wet. The colors of the subjacent horizons are in the yellow scale (10 Y R - 7.5 Y R). The values (≥ 5) and the intensities (≥ 4) are high. A major characteristic is the sharp variation in color between the soil when wet and dry (decrease of 2-3 units in value of intensity).

The depths of the profiles reach 200-250 cm with shallow (< 100 cm) alternating horizons. They are only slightly colored (whitish grey with seams and diffuse spots of rust color). Tropical ferrugenous soils deep down may have armor coated or concretion horizons, composed mainly of iron oxides. Their analytic characteristics are the following:

(1) Often sandy surface texture with possible leaching of the clay which accumulates deep down, thus sometimes forming a clogged horizon.

(2) Rather undeveloped structure, quite clearly nuciform in B.

(3) Low organic matter content (1-2.5%) under natural vegetation: relationship C/N + 14 - 17). Humification relationship: 10-20%. Prevalence of fulvic acids over humic acids.

(4) pH only slightly acid (6.0-6.5) at the surface; does not vary greatly with depth.

(5) Degree of base saturation between 70-90% in the accumulation surfaces.

(6) Low base capacity related to the prevalence of kaolinitic clays, in association with illites, and sometimes a little montmorillonite.

(7) Relationship free iron/total iron always more than 50-60%.

The classification of the ferrugenous soils depends on the intensity of the iron and clay leaching of the surface horizons downward to deep horizons. This process brings about the formation whose more or less high degree of clogging, during the rainy season, directs the distribution and immobilization of the iron sesquioxide.

Leached tropical ferrugenous soils have a textural B horizon of clayey illuviation. Included in this classification are soils with ferrugenous spots and concretions just below the clayey accumulation horizon. There is an extremely clear relationship between the intensity of the formation of concretion and the clayey illuviation. Signs of temporary hydromorphy are seen in the development of a humus bearing blackish-grey horizon, about 30 cm thick, with the relationship C/N almost I4.

The horizon A2, of ocre color, is porous, thus pointing out the leaching of the clay.

Among this fourth soil type is the family on sandy-clayey sandstone, which occurs in the main drainages of the Toulekedi zone. These are very characteristic soils which developed on the grooves in the Continental Terminal and are widely used for cultivation. Serious sheet and gully erosion is occurring on these soils due to overuse by livestock in these drainages where water collects. During the rainy season when high intensity storms occur, these large bare areas on slopes leading directly into stream channels allow very little infiltration with high runoff rates.

APPENDIX D

POND CONSTRUCTION

POND CONSTRUCTION

Calculations for animal water requirements should also be made using confidence intervals for each pasture. Each watershed drainage area should be calculated as to amount of annual runoff given varying amounts of precipitation. In this way, a protection factor is built into the calculated size of each pond. That is, the lowest probability is obtained whereby a pond does not catch and hold enough water for the carrying capacity of a management unit during a given year. The risk of this happening can be and should be calculated before ponds are constructed for the project, for it is necessary that a balance be obtained between the maximum water ponds may hold in a given year and the CC of the management unit. The latter value will assume an average carrying capacity over several years.

Precipitation data was obtained from the Bakel station and includes 56 years (1919-1974) of rainfall by month. This information will be a useful approximation of rainfall occurring on the project area. Evaporation data from Matam (the closest and most similar station to Bakel) was obtained for use in addition to the rainfall data for calculation of pond sizes to be constructed in the pastures. These data should be analyzed and used for the actual implementation phase. Emphasis of the analysis should be placed on the minimization of making a false decision in construction of ponds on the project. The microwatershed

area located above each recommended pond location in the range management plan must be determined for proper pond construction.

The two designs developed for water storage make use of the generally flat topography and the storage of water below the ground level which reduces the height of the earth fill required to build other types of dams. It will be difficult to provide enough water to properly tamp earth fill dams that are built to store water above ground level. This type of construction will have to be done during the rainy season when the soil is damp enough to obtain the required compaction to prevent failure. When the tanks are constructed in the flat areas, any runoff in excess of that required to fill the tank can be diverted and used for water spreading which should help to increase forage.

There will be cases where flat areas are not available for tank development. In such cases the widest section possible in the stream channel should be selected. The tank should be dug out of the side of the bank and the water diverted into a settling basin by a wing dyke from the main channel. Enough room should be left for the excess water to flow around the end of the dyke without washing or eroding.

The annual evaporation is reported to range from 370 cm per year to over 900 cm. For this reason tank depths will need to be at least eight to nine meters to provide the livestock requirements for yearlong water.

The stock water tanks can be any shape. The two designs (Figures D-1 and D-2) are for round and rectangular shaped bottoms.

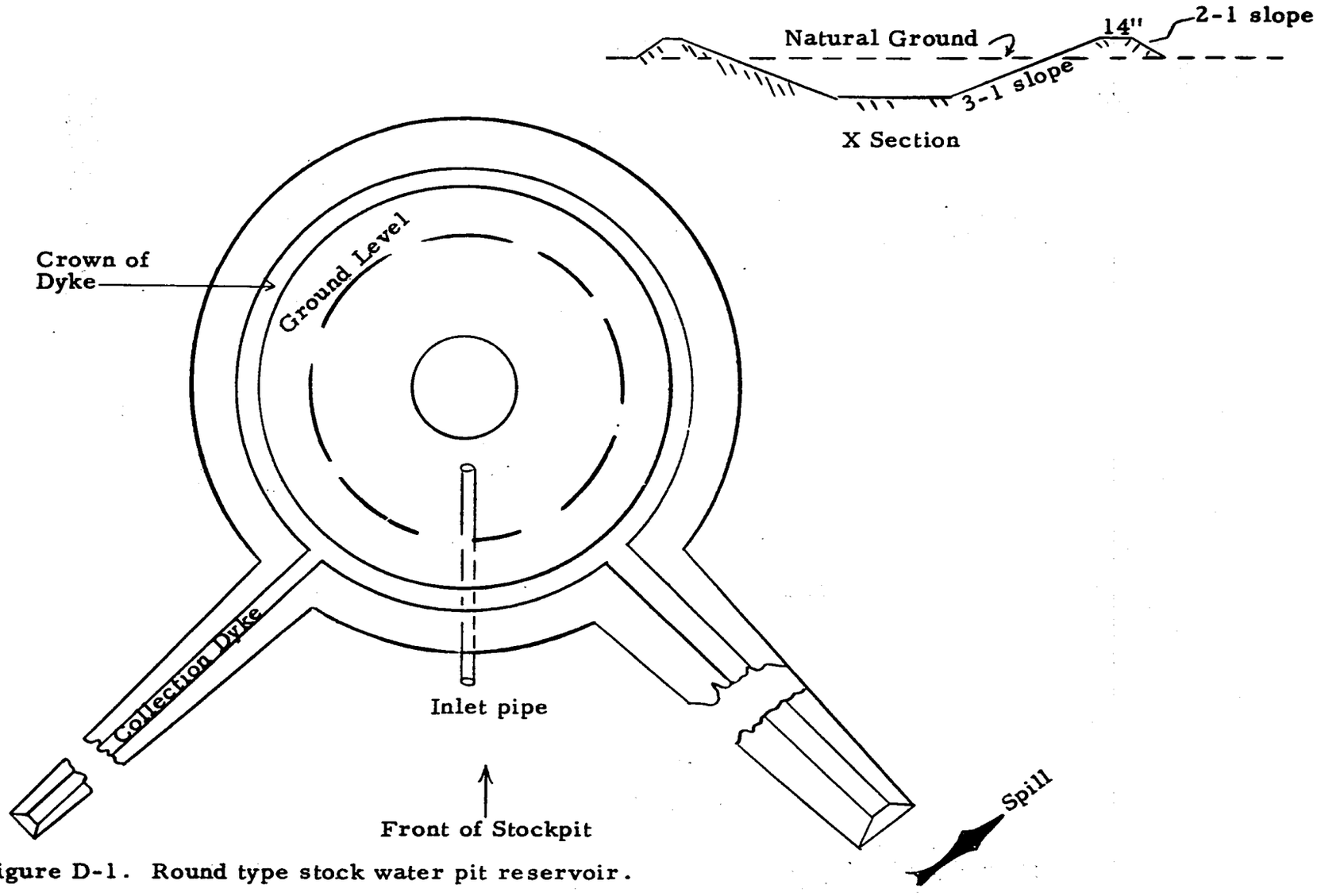


Figure D-1. Round type stock water pit reservoir.

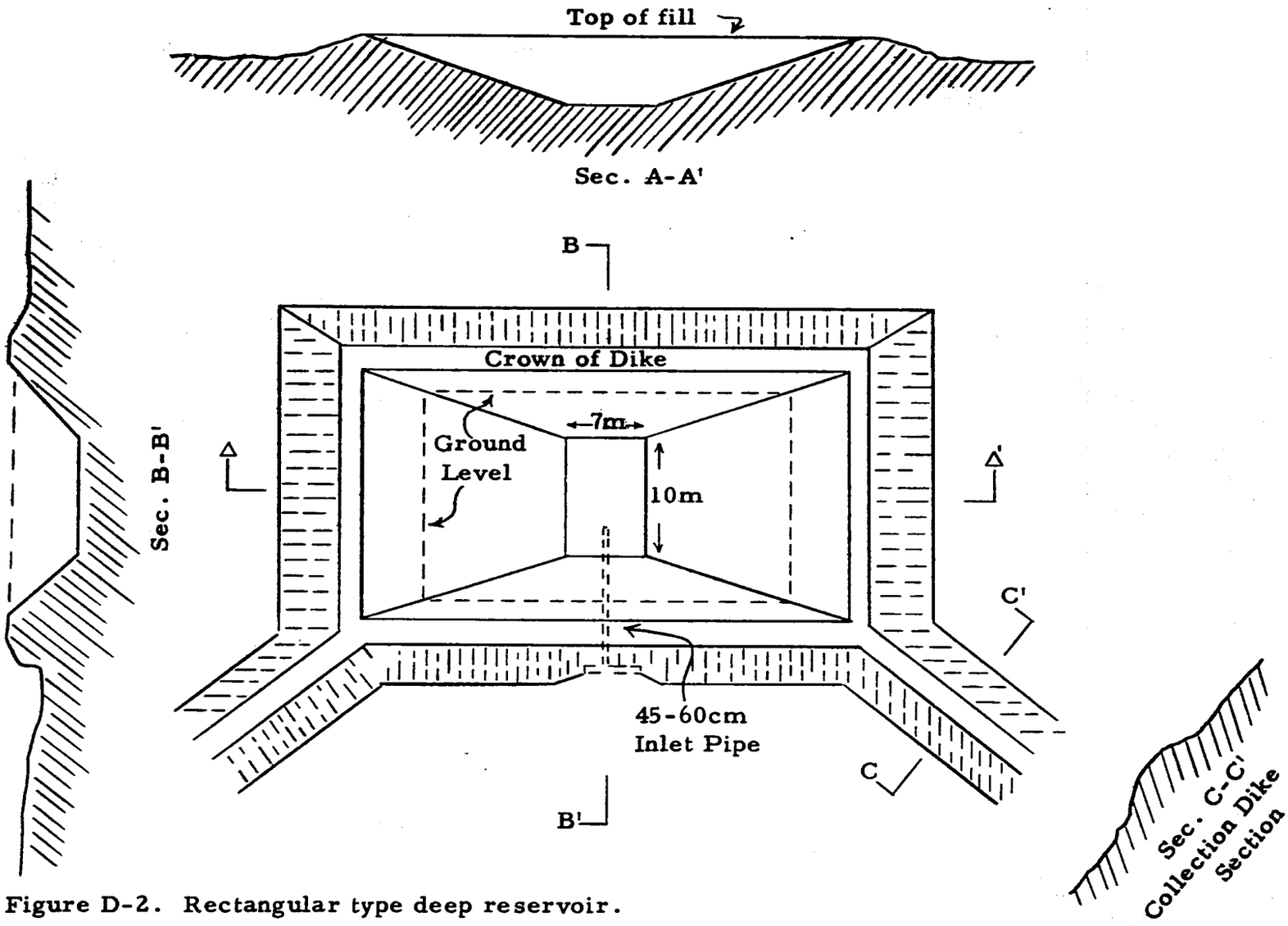


Figure D-2. Rectangular type deep reservoir.

Each have advantages depending on the site location. Another limiting factor in determining the site is the type of soil where the tank is to be constructed. Slopes on the sides should not be greater than the angle of repose so the soil will not slough off as the tank is filled. It is recommended that slopes greater than 3:1 be avoided. The material removed from the tank will be used as fill above the ground level. This should be about 3-4 meters above the ground assuming the fill has a 3:1 front slope, and a 3-4 meter top width. The back slope should not be greater than 2:1 slope (see Table D-1). It will not be critical to have moisture available at the time of construction because there will not be any great head against the fill. As the soil is placed in the fill it should be rolled with the tractor after each 20-30 cm of soil is placed on the dyke. To avoid piping at the ground level the ground should be ripped before placing the fill upon it. On the side of the tank where the livestock are permitted to enter, the slope of the tank should not be greater than 4:1 to avoid steep inclines as the water drops in the tank. If the incline is too steep the cattle tend to spiral down the slope to flatten the grade, which is not desirable. All tanks should be fenced with brush fencing to prevent livestock from entering the pond except at the prepared point. This will help to keep the ponds fresh and discourage algal growth. Any excess carry-over of water from one season to another can be withheld from use, if the amount of forage available has been used, by blocking the entrance to the tank.

Table D-1. Excavation and capacity of tanks having a bottom of 6x9 meters with slopes of 3:1 on the long dimension and 2:1 on the short dimension.

Depth (meters)	Excavation (sq. meters)	Capacity[a] (liters)
3.0	650	593,762
3.5	927	846,875
4.0	1268	1,157,440
4.5	1676	1,530,889
5.0	2161	1,972,650
6.0	2725	2,488,147
6.5	3376	3,082,813
7.5	4120	3,762,079

[a]Capacity shown is for water level at ground level. If filled two feet above ground level, the next highest capacity will be possible.

Because of the high amount of sediment carried by the streams, a large shallow desilting basin should be provided above each storage tank. This desilting basin will act as a detention basin where all of the larger sediment can be deposited. The minimum capacity of the settling basin should be twice that of the storage tank for the smaller streams and three times as large as the storage tank for the larger streams.

Proper rip rap protection must be provided around the ends of the dykes as well as adequate free-board of 1-1$\frac{1}{2}$ meters for the dyke itself. Spillway capacity should be large enough to bypass the highest expected flows when the structure is filled to capacity.

The water will enter the storage tank through a pipe inlet which will be large enough to fill the tank in 24 hours. It is estimated that this pipe should be 30-40 cm in diameter. The inlet should be parallel with the surface of the water and rise 1-2 meters above the bottom of the desilting basin. It should extend at an angle downward to the bottom of the storage basin. An extension should be added that will allow the water to flow out without a drop in the bottom of the tank (see Figure D-3). A trash rack should be placed over the inlet to prevent the larger trash from entering the tank. As the desilting basin drains, any trash that is deposited on the trash rack will be removed with the next flow. Care should be exercised to see that trash is removed when the desilting basin is dry. If the inlet needs to be raised as sediment is deposited, an extra length can be added to the inlet.

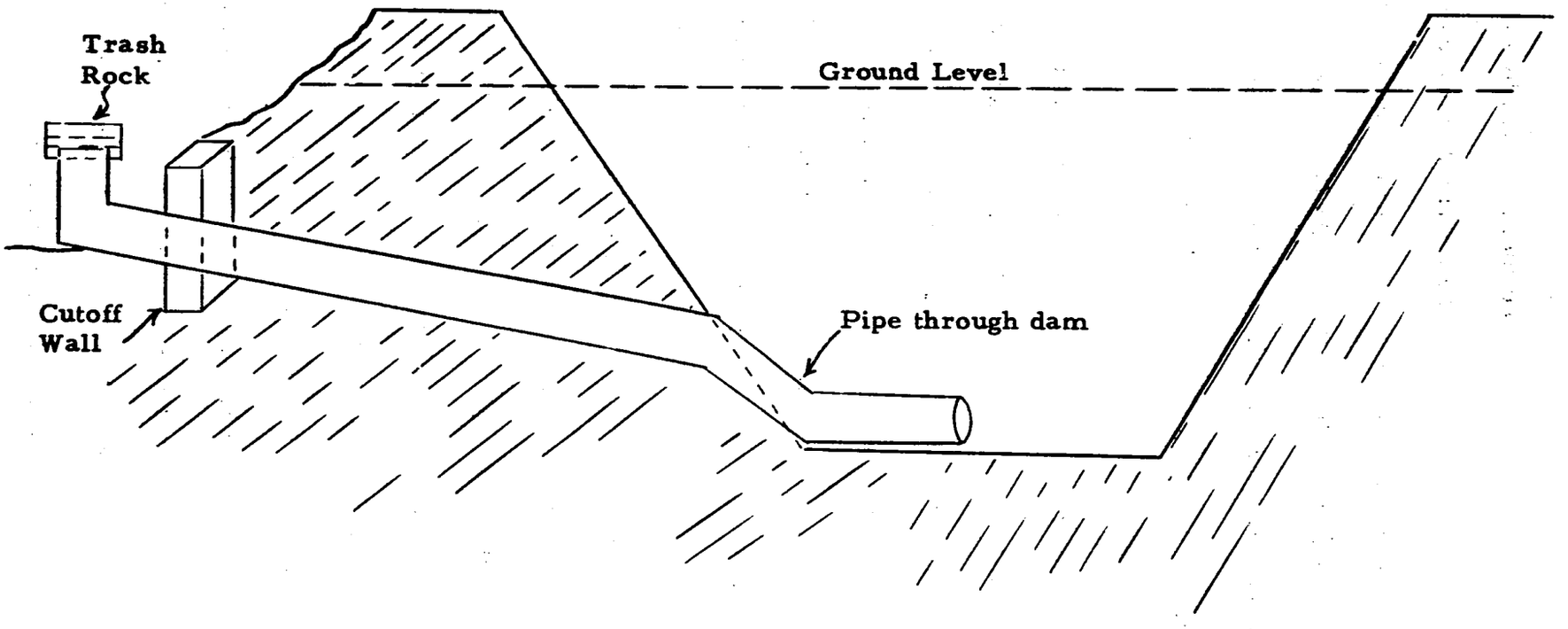


Figure D-3. Stand pipe installation section.

It is anticipated that some leakage may occur in the tank the first or second time it fills. However, there should be enough organic matter and fine sediment in the water to seal any sand layers that are encountered in the construction. Due to the fact that the soils are high in clay, these ponds should seal. If the tank fails to hold water, fine clay will have to be hauled in to seal the leakage. This could come from the drainage ways or from the numerous termite mounds, which are high in clay. Should none of these be possible, it would be necessary to use bentonite or to line the ponds with plastic materials.

Invasion of vegetation in the desilting basin will be rapid and should be removed each season as needed. One advantage of this type of structure is that the desilting basin should be large enough that a tractor can be used to remove the sediment as it is built up in the basin. As soon after the rainy season is over and the basin is dry the sediment can be removed without disturbing the stored water in the tank. Each structure should be inspected after each rainy season to determine the condition of the facility and if it will need cleaning before the next flow.

APPENDIX E

FORAGE RESEEDING SPECIES

FORAGE RESEEDING SPECIES

No information is presently available on forage species adaptable to the area, but suggestions from Dakar-Hann laboratories include the following:

1. Natural Rangeland

   a. Stylosanthus humilus--work is only just being begun on this species in higher rainfall areas of Senegal.

   b. Stylosanthus fruticosa--drought resistant, perennial, species flowers in Senegal but will not produce seed.

   c. Andropogon gayanus--not good in sandy soils; must have fair clay content.

   d. Bracharia mutica--perennial adapted to wet or inundated areas; even productive in dry season and can stay green all year; try on pond areas near rim especially.

   e. Eragrostis curvula--perennial; resists drought but not a high producer; does not require rich soil; may be good in badly eroded areas.

   f. Cenchrus ciliarus--perennial; better in drought than Andropogon gayanus; adapts to sandy or heavy soils.

   g. Microchloa indica--native annual well adapted to highly eroded, tight soil conditions; method of planting quite possibly a problem.

   h. Schoenfeldia gracilis--same as Michrochloa indica.

2. Cultivated Pasture

   a. See species listed under natural rangelands.

   b. Pennisetum pedicellatum--annual.

   c. Vigna unguiculata--cowpeas; annual; hay or silage.

   d. Eleusine indica--annual; hay or silage.

   e. Pennisetum spp.--millet-hay or silage.

In addition to the species listed, other plants that have proven successful in the southwestern U.S. or in Australia should be considered such as the following rangeland grass examples:

a. Panicum antidotale--blue panicgrass

b. Panicum coloratum--Kleingrass

c. Eragrostis superba--var. Palar-Willman lovegrass

d. Eragrostis curvula--var. conferta-Boer lovegrass

e. Eragrostis lehmanniana--Lehman lovegrass

f. Bothriochloa insculpta

CHAPTER 3

LAND RESOURCE BASE--SARRE ZONE

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I. SURVEYS

A. OBSERVATIONS

The Sarre zone is a complexity of grazed, farmed, and burned ecosystems. As a result, the design team made no attempt to present a definite range management analysis or associated plans. Although much information was obtained on livestock numbers and grazing patterns, there was no way of determining available rangeland areas since extensive farming is carried on in the region.

B. RECOMMENDATIONS

Since very little is known about the land uses and areas involved a complete land use study of the Sarre zone should be undertaken. It is suggested that new aerial photographic coverage using both color infra-red and black and white film be obtained for the area at a scale of 1:24,000. The color infra-red photographs would be useful for determining productivity levels of the vegetation by life forms (trees, shrubs, grasses) as well as the vigor state of the vegetation. The coverage should be made at the end of the wet season before the vegetation matures or goes into drought induced dormancy.

Areas and hectares involved can be determined for farm land. Differentiation can also be made as to the specific crop involved. The number of hectares recently fallowed can be calculated, as well as

areas which are in various stages of secondary succession. This can be accomplished by an evaluation of the amount and type of vegetative regrowth in fallowed areas.

Levels of grazing intensity and distribution over the zone can be obtained from the photographs (color infra-red). Since water collection areas and surface involved can be determined, this information can be correlated to grazing use patterns as they now exist. Future range management plans for the zone will use this information.

Both soil and vegetation maps can be constructed using the aerial photographs. However, a soils map is being prepared for the area by Dr. Feller of ORSTOM. This map, if available, should be used if practical.

Additionally, USAID is supporting an irrigation project on the Senegal River near the Sarre zone. Any planning for range-livestock management of the zone should be coordinated with this project. This suggested integration of the two programs is essential since a significant proportion of the Sarre zone is farmed.

II. DESCRIPTION OF THE SARRE ZONE

A. OBSERVATIONS

The Sarre zone covers an area of 50,000 hectares. Forty percent of the zone lies northeast of the Kidira-Bakel road and slopes into the Faleme and Senegal Rivers. Six major drainage systems dissect

the zone. The remaining 60 percent of the zone contains the drainage heads and has steep, undulating topography. The soils of the zone are predominantly sandy loams. The zone is accessible by the Kidira-Bakel road and much of the interior is accessible by vehicle during the early rainy season. As the rainy season progresses, passage through the area is restricted.

B. RECOMMENDATIONS

Since much of the Sarre zone originally outlined is being or has been farmed, a new perimeter boundary is suggested (see Bakel Range Livestock Project map). The new northern perimeter would follow a watershed drainage system beginning at the rim northeast of the Seno Malik Ali village, and continue down slope to a point 2 km south of Gabou on the Kidira-Bakel road. This boundary is suggested because it does follow a natural landscape phenomenon and would be easy to locate in the field.

It is recommended that a boundary for the eastern perimeter follow the Kidira-Bakel road southward from the above mentioned point to a point 9 km northeast of Kidira. Much of the area eastward from the road is subjected to farming and would make range management planning difficult. Implementation of any such planning would probably take a considerably longer period of time if the area east of the road is left in the perimeter.

The suggested southern perimeter meanders to the southwest toward the rim, making contact at a point west of the Seno Issaga village. The boundary also follows along ridges of the several watersheds in the perimeter. The west boundary should follow the rim since it is easily recognized in the field.

These new perimeter boundaries include 42,977 hectares in the area compared to the original area of 50,000 hectares. There are essentially five small watersheds that head within the zone outlined.

III. VEGETATION COMPLEXITY

A. OBSERVATIONS

The vegetation of the Sarre zone is much more complex than that of the Toulekedi zone. The drainages have steep slopes and land uses have been considerably different. Soils are also of different origins. These factors have caused diverse vegetation patterns to occur in the zone.

The potential for high range forage productivity exists throughout the zone except on the rocky slopes of the hills. The soils over most of the area are deep sandy loams and are well-drained.

B. RECOMMENDATIONS

A detailed vegetation description needs to be conducted for the zone. Natural vegetation communities probably do not exist in the area because of man and his influence on the plant life. Therefore, a

vegetation description for Sahel-Sudanese areas will not be appropriate for the area. The recent vegetation maps and description provided by J. Valenza (L.N.E.R.V.), when published, may be sufficient for preliminary range condition classification. For more detailed planning, however, the present vegetation types should be mapped with the respective soils on which they occur. This up-to-date information should be obtained before any range site definitions are made for management purposes.

Ecological characterizations need to be made for dominant trees, shrubs and grasses of the zone. These characteristics will not necessarily be the same for a species occurring in both the Toulekedi and Sarre zones. In fact, the two zones are quite diverse environmentally. Such descriptions by species will be necessary in order to establish the respective roles of the species as decreasers, increasers, or invaders under various land use alternatives for the zone.

IV. LAND USE PRACTICES

A. CULTIVATION

1. Observations

Farming is much more extensive in the Sarre zone than in the Toulekedi zone. Furthermore, extensive areas have been farmed and left in a fallow state for considerable periods of time. As a result complex patterns of vegetation are found to be distributed accordingly. Areas immediately surrounding villages are currently being farmed

and as villages are relocated, more land is subjected to farming practices.

The area surrounding the villages of Sarre and Kadiel is subjected to approximately the same amount of farming as shown on aerial photos made in 1952. This pattern is not consistent, though, since observations showed that the village of Gabou (north and east of the Sarre perimeter) formerly extended to the west of the Bakel-Kidira road. Young Acacia seyal trees are now abundant on the abandoned farmland.

2. Recommendations

Farming should be restricted to certain areas surrounding each village. Rather than fallow areas for four to ten years as currently is practiced, a system of fertilization and crop rotation in addition to shorter term fallowing should be considered. However, before any agronomic practices are implemented, an extensive soil survey needs to be made and agronomic needs of the people should be determined.

B. GRAZING

1. Observations

The Sarre zone has been subjected to grazing practices which have resulted in considerable deterioration of the grazing lands. Extensive areas are completely denuded because of overgrazing and trailing by livestock.

Aerial observations revealed that large areas are barren of vegetation with the exception of a few scattered trees. Even after the rains began and annual grasses were germinating, some areas were still barren. The northeast portion of the zone, near the villages of Sarre and Kadiel westward to Sanba Kontaye, has been subjected to overgrazing for years.

The Sarre zone has had at least three levels of grazing by livestock. The northeastern portions have been heavily grazed in non-adjacent village areas. The third level of grazing has occurred just below and adjacent to the rim. Distance from villages and lack of permanent water probably contributed to very light grazing of the area. It was impossible to determine the amount of areas involved without up-to-date aerial photography.

Heavy grazing covers a larger area, followed by moderate grazing, while light grazing covers the least area.

2. Recommendations

Aerial photography should be obtained which portrays the present land use patterns of the zone. The grazing intensity levels are currently compounded with other land uses and practices. A range management plan cannot be designed until areas and forage available for livestock can be delineated.

C. WOODCUTTING

1. Observations

Woodcutting for fuel and construction of infrastructures is being practiced. Most of this activity involves the gathering of dead trees or shrub material. However, tree cutting is carried out to clear new areas for farmland. The extent of the practice and amount of wood involved is unknown.

2. Recommendations

Up-to-date aerial photography needs to be obtained in order to evaluate both the distribution and patterns of tree and shrub vegetation types. Relationships need to be obtained for plant species involved in woodcutting, distribution relative to villages, and uses of such wood. Woodcutting practices can be and should be coordinated with range management practices for enhancement of grazing. Bush and shrub species will need to be controlled for increased grass production and for animal movement. The wood for fuel and other needs should be taken advantage of in formulation and implementation of a management plan.

V. LAND MANAGEMENT PRACTICES

A. CULTIVATION

1. Observations

Farming practices of the Sarre zone includes fallowing of farmed areas for five or more years. After decades of farming and fallowing, complex native vegetation patterns have resulted. Such vegetation is often dominated by thickets of bush species which invade the fallowed areas. Acacia seyal is one species which apparently invades quickly and forms a high density. These thickets decrease grazing opportunities and hinder animal movement.

2. Recommendations

Areas within the zone should be selected which are best for agronomic purposes. Fallowing of these lands, if practiced, would prevent a sequence of periodic disturbances occurring over a large area. Restriction of farming-fallowing must be enforced if a range livestock program is to be successful. Soil surveys and analyses should be conducted in order to designate appropriate areas for farming practices.

B. GRAZING

1. Observations

The Sarre zone is subjected to heavy land use since a greater number of humans live in the area. Parts of the areas have been subjected to trailing of cattle herds to and from villages. This practice

has had a more profound effect in the northeastern portion of the Sarre zone which has a higher concentration of villages in or near the perimeter.

2. Recommendations

The design and implementation of a total land use program will be needed to alleviate the problems caused by trailing. Areas are available for grazing of livestock, but do not currently have available water. Furthermore, these areas are too far from the present villages to permit the animals to be returned each night. Range management practices, however, can be designed and implemented only after a total land use analysis has been made for the entire zone. Then livestock grazing can be distributed in such a way as to eliminate the need for the trailing practice.

C. FIRE

1. Observations

Large areas of the Sarre zone have been subjected to burning on a frequent basis. Fires have been caused by man; probably on intentional as well as unintentional bases. The villagers indicated that no fires were started by lightning, but rather admitted that all were man-caused. They further stated that fire often burned grass that could have been utilized by livestock and something should be done to stop such fires. Frequent burning has apparently reduced the vigor of perennial grasses, although heavy grazing has also contributed to such

a reduction. The absence of frequent burning would allow the perennial grasses to regain vigor, reproduce by seed, and as a result increase in vegetation composition. A number of perennial grasses were found in the zone, but were of low vigor and shallow rooted.

2. Recommendations

A program of education for the villagers, as well as installation of fire breaks will need to be implemented. The establishment of fire breaks alone will not be sufficient since range management planning will include use of a given percentage of the forage crop produced on all areas. Therefore, any loss of this forage due to fires will cause a decrease in carrying capacity in the management unit burned over for that year. The location of these fire breaks should be made and incorporated as the overall range management program is designed for the Sarre zone.

The educational program should be a part of the Department of Promotion Humaine (GOS) effort among the villagers of the zone. Since farming practices include slash burning and the Sarre zone is extensively farmed, the educational effort will determine the success of fire control. Further, livestock herders will have to be educated as to the proper use of campfires.

VI. GROUND WATER AND WELL CONDITIONS

A. OBSERVATIONS

On the Sarre side of the rim, the rocks are largely quartsite and sandstones which are underlain by impervious Cambrian schists and gneiss. The sediments were formed from these rocks which are largely sand with moderate amounts of clay which fill the stream channels. Most of the streams have eroded into the parent bedrock in many places.

Chances for deep water development in rocks of this nature are very limited. The only possible chance of locating deep wells would be to locate underground fissures which may or may not carry water.

Some shallow water can be developed in the recent stream alluvium, the major consideration for the location of water being the amount of area drained. Most of the water in this zone comes from wells which are dug down to the water level.

The ground water conditions in the Sarre zone are entirely different from those that exist in the Toulekedi area. In the Sarre zone the wells are located in the stream channels which are largely alluvium from the crystalline rocks of Cambrian or older geologic age.

From the village well chart (Table 1) for the Sarre zone, it is apparent that the majority of the wells are not dependable for people and cattle. It is unlikely that this condition can be improved by drilling deep wells. From the examination which was given this area, deep wells are going to be very difficult to locate as the crystalline

Table 1. Village wells in Sarre area.

Village	Well No.	Estimated Depth (meters)	Dry or Seasonal	Year Long	Conditions of Casing	General Conditions and Comments
Fete Colonbi	1	20-30	Dry			This well has never had water. People go to Oursoule for water.
Birfal	1	10-20	Dry			Well started but never finished. Still in sand.
Oursoule	2	20-30	Dry		No casing.	These wells go dry during dry season. One looks like it has always been dry and not ever used.
	3	40		People and cattle	Not cased; logs on top.	Old well--29 years old. Only good supply for many villages near terminal. Want water so people will come to village.
Arigabo	1	55		For people	Good casing.	Above rim $2\frac{1}{2}$ km from village. Spent $2700 to dig. Needs to be deeper. Used own money.
Niedebel	1	30		For people	Good	Have no cattle. Serves one family who are farmers.
Sarre	1	30-40	Seasonal	For people	Good	Government dug well. Water not dependable. Can dry about four hours. Dug in 1947. Takes about four hours to recharge.
Kadiel	1	10-15		For people; some cattle	Poor	Water is forced up by dyke across stream channel. Problems in dry season. Go to the river.
Samba Kontaye	1	16-20	Seasonal	For people	Good	Government dug well. Can dip dry in three hours. Then takes 24 hours to fill.
	2	25		For people	Fair; poor drainage at top.	Can draw water for two hours, then have to wait five hours. Each family allowed so much during rainy season.
	1	17.5		For people; some cattle	Good; new well belongs to one family	Cost 2,500 CFA per meter to dig. One ton cement. All wells seem about same production. Family has first use.
	4	Not finished			Good	Had some water but three cows died so they do not use it. Could be finished and be a good well.

rocks on this side of the rim are non-water bearing. Those wells that have enough water for the people during the dry season are generally in poor repair with one or two exceptions. As can be determined from the table, generally these wells are shallower than the wells in the other zone, and many attempts have been made near the headwaters of the drainages to obtain water which have only resulted in dry holes.

B. RECOMMENDATIONS

When the livestock and farming requirements are planned and determined, careful consideration should be given to developing surface water storage facilities for the water requirements. The nature of the topography and the stream patterns lend themselves to the possibilities of developing surface storage ponds to supply the water needs of this area. When new aerial photographs are available the more desirable sites can be determined for both masonary and earth fill type structures. There should be sufficient runoff to supply all the water requirements if it is properly developed.

CHAPTER 4

LIVESTOCK MANAGEMENT

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I. INTRODUCTION

The ownership of cattle forms a major lifestyle for the people living within the Bakel Range Livestock Project area. To the herder and/or owner, cattle serve a number of purposes including: (1) a source of capital; (2) a source of food; and (3) a source of milk. Cattle are closely associated with the herder as they are kept near his village and provide a daily source of milk. As a source of food, cattle rank third in importance behind sheep and goats and possibly even below poultry in more settled villages. When cattle are slaughtered locally in the villages, the meat is often sold to other village members to earn money for the owner. Other family needs such as ceremonies, clothing and food items which must be purchased outside the village, result in the marketing of cattle. Outside of these needs, there are few cattle sold for purely monetary gain.

The handling of cattle in the project area, in contrast to livestock ranching in the Western culture, is quite intensive and unfortunately works a great disadvantage to the cattle herd in general and to the land which supports them. During the dry season, cattle leave the village during the early-to-mid-morning period following watering. Each herd is watered separately near the village well where stock troughs are usually constructed of cement or hollowed tree trunks. The troughs are supplied with water by a team of men, usually the herders,

who draw the water from hand-dug wells which may exceed 40 meters in depth. The water is drawn by hand with fiber ropes attached to rubber buckets (usually constructed locally from old tire tubes and sewn together with twine). Despite the apparent inefficiency of such a system some villages water in excess of 1000 head of cattle and numerous sheep, goats and donkeys.

After a herd is watered, it trails out of the village accompanied by one or more herders who often are the older boys of the village (occasionally a herder may be hired who has no direct kinship to the village). The herd will leave the village along one of several trails radiating outwards to adjacent rangeland. If the village is located along a drainage (and most are) the main trail will follow along the drainage for several kilometers with minor trails heading off from it. Once the cattle reach an area of grassland the herder will allow the cattle to graze for the remainder of the day. Apparently, conditioned to this daily ritual, the cattle remain in common proximity of each other; and during the late afternoon, they will begin to move back toward the village. Upon arriving back at the village, the cattle are tied individually to ropes attached to wooden pegs driven in the ground. Tying the cattle serves several purposes including (1) security of the herd, (2) strategic placement of the herd for the purpose of manuring land to be cultivated for food crops near the village, and (3) ease of milking the cows.

Calves (birth to 18 months) are not allowed to be with the main herd during the day and are kept tied or in bush corrals until the herds have left the village. During the day, the calves are usually free to graze in the village vicinity and may be under the supervision of younger boys of the village. They are again penned prior to the herds arrival in the evening. As the milking process begins, the cow's calf is allowed to nurse 3-5 minutes or less and is taken from the cow while the milking is done, after which the calf is again allowed to nurse another 2-3 minutes. The herd remains tied during the night and when morning arrives, the milking process is repeated. The herd then moves to water and trails out to graze the remainder of the day.

The pattern of cattle herding varies between wet and dry seasons. Most herds may remain away from the village in temporary camps during the wet season when water is readily available in natural ponds. Milk is either carried back to the village or some of the milk herd are left at the village. In other villages, cattle are brought back to the village every night regardless of the season. During the wet season when food crops are being grown in the village perimeter, herding becomes more intense in order to keep the cattle from damaging the crops.

II. CATTLE BREEDS

Cattle in the project area are primarily composed of three different breeds--Zebu, N'Dama and Diacori. These breeds have various genetic characteristics which are important in adapting them to the condition of the region. Each of the breeds will be briefly described in the following discussion.

A. ZEBU

Zebu cattle in the area are primarily of Zebu gobra breeding and comprise about 20 percent of the cattle numbers. These animals are large with mature bulls weighing 415 kg and mature cows weighing 322 kg. They stand 70-80 inches tall and have a prominant hump over the shoulders. They have good muscling features and long horns. The coloration of Zebu gobra cattle varies from gray to tan to white. This breed is well suited for meat production as they gain rapidly during feeding trials and have been shown to have a carcass yield of over 50 percent. They are also well suited for work animals and are used as draft oxen in the project area.

Cows have their first calf between 36 and 48 months of age with the calf weighing an average of 15.5 kg. Females produce 450-500 liters of milk during a 180-250 day lactation period. This milk contains approximately 5.5 percent fat. The period between lactations is 10-12 months with an 18-month interval between calving.

Zebu cattle have an advantage in being well suited to hot climates but have a weakness in being susceptible to tryponosomiasis.

B. N'DAMA

The N'Dama breed is smaller than the Zebu, weighing 300 kg for a mature bull and 230 kg for a mature cow. Their height is 104-110 inches, and they lack the prominent hump of the Zebu. N'Dama cattle comprise less than one percent of the cattle in the project area, but are more prominant in the southern part of Senegal. The horns of this breed are short and usually curve gently to the inside. Coloration varies from wheat colored to a dark brown or black.

Carcass yields average 40-50 percent but have gone as high as 55 percent in feeding trials. Meat is of good quality and contains little fat.

Milk production is less than the Zebu with the average of 350 liters during one lactation period. The milk, however, is very rich in fat content.

The strongest quality of the N'Dama is its resistance to tryponosomiasis which has favored the breed being used in tsetse fly infested regions. This breed is limited in the project area due to its inability to withstand heat and also its requirement for a constant supply of feed.

C. DIACORI

The Diacori is actually a crossbreed between the N'Dama and the Zebu gobra breeds. The percentage of each breed in the cross varies greatly from herd to herd. The Diacori represents 75-80 percent of the cattle in the project area. Weights of mature animals approach those of the Zebu breed. Most Diacori are light colored, varying from tan to white. The milk production is intermediate between the Zebu and N'Dama breeds. Their advantage lies in their partial resistance to trypanosomes and their ability to withstand both heat and humidity.

III. BREEDING AND REPRODUCTION

Although bulls remain with the herd year-round, most births occur during the summer months (May-August) with the months of June and July having the greatest numbers of births. Since the Zebu gobra gestation period averages 300 days, this birth period corresponds to a natural pattern determined by a higher level of nutrition in the breeding herd following the wet season when green forage and Vitamin A are abundant.

Animals born prior to or during the rainy season are considered to be one year old locally, since age is determined by the number of wet seasons which the animal experiences. Using actual age rather than local, females will usually have their first calf at four to five

years of age. Calves are nursed (extremely limited due to human milking) for 18-24 months prior to weaning.

Rates of fecundity of local cattle average 50 percent but may be as high as 70 percent in a good year. Maximum weights of cattle are usually reached at 6-7 years of age and animals may remain productive up to 15 years of age. The average cow produces four to five calves during her productive life.

Bulls are selected from the offspring of the herd, all or most of which remain uncastrated until maturity (four to five years of age) at which time the herder decides which bulls to keep for the herd sires.

Herd composition of the average herd in the project area at present contains 25 percent calves, 60 percent cows, 3 percent bulls, and 2 percent steers, with the remaining 10 percent being immature weaned animals. Herd sizes vary considerably but generally average 50 to 100 animals.

Cattle ownership is apparently well-known locally as some cattle herds are branded according to individual owners. Cattle participating in herd improvement programs sponsored by the Livestock Service receive regional brands in addition to other brands. Cattle hides are

often heavily scarred from large elaborate brands or from the practice of branding the hide to cure various disease conditions. Apparently, this process often converts chronic infections to acute ones which may hasten the healing process. Unfortunately, this practice is used for practically all ailments and any cow may show many of these types of scars. Horn injuries also cause a number of skin wounds and hide scars as dehorning is not practiced locally. Horns are said to be aesthetically pleasing to the cattle owners. All unbranded cattle, regardless of age, are branded on one particular day of the year specified by the Islamic calendar during the time known as Harane. This date is observed at different times by various villages but usually occurs in April to June.

IV. SHEEP AND GOAT MANAGEMENT

Sheep and goats are relegated a lower priority of ownership and status in comparison to cattle by people in the project area. Because of their lower position, they are more readily marketed and eaten. Sheep are slaughtered and served on special occasion while goats seem to be a more common meat.

The management of sheep and goats is similar to that of cattle in that they are usually accompanied by a herder. Sheep and goats in particular seem to be in better condition relative to cattle and are more productive, having one to two young per year. However, as smaller body size may be advantageous during the dry season, it is a

disadvantage in terms of susceptability to predators such as hyenas, dogs, jackels and leopards. In the project area, goats outnumber sheep considerably, with some villages having no sheep. The hides from goats are used for many purposes including waterbags, while sheepskins are used for rugs. Sheep and goats, like cattle, are a source of milk to the villagers.

The most common breed of sheep in the area is the Peul. The coloration varies between light and dark with a mixture of brown or black and white being common. Usually, the front part of the animal is dark and hind quarters are white. Mature sheep weigh 50 kg, and are 75 cm tall.

Meat qualities of the Peul sheep are good with dressing percentages avaraging 50 percent. Live weights of up to 80 kg have been reached in feeding trials.

Sheep are susceptible to parasites and other diseases which probably account for the relatively low numbers in the project area.

Goats of the project area are more numerous than sheep and most follow the description of the Sahel goat. These goats are large (up to 80 cm) but usually weigh 35 kg or less. They have a short-haired coat which may vary in color between black and white and usually is a mixture of the two colors.

Milk production from goats averages 100-120 kg during a 120-day lactation period. Both meat and milk from goats is consumed by the herders of the area.

Goats possess both good and bad qualities in terms of range and livestock development programs. They are detrimental to rangeland in large herds and may overgraze pasture and forest lands. Their problems, however, are actually management problems caused by man's lack of knowledge and not necessarily the fault of the animals. Goats offer advantages in brush control since their grazing patterns classify them as browsers. They are able to withstand drought and are valuable as milk and meat producers.

V. RECOMMENDATIONS FOR LIVESTOCK MANAGEMENT AND HERD IMPROVEMENT

The introduction of improved livestock management techniques will be a key role of specialists assigned to the project. The technical solution for improved herd health and condition are minimal and well-defined compared to the problems to be faced in readjusting social values and attitudes necessary to carry the technical improvements into implementation. The close cooperation between the technical people involved with the project and the education-oriented personnel of Promotion Humaine will be essential and of great value to the successful implementation of the project.

Technically, several changes in present livestock management will be essential if desired goals in livestock and range management are to be obtained. From a beef cattle operation, the entire pattern of livestock management will need to be changed. The cattle must be

kept in designated pastures away from the villages and not herded back and forth to the village each night. The herd must remain away from the village at all times. In times of severe drought, the number of animals should be reduced to meet the carrying capacity of the range rather than being forced to trail endlessly in search of scarce and poor quality forage.

In organizing the management units, it will be the responsibility of the range management specialist to evaluate the range and set the carrying capacity. The animal scientist in cooperation with the herder will determine what animals are to be sold in order to keep the range properly stocked.

Calves must be left with the herd at all times and given access to the cow's milk. Cows in the beef herd should not be milked for human consumption at the expense of the calves. There should be a study conducted by Dakar-Hann scientists to test the feasibility of utilizing goats to provide milk for calves. Milk goats should also be evaluated for supplying human milk needs.

A special herd of cattle has been recommended for use as a milk herd for each village. This herd will be limited to a small number of milk-producing cows which can be maintained on special pasture or silage made from crop residues. A large protion of the crop aftermath is wasted under present practices whereby animals are simply turned onto peanut hay piles immediately following thrashing, or allowed into fields once maize, millet or sorghum heads are harvested. The use

and storage of crop residues for the purpose of supplying the milk herd should be an initial study for Dakar-Hann scientists and specialists assigned to the project. The use of milk replacers should be evaluated for the calves in order to provide the needed number of milk cows to supply the immediate needs of the villagers in the project. Selection of cows for the milk herd should emphasize the fact that if high producing animals are selected, there will be an adequate supply of milk from fewer animals. The milk herd should utilize the common ownership of animals by the extended family unit rather than individuals, if possible, to reduce the effective number of animals to be kept at the village.

A selective breeding program must be instituted along with a rigid record-keeping system and branding method. Older, nonproductive animals should be eliminated from the herd as soon as possible through a marketing system advantageous to the cattle owners. Systematic scheduling of cattle sales must be instituted in order to encourage the marketing of animals at a proper age for efficient finishing and the production of a quality meat carcass.

Quality bulls should be selected for herds based on performance records as the project plans are implemented. All other bulls should be castrated at an early age or removed from the herds by sale. Designated herds may be utilized for the production of herd sires, and the practice of in-breeding within herds must be discontinued.

Animal health measures must be rigid and well-enforced within the project. This applies to veterinary services as well as the regulation of animal numbers to the designated carrying capacity of the pastures within the project zones. Proper animal nutrition must be demonstrated and encouraged through educational programs.

Mineral (calcium, phosphorus, trace minerals), protein, and vitamin (especially Vitamin A) supplements should be used to improve animal health and performance. Again, the scientists from Dakar-Hann laboratories and project specialists should evaluate the types and amounts of supplements which will yield the best results at an optimum price. These supplements should be utilized to distribute grazing use by systematically placing them in underutilized pastures and moving them as needed. Mineral blocks (60% calcium phosphate and 20% NaCl) are provided free to villages at Elevage offices in Tambacounda.

The need for water must be equated with the need for forage if range management concepts are to be accepted. It must be stressed that water is only one of many limiting factors and that its abundance will not alleviate associated problems of overgrazing and man-made drought, but, in fact, may cause these problems.

To better utilize herd bulls and improved livestock management techniques, herds should be combined for maximum efficiency of manpower and desired performance of the livestock, up to a limit of 200 animals per herd.

Again, by instituting the common management of cattle by extended family units or even groups of these units, much better livestock management can be practiced. For instance, instead of maintaining numerous herds of mixed composition, cattle can be grouped into special herds such as heifers and productive young cows, older and less productive females, bulls and steers, and immature animals. In their scheme of livestock management, the cattle can be managed for better reproductive performance and nutritional supplementation. Better animal health and production would be possible from such a system since only one herd would be involved in the handling of animals rather than having every herd, each and every animal, involved in each vaccination or gathering for sale. This would greatly reduce manpower needed for many operations and would also reduce excess trailing which is detrimental to both animals and the land.

Seasonal breeding patterns will result in more efficiency with which the herd can be managed nutritionally and marketed. A specific breeding season will also be advantageous to manage the calf crop from a health standpoint.

Since older cows frequently do not adjust to such a system, it would probably be best to initiate such a program with heifers and build a new cow herd based on this program.

Since the subject matter area of selective breeding programs is especially important as far as the potential improvement of the livestock in the project is concerned, a special section on this is included as Appendix A.

APPENDIX A

HERD SELECTION FOR INCREASED PRODUCTION

I. Introduction

Each and every animal in the herd should be a productive individual since as much water and grass are consumed by a non-productive animal as a highly-productive one.

The largest, fastest growing animals usually are the best replacement prospects for the herd. If these better animals are selected out of the herd for market, the quality of the herd, whether it be cattle, sheep, or goats, will deteriorate since poor quality animals are being left for herd replacements.

The only efficient way to improve the quality and productiveness of a herd is through a long-range program of selective breeding according to definite ideals and goals. This may, although not necessarily, require an intensive training program to teach and demonstrate the benefits of good herd management. In some cases, definite breeding seasons will need to replace year-long breeding in order to better manage the herd on a nutritional basis.

II. Application of Herd Selection

Selective breeding programs will increase herd production the greatest in those herds having a wide range of productivity and less in herds of good uniformity. Likewise, there are certain requirements for success of such a program:

(a) There should be enough animals in the production program each year to enable the owner to sell the inferior animals. This should be done faithfully.

(b) Selective breeding should be practiced for at least five to six years in sheep and goats and longer for cattle to derive longlasting benefits.

(c) The person selecting should have a goal in mind and select toward it. He should not allow minor things, such as appearance of the ears, color of the eyelashes, color of the hooves, or length of horns to influence greatly his selection.

(d) Herd sires should be selected especially carefully due to the fact that those traits will comprise one-half of the genetic make-up of the herd.

(e) Trained personnel must be available to the livestock owner to assist with the selection process,

III. Obstacles to Selective Breeding Programs

There are obstacles to a selective breeding program which must be expected and overcome.

(a) Few people are trained and qualified to make proper selection. Personnel should be trained and assisted early in the program in order to gain the confidence of the herder/owner.

(b) A poor job on a first selection attempt may discourage the livestock owner. Trained personnel should be on hand to help initiate the selection program.

(c) Some owners will probably think that all of their animals might be culled. A plan can be adopted where numbers will not have to be reduced greatly.

(d) A breeding program that does not provide enough replacement females to the herd makes rapid progress impossible.

IV. Inherent Limitations to Successful Programs

While such a program can make significant changes in herd production there are certain obstacles which cannot be overcome. These include:

(a) A selection program cannot overcome the effect of poor herd sires.

(b) It cannot improve the herd if culls are not sold or managed according to plan.

(c) It cannot overcome the effect of poor herd management (trailing and milking all of the cows).

(d) It will not convert a low-producing herd into a high-producing one in one to two years. Long-lasting changes depend upon heredity and take time to establish.

(e) It cannot overcome the effect of poor nutrition or physical condition caused by disease, parasitism, or overgrazing.

V. How A Program Works

Every herd has a population distribution that includes some high-producing individuals, a large number of average producers and some low-producing indificuals. A selective breeding program should identify the high, medium and low producing individuals and mate them for the greatest use of superior herd sires. A selective breeding program should move the average production up due to greater uniformity in the herd with fewer extremes of high and low production.

Improvement is greatest in such a program when a certain percentage of the poorest individuals is sold. The culled animals should be replaced with carefully selected young females.

The most advantageous way to insure the success of such a program is to identify three groups within the herd based on their productiveness. Colored ear tags are often used for this purpose. The highest production group is given the best sire, the second best group the next and so forth. This almost necessitates a definite breeding season

and division of the herds during this period. The advantages, however, should outweigh the difficulties since the system of mating the most productive males and females will yield individuals more productive than their parents. Cooperation between owners and between herders during the breeding season could enable herds to be divided.

Record keeping in which production, weights and weight gain are tabulated provide a good basis for continued selection. Body conformation and size by visual estimate may be just as meaningful in early stages of the program.

The best time to make herd selection will depend on the calendar of operations. Hopefully, it could be done at a time when the animals are being gathered for another purpose such as vaccinations or branding in order to reduce the amount of trailing.

VI. Conclusions

The benefits of such a program include: (1) a healthier herd; (2) a higher percentage calf crop; (3) better quality herd; (4) less decision about which animals should be sold; (5) faster-growing animals; and (6) more profit to the owner.

The success of such a program will depend in large part on the degree of cooperation which can be established among owners and herders to enable herds to be divided and managed properly during a given breeding season.

Table A-1. Livestock numbers for certain villages within the Bakel Range Livestock Development Project.

	A	B	C	D	E
Toulekedi zone					
Diare Mbolo	2,000		631	2,000	1,000
Diare Mabobe	300			300	100
Medina Geri	250			200	50
Garala	250			250	200
Guanade	30				5
Ndiakone	800		200	700	400
Baniou	1,000		470		400
Ndia	700			600	200
Boulel	1,000	700	200		200
Toulekedi		600	350	600	250
Sarre zone					
Seno Issaga	500				120
Seno Andale	120				40
Oursoule	1,500		900	5,000	300
Wali Diala	250		330	600	100
Birfal	300			300	400
Gourel Mama Ndiaya	175				
Fete Colonbi	170			300	
Sarre and Kadiel			700		

A = cattle numbers obtained by design team from villagers during on-site interviews.

B = actual count of cattle by design team.

C = cattle vaccination figures from Livestock Service.

D = cattle numbers obtained by Promotion Humaine team during village interviews.

E = sheep and goat numbers obtained by design team during village interviews.

CHAPTER 5

ANIMAL HEALTH PROGRAM

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I. INTRODUCTION

In recommending a livestock disease control program for the project area, several elements as they relate to the present situation and to the future plans for the area must be taken into consideration. Except for a few major livestock diseases, very little is known regarding the diseases which probably occur in the area. Even with some of the major diseases, such as trypanosomiasis, which are known to occur in the area, the knowledge relating to the incidence, transmission and the species of organism involved are not well understood. The importance of making the herder aware of the need and reason for a herd health program and what it can do for his herd, as well as what he must do to make it successful, are essential elements in establishing a program for controlling animal disease.

In the project area the spread of infectious diseases has been enhanced by movement of animals for long distances to water, mixing animals in communal grazing areas, and the practice of allowing outside herds to water and graze while moving through the area. This is especially true during the time of drought when animals from other countries (Mali and Mauritania) migrate into the area.

In the governmental plans for the area as a cow-calf operation, special emphasis in the control of disease must be on the young animal. Present management practices in which the greatest part of the cow's

milk is used for human consumption leads to a low nutritional status in the calf. Young animals suffering from energy and protein deficiency are more susceptible to parasitic and infectious diseases than well-nourished, young animals. The disease situation is intensified by the practice of holding young animals together in small enclosures or on common bedding ground during the day while their dams are in the pastures.

More adequate veterinary diagnostic services and better use of existing trained personnel must be forthcoming if a livestock project as planned for the area is to be successful. In the project area, strong local governmental administrative action must ensure that the maintenance of the health of livestock is safeguarded by:

1) prevention of illicit stock movement, and timely notification of disease outbreaks;

2) accurate diagnosis of disease outbreaks;

3) the quarantine of infected animals and herds;

4) prophylactic treatment by vaccination, drug administration and pesticide application;

5) proper disinfection and sanitation;

6) prohibition of the sale of animals and other livestock products which may carry and spread infectious diseases to other animals and man.

II. DISEASES AND RECOMMENDED CONTROL

A. CATTLE DISEASES

1. Blackleg (Charbon Sympotomatique)

a. 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. In 1974, the Bakel district vaccinated 23,440 cattle for blackleg.

b. 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.

2. Rinderpest

a. Observations

Cattle in the area were first vaccinated during the Project JP 15 rinderpest campaign of 1968 and 1969. Since that time the livestock service has maintained the vaccination program. In 1974, rinderpest was diagnosed in six animals entering the Bakel district in a herd of 53 cattle crossing from Mauritania. These six animals were destroyed

and the remaining herd sent back to Mauritania. No additional cases have been reported since that time. Dr. Diémé reports that at the present time 75% of the animals in the area have had three vaccinations. This he feels is sufficient to maintain control, provided that the present program for vaccination remains in force. In 1974 the Bakel district vaccinated 26,108 animals for rinderpest.

b. 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 revaccinated 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.

3. Trypanosomiasis

a. Observations

Trypanosomiasis may in fact be the most serious disease in the project area as far as mortality in animals is concerned. Due to the lack of diagnostic facilities in either Bakel or Tambacounda and the remoteness of the laboratory in Dakar, very little reliable information

is available on this disease in the area. According to a published report by Dr. Toure of Dakar Hann Laboratory, the northern limit of Glossina norsitans subnorsitans is between Toulekedi and Kidira. Glossina palpalis gambiensis, another vector occuring in southern Senegal, is not reported to be present in the area.

Dr. Toure has reported the isolation of Trypanosoma vivax and T. congolense from cattle in the Bakel district. Dr. Diémé feels that T. vivax is the more common of the two species in the area, because it is found more commonly in arid areas, and because mechanical transmission by other biting flies (i.e. Tabanids) which are common in the area is possible.

No information could be found on trypanosomes in wild game animals in the area. Warthogs are common throughout the area and are known to harbor trypanosomes. Limited numbers of species of wild ruminant game animals are also in the area and are possible natural hosts for the trypanosome organisms.

In 1974 the Bakel department treated 389 animals for trypanosomiasis. This is far fewer than the reported 6000-7000 cattle treated by the department in 1973. This reduced number is probably due to a lack of available drugs, as many herders mentioned the need for treatment.

b. Recommendations

More information on the incidence of trypanosomiasis must be collected from field data cases in the area before any control program can be established. Dakar Hann Laboratory has offered their services in examining blood smears from field cases. The proposed field diagnostic lab for the project area should have the capability to collect blood samples and examine smears from test animals for trypanosomiasis.

All animals suspected of having trypanosomiasis should be tested by blood examination prior to the time they are allowed to enter one of the developed grazing blocks. All animals entering a grazing block should be treated with a curative drug such as Berenil or Homidian. After animals have entered the grazing blocks any animals suspected of having trypanosomiasis should be tested and those found to carry the parasite should be treated with a curative drug.

At this time it is recommended that no prophylactic drugs be used. After checking all cases suspected of the disease and determining the seasonal incidence of the disease in the area, if it is decided that prophylactic drugs could be used in the control program, the recommendation for their use should be made.

4. Contagious Bovine Pleuropneumonia (CBPP)

a. Observations

CBPP has not been reported in the area since 1967 when it was brought in by cattle entering from Mali. At the present time all cattle over six months of age are to be vaccinated annually. In the Bakel region in 1974 there were 33,803 cattle vaccinated.

b. 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 because the number of N'Dama cattle in the project area is very small, and reactions to the vaccine in this breed are not considered a serious problem.

5. Hemorrhagic Septicemia (Pasteurellosis)

a. 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. There were no cattle vaccinated for this disease in 1974 in the Bakel district.

b. 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.

6. Botulism

a. Observations

During the drought this disease was a serious problem in Senegal, especially in the western part. It was caused by animals 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.

b. 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.

7. Streptothricosis

a. Observations

This disease is thought to be associated with tick bites and possibly other skin conditions in cattle. Amblyomma and Hyalomma ticks

are thought to be the main ones involved. In the project area the disease occurs sporadically in cattle during the wet season.

b. 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 added to the pesticide spray during the rainy season to aid in controlling this disease.

8. Anthrax

a. Observations

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

b. Recommendations

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

9. Piroplasmosis

a. Observations

To what extent this disease occurs in the area is not known. In 1974 the Bakel department treated 21 suspected cases of piroplasmosis.

The disease is tick-transmitted, mostly by Boophilus ticks which are present on cattle in the area primarily during the rainy season.

b. 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.

10. Anaplasmosis

a. 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 suspect.

b. 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.

11. Internal Parasites

a. 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 in Bakel and Tambacounda do not have the equipment available for doing fecal examinations or necropsies on animals to confirm their diagnosis of internal parasites. The F.E.D. has as part of its drought relief program the dispensing of anthelmintics to livestock owners for roundworm control. The program was to be done in three phases, only one of which has been completed. The second phase has been delayed.

b. Recommendations

The project 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 program is 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.

12. Coccidiosis

a. 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.

b. 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 as controlling this disease as well as other enteric infections in the calves.

13. Ticks and Other External Parasites

a. 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.

b. 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 for the vaccination parks. 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. Dr. Toure recommended spraying every 15 days during the rainy season, and these recommendations should be followed if at first it is found that monthly spraying is not sufficient. It is recommended that toxophene be used for the pesticide in the spray and that it be carefully monitored for the development of resistance.

14. Reproductive Diseases

a. 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.

b. 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.

15. Deficiency Disease

a. Observations

There is no question that various nutritional deficiencies occur in cattle 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.

b. Recommendations

It is recommended that Dakar Hann 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.

16. Other Diseases

a. 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.

b. 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.

B. SHEEP AND GOAT DISEASES

1. Contagious Caprine Pleuropneumonia (CCPP)

a. Observations

This is one of the most serious diseases affecting goats in the area. This year the Bakel livestock service personnel described the disease as a plague, with many deaths. According to them it affects both sheep and goats, but this must be evaluated closer as the disease does not normally occur in sheep to any extent.

b. 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.

2. Sheep Pox

a. Observations

This disease was brought into 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 occurred sporadically in the area. A vaccine is produced at Dakar Hann Laboratory for the disease.

b. Recommendations

The incidence of the disease in the area should be studied 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.

3. Internal Parasites

a. 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.

b. Recommendations

In the beginning a survey of the incidence and seasonal occurrence of parasitism in sheep and goats should be undertaken by the 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.

4. Other Diseases

a. 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.

b. Recommendations

No recommendations can be made regarding the control of these diseases until more information is available from the project area. It is recommended that the veterinary staff collect as much information on these diseases as possible and at some later date make their recommendation on the need for control programs. In any event, these diseases do not appear at this time to provide any threat to sheep and goat production in the area.

III. VACCINATION PARKS AND MARKET POINTS

A. OBSERVATIONS

At the present time the Bakel department has six vaccination parks. According to the livestock officials in Bakel, all except one of these are in need of repair and some could not be used at all. No operational vaccination parks were observed within the project area.

Neither the Bakel district nor even the Tambacounda region has any dips or spray facilities for treating of cattle for external parasites. The only method presently used to apply pesticides is by hand application using a basin containing a pesticide wash. This method is not applicable to large numbers of animals.

B. RECOMMENDATIONS

Vaccination centers will have to be built within the project area. As nearly as possible, these centers should contain facilities for branding,

tagging, vaccinating, castrating, dehorning, treating, applying pesticides and weighing of animals. In addition the parks can be used for separating animals and as marketing places. Insofar as possible, the vaccination parks should be located so as to minimize the use of communal facilities thus decreasing the danger of spread of disease. The proposed placement will avoid trailing and concentrating livestock, which tends to cause soil erosion along the route and around the parks. The parks will be constructed in locations where they can be used to treat and control animals entering and leaving the project area. The parks will be adjacent to proposed quarantine areas.

The vaccination parks should be built initially with one large entry holding pen. Leading from the entry pen is a long squeezing or crush area. The crush area is connected to another large, divided pen which will permit the separation of animals into two groups. In the crush area there will be a permanent spray race and foot bath. The crush will also have an area for placing portable weigh scales. The exit of the crush will be provided with a head-catch to facilitate treatment of single animals.

In the Toulekedi zone, four vaccination parks are proposed for the following locations (see Toulekedi Zone Map):

(1) One at the northern entrance of the zone to serve the quarantine park and grazing block VIII (park number 1),

(2) One at the southern entrance of the zone south of Ndiakone, to serve grazing blocks I and V (park number 4). At a later date it

may be necessary to construct a quarantine park at this end of the zone and if so this vaccination center will serve it. The park could also serve additional animal units if they are added to the area.

(3) One at the common boundary of grazing blocks II, III and IV to be used by these blocks (park number 2).

It is not possible to establish the number of locations of the vaccination parks in the Sarre zone at this time. In developing this zone, however, consideration should be given to having a vaccination park at each end of the main, Bakel-Kidira road. This would help to control movement of livestock into and out of the area. In addition to these two vaccination parks, one and possibly two more will be required in the Sarre zone.

The vaccination parks can also serve as market centers for livestock. Since the only separating pens and weigh-scales will be at these parks, they can be used to weigh and separate animals according to size. It may be necessary, after the need demonstrates it, to build additional holding pens at one or more of the parks for separating of animals.

No separate facilities have been proposed for handling sheep and goats in the project area. It is proposed, however, that the lower railings in the vaccination park be close enough together to restrain sheep and goats as well as smaller calves. The crush area can then be used to handle all classes of livestock.

IV. VETERINARY POST

A. LOCATION RECOMMENDATIONS

It is recommended that only one veterinary post be established for the entire project area. This post should be located at the site of the proposed project headquarters in Baniou.

B. STAFF RECOMMENDATIONS

It is recommended that the veterinary post be staffed by one technical agent, two nurses, two laborers and one driver. The staff at the post will be responsible to the Project Director and the Animal Scientist/Animal Health Advisor and under supervision of the Ingenieur d'Elevage for the Bakel Department. This staff will be able to handle the day-to-day operation of the veterinary post. It is anticipated that during vaccination campaigns and at other times when larger numbers of animals are to be treated the staff from Department de l'Elevage in Bakel will be called upon for additional help.

C. TRANSPORTATION RECOMMENDATIONS

It is recommended that the veterinary post be equipped with one 4-wheel drive, land rover pickup. The vehicle should be equipped with a mobile radio unit as are other vehicles in the area.

V. PROJECT DIAGNOSTIC LABORATORY

A. OBSERVATIONS

The greatest obstacle to developing an animal health program in eastern Senegal at this time is the lack of knowledge regarding what diseases are present and to what extent the diseases occur. The main reason for this is the absence of any facilities and equipment with which to do diagnostic work in the area. The laboratory at Dakar, where such facilities exist, is too remote to be a practical solution. Certainly the staff capability of performing basic diagnostic tests is already present with the Ingenieur de l'Elevage and his staff in Bakel and the regional veterinarian and his staff in Tambacounda. Neither of these two posts has the equipment to do even the simplest diagnostic test. Neither can they perform a post-mortem examination on animals which only requires a knife, a pair of scissors and a saw or meat cleaver. The only equipment available at the Bakel station were several pairs of surgical scissors and forceps, given by drought disaster relief, and two broken syringes. They were able to locate one syringe but no sterile needles. The situation at Tambacounda was reportedly similar.

B. RECOMMENDATIONS

The only way to develop and maintain an animal health program in the area is to establish a small project diagnostic laboratory at the

veterinary post. The lab will be capable of examining slides for the presence of hemoprotozoan parasites. They will also be able to examine fecal samples for evidence of internal parasitism. Some simple diagnostic test in the lab such as the plate test for brucellosis and leptospirosis, and the card test for anaplasmosis and piroplasmosis, should also be available. The lab should have the capability to sample bulls and culture for trichomoniasis. As the lab develops it should be able to do simple bacterial isolations and antibiotic sensitivities as well as other tests.

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

It is recommended that a building be built at the project headquarters to house the lab. The building should consist of one laboratory room equipped with work benches, sinks and running water. The lab should have an office and files for keeping records of the animals in the project area. The office should be used by the technical agent and his staff. The laboratory should have a storeroom for drugs and other veterinary supplies.

If staff as proposed for the veterinary post are not capable of performing the diagnostic work, other more highly trained personnel will have to be obtained. Dakar Hann Laboratory has offered their services to bring an individual into their establishment for a two-week

or longer training period. This service should be utilized whenever the need arises.

VI. ANIMAL HEALTH PROGRAM

A. MARKING OF ANIMALS--RECOMMENDATIONS

It is recommended that all animals be permanently identified before entering the project area. This can be accomplished by hot iron branding of cattle over six months of age and by ear tagging of sheep and goats. Calves under six months of age can also be ear tagged until they are branded at six months.

Brands 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 brands will serve not only as a means for owners to identify their animals but will also enable the staff to maintain individual health, vaccination and reproduction records for animals in the project area.

B. HEALTH AND REPRODUCTION RECORDS--RECOMMENDATIONS

Individual records should be maintained on all cattle in the project area. Using the branding system as proposed this can be accomplished. These records should show all procedures applied to the animal by date. They should also contain the reproductive record of all breeding animals. Death and sales of animals should be recorded by date. Production records of animals including the weight of the animal can be kept on cards, and the cards can be kept filed in the project office or at the veterinary diagnostic lab office. It will be the responsibility of the technical agent at the veterinary post to maintain the animal health records. These cards can be used to make lists of animals to be treated at a given time and to check and see if the animals have been treated.

C. ROUTINE VETERINARY PROCEDURES

1. Observations

Presently, cattle in the area are not dehorned and the bulls are not castrated until they are several years of age. There are also very few other veterinary services available for animals in the area except routine vaccination and occasional worming of some animals.

2. Recommendations

Generally there is an overall advantage to be gained by dehorning of calves and castrating bull calves at an earlier age. Livestock owners will have a very hard time accepting these recommendations. This can be implemented by establishing each practice in a demonstration herd and when there is significant proof of the advantages a campaign should be undertaken to incorporate this practice into the project.

The livestock owner should have limited veterinary services available to him at times other than when routine procedures are performed. This can be accomplished by setting up certain days in the months when the owners may bring their animals to the vaccination parks in their area for treatment and advice. On these days there would be available staff at the post to treat these animals. Drugs should be available to handle these routine treatments. This activity should be planned so as to eventually regain at least the cost of the medicines if not service.

D. HERD HEALTH PROGRAMS

1. Observations

The management system presently used by herders in the area is not based upon effective disease control and efficient reproduction. Calves from the time of birth are greatly deprived of milk and thus are more susceptible to all diseases. Due to poor nutrition, primarily the

lack of milk, minerals, etc., sexual maturity of the animals is greatly delayed, thus reducing their reproductive life and efficiency by half or more. Normally a cow should have eight to ten calves in a lifetime. Much of the death rate in the calves must also be attributed to the manner in which the calves are raised. The keeping of the calves in small pens on common bedding ground provides an ideal environment for infective disease to become established.

2. Recommendations

Calving should take place in the pasture in a much cleaner environment than the bed ground affords. Calves must be able to stay with their mothers throughout the day to nurse and receive all of the cow's milk. Mineral supplement must be available to all cattle. The possibility of protein supplement to the calves and vitamin supplement to the calves and cows should be evaluated. Trials at the Dakar Hann Laboratory have shown these to be beneficial in other areas in Senegal. They have offered their services to conduct such trials in the project area, and the project should take advantage of these services. Information obtained from these trials should be utilized by the project to improve continually the herd health and production programs.

A seasonal breeding program must also be established. This program should take advantage of studies already done at Dakar Hann Laboratory establishing the best time to breed animals for maximum milk production and reproductive efficiency.

VII. ZOONOSIS

A. OBSERVATIONS

In visiting with the Bakel physician, Dr. M. Ly, and the livestock services staff, it was evident that very little information is available on diseases transmissible from animal to man. The livestock services said there was no testing of animals for such disease as TB or brucellosis. They did report seeing cysticercosis in the animals occasionally at slaughter. They did not think that hydatid disease was a problem.

Dr. Ly reported that about 20 cases each year of TB in man were diagnosed. These people were sent to Tambacounda and Dakar. He also reported that blood samples were taken from individuals several years ago for testing for brucella antibodies but he had never heard the results of these tests. He did report that Taenia tapeworm infections in the people were very common but they were not doing anything for control. Dr. Ly did not think that anthrax was a problem in the area.

B. RECOMMENDATIONS

A survey should be made of cattle in the area for TB and brucellosis. This can be done by the staff using the facilities at the proposed

diagnostic laboratory. Slaughtered animals should also be examined for evidence of cysticercosis and hydatid disease. If any of these diseases are a problem in the area, control measures should be initiated.

CHAPTER 6

EDUCATION AND EXTENSION

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I. ACTIVITIES OF PROMOTION HUMAINE IN SUPPORT OF THE DESIGN TEAM EFFORT

The work of the Promotion Humaine (PH) team within the Project Mission consisted of obtaining knowledge of the area, the people and their problems; to inform and, to a limited extent at this point, to sensitize the population as to the nature of the planned project. What is to be emphasized is that while informing and sensitizing people to the objectives and nature of the livestock project, no promises were made as to what they could gain materially from the implementation of the project. This is said particularly in the light of the constant expression on the part of the villagers of their principal problem, that of water supply. In addition, the members of the PH team tried to ascertain as much as possible the extent to which the people of the zone are organized, with particular reference to the subject of cooperatives, their presence, structure, form and functioning. Out of the discussions bearing on this subject, quite a bit was learned regarding their "encadrement", and even more was learned as to their needs in terms of basic literacy/education, knowledge of marketing and banking mechanisms, elementary notions of book- and record-keeping, and training in agro-pastoral techniques.

In addition, care was taken to allow the villagers full freedom to discuss their problems and aspirations. Wherever possible the names of village chiefs and/or leaders in the villages were obtained and noted.

It is again to be noted that emphasis was put on the villagers' responsibility for their own development and in terms of their eventual role within the project. The PH team tried to ascertain from the villagers information regarding their previous or ongoing efforts to help themselves in the solution of their own problems. In a number of instances, it was learned that construction of wells, for example, on the part of the villagers, frequently with financing from emigrant members of the community, was undertaken. In some instances, villagers having requested such aid from governmental authorities (often in the form of cement and other construction materials) and the aid not being forthcoming, attempted to construct wells with local, natural materials (e.g. logs and earth) and were subsequently faced with cave-ins and consequently lack of water supply. In other instances, villagers stated that they were promised such aid by political and/or administrative authorities and have been bitterly disappointed by the lack of real follow-up. Similar information was obtained concerning promised and expected distribution of end-of-dry-season food rations. It is to be noted that in numerous instances villagers reported receiving help with regard to food and clothing from village men working in France.

In support of the design team effort, Promotion Humaine personnel visited villages within the project area to inform and explain the presence of the design team technician and the general nature of the project. In addition to this role, the PH team attempted to gather data related to particular "human constraints" such as:

1) demographic characteristics of the population of the area;

2) nature of the present economic organization of the area;

3) social organization and structures within villages, zones, and between those and larger administrative-geographical entities contiguous to the project area;

4) communications systems;

5) values, attitudes, beliefs;

6) decision-making structures and processes among the herders;

7) concepts of ownership and property;

8) concepts of land tenure and use;

9) nature of traditional herding management systems;

10) present organizational structures--economic and social, e.g. cooperatives and/or other associations, mutual aid, inter-village relations, etc.

In addition to the above areas of concern, the following areas were examined:

1) the extent and nature of existing "popular structures" (all types of associations, organizations, etc.);

2) the nature, extent and the factors involved in the polarization of certain villages by others, the existence of villages satellite to others, the role of key individuals in this process, etc.;

3) the nature and extent of relations between villagers of the zone and all governmental structures of the area;

4) the villagers' attitudes and values concerning their livestock, their problems and their aspirations for themselves and their children; attitudes towards change and "progress". toward self-help, toward education and training, etc.

II. FINDINGS AND RECOMMENDATIONS RELATED TO THE ROLE OF EDUCATION IN PROJECT IMPLEMENTATION

The four weeks spent in the Bakel area provided the opportunity to visit, observe, and formulate a number of ideas concerning educational and social needs necessary to accompany and insure successful implementation of the Range Livestock Project. In order to describe the findings in the area of extension and education, this section is discussed under the specific areas of: (1) project perimeters, (2) animal breeding and health, (3) water resources, (4) land utilization and range management, (5) forage and other crop cultivation, (6) fire prevention and suppression, (7) organization of herders, (8) commercial marketing of livestock, (9) legal-administrative requirements, and (10) extension educational program.

A. PROJECT PERIMETERS

The actual and more or less definitive perimeters and boundaries of the project area have been delineated by the design team technicians and may be examined on the Bakel Project and Toulekedi Zone maps. These boundaries were determined by criteria such as drainage systems, pastures, patterns of seasonal and other cattle movements, the presence of certain villages or clusters of villages, patterns of social relations among villages, and, to the extent possible, the presence of existing or potential "popular structures" with particular reference to cooperatives. The fact that perimeter boundaries are to be set,

respected by the population within and contiguous to them, and that project management will have the task of surveillance of these boundaries in order to control movements of cattle in and out of the perimeters, immediately supposes and involves an intensive informational and educational role in this regard on the part of Promotion Humaine in collaboration with the technical services responsible for carrying out the objectives of the project. Without adequate and intensive preparation and information of the population which is to participate in the project it is difficult to see how the zone can be controlled for purposes of such a pilot project, short of the use of coercive measures. Inasmuch as the "maximum feasible participation" of the population is a sine qua non for the success of the project and, in terms of its ultimate goal, the maximum share of the fruits of such development must go to the peoples of the zone. Here is very definitely a facet of the implementation phase which will and must involve careful educational and informational efforts on the part of Promotion Humaine.

B. ANIMAL BREEDING AND HEALTH

Although to a certain limited extent, many of the villagers of the area are already attuned to the necessity of maintaining the health of their livestock, the need for and the value of innoculation and treatment, etc., plans for animal health services within the project area will undoubtedly involve more intensive and systematic efforts on the part of project management than has hitherto been the case regarding

the veterinary services of the Livestock Services in the area. The recommendations include the creation of new vaccination and quarantine posts situated both within and at designated points on the boundaries of the project area. Again, such changes, even though they may tend to improve animal health and so satisfy the desires of the herders, also require much explanation, information and education which Promotion Humaine personnel and the Extension Education specialist working closely with the livestock service and the animal scientist/animal health specialist assigned to the project can provide. As for improvement of breeding stock and selection for amelioration of meat and milk producing stock, such efforts would require intensive informational and educational efforts to have any chance of success.

C. WATER RESOURCES

The present, if not necessarily definitive, plan for improvement of control over water resources and the provision of more water for both animal and human needs, with its emphasis on the use and control of surface water, rather than any significant program of deep-bored wells, will undoubtedly require a very intensive and well-thought-out informational and educational program which, again, would definitely seem to require the efforts of Promotion Humaine personnel and the Extension Education specialist in close collaboration with the technical services. Data gathered during the design team survey indicate strongly that not only is water the overriding preoccupation of virtually

all of the people of the zone, but that there is the strongly expressed expectation of well-boring as a means of solving what is to them the fundamental problem. That the hydraulic engineer of the design team recommends maximum use of surface water and the construction of works such as earth dams, sand reservoirs and the like, both in terms of estimation of rainfall, runoff, soil conditions, etc., and on the other hand his estimation of the paucity of underground sources which might yield significant quantities of water in the area, makes the task of explanation and information extremely difficult and a vital necessity. Among the populations of the area, and over a period of many years, much time, energy, and money have been expended on well-digging, frequently with poor results; but this remains in the minds of the overwhelming majority of villagers who expressed opinions on this subject, the panacea, the solution to their problems. Almost needless to say, the decision to exploit surface water resources, for excellent technical reasons, will be a source of disappointment and perhaps of despair (despite the extreme care taken by both the team technicians and the PH team not to promise anything in this regard) on the part of the inhabitants of the area. It is then obvious, with regard to this fundamental problem, that very intensive efforts of information, consciousness-raising, and education are imperative for the success of this aspect of the project's objectives. The relationship between people and livestock on the one hand, and pasture and water capacity to sustain animals and

men within a controlled situation will require long-term intensive educational effort and planning.

D. LAND UTILIZATION AND RANGE MANAGEMENT

Here again, plans for grazing management, proper land use (even without rotation of pasture use, as was originally recommended by the first survey team), and the delineation of designated, delineated pastures as a function of the presence of various kinds of natural forage and their seasonal variation coordinated with numbers of cattle to be grazed, calls for a great deal of information and communication with the herders. These pasture management units have been set up so that there will be a controlled equilibrium between livestock, forage and water resources. Traditional patterns of grazing and movement of cattle have been ascertained and taken into account in the planning. But undoubtedly, modifications of the traditional patterns will be introduced. Again, as with other facets of the land utilization and range management plan, maximum participation of the herders, based on full understanding and information, along with a sustained educational program, would appear to be absolute necessities for success in this domain. The Extension Education specialist personnel and Promotion Humaine, working with the Range Management specialists can contribute greatly to the success of the project by assuring the understanding and full participation of the populations concerned.

E. FORAGE AND OTHER CROP CULTIVATION

It must be kept in mind in this connection that even if the overwhelming majority of the inhabitants of the project zones are culturally, emotionally, and in terms of the traditional economic system, more oriented to livestock herding than cultivation, they are undoubtedly cultivators as well, and particularly involved in this activity at the beginning of the rainy season and until harvest time. They engage in traditional cereal grain cultivation in the main, basically for subsistence purposes. (It should be noted that in the course of our inquiries we found that many villages, particularly in the southwest corner of the project area, have, to varying degrees, been organized within cooperative organizations, with particular regard to cereal--i.e. millet--cooperatives. In other instances, and often in the very same villages, membership in livestock cooperatives was noted. However, these latter, while in the main no longer functioning actively, were primarily oriented toward the selection and sale of oxen for agricultural purposes, rather than for sale of animals for meat and other animal products. In numerous instances, we observed the use of yoked oxen in cultivation, and the presence of plows and other agricultural implements and material in villages.) If the project is to recommend improved agricultural techniques, further use of yoked oxen, cultivation of other crops, including forage crops, then a significant

informational and educational program must be built into the implementation phase of the project if this is to be a success.

F. FIRE SUPPRESSION AND PREVENTION

This entire aspect of project operations--the setting up of a system of fire prevention and suppression and the engineering, construction and maintenance facets of such a system--is planned for in detail within the design team's study and recommendations. Plans for mobilizing construction crews, creation of village or zone fire brigades, the use and maintenance of fire-fighting equipment, watch-tower crews, communications systems for fire suppression, etc., are all included in the design team's recommendations. They all involve not only information and consciousness-raising efforts, but fairly detailed instructional/training programs. Promotion Humaine, together with the appropriate specialists, can play an important role in the informational, organizational and educational aspects of such a plan. Certainly, at a later phase of the project scheme, when controlled burning of brush may not only be tolerated but encouraged for technical reasons, such information and education will also be necessary.

G. ORGANIZATION OF VILLAGERS

The term "organization" as used here covers a number of different kinds of possible structures which will be necessary either to

create or to re-activate and re-orient in new directions, as the case may be. Thus, the technical members of the design team, and most particularly the PH team, gathered data concerning existing and/or partly functioning cooperative organizations in or contiguous to the project area. As was mentioned above, a significant number of villages had members in the cereal-production cooperatives, particularly those whose center is Baniou (which is, in fact, included within the perimeters of the project). According to statements made by village chiefs and other members, the millet cooperatives appear to function adequately; however, given the subsistence nature of cereal production in the area, there does not seem to be a marketing objective involved in this cooperation organization. Farm implements and perhaps plant seeds are obtained through the cooperative and membership fees appear to have been paid. The "livestock" cooperatives mentioned in quite a number of villages, particularly in the western and southwestern corner of the project area, appear to have been started several years ago with the goal of members providing oxen for cultivation to the agricultural services and other farmers, and not as meat, milk or other animal by-product marketing mechanisms. However, numerous informants indicated that these cooperatives have been "marking time" for several years, and many members have not paid membership fees as yet. Information provided indicated that some attempt to reactivate these livestock cooperatives has been undertaken lately by the present director of livestock services for Bakel department.

In our inquiries throughout the area, other groups of villages clustering around Oursoule, to the east of the previously mentioned area, and part of the design team's new "Sarre zone", expressed an interest in the setting up of livestock cooperatives, particularly if the cooperative center would be in Oursoule itself (many of these villages are in the Oursoule orbit. are in a sense satellite to it, have relationships of kinship and other ties, to Oursoule. For example, it is their dry-season village for much of the year, many people returning to their "home" villages during the rainy season, especially for cultivation of crops.)

Reactivating and, in some instances, creating genuine functioning cooperatives oriented towards eventual commercial marketing of livestock will necessitate a very great, intensive effort of information, education, and training in cooperation if these are to be vital, functioning organizations. Such a task would appear to be eminently within the scope of Promotion Humaine's work in general and specifically one of its more important roles within the project.

As for other types of organizations/associations having an economic and administrative function within the project area, perimeter councils organized within subzones of the area (perhaps in the "management units") would seem indicated in terms of the many activities and facets of the project needed to be carried out. Thus, we can envisage the creation of at least two or more subzone councils which might be coordinated by some sort of project area "assembly" at a

much later phase of the implementation period . The organization of these councils would be undertaken by Promotion Humaine in collaboration with the project management and other technical services within the project. The function of these councils and the ultimate "assembly" would be not only technico-administrative but would be genuine structures for popular participation in decision-making and in terms of sensitizing the project-area populations to the necessity of their taking responsibility for the success of the project and for the ultimate benefits which may be derived from it. Here again, Promotion Humaine has an important role to play and a great deal of previous experience elsewhere in the country on which to draw in this regard.

H. COMMERCIAL MARKETING OF LIVESTOCK

This, of course, is one of the ultimate goals of the project, which is itself a response to a long-range GOS objective; the improvement of the standard of living of the populations not only of the project area, but of those elsewhere in the country as well. In terms of the findings of the design team, these fairly well confirm general ideas on the attitude of the herding populations of the area toward their livestock as living capital and social "cement" at the same time. Flowing from these attitudes, it was no surprise to learn that the herding people part with their cattle reluctantly, to say the least, and then generally at moments of severe need for money for subsistence, taxes, etc., or a very needed village project such as construction of a well.

In fact, even at the end of the dry season, during which time the design team was in the area, very little beef was to be bought. It certainly does not seem to enter into any really discernible commercial circuit, although it was learned that occasionally "diolua"--buyers of cattle under certain conditions--do manage to purchase cattle from the villagers. There appears to be somewhat less reluctance on the part of area villagers to part with sheep and goats, although there is in that regard no really discernible "marketing" of any consequence even for these animals.

Thus, in terms of plans for eventual commercial marketing livestock, and given the attitudes of the population on this score, it would appear likely that numerous other changes and modifications in outlook and attitude on the part of the herding populations of the area would have to precede any serious attempts at commercial market organization of the area. Only through slow informational and educational extension-type action as well as adherence to the "rules" of membership in the project can these objectives be attained. The project outline includes a comprehensive range and water management plan which would limit size of herds naturally, i.e. disregard for proper management and the retention of large numbers of animals beyond a certain animal population would result in both forage and water being exhausted, which would, it is thought by technicians, "oblige" the herders to recognize and regulate animal numbers or be forced by natural limitations to sell off "excess" cattle, particularly calves. There is skepticism

as to the success of an approach based on "natural constraints" unless very comprehensive and long-term efforts of education and information are seriously undertaken. This should be a joint effort of Promotion Humaine personnel and the Extension Education specialist in close collaboration with the technical services.

I. LEGAL-ADMINISTRATIVE REQUIREMENTS

Certainly a detailed legal-administrative framework within the project and the organizations to be created within it is a prime necessity. This must establish the juridicial status of the project and its component parts; it must also clearly delineate the project boundaries and the rules by which herders within and without those boundaries must be guided. On yet another level, and in line with the planned administrative reform which must be taken into account in any project planning done, the administrative status of the zone and its eventual organization into one or several "rural communities", poses yet another series of problems for the attainment of project goals. (In this regard, it is to be noted that the government has placed important responsibilities for the carrying out of the administrative reform throughout the country in the hands of Promotion Humaine.)

Thus, in both connections, legal-administrative status of the project itself and the area's incorporation into one or a series of "rural communities", the work of informing, sensitizing, and training

the population of the area falls very much within the "jurisdiction" of PH, which will undoubtedly play a major role in those processes.

J. EXTENSION EDUCATIONAL PROGRAM

In order to accomplish the goals of the Bakel Range Livestock Project and institute a program of range and livestock management at the owner/herder level, an in-depth educational effort equal to or greater than the technical expertise, must be implemented. It should again be restated that the technical solutions to problems in the project are relatively simple and straightforward compared to the educational task which must accompany the successful implementation of the project and insure its acceptance by the people.

Each and every individual associated with the project should be cognizant of the educational program and its importance to the success of the project. There must be a close working relationship between the technicians assigned to the project and the people of Promotion Humaine. Without close cooperation of this type, there can be little hope for successful implementation of the project.

To improve working relationships and exchanges of information among the personnel assigned to the project, periodic seminars should be conducted within the zones to discuss various aspects of the project.

Promotion Humaine personnel could receive in-service training within their organization from higher administrative levels. This type of training should help the specialists become more competent in

dealing with their day-to-day problems and at the same time keep higher levels of administration better informed of the problems and progress of the project.

Technical personnel such as subject matter specialists and the personnel from Promotion Humaine assigned to the project should be encouraged to engage in multi-disciplinary endeavors. All project personnel should be keenly aware of the overall goals and objectives of the project and should gain a thorough understanding and appreciation for the technical recommendations associated with range management and livestock improvement.

The Extension Education specialists should be the key individual responsible for identifying educational program opportunities which utilize the combined efforts of the technicians assigned to the project and the personnel of Promotion Humaine. This specialist should be instrumental in organizing workshops, short courses, and seminars involving technical aspects of the project. This specialist should also coordinate the educational budget for the project, working in close cooperation with the special needs of other specialists and educators assigned to the project.

It is essential that the technical people assigned to the project be supportive of the educational efforts involving their specific subject-matter fields. The educator cannot be expected to teach animal husbandry or range management unless he has had an intensive training session in those subjects. Even then, unless he is actually experienced

in working with rural people and livestock, he may not be an effective educator in those subjects.

A role of the personnel of Promotion Humaine should be to assist and train technical people in educational techniques and to work with rural people in roles other than those requiring extensive subject-matter background and training. Formation and general orientation and sensitization of the people in the project area will be a productive role for Promotion Humaine.

It must be the personal responsibility of each person assigned to the project to work closely with his Senegalese counterpart in order that each subject matter area be thoroughly understood. It must be a goal of the project to insist that the government of Senegal provide counterparts properly educated in their specific subject-matter expertise at the outset of the project. Progress in the educational effort should be evaluated in part by the willingness and rapidity of the government of Senegal to educate and provide effective counterparts to work with and eventually replace U.S. personnel assigned to the project.

III. IMPLEMENTATION OF THE OVERALL EDUCATIONAL PROGRAM

A. ORIENTATION AND IN-SERVICE TRAINING

The need for an understanding of the project goals and recommendations has been emphasized in subsection II-J, Extension Educational Program. All personnel assigned to the project should receive some in-service training in livestock and range management. This could be accomplished during seminars held at Baniou or a similar location within the project area for project personnel. In addition, other areas of importance could be covered, such as fire control and suppression, the structure of cooperatives and committees within the project area and their purposes, and related areas of interest to the project personnel which would keep them informed and up-to-date.

B. GATHERING OF BASIC SOCIOLOGICAL DATA

This includes obtaining detailed knowledge of the people, the social systems, the traditional culture and its potential for change. These data would be gathered by Promotion Humaine personnel in order to have a solid baseline from which to plot, monitor, and evaluate change. The drawing up of research guides, schedules, and questionnaires will require close cooperation with other project personnel. Evaluation of such data must be an important part of this aspect of the implementation phase.

C. INFORMATION AND "SENSITIZATION" OF THE POPULATION

This can be begun simultaneously with data gathering, but will continue beyond the data-gathering and evaluation period. This involves clear and straightforward explanation of the project and its objectives to the population and to obtain from them their suggestions and their ideas and conceptions of the project. This first "dialogue" of the implementation phase will be carried on prudently and will place the accent of free expression of ideas and feelings on the part of the herders. It will also enable Promotion Humaine project personnel to know and to establish close working relationships with village and area leaders. It is at this stage of implementation that extreme care will be taken to explain the advantages of participating in the project and the responsibilities of such participation on the part of the herders.

D. EXTENSION EDUCATION

The extension educational program for the project will be established on the village level in the form of committees for livestock and range management, agronomy, animal health, and other needs. These committees will serve to localize the project goals and objectives, and to gain local support for these ideals. The committees should serve as supplements to the cooperatives which will probably be organized on a zone basis. The committee should have the educational objectives as its main function while the cooperatives will be mainly a

marketing and financing organization. Committees on specific subject matter areas, such as range and livestock, should serve to reinforce and inform other village organizations and should not be confused with the pre-existing governing bodies already present and functioning on the village levels.

The committees, once formed, should serve as the local contact for instituting additional educational programs such as tours, field days, short courses, and demonstrations. The committee will serve to select good demonstrators and to inform the local people of activities being conducted by the project personnel. These committeemen should be considered for in-depth educational programs such as those outlined in Appendix C. The Extension Education specialist should have primary responsibility for organizing these committees utilizing the constant and close support and assistance of the Promotion Humaine personnel.

A primary function to be conducted early in the educational program will be a number of result and method demonstrations in which the villagers learn by doing certain activities. These demonstrations should be conducted with the support and assistance of the village committee and will be under the supervision of the Extension Education specialist. Subject-matter specialists should be available to assist with

technical portions of the demonstration activities as needed. Guidelines for conducting demonstrations are outlined in Appendix D.

The educational program, like other aspects of the project, will need to remain flexible enough to capitalize on local needs and opportunities which may arise. These needs can be best ascertained by the Extension Education specialist, technical subject-matter specialists, and the personnel of Promotion Humaine as the project is implemented.

Those persons involved with educational programs in the project should attempt to establish and standardize their terminology early in the program in order to minimize confusion and eliminate misunderstandings. Appendix E suggests a number of definitions which could be utilized and expanded for the needs of the educational program.

E. MONITORING AND EVALUATION

Each phase must be carefully watched and evaluated in terms of changes and the direction of these changes, modifications of attitudes, reactions to introduced changes in life-style and habits. Such constant monitoring and periodic evaluation is crucial for the life of the project, and Promotion Humaine and Extension Education specialists should have, along with the technical services, an important evaluative role. Additional services, particular to Promotion Humaine, are covered in Appendix B.

APPENDIX A

PRIMARY ROLES OF PROMOTION HUMAINE

I. THE NATURE OF PROMOTION HUMAINE'S INTERVENTION IN PROJECT IMPLEMENTATION

During the implementation phase of the project, and in the light of the foregoing observations and remarks, we may consider PH's eventual intervention in the following schematic way, and in roughly the time order presented:

1. Training the "Trainers"

Here, even before anything of a substantive nature directly concerned with contact with the project area populations is concerned, and after careful selection of PH project personnel, "trainers" would undergo various kinds of training and orientation for eventual work in the project. Certainly the Promotion Humaine project-based chief representative ought to have some basic training in livestock and range management, some notions of fire suppression and control and organization of such efforts. Training in cooperative and other kinds of organizational work, while of necessity being part of the prior education and experience of such an individual, should be up-dated and pointed toward the organizational problems and techniques of livestock cooperatives in particular and those of territorial or zone-based representative-administrative bodies in general. The training/orientation of other personnel in the PH project-based contingent, while necessarily multi-functional, must cover, inter alia, such areas as

women's activities, youth programs (including "4-H" type work) pointed toward herder populations in particular. Training of some of the eventually project-based Promotion Humaine personnel may be either elsewhere in the country at training schools/institutes which are either general and autonomous or falling under the jurisdiction of particular technical ministries, or even out of the country for short periods of time, as the case may be or the need manifests.

2. Follow-up and Recycling

After training and organizing and a period of monitored and evaluated functioning, persons involved in the project and trained under PH, technical services, etc., must be followed up in terms of problems and difficulties and improvement in performance. In some instances this may require additional or renewed training of indiduals and is vital to the ultimate successful operation of the project.

APPENDIX B

ADDITIONAL ROLES OF PROMOTION HUMAINE

I. EARLY PERIOD OF IMPLEMENTATION PHASE

This is action essentially of "Animation Rurale" personnel of the project.

A. VILLAGE SESSIONS

These are to be held to provide information and to sensitize herders of the project area to the objectives of the project; to prepare them for the intervention of the agents of the various technical services and for their own active participation within herder associations and/or herder cooperatives; to organize the selection of delegates to the herder associations/zone or "management unit" committees, etc.; to elicit responses to the possibilities of agro-pastoral training for their children or themselves. These sessions would be held in central villages and other villages within the project zones. Participants would be village chiefs, "chefs de carres" or "chefs de menage," women's delegates, etc.

Still within the framework of "animation rurale" functions, a series of "stages" and seminars on various levels and for various purposes can be envisaged. For example:

B. SEMINARS

1. Seminars bringing together project technicians and village delegates, for the setting up of the zone herders associations; the zonal "councils" and the ultimate project area "assembly."

2. Training "stages" for leaders of "popular participation organizations"--livestock cooperatives, their organization or reanimation, programming, and management. These "stages" could include training/instructional sessions on record-keeping, basic notions of cooperative management, etc. Or these sessions could, initially, plan the setting up of "courses" in functional literacy, bookkeeping, etc., to be carried out later by the action of zone-based structures, such as the "Maison Familiales" (see below).

C. SPECIAL SESSIONS

These can be planned by PH project personnel to bring together the members of the herders' committees, the livestock service personnel, and personnel of other services involved in the project, for the purpose of discussing and solving particular problems involved in the implementation of the project goals (e.g. use of water resources, allocation of pastures, observation of project boundary restrictions, particular problems of animal health, etc.).

II. LATER PERIOD OF IMPLEMENTATION PHASE

During later periods of the implementation phase, where the accent is to be placed somewhat more on training for full participation in project operations, and until a full-fledged Agro-Pastoral Center (under PH's Rural Vocational Training Division, i.e. FPR) will be established at Bele to serve the populations within the project and in contiguous areas, a multi-functional zone or project-area based

structure of PH can lend itself well to the needs of the populations and of the project: the Maison Familiale. A Maison Familiale in each of the several zones within the project area, and physically situated next to or near the project zone services, can provide the pedagogical framework, course development, audio-visual support, for Extension tasks in close collaboration with the livestock and other technical services, and can undertake training programs in, for example:

1) construction and maintenance of enclosures/corrals, watering troughs, etc;

2) equipment maintenance and repair;

3) technical training regarding livestock management;

4) training and organization of fire-prevention and fire-suppression methods and techniques and the maintenance of fire breaks;

5) training of masons, carpenters, metal workers for construction, maintenance and repair of project buildings and village improvement (house improvements, better food storage facilities, well repair, etc.);

6) training and education in the organization and management of cooperatives and/or herder associations;

7) instruction in milk and milk-product preservation, transformation, storage and use; gardening, sewing, health and hygiene (nutrition), child-rearing, home economics; training of managers of village or "management unit" pharmacies/first aid posts;

8) functional literacy and practical record- and bookkeeping for the herders' associations and/or livestock/millet cooperatives;

9) commercial marketing operations--instruction in notions of marketing of cattle, sheep and goats.

It becomes apparent, as indicated above, that the ideal situation is ultimately the establishment of the Agro-Pastoral Center at Bele, which would offer serious well-planned, longer-term training programs in animal husbandry, range management, animal health, agricultural mechanics, and general education (including applied arithmetic, agro-pastoral terminology, business methods and elementary notions of the banking system, credit and commercial system, management of cooperatives, hygiene, etc.).

On another level, it is perhaps too early to speak of the eventual role in the later phases of the project operations of yet another PH "direction", that of "Enseignement Moyen Pratique." Given the fact that there exists just about one school of any kind serving the needs of children within the project area, a Kozanic school located in one village, it is premature to speak of the role of a program, EMP, which has as its goal the dispensing of practical, nonformal education beyond the elementary school level. However, sooner or later, the problem of children's education or lack of it, linked to the present situation of rural exodus and foreign emigration, will have to be faced if the role of young people and the future and stability of the villages of the area have a bearing on the successful realization of the project and its potential for change and improvement in life-styles and living standards of the populations of the area. Some form of basic education for area children must be invisioned and the later stages of this process will fall within the area of concern of EMP.

APPENDIX C

EXTENSION EDUCATION PROGRAM

A program dealing with a cow-calf operation is comprehensive because it incorporates the practical use of many of the fundamental concepts of plant science, animal science, animal health, marketing and business. Such an operation may be divided into 11 subject matter areas where major problems may be encountered. It is not implied that each of these areas carry equal importance or that in the beginning of the Bakel project, that more than one or two of these areas be stressed. It should be recognized, however, that education is a continuing process and that as new knowledge becomes adopted, additional information will be sought. The 11 subject matter areas are as follows:

1) pasture improvement
2) range management
3) beef cattle nutrition
4) beef cattle breeding
5) beef cattle reproduction
6) beef cattle health
7) beef cattle marketing
8) beef carcass composition
9) farm and ranch management--economics of production
10) farm and ranch management--business management
11) extension education program in sheep and goat production

An educational program does not indicate a single short course, meeting or seminar. An education program consists of many various techniques including field trips, demonstrations, and meetings. Education is evaluated in terms of change in peoples' attitudes, goals and accomplishments, and it is a never-ending process. An educational program does not just happen; it must be well-planned with teachers and students properly prepared.

In providing educational programs for livestock producers the mistake is often made to attempt to cover too much subject matter in one meeting. Audiences should also be kept to the limited number necessary to accomplish the educational goal.

One of the best methods of initiating interest in educational programs is the establishment of demonstration projects. As new techniques and methods are used in the demonstration, an opportunity is provided to explain its purpose and anticipated results. Comparisons between demonstration herds and regular local herds may be an effective method of encouraging herders to learn more.

For a sample guideline, each of the 11 forementioned subject matter areas are discussed briefly and suggested teaching points are given. It is again emphasized that these are suggestions which should be modified and changed according to the educational objective and need.

I. PASTURE IMPROVEMENT

The word "pasture" implies cultivated fields for forage as opposed to uncultivated rangeland. Cultivated pastures could be an important source of good-quality forage for a limited number of milk cows for a village. To make best pastures, fertilizers other than manure should be applied.

A. Suggested Teaching Points

1. Adopted and recommended cultural practices
2. Methods of establishing cultivated pasture
3. Fertilization--how, when, how much, why
4. Forage quality--which species, when to cut or graze
5. Weed control
6. Insect and disease control
7. Utilization and management of pasture
8. Seed production
9. Economics of pasture production

B. Suggested Educational Activities

1. Method demonstrations of cultivating, contour furrowing, seeding techniques
2. Comparative plots using various rates of fertilizers, different varieties of forage crops
3. Grazing demonstrations on pasture basis to show advantages of proper utilization of forage and avoidance of overgrazing or grazing very wet areas
4. Introduce the identification of soil types and basic soils information as they relate to pasture production

5. Work with youth groups to organize 4-H projects and investigations

6. Use mass media to publicize successful demonstration work or to give cultural information of timely nature

C. Potential Resource People

1. Agronomist

2. Soils scientist (Dakar-Hann, ORSTOM)

3. Animal scientist/animal health specialist

4. Research station personnel (Dakar-Hann, ORSTOM)

5. Range management specialist

6. Special consultant personnel from U.S. (major professors)

7. USAID mission personnel

8. Extension education specialist

9. Promotion Humaine personnel

II. RANGE MANAGEMENT

Successful livestock production is dependent on rangelands and must include provisions for range improvement and proper rangeland management. An educational program in range management should be designed to maintain sustained high production of the native pastures consistent with the improvement of the range forage plants, efficient use of the precipitation received, protection of the soil base, provisions for the wildlife inhabiting the area which will minimize severity of drought. The principles of range management should be taught by a

qualified range management specialist familiar with livestock and applied plant ecology.

A. Suggested Teaching Points

1. Range plant identification
2. Response of plants to grazing and fire
3. Basic plant physiology--how a plant grows, reproduces
4. Basic range ecology--plant succession and range condition
5. Proper use of range forage plants
6. Proper stocking rates--livestock and wildlife
7. Estimating forage production and utilization
8. Proper distribution of grazing
9. Range site classification and potential
10. Range animal nutrition
11. Range seeding
12. Bush control
13. Flexibility in stocking rates according to forage production
14. Maintenance following bush control
15. Poisonous plant identification, prediction of problems, control and treatment of poisoned animals
16. Negative impacts of overgrazing, trailing, and milking of the beef herd

B. Suggested Educational Activities

1. Field training sessions for technicians
2. Short courses for technicians

3. Field demonstration to show technicians and herders what is meant by proper use and distribution of grazing

4. Demonstration of range seeding trials

5. Short courses to teach plant identification for technicians and herders

NOTE: Range subject matter should be integrated into general livestock programs when presenting information to herders in order to teach the equal importance of livestock and range management.

C. Potential Resource People

1. Range extension specialists (major professors) from U.S.

2. Range management specialist

3. Senegalese personnel trained in range management

4. Extension education specialist

5. USAID mission personnel

6. Animal scientist/animal health specialist

7. Promotion Humaine personnel

III. BEEF CATTLE NUTRITION

Research and practical experience provide helpful, rather specific guidelines concerning nutrients required by various classes of cattle for the functions of maintenance, growth and fattening, reproduction, and milk production. Variations in cow size, fattening tendencies, growth rates, milking potential, and stage of the production cycle require consideration in designing an efficient forage-animal program.

Beef cattle nutrition is essentially energy management. About 90 percent of a cow and calf's nutrient requirement is for digestible energy, nine percent for protein, and less than one percent for minerals and vitamins (by weight). Protein, minerals, and vitamins are essential for efficient energy utilization but deserve serious consideration only after due attention has been given to the economic production and efficient utilization of energy. Goals for a program in animal nutrition should be better herd health, better reproduction and profit for the livestock owner. Evaluation of specific supplements and nutritional practices adaptable to the project area should be emphasized as needed.

A. Suggested Teaching Points

1. Life cycle nutrition: desirable nutrient intake for calves, steers, gestating heifers, pregnant cows, lactating first calf heifers, mature cows and bulls

2. Capacity of forages and native range grasses for supplying nutrient requirements and the inherent seasonal deficiencies which necessitate supplementation and feeding

3. Weight changes of animals, a guide to energy feeding

4. Energy supplementation

5. Protein supplements: evaluation, determining needs, methods of supplying, means of limiting intake

6. Mineral supplementation, phosphorus, calcium, trace minerals

7. Vitamin supplementation

8. Water requirements

9. Feed evaluation, testing of native and cultivated forage

10. Energy management, relationship of digestibility and forage intake to maintenance and production

11. Creep feeding of calves

12. Early weaning, feasibility, rations

13. Nutritional deficiencies leading to poisonous plant intake: nitrate toxicity, prussic acid poisoning, alkaloids

B. Suggested Educational Activities

1. For technicians, several one-day short courses to cover some of the above teaching points

2. For technicians and/or herders, field trips to discuss several of the points in a general manner

3. Demonstrations involving cow/calf herds to show the combined effects of quality cattle under good pasture or range management as related to production and profit accrued to the owners

4. Applied research on various herds to determine proper levels of supplementation and research needs

5. Mass media to create awareness, announce meetings, and present information for cattle owners

C. Potential Resource People

1. Animal scientist/animal health specialist

2. Research station personnel (Dakar-Hann, ORSTOM)

3. Livestock service personnel

4. Promotion Humaine personnel

5. USAID mission personnel

6. Local livestock owner cooperating with demonstration herds

7. Extension education specialist

8. Range management specialist

9. Special consultant personnel from U.S. (major professors)

IV. ANIMAL BREEDING

It may not be practical within the scope of the project to experiment with the introduction of new breeds. Much can be accomplished, however, with selection programs using local cattle. At some future date and depending on the success of selective breeding programs it may be desirable to introduce improved herd sires and different breeds from outside the project area.

A. Suggested Teaching Points

1. How to select quality animals within a herd
2. How to manage a selective breeding program
3. Beef cattle breeding as a tool to make improvements in the herd
4. Measures of production efficiency
5. Measures of product quality
6. Conformation of productive breeding cattle
7. Advantages and disadvantages of local breeds

B. Suggested Educational Activities

1. Short course or field trips for technicians
2. Demonstration programs on herd basis in selective breeding programs
3. Training sessions for technicians to select quality cattle
4. Direct assistance to livestock owner/herders to discuss and demonstrate traits of quality reproductive cattle and their advantages

5. Mass media programs to create awareness, to illustrate methods of selection, the ideal animal conformation, etc.

6. Youth training in cattle selection and judging livestock conformation according to desirable traits

C. Potential Resource People

1. Livestock service personnel

2. Promotion Humaine personnel

3. Animal scientist/animal health specialist

4. Cattle buyers and marketers

5. Research station personnel (Dakar-Hann, ORSTOM)

6. Special consultant personnel from U.S. (major professors)

7. Extension education specialist

V. BEEF CATTLE REPRODUCTION

Reproductive efficency is important, and perhaps the single most limiting factor to increased returns and profit in a cow-calf operation. Continuing educational programs in this subject are most effective when livestock owners/herders are shown that reproduction is a function of nutrition, breeding, disease, and a variety of management conditions. Awareness of these principles assist the owner/herder to understand better the need for other beef improvement programs. In addition, they may be shown basic management programs which can enhance reproductive performance.

NOTE: The importance of establishing specific breeding seasons for an entire herd is basic to the successful implementation of many of these programs. It is, for example, practically

impossible to manage a breeding herd on a nutritional basis if year-round breeding is permitted. This is because cows are in all stages of gestation, lactation, etc., and their nutritional requirements are not coordinated so as to make supplementation and feeding a profitable venture.

A. Suggested Teaching Points

1. Relation of reproductive performance to return and/or loss
2. Percent calf crop as it affects the cow/calf operation
3. Measures of reproductive performance
4. Management of virgin heifers as related to reproductive performance
5. Management of first-calf heifers as related to reproductive performance
6. Early weaning and its effects on reproduction
7. Postpartum intervals as related to conception and breeding difficulties
8. Selection and culling programs for increased reproductive efficiency
9. Nutrition as related to efficient reproduction
10. Bull fertility and breeding soundness
11. Diseases affecting reproduction
12. Factors associated with calving difficulties
13. Factors associated with death losses of calves at or near birth
14. Management systems for increased reproductive performance

B. Suggested Educational Activities

1. In-depth short courses for technicians on a continuing basis to keep them current and to discuss potential methods of implementation

2. Demonstrations and field days to discuss the results and emphasize key points

3. Personal contact with owner/herders to discuss and seed new ideas and concepts

4. Mass media techniques to create awareness and encourage adoption of improved techniques by owners

C. Potential Resource People

1. Veterinarians from Livestock Service

2. Technicians from Livestock Service

3. Animal scientist/animal health specialist

4. Scientists from research laboratories and diagnostic labs (Dakar-Hann, ORSTOM)

5. Extension education specialist

6. Promotion Humaine personnel

VI. BEEF CATTLE HEALTH

The adoption of a proper herd health program to prevent the introduction and occurrence of disease problems in a cow-calf operation is an absolute necessity for efficient production of beef calves. All other phases of the program are nullified if after producing a calf, it is allowed to die through the lack of using known techniques to prevent the animal's death.

The prevention of livestock disease not only lies with the individual owner/herder in recognizing and seeking assistance from local veterinarians but also with the support from the Senegalese government in the strict enforcement of quarantine.

Educational activities should train livestock owners/herders in the recognition and prevention of animal health problems. Demonstrations should be conducted to show the effectiveness of such programs as parasite control and vaccination. Special educational meetings, tours, and mass media can be utilized to disseminate information.

A. Suggested Teaching Points

1. Diseases of mature animals--recognition, prevention and control

2. Calfhood diseases--recognition, prevention and control

3. Reproductive diseases--recognition, prevention and control

4. Control of internal parasites--management of pastures, animals and treatments

5. Control of external parasites

   a. seasonality and recognition of external parasites

   b. economic impact of external parasites

   c. methods and materials for control of external parasites

6. Toxic problems causing livestock losses, recognition and prevention

7. Disease prevention through regulations and restrictions

   a. present regulations

   b. purpose of regulations

   c. benefits to livestock owners

B. Suggested Educational Activities

1. Short courses for technicians

2. Livestock health conferences

3. Radio and news releases

4. Consultation with individual livestock owners and herders

5. Field days and tours to cover specific teaching points

6. Method demonstrations to show methods of treating parasites

7. Result demonstrations to show the economics and benefits of parasite control

8. Use of mass media to create awareness, announce meetings, and describe results of demonstrations

C. Potential Resource People

1. Veterinarians assigned to the project

2. Animal scientist/animal health specialist

3. Research station personnel (Dakar-Hann, ORSTOM)

4. Representatives from livestock chemical companies

5. Promotion Humaine personnel

6. Extension education specialist

7. Special consultant personnel from U.S. (major professors)

VII. BEEF CATTLE MARKETING

Marketing of livestock within the project area is not well organized and is handled as an individual matter, often through the use of intermediaries. Through organization and financing schemes the government may be able to better organize the marketing process. Cooperatives of stock-raisers working and selling directly to cooperatives of butchers may be the best method by which incentive can be provided the livestock owner to improve quality and quantity of beef.

Likewise, the butcher or buyer must receive educational programs which teach him to recognize and pay a premium for high-yielding types of cattle. Marketing is a complex subject, and the following outlines are offered only as a guide which should be expanded and intensified according to local situations and needs.

A. Suggested Teaching Points

1. Market organization and structure for beef cattle

   a. Current and future structure of the marketing system from weaned calves to beef at the retail level

   b. Government programs and regulations affecting marketing and production alternatives

   c. Advantages and disadvantages of group action to solve marketing problems; kinds of group action alternatives available and legal and budgetary requirements

2. Market needs in terms of quantity, quality and grade of beef

   a. Domestic consumption trends and relationship of production changes

   b. Effect of drought on market supplies and the situation following drought

   c. Analysis of seasonal price changes and price differences for various weights and breeds

   d. Kinds of animals best suited to satisfy the current market needs; alternative production/marketing decisions which yield the maximum profit potential

B. Suggested Educational Activities

1. Discussions with owners at village level committee meetings

2. Short courses or clinics for technicians and educators

3. Market information, outlook, and other economic material be published and/or posted at village level

4. Mass media to create awareness through market reports, announce sales, and describe results of improved marketing

C. Potential Resource People

1. Agricultural economist or marketing specialist from USAID

2. Butcher cooperative spokesman

3. Research station personnel (Dakar-Hann, ORSTOM)

4. Livestock Service personnel

5. Livestock owners or cooperative spokesman describing their own marketing programs

6. Feeding industry representative

7. Government marketing specialist (GOS)

8. Market-oriented educators (University of Dakar)

9. Special consultant personnel from U.S. (major professors)

10. Extension education specialist

11. Promotion Humaine personnel

VIII. BEEF CARCASS COMPOSITION

All beef is not the same quality and, therefore, should not bring the same price. Beef which is in highest demand by the consumer should bring the highest price. This type of beef should be the goal of the livestock owner if he wishes to realize the best profit for his enterprise. The production of high quality beef of good cutability begins with the cow-calf producer. He must be aware of market needs and

desired types of animal composition if he can be expected to produce the desired type of beef animal.

The development of a continuing education program at the local level will assist beef cattle producers in understanding the interrelationships necessary to produce the type of carcass attuned to the market demands.

A. Suggested Teaching Points

1. The relationship of fatness and muscling to quality and yield
2. The importance of size carcass evaluation for herd improvement
3. Carcass composition of consumer demand beef
4. Carcass evaluation according to breed
5. Carcass evaluation according to age
6. Carcass evaluation from selective breeding herds versus regular herds
7. Carcass evaluation from herds receiving good management and nutrition versus nonmanaged herds

B. Suggested Educational Activities

1. Arrange for several livestock owners and/or technicians to estimate and classify a number of animals on the hoof prior to slaughter; follow the animals through the slaughter and determine actual yields and carcass evaluation, using this opportunity to reinforce teaching points
2. Evaluate improvement in selecting breeding herds or those receiving proper nutrition and management by keeping herd records

C. Potential Resource People

1. Butchers
2. Cattle buyers
3. Research station personnel (Dakar-Hann, ORSTOM)
4. Livestock service personnel
5. Government meat inspectors or graders (GOS)
6. Extension education specialist
7. Personnel from USAID mission
8. Promotion Humaine personnel

IX. FARM AND RANCH MANAGEMENT-- ECONOMICS OF PRODUCTION

There are certain costs assigned to a cow-calf operation which should be evaluated in terms of economic return and stabilization or improvement in the overall system. Much of this information will come through the results of demonstration and research projects.

Additional information will be derived from records of expenses and sales related to livestock production. Some of the factors affecting cost and return are listed in the following outline. Each of these factors can be discussed as to their possible impact on the economic return to the project and management alternatives considered.

A. Suggested Teaching Points

1. Factors affecting cow-calf profits
   a. level of management
   b. weaning weights, calving dates

c. herd health and nutrition

d. reproductive performance

e. seasonal price fluctuations

f. type and time of marketing

g. costs of production

h. range condition

2. Profitable herd adjustment or expansion

a. planning pasture or range improvement and herd expansion systematically

b. raising versus buying replacements

c. value of good bulls

d. costs and returns, along with potential of performance testing within a herd

B. Suggested Educational Activities

1. Clinic to discuss project progress and failures

2. Examination of records to demonstrate the value of good record-keeping

3. Interview producers to gain their attitudes and evaluations

C. Potential Resource People

1. Project manager

2. Livestock Service personnel

3. Promotion Humaine personnel

4. USAID personnel

5. Range management specialist

6. Extension education specialist

X. FARM AND RANCH MANAGEMENT--BUSINESS MANAGEMENT

The livestock owner, whether he be large or small, will be interested in the business side of his operation. He will probably want to know the qualitative and quantitative limits of his cow herd and what the social and monetary costs may be for changing his model of operation. He will need to know what risks he may be taking and the chances of success for certain management decisions.

The outline below can provide a basis for livestock owners receiving answers to their questions and making appropriate decisions which may result in the success or failure of their operation. A degree of flexibility can be achieved for this educational program by combining the points in section IX with these.

A. Suggested Teaching Points

1. Economic position of the owner/herder

   a. production costs and returns under varying levels of management within the project area

   b. interpreting returns and identifying the weak spots

2. Analysis of the cow-calf situation--local and national

   a. government analysis and trends

   b. production records

   c. components of total costs, fixed and operating

d. returns per cow

(1) return to investment
(2) return to labor and management
(3) net return

e. increasing profits within available resources

(1) modification of enterprise to other kinds of livestock
(2) allocating capital--investment analysis for range or pasture improvement, herd expansion, hiring of herders

B. Suggested Educational Activities

Essentially the same as for section IX

C. Potential Resource People

Essentially the same as for section IX

XI. EXTENSION EDUCATIONAL PROGRAM IN SHEEP AND GOAT PRODUCTION

While major emphasis of the Bakel Range Livestock project centers around improvement of rangeland for cattle production, sheep and goats have an important role in the overall livestock scene. Sheep and goats offer several important opportunities in achieving changes in general livestock management. These animals are more readily marketed than are cattle and their rates and frequency of reproduction are greater, thus offering opportunities to show rapid improvement from breeding program and herd management.

Sheep and goats may provide more of an opportunity to initiate livestock programs for youth since less significance is assigned to

these animals than to cattle. Investments for feed and supplements would also be less per animal and desirable results could be obtained for less cost while accomplishing a number of educational objectives.

The following suggestions are offered for an educational program in sheep and goats. The outline is intended to serve as a guide for a person trained in animal science and is not a teaching plan which could be used by an untrained person. This outline consists of two broad sections: (1) production and (2) marketing. Each of these has several subsections.

This outline can serve as a guide for in-service training for field technicians as well as identifying areas of emphasis for programs at the village level. It should again be emphasized as with the cow/calf operation that it is not implied that all phases of the educational program be implemented simultaneously. It should serve to show the overall program and subject matter relationships to sheep and goat production and marketing.

A. Teaching Points--Production

1. Forage management for sheep and goats

    a. Integration of available resources and animal requirements

        (1) range sites and potentials
        (2) acres suitable for cropland
        (3) range condition by pasture and site
        (4) bush and weed infestation
        (5) kinds and classes of animals
            (a) present situation
            (b) potential number and ratios

(6) seasonal forage need according to:
  (a) quality
  (b) quantity
(7) methods of balancing number of animals with available rangeland and cropland
  (a) herd reduction
  (b) herd increase
  (c) improving distribution of livestock

b. Rangeland forage production

(1) range plants
  (a) plant phenology and nutritive value
  (b) physiological responses and proper use
  (c) palatability--by species and season
  (d) poisonous plants--recognition and control
(2) range improvement practices
  (a) moderate use versus heavy use
  (b) proper distribution of grazing
  (c) water development in balance with available forage and grazing capacity
  (d) negative impacts of trailing
  (e) seeding--natural and artificial
  (f) protection from wildfire
  (g) use of controlled burning
  (h) bush and weed control
  (i) methods of achieving flexible stocking

c. Cropland forage production

(1) choice of crops
  (a) adapted forages
  (b) use of food crop stubble and by-products
  (c) use of cultivated forage to supplement range forage deficiencies
(2) crop production practices
  (a) land preparation
  (b) planting and cultivation
  (c) fertilization
  (d) weed control
  (e) storage of grass hay and ensilage

2. Range nutrition for sheep and goats

a. Nutritional requirements of animals

b. Supplementation--amount and season

c. Types of feeds and methods of feeding

d. Frequency of feeding

3. Breeding program for sheep and goats

a. Implementation of selective breeding programs (see description in special section on this subject for more detail)

b. Methods of selection

c. Mating for maximum use of sires

d. Production results

e. Economic benefits

4. Sheep and goat reproduction

a. Effect of age of female

(1) breeding young females
(2) culling old females

b. Reproduction diseases

(1) recognition
(2) control

c. Role of the herd sire

d. Influence of season and temperature on reproduction

e. Care of young animals

f. Culling practices

g. Influence of predators

5. Disease and parasite control

a. Economics of disease

(1) death loss
(2) loss of production--feed conversion, weight loss
(3) loss in market value

b. Recognition of internal, external parasites and diseases

c. Sampling methods to determine extent of parasite problems (for technicians)

d. Control of external parasites

(1) treatments--type and frequency
(2) application equipment and techniques
(3) proper handling and application of insecticides
(4) sanitation practices to reduce populations of external and internal parasites

6. Quality meat production

a. Importance of good herding practices

b. Influence of breeding practices

(1) continuous versus seasonal breeding
(2) age of females and productive life span

c. Conformation and size of animals

d. Proper ratio of males to females

e. Influence of supplementation and feeding

f. Age at marketing

g. Selection of animals to be marketed

h. Method of transportation to market

i. Influence of range condition

B. Teaching Points--Marketing

1. Plans, programs and incentives for marketing meat and hides

2. Market needs for sheep and goats in terms of quantity

a. Local needs--national needs

b. Types and breeds best suited to meet market demands

3. Market needs in terms of time and location

   a. Seasonability of markets

   b. Carryover and inventory handling

4. Preparation, assembling, processing, handling, selling and transportation to meet market needs

5. Pricing and selling arrangements

   a. Current situation

   b. Alternative programs--cooperatives

   c. Advantages of organized marketing for owner and butcher

6. Sheep and goat market information

   a. Current prices and trends

   b. Daily market reports

7. Financing, sheep and goat marketing

   a. Current situation involving intermediaries

   b. Proposed government-supported schemes

   c. Opportunities for cooperatives

   d. Alternative systems available

APPENDIX D

PLANNING, CONDUCTING AND USING DEMONSTRATIONS IN AN EDUCATIONAL PROGRAM

A planned and conducted demonstration is one of the quickest and surest ways to introduce new information and technology into an educational program. The purpose of the demonstration is to apply methods and materials which have been developed through research programs in order to encourage their quick adoption. In range and livestock programs, the results gained from demonstrations may take several years to evaluate and use. However, many types of method demonstrations can be valuable in showing immediate benefits such as equipment and its use.

Several types of range management demonstrations include:

1) range seeding
2) bush or weed control
3) water development
4) techniques for obtaining better distribution of grazing

Evaluation of demonstrations can be accomplished by several methods. Some results may be qualitative; and pictures taken before and after the demonstration may be more meaningful than attempts to collect data. Other ways for reporting the results from range and livestock demonstration include:

1) increase in livestock gain
2) increase in animal unit days, months or years of grazing
3) increase in nutritive value of forage

4) reduction in livestock losses from malnutrition, disease and toxic plants

5) increase in pounds forage production

6) improvement in range condition

7) improvement in calving percentage

8) improved ease of livestock handling

9) improved herd nutrition from better feed supplies, supplements, and water

A good demonstration does not just happen--it takes planning, cooperation and experience. The following guideline includes some of the more important points in planning, conducting and reporting the demonstration.

I. PLANNING THE DEMONSTRATION

A. Phase I

1. Determine the need

2. Localize the problem

3. Design a demonstration to solve the problem or fulfill the need

4. Select the cooperator (very important)

5. Determine sources of assistance, materials, and equipment

6. Determine what personnel are needed and schedule their time

7. Plan the methods by which to apply, evaluate and present the results of the demonstration

8. Determine the possibility and advantage of incorporating method demonstrations, subsequent tours and field days

B. Phase II

1. Secure the cooperators' permission and assistance with the demonstration

2. Survey the demonstration area or herd

3. Delimit the size of the demonstration, collect samples, measurements or other data such as herd size and composition

4. Select an experimental design (if applicable)

5. Diagram the study area and list treatments

6. Obtain necessary materials and equipment

7. Test the equipment to insure it is functional

II. CONDUCTING THE DEMONSTRATION

A. Inform the cooperator and interested persons sufficiently ahead of time

B. Note weather condition (if applicable)

C. Note any equipment failures or discrepancies

D. Standardize replication of treatments as much as possible

E. Avoid intentional personal bias

III. DEMONSTRATION FOLLOW-UP

A. Locate permanent plot markers or mark individual animals

B. Make evaluation according to plan

C. Discuss techniques and answer questions arising from the demonstration

D. Show the outcome of the demonstration whether it be positive or negative

IV. DEMONSTRATION REPORT

A. Title--type of demonstration and location

B. Introduction--note objectives

C. Background--note any information which supports the need for the demonstration

D. Methods--description of the area, plot diagram, methods of application and materials

E. Evaluation--note method of evaluation and results

F. Summary--brief summary statement

G. Acknowledgements--list of cooperators, resource people, equipment, donors

The demonstration is a positive way to institute an educational program. However, it is only one technique to be used and is not a substitute for an overall in-depth educational effort.

APPENDIX E

GLOSSARY OF EDUCATIONAL TERMS

A number of terms are used to explain and describe an educational program. Unfortunately, these terms are not always well understood even by the educators. It may be helpful, therefore, to define some of the terms used in the description of an educational program.

1. An educational program

A series of coordinated educational activities or methods designed for well-defined audiences to achieve a realistic goal. (Examples: range improvement program; selective breeding program)

2. An educational activity or method

A single teaching effort designed to move the total educational program closer to its desired goals. (Examples: short course; tour workshop)

3. A short course

A series of instructional sessions, with qualified instructors, in which the participants receive intensive training in the scientific principles and subject-matter content of a specific program area. (Examples: beef cattle reproduction; beef cattle nutrition)

4. A workshop

One or more training sessions, with qualified instructors, in which the participants plan and carry out specific study or work assignments based on the subject matter taught. A workshop is usually

concluded with a summarizing and evaluating session. (Examples: crop fertilization workshop; cattle branding workshop)

5. A seminar

A study course pursued by a group of advanced students, with one or more qualified instructors, in which each student conducts a study assignment and results are exchanged through reports and discussions. (Examples: credit and finance seminar for cattle buyers; management and organization seminar for cooperative directors)

6. A field day

A group meeting conducted on a single location, such as a village to observe and discuss improved practices, equipment, or facilities. (Examples: fire fighting field day; crop seeding field day)

7. A tour

A group meeting conducted on two or more locations. Similar to field day except it requires transportation from one place to another. (Examples: tour of stock water ponds; tour of vaccination facilities)

8. A result demonstration

A progressive and practical example in agriculture conducted by a herder under the supervision of an extension person to show the value of a recommended practice. It invloves a substantial period of time, records of results, and comparisons. It is designed to teach others in addition to the person conducting the demonstration.

Result demonstrations are planned in advance, not merely found. (Example: range improvement demonstration)

9. A method demonstration

A teaching technique in which a process, fact or idea is described or shown. (Example: a cattle branding demonstration)

10. Teaching

The process of arranging situations so that learners by their own activities become changed in behavior.

11. Learning

The process of acquiring habits, knowledge and attitudes involving new ways of doing things.

12. A clinic

A group meeting to diagnose or study in detail a particular topic or subject.

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CHAPTER 7

ECONOMIC ANALYSIS

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Two sections are contained in this chapter. First is an analysis of economic requirements for the implementation phase of the project. A major emphasis is upon the steps which the Government of Senegal should take to ensure success of the project. In the second section, an economic feasibility analysis is conducted.

I. ANALYSIS OF ECONOMIC REQUIREMENTS

A. ECONOMIC DESCRIPTION OF THE PROJECT AREA

The principal barrier in implementing the project is overcoming the isolation that exists in the project area. This isolation is, of course, a primary factor in the lack of development that has occurred to the present date. The Toulekedi zone is approximately 50 km from either Bakel or Goudiry. In addition, much of the road from Goudiry to Tambacounda is in poor repair. The transportation of people and goods is extremely difficult under these road conditions. The development of the project area will require the transportation of large quantities of equipment and materials. In addition, frequent trips will be essential for moving project staff in and out of the area.

A major step toward an improved road situation will be achieved when grading is completed on the Bakel to Goudiry road which runs along the project area. If maintained, this road will greatly facilitate the provision of transportation for the project area.

Recommendation: That the Government of Senegal continue to improve and maintain roads into the project area.

The economy of the project area is now oriented toward self-sufficiency. The basic diet of cereals, milk, meat and poultry products is all produced within the village. Occasional purchases of commodities such as oil or rice are made. Other cash needs are for cloth, some vaccines for animals, taxes, and a few "luxuries." Sales of livestock or grain are made only if a need for cash exists.

The desire for greater cash purchases is present. A few families have purchased household goods such as a European-style bed, a radio, and a flashlight. The purchase of horses, bicycles or motorbikes for transportation exists. In the wealthier families, the mud-walled, straw-thatched huts are being replaced by concrete-walled, tin-roofed houses.

Efforts, in addition to crop and livestock sales, have been made to obtain greater cash income. A few young men have become migrant workers in France. It is estimated that they each remit as much as 220,000 CFA per year to their families ($1,000 U.S. dollars). This practice indicates that the young, at least, will accept great change in order to improve their cash income and family status.

If the project is to be implemented and rather large cash investments made, then greater cash income must be generated from the area. The economy must become cash-oriented in contrast to traditional self-sufficiency. The cash generated should be sufficient to

repay all investment and recurring costs of project implementation. In achieving the switch to a cash-oriented economy, three interrelated changes are recommended.

The first change is an increase in the amount of livestock production in the area. Production now barely exceeds family consumption. Through improved range management and veterinary services provided by the project, livestock production is expected to increase substantially. The project goals for livestock production are outlined in subsection I-D of this chapter.

A second change is the improvement in local livestock marketing. The cattle produced in the project area must be sold at a high price with quick, guaranteed payment. Livestock marketing improvements are suggested in the following subsection.

The third necessary change for a cash-oriented economy is the greater availability of consumer goods. Cash sales are of little value unless they can be used to purchase consumer goods that are readily available. Although traders do move among the villages with consumer goods, the selection of goods is limited and high prices are likely. The greater availability of consumer goods will provide a strong factor in encouraging greater cash sales of cattle and overgrazing will be minimized.

Recommendation: That the project establish a retail store at the project headquarters which would sell basic consumer goods and building supplies.

B. LIVESTOCK MARKETING

Sales of livestock from the project area have been small in the past. However, with project development the sales should increase significantly. The current marketing system is not adequate to handle the increased volume.

Two intermediaries operate in the current livestock marketing system. A herder will normally sell his cattle to a dioula. The dioula buys cattle, assembles them into a herd, trails them to a market area, and then sells the cattle. If the dioula trails the cattle to a regional market such as Bakel, Tambacounda or even Dakar, he can sell to or have the cattle sold by a teffanke. A teffanke operates normally at only one market and usually acts as the dioula's agent in selling the cattle to the butcher. The butcher will then slaughter the cattle and sell the meat to retail purchasers. Many variations of this process exist. For instance, a butcher often buys directly from a herder or a dioula.

Terms of the sale depend upon current economic conditions. During earlier drought years, cattle for slaughter were plentiful with dioulas selling cattle to the butcher on credit and herders selling on credit to dioulas. Often, payment was delayed several months and full payment was often not received. Now with improved range conditions, all sellers demand cash payment.

Livestock prices are dominated by the meat price controls of the Economic Control Board of the Government of Senegal. Prices are set for two qualities of meat--first quality and second quality. First quality meat requires a covering of fat under the hide. The retail beef prices established vary for department capitals such as Tambacounda or Bakel and for district centers such as Goudiry. The controlled prices in CFA per kilogram for December 1975 were:

	Department	District
First Quality	245	210
Second Quality	210	185

The price of first quality beef in Dakar is reported to be 450 CFA per kilogram.

These controlled prices vary widely. They also cause distortion in normal marketing patterns. For instance, a dioula in Goudiry can gain a 35 CFA per kilogram higher cattle price in Tambacounda. It is difficult for butchers in Goudiry to buy quality animals at market prices. As a result of these price controls, one can observe second quality beef being sold at first quality price and offal is mixed and weighed in with beef for sale at the regulated price. Price distortions around the controlled price are then common.

Liveweight prices, though largely controlled by retail prices, still fluctuate widely. A Goudiry butcher claimed that during the drought period, he could buy a cow for 7,500 CFA that weighed 100 kilograms. By selling the meat for 100 CFA per kilogram, profit was

2,500 CFA. Now, he must pay 25,000 CFA for a cow and he will lose 4,000 CFA. Although the claim of losses is to be doubted, the profit margin has obviously declined. The rise in prices in Senegal has corresponded to the international situation with the possible exception that Senegalese prices rose later than in international markets due to excessive liquidation caused by drought.

Hides are now being bought from butchers by the Senegalese Animal Resources Exploitation Company (SERAS) at a price of 100-110 CFA per kilogram of dressed weight. With an average weight per hide of three kilograms, the value of a hide is 300-330 CFA. SERAS does not buy hides from herders. Cattle hides are now discarded from cattle slaughtered in the villages.

Liveweight prices of young cattle are not now available in the project area and must be estimated. Few cattle are being sold because of good grain harvests and the desire to rebuild herds to predrought levels. In estimating the liveweight price, a value of 90 percent of the retail meat value is assumed. For instance, a dressed weight bull selling for 245 CFA per kilogram times 90 percent is valued at 28,700 CFA. If the same animal is sold in Dakar for 450 CFA per kilogram, additional costs of trailing the animal to Dakar of perhaps 4,000 CFA are incurred but the remaining value is 48,650 CFA.

Considerably higher returns can be gained by herders if their marketing program maintains control of cattle to Dakar. It appears

that Dakar is extremely short of meat at the present time so prices have been raised. The Dakar area also imports considerable meat with all of Senegal importing an estimated 25 percent of beef consumption in 1970. The regulated prices in Dakar have obviously risen more in response to international prices than in the beef surplus areas surrounding the project.

As shown in the above analysis, cattle prices vary widely by region. Future cattle price levels in Senegal will also be affected by international beef prices, and weather conditions. Therefore, the feasibility analysis will be conducted for a range of alternative prices from 210 to 450 CFA per kilogram.

Market planning and organization will be of critical importance in the overall success of the project. By marketing cattle in Dakar, the potential for considerably higher prices exists. In addition, an organized group could more fully utilize by-products such as hides and skins which are currently discarded. It is also essential that herders be directly involved with the marketing program.

Recommendation: That a livestock marketing cooperative be established and given financing for the purpose of marketing production from the project area. Financing should be under the direction of the AID project director.

The idea of marketing cooperatives is not new to the residents of the project area. A livestock cooperative with 16 members was established in Baniou seven years ago. Each member paid a fee of

22,250 CFA to join with the expectation of government purchase of cattle. Since government recognition of cooperatives apparently requires 25 members, the cooperative never functioned as planned. However, the herders are familiar with the cooperative concept and have indicated a willingness to invest cash in solving marketing problems.

Once established, the marketing cooperative needs continuing government support. The cooperative should develop a marketing plan with assistance of the Government of Senegal.

Recommendation: That the Government of Senegal with SERAS's Doli Ranch and slaughter operations assist in developing a marketing plan for the project area.

The details of the marketing plan must be developed during the life of the project. At the present time, marketing plans should call for sales of mature weight cattle in the highest price market, probably the Dakar area. Therefore, the project area would independently produce cattle. Government of Senegal plans call for the use of the project area for calf production. The calves would then be moved to the peanut basin for fattening on peanut residues. Although this plan may be feasible in the longer run, there appear to be few fattening facilities available in the peanut basin at the present time. In fact, few cattle are now in the region. Peanut fields are scattered over large areas and each grower has rather small areas in production. A huge

organizational effort would be required to obtain sufficient residues for a cattle fattening operation.

Recommendation: That initial cattle marketings from the project area be mature weight cattle until a more complete marketing plan with integrated fattening in another area is developed.

C. COSTS OF PROJECT IMPLEMENTATION

The project budget has been detailed in Chapter 1, Section VI of this report. The costs of implementation total a substantial $2.5 million for an area which contains only 15,000 cattle. This is a substantial cost burden per animal.

Should all these costs be allocated to this specific project? Costs for physical improvements such as dam construction or firebreaks should obviously be paid by project benefits. However, the technical assistance portion of the budget is largely an applied research effort. Research results would be applicable to large areas of Senegal and in surrounding countries. The effort is also a demonstration project which will give a practical field test of the proposed changes. For these reasons, only 10 percent of the technical assistance budget will be included in the project costs.

An additional factor affecting feasibility is the timing of investments. Because of the time value of money, investments that can be delayed result in lower cost because the money can earn interest during the period prior to investing. In Table 1 the planned timing of

budget costs by years is presented. Operating costs past the three-year life of the project are estimated at $103,720 per year.

Table 1. Planned budget costs for the Bakel Range Livestock Project by years from date of project approval.

Budget Item	Year 1	2	3	4	5+
	- - - - - Thousands of U.S. Dollars - - - - -				
A. Infrastructures	$299.21	$248.55	$238.05	$151.70	$ 0
B. Equipment	255.30	0	0	0	0
C. Educational	25.00	25.00	25.00	0	0
D. Design and Evaluation	106.00	0	0	25.00	0
E. Technical Assistance[a]	7.76	23.29	23.29	15.53	0
F. Participant Training	45.59	31.91	0	0	0
G. Sarre Zone Development	0	28.00	0	0	0
H. Operation Cost	62.16	82.78	137.61	118.72	103.72[b]
TOTAL	$761.02	$439.53	$423.95	$310.95	$103.72

[a]Only 10 percent of total budget costs are included.

[b]For continued operations, only veterinary supplies, minerals and reduced equipment and office costs are incurred.

D. LIVESTOCK PRODUCTION BENEFITS

Numerous benefits are derived from an effort such as the Bakel Range Livestock Project. Expanded alternatives will be available to the population in such areas as consumer goods, transportation,

housing and food. Education and medical systems will also be introduced into the area. For agriculture, improved agronomic practices can be introduced and, perhaps most important for the longer run, erosion rates to rangeland can be lessened. Although these changes surely produce benefits, these benefits will not be measured monetarily in this report.

Livestock production improvements are crucial to project success. These improvements are identified and given an economic value. The benefits of increased livestock sales available from the project area are then compared to project costs for a determination of overall project feasibility.

Improved milk production has been cited previously as a possible benefit of project implementation. Although milk production will rise with the implementation of the project, it is critically needed for calf nutrition so that weight gains are raised and mortality reduced. In addition, transportation, processing, and refrigeration equipment do not exist either in the project area or urban regions for marketing of fluid milk. A fluid milk market does not exist in Senegal. Sterilized milk that is imported from France is all that is available in Dakar. In the project area, excess milk is given away or thrown away rather than sold. Therefore, increased milk production is not a feasible economic benefit from the project.

With the improvement in range management practices and veterinarian services, four specific livestock benefits are anticipated.

First, the fertility or calving rate for cattle will improve. Secondly, death rates for all classes of cattle will be reduced. The third improvement is that cattle weight gains will improve and cattle sales can occur at an earlier age. Finally, improved range management will increase herd size allowing increased sales.

At the current time, cows sometimes calve only every three to four years. Therefore, calves born each year are estimated to be only about 55 percent of the number of cows. With project implementation, we anticipate that the calving rate will improve to 75 percent.

Death rates of calves are currently estimated to be 45 percent in the project area during the first year of life. The project goal is to reduce first year death rates to 15 percent. In addition, death rates for other ages of cattle will be more than cut in half. Specific death rates are shown in Table 2. Offtake rates are also shown in Table 2.

Current weight gains by cattle are very low. Mature cattle are traditionally six to seven years old when sold. Carcass weights of mature cattle are estimated at 110 kilograms. With a dressing percentage of 55 percent, live weight is 200 kilograms. With a birth weight of approximately 15 kilograms, the average weight gain per year is but 30 kilograms. Although weight gains are substantial during the wet season, dry season weight losses are nearly as great as gains. With improved range management, the goal is to reduce or even eliminate dry season weight losses. During the first year of calf life, it is anticipated that 102 kilograms of weight will be gained so that the

Table 2. Mortality and offtake rates with project area cattle for both pre-project and post-project.

Years of Age	Mortality, %		Offtake, %		
	Pre-	Post-	Pre-Project Female	Pre-Project Male	Post-Project
0-1	45	15	0	0	0
1-2	10	5	0	20	0
2-3	5	3	0	30	0
3-4	3	1	0	40	99,43[a]
4-5	3	1	0	50	0
5-6	3	1	2	50	1
6-7	3	1	2	50	2
7-8	3	1	2	50	5
8-9	5	3	5	70	10
9-10	6	3	25	100	20
10-11	10	5	50	-	65
11-12	15	8	80	-	80
12-13	20	10	100	-	100

[a]Available cattle for sale are 98.6% of males and 43.3% of heifers.

Source: Pre-project rates estimated in Sarniquet, de Mieulle and Blanc, Meat Supplies in West Africa, Part One. Sociéte d'Etudes pour le Développment Economique et Social, Feb. 1973.

animal weighs 117 kilograms at one year of age. In the three years following weaning, weight gain will average 70 kilograms per year or about 0.7 kilogram per day for 100 days with no weight change for the remainder of the year. At four years, the cattle weight will be 327 kilograms live weight or 180 kilograms carcass weight.

If these assumptions are combined, the structure of the herd both before and after project implementation can be derived. Before implementation, the structure and offtake rates are estimated as:

Class of Cattle	% of Herd	Offtake Rate, %
Young males, 0-4 years	22	12
Bulls, 4 or more years	6	46
Heifers, 0-4 years	31	- 1
Cows, 4 or more years	41	10
TOTAL	100	9

Note that the offtake rate on young heifers is actually negative. Due to a low calving rate and high calf mortality, the herd does not produce enough heifers to even reproduce itself. Therefore, heifers are bought with bull and older cow sales.

Following project implementation, the herd structure and offtake rates are estimated as:

Class of Cattle	% of Herd	Offtake Rate, %
Young males, 0-4 years	36	23
Bulls, 4 or more years	1	13
Heifers, 0-4 years	36	10
Cows, 4 or more years	27	13
TOTAL	100	15

The major change is the reduction in the percentage of older cows and bulls. With project implementation, the relative proportions of young cattle increase and offtake rates double for males and increase by 11 percent for heifers. Overall, offtake rates improve from 9 to 15 percent. This extra six percent offtake is a clear economic benefit derived from the project. In addition, a larger proportion of offtake is in younger, higher valued animals and the weights of the cattle will be improved.

In the range management section of the report (Chapter 2, Section VII) the total carrying capacity of the Toulekedi zone is estimated to be 16,371 animal units (AU). In converting cattle numbers into animal units, the following conversion factors are used for the four classes of cattle considered:

Class of Cattle	AU per Head
Young males	.70
Bulls	1.25
Heifers	.70
Cows	1.00

By multiplying the AU per head values by the percentage of the herd in each class and summing, an average AU value for the herd is obtained. Before project implementation, the average animal is equivalent to 0.86 AU. Therefore, with a herd of 12,000 cattle, only 10,300 AU are being utilized. Following project implementation, the average AU per head is only 0.78 since more young animals are in the herd. With

16,371 AU of grazing available, a total herd of 21,000 head is possible.

With an increased herd size, a period of expansion of the herd will be necessary. Also, offtake will be depressed while expansion occurs. Estimated annual sales during the expansion period are found below. The herd is expanded from 12,000 head to 21,000 head over a six-year period.

	Number of Offtake			
Year in Project	Cattle 0-4 Years	Bulls > 4 Years	Cows > 4 Years	Total
1	194	200	64	1034
2	404	66	631	1101
3	570	55	628	1253
4	1057	46	631	1734
5	1839	39	667	2545
After Expansion	2514	33	766	3313

Without project implementation, offtake would be 1080 cattle per year from a 12,000 head herd.

Sales will be valued for sale in three different locations. Due to retail price regulations, value of cattle will depend upon whether sales are in a district center such as Goudiry, a department capital such as Bakel or Tambacounda, or in the Dakar area. The procedure for estimating the value of a live animal is to multiply the carcass weight times retail price times a factor of 90 percent. The 10 percent reduction is for slaughter and retailing costs. In addition, Dakar sales of young cattle have an additional reduction of 4,000 CFA per head for

trailing costs from the project area. Estimated cattle values are:

	Carcass Weight (kg)	Price/kg (CFA)	Value/Head (CFA)
Without Project:			
District Sales	90	200	16,200
With Project:			
District Sales			
Young Cattle	180	210	34,020
Mature Cattle	110	185	18,315
Department Sales			
Young Cattle	180	245	39,690
Mature Cattle	110	210	20,790
Dakar Sales			
Young Cattle	175	450	66,875
Mature Cattle	110	210	20,790

For value of sales without the project, carcass weights are low primarily because many male calves are slaughtered at a young age.

Value of sales is obtained by multiplying number of offtake times the value of sales. For the first six years of the project, the sales values are:

	Annual Sales (million CFA)		
Year	District	Department	Dakar
1	21.98	25.16	30.44
2	26.51	30.53	41.51
3	31.90	36.82	52.32
4	48.36	56.03	84.76
5	75.49	87.67	137.66
6+	100.16	116.39	184.73

Without the project, sales are estimated at 1,080 head per year at a value of 16,200 CFA per head. Therefore, annual sales are only 17.50 million CFA. The difference between projected annual sales with the project and the 17.50 million CFA value without the project is the net sales resulting from project implementation. In addition, net sales are the monetary benefits derived from the project.

II. ANALYSIS OF ECONOMIC FEASIBILITY

Benefits from the project are the additional value of cattle sales generated by project implementation. When the costs are subtracted from benefits, a net cash flow is obtained for each year. Each cash flow is then discounted to present value terms and the terms are summed. The discounting process accounts for the time value of money, or interest cost. The sum of the present value terms is called the net present value (NPV) of the investment. If NPV is positive, then benefits exceed costs and the project is feasible. If NPV is negative, then the investment should not be made. As the interest rate rises, the distant revenues are more heavily discounted and NPV declines. Eventually one finds an interest rate where NPV = 0. This interest rate is the maximum rate that can be paid if the project is to be considered feasible and is often called the internal rate of return.

The feasibility analysis for the Bakel Range Livestock Project is shown in Table 3. Sales of cattle at three locations is considered. Net cash flows projected for the project are presented first. Note that

Table 3. Investment feasibility for the Bakel Range Livestock Project with sales in three locations. (U.S. $1.00 = 220 CFA)

Net Cash Flows in Year of Project	Sales Level		
	District	Department	Dakar
	- - - thousands of U.S. dollars - - -		
1	$-740.66	$-726.20	$-702.20
2	-398.58	-380.30	-330.39
3	-358.50	-336.13	-265.68
4	-170.68	-135.81	- 5.22
5	159.87	215.23	442.46
Following years	272.01	345.78	656.42
Net present value at 8% interest rate	$ 814.03	$1651.80	$4323.95
Internal rate of return on investment (in percent)	11.7	14.8	23.5

substantial cash outlays are required during the first four years. Sales are assumed to continue indefinitely. The discount or interest rate used to compute NPV is eight percent. The NPV sums are positive at all three sales levels indicating that the project is definitely feasible. In addition, the internal rate of return figures range from 11.7 to 23.5 percent. Since financing is less costly than these rates, the recommendation is made to implement the Bakel Range Livestock Project.

An additional measure is the percentage of potential net sales that must be realized to ensure feasibility. For district sales, 75 percent of potential benefits must be realized. For Dakar sales, the percentage declines to 36 percent. These percentages seem to be within reach.

A. CONCLUSIONS

The Bakel Range Livestock Project is economically feasible as proposed. Of course, feasibility depends on the assumed conditions upon which the calculations are based. The crucial assumptions have already been discussed. First, it will be necessary that the government assist the project with road maintenance and by helping in the development of a cattle marketing plan. Secondly, it is essential that the local populations develop a market-oriented economy where cattle sales are regularly made so that overgrazing is controlled. Finally, the project staff chosen must be well-trained and competent to implement the proposed plan.

CHAPTER 8

SOCIOLOGICAL REPORT

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I. INTRODUCTION

The observations of the culture and social system among Diery livestock raisers leads to the following recommendations for the introduction of management practices proposed by the Range Livestock Design team. The social system of the perimeter includes eight major components which interact in the framework of bringing about change. These elements are:

(1) Language (dialect) and ethnic identity which set boundaries around the system. (2) Interdependence of persons and groups within the system based on links of kinship, marriage, property, and territoriality. (3) The outstanding beliefs and values of the society which determine group responses to change introduced at any level. (4) The goals and aspirations of societal members which must be taken into account in attempts to alter incentives and modify behavior. (5) The size and density of the population and its dynamics over space and time in relation to ecological variables. (6) Hierarchial stratification and power structures which determine leadership and legitimize key roles in contacting the population for the purpose of developing new techniques. (7) Social controls, rewards, and punishments which feed back into the system to maintain its integrity and manage tensions. (8) External linkages and receptivity points in adapting to changing

conditions from the wider society, represented by government, outside opportunities, and incoming agents of change.

The discussion of recommendations comes from a sociological perspective based on observations in the field, research into previous studies, and consultation with other members of the design team and Senegalese experts.

II. LIVESTOCK CONSIDERATIONS

A. CONCENTRATION OF PROJECT ON CATTLE OF RESIDENT INHABITANTS

The project will aim to provide range management, water resources, animal health facilities, marketing structures, and herding organizations for the resident inhabitants whose cattle and small ruminants utilize the region of the perimeter. As they are mainly sedentary villagers who speak a common language and share ethnic identity, this should make for a homogeneous region for development. The identification of watersheds and grazing units for the livestock on a year-round basis fits well into their preference for sedentary living, as they transhume only when water and forage are exhausted. In order to control the perimeter, certain obstacles must be overcome:

Outsiders and transhumants from other regions (no longer a major problem in the Diery) should be discouraged from entering the perimeter. This can be done through clear-cut borders (i.e. wide firebreaks), an information campaign, and warnings by government

agencies. Herder organization within the perimeter and stationing of guardians would be of use, but it would not be advisable to set up border police or armed guards as this would create potential for violence and conflict. Stockowner organizations should be the means of dealing with trespassers and legal action should be taken only in case of excessive infringements or destructive acts like setting of fires, etc.

Attempts at in-migration are likely to occur once surface water and forage units are constructed and seen to operate well. As out-migration has recently depopulated the area, so future in-migration may tend to over-populate it. Therefore, a system to preserve the human and animal population base within the carrying capacity of the land must be devised. The design team has set up natural limits of water supply for cattle in order to prevent overgrazing and destruction of the soil.

Herding councils should be elected from among participating stock raisers to develop procedures for controlling access to the range. Group attempts to control individual behavior may result in complex decision-making problems which could divide participants. The help of trained intermediaries familiar with Diery kinship and social obligations and duties is recommended to help resolve conflicts. The implementers will need to be patient and accept trial-and-error methods in shaping the behavior of stockraisers' management of their cattle and land.

One alternative to forbidding outside use of the perimeter range, is to encourage would-be joiners to emulate the project on their own lands adjacent to the perimeter. The design team has left this possibility open in the case of the southwest corner of the Toulekedi zone, where some of the villages belong to a temporarily defunct livestock cooperative situated in the village of Baniou (in the perimeter) and including other villages outside the boundary. Similar additions could be made in the northern side of the Sarre zone where another non-functioning cooperative, located at Ololdu (outside the perimeter), includes some of the perimeter villages.

It is recommended that the implementation team gather comparative data on the livestock and populations of these border areas for the purpose of evaluating the impact of the project as it is implemented. The cooperative units form a natural "control group" situation for the collection of data on the productivity of the cattle, their health, milk production, and offtake rates and economic returns between those receiving a specialized "treatment" and those remaining untreated. The variables to be measured should be set up in advance of the implementation phase and followed through with repeated surveys of the two systems.

B. CONSTRUCTION OF A COW-CALF OPERATION

The long-range aim of the project is the creation of a cow-calf breeding zone with early offtake of young animals for transfer to other

parts of the country for growing out and eventual fattening and slaughter.

A clear set of legal regulations cordoning off the perimeter for this purpose and setting down regulations as to land use should be prepared in advance in order to anticipate challenges to the project goals. There are no existing private claims to the Diery lands by individuals or groups in the Bakel Department, and it is recognized as a public commons for "free" use by all comers. The government considers it to be part of the national domain. The project agreement should legally define the land, if possible by decree to set it aside for this specialized purpose.

Implementation of the project should take place in step-wise fashion, starting with a single grazing unit designed in collaboration with the stockraisers who will use it. This may require minor modifications in the range map designed by this team to accomodate stockraiser needs. This possibility has been foreseen by the design team. However, the absence of an ownership sense of traditional grazing "territoriality" on the part of villages or herders facilitates the creation of rational and pragmatic boundaries for grazing units to suit ecological watershed topography and carrying capacity of the land.

Because Diery herders are unaccustomed to remaining within permanent frontiers when grazing, the project implementers will need to convince the participants of the utility of these new restrictions. Education about the value of firebreaks and training of fire brigade

workers will help develop a sense of attachment to the grazing land among the husbandmen.

Control over the exchange of animals between different herds and across grazing unit boundaries will also require managerial expertise, as stockraisers may wish to continue their current practices of transferring cattle according to social customs as they have in the past. Branding and numbering of animals and record-keeping may become an important aspect of control.

There may be certain locales suitable for grazing and water development which for customary or mystical reasons Diery herdsmen try to avoid. Some waterpoints may be considered "poisonous" and certain places are "known" to be haunted by spirits or to be the dens of lions or hyenas, and hence avoided. Other areas physically inaccessible may be considered unfamiliar and herders may be reluctant to graze cattle there. Demonstration by volunteer herds of innovative individuals will be the key to overcoming these fears and avoidances.

C. KEEPING CATTLE ON PERMANENT PASTURES

The design team concept of separating the beef herd from the village while leaving a small milk herd close to the village is likely to be the greatest initial cultural and technical obstacle to project implementation. The Diery value system insists on stockowners keeping

their herds close to the village at night most of the year. Milking of cows near the village is performed to provide an essential food source for each extended family, and dry season watering of cattle is presently done at the village well. Livestock are built into the extended family social organization and sentiments. Abolition of these work roles and personal contacts through professional management techniques will affect the whole way of life of the husbandmen.

A "go-slow" approach is recommended for this problem. It should begin with family education and reassessment of the traditional division of labor for men, women and children in the extended family compound. Permanent grazing should be started initially with the most progressive volunteer stockraisers. Owners should be encouraged to make regular visits to their herds and consult with the herders. If possible, the herders should be recruited from the participating families and trained before the cattle are placed on the grazing unit. As these model herds improve, other husbandmen should be encouraged to observe them and imitate their permanent grazing methods.

It might also be useful to utilize small ruminants such as sheep or goats for some experimental herding techniques, since they do not carry the cultural load of associations, and sentiments that surround cattle and their management under the new methods would not produce as much resistance to change.

Education by livestock extension agents, Rural Expansion Center workers (CER) and Promotion Humaine animators should concentrate

on helping the people overcome this strong desire to see their animals by the village each morning. Set-backs to the innovation must be anticipated and accepted. It is essential that the stockowners maintain a sense of identification with their family herds and not be alienated from the managerial aspects since for them "management" is not only a technique but a sentimental and mystical mode of behavior concerning cattle.

D. OWNERSHIP PROBLEMS

While grazing units have been designed around one or more villages' livestock, sociological investigation shows clearly that the basic unit of herding is the extended family compound. Therefore, special attention from extension education and herd management agents should be directed at the compounds (the basic livestock owners), whose membership shares rights and duties, responsibility and pride, as well as food and economic benefits in the family herd.

Through its headman, the extended family should be consulted when herding or commercialization decisions are to be made. The headman should be given ample time to consult with his extended family members before agreeing to change herd management techniques in line with project aims.

E. THE PROBLEM OF INCREASING LIVESTOCK NUMBERS

The need to limit the growth of herds on the grazing units to the carrying capacity of the forage must also be addressed in the context of the extended family. Diery husbandry norms favor big increases in herd size and small levels of offtake currently. Thus the stockraisers must be convinced of the benefits of controlling their herd numbers, increasing offtake, and changing the composition of their herds in the direction of a cow-calf operation. The implementers will need to work in a step-by-step manner on these delicate issues.

The qualitative rather than quantitative aspects of herd improvement must be emphasized. The responses will be shaped by dialogue and by trial and error as the stockraisers see the effect of overgrazing and loss of water for their beasts.

F. MILK-RELATED OBSTACLES

Dietary and ceremonial uses of milk by Diery people are so culturally ingrained as to be a major stumbling block to rapid change. Cow's milk from extended family herds is one of the most important dietary sources of high quality nutrients for children and adults and is considered a social necessity in this society. In separating the beef herd from the village and utilizing this milk as calf-feeding material, extreme care must be taken not to deprive the extended family of its milk supply. Under no circumstances should outside change agents

oblige husbandmen to do without milk for household consumption as this will turn all the members, including the women who milk the cows, against the project.

The design team proposes to create herds of milk cows near the villages. The implementers should initially take care to allow each extended family group to obtain milk from its own cows, rather than mix the milk or take it from any cow. Over time with extension education and improved milk processing for sanitation and preservation of milk products, it may be possible to develop community or regional improved dairy herds.

G. MARKETING PROBLEMS FOR LIVESTOCK

It is clear that the current system of cattle buying in the Diery is a disincentive to sales. Based on discussion with the team economist and extension livestock specialist, it is recommended that regular auctions be organized so that forces of supply and demand and fuller knowledge of prices can be made available to the stockraisers. Radio programs and educational meetings explaining seasonal variations in price and the value of raising young animals for market could be built into the project.

Credit facilities and safe banking organizations more easily accessible to the region would be a great boon to sales promotion and improvement of herd composition.

However, attempts to cull herds of older animals and sterile cows will probably be a slow behavior-shaping process until the stock-raisers gain confidence in the perceived benefits. Attention should be paid to the extended family herd composition in light of the size and needs of each family group and their attitudes toward change.

III. SOCIAL CONSIDERATIONS

A. TENSION MANAGEMENT TECHNIQUES

One problem raised by innovation in a traditional society is the increase in anxiety and tension concerning the well-being of the livestock on the part of participating owners. In the Diery, Islamic prayer sessions, magical protective devices, are employed at the outset of any new and important cattle movement. This is part and parcel of current livestock "management" practices in the Diery. It is recommended that religious functionaries such as "Imams", "Marabouts" and fetish priests and other Koranic notables be contacted by the implementers and given incentives to support the project aims. They may be given the honor (and gifts) for blessing the inauguration of new grazing units. Public prayers will be of great use in inducing social change as it shows respect for the established order and traditional wisdom of the elders in association with innovation.

The implementers should develop culturally acceptable explanations for their technical actions, which can be translated into the Pular

language and communicated to the people as well as their ecclesiastical and secular leaders. In case of setbacks such as loss or disease in the herds, rationalizations and appeals to the supernatural may also be of use in consoling the husbandmen and retaining their faith in the project. Thus coordination between new extension techniques and traditional ways of reducing tension, rather than denigration of "outmoded" traditions, would help the stockraisers deal with uncertainties about innovative practices.

B. KEY SOCIAL CHANGE AGENTS FROM INDIGENOUS COMMUNITIES

The hierarchial power roles based on class and caste nobility and patrilineal gerontocracy should be respected by the implementation team as this authority structure lends legitimacy to the Diery society and can be used as well to induce legitimate-appearing changes in husbandry and range practices.

Other linkages for external change agents into the communities include the returned army veterans who served in the French military and are now middle-aged or older extended family headmen. These men speak some French and have a more open view of modern technology and cash economy due to their experiences abroad. They have expressed willingness to take risks with livestock innovations and often they have income security from military pensions to reduce fear of losses. They come from various castes in the society and thus cut

across stratification lines. Perhaps even more open to new ideas are the younger returned migrant laborers from France or elsewhere who have accumulated some cash and developed a taste for consumer goods not shared by the older generation. These men, most of whom are married but not yet compound headmen, could become grazing unit workers through training, and influence their headmen to change livestock management practices.

C. LITERACY AND INFLUENTIAL PERSONS

In Toucouleur society literacy in Arabic carries great prestige, while French literacy is used more for pragmatic purposes. The implementers should develop good relations both with the Arabic literati who perform many ritual and social services for the people, and the French-speaking members of communities who help others in reading and writing letters to migrant kinsmen, and in dealing with administrative papers and documents sent by government officials. Such individuals could be hired as census agents and herd clerks in order to obtain their approval of the project as well as organize the regular gathering of information on herd conditions and local problems.

D. THE ROLE OF WOMEN

Among the women in Diery communities, who lack authority in family and community matters, there are certain key individuals who are admired by other women for their wisdom and influence with the

menfolk. These are often the wives or mothers of powerful males, and sometimes they marry into communities from more sophisticated areas of Senegal. Once identified, such women can be tapped by home economics and extension agents to initiate women's organizations for the care and nutrition of children, and improvement of sanitary facilities especially with regards to water supply and milk processing.

As males control the extended family finances, women are permitted to engage in small-scale enterprises to earn money or barter for consumer goods which meet their personal needs. If women's groups could learn small-scale income producing activities, this would help in the redefinition of their roles in this society as livestock management techniques become more sophisticated. It would also encourage their participation in the wider market economy and make them more willing to agree to the commercialization of extended family cattle, some of which they may own. One suggestion is that women be taught to raise poultry efficiently, or to handle the milking operations of the village dairy herd.

E. THE CONVERSION OF THE YOUTH AGE GROUPS INTO RANGE-LIVESTOCK ORGANIZATIONS

The age group institutions for adolescent boys and girls at the inter-village level form a traditional corps which could be incorporated into the practical education and training plans for youth participation in the development of the herds. Consultation with the team

livestock expert on this matter has led to the recommendation that 4-H type youth organization can be adapted to and grafted onto the existing age group system to provide this segment of the population with knowledge and incentives concerning modern management.

It is common practice for boys to engage in competitive displays of prowess in handling cattle in bush-camps during the rainy season, and at the time of vaccination compaigns when a kind of steer-wrestling contest takes place. These practices can be exploited by the implementers to teach safety and improved methods of handling the beasts to prevent injury to animals and people. The youth can be taught improved nutritional and breeding techniques using the beasts they traditionally receive as gifts from their parents. Prizes for weight gain and conformation through the institution of regional fairs and exhibitions in a festive atmosphere can encourage learning and individual achievement.

In this way skills and interests in livestock can be fostered regardless of family standing or caste origin on the basis of individual merit, and early marketing of calves can be induced. One of the great advantages for the project is that the youth age groups cut across caste and class lines and permit young people throughout the Diery region of the perimeter to meet and exchange ideas together. Similarly, the age group institutions for girls could be transformed into extension clubs for learning new roles in the changing society.

F. VILLAGE CONSOLIDATION AND COOPERATION

As many of the Diery villages are quite small in size and numbers, regroupment of hamlets into larger units is likely to occur in part as a result of the project. Meanwhile the Senegalese government administrative reform will be extended to the department of Bakel by 1980, creating sub-prefects in place of district chiefs and rearranging the administrative boundary lines. Smaller villages will be united under a single village chief and community council. If possible, these two forces for change over the next five years should be carefully coordinated rather than work at cross-purposes in the project perimeter. Administrative reforms should take into account the firebreaks and roads constructed by the project and the grazing units and zones already organized.

G. COMMUNITY COHESIVE AND DIVISIVE TENDENCIES

There are certain sociological tendencies among the livestock people of the Diery which respond to environmental change. When times are hard, as in the recent drought period, larger villages with more permanent water supply and land for cultivation may grow at the expense of smaller communities where water is scarce. This has been noted in the case of the small villages which depend on Oursoule in the southern segment of the perimeter east of the Continental Terminal. A similar effect occurred among the Sira group of villages which lost

their surface water sources and were obliged to transhume toward the river and gather near large villages like Gabou. However, when water resources and forage become abundant, the smaller communities flourish again. Therefore, project implementers should be aware of this tendency for village size to fluctuate.

Within each village the compounds composed of extended families become more conservative and interdependent during bad times, such as drought or hunger periods, as a kind of social insurance against individual disaster. However, as livestock improve and incomes rise there is a tendency for extended family solidarity to decrease and nuclear households and individuals to take new initiatives and accept innovations. Project implementers should be aware of these alternate centripetal (withdrawal during bad times) and centrifugal (expansion during good times) forces, and use the basic technical improvements in the peoples' standards of living derived from the project to encourage behavioral change within the extended family as the project shows signs of success.

G. DEVIANTS AND INNOVATORS

Sociologically speaking, deviants are looked down upon in rural communities when they experiment with innovations that go wrong and they are sanctioned by group negative feedback devices such as ostracism, malicious gossip, and loss of prestige and influence over others. However, when an innovative member of the group who risks livestock

and gains from the project in a clear-cut manner is seen to have been successful, the imitative response of others in the community can lead to broad-scale acceptance of new husbandry and range management techniques and increased prestige and respect for the innovator. Thus positive and negative feedback mechanisms will be critical elements in stockraiser readiness to participate in the project.

IV. IMPROVEMENTS

A. IMPROVING COMMUNICATIONS AND TRANSPORT

With the development of graded roads and firebreaks linking Diery communities to one another, the rate of interaction and visiting among the populations will be increased. The implementers should employ this benefit to the advantage of the project goals by encouraging stockraisers to gather for meetings on a regular basis, to visit model areas, and participate in market and educational activities concerning their cattle. Providing public transportation to and from the project perimeter would aid in gaining the approval of its people who currently feel very isolated from the market and administrative towns of the Bakel department.

B. RECOMMENDATIONS FOR IMPROVEMENTS IN HUMAN LIVING STANDARDS

Based on observations of the total lack of health facilities in the Diery, it is recommended that medical facilities, especially in the

form of first-aid stations and sanitary water supplies, be provided each community. In addition, health education and maternal and child nutrition services should be extended to the perimeter villages.

The health plan devised by the late Dr. Jacques May for other regions of Senegal could be adapted successfully on a smaller scale to the project area. It would fit well into the extension and animation activities already envisaged. One of the major effects would be to reduce the loss of life and uncertainty that afflicts the Diery population and lowers their capacity for productive work. This would permit stockraisers to meet better the challenges of long-range land and animal development instead of having to restrict themselves to short-range survival needs, which make their cattle a form of family "insurance" against disaster and hence less open to improved management and marketing techniques.

C. DEVELOPMENT OF HUMAN WATER SUPPLIES

Careful choice of location for deep-well digging, where necessary, could be of critical value in promoting village cooperation in the range project. The Diery people visited expressed an intense interest in permanent wells, and many were willing to adjust their herd management techniques in exchange for provision of community water sources. The main problem with wells is that they require maintenance and must be kept separate from animal watering ponds for project purposes. At the current time, wells are used by both people and

animals and it will be necessary to educate the population as to the benefits of obtaining a pure water supply.

V. SECOND ORDER OBSTACLES

A. THE PROBLEM OF HUMAN POPULATION GROWTH

The demographic problems posed for the project are not only those of potential in-migration, but the year-to-year natural increase of the existing population base. Diery people value human fertility highly, and women are expected to bear as many children as possible. Greater advantage is taken of female reproductive capacity by marrying girls off at an earlier age than anywhere else in Senegal, and by rapid remarriage of divorced and widowed women between the ages of puberty and menopause. Given the relatively high birth rate and heavy infant mortality rate, the population of the perimeter has been estimated to have a doubling time of 28 years. This could be an obstacle to improvement in standard of living by cutting into the per capita benefits expected from the livestock project.

If health and sanitation measures are provided in association with the range perimeter, the initial demographic effect will be to lower infant and child mortality significantly. While favoring this kind of benefit, it must be noted that it will have an additive effect on the rate of natural increase, raising the current approximately 2.5 percent rate to near 3 percent per annum.

The consequences between now and the end of the century will be acceleration of population growth and an increasing proportion of children in the already youthful age-sex pyramid. In other words, a veritable human population explosion could occur which would double the population from 2,500 in 1975 to more than 5,000 by the year 2000. To deal with this problem, various recommendations are proposed as follows:

1. A clear alternative to excessive population growth when the death rate decreases is the simultaneous limitation of births through contraceptive technology and birth-spacing education. However, Senegalese government population policy is opposed to modern forms of birth control, so these techniques may not be available.

2. A major reason for a surge in the birth rate is the large cohort of women just entering reproductive age or nearing the peak fertility age bracket between 20 and 30. Family life education on the value of birth spacing would be of use in encouraging younger wives to use traditional means of spacing their children. For example, the encouragement of lengthy periods of breast-feeding and gradual weaning of babies has the natural effect of reducing fertility. In addition, Peuhls customarily avoid sexual relations for up to two years after the birth of a baby while the mother is nursing her child, thus spacing childbirth to the benefit of both mother and infant.

3. Polygamy is commonly practiced in the Diery in about one-third of the marriages, and men value the taking of additional wives up

to a maximum of four if they can afford it. Rather than trying to introduce monogamy as a more modern form of marriage, the project implementers should be aware of the possibility that as incomes rise, the rate of polygamy may increase. Since monogamous marriage is associated with high rates of fertility and polygamous marriage with lower fertility among the wives, this could serve as a means of lowering the birth rate in a traditional manner.

4. The extremely early marriage age for girls in the Diery contributes to complications in delivery of immature teenage mothers. Through family life education and counseling or training for productive occupations, girls may be able to put off marriage for up to five years, thus reducing the population growth and improving maternal and child health. However, cultural attitudes toward delayed marriage are difficult to predict. In other parts of Senegal the tendency is toward a later marriage age, and as the Diery becomes less isolated its youth may begin to participate in the changing marital values of the wider society.

5. In general, as people perceive that improved health standards allow more of their children to survive, the impulse to have as many as possible may lessen.

B. TECHNICIAN TRAINING, LANGUAGE AND COORDINATION PROBLEMS

The team is recommending that the training of Senegalese range and livestock agents in the United States precede the project implementation, and that the recruitment of American personnel also be done well in advance so that language training and experience may be gained before attempting the innovations. In the selection of Senegalese project personnel their abilities and knowledge will be of great importance. However, an additional sociological element should also be considered.

The Senegalese agents in the field should be of similar ethnic background to the Peuhl-Toucouleur residents of the Diery, and speak the Pular dialect fluently. This will make them more acceptable agents of change and will allow them to understand better the concerns of the population. If possible, these technicians should be of rural origin and have raised livestock in their own families so that they understand the conditions intimately.

Although national law codes no longer accept the stratification of the population by caste and class, these social prejudices remain strong among the stockraisers. The choice of agents from artisanal or "griot" caste origin, which is considered mystically polluting by the majority of freemen and nobles in the region, could lead to avoidance and mistrust on the part of the husbandmen. Therefore this delicate

problem should be thoroughly discussed before choosing extension agents, Promotion Humaine animators, and other project-related workers.

C. SENEGALESE-AMERICAN COORDINATION PROBLEMS

As shown in the team study it is of critical importance that the American implementers have a command of the French language in order to deal with Senegalese government agencies and work in this country where French is the official language. In addition, the American experts in the field should receive language training in Pular so that they may communicate with the husbandmen, most of whom do not speak French.

A person-to-person working relationship between Senegalese and American counterparts should take place in the field situation, at the district level, and with the heads of the various Senegalese service agencies involved in the region. More formal relations with the governor's office at Tambacounda and Dakar-based ministry directors are also essential confidence and organizational building blocks to contribute to project success.

In general, Senegalese officials prefer to work on an individual-to-individual basis with external experts, and to use group meetings as a show of previously agreed-upon strategy, rather that debate differences of opinion in a public forum. Therefore, the Americans should be prepared to adapt some of their expertise with techniques to the

needs of the situation to avoid the appearance of conflict. With these positive attitudes and a willingness to live within the perimeter under difficult conditions, the American contribution will be maximized.

APPENDIX A

FIELD OBSERVATIONS IN THE BAKEL RANGE LIVESTOCK DEVELOPMENT PROJECT AREA BY THE PROMOTION HUMAINE TEAM

Table A-1. Toulekedi zone.

Village	Human Population[a]	Cattle Population[b]	Condition of Wells	Conditions in Village
Toulekede	33 families 8 carres Toucouleur, Sebe, Peuhl	600 cattle + sheep + goats + donkeys	At least one functioning for people and livestock.	Emigrants in France--number not known. Relations with other villages--Boudel, Ndia, Ndiakone, Garalla, Diare Mbolo, Diare Mabobe, and with villages in Matam Department
Baniou	80 people	+ cattle + sheep + goats + donkeys	2 wells, 1 good. Dudi pond 6 km away.	Emigrants in France--number not known. Cooperatives--is the seat of millet and cattle cooperatives. Problem--water and animal health.
Diare Mabobe	75 people 8 carres	300 cattle 100 goats 1 pair oxen 1 donkey + sheep	1 well, badly built, insufficient. Pond at Fete-Koli, 6 km away. Hope to find money to dig another well.	Emigrants in France--are emigrants and ex-emigrants; help whole village for food and clothing. Cooperatives--Baniou, millet and cattle. Relations with other villages--in January and for rest of dry season go to Diare Mbolo and Garalla. Use vaccination center at Diare Mbolo (2 km away); have kin ties there and with Garalla (4 km away). Village Chief--Amadou Mamadou Dionque (not present, but son there). Villagers all close kin. Caste--probably weavers (Mabobe = weaver's caste).
Garala	30 people 3 carres	250 cattle 100 goats 20 sheep 3 donkeys	2 wells, very little water. Go to ponds; also to Ndia and Ndiakone for water.	Emigrants in France--number not known. Cooperatives--Baniou millet and cattle. Village chief--Cire Amdiatou Mangane.
Diare Mbolo	127 "taxables" 11-13 carres many children	2000 cattle 1000 sheep and goats 26 pair oxen 10 donkeys 6 horses	1 well 45 m deep; problem is raising water--must work in shifts; need pump. Nearby ponds last until Jan. People from Diare Mabobe use well in shifts.	Emigrants in France--10: help own families only. Cooperatives--Baniou millet and cattle. Relations with other villages--Medina Guiraye, Garalla, Diare Mabobe. Village chief--Amath Cire Baba Ly Problem--want another well. Key personality--Marabout ('Tierna') Village Koranic school here. Villagers negative toward incumbent Deputy--he promised help, none given.
Ndiakone	102 people	700 cattle	1 well 500 m from village; 25 m deep; very slow recharge. Pond nearby, dry 5 months after beginning of wet season. Use water on rotation/shift basis.	Emigrants in France--none; 1 man stated bitterness at no longer being allowed to emigrate to France. Cooperatives--Baniou millet for 13 years; cattle, 2 members. Village chief claims is Vice-President of millet cooperative (see Medina Guiraye). Relations with villages--Ndia, Diare Mbolo, Diare Mabobe, Garalla, Siwiabe, Baniou, Sohol, Boulel, Toulekede, Sinthiou Bilali. Village chief--Mohadji Niang. Problem--animal health (botulism): need farm implements. Have not received end-of-dry-season rations.
Ndia	118 people 13 carres	600 cattle 200 sheep and goats 4 pair oxen 2 donkeys	1 well dug in 1937, repaired twice since; gives little or no water. Ponds near village during wet season.	Emigrants in France--5; aid only own families. Cooperatives--Baniou millet; no information on cattle coop. Relations with other villages--(marriage, kinship, etc.)--Boulel, Diare Mbolo, Ndiakone, Garalla, Baniou, Diare Mabobe, Medina Guiraye, Velingara, Samba Seydou, Boulbi (in Matam). Village chief--Amadou Sy. Problem--wild animals; cattle suffer from botulism.
Medina Geri	57 people 7 carres	200 cattle 70 goats 2 pair oxen + sheep + donkeys	1 well without water; sides caved in. Women go to pond nearby which goes dry 4 months after dry season.	Emigrants in France--none at present; village chief went to France but put in jail 3 days, lost 50,000 frs. and returned home. Cooperatives--Baniou cattle. Relations with other villages--said to be vaccination center for Garalla and other villages. Animals go to Ndiakone and Diare Mabobe when pond goes dry. Also have relations with Seno Issaga and Arigabo. Village chief--Guiraye Diallo (also Vice-President of millet cooperative of Baniou).

[a]Carre is an extended family unit comprised of several families living under an immediate form of mini-government and usually living in close proximity to each other

[b]The sign "+" denotes animals present but not counted.

Table A-2. Sarre zone.

Village	Human Population[a]	Animal Population[b]	Condition of Wells	Conditions in Village
Canbi Diaoube	+ people 7 carres	3 pair oxen + cattle + sheep + goats + donkeys	1 well but no water.	Emigrants in France--4; 1 ex-emigrant now in village worked in Renault. Cooperatives--Sinthiou Fissa millet and cattle. Relations with other villages--Oursoule. Claim they sell cattle when need money.
Seno Andale	42 people 5 carres	+ cattle + sheep + goats + donkeys	No well; water from ponds.	Emigrants in France--number not known. Village chief--Ama Samba Ba, of Oursoule, resides here during wet season; 35-40 years old; ex-emigrant. Problem--water and grasshoppers/locusts.
Oursoule (not visited; chief interviewed at Seno Andale)	368 people 48 carres	5000 cattle (estimate of chief) for Oursoule and zone satellites.	3 wells; 1 good one. No ponds.	Emigrants in France--number not known. Cooperatives--Sinthiou Fissa millet; would be interested in cattle cooperative if in Oursoule. Relations with other villages--many villages in orbit of Oursoule.
Birfal	100 people 8 carres	300 cattle 400 sheep and goats 60 donkeys 11 pair oxen	No wells; give money for well construction at Oursoule. Only water points east of village.	Emigrants in France--5. Cooperatives--Sinthiou Fissa millet; cattle cooperative not operative but chefs de carres are members. Relations with other villages--Oursoule (go there Feb. to June, after end of wet season). Hope for water development and veterinary "pharmacy".
Wali Diala	220 people (?) 11 carres	600 cattle 200 sheep and goats 11 pair oxen 10 donkeys	No water; go to Oursoule for animals' water. Well dug here, 25 m deep; still no water.	Emigrants in France--number not known; sent money for well at Oursoule and for food. Cooperatives--Sinthiou Fissa cattle. Relations with other villages--go to Oursoule Jan. to April. Crops--millet, sorghum, peanuts (market when raise enough), maize, cotton (not marketed but weavers in village). Interested in future Agro-Pastoral Center at B~le.
Fete Colonbi	700 people (?)	300 cattle 70 goats (?) + sheep + donkeys	No functioning well; one dug but not completed.	Emigrants in France--7. Cooperatives--do not belong but say get seed from Secco at Sinthiou Fissa. Say would join if cooperative is based in Oursoule. Relations with other villages--Oursoule, Gourel, Mama N'diaye (Thioke), Gabou, Sinthiou Fissa (marriage, mutual aid). Go to Oursoule for water and vaccination of cattle. Also send cattle to Gabou, Kadiel, Sarre.
Gourel Mama Ndiaya	+ people 6 carres	5 pair oxen + cattle + sheep + goats + donkeys	No functioning well; one built, went dry 2 years later. Say are 2 wells near village not yet operative.	Emigrants in France--none; 1 ex-emigrant. Cooperatives--do not belong but say if gain by joining, then would do so if based in Oursoule. Relations with other villages--Fete-Golombi, Wali-Diala, Seno (W)andale, Oursoule (kin, etc.).

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[b]The sign "+" denotes animals present but not counted.

Table A-3. Out of project perimeter.

Village	Human Population[a]	Animal Population[b]	Condition of Wells	Conditions in Villages
Sinthiou-Mamadou-Boubou	+ people	+ cattle + sheep + goats + donkeys	1 well but water raising is problem.	Emigrants in France--number not known. Cooperatives--Butchers Cooperative (12 members); member cattle cooperative at Goudiry. Village chief--Sega Alpha N'Gueth; he is President of Butchers Cooperative.
Siwiabe	+ people 8 carres 12 chefs de "menage"	+ cattle + sheep + goats + donkeys	No well, no permanent water; dig wells but cave in.	Emigrants in France--number not known. Cooperatives--members Baniou cattle and millet (19 members). Relations with other villages--people go to Sohol and Gourel Oumar for water for animals. Villagers have social relations (marriage, etc.) with Baniou, Ndiakone, Sohol, Goniedji, Gourel Oumar, Fuina, Sinthiou-Mamadou-Boubou.
Sohol	97 people 8 carres	700 cattle 120 goats 60 sheep + donkeys	1 well with no water. Must dig sumps. Pond goes dry 3 months after rainy season.	Emigrants in France--number not known. Cooperatives--Baniou millet (8 members) and cattle. Relations with other villages--likely go to Siwiabe for water in dry season (Siwabe people claim go to Sohol). Sohol people do not go to Seno Issaga or to Faleme R. Village chief--Fara Diallo. Problem--animal illness.
Yavorodji	63 people 6 carres	87 cattle 20 sheep and goats + donkeys	2 wells dug by themselves; 22 m deep. Had enough water but sides caved in; need cement.	Emigrants in France--number not known. Cooperatives--Baniou cattle; Mayel (W)ambabe millet. Relations with other villages--Baldi Kodjole, N'gari-Ali, Doubel Bai'di Cisse, Baniou, Sohol, Binguel, Siwiabe, Boki-Guile.
Baldi-Kodjole	15 "imposables" 4 carres	+ cattle + sheep + goats + donkeys	1 well, some water but smells bad; say people get diarrhea from it.	Emigrants in France--number not known. Cooperatives--Baniou cattle (dues not paid), millet. Relations with other villages--people left 10 years ago because of water problem to go to Gourel Dialobe and Boulel Kaye (in Matam). People go to Yavorodji for water. Village chief--Hamady Sira Camara (called Daya). Say soil is good.
Binguel	38 people 5 carres	100 cattle 100 sheep and goats + donkeys	1 well near pond, spend 50,000 frs. annually to repair but still problem.	Emigrants in France--number not known. Cooperatives--Baniou millet, catile (e members). Relations with other villages--Go for water to Siloro (Matam), Boki Sabodou, Baldi Kodjole. Village chief--Bocar Demba Diallo.

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[b]The sign "+" denotes animals present but not counted.