ISLAMIC REPUBLIC OF MAURITANIA

Honor — Fraternity — Justice

Ministry of Economy and Finance

Directorate of Studies and Programming

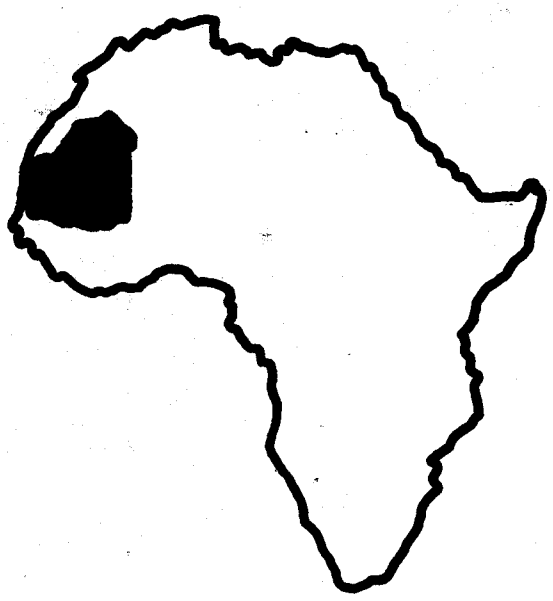
RAMS PROJECT

Rural Assessment and Manpower Surveys

Livestock Subsector Study Supplement

Range Management and Development

SS 3a



Financed by the U.S. Agency for International Development (USAID)

With the cooperation of:

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I. Introduction

Range livestock production plays an important role in the agriculturally oriented society of Mauritania. The livestock are managed under century old sedentary and nomadic (transhumant) systems. Efforts to increase livestock production must build on these traditional systems which capitalize on the use of different climatic and ecological zones with flexibility built into the system to maximize utilization of seasonal supply, while minimizing the impacts of droughts and other uncertainties.

These production systems have and will continue to serve the livestock breeders well until livestock numbers increase to a level that weakens one or more segments, and then the whole system is threatened.

Logical development strategy facilitates the identication of weak segments in this production system and attempts to strenghten these weak segments with properly designed interventions.

Many reports describing livestock production in Mauritania have been prepared. Some focus attention on the range management aspects of livestock production. The major range management problems identified include: deterioration of the forage resource as a result of increasing livestock numbers, excessive livestock concentration around limited permanent water sources, limiting grazing areas by expanding cultivation, uncontrolled burning and drought.

II The Present and Potential Grazing Resource

An estimated 55 million hectares of the 103 million hectares total land area of Mauritania are suitable for livestock grazing. Grazing capacity estimates range from a low of 70 ha/UBT in the north to a high of 4 ha/UBT in the more climatically favored regions in the south. The average carrying capacity for these grazing lands is estimated at 14 - 16 ha/UBT. The long-term grazing capacity for the 55 million hectares would then be 3.4 - 3.6 million UBT's.(1) Most of the range sites now being used are in poor condition

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(1) CILSS Provisionary report - Jan. 1980.

and producing only a fraction of their potential.

Livestock numbers are estimated by the RAMS to be 1,060,000 cattle, 2,634,000 sheep, 2,513,000 goats, and 656,000 camels. These numbers total 2,223,000 UBTs when applying the established conversion factors.(2)

Although estimates vary, probably about 60% of the cattle, 25% of the sheep and goats, and 8 - 10% the camels graze at least part of the year in Mali and Senegal. However, no estimates have been made of the number of animals belonging to Malian and Senegalese herders and breeders that graze in Mauritania for part of the year. Probably an equal amount of forage is consumed. The forage consumed by the Malian and Senegalese livestock in Mauritania is of higher quality, as grazing occurs during the green season, whereas the Mauritanian livestock graze in Senegal and Mali during the dry season when forage plants are dominant and less susceptible to damage from over-grazing.

By comparing the 2.2 million UBT level of current grazing use and the 3.6 million UBT forage production level it can be speculated that 1.4 million UBTs of forage are not being grazed because of livestock water deficiencies and annual burning practices. When added to this, another 0.9 million UBTs (a reasonable estimate of 20% increase in grazing capacity by applying proven range management and development practices) an estimated potential grazing capacity of 2.3 million UBTs more than the 2.2 million UBTs now being grazed is suggested.

Increases in forage production resulting from improved range management and development practices, being ecological in nature, take several years to materialize. At least a 20 - year time-frame would be required after management and development practices are instituted before maximum production could be expected.

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(2) 1 Adult Camel = 1.00 UBT
1 Adult Cow = 0.75 UBT
1 Adult sheep or goat = 0.15 UBT

III Description of the Rangelands

Previous livestock development studies of Mauritania have reported that the country is divided into three broad belts or zones: The Senegal River Basin in the southwest, the Desert zone to the north, and the Sahel Belt in between.(3) The Senegal River Basin has the greatest potential for cultivated crop production. The Desert Zone north of the 19th parallel receiving less than 100 mm of rainfall, or infrequent rainfall, has limited value for range livestock production. The Sahel **Belt**, the vast area in between the 16th - 18th parallel, extending east and west across the country, is the most important zone for livestock production and will be the focus of this paper.

A. Climatic

The Sahel Belt has three distinct seasons, each of approxiamtely 4 months duration. The period of rain begins about the first of July and continues intermittently through September. This is followed by the cool season which usually lasts until February, succeeded by the hot dry season until July when the rain storms come again, and the cycle is completed.

It is customary to refer to the Sahel as a rain-deficient area. This statement is an over-simplification. With a range of precipitation between 100 - 600 mm, the zone receives as much precipitation as desert cattle raising areas in the United States and other countries where successful livestock operations have been developed. The problem is poor distribution of the rainfall, with almost all of it occurring during the four-month rainy season. In addition, the intensity of precipitation is very high and the torrential storms cause erosion, some crop damage, and accumulation of surface run-off between the dunes and in the numerous shallow depressions, or "mares". This accumulation is significant because it points to the possibility of capturing and storing a portion of the run-off in propoerly constructed ponds in spite of the sandy soil and high evaporation.

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(3) Project Report Mau/7/NETH
Livestock and Rangeland Improvement, Rex, L. Henry, December 15, 1978.

Temperatures vary from a high 48°C in May and June to a low 30°C in December. The annual evaporation will probably exceed 3 meters. The months of highest evaporation are March - May, which corresponds with the period of lowest relative humidity.

The prevailing wind is the Harmattan, which blows from northeast to southwest from October to July. This hot, arid wind comes from the desert and increases both the rate of evaporation and plant transpiration. During the rainy season the wind direction is reversed, and the so-called monsoon wind is humid and relatively cool. Both the Harmattan and the monsoon are characterized by brief gusts of very high velocity.

B Soils and Vegetation

The soils in the Sahel Zone are low in organic matter, varying in texture from heavy sand to silty clays. The dune soils are brownish in color with heavy sands at the base of the dune to fine silty sand, or clayish, in the depressions between the dunes. Geologically, they are considered young immature soils without definite horizons. A few outcrops of dolorite pierce the sandy overburden. In some areas the sand has blown away, exposing a clay or laterite sub-soil, especially where the vegetation has been destroyed by fire and over-grazing.

The vegetation of the Sahel Zone can be divided into major groups based on the ligneous species that dominate the vegetational aspect. In the southern part of the zone the small thorny leafed shrubs such as Acacia, Balanites and Combretum dominate.

The grass cover consists mainly of Cenchrus biflorus with species of Ctenium, Dactyloctenium, Eragrostis, Schoenefeldia, Sporobolus, Aristida, and Diheteropogon making up a lesser portion of the composition.

Remnant perennial grass plant, mainly Andropogon gayanus, can be found on isolated sites protected somewhat from the full impact of grazing and annual burning, predominatly in the southern part of the zone.

Some of these grass species have important uses other than providing livestock forage. The long culms Andropogon are used to make mats for shade and sleeping. It is also used to make the thatched roofs for huts. The grains of Cenchrus are sometimes crushed and used for porridge.

Trees and shrubs supplement grasses for livestock feed during the dry season. In some situations the branches are cut and carried to the livestock, or the branches cut or bent down so they are acessible to the livestock.

Trees and shrubs in the Sahel Zone include Guieara Senegalensis, Terminalia avicennicides and Tribulus terricatris.

C Livestock Water

Livestock production in the Sahel Zone depends entirely on direct rainfall. For human consumption and cattle watering there are three types of water sources: traditional hand-dug shallow wells, machine-dug deep wells, and natural ground depressions, or "mares", which collect surface run-off and store it for periods up to 4 to 5 months after the end of the rainy season.

Vast areas within the Zone support little or no grazing after the rains because of the absence of permanent water sources.

IV Major Constraints to Increasing Livestock Production

Livestock production in the Sahel Zone, as well as elsewhere in Mauritania, is fully dependent on the native forage resource. While the supply seems unlimited during the rainy season (July to September), there are many obstacles to overcome in developing an efficient livestock production system that provides ample forage and water on a daily basis year-long.

Palatability and nutritive content of the native range forage decreases during the dry season. Shortages develop during low rainfall years, and each year fire destroys a high percentage of the forage that would otherwise be available for livestock. Limited livestock water sources during the dry season further curtails access to otherwise available forage, thus contributing to range degradation near the permanent water sources where livestock are forced

to congregate. Nutritional deficiencies weaken the livestock, resulting in weight loss, lower offspring percentages, higher death loss, and higher susceptibility to disease.

Although the constraints to improvement and expansion of livestock production has many ramifications, these constraints can be simplified into a few words: availability of adequate water and forage on a continuing basis.

A. Fire

Generally, to livestock breeders, fire represents a loss of forage that could have been grazed. Range fires destroy large amounts of forage each year. For example, Le Houeron reports in the African Savanna 80,000,000 tons, forage enough for 25 million cattle for 9 months, is destroyed by fire each year.(4)

In the Sahel Zone in Mauritania forage losses to fire are substantial each year. Most of the fires occur in the areas that are ungrazed or lightly grazed because of livestock water deficiencies. These areas support the heavy vegetative cover necessary to carry a range fire. Consequently, fire problems are concentrated in the Sahel Zone south of the 200 mm isohyet.

Fires occur mostly in the early dry season. Some are set accidently or deliberately by transhumants; others are set by farmers to kill the larvae of crickets which invade their fields; some are set to control ticks that attach themselves to livestock as they graze the heavily vegetated areas; some are set to get rid of the dry grass so the new green shoots that usually develop following burning of perennial grass species are more accessible to livestock; and some are started naturally by lightning. Regardless of cause, continuous burning results in destruction of the most desirable vegetation and increases growth of the less desirable plants, and sometimes leaves an area denuded of vegetation and subject to erosion by both wind and water.

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(4) Le Houerou. Report to XIII International Grasslands Congress, 1976.

Once vegetation is burned, adequate forage may not be available to maintain the livestock, which are required to trail longer distances for forage. This may be a factor in determining whether or not livestock are sent on transhumance.

A fire on grass land reduces the litter and mulch that protects the soil from wind erosion during the dry season. A bare or black surface after a fire readily absorbs heat from the sun's rays, and the soil temperature is usually much higher than on adjacent unburned areas. The fluctuation in soil temperature during the day is also much greater on burned areas. Burning usually reduces the soil moisture by causing higher soil temperature in the surface layers resulting in higher evaporation from the soil surface. Without vegetative cover, the burned areas are more easily eroded by water when the rains begin, and the amount of rain that actually infiltrates into the soil is usually less on areas that are burned. Fire damage to the individual plant varies depending upon the temperature reached during the burn and the length of time higher temperatures are maintained.

Fire, however, is not always harmful. Situations may develop when fire can be a useful tool in managing rangelands. When shrubby vegetation increases in the vegetation complex beyond desired levels, planned burning at appropriate intervals and at the proper time can be effective in controlling the invasion of shrubs. Once areas are burned, proper livestock management and control on the area are necessary to obtain desired results.

B. Livestock Water Deficiencies

Proper livestock distribution in the Sahel Zone is impossible with limited water sources. Ranges are heavily grazed for 10 km from existing permanent water sources. Areas which are 20 km beyond a permanent water source are sometimes lightly or totally ungrazed, with the effect that the density and population of desirable forage plant increases as the distance from the water source increases, especially if these areas escape the annual burning.

Poor water quality is a related constraint. The questionable condition of many of the handdug wells and the village "mares" is of concern. Water which is not free from debris, decay, even the decomposition of dead animals may be objectionable to livestock, and in some cases toxic as well. Stagnant water usually decreases the amount of water the animals will drink.

Another water-related constraint that may occur as additional permanent water points are developed is that of village expansion on new village establishment around new permanent water points. This will result in a reduction in the potential grazing area as cultivation occurs to support the new or expanded village populations. It will also interfere to a degree with free access to the water points for the grazing herds.

C. Poor Range Condition - Imbalance Between Wet Season and Dry Season Forage Supply

During the dry season extensive areas around the limited water sources are completely denuded of vegetation that can be grazed by livestock. Animals are forced to trail as far as 20 km. or more to find enough forage to maintain themselves. In order to reach forage animals sometimes water only every other or every third day. These heavily grazed areas are in poor condition, producing only a minor portion of their forage potential, and are subjected to further degradation by wind erosion. Animals suffer from malnutrition and lose considerable weight during the long dry season. Most of the wet season grazing is required for the animals to regain the weight lost during the dry season. Poor animal condition adversely affects calving and lambing percentages, mortality rates, resistance to disease, and the maturing age of the livestock.

The imbalance between wet season and dry season forage supply is compounded further when fire burns the ungrazed or lightly graze area.

Range management problems, such as poor range condition, develop because ranges are grazed with too many livestock, poor distribution of livestock on the range, and livestock are allowed to graze for too long a period, even after the forage is used beyond its productive potential.

Ranges deteriorate because plants are killed by continuous, uncontrolled grazing and fire. Perennial plants that are weakened by heavy grazing and fire are more susceptible to further damage when droughts occur. The ground space vacated when desirable plant species are killed is taken over by less desirable plants, or in some cases the area remains bare and subject to erosion.

High-level livestock production depends on the maintenance of desirable forage plants. Plants, like animals, require food for growth and sustenance. Plants manufacture their own food through the process of photosynthesis. In perennial plants some of the food materials made by the plant each year are stored for future use. In perennial grasses most of the reverse food material is stored in the roots of plants. In annual plants the food reserve for future years is concentrated in the seed. In woody plants food storage occurs in the stems, branches and twigs as well as the roots of the plant. This stored food is necessary for the plant to start growth after the dry season. Perennial plants usually store enough food supply to last several years. They can, therefore, withstand much better than annuals.

With uncontrolled and continuous grazing year after the leaf surface of the preferred plants where most of the plant food is manufactured is greatly reduced in size and number of leaves, and the plants ability to manufacture food and store reserves is reduced. Eventually the reserve supply is depleted. With continuous uncontrolled grazing the plant becomes progressively weaker and smaller as the food supply is exhausted, and the plants actually die of starvation.

Livestock prefer certain plants more than others. They graze the forage plant selectively by species and consistently graze the plant species they like best time and time again and beyond proper limits for the plant to survive. They then switch to less preferred species, as the ones they like best are killed.

Livestock are naturally lazy and when uncontrolled will graze areas that are easily accessible before moving to more inaccessible areas. Consequently, the areas close to water are denuded of vegetation before livestock

more farther from water. This uneven grazing pattern is the same year after year. Both perennial plants and areas over-grazed one year will be over-grazed the next; hence, desirable forage plants are seldom found close to water points when continuous uncontrolled grazing is present.

This deterioration process occurs much the same way with annual species as well as perennials, with the end product being progressively enlarging areas of poor range condition and range sites being occupied by weeds and other plants that have little value in providing forage. When sites become completely denuded of vegetation, they are usually damaged further by wind and water erosion, thus limiting the sites ability to support livestock at all.

Although little if anything can be done to prevent selective grazing when the range is being grazed, the harmful effects can be counter-acted by rest from grazing at appropriate intervals giving the desirable forage plants an opportunity to grow and reproduce normally throughout the entire grazing area.

Most successful range livestock operations rely on supplemental feed to help maintain the livestock through critical periods of the year when native range forage is not available, in short supply, or is low in nutrition. Improved pastures, hay, silage, and concentrates usually fulfill this need. Even in the Sahel Zone dry grass is cut and carried to the village and fed to sick and weakened animals late in the dry season. At this time of the year areas close to the villages are grazed completely, and the dry grasses have to be carried long distances. The grasses that are cut late in the dry season are lacking in nutrients and provide very little nourishment for the animals.

In order for this practice to be of most value grasses should be cut just before maturity when high in nutrients, made into silage, or stacked for proper curing, and then fed in the dry season when needed most.

Consideration should also be given to production of a livestock fodder crop on abandoned millet and sorghum fields to provide supplemental feed for livestock and add fertility to the cultivated field through crop rotation.

D. Lack of Trained Range Management Personnel

Range management is the science and art of obtaining maximum sustained use of the forage crop without damage to other resources or uses of the land. To successfully apply range management one must have a knowledge of: the biological sciences to understand the response of the animals and vegetation to grazing; the physical sciences because climate, topographic and hydrologic factors determine the kind and amount of grazing that can be made on a range area; and the social sciences because the needs of society determine the use of the land.

The skill with which the range manager blends these factor together to the benefit of all concerned is an art learned by working with people having divergent points of view and interests.

At the present time no Mauritanian has the training and skills in the technical aspect of range land management. The herders and breeders have, however, learned by trial and error certain practices and methods of livestock management necessary to survive in their rugged environment.

Technically trained range extension agents to work directly with the herders and breeders, range technicians to plan, organize, implement, and monitor a range management and development program at the ground level, and range specialists to serve within the government ministry as policy makers, program developers, and budget analysts will be required before progress can be made in developing the potential productivity of the range resources

E. Budget Limitations

Currently, only a small percentage (approximately 0.5%) of the Mauritanian national budget is programmed for the livestock sector, while 20-25% of the Gross Domestic Product is derived from livestock. For the rural sector 75% of the GDP is derived from livestock.

Of the meager budget for the livestock sector none is programmed for range management and development activities, although livestock production depends entirely on the condition and productivity of the country's range lands.

The entire budget allocated to the livestock sector is used for salaries and vaccinations in the annual health program.

Greater emphasis must be given in the budget to the livestock sector with special attention to rangeland conditions.

V. Range Livestock Development Alternatives

Although the constraints to increasing livestock production in the Mauritanian Sahel Zone are substantial, they are no greater than the ones facing livestock breeders in other range livestock producing desert areas of the world where efficient livestock operations have been established.

The range management and development alternatives proposed for increasing livestock production relate directly to the constraints discussed in section IV of this report. They include:

a. Fire control
b. Livestock water development
c. Range Management and Protection
d. Do nothing

These alternatives, when planned and applied properly, can be technically, economically and socially feasible. They will be presented in such a manner that they can be considered separately or in combination. To assist the decision-maker, some of the advantages and disadvantages of each proposal are listed.

The "Do Nothing" alternative can be quickly dismissed as not being appropriate for further consideration unless the decision-makers are willing to accept the consequences of further deterioration of the forage resource and associated livestock problems. Unless something is done, the time may come when the range resource deteriorates to the degree that village populations will have to be relocated to other areas or food supplies for their existence brought in. The cost of such relief actions should certainly be considered when studying the economic feasibility of development alternatives. The costs of doing nothing may far exceed the costs involved in the actions alternatives.

The Range Management and Protection alternative "C" is recommended because it offers the only systematic approach to range livestock production on a sustained basis with full consideration for improved range conditions. This alternative provides the range manager with sufficient latitude to tailor the range management program to specific management and development areas, recognizing that differences in resources, people, and problems occur. It is equally applicable to both the sedentary and transhumant systems.

Implementing the Range Management and Production alternative throughout the entire Sahel Zone would be an over-whelming undertaking, even under the best of conditions. It is, therefore, suggested that the program be planned and implemented over a long period of time as money, supplies and manpower become available; but a "start" now is not too soon.

A relatively small area should be selected for beginning, and a range management and development plan formulated and implemented. As range technicians and administrative personnel are trained and gain experience, and as the program demonstrates its value, it can be expanded to other areas on a priority basis.

Consideration of alternative "A", Fire Control, by itself would provide protection to areas ungrazed or lightly grazed. Although protecting the vegetation from fire would, no doubt, improve the ecological condition, very little supplementary livestock forage would be available unless additional livestock water were developed.

Combining alternative "A", Fire Control, with alternative "B", Water Development would make additional forage available for increased livestock production on a short-term basis. Without the necessary management and livestock control, the area around newly developed water would soon deteriorate to the poor condition currently found existing around existing water sources.

Range management and development activities will require substantial inputs of manpower, money and equipment. Generally, the investmensts are required the first few years of the implementation phase of a project. On the other hand, the outputs or benefits take several years to accrue. Consequently, range management and development efforts must be considered long-range programs. Their success depends on commitments for the full term of the project, Unless this commitment is assured, the project should never be started.

A. Fire Control

A fire control program in the Sahel Belt of Mauritania would help alleviate the existing forage shortage during the dry season. Such a program should consider fire prevention, control and suppression. If a major portion of the man-caused fires could be prevented, and those that are set controlled within reasonable limits by firebreaks and suppression crews, a substantial portion of the 1.4 million UBTs of currently unused forage would be available for livestock production, provided water supplies are made available and necessary management applied.

1. Fire Prevention

A fire prevention campaign could be organized to inform all land users of the harmful effects of uncontrolled burning of the vegetative resource and the impact it is having on livestock production. The campaign should reach all livestock herders and breeders, farmers, hunters and others who have occasion to travel through or work in the zone.

The campaign should be designed to use every means available to inform the population: radio broadcasts, pamphlets, and posters in the village market place; contacts with the school children have also proven affective

in such campaigns and, of course, the government officials and livestock technicians administering the animal health program can serve as a communications link.

A well planned and executed fire prevention campaign in the Sahel Zone should reduce the number of man-caused fires by at least 50% within a three-year period, and as much as 90% within a 10-year time-frame.

If after a concerted effort the campaign is not successful in reducing man-caused fires to an acceptable level, consideration should be given to establishing rules that would penalize violators who persist in starting range fires.

Advantages

1. Preventing or reducing the number of man-caused fires through an effective fire prevention cmapaign assures availability of range forage when needed.
2. Elimination of uncontrolled burning will result in improved forage quality when ranges are protected and managed properly.
3. Fire prevention campaigns can be planned and implemented for a fraction of the costs involved in combatting or attempting to control wildfires once started.
4. Fire prevention campaigns can utilize existing communications networ such as radio stations, government offices, schools, and village organizations.

Disadvantages

1. Effective fire prevention campaigns require dedicated personnel to plan, organize and implement. An intensive training program for those involved would be required to assure success.

2. Fire Prevention and Suppression

The cumulative results of combining a fire suppression program with the fire prevention campaign could be a reduction in the number of hectares burned by at least 50-75%, thus increasing the amount of forage

available for livestock production. The fire suppression activities would include training and equiping village fire control crews to suppress wildfires occurring near their villages.

The most important feature of wildfire suppression is early detection and getting a fire control crew to the site as soon as possible. Wind-driven fires move extremely fast. In order to control wildfires more easily, they should be fought at natrual barriers such as ridge tops, roads, livestock trails, or other places where they might be controlled more easily.

When wind conditions are extremely strong and fire is moving rapidly across the range, little can be gained by trying to control fire under these extreme conditions. It is usually a better strategy to save the strength and energy of the fire fighters until the winds have died down in the late evening or early morning when the air is cooler and more humid. When grasses are tall, a fire blazes high above ground level and burning pieces of grass can float considerable distances through the air. Consequently, the fire crews must be constantly on the alert to spot fires outside the major burn area.

A very effective way to fight grass fires is to pull a light-weight harrow with oxen or some other means and disk all the grasses down to ground level, forming a line around the fire. Fire lines can also be cleared with shovels or rakes.

Sometimes grass fires can be effectively controlled by beating the flames down with densely-leafed tree branches, pieces of hide or leather, burlap sacks, or anything that can be use for beating. Throwing sand or soil with a shovel is sometimes effective in beating a fire down to ground level where it can be suppressed.

Advantages

1. Training village crews in fire behavior and suppression techniques will help develop a fire consciousness among the villagers which should reduce the number of man-caused fires.

2. A balanced program of fire prevention and suppression will reduce the number of man-caused fires and also limit the number of hectares burned.
3. Using village trained fire crews to control range fires could provide intermittent employment for villagers during the time of year when cultivated crops do not require their attention.

Disadvantage

1. Fire suppression activities require sizable commitments of funds for hand tools, other equipment and transportation.
2. Manpower requirements to organize and train fire suppression crews each year could be substantial.

3. Fire Prevention, Suppression and Firebreaks

Maintaining a firebreak network along with fire prevention and suppression activities combine to make a balanced fire control program and should further reduce the number of hectares burned each year, possibly protecting an additional 10-20% of the forage normally lost to fire.

Firebreaks are strips of land where burnable material have been removed before or at the beginning of the fire season. In light vegetation firebreaks need only be a few meters in width, but in heavy vegetation 10-30 in width are necessary to control fires when burning conditions are normal. Under extremely hazardous conditions, such as when strong winds occur and relative humidity is low, fire can jump firebreaks 30 meters in width.

Firebreaks do, however, give the fire suppression crew a logical place to start fire control efforts by backfiring, thus widening the firebreak to 100 meters or more as the backfire burns toward the wildfire.

Firebreaks can be cleared a number of different ways. When heavy equipment such as graders or bulldozers are available, a common practice is to clean two parallel strips the width of the dozer or grader blade 5-30 meters apart and then burn out the mid-strip when burning conditions are favorable. Another way of constructing firebreaks is by using oxen-drawn plows

or harrows to clear the parallel strips. In light vegetation hand-clearing with shovels may be all that is necessary, then burning out the mid-strips.

It is important that all firebreaks be cleared before the beginning of the high fire danger season. The mid-strips must be burned out before the fire hazard is so great that burning is inadvisable.

Primary firebreaks should be constructed perpendicular to the prevailing wind direction and should be spaced 5 - 10 km apart. The actual distance should be determined by vegetation conditions and losses that would be sustained if the area were to burn. Secondary firebreaks may be established at similar intervals but running parallel with the prevailing wind direction.

Firebreaks are more effective and easier to construct when they are located using natural features of the landscape. They should be placed on ridgetops when possible and should take advantage of roads and livestock trails when the vegetation is thinned by livestock grazing, trailing, and vehicle travel.

Sometimes firebreak clearings are seeded with plants that are more attractive to livestock than those found naturally on the range. This attracts livestock to the firebreak and they graze the firebreak area first and reduce the vegetative cover to the extent it will not carry a fire, thus effectively clearing the firebreak by grazing.

Advantages

1. Controlling wildfires within a firebreak network and reducing the size of the area burned contributes to the development of high quality forage, reduces the area subjected to wind and water erosion, and assures forage availability when needed for grazing.
2. Firebreak networks serve a valuable function when used to delincate grazing area boundaries as part of a range management plan.

3. Firebreaks provide cleared access routes to rangelands for fire suppression crews and other range development and management activities.
4. Firebreaks can be used as boundaries for controlled burning programs if shrubby vegetation increases beyond the level desired in the management of a project area.
5. Clearing firebreak by hand or oxen drawn equipment can provide meaningful employment to village populations.

Disadvantages

1. Construction and maintenance of firebreaks is costly and time consuming.
2. Man-caused fires can be started on both sides of a firebreak making them ineffective in limiting the number of hectares burned.

B. Livestock Water Development

Maximum livestock production can be obtained only when both forage and water supplies are adequate on a year-long-basis.

Generally, fires occur mainly in the lightly grazed or ungrazed areas where vegetation is dense enough to carry a fire. These areas are ungrazed usually because of inadequate water. By implementing a water development program the forage protected by the fire control activities can be grazed. However, without proper management and livestock control, the area around new water sources would soon deteriorate. Both wells and surface water catchments should be considered in supplying the water necessary for livestock grazing in the presently ungrazed areas.

Surface water catchments seem to have the greatest potential in the Sahel Zone. There are many ground depressions with drainage basins of one-half to several square kilometers where erosion has left a clayish, silty soil in the bottom of the depression. Some of these basins now collect run-off in shallow mares, but usually dry up shortly after the rains. The potential for collecting water by constructing reservoirs in the bottom of these basins is

obvious when one considers that a small drainage area of one sq. km in the 500 mm rainfall belt receives ½ million cubic meters of water per year. Only 0.2% of the total rainfall would fill a reservoir with 1,000 m^3 capacity.

The amount of water required by livestock varies depending on the kind, breed and size of the animal, moisture content of the forage, air temperature, humidity and winds. For planning purposes 20 liters/day for Zebu-type cattle is often used.

Three different approaches can be considered in planning water developments and balancing forage and water, using surface water catchments:

1. Determine the available forage, determine the grazing season or the length of time the range will be grazed, and then compute the volume and distribution of water necessary to make the projected grazing use. For example, the estimated grazing capacity of a typical range site in the Sahel Zone is about 1 AUM/hectare. (The AUM (Animal Unit Month) is the most common term used to express the amount of forage produced on a specific range area. A range area with 600 AUMs will support 100 cattle for 6 months. or 50 cattle for 12 months. In the Sahel Zone about 6-10 kg of air-dry forage is required for a mature cow every day. Using 10 kg, an AUM would represent 300 kg of forage. (1 UBT equals 12 AUMs)

   Using an estimated rating of 1 AUM/hectare, it will require 12 hectares to graze 1 cow year-long. For 100 cattle year-long 1,200 hectares would be required. The amount of water needed to properly graze the 1,200 hectares would be 730,000 liters (100 cows x 365 days x 20 liters/day equals 730,000 liters). A reservoir or surface water catchment with a storage volume of 730 m^3 would be required to store this amount of water (not taking into account losses due to evaporation and seepage.)
2. Another approach to water development planning would be to locate the potential water point, then compute the amount of forage within

a 5-10 km radius (under ideal conditions cattle should not be required to trail more than 5 km for water) and determine the volume of water necessary to properly graze the area. For example, the number of hectares within a circle with a 5 km radius = 7,854. If the grazing capacity is 1 AUM/hectare, the area will provide forage for 654 cattle year-long. ($\frac{7854 \text{ AUMs}}{12 \text{ months}} = 654$ cattle). This number of cattle year-long will require a reservoir with a storage capacity of 4,774 m^3 (again, not taking into account evaporation and seepage losses).

3. Another approach is to locate the potential water points, determine the volume of water it is feasible to collect and store and then compute the size of the grazing area based on the amount of water that will be available. For example, for a potential water development site that can be transformed into a reservoir that will fill each year with the following dimensions:

20 m long x 10 m wide x 5 m deep = 1000 m^3. This amount of water (1,000,000 liters) will supply the needs of 136 cattle year-long, or 1,632 AUMs. If the grazing capacity of the range is 1 AUM/ ha, the grazing area serviced by the water development would be 1,632 hectares. In this situation cattle would only be required to trail a maximum distance of 2.2 km to properly graze the area.

On areas with very course textured or shallow soils, where enough surface run-off does not occur to fill a reservoir, a rainfall catchment apron may be required. The catchment apron may be of buty/rubber, or plastic materials, placed on the soil surface near the reservoir. The rainfall collected is then piped into the storage reservoir. To illustrate the utility of such a practice the following example may be helpful: In the 400 mm rainfall zone an apron 30 m x 30 m will intercept 360 m^3 of water. To prevent damage to the catchment apron, it should be protected by fencing. The life of the apron can also be extended by covering it with 6-10 cm of soil.

The examples presented to show water storage capacities have not taken into account evaporation and seepage losses. These factors must, of course, be taken into account in the final analysis. The water losses from the surface of a reservoir through evaporation can be substantial in hot, dry climates such as the Sahel. The actual amount will vary dpending on the ration of water surface to the depth of the reservoir, temperature, humidity and wind conditions. Water losses through evaporation can be reduced by designing storage areas with maximum depths and as small a water surface area as possible. Evaporation can also be reduced by covering the water surface with grass mats, plastic or some other material. Water losses due to seepage through the sides and bottom of the storage area can be reduced by lining the storage area with heavy clay soils , bertonite, or with plastic or rubber material.

Computations such as presented above must be considered as rough estimates for planning purpose only because of the many variables which can not be predicted with accuracy.

Once water developments are installed and put into use, refinement in livestock numbers and grazing seasons must be made based on actual livestock performance, range forage conditions, rainfall variations and other factors. For these reasons range livestock projects must be planned with a margin of reserve built into the program and with considerable flexibility, so the livestock operation can be adjusted to cope with conditions affecting both water and forage availability.

Wells are usually a more dependable source of livestock water, but their use is limited to areas where ground water is available within a reasonable depth. When wells are used to supply livestock water, provisions must be made to limit their usage within the grazing capacity of the grazing area to prevent over-grazing.

After developing new water supplies, first consideration should be given to better distribution of present livestock use rather than increasing livestock numbers.

Advantages

1. Additional water development schemes can facilitate better distribution of livestock throughout the Sahel Zone. This could result in improved range and livestock conditions, if livestock are managed properly.
2. Development of reservoirs, even though some may only be a temporary source of livestock water can facilitate a range rotation program wherein the temporary sources of livestock water are used first and the forage around permanent sources saved until later in the dry season when the temporary waters are no longer available. This will extend the time of livestock grazing in a general area and will help alleviate the imbalance between wet and dry season forage supply.
3. The land form in the Sahel Zone is such that many natural sites exist for potential reservoir construction.
4. Construction and maintenance of reservoirs with the use of hand tools, shovels, picks and wheelbarrows, etc., could provide employment to village crews during the time of year their labor is not needed for the cultivation of cereal or other crops.

Disadvantages

1. Reservoirs are not fully dependable sources of livestock water. The amount of water collected, stored and available for livestock depends on fluctuations in rainfall, evaporation and seepage.
2. Wells can only be situated on sites where underground water can be reached at a reasonable depth. This may not be where the forage supply is located. They are also costly to drill and maintain.
3. WATER DEVELOPMENT WITHOUT LIVESTOCK MANAGEMENT AND CONTROL WILL ONLY CONTRIBUTE TO FURTHER RANGE DETERIORATION.

C. Range Mangement and Protection

Range Management is the science and art of obtaining maximum sustained use of the forage crop without damage to the land and other resource uses. The actions necessary to apply range management are usually set forth in a range management and development plan. The plan will describe the management of the project area including the resources available and current problems, state the management objectives, outline a grazing system and livestock control measures. It will also describe a monitoring system (studies) to be used in evaluating the effectiveness of the plan.

In order to apply range management effectively certain facilatating measures such as water developments and fire control must also be considered and incorporated into the plan. Therefore, the range management and protection approaches discussed below incorporate fire control and water development, and add the necessary grazing systems and livestock control measures.

Livestock production in Mauritania, and more specifically the Sahel Zone, can be increased substantially by implementing an agressive range management and development program. Forage can be improved in both quantity and quality. Improvement in quantity and quality of forage can help alternate the imbalance between wet season and dry season forage supply and improve livestock condition.

When ranges are managed properly, considerable flexibility with forage reserves are built into the program. When droughts occur, the areas being rested from grazing can be used to help keep livestock alive through these critical periods. After drought situations improve and conditions revert to normal, it is important that the management program be reinstituted for sustained livestock production.

Range management and development programs are not short-range programs. They involve tasks that require careful planning, implementation

and monitoring year after year. Only through strict attention to these details and proper emphasis can deteriorated rangeland be restored to its productive potential. In implementing a range management program control of livestock is a must; the success of the program depends on it. Control measures must regulate numbers within limits of the grazing capacity of the range and assure that livestock graze within designated areas scheduled for use within the grazing system.

Advantages

1. Range management plans, properly designed and implemented and incorporating grazing systems designed to increase perennial grass species in the Sahel Zone, can improve livestock production by extending the time nutritious forage is available. This will help alleviate the present imbalance between wet season and dry season forage supply. (Perennial grass species generally stay green and maintain their nutrients 2-4 months longer than annual grasses)
2. Range management and development efforts applied throughout the Sahel Zone will do much to improve range conditions to an acceptable level and provide forage on a sustained basis once the potential level of production is reached.
3. Grazing systems incorporating periods of rest from grazing build up forage reserves that can be used during emergency drought periods.
4. Range management and development planning in the Sahel Zone can be scheduled over a period of years on a priority area basis to gain experience, train personnel and select proven practices and techniques.

Disadvantages

1. To design and implement range management and development plans throughout the Sahel Zone will require a long-term commitment of scarce resources - - money, manpower and equipment.
2. Trained technicians required to design, implement and monitor range management programs are not currently available.
3. Unless the range management and development program is properly designed and monitored closely, it could be counter-productive and result in further range deterioration and decreased livestock production.

Facilitating Activities

In order to follow a range management and protection approach certain facilitating activities will require special attention. The major ones are:

1. Range Management Training

The success of a range management and development program for Mauritania will depend on the motivation and interest of the herders and breeders themselves. They alone control the key to success on failure, the livestock. In other words, the livestock are the most important tool the range manager has to manipulate the vegetative environment to a more productive condition. On an area of rangeland three vegetative factors can be influened by the grazing animal: the vigor of the plants, the density or ground cover provided by the forage plants, and the composition or make-up of the vegetation. These factors are influenced directly by the time of grazing, the frequency of grazing and the intensity of grazing.

Range extension agents trained in the basic principles of range management, animal husbandry, sociology, and extension techniques can serve as a motivating force in the major livestock-producing villages. The

most effective extension agents are usually the ones recruited from livestock-oriented villages and families. After training they are more willing to live and work in the rural environment.

The range extension agents could receive their training within the Mauritanian education system. At the beginning, course materials and instruction would have to be provided by expatriate teachers, but eventually the program should be handled by Mauritanian instructors as they become trained by the expatriates.

The second priority for training should be to provide range technicians also trained in the basic principles of range management but with emphasis on field techniques for analyzing range conditions, inventorying the resource, and determining its potential for livestock grazing. Instruction should also be provided in basic range management planning. Both classroom and on-the-job field training would be important.

Upon completion of training, these technicians could be assigned to specific project areas to work with the villages and extension agents in designing range management programs requested by livestock breeders and village groups.

As interest in range management increases, hopefully, from the efforts of the extension agents and range technician a few range specialists will be needed within the government organization structure. Their major role would be to help formulate and provide policy direction to the programs established at the "grass roots" level, and coordinate and provide budget inputs into the program. This would be extremely important when programs are financed by donor countries.

The range technician training could be provided in-country with expatriate instructors. However, range specialist training may be more effective if provided in the United States or some other country with degree programs strong in range ecology and environmental science.

As the range management program expands in Mauritania, provisions must be made for advancement and job satisfaction among the extension, technician and specialist grouping within the program. Efficient and effective work could eventually be rewarded by further training and reassignment to more responsible positions; for example, candidates for range specialist training could be limited to those with experience and proven abilities as range technicians. Candidates would be selected from the range extension workers based on past performance and demonstrated potential for more difficult and responsible assignments.

Modifications must be made in the governmental framework so this new specialty can function. Livestock programs must be modified to recognize the importance of the foreign resources as well as the animal health services provided by veterinarians. Range specialists should serve within the ministerial organization at the same level and not be subordinate to the animal health specialists.

Although expatriate help will be required in the training program and project development activities, the long lasting and successful programs will be those designed, implemented, and regulated with maximum participation of the herders and breeders themselves.

2. Research

Sound range management programs apply basic principles that have been developed through research and trial and error experiments. Large-scale range improvements necessitate working with existing vegetative resources and natural tools such as the livestock themselves to bring about the desired improvements. There are extremely deteriorated sites where natural recovery may take several hundred years. In these situations actions to hasten recovery by artificial means may be justified.

Research efforts are needed in Mauritania to find ways or re-vegetating abandoned cultivated fields and damaged range sites with vegetation useful in providing forage for livestock production. Seeding trials should be established in the various climatic zones where plant species developed for range reahbilitation in others like environment can be tested. Species that prove effective could be propagated on protected seed production sites, until the seed supply is sufficient to attempt rehabilitation of the damaged sites on a modest scale. Once areas are rehabilitated, management and control of livestock become even more important because of the substantial investment in rehabilitation.

Livestock exclosure studies are needed on the various range sites within the Sahel Zone to help determine their production potential. Exclosure studies carried out over several years will be helpful in determining whether or not Sahelian ranges should be managed with a goal of increasing perennial grasses or merely managed to harvest the annual grasses.

Livestock exclosures are fenced plots of varying sizes constructed in key areas of the range where biotic factors can be measured, recorded and evaluated. Vegetative data from these areas can be compared with data from plots in adjacent uncontrolled areas to study the effect on vegetation and soils due to grazing management such as complete rest from grazing, protection from grazing during certain seasons and site treatment practices, such as burning or eradication of the shrubby species.

Exclosure may be either permanent or temporary structures; both are important and may be designed to exclude all domestic livestock, wildlife, and sometimes rodents, or they may be designed to exclude certain classes of livestock while others are allowed to enter.

Research projects should be problem-oriented, and not duplicate work done in other Sahelian countries that may be applicable to Mauritania.

Training programs that have thesis requirements should include research relating directly to range management problems in Mauritania.

3. Land Tenure

A very important factor which has a real influence on all phases of range management is man's control of grazing lands. Since earliest times, efforts to encourage improvement of the land and increase its productivity have depended on the rights and obligations of the land user. Appreciable development has never occurred except under systems of land use which guarantee reasonable permanence to land occupants, plus a fair and just return for their investments and efforts.

In Mauritania, as in most countries, land use and control patterns are very complicated. With cultivation of an area, control of the land is usually recognized and respected, but grazing land is not privately controlled. Accordingly, in most cases the individual range user lacks the incentive to improve or conserve rangelands. The grazing use is free to everyone and is no one's responsibility. The results are apparent and reflected by such conditions as over-grazed deteriorating range sites, erosion, desertification, and a low standard of living.

In many cases where individuals, families, villages, or tribes have control of land, the responsibilities which accompany this control are not fully understood. People too often think of rangeland as indestructable and unimportant. Once an area is degraded, they plan to move to other areas. This practice may have been possible years ago, but now productive rangelands are usually fully occupied. The opportunities for improvement in land use and development of the land potential for range livestock production are substantial. In Mauritania, a change in land use policies to encourage range mangement and development would be helpful in interesting livestock herders and breeders as well as potential donor countries willing to finance livestock development projects.

Such a policy should consider establishment of "grazing reserves" with appropriate regulating authority to control livestock numbers and grazing areas.

The new policy could restrict village expansion or creation of new villages around newly developed water sources and would ensure that the lands would continue to be available for livestock grazing once investments are made in range management activities.

Changes in land tenure are appropriate only when people either do not like existing conditions or when they are able to see better and more productive ways of using the land's resources. Consequently, the success of land tenure reform hinges on education of the land users. Following education of the occupants, they should be able to determine and understand the major land use problems and establish broad objectives for improvements. Without the people's involvement in land tenure reform and in the formulating of regulations for grazing use, the program is not likely to succeed. Once "grazing reserves" are established and regulations formulated, the grazing users should also be represented in the enforcement aspects of the program. Grazing committees selected by the users themselves can be very helpful in self-enforcement to conform with regulations they helped to establish.

4. Budget

A re-ordering of priorities in the national budget of Mauritania, recognizing the importance of the livestock sector, and particularly the importance of forage production within that sector, is necessary in order to encourage interest in range management and development activities by donor countries.

VI Planning for Range Management

As mentioned above, the usual approach to increasing livestock production is to assess current production systems, identify problem areas, and seek appropriate solutions. Range conditions and the way livestock are managed are important factors in most livestock production systems. It is usually found that more intensive livestock management and development practices would be beneficial. The necessary management and development is then set forth in a range management and development plan.

The first step in range management planning is to define the boundaries of the project or management and development unit. This can be done with more certainty if the grazing lands have already been separated from the agricultural land through a land use classification process, with appropriate tenure assigned to the rangeland for grazing purposes.

Range management plans may be developed for a specific ranch unit, for a specific public range area, or even a general plan for an entire developing country. A range management plan for a public range area may involve the livestock of a single livestock operator, or it may involve the livestock of many individuals. The planning unit (land area) determines to a large degree the scope and complexity of the plan. The planning unit boundaries serve as the basis for analyzing the management and development problems associated with current uses, preparing and analyzing the planning data, projecting goals, and evaluating progress and accomplishments. Aerial photographs and good maps of the planning unit or project are very important and helpful in all aspects of the planning process.

A range management and development plan for a specific range area should include the following components:

1. Background Information

This section of the plan includes a discussion of the present situation with regard to the resources, their condition, production, uses and problems. This information must be thoroughly studied and analyzed prior to deciding on the management objectives for the area. The planning map should show the status of all land, existing range developments, such as water points, and any other features associated with livestock management.

2. Objectives

This is the most important component of the plan. The objectives must be in accord with governmental policies and the livestock program guidance in effect. The objectives must be stated clearly and should be specific as to what is to be accomplished in terms of livestock production and vegetation improvements. The vegetative objectives should be specific enough so the range manager can select one or more key forage plants for which the range unit will be managed. A key species is a plant that is relatively abundant, or potentially so, endures moderately close grazing and will serve as an indicator of changes occurring in the vegetation complex. The key species should be an improtant vegetative component that, if over-grazed, will have significant effect on erosion conditions, grazing capacity of the area, or other resource values. More than one key species may be important and may be selected to guide the livestock management in the area, e.g., one species may be particularly important for erosion control or sand dune stabilization, another species may be important from a widlife standpoint, and another for livestock forage. The key species should be abundant on a range in good condition and potentially so on a range in unsatisfactory condition. On depleted ranges the plants being considered for the key species may be so scarce that they are found only on sites protected from grazing and fire. If these species are the best plants for the area and their restoration is ecologically feasible, management should be based on increasing these species until they are major components of the plant community. This may require severe changes in current management and may involve grazing use restrictions.

3. Grazing System

Grazing systems are sequences of livestock grazing by area (pasture, block, etc.) designed to accomplish the specific management objectives. Without well conceived and explicit objectives, it is difficult to design a grazing system which will be effective. Information concerning phenological development (when various growth stages occur) and physiological requirements (manufacturing and storing food reserves through photosynthesis) of the key plant species are necessary to formulate sequences of grazing use that take into account the vigor of the plants, density of ground cover provided by the forage plants, and the composition or make-up of the vegetation. These factors are influenced directly by the time of grazing with relation to plant growth, the frequency of grazing, and the intensity of grazing. All of these factors can be controlled by the range manager and the livestock breeders.

Systems of grazing fall into two general classes, continuous grazing and non-continuous grazing. Under continuous grazing the range is grazed season-long or year-long year after year. In general, continuous grazing is not an acceptable practice since it results in undesirable successional changes in the forage plants. To prevent this, specialized systems of non-continuous grazing schemes have been developed and used widely throughout the range areas of the world. Although differing greatly in detail, they have two features in common, a period of rest from grazing to allow the forage plants to grow unmolested and a systematic schedule for grazing use.

Non-continuous grazing systems employ deferment, rotation, or rest from grazing to restore vigor to the forage plants and to allow them to produce seed. These practices may be applied individually or in combination.

Many different terms have been used to describe grazing systems. Despite differences in terminology and variation in detail, all can be considered as belonging to the following basic types.

a) Deferred grazing is delaying grazing for a specified period of time during the growing season. The longer the delay in the beginning of grazing on a range the better the opportunity is for new plants to become established and for old plants to gain vigor. Any prescribed delayed date for placing animals on the range is considered deferred grazing.

Deferred grazing has certain advantages. If grazing can be deferred every few years, forage plants have a better opportunity to reproduce. Grazing after seed ripening injures plants less and the grazing animals help scatter and cover the seed by trampling. However, forage at maturity is less palatable and nutritious.

b) Rotation grazing is grazing on a portion (pasture block, etc.) of the range, then another, in regular succession. The rotation system of grazing is based upon the assumption that animals in large numbers make more uniform use of the forage and that rest from grazing is beneficial to the plant, even though it must support a greater number of animals during the shorter time during which it is used. Certainly, proper rotation of grazing results in more uniform use. Larger numbers of animals in smaller units are forced to spread over the entire area and to use the available forage more uniformly. Trampling is reduced because animals are held on small areas where feed is more abundant.

c) Deferred-rotation grazing combines the idea of rotation and deferment. Under such a system, grazing on one part of the range may be deferred; then by rotation areas are successively given the benefit of deferment until all units of the range have been deferred.

A change in rotation order on grass ranges should not be made until after two years of rotation; thus, the seeds that are allowed to mature the first year will germinate the second year, and the young plants are given protection from grazing while they are becoming established. Longer periods of deferment may be advisable if growth conditions are poor or if the range is in poor condition. Design and operation of a deferred-rotation system requires division of the range into two or more units (pastures, blocks, etc.). Grazing is rotated among all the units during the grazing season except one which is deferred each year until after seed ripens on the key forage species.

d) Rest rotation grazing is a system wherein the deferred part of the range is given complete rest from grazing for the entire year. This system of grazing allows the desirable forage species to recover vigor, produce seed, and reproduce. Timing and duration of rest periods are determined by the growth requirements of the key plant species. To establish and apply rest and grazing in proper sequence, two or more pastures or units should be established, although three to five are more desirable. The pastures or units should be approximately equal in potential grazing capacity. This system places heavy emphasis on restoration of plant vigor to the point where desirable forage plants can produce seed and establish new seedlings. To obtain plant reproduction, it is necessary to rest the range from grazing to restore plant vigor, insure development and ripening of seed, and the establishment of seedlings. More tham one year's rest of a pasture unit may be necessary to achieve desired results before rotating the rested pasture or unit.

The selection of a grazing system for any given project area is one of the most difficult tasks of the range manager. Consideration must be given to topography, climate, range improvement, kind, breed and class of livestock. The system must also take into account, and be compatible with, the physical and social conditions and customs within the area.

There are a few points to stress when selecting or developing a grazing system:

- Livestock grazing may be managed to alter the ecosystem in any manner desired within certain limits (use of livestock as a tool to manipulate the vegetation toward the management objectives).
- Most any grazing management system is better than no management at all.
- In order to develop a feasible system of grazing management a vegetative inventory and map of the range is essential.
- There is no system of management that will work on an overstocked range. Livestock numbers must be adjusted to the carrying capacity of the range and then managed to provide rest from grazing at periodic intervals.
- For any given system to be effective, control must be exercised over the livestock to achieve proper distribution and utilization of the range.

4. Needed Range Improvements

Implementation of grazing systems generally requires additional water development and fencing to control livestock within the appropriate pasture or grazing block. In situations where livestock are herded, such as prevails in the Sahel, it may be desirable to mark pasture or grazing block boundaries with firebreaks, boundary stakes, or some other way.

Severely depleted sites may require some form fof of vegetation treatment, such as reseeding, erosion control, or spraying with chemicals to suppress undesirable plants in order to accomplish the desired objectives within a reasonable period of time.

Intensive management of livestock often requires handling facilities such as corrals, dipping vats, etc.

All the facilities needed to implement the grazing system and handle the livestock properly should be provided for in this component of the plan. Sometimes they are not all needed the first year of implementation, so construction or treatment may be scheduled over several years. This is especially important when funding is limited and large areas need to be brought under management. Equipment, labor and cost estimates to install the necessary range improvement should be included.

5. Coordination

Products from rangeland vary as much as the sites, climate, and vegetation. Range management plans should consider all possible types of production.

The development and management of rangelands not only improves the habitat for domestic animals but also wildlife through providing additional water, control of fires, and prevention of erosion. With the exception of predators and possibly the spread of animal disease by wildlife, there is no reason for not having game species on the range area.

Poles, wood and charcoal are also valuable products of rangeland and should be considered before plans are made for controlled burning or other eradication program to remove woody species to improve grazing conditions.

This component of the plan must identify products other than livestock and describe how these other uses will be coordinated with the livestock grazing program.

6. Evaluation

This component of the range management plan should contain a brief description of the range studies needed to evaluate the effectiveness of the grazing system and the improvements in meeting the objectives of the plan. A study schedule should be included that describes the frequency and time of year studies are to be conducted. Studies must include stratification and selection of key areas for proper location of the studies. Studies will generally include: actual use (livestock inventories), utilization patterns, livestock exclosure, range condition and trend. Others may be scheduled as needed. It is important that studies be initiated the same time the plan is implemented to insure that a complete record is available for periodic evaluation. It is also important that study data be collected, recorded and filed systematically so it will be readily available.

Actual use studies or livestock inventories are needed to determine the numbers of livestock that are competing for grazing use of the project area, and to determine the actual numbers of livestock grazing the range area. Livestock numbers and the length of time they are allowed to graze must be limited to the grazing capacity as determined for the project or management area. Management and evaluation studies are useful only to the extent that the range manager knows or can determine the number of livestock using the grazing area and his ability to exercise control as to when they graze and the length of time they are allowed to graze. Livestock numbers can be obtained in different ways. Some methods are more accurate than others. The method used will depend upon the complexity of the grazing management program. Direct methods include counting the livestock as they enter the grazing area, counting the livestock after they are in the grazing area

at water points or other places where they concentrate, and aerial counts from low flying aircraft. Indirect methods include livestock owners reporting their livestock numbers in response to questionnaires or interviewers, and obtaining numbers from vaccination records, tax records, or market information.

Utilization studies are used to determine the current grazing pressure on the project or range area, or the extent to which the current livestock numbers have consumed the available forage. Utilization of the forage plants in excess of that which the plants are capable of sustaining will require adjustments in livestock numbers or in the length of time they are allowed to graze. Unequal utilization throughout the grazing area will suggest the need for additional water points on better herding pratices. More uniform utilization can also be obtained by providing salt or other mineral supplements to the under-utilized areas.

Utilization is defined as the degree of herbage removed. It is expressed in percentage of weight, height, or number of plants within reach of the grazing animal. Utilization may refer to the range as a whole or the use of specific sites. It may refer to several plant species or only to the key species. The amount and frequency of utilization is one of the few factors over which the range manager may exercise some degree of control.

The usual methods of judging utilization include the paired plot method, ocular estimates by plot method, key forage plant method, actual weight method, stem count method, and the photographic method. In selecting an appropriate method the range manager must carefully consider the advantages and disadvantages of each method as they relate to the particular type of range being studied. With limited input, estimate methods permit a greater number of samples than methods that require measuring or clipping and weighing the vegetation. Some methods listed were designed for a particular plant species and species with specific growth forms, thus limiting their use. A method such as the ocular estimates by plot and the key forage plant method have wide applicability and are suited for use with grasses, shrubs and forbs.

Range condition and trend are closely associated, for one is the reflection of the other. Range condition is often referred to as range health, and trend is the indicator of change in health. One range may be healthy or in excellent condition; another may be unhealthy or in poor condition. In between, there may be other ranges in only fair to good condition. The unhealthy range may be improving, in which case the trend is up. If a healthy range is deteriorating, the trend is down. When the trend direction can not be determined, the trend is static or stationary.

Range condition studies generally relate the current condition of the range to the potential of which the area is capable, or "climax condition" in ecological terms.

Climatic studies or records are very helpful in interpreting other range studies. Factors such as time and amount of rainfall, its distribution over the area, temperature, humidity, and wind velocity and direction are important in understanding vegetative changes and in predicting fire hazard occurrences and in planning fire suppression activities.

7. Agreement

Most plans, particularly if they involve more than one livestock owner will have an agreement component where all parties to the plan signify their acceptance of, and participation in, the plan. The agreement component should set forth any special livestock handling requirements, and funding arrangements for construction and maintenance of range improvements. In order for the range management plan to be effective, it must take into account the physical and social conditions and customs within the general area. The livestock breeders and herders must understand all aspects of the plan and must agree with them. For this to occur, the parties involved should participate in all phases of the planning process and must feel that the plan will have value to them by increasing or stabilizing livestock production, or doing a

better job of land and resource conservation. Changes must not be so great as to make participants uncomfortable.

If these conditions are met, all parties involved should be willing to confirm their participation and acceptance of the plan by signing the agreement.