SUDAN'S SOUTHERN STOCK ROUTE

AN ENVIRONMENTAL IMPACT ASSESSMENT

Prepared by
Institute of Environmental Studies
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for

The United States Agency for International Development

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Khartoum and Worcester,
Massachusetts 1985

PREFACE

The Sudan is a country rich in livestock. Yet during the late dry season most of the Sudan experiences shortages in meat and the country is unable to export meat to neighboring countries. These shortages result mainly because livestock are raised in areas far distant from the consuming and export centres, and the animals are usually transported on the hoof along what is known as the Northern Stock Route. Unfortunately, water is unavailable along some stretches of this route, and the route has become seriously desertified.

For many years planners were thinking of opening a southern stock route where both water and grazing are available or can be made available. However, the present work is the first serious study to be done on the Southern Stock Route. In this sense the study is a bold new concept. When the study was started, it aimed at looking at the expected environmental problems which might result from opening a southern route. As the work progressed it became clear, as the reader will notice, that it turned to be a more comprehensive and integrated study, considering not only the immediate environmental impact but the broader social and economic contexts as well. Furthermore, the study provides an example of a work that gives full consideration to assessing environmental problems before the start of the project, in this case the Southern Stock Route. The work was carried out by local Sudanese experts from the University of Khartoum as well as from other institutions in the country.

Among the positive aspects of a Southern Stock Route which the study identifies:

(a) reduced costs of livestock transporting, therefore bringing financial gains back to the producers;

(b) year-round trekking and therefore a more consistent flow of meat to domestic and overseas markets;

(c) increased off-take and therefore less pressure on grazing lands;

(d) improved veterinary services for the trekking animals as well as greatly improved control of animal diseases along the Route;

(e) expanded provision of water for both human and animal consumption;

(f) controlled natural grazing (thinning of kitir, and fire lines) as well as establishing a fodder farm for critical areas;

(g) greater control of livestock movements by the producers themselves.

Perhaps even more important, the Southern Stock Route will relieve current environmental pressures on the Northern Stock Route. Simultaneously the study determines that there will be no serious adverse environmental impacts if:

(a) the recommendations of this study are implemented;

(b) the Route is well managed including attention to security:

(c) the environmental conditions are carefully monitored along the Route and appropriate steps taken in situations where danger signs reveal potential problems.

In addition to the points mentioned directly in this study, the report offers a wealth of information about topics that are usually controversial-e.g. Will the nomads cooperate and sell the surplus animals? Will the well-established traders of the Northern Stock Route be willing to accept the Southern Route? Will the opening of the Southern Route help in breaking the traditional monopoly handful of livestock merchants at Omdurman?

Finally, the report provides an invaluable wealth of data on the current conditions of water, pastures, soil, feed resources, and marketing. Any follow-up or monitoring efforts in the future which are associated with the Southern Stock Route will find this publication a storehouse of valuable information.

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Conversion Rates

Throughout this study, conversion rates were computed on the basis of the prevailing exchange rates at the time of the field work (November/December 1983). This official rate was:

$1.00 = £S 1.30

Other important conversion rates are:

1 feddan = 4200 m^2

1 feddan = 0.42 ha

1 feddan = 1.038 acres

SUMMARY OF RECOMMENDATIONS

1. Northern Stock Route Use Should Be Limited Or Even Stopped.

Until a few years ago, many viewed the main problem with the Northern Stock Route (NSR) to be lack of dry season water along some of its stretches. These dry areas are the ones covered by Basement Complex Formations and sandy soils. They do not yield underground water nor are they suitable for hafir construction, primarily because of the porosity of the sandy soil. Recently, however, an equally serious problem has emerged. Several parts of the NSR have been severely desertified, mostly because of the large number of animals that are trekked every year. These desertified areas need to be rehabilitated. It is therefore recommended that the NSR be used as little as possible or, if feasible, not used at all.

2. A Southern Stock Route Is An Appropriate Alternative.

As the main supplies of livestock for export and domestic consumption come from western Sudan, a more suitable route has to be found. A Southern Stock Route (SSR) is therefore proposed. It starts from Birka Khadra in southwestern Darfur and passes eastward somewhat parallel to Bahr el Arab until a point near Abyei. Then the route takes a northeasterly direction to Delami, and then an easterly direction to Kosti. From Kosti the route is suggested to follow the eastern side of the White Nile to Khartoum. Two feeder routes are also suggested. One starts from Lake Abyad and passes by Kadugli and joins the main route near Delami. The second feeder route starts from Liri, passes by Abbassiya, and joins the main route near Kermal. The total length of the route from Birka Khadra to Khartoum is about 1653 kilometres compared to 1400 kilometres for the NSR from Nyala to Omdurman. The width of the proposed route is about 40 kilometres. But where this is not possible because of mechanized rainfed areas or in the overgrazed area between Kermal and Kosti, a narrower route is acceptable, provided that sufficient feed from agricultural residues or irrigated fodder is provided. From Kosti to Khartoum, irrigated fodder is essential and therefore a narrow route is sufficient. In this particular stretch, however, six holding grounds for animals to rest and feed have to be established. Each holding ground should have an area of about 25 square kilometres.

3. New Areas Will Be Tapped By SSR.

The first part of the SSR (From Birka Khadra to Delami) and the two feeder routes will pass through the largest dry season animal concentrations in Sudan. Thus the proposed route and its feeders will tap not only the traditional western areas of livestock supplies but also areas of the Nilotic tribes of southern Sudan. Until now, these southern areas have played only a minor role in the livestock trade of Sudan.

4. SSR Will Require Supplementary Transport Capability.

About twenty percent of the livestock in southern Darfur and part of southern Kordofan will be north of and far away from the suggested SSR. It is recommended that these areas be served by the Livestock Meat and Marketing Corporation (LMMC) block trains. From Kosti to Khartoum, most livestock will be trekked along the eastern side of the White Nile. However, if stock numbers become too large, some animals can be transported by trucks, river transport, or LMMC trains which will be more efficiently used as the turnover of engines and wagons will be quicker.

5. The SSR Is Both Desirable And Feasible.

The opening of the SSR is technicaly possible, economically feasible, and nationally desirable. The technical possibility of SSR is based on the following:

(a) water can be made available all along the proposed route and its two feeders;

(b) grazing from natural pasture and agricultural residues from Birka Khadra to Kosti is plentiful for the estimated 300,000 animal units that are expected to use the route and its feeders;

(c) from Kosti to Khartoum the livestock will need irrigated fodder which will come from a proposed 4,000 acre farm to be established near Kosti. It should be noted that NSR animal trekking from El Obeid or Tendelti to Omdurman currently uses fodder transported from Omdurman and parts of White Nile region.

The economic feasibility is based on:

(a) the cost of trekking and watering the livestock will be less than in the case of the NSR;

(b) the assumption that the savings made from (a) will be shared by the producers, traders, herders, and merchants and this will give incentives for increased sale of animals;

National desirability stems from the fact that the SSR will:

(a) effectively reduce the present seasonality of livestock and meat supplies in domestic and export markets;

(b) help Sudan to increase its earnings in foreign currencies from the export of livestock.

6. Successful Operation Of The SSR Involves Six Essential Components.

The following are suggested as necessary elements for the SSR:

(a) Water supply

It is recommended that 76 boreholes and 40 hafirs be drilled and excavated along the route and its feeders. The water points should be 20 kilometres apart. The total cost of constructing the water points is estimated at roughly $17,000,000.

(b) Veterinary services

The SSR should upgrade existing veterinary facilities and establish new ones. It is therefore recommended:

(i) to rehabilitate and establish new veterinary posts in strategic locations, i.e., near large markets and at the junction of the feeders and main route;

(ii) to establish and equip 26 dips and 4 dip-strength monitoring laboratories.

The total cost of rehabilitating old and establishing new veterinary posts, mobile units, dips, and laboratories is estimated at approximately $5,000,000.

(c) Animal feed

Grazing and feeding potentials will require expansion. Recommendations include:

(i) opening fire line grids;

(ii) rehabilitating overgrazed areas through reseeding and reservation of some areas;

(iii) thinning of dense kitir;

The cost of the above three items will be about $500,000.

(iv) establishing a commercial, 4,000 acre irrigated fodder farm near Kosti to provide fodder for animals trekking from Kosti to Khartoum. The farm is expected to produce about 7616 tons of digestable nutritive fodder every six months. The required amount of fodder is 5,400 tons.

(d) Markets and credits

(i) New markets are required in Birka Khadra, Safaha, and Abyei. These locations potentially have large sales of animals though at present they have no organized markets;

(ii) It is important that small traders, producers, or their relatives and kinsmen enter the livestock trade. Small cooperative societies may also be encouraged by offering credit facilities.

(e) Security

It is important that the SSR gradually build its own security forces, perhaps similar to that of the railways. These security arrangements would have to be negotiated and coordinated with the central and regional security forces.

(f) Administration

The SSR is a national project with different components which overlap with responsibilities of departments and units at the central and regional level. It is therefore suggested that the SSR be administered as one integrated project. As such, it should come under one administrative unit with authority to make use of and coordinate the existing facilities, as well as to establish new ones. It seems that LMMC is the appropriate body to be entrusted with such a work.

However, LMMC cannot do everything by itself. Certain work such as construction and maintenance of water points can be executed by the National Administration of Water (NAW). Equally, the opening of fire line grids, rehabilitation of overgrazed area, thinning of kitir, and establishment of the irrigated fodder farm would be contracted with the Range and Pasture Department. Similar arrangements could be made with the Animal Resources Department and with the Security Forces. Items such a selling water should be managed strictly on a commercial basis and require that a company be formed, preferably by the user of the SSR, for the purpose of administering the water points. But if a company cannot be formed, water management has to be given to a contractor or contractors. The livestock markets can be managed by LMMC which has good experience in running the nations's major livestock markets.

PROJECT SUMMARY AND CONCLUSION

The Need For A Stock Route

The Democratic Republic of the Sudan possesses a large wealth of livestock, estimated in 1981 to number about 19.5 million cattle, 18 million sheep, 13 million goats, and 2.7 million camels. From this wealth, the country meets its domestic needs of meat as well as provides a surplus for export. It is thought that annually about 1.8 million head of cattle and about 4.2 million head of sheep are slaughtered for local consumption or exported. Hides and skins also contribute to the economy of the Sudan.

The demand for meat will probably continue to rise, both for local needs as well as exports, especially to the Arab countries and some neighbouring African states. This rise is due to the rapid increase of human population, urbanization, and rising standards of living. The annual rate of increase of the Sudan population ranges between 2.5 and 3.2 percent, a figure which is comparable to that of most importing countries.

The Sudan has been trying, during the last few decades, to develop its animal wealth as a way to meet its rising domestic needs and to increase its foreign currency earnings which at present depend heavily on crops, including cotton, groundnuts and other oil seeds, and gum Arabic. Cotton and its by-products, which constitute over 50 percent of Sudan's exports by value, are becoming less profitable due to the rising prices of pesticides, insecticides, fertilizers, machinery, and labour.

The main livestock producing region of the country is western Sudan which has numerous advantages for raising animals. One striking feature of the geography of the west is the seasonal shortage of water. The region has no perennial rivers; its rainfall is seasonal, ranging between less than 100 mm in the northern semi-desert parts to 800 mm in its southern areas. From a climatic and vegetational point of view, western Sudan can be divided into three distinct zones:

(1) The northern semi-desert with annual rainfall less than 250 mm. Here the main occupation is nomadism, raising mainly sheep and camels;

(2) The middle zone with an annual rainfall between 250 to 450 mm and poor savanna vegetation. The main occupation is traditional rainfed cultivation, though a few animals are also raised by the cultivators. This zone is visited seasonally by the nomads from the north and south;

(3) The southern zone with an annual rainfall ranging between 450 to 800 mm has rich savanna vegetation. Here the main occupation is raising animals under nomadic and sedentary conditions. Cattle are the most important animals (hence the tribal name Baggara meaning cattle people), though sheep are increasing;

This southern zone is the primary concern of this study because: (a) it is the main zone for raising cattle in the Sudan, producing 70 to 80 of all the trade in (b)

of drought, large numbers of people, (about 1.8 million persons in 1983), together with their livestock, move from the northern and the middle zones and take refuge in the southern zone, thus increasing its importance as a livestock producing zone.

The southern zone comprises the whole of Southern Darfur and Southern Kordofan Provinces and the southern part of the White Nile Province. The zone is the catchment area for the SSR. Animal raising in the catchment area is characterized by: (a) low inputs as land is owned by the state, but is communally used. Thus, pasture is free, and this is also the case with water which is obtained from surface sources most of the year; (b) low commercial off-take because of high mortality due to animal diseases and seasonal inadequacy of pasture; (c) great distances from source to markets because the main producing parts of the catchment area (Southern Darfur and Southern Kordofan) are far from the consuming areas. Nyala, the largest producers' market, is over 1,400 kilometres from Omdurman, the largest consumers' market. The livestock trekking time between the two towns is about 60 days.

Animal sales in the markets of the catchment area reflect seasonality. This is because the animals are trekked on the hoof along the NSR where water and pasture are easily obtained during and shortly after the wet season. However, during the long dry season, both water and pasture are difficult to obtain.

The water problems are two-fold: (a) long sections of the NSR are made up of Basement Complex which does not allow underground water storage. Further, these sections are covered by sand sheets and dunes which make hafirs a useless storage device; (b) boreholes in areas covered by water bearing formation, i.e., Nubian Sandstones and Umm Ruwaba Series (about 2/3 of the route), are badly managed. Maintenance is not regularly done, spare parts, fuel and machine oils are not easily available. As a result water provision is not always guaranteed along the NSR, even where there are boreholes.

Pasture along the NSR is normally available during the wet season but becomes sparse during the early part of the dry season (October-January), and may disappear completely during the later part of the dry season (February-June). In addition, the recent drought destroyed vegetation cover over wide areas, especially in the northern section of NSR.

Due to the problems of inadequate pasture and water during the dry season along the NSR, livestock traders hesitate to trek animals to Omdurman after December. Thus, the main sales in the production areas are between July and November/ December. Some sales are concluded after December but these are mainly for either local consumption or for animal speculators who store animals near water points. Such animals feed on dry natural pastures, on crop residues, or on irrigated fodder as available. Once the rainy season begins, these animals are dashed to Omdurman in the hope of receiving high prices. It is estimated that between 80 and 85 percent of all trekked cattle and sheep are moved between August and December when water and feed are available along the route. Other than speculator stock, very few animals are trekked between March and June.

The seasonality of sales and trekking from the producing areas is accompanied by seasonality of supplies to consumers, both local and foreign. This has two undesirable effects:

a) Prices in the late dry season in Khartoum and other towns along the Nile rise sharply, creating frustration and political dissatisfaction;

b) Stability in Sudan's export trade suffers as there is keen competitors from sources such as Somalia, Australia and New Zealand which are able to supply live animals and meat throughout the year in continuous regular quantities at competitive prices.

Studies Aimed at Improvement of the Northern Stock Route

The Sudan, trying to solve the seasonality of meat supplies, has carried out a number of a studies. With the help of the World Bank, seven boreholes were dug and equipped between El Obeid and En Nahud. Baling of green natural fodder was also attempted for use in areas where pasture was not available, mainly in the northern parts of the route. Despite these efforts the NSR could not offset the seasonality of supply, mainly because new wells and baling efforts were not enough to provide reliable sources along the entire route.

In June 1981, an IFAD Identification Mission visited the Sudan and selected the western stock transportation need as one of the projects requiring further studies. The IFAD Mission was followed in October 1981 by a FAO Team which concluded that, "the route proposed by IFAD is not technically possible because the availability of adequate water supplies along the route cannot be guaranteed." FAO investigated alternative possibilities and suggested a route farther south along the railway from Nyala through Rahad to Tendelti and then north to Omdurman. This was called the "hafir" route since year-round water supply can be secured by the construction of hafirs. In addition to its recommendations on water, the FAO Team also suggested that feed be supplied and that animals be reconditioned at feed lots after reaching Omdurman. However, the Team raised the possibility that if a large number of animals were offered during the late dry season, prices might drop substantially, leaving insufficient incentive to trekkers. Nevertheless, it was also mentioned that export demand may provide an off-setting factor if animals are in good condition.

Sudan did not accept the FAO proposal. Thus in 1983 a World Bank Appraisal Mission (of Marples, Mukawi, Tate, Sammani and Ms Folk) visited the Sudan and recommended that the NSR be used from July to December and then the SSR be opened after December.

The Southern Stock Route

The Institute of Environmental Studies (IES), University of Khartoum was requested by USAID/Khartoum in October, 1983 to study and "determine the potential environmental impacts of increased dry season livestock trekking on the proposed project area following the railway line from Nyala through er Rahad to Tendelti and then northwards to Omdurman, and on two feeder routes

from grazing areas south of the railway line leading to this proposed route." The ambitious scope of work asked IES to:

1. Determine the type of rangeland involved, project range carrying capacity, current condition, and current pattern of utilization by existing agricultural groups on a seasonal basis;

2. Identify potential hafir, well, or borehole sites at distances of 20 km. from each other;

3. Determine methods of control for access to new water points;

4. Identify areas of social conflict between sedentary farmers and trekking herders;

5. Identify constraints and problems with marketing channels and livestock movement in the project area:

   a. how will the producer "fit in" to this type of system?

   b. how does the marketing system function?

6. Determine when pastoralists sell their livestock and where markets are located outside official markets;

7. Determine how much land will be taken from traditional producers if access to water and forage supplies around it are used by trekking market animals;

8. Determine (a) the impact of land expropriation (7 above) on traditional producers, and (b) the impact of traditional producers and their animals on the stock routes;

9. Identify native and supplementary forages and their impact on availability of supplementary feed supply;

10. Evaluate the economic benefits of supplementary feed supply;

11. Recommend a resource management plan and provide an outline in terms of how water will be used;

12. Determine market incentives and benefits for producers. Assess what factors influence decision-making at the producer level;

13. Assess the producers' ideas of the effects of putting in more watering points;

14. Determine possible supply-stimulating effects for producers which may result in increased off-take;

15. Assess the availability of water along the route, including rainfall and hydrology data;

16. Analyse the feasibility and cost of hafir construction;

17. Recommend methods of self-financing maintenance of boreholes and hafirs;

18. Anticipate the potential increase in livestock off-take if the southern route is developed;

19. Estimate the distribution of project benefits between large traders, small traders, stockmen, and livestock producers;

20. Evaluate the proposed methods of regulating the number of animals trekking to market with the forage supply;

21. Review methods of improving long-range productivity, i.e., forage supply as a resource base;

22. Estimate the types and numbers of animals owned by sedentary groups living in the vicinity of southerly grazing areas during the dry season;

23. Present actual numbers, ages, weights and types of animals that are trekked on the traditional route per month;

24. Locate available veterinary services in the field and evaluate their capacity;

25. Propose how increased funding for veterinary services can be utilized;

26. Determine whether a demand exists, the nature of supplementary feed supply, and how it might be provided by private dealers.

Given these terms of reference, IES formed a team of specialized experts, all of whom were well versed on western Sudan's hydrology, hydrogeology, livestock production, range and pasture production systems, nomadism, regional planning, and water services. Most of these experts had previously worked in western Sudan as high government officials in the departments of Range and Pasture, Rural Water Supply, and Veterinary Services. The rest had carried out extensive research on one topic or another in western Sudan.

Members of the team were:

- Professor M.D. El Khalifa
  Director, IES, Editor and Evaluator of the Report.

- Dr. Mustafa M. Khogali, Geographer
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- Dr. Yagoub Abdalla Mohamed, Geographer,
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- Dr. Tag El Sir Ahmed,
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  National Administration for Water.
  Surface Water Expert.

Three research assistants assisted the team:

- Sayed/Saad El Din Ibrahim, Soil Expert.

- Sayed/Kamal Ahmed, Crop Production Expert.

- Sayed/Adam Dhaw El Beit, Research Worker on Marketing.

The methods of invesigation included:

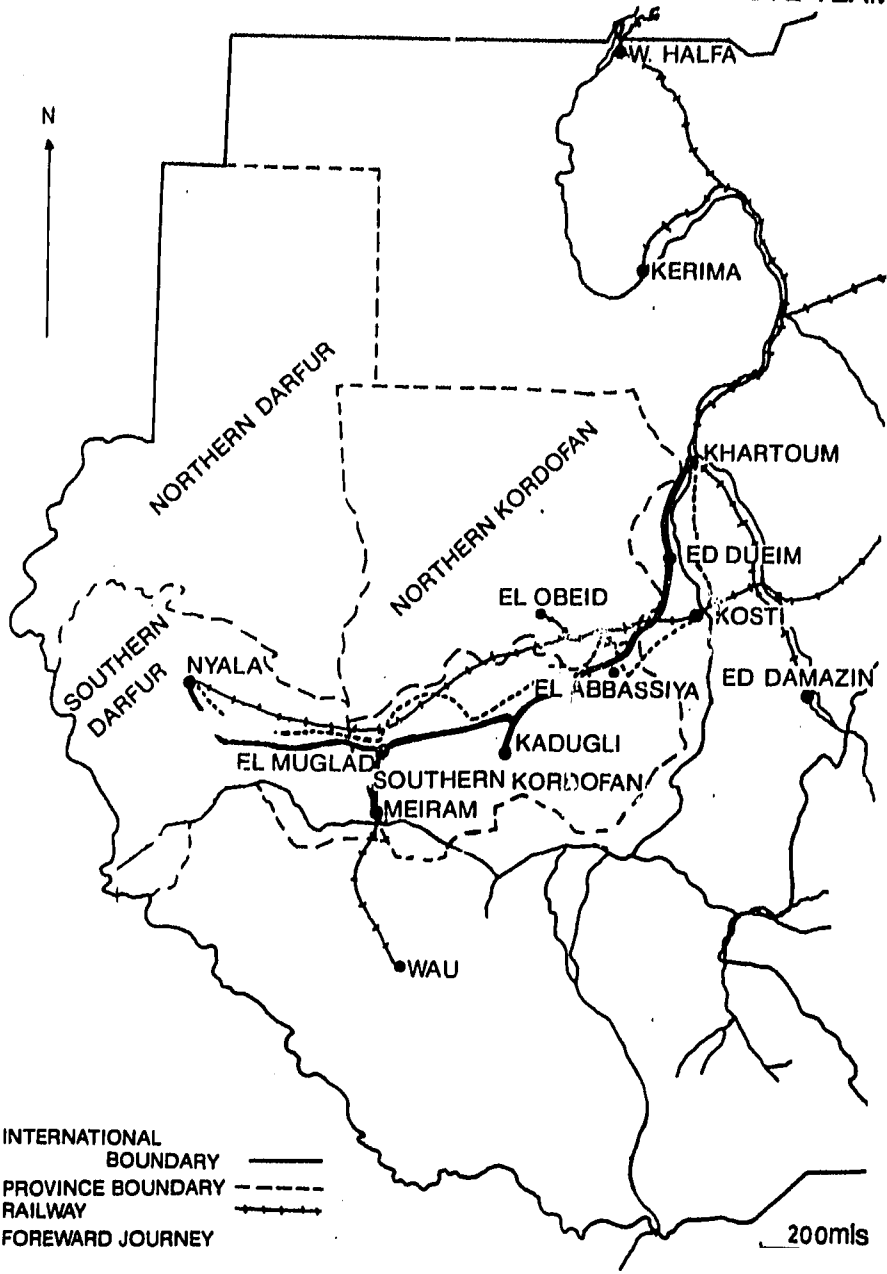
a) A review and examination of literature pertaining to the scope of work. Books, papers and important reports on geology, hydrology, hydrogeology, grazing resources, and marketing were consulted including reports by Hunting Technical Services, the Kordofan Special Fund, and government agencies;

b) Field trips including one major trip that lasted for 30 days between 23 November and 22 December, 1983. This trip covered most sections of the proposed SSR (Figure 1). The aims of the trips were:

   - to collect information and data from government offices and livestock markets,

Fig.1

ROUTE FOLLOWED BY THE SOUTHERN STOCK ROUTE TEAM



- to carry out interviews with producers, traders and agents, herders, and cultivators along the route,

- to measure and determine forage production at randomly located samples, using a 9.6 square foot hoop,

- to visit existing boreholes and hafirs along the proposed SSR route and to collect information on the conditions of pumps, engines, storage tanks, borehole yields, and hafirs,

- to visit veterinary centres and assess the facilities,

- to visit and discuss with professionals, administrators, politicians, and community leaders, the possible management problems of the proposed route.

Criteria for the Selection of the Main Southern Route and its Two Feeders

To select the appropriate main route and two feeder routes and to assess the potential socioeconomic, physical, and biological impacts, three major yet interrelated factors were considered. Each of these factors had been examined in light of the following:

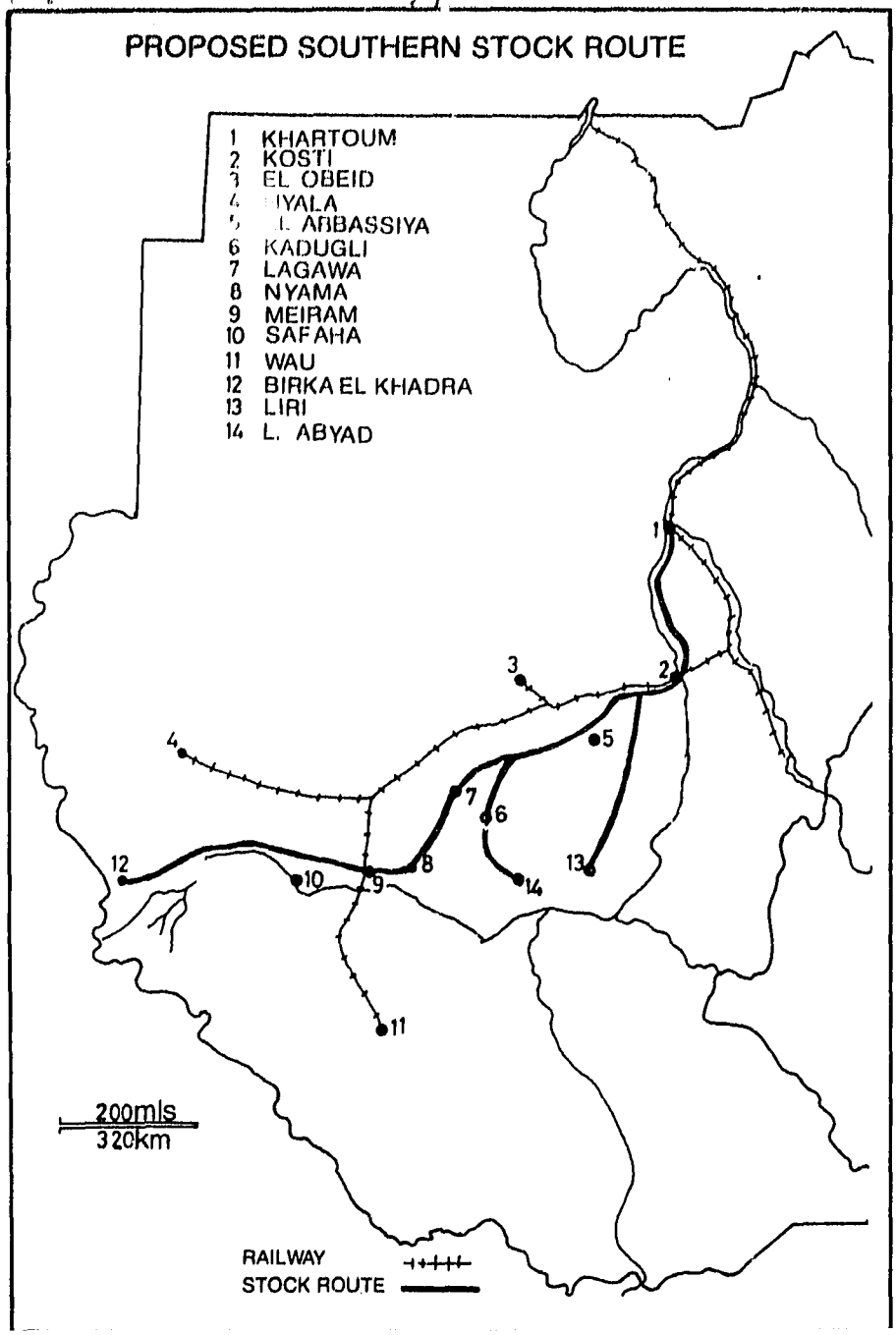
1. Adequate supply of livestock: This includes the physical presence of livestock along or near the route and the feeders as well as the willingness of the producers to sell during the dry season;

2. Technical feasibility of the route: This includes the possibility of finding adequate water, enough grazing and other feed without causing overgrazing, and the possibility of trekking livestock without spreading animal diseases along the different sections of the route;

3. Acceptability of the route: This includes economic acceptability in the sense that the cost of trekking animals along the route should be cheaper or, at least comparable to that along the NSR; social acceptability among the people (pastoralists and cultivators) who are using resources along the route, including acceptability by the potential users of the route, i.e., herders and traders.

It is understood that no route will satisfy all of these conditions. So the Team settled for a compromise that would best meet conditions for the route and looked into measures that would overcome the problems of the unfulfilled conditions.

Applying the criteria set above and after analysing the data collected in the field, the Team agreed on the main route and two feeders shown on Figure 2. The proposed main route is 40 kilometres wide and starts from Birka el Khadra/Lake Kundi south of Buram. It passes about 20 kilometres north of Bahr el Arab near the Baggara dry season concentrations of Habbaniya, Rezeigat, Messeiriya Humr, and Messairiya Zurg. Thus, the route will pass near Safaha, Meiram, and Nyama and, then turn in a northeasterly direction along Wadi Shalango to Lagawa. From Lagawa the route passes about 10 kilometres south of Habila where dry is then Abu


PROPOSED SOUTHERN STOCK ROUTE
1 KHARTOUM
2 KOSTI
3 EL OBEID
4 NYALA
5 L. ABBASSIYA
6 KADUGLI
7 LAGAWA
8 NYAMA
9 MEIRAM
10 SAFAHA
11 WAU
12 BIRKA EL KHADRA
13 LIRI
14 L. ABYAD
200mls
320km
RAILWAY
STOCK ROUTE

Karshola, Gardoud Nyama, and then south of Wad el Hadig to Kermal, Abu Rukba, Gadid, ending at Kosti. From Kosti the proposed route traverses the eastern side of the White Nile. Alternatives to this last section are either the trekking route west of the White Nile, or transporting animals by rail, steamer, or truck.

The proposed first feeder route starts near Lake Abyad and then goes near Lake Keilik to Kadugli and then joins the main route near Delami.

The proposed second feeder route starts from near El Liri and goes to Abbassiya, then east of Jebel Abu Dom, west of Goz Khadra and then joins the main route near Kermal.

Justification for the Route Selection

The scope of work mentioned "the proposed project area following the railway line from Nyala through or Rahad to Tendelti...." However, looking at the concentration of livestock during the dry season it was found that the area along or near the railway contains only about 25 percent of the total number of livestock in the project area. In contrast, the area farther south along and near Bahr el Arab has about 75 percent of the area's total livestock. Using aerial photos taken in April, 1975, Hunting Technical Services (March 1976) calculated that the Bahr and Ragaba land systems of the Rezeigat had about 1.5 million head of cattle and 0.4 million head of sheep out of a total of 2.49 million and 0.9 million head of cattle and sheep respectively in the whole study area. In the case of the Humr where settlement of nomads has not been on large scale, almost all the cattle (over one million head) move to the Bahr and Ragaba system at the beginning of the dry season. Figure 17 shows areas of livestock concentration of the Arab nomads during the dry season. Because the proposed route and its two feeder branches start from near Bahr el Arab, they are bound to tap livestock of the southern tribes which are now far away from any cattle route. Thus, relocation of the SSR route to a more southerly location makes many more cattle potentially available for trekking.

Two misconceptions about nomadic behavior must be mentioned: (a) that nomads are reluctant to sell animals because livestock have special functions, and (b) that nomads do not sell animals during the dry season. Although there are some grains of truth in these ideas, they have been exaggerated by many scholars, e.g., Cunnison. The fact is that nomads do sell animals if market prices are high enough and if access to market is easy enough. This behavior was demonstrated during the Second World War when meat was in great demand to feed the British troops in the Middle East. Prices rose sharply. The authorities began to worry that the high prices would drain away Sudan's animal wealth.

The point was also discussed at length with many stock producers when the SSR Team was in the field 40 years later. Producers made clear that once a male animal attains maturity or a female becomes infertile, the animal is available for sale and all or part of the earning is reinvested in buying young animals from other nomads who may be in need of money or from the tribes of southern Sudan. This practise allows the social prestige gained from animals to continue but on a commercially viable basis.

Producers also made clear to the Team that they sell part of their herds during the dry season. As evidence to this point, it was noted that many traders buy animals during the dry season and "store" them near water points until the first weeks of the rainy season when they can fetch a high price.

In spite of these testimonies, records of animal sales clearly show that the main selling is done at the beginning and end of the dry season. This can be explained by a number of factors. First, during the Condominium era the nomads were not allowed to cross into the wet grazing areas of the gozz until they had paid the animal tax. In order to pay the tax, herders used to sell some animals at the beginning of the wet season, despite the fact that the animals were not yet in their best condition. Selling at the end of the wet season was based on two factors: (a) the animals were at their best, and (b) the nomads needed money to buy items such as grain, sugar, and tea to last during the dry season which the nomads spend in the south where there are no proper markets for selling or buying. It should also be noted that the records in the various markets show that a substantial number of animals are taken to the markets throughout the dry season. However, only a few are actually sold because dry season trekking along the NSR is not possible and thus sales are few.

It can be concluded, therefore, that the opening of the proposed SSR and the two feeders will make trekking possible during the entire dry season. This will encourage traders to buy more livestock. In turn, these sales will put the producer in a better bargaining position as it will no longer be necessary to sell only at the end of the rainy season. It is estimated that about 300,000 animal units may be available for trekking should the SSR be opened.

Technical Feasibility of the Route

The water supply analysis shows that water can be made available in large quantities all over the SSR and its two branches. About 70 percent of the route lies across the rich Baggara Basin where boreholes can be drilled to yield large quantities of water. It is important to note here that numerous boreholes have already been drilled, (Figure 11) with no sign of the water table being lowered. Figure 12 shows the approximate location of 76 suggested new bores, spaced about 20 km. from each other. In the rest of the route, hafirs can be constructed. The approximate locations of 40 hafirs have been shown by Figure 12. In addition, the calculation made in this study shows that water can be provided at lower prices than along the NSR.

Analysis of the field data shows that there is adequate feed along the route from Birka Khadra to Kosti as well as along the two feeders, but at rates of production that vary between 0.1 and 0.26 tons per feddan, air dry. It has been estimated that the natural feed available along the sections of the route at 40 km. width would be sufficient for a total of about 790,000 animal units trekking during the 6 months dry season. In addition, the crop residues available are sufficient to accommodate another 930,000 animals for 6 months. All this is more than three times the number of animals estimated to be trekked along the route. However, to avoid overgrazing, a number of measures are suggested. These include:

1. opening of fire line grids and providing fire line guards;

2. reseeding in areas of high rainfall, where overgrazing has taken place;

3. reserving degraded areas;

4. establishing holding grounds;

5. bush-thinning where the kitir is dense.

But the northern stretch, i.e., Tendelti-Kosti up to Omdurman, which is common to both the SSR and the NSR has no pasture on either side of the river. It is therefore referred to as a critical area. The Team suggests that whatever feed may be available should be saved to feed local livestock. For trekking animals, irrigated fodder should be provided. It is therefore suggested that a series of six holding, feeding, and resting grounds (25 km.^{2} each) be established at 40 km. intervals. Given the total distance from Kosti to Khartoum at 240 km., stock would require 6 trekking days on an average of 40 km./day. Given need for roughly one day to rest for every 40 km. day of trekking, stock would require about 12 days to make the final portion of the journey.

Another consideration is livestock health. There are a number of fatal and wasting animal diseases in western Sudan. The high temperature, the comparatively high humidity, the large numbers of livestock, and the markedly long and widespread nomadic mobility have all conspired to raise the incidence of animal diseases in the region. These diseases can be classified as infectious, parasitic, and tick-borne. The most serious infectious disease is rinderpest which used to be known in the whole Sudano-Sahelian zone. Other infectious diseases include Contagious bovine pleuropneumonia (CBPP), Haemorrhagic septicemia (H.S.), Blackquarter (BQ), Anthrax, and Foot and Mouth disease (FMD). Parasitic diseases include Trypanosomiasis and internal parasites, while tick-borne diseases include species such as Ixodes, Boophilus and Amblyommae rhipicephalus.

The policy of controlling animal diseases dates back to the early years of this century, but took shape in active form only after the Second World War. Normally, the infectious diseases are controlled through the use of vaccination. The most serious disease, rinderpest, was almost eradicated when the Transnational JP-15 Campaign was started in 1960's. But due to relaxation of control measures (in turn due to shortage of funds and facilities) the disease broke out again in the late 1970's and early 1980's.

The possibility of livestock trade spreading diseases to different regions of the Sudan and to importing countries was considered a long time ago. The problem is generally solved in the case of the NSR by vaccinating animals at controlling points and issuing permits of movement. Animals intended for export must stay in quarantine at least 21 days for cattle and 7 days for sheep. The same procedure should be followed for the SSR. The policy should aim at ensuring health, well-being, and soundness of trekked livestock and to prevent the spread of disease. For this reason it is of vital importance to coordinate veterinary services of the SSR with those provided by veterinary

new posts be established, 28 mobile units be created, 26 dips be constructed, and 4 dip-strength monitoring laboratories be built. The veterinary and dipping services can be made available to trekking as well as to nomadic and settled animals on a payment basis.

Acceptability/Benefits

One of the most important considerations for the livestock traders and producers is whether the SSR will be of material benefits, and how these benefits will compare to those derived from the NSR. The benefits take two forms: (1) The cost of watering and trekking, and (2) how long capital will be tied up in the trek.

The calculations made in Chapter 4 show that water for one animal unit per day from boreholes and hafirs along the SSR will cost approximately 9.05 or 6 to 8 piasters.

Cost of Watering One Animal Unit/Day (piasters)

	NSR	SSR (Estimated)
Boreholes	(Black Market)	6 to 8 pt.
Hafirs	No hafirs	

Therefore, the saving in watering 1455 animal units per day from a borehole along the SSR equals (25-7.22) X 1455 = £S 258.7. In the case of hafirs, the saving in watering 1455 animal units per day equals (25-10) X 1455 = £S218.25. From this calculation it can be seen that estimated reduced water costs on the SSR can bring direct economic benefit (and incentives) to stock owners.

Transport costs along the SSR also appear to be advantageous:

Cost of Transporting One Animal Unit

NSR	Railway	SSR (Estimated)
Nyala-Omdurman	Nyala-Omdurman	Birka Khadra - Omdurman
£S 89.2	£S 73.1	£S 43.3

The second major consideration is length of time of the investment. NSR traders and merchants buy animals in the peak season but "store" some near water points until the next rainy season. This practise ties up capital for 5 to 7 months. But with the opening of the SSR, "storing" livestock

unnecessary as the route will be in use throughout the dry season. Year-round trekking will no doubt increase the turnover of capital. Furthermore, the availability of water, feed, and veterinary services along the SSR is bound to reduce ... tality among trekking livestock which presently amounts to about 10 percent along the NSR between December and March. After March, very few animals take the NSR.

It is expected that these material gains will be distributed among merchants, traders, herders, and producers. If the incentives to producers and herders are large enough, more selling will more than likely take place.

On the other hand, many of the traders and merchants are presently tied to the NSR. Traders usually live in towns such as Nyala or Ed Daein. In addition, many have other business interests to manage during the dry season. For the SSR, traders would have to live for many months near Bahr el Arab in order to supervise their livestock trade effectively. So many of the present traders may be against the SSR. If this opposition develops, it may be a blessing in disguise as the new stock route may allow the emerging small traders (gallaba) from the nomads to grow. To encourage these new traders, credit facilities should be provided.

The large merchants, most of whom live in Greater Khartoum, may find communicating with their agents and herders near Bahr el Arab rather difficult. This problem however can be solved if the SSR develops an efficient communication and information system as one of its components.

The producer who presently sells most animals at the end of the wet season will get two forms of material benefits: (a) part of the saving from the cost of trekking and watering, (about 10 to 20 percent of the total cost) is bound to go to him; (b) the producer will be in a better bargaining position as it will not be necessary to sell animals at the end of the wet season to buy his needs. Instead, he will sell any time during the year depending on his needs and the prices.

There is one factor to consider when weighing year-long sales. It was stated in IFAD's Report, (1981) that:

> ... if a considerable number of animals - say 20,000 - would be offered for sale in Omdurman during the peak of the dry season, prices might drop substantially, leaving insufficient incentives to trekkers. Export demand might provide an offsetting factor, if the animals are in good condition.

The present Team disagrees. Instead, the SSR will create sufficient incentives for sales throughout the year, independent of seasonal fluctuation in price. Furthermore, it is not likely that prices will drop, not only because of rising export demand, but also because the domestic human population is increasing and therefore requiring more meat and the SSR animals will reach Omdurman in good enough condition to command a good price.

Another issue of acceptability is land access. It is recommended that the width of the SSR be 40 km. This is bound to take land from both the nomads and cultivators. Theoretically speaking the nomads should not object because: (a)

the land is communally used and no one has the right to prevent animals from crossing, and (b) the nomads will benefit directly from the route as more animals will be sold and at a higher return to the nomads. In practise, however, the trekking animals will compete for grazing with the nomadic and settled animals and this creates potential conflict. The solution to this problem lies in making continuous improvements in the range so that the pastoralists, nomads, and settlers, feel that they are benefiting as a result of the total improvements.

Cultivators will also require attention. There are two types: traditional cultivators and owners of mechanized farms. Conflict may arise with both, especially in the over-cultivated and over-grazed area between Karmal and Kosti (traditional) and in the Habila area where the mechanized farms form a continuous block 40 km. X 40 km. However in the case of traditional cultivators, this conflict may not be as serious as first appears. The main crops, dura, dukhn, and groundnuts should be harvested by December/January, but watermelons may remain unharvested until the middle of March. After that date, the cultivators have no right to prevent animals crossing. Furthermore, many cultivators may find it profitable to sell crop residues and watermelon as feed for trekking animals.

The problem with mechanized cultivation is that the owners of the schemes will strongly object to land taken from them although they will welcome selling stalks to trekking herders and traders. The solution is that the route should go south of the mechanized farming schemes. Even so, there are still several potential problems and the entire conflict between trekkers and farmers should be discussed with the regional authorities to assure that: (a) no new schemes are developed near the route, and (b) rehabilitation programmes are introduced to bring already degraded agricultural lands back into use.

Another concern is social acceptability and security. There are no social inhibitions against livestock routes crossing different tribal territories. But sometimes there are tribal conflicts as was the case between the Rezeigat and the Humr in 1983, and currently between the Humr and the Dinka of southern Sudan. The problem here is that a herder from one tribe may feel unsafe when crossing the territory of a hostile tribe. The solution to this problem lies in provision of security administered by a fully equipped police force. It has to be mentioned here that security is not a problem specific to the SSR because problems are also experienced on the NSR.

Water access is still another dimension of acceptability. The SSR should have its own water points, boreholes and hafirs. These should be managed by a body different from the NAW or the regional authorities and allocation should be on a commercial basis. In theory, there should be no conflict between trekkers on one hand and the pastoralists and settlers on the other. However, in practise, conflict may arise because the water points currently managed by the NAW or the regional authorities are badly maintained and breakdowns of machines, lack of spare parts, and shortages of fuel and engine oil are common. Thus, there is always the possibility that the people living near the SSR may not find water in their water points. Sometimes the question of obtaining water may be one of life and death for the livestock of the local residents. Consequently, such people may be tempted to use force if they cannot get water by peaceful means. It should be a stated policy that the SSR water points are for the [illegible] in times of

the local people as a sign of good will on the part of SSR. But it should be remembered that no settlement is allowed along the 40 km. width of SSR.

A final issue of the SSR's acceptability is management. This report recommends that the SSR be considered a national project under one authority. The many components within the SSR, including provision of water, range improvements, veterinary and marketing services, and security forces must be carefully integrated in order to avoid conflicts. All these aspects are currently claimed by differet departments in the regional governments. Thus, conflict may arise unless adequate measures are taken to clearly define the regional and central responsibilities. With wise management this will not be a difficut task as the LMMC has already gained experience in dealing with such situations.

Conclusion

The following points can be stated as conclusions to this study. The SSR is:

1. needed.

There is a need to open a Southern Stock Route as the Northern Stock Route cannot operate during the dry months. NSR problems include water shortages along some of its stretches and inadequate natural pasture in a number of locations, due partly to desertification which the trekking animals themselves have created. Furthermore, the opening of the SSR will be nationally desirable as it will increase livestock sales during the dry months, thus relieving the present dry season shortages of livestock. Finally, the SSR will help in tapping the animal resources of Sudan's southern regions.

2. techincally feasible.

The opening of the SSR is technically possible because (a) water can be made available from boreholes and hafirs throughout the year and, (b) because there is enough grazing along all the route from Lake Kundi up to Kosti. From Kosti to Khartoum, irrigated fodder and other feeds can be provided from a 4,000 acre fodder farm to be established near Kosti.

3. economically attractive.

Trekking and watering animals along the SSR will be less expensive than along the NSR. The saving in the cost of trekking and watering will be shared among the producers, herders, traders and merchants.

4. in need of good management.

Some negative social and environmental impacts may result. Conflicts between trekking livestock and some users of the resources along the SSR are expected. This is especially so where overgrazing and overcultivation are likely, in areas of mechanized cultivation, and in zones of tribal conflicts. These potential problems will require good management.

5. of considerable potential benefit.

On the other hand, the route will have positive impacts on those living near it. Better facilities in marketing, veterinary services, and improvements in the range will be some of the benefits that will offset the negative aspects.

Given the potential direct and indirect benefits of the GSR, it is recommended that the project go forward. However, given the sensitivity of livestock issues in Sudan and the possibility of major land use conflicts developing, it is also recommended that an independent body be designated as "Project Monitory Unit." This unit would serve as a liaison group which would record trends in water, pasture, fodder, health, and pricing and would be in a position to recommend modifications in land use and livestock management practise to the project's managing body.

CHAPTER I

GEOGRAPHICAL BACKGROUND AND LAND USE

This chapter provides a general geographical background for the project area. Within this context, the following aspects are considered:

1) the importance of western Sudan in general and of the project area in particular as livestock raising regions;

2) the land use patterns in the project area, including livestock and crop production in the different sections along the suggested route;

3) potential resource use conflicts along the suggested route.

Western Sudan, The Main Livestock Producer in the Sudan

The term western Sudan is often used to mean the region west of the White Nile. It comprises the regions of Kordofan, Darfur and part of White Nile Province. This is the nation's main region for cattle, sheep, and camels. It is estimated that western Sudan produces 50 percent of all the cattle, sheep and goats and over 70 percent of all camels in the Sudan (Table 1). The importance of western Sudan in livestock production may be even greater than suggested in Table 1, not only because it has a large number of livestock, but also because the considerable animal wealth of southern Sudan (over 36, 19 and 17 percent of all cattle, sheep and goats respectively) remains largely untapped. A number of factors, including the long distances involved, the prevalence of many animal diseases, and the reluctance of the producers to sell their surpluses contribute to reducing the commercial importance of southern livestock.

Western Sudan's prominence in livestock raising results from a combination of physical and human factors. The central physical factor is the problem of the long dry season, consuming 6 to 9 months each year. This is related mainly to the climate, but the geology, topography, drainage, and soils also have their effects. The dry season assures that agriculture may be a risky business and that livestock raising or mixed farming/pastoralism is a more sensible use of the land and water resources.

Climat

In common with the other parts of the country, western Sudan has a tropical continental climate. Rainfall occurs in the summer months. Its annual amount, duration, and dependability decrease the farther north one goes. Temperatures, which largely determine the rate of annual evaporation, are high throughout the year, but as one moves northwards the summer becomes very hot and the winters more cool. The southern parts however, have less extreme temperatures. It is customary to divide the western Sudan into three zones

TABLE 1

LIVESTOCK NUMBERS IN THE SUDAN, BY REGIONS, 1980/81

Region	Cattle	Sheep	Goats	Camels	Animal Units
Northern	73,368	532,645	479,974	190,961	599,419
Eastern	860,933	2,025,252	1,608,868	75,363	2,680,816
Khartoum	72,069	331,648	504,940	15,705	293,586
Central*	3,759,976	5,028,925	2,813,245	299,166	5,243,647
Kordofan	3,047,090	3,686,120	2,794,608	975,500	5,304,470
Darfur	4,615,874	2,950,070	2,713,761	420,873	5,369,284
Total Northern Regions	12,429,310	14,554,660	10,915,396	2,660,568	19,491,222
Total Southern Regions	7,044,726	3,562,054	2,355,013	38,124	6,619,645
Total of Sudan	19,474,036	18,116,714	13,270,409	2,698,692	26,110,867

Source and Note: The Democratic Republic of the Sudan, Ministry of Agriculture and Irrigation, Animal Resources Economics Administration, Annual Bulletin of Animal Resources Statistics, No. 5, May 1983, p. 1.

* The White Nile Province is part of the Central Region.

1) The northern zone is semi-desert and the average annual rainfall is less than 300 mm, occurring from July to September. Rainfall is quite variable and in some years, as in 1983, the total annual rainfall may be very low and the time between showers may be too long to allow any substantial growth of vegetation. The zone may be represented by Sodiri where the average annual rainfall is about 250 mm., the average maximum (May) temperature is about 41°C while the average minimum (January) temperature is about 15.5°C. The average annual evaporation rate exceeds 2500 mm. Here cultivation is not practised on a large scale; the main occupation is raising camels, sheep, goats and a few cattle. This is the zone that supplies sheep for local consumption and sheep and camels for export. A short stretch of both the Northern and Southern stock routes falls within this northern zone.

2. The middle zone is part of the open savanna. Here the average annual rainfall varies from 300 to 500 mm., falling mostly from July to October. The zone is represented by En Nahud, El Obeid, Umm Ruwaba and Kosti. El Obeid has an average annual rainfall of about 380 mm., average maximum (May) and minimum (January) temperatures of 39° C and 13.5° C respectively. The average annual evaporation rate is about 2,253 mm. The middle zone is characterized mostly by settled tribes who practise rainfed cultivation and produce a variety of crops including sorghum (dura), millet (dukhn), groundnuts, sesame, and gum Arabic. The cultivators also raise some cattle and goats which graze near the villages while some are sent with the nomads. But there are also some nomadic tribes such as the Shanable and Hamar. The zone is also visited seasonally by the nomads from the north and south.

It should be remembered that a good part of the NSR crosses this middle zone and that part of the SSR, west of Kosti, falls within this zone.

3) The southern zone is part of the park savanna. The average annual rainfall varies between 500 and 860 mm. The zone is represented by Nyala, which is located on the northern fringe of the zone, Buram, Kadugli, and Radom which lies on the southern part of the zone. Kadugli has an average annual rainfall of 767 mm., most of it falling from May to October, average maximum and minimum temperatures of 38° C and 15° C respectively. The average evaporation rate is 2,187 mm. The zone supports large numbers of cattle nomads who raise many cattle and sheep. There are, however, a number of small and large settled agricultural communities which practise rainfed cultivation together with raising some cattle and goats.

This zone which supplies most of the cattle for the SSR will be studied further in the section headed Baggara Belt in this chapter.

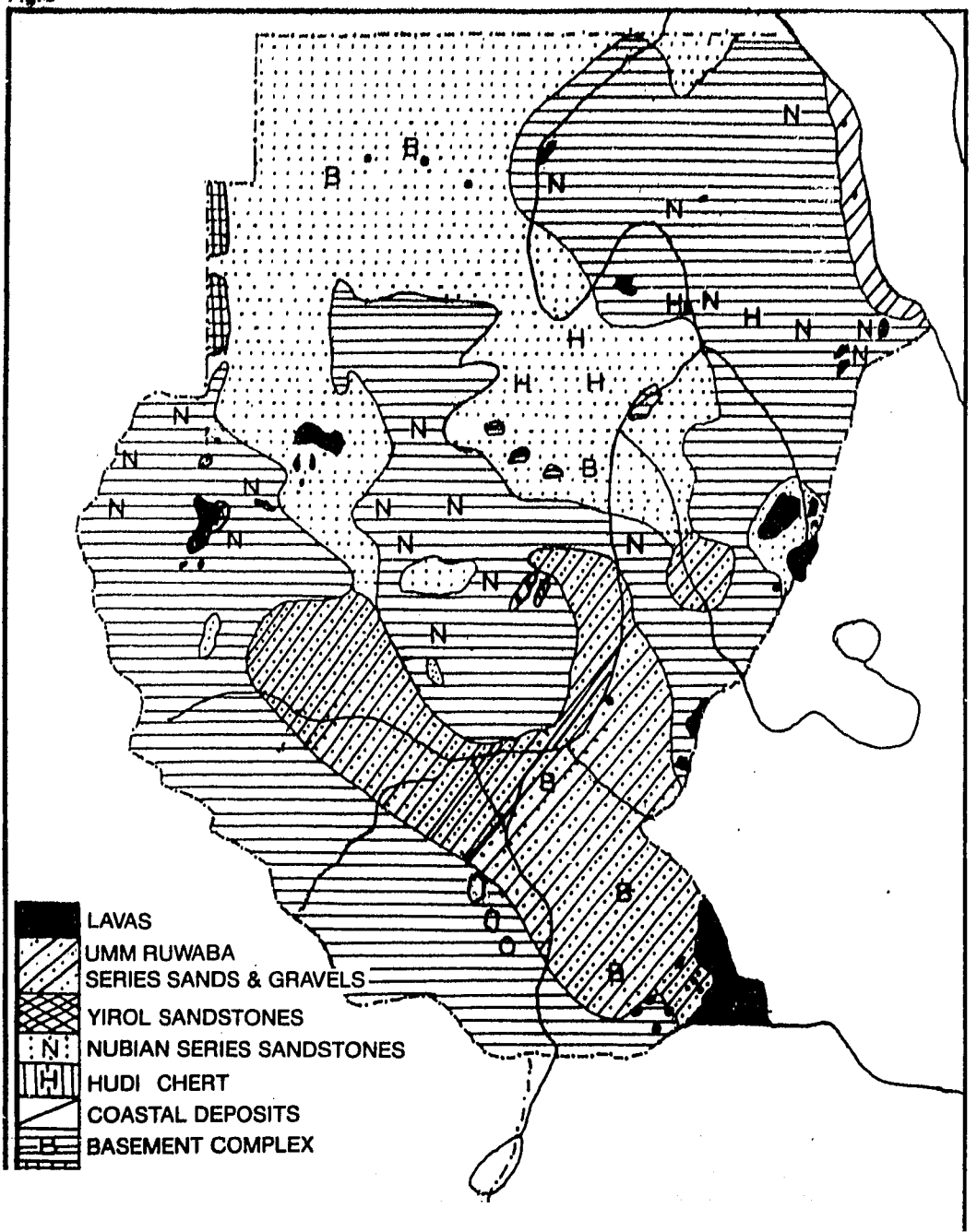
Geology

The basic geological formation of the Sudan is Basement Complex. It consists of a wide variety of rock types including granite, gneises and schists. None of the constituents of the Basement Complex rocks is water bearing. Thus, in areas where the Basement Complex outcrops are marked by thin layers of superficial deposits, underground water cannot be found except in areas where the rocks are fractured or weathered. Figure 3 shows the areas where the Basement Complex Formation outcrops or comes near the surface. It can be noticed that the NSR crosses part of the Basement Complex area, and it is here that water is unavailable during the dry season. The Basement Complex also outcrops or comes near the surface in part of the SSR. This is mainly in the Nuba Mountain region. But here hafirs can be excavated as the Basement Complex is impermeable and it is also covered by clays.

The Basement Complex however is marked in some areas by deep sedimentary formations of which the Umm Ruwaba and the Nubian Sandstone Series are important. The Umm Ruwaba series is made up of unconsolidated sands, gravel, and mud lying in a hollow or a basin upon the Nubian Sandstone and the Basement

Fig.3

GEOLOGY OF THE SUDAN



Rift Valley. The Umm Ruwaba is a water bearing formation, although water is not assured everywhere and the quality of water is not always good. About 70 percent of the length of the proposed SSR will cross Umm Ruwaba series where two rich water basins exist: the Baggara and Bara basins. The Nubian Sandstone is also a water bearing formation, but the SSR will cross only a small stretch of the Nubian Sandstone and this is in the northern parts.

Topography and Drainage

Western Sudan is mainly an undulating low lying plateau where the general elevation is less than 600 metres above sea level. There are two exceptions to this, Jebel Marra and the Nuba Mountains. Jebel Marra in western Darfur has a peak of about 3150 metres above sea level and the massif extends for about 50 kilometres east-west, and about 110 kilometres north-south. A number of water courses radiate from the mountain and have important effects on the availability of water. Important among these water courses are Wadi Azum, Wadi Tiwil, and Wadi Ibra. Water is obtainable from the vicinity and beds of these wadis by shallow wells. The Nuba Mountains are inselbergs and the highest peak is only 1407 metres above sea level. Yet the Nuba Mountains enjoy somewhat higher rainfall than the surrounding areas, and a number of important water courses, such as Khor Abu Habil and Wadi el Ghalla flow out of these mountains. Water can be obtained from the beds of these water courses as well as from the pediment of the mountains. In addition to the water courses that originate from local highlands, there are two other drainage systems: the Bahr el Arab/Bahr el Ghazal system which originates from the Sudan/Central Africa watershed; and the White Nile which originates from the East African plateau. The first is joined by channels locally known as regabas (Arabic neck) which take water to or from the main water course. Bahr el Arab/Bahr el Ghazal runs only part of the year, but forms scattered water pools during the dry season. These pools are extremely important to the Baggara nomads. The regabas are also important as shallow wells are dug in their beds. The White Nile, on the other hand, is a perennial river and it is used by both nomad and cultivators.

Soils

The soils of western Sudan are varied. In the northern parts some rocky and sandy soils dominate. In the middle zone, sand dominates although there are a few clay depressions. Because of the dominance of sand this zone is known as the goz land. The sand occurs in the form of sand ridges and sand sheets. The sand was deposited during the Quarterninary era and has been stabilized by vegetation. But where the vegetation has been removed, sand became mobile, especially the whitish sand. But there are some areas with reddish sand, indicating traces of iron, and these are more stable. As one moves southwards the occurrence of clay depressions increases at the expense of sand. So three ill-defined zones succeed each other. These are: the Baggara Repeating Pattern (alternation of sand ridges and clay depressions); the Regaba Repeating Pattern (where non-cracking clay dominates), and the Bahr el Arab clay plain. A general understanding of the soil distribution in western Sudan is important for a number of reasons. First, the types of soils determine to a large extent the drainage systems and the surface water. The sandy soil is

other hand, clays are less permeable and have many natural pools. Furthermore, clayey areas offer good hafir sites. Second, different soil areas with the same annual rainfall have different vegetation and salt contents. Third, clayey soils with comparatively heavy rainfall are a good breeding ground for flies.

Natural Vegetation

In the absence of highlands over most of western Sudan, the natural vegetation is a function of rainfall and soil types. The northern areas are semi-desert where the natural vegetation consists of herb, annual, and perennial grasses, and scattered bushes and trees. There are a number of grass types, the main ones being Aristida genus, while the trees are mainly of Acacia types. A number of vegetation types of high nutritional value such as Siha (Blepharis species) has been overgrazed and replaced by less palatable types.

The vegetation of the low rainfall woodland and savanna is composed of grasses and greater numbers of trees than in the semi-desert. The main grasses are: Aristida pallida, Andropogon gayanus, Cenchrus biflorus, and Eragostis tremula. Trees are mainly of Acacia types of which Acacia senegal is the most common as it is usually part of the cultivation rotation.

As one moves southwards where rainfall is comparatively high and the percentage of clayey areas increases, the vegetation changes. Although the vegetation of the moist sandy areas is more rich, its composition is similar to that mentioned above. The vegetation of the clayey areas is dominated by Acacia mellifera, Acacia seyal, Balanites aegyptica, and grasses such as Sorghum purpurea, Cymbopogon nervatus and Brachiaria obtusiflora. It should be mentioned here that: (a) as one moves south, the occurrence of broad-leaf trees increases. The dry leaves and the pods of acacias are utilized by the different animals; (b) that Acacia mellifera may become dense and thus reduce the undergrowth, and animals cannot penetrate it; and (c) that mechanized cultivation has resulted in the removal of the tree cover from wide areas, and when abandoned inferior types of grasses such a Sorghum purpurea dominate.

Population

The population of western Sudan is a mixture of Negroid, Arab, and Arabicized groups. There has been quite a lot of intermingling between these groups. Yet the people always identify themselves as either Arab or non-Arab. The Arabs have different tribes and these are spread all over the region. The non-Arabs are found in small and large pockets and they can be divided into two main groups: the Fur and the related groups in Darfur, and the Nuba who are found mainly in the Nuba Mountain region. The culture of Negroid stock is based on settlement and cultivation. On the other hand, the Arab culture is based mostly on raising animals.

During several centuries of contact between these groups, social intercourse has resulted. Some of the Arab tribes such as the Gawamma and Bedeiriya of Kordofan settled and currently depend mostly on cultivation although they still raise some animals. This process of sedentarisation is still
and is

and other services. The Negroid stock have become interested in animal raising as livestock provide additional income to the family, and acts as a safeguard against crop failure. The tendency to raise animals has increased as the water situation has improved. Not long ago some individuals from the Negroid groups acquired large animal wealth and thus found it necessary to adapt a nomadic life. This nomadization process has slowed down as the current public opinion seems to favour settlement rather than nomadism.

Land Tenure

Agricultural land belongs to the Government. However, the people have the right of use according to tribal customs. A person may cultivate a plot of land as long as he lives in an area, but he may lose rights to land if he leaves the area for a long period. Also, a person may raise as many animals as he likes and these animals may graze anywhere as long as they do not damage the cultivation of another person. It is also the custom that in rainfed areas, animals may graze anywhere after 15 March as by that date all crops must be harvested and cultivators may not prevent animals from entering or crossing the land.

The Baggara Belt

The Baggara belt is part of western Sudan. It comprises Southern Darfur, Southern Kordofan and part of the White Nile Provinces. This belt is the main concern of this study as it is the main producer and the main supplier of cattle that enter Sudan's trade (Table 1). Almost all the SSR from Birka Khadra to Kosti crosses this belt. Furthermore, due to the recent drought, the belt has attracted a large number of people and livestock and given them shelter. This migration has increased the number of cattle in the belt.

The main physical features of the Baggara belt were discussed in the previous section. In this section some economic, social, and land use details are added. The name Baggara, meaning cattle people, is given to signify the importance of cattle in the economic and social life of the people. Other animals, namely sheep and goats, are also raised, but cattle remain the principal animal. This is mainly because of the comparatively high annual rainfall, 500-860 mm. (Table 2), that produces rich vegetation cover which allows cattle to thrive.

Not only is there good rainfall in the Baggara belt, but the soils tend to be impermeable. Bahr el Arab/Bahr el Ghazal is a semi-perennial river, and there are a number of regabas and natural depressions that keep rainwater for some months after the end of the rainy season. Shallow wells in the vicinity of river beds and water courses produce water year round. In addition, the waters and the plants of the clayey soil provide considerable amounts of salts that animals need. On the other hand, the clayey soils turn to mud and provide breeding grounds for biting flies that irritate animals and transmit diseases including Trypanosomiasis.

TABLE 2

AVERAGE ANNUAL RAINFALL IN SELECTED STATIONS IN THE PROJECT AREA, (mm)

Month	Stations							
	Radom	Abyei	Buram	Kadugli	Habila	Nyala	Abbassiya	Kosti
January	0	0	0	0	0	0	0	0
February	0	0	0	2	0	trace	0	0
March	6	2	0	1	4	trace	0	1
April	7	10	8	14	7	3	14	4
May	81	65	45	90	17	25	49	18
June	140	113	97	107	95	54	83	47
July	157	131	171	162	174	122	149	111
August	241	213	218	154	235	162	187	143
September	169	110	122	144	117	81	124	60
October	62	31	38	90	20	18	159	22
November	0	5	0	3	0	0	1	1
December	0	0	0	trace	0	0	0	1
Total Year	863	680	699	767	669	465	660	407

The sandy soils are poor in surface water, especially in the dry season, and are saltless. But such soils are comparatively free from biting flies.

As a result of these differences between the clayey and sandy soils, the livestock owners developed the traditions of using the different parts of the belt in complementary ways. The southern parts where clays dominate are used during the dry season, while the northern parts where sand dominates and flies are not an important constraint, are used during the rainy season.

In general the Baggara belt can be divided north-south into three ecological zones of varying extent, based primarily on the distribution of soils, although the rainfall element is also taken into consideration. These zones show how the pastoral people utilize the whole belt.

(1) The sand zone (goz) in the north. This is the southern part of the mid-western Sudan. Here, there is very little surface drainage and the vegetation is saltless. However, the zone is free from biting flies. The main economic activity here is rain cultivation under settled conditions. The Baggara nomads visit this zone during the rainy season (July-October);

(2) The middle belt. This is a zone of alternation of sand and clays, referred to by Harrison as Baggara Repeating Pattern and by Hunting Technical Services as Baggara Land System. Here are short seasonal

junction between the clay and the sand is considered the best grazing in the zone. The zone is the dars (home) of the different Baggara tribes who visit it at the beginning and at the end of the rainy season. Here the Baggara practise their rainfed cultivation which, together with settlement, started to increase in the post 1960's period after the Nyala Railway was constructed and the water supply situation improved. The problem of shortage of water was solved by digging shallow wells (in southwestern Darfur) and boreholes in the Rezeigat-Humr region;

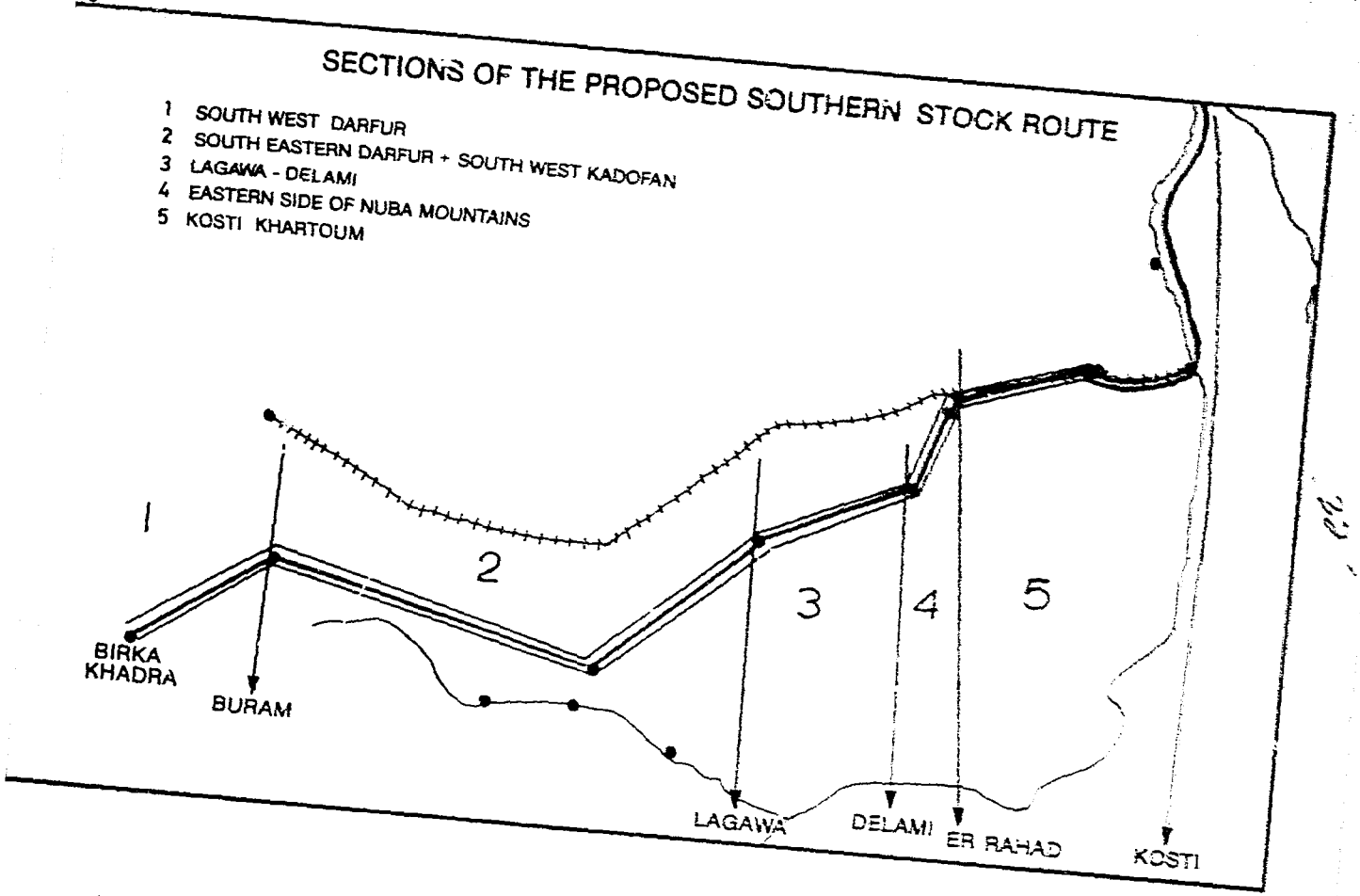
(3) The Bahr clay zone. This includes the whole clay plain north and south of Bahr el Arab/Bahr el Ghazal together with the regabas and depressions. The comparatively high rainfall and the clays encourage the breeding of biting flies during the wet season. The zone is utilized during the dry season by Arab and Nilotic pastoralists. The Arabs spend the dry season, December-April in the zone, usually north of Bahr el Arab, although some may also cross the river seeking good grazing. But the Arabs leave the zone and move northward as the rainy season continues and flies breed. The Nilotics occupy parts of the zone, especially the north and south of Bahr el Ghazal, during the dry season. But as some of these areas turn into swamps, the Nilotics take refuge in the slightly higher ground in the nearby areas. In general it can be said that most of the zone remains empty during the rainy season.

Land Use Pattern and Problems in the Project Area

The three north-south sub-divisions sketched in the previous section are not uniformally located over the whole project area. The Nuba Mountains, for example, create new conditions of topograpy, soils, climate, and populations. For this reason the belt is divided into five sections running from west to east, Figure 4. The objective is to discuss the land use patterns in the whole project area. The criteria for the divisions which follow are based on similarities or differences in the land use. Thus, the zones are to a large extent similar, but they are not identical to those used in the Chapter 5 on vegetation where the main concern is similarity in the plant cover.

Southwest Darfur. This is a section of varied physical conditions. The zone is characterized by a number of intermittent water courses that drain the south and the southwestern parts of Jebel Marra. These include Wadi Azum, Wadi Tiwil, and Wadi Ibra. Water can be obtained during the dry season by digging shallow wells in and near the beds of these wadis. The soils of the different parts show a marked difference. The northern parts, i.e., near Jebel Marra, are covered by tuft and sand that mask the Basement Complex formation. However, in certain areas the Basement Complex outcrops form rocky terrain. The sands (goz) extend southwards forming two extensive areas namely goz Dango and goz Gireida. But these two gozs are separated by two tongues of alluvial formation with some minor sand ridges. This may be looked at as part of the Baggara Repeating Pattern. It is here that important settlement represented by Rahad el Birdi, Idd el Ghanam, Tulus, and Buram have developed. To the south is the clay plain of Bahr el Arab.

Fig.4


SECTIONS OF THE PROPOSED SOUTHERN STOCK ROUTE
1 SOUTH WEST DARFUR
2 SOUTH EASTERN DARFUR + SOUTH WEST KADOFAN
3 LAGAWA - DELAMI
4 EASTERN SIDE OF NUBA MOUNTAINS
5 KOSTI KHARTOUM
1
2
3
4
5
BIRKA KHADRA
BURAM
LAGAWA
DELAMI
ER RAHAD
KOSTI

In 1974, Hunting Technical Services estimated the total population in Southwest Darfur to be about 135,000 persons of whom 18,500 were living in ferige (nomadic camps) and the rest (116,500) in proper compact villages. The overall human density was 6.5 persons per square kilometre. The population is made up of a number of Arab and non-Arab tribes. Of the first category, the most important are the Ta'aisha, Beni Helba, and Habbaniya while the non-Arab tribes include the Gimir, Birgid, Daju, Fur and Messalat, and Fellata.

The Arabs together with large section of the Fellata were originally nomads, raising cattle and sheep. However, since the early part of this century some groups of those nomads began to settle as they lost their animal wealth during the Mahdiya regime 1881-1898.* The settlement was made possible because water was available from shallow wells. The tendency for settlement increased after the Second World War when a programme for provision of rural water was started. At present, the majority of the population are settled and practise rainfed cultivation, while the nomads and semi-nomad (those who live in ferige) form about 14 percent of the total population.

The settled and nomadic population use one integrated economic system, based on cultivation and livestock. This is also the economic base of the non-Arabs except that these tribes emphasize their cultivation more than their livestock although some households have large herds. On the other hand, the majority of the non-Arabs have small herds that will not support their owners entirely through livestock.

Cultivation for both Arabs and non-Arabs is basically subsistence, producing dukhn and dura while commercial groundnuts became important during the last decade. A family plot is usually small, about 5 hectares, two-thirds of which is normally put into subsistence crops. Yet, there are variations in the size of holdings, according to the type of soil, availability of water, and population pressure. In the alluvial areas near Buram, the cropping areas average 3 to 4 hectares while in Goz Dongo, plots may increase to 6 to 7 hectares. Animal manure is used where land is scarce. Cultivation inputs are small, based upon unimproved seeds, labour, and hoes. Accordingly, outputs are small. Nevertheless, most of the population in this section consider the returns from cultivation to be greater than from livestock. The cultivators think of livestock raising as complementary to crops as animals provide milk, meat, and additional income to that derived from cultivation. For this reason, most of the settled population keep a few animals. These stay year-round near the water points which have increased during the last few decades. But some of the animals are moved seasonally to good grazing, either under the care of hired herders or together with nomads.

The nomadic and the transhumant pastoralists have regular seasonal movements, but there are variations in the direction each tribe takes. The Ta'aisha spend the wet season, June-October, in their dar (homeland), around Rahed el Birdi. Here, there is usually good grazing on the contact zone

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* The Baggara were supporters of the Mahdiya, and they formed the core of the army of that regime. The Khalifa himself was from the Ta'aisha tribe.

between the goz and the clay. Cultivation is widely practised and, together with rising population, has led to reduction of the grazing grounds. Reduced grazing land is also a problem for other tribes. As the dry season sets in and surface water dries, the Ta'aisha move southwest toward Bahr Oulou in the Republic of Chad. They stay there from December until May when rains start and flies appear.

The Beni Helba spend the rainy season on the goz of southern Jebel Marra. As the dry season deepens, the surface water of the goz dries and the Beni Helba move to their dars in Idd el Ghanam and the surrounding areas. There, they find water in wells dug in the beds of Wadi Ibra and its branches. In January, however, they move to the western slopes of Jebel Marra where water is available and there is good grazing, making use of the pods of the Acacia albida (Haraz). Once the rainy season starts, the Beni Helba move away to the goz to avoid causing damage to the Fur cultivation.

The Fellata tribe is composed of both cultivators and pastoralists. The difference between the Fellata and the Arab tribes is that the Fellata take their cultivation more seriously and the nomadic sections leave the families in the dars while men move after the livestock. Furthermore, the Fellata, although they move north-south to Birka Khadra near Bahr el Arab and the goz, may also move west-east crossing the dars of other tribes. In doing so they look for good grazing for their animals, regardless of the tribal boundaries.

The Habbaniya, like other tribes, have many settlements, and cultivation is practised on a large scale around Buram. But both the settled and the nomadic Habbaniya raise large numbers of white cattle for which they take special pride in the colour. This type of cattle also has a good reputation among livestock traders because it responds quickly to feeding although it is a weak breed if long treks are taken. The Habbaniya nomads spend the wet season in the northern goz, north of Nyala, while they spend the dry season around Lake Kunde. The distance, compared to other nomadic tribes, between the wet and dry season grazing is not long and perhaps this is one reason why the Habbaniya cattle are not strong enough to walk long distances.

Concerning the proposed SSR, it is clear that a high percentage of the nomadic animals, mainly cattle of Ta'aisha and Beni Helba, will not be available for sale during the dry season near Birka Khadra, the starting point of the SSR. The cattle will be either in Bahr Oulou, in Chad, or on the northern goz. On the other hand, the Fellata and Habbaniya cattle of both settled and nomadic sections will be available in their dry season grazing area or in the dars which are not far from the starting point of the SSR. In 1974 Hunting Technical Services estimated that these animals numbered 600,000 head of cattle and about 60,000 head of sheep.

Southeastern Darfur and Southwestern Kordofan. The western limit of this section is the border with southwestern Darfur (above section) while the eastern limit is the Nuba Mountains. The section under discussion is an extensive one, but is treated here as one region for several reasons: (a) the physical features are similar, (b) throughout most of the region animal raising is the most important economic activity, and (c) it is the region of the largest and the most prosperous cattle raisers in all of western Sudan. These include the Rezeigat, the Messeiriya Humr, and Messeiriya Zurg. Dar Reizeigat alone supports more than 2.5 [illegible] head of cattle and about [illegible] head of sheep

while the Humr own more than a million head of cattle. In addition to the large tribes, there are small tribes such as the Maaliya, Birgid, Dago, and Nuba. The Maaliya are of Arab descent but live in permanent settlements while keeping a large number of transhumant livestock. The Birgid, Dago, and Nuba are non-Arabs who practise settled, traditional agriculture but who keep some cattle.

The Rezeigat, until 1940, were predominantly nomads with no permanent settlements. They lived in seasonal camp sites such as Ed Daien, Sibdo and Abu Gabra. Lampen, in 1934, described the Rezeigat as "hardly cultivate." But since then, and especially in the early 1960's when the Nyala Railway was built and many boreholes drilled, cultivation and settlement developed. Settlements such as Abu Gabra, Abu Matariq, Gimeilaya are large villages by any Sudanese standard, while Ed Daein developed into a comparatively large town of over 30,000. By 1956, when the first population census was taken, 51 percent of the people of Dar Rezeigat were classified as settled and only 49 percent as nomads. Since then the percentage of the settled population has increased. Cultivation is mainly for subsistence, producing dukhn and sorghum, though commercial crops, mainly groundnuts, are also grown. Holdings are small, about 3 to 5 hectares. Between two-thirds and three-fourths of the holdings are used for subsistence crops. Some wealthy families hire labourers (mostly from the visiting Dinka) and cultivate up to 20 to 25 hectares. But both inputs and outputs are small. The Rezeigat derive modest cash income through taping gum Arabic (Acacia senegal). The cash is used to buy items such as tea, sugar, and clothing. This cash has enabled the pastoralists to keep their animals until they mature in body weight and fetch high prices.

During recent years, Dar Rezeigat has become one of the large groundnut producers in Sudan. Most of the crop is decorticated in Ed Daein and then exported to Khartoum. However, part of the groundnuts are crushed locally in Ed Daein and Nyala and most of the oil cake is exported. In future, the cake and the shells may be used locally as feed for the animals.

Despite the fact that settlement is increasing, nomadism is still alive and animal raising is still the main economic activity of the section. At present cultivation and animal raising are two parts of the same economy as most families split into two sections, one to cultivate while the other to look after the animals.

Movements of the nomads include long and short distances, depending on the herd size and the availability of pasture. During the wet season, the Rezeigat graze the goz north of Ed Daein and may go as far north as the latitude of El Fasher. But when the rain stops and the water pools begin to dry up, the Rezeigat move southwards to their dars in Abu Materiq, Sibdo, and others. There they stay for 2 to 4 weeks to help harvest crops. They then resume their movements to regabas and Bahr el Arab which they reach in December. There they make their camps while the animals move between the watering and grazing areas. In April, when the grazing becomes scarce and the health of the animals weakens, rain starts to fall in the area south of Bahr el Arab. Formerly, the nomads used to take some of their animals south for the young grasses, leaving their families in the camps. In recent years, however, this tradition has fallen away as the relationship between the Rezeigat and the Dinka has become strained. Instead, when the rains begin north of Bahr el Arab, the nomads, together with their animals and families, move northward to the dars where they

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The Messeiriya Humr are another important cattle people. They make contact with the Dinka in the area of Abyei, Abyemnom, and Umm Shebushaya. But unlike the Rezeigat, settlement and cultivation are not so important and they remain predominantly nomadic with only a few villages such as Muglad, Babanousa, Abu Batikh, and Meiram. The few who do cultivate practise subsistence agriculture near and around Muglad, and along Wadi al Hagiz and Wadi El Ghalla. However, some commercial cultivation is taking place in Abu Batikh (west of Muglad) and in el Meiram (in the southwest of the region). In both areas, groundnuts are the main commercial crop. Watermelon is grown in Meiram and exported to Kosti and Khartoum. Some cotton is cultivated around Nyama and north of Lake Keilak.

The migration routes of the Humr are oriented north-south and northwest-southeast. During the rainy season, they graze their animals around Babanousa and el Fula. But when the water pools dry after the rain, the Humr start moving south. They stop for 2 to 4 weeks in areas where they cultivate and help in harvesting the crops. Then they fan out in a south and southeasterly direction in a wide belt from Tigil and Grinty to Umm Shebushaya, along Bahr el Arab and its regabas, mainly regaba Zerga. The Humr stay there from December to May when the rains start and flies appear. To avoid the biting flies, the Humr move northwards towards the goz. The tradition of grazing the livestock in the area south of Bahr el Arab is no longer practised for security reasons as the relationship between the Humr and the Dinka is currently strained.

When the Rezeigat and the Humr (as well as the other Baggara) are near Bahr el Arab and the regaba region, they burn the tall dry grass to initiate green regrowth and to kill ticks and snakes. During the early dry period when there is plenty of water and grazing and the livestock needs little care, the nomads gather together in their campsites for social activities and relaxation. But as the dry season deepens, the distance between the grazing grounds and the water points increases and animal health deteriorates.

The Messeiriya Zurg are a comparatively small group. They occupy the clay plain west of the Nuba Mountains as well as the local clay plains surrounding some of the western mountains. The Zurg region is therefore predominantly clayey with little variation except for the rocky areas, which are not used by the Zurg, and except for the restricted sandy area near El Fula. Such a region is not suitable for raising cattle, although some livestock do graze here. The Zurg have mixed with the Nuba of the Nuba Mountains where both peoples first came into contact. Originally the Zurg were nomads, but since 1924 when cotton was introduced, the Zurg developed a taste for cultivation settlement. They cultivate both subsistence and commercial crops, including cotton and groundnuts. Each family cultivates only about 3 to 5 hectares because the agricultural work depends on the family labour which is in short supply. In addition, the clayey soils are difficult to work, the agricultural implements are small, and the inputs are limited. The cultivated plots are also scattered and do not form a continuous belt.

The Zurg also raise cattle and sheep which are grazed on the goz near El Fula during the wet season and along Wadi Shallengo during the dry season. But some of the Zurg go southwards to Lake Keilak and Lake Abyad. For the Zurg, the seasonal migration routes are comparatively short except for those who go as far as Lake Keilak and Lake Abyad.

Lagawa-Delami. This section covers the bulk of the Nuba Mountains and their northern and southern clay plains. Over 65 percent of the total population are settled Nuba. Originally, for security reasons the Nuba settlements were on the mountains. But from the beginning of this century, the Nuba began to occupy the foot of the mountains. Agriculture is their main occupation. They cultivate part of the clay plain where they grow dura, groundnuts, and cotton which was introduced in the region in 1924. They have recently begun to terrace the lower parts of the mountains where they grow fast maturing varieties of dura, maize, and vegetables. The Nuba raise some cattle and goats and the non-Muslims raise a few pigs.

The rest of the population are Arabs of whom two groups are the most important, the Hawazma and the Awlad Hemeid. Like the other tribes of western Sudan, these people were originally nomads. But many have settled and started to cultivate dura, groundnuts, and cotton, the same as the Nuba. These former nomads still keep comparatively large numbers of livestock, some of which graze around the villages while the large herds are sent away with the nomadic relatives or with hired shepards. Those who have not settled also practise small cultivation but the main emphasis is on raising livestock. The nomadic movements are generally in north-south and south-easterly directions. During the wet season the nomads move to the goz belt in the region of El Obeid-Er Rahad. In the dry season they retreat southward to Lake Abyad and as far south as Bahr el Ghazal and to the southeast to Kaka near the White Nile where they come in contact with the Shiluk.

Recently two important changes have taken place in crop production: (a) modernization schemes, initiated by the State, have introduced tractors to produce more cotton. Each farmer receives 6 to 8 hectares (2 for cotton, 2 for subsistence crops, and 2 to 3 to remain fallow). The Nuba Hills Cooperation provides tractors and ploughs as well as the land on a payment basis, on condition that the farmer cultivates 2 hectares in cotton. These modernization schemes are available only in some of the larger villages where the soils are good. The total area in the whole of the Nuba Hills Corporation is not more than 15,000 hectares; (b) Rainfed, mechanized, large-scale cultivation, where holdings are usually 500 hectares and over. The present number of these schemes in Habila-Kortala is 209 with a total area of over 175,000 hectares. These are referred to as planned schemes. In addition, there are over 20 schemes referred to as out-of-plan schemes, i.e., approved by the local authorities in contrast to the schemes that were planned and allotted by the Mechanized Agricultural Corporation in Khartoum. The main idea behind developing mechanized cultivation is to produce large quantities of dura to fill the possible gap between grains produced by the traditional cultivators and the needs of the people of western Sudan. Although there is a State-owned farm with an area of about 27,000 acres, the great majority of the schemes are privately owned. The owners are mostly rich traders from towns such a El Obeid and Kadugli. However, there are a few farms owned by elite of the local tribes, mostly from among the Arabs.

The mechanized schemes produce dura. They may provide an advantage for the SSR in that the dura stalks, available in December, may be used as feed for the trekking animals. Normally these stalks are burned. However, there are two problems:

(1) Harvesting is done by hand and continues for 2 to 3 months, depending on the availability of the labourers. Getting stalks to the trekking cattle becomes a problem. The schemes form a solid block of about 40 kilometres in length and the same distance in width. In theory, the planners of the schemes set aside narrow corridors for the nomadic livestock moving north-south. But they made no allowance for livestock moving west and east, i.e., trade cattle. The proposed SSR is therefore planned to go south of the schemes. In practise however, even the north-south paths have been blocked by scheme owners, a fact that causes frustration and conflict for the nomadic Messeirya Zurg, Hawazma and Awlad Hemeid. But given that even more dura is needed to satisfy the increasing population, and considering that local authorities need revenues, more licences will most likely be issued for more schemes which will expand southwards and east-west, into the very areas where the proposed SSR would go.

(2) These schemes produce dura with no allowance for fallow cycles and no diversification of crops. It is predominantly monoculture cultivation. Thus, the land quickly loses its fertility. Many schemes are already abandoned with the result that inferior types of vegetation have invaded the fields. Furthermore, there is a possibility that some of the less successful scheme owners will try to exploit the situation by planting a poor crop, hoping that the trekking animals will enter the field and cause damage. Then the scheme owners ask for compensation. This trick is practised along the NSR by some of the traditional cultivators who always hope that the local courts will side with them, against the livestock traders.

To counter these problems, it is suggested that:

(1) an agreement be made between the SSR authorities, the Union of the scheme owners, and the local authorities to open an east-west corridor. This may provide an advantage to the scheme owners as their stalks which are presently being burned may then be sold to trekkers.

(2) an agreement be made with the local authorities that no southward expansion of the scheme be made before opening proper east-west trekking corridors.

The Eastern Side of the Nuba Mountains - White Nile. This section is made up of 3 regions put together:

(1) the Eastern side of the Nuba Mountains. This area consists of mountains and cracking clay plains.

(2) the western White Nile clay plains where there are some gozs, and,

(3) the alternating goz and clay plains between the railway and the mountains.

The eastern Nuba Mountains are occupied by the Nuba people who are settled to the Nuba who live on the side. They keep

livestock and some pigs (for non-Muslims). Modernization schemes and rainfed mechanized farming have been introduced. The first is in the plains surrounded by inselbergs while the second lies in the plains northeast of El Abbassiya. The total number of these schemes is 85, each with an area of about 750 hectares. A similar number of schemes is located in the Migeinius area. These schemes are bound to increase in the future as more grain will be needed to feed the increasing population.

The White Nile clay plain is home for the nomadic Selim and Ahamda. The region has provided grazing grounds for the nomadic animals for many years. In the 1950's, irrigated agricultural schemes were developed to produce export cotton as well as some dura. As a result, many nomads have settled in permanent villages and acquired hawashas (agricultural plots) although most continue to raise some animals. Those who still practise nomadism have modified the older north-south migration movements between Kosti and Kaka. Because the irrigated plots block the old route, the nomads now spend the wet season in the clay plain north of Abbassiya while some go north to the goz area south of the railway. As the dry season sets in, most nomads go south near the White Nile and the Shiluk area.

The area south of the railway consists of goz and clay rocks. It looks very much like the Baggara Repeating Pattern of the Rezeigat, but here the rainfall is less than in the Rezeigat area. The Habbaniya and the Gimi occupy the region. These are former nomads who settled and began to cultivate subsistence crops. The region is characterized by a dense network of villages, separated from each other by open space of about 7-10 km. Almost all the goz lands are either under annual cultivation or under fallow. Because of population pressure, overcultivation is common. The residents continue to keep some cattle and a large number of sheep which graze around the villages. They also own large herds of cattle which are sent away with other nomads or with hired labour.

The nomadic groups spend the wet season north of the railway and trek in a northwesterly direction near El Obeid and er Rahad. But as the dry season arrives, they move toward Skirkeila, Gadid and as far east as Kosti. Some also travel south to Abbassiya and beyond.

Since the rains began to fail in the late 1960's, more and more of the northern nomads began to visit the goz and go as far as Abbassiya. Thus, the clay plain north of Abbassiya became a wet grazing ground for Selim and Ahamda (of the White Nile) and a dry season grazing for Habbaniya, Gimi, Shanabla and others. Thus, these sections became heavily overgrazed.

This section of the eastern Nuba Mountains is important for trade in both cattle and sheep in contrast to the previous sections where cattle trade dominates. Sheep are important for two reasons:

(1) The peoples of this section, even the Baggara Selim and Ahamda raise large numbers of sheep in addition to cattle. This is also the case with the Habbaniya and Gimi of the goz. The main reason is that mutton finds good markets in the urban centres. Furthermore, the large number of Shanabla and Hassaniya that started to come to the section from north of the railway are traditionally interested in sheep.

(2) The distance between any part of this section, except the very southern parts, and Kosti/Khartoum is comparatively short. It is easily within the ability of sheep to travel to these markets on the hoof. This is in contrast to the long trekking distance between Southern Darfur and Kosti.

However, the eastern Nuba Mountains has three problems for the main stretch of the SSR and its Abbassiya branch. These are:

(1) The trek corridors through the mechanized rainfed schemes of Abbassiya are only a few metres wide, and allow the animals to trek, but not to graze. The solution to the problem lies in either: (a) bringing fodder from other areas to this part, or (b) finding a means to bring the abundant supplies of dura stalks from local farmers.

(2) The stretch along the main SSR is densely settled, heavily cultivated, and already overgrazed. Therefore, the stretch that lies along the main SSR should be considered a critical area as far as animal feed is concerned. The problem may be solved however, if a fodder farm is established in the irrigated schemes near Kosti and fodder is transported to points where it is needed. Even more appropriate would be an intensive rehabilitation programme to restore the overgrazed areas. This is feasible because the annual rainfall is over 400 mm.

(3) Although the traditional farmers are accustomed to livestock crossing their land, and although traditional law grants such trekking rights, the large number of animals trekking may cause some tensions. This is because those animals will compete for grazing in an area already overgrazed. It is therefore suggested that the SSR, particularly in this section, be clearly demarked by a decree and be discussed thoroughly with local farmers.

The White Nile North of Kosti. The NSR uses the goz west of the White Nile, while the last section of the proposed SSR is to use the eastern side of the river. Thus, this part of the study deals with both sides of the river as one region.

The White Nile is known to have a shallow and wide trough. On the western side, the river has low banks that become ill-defined from Kosti to near El Alaga, about 140 kilometres south of Khartoum. From El Alaga northward, the Nubian Sandstone formation forms comparatively high banks and this confines the river channel. On the eastern side, the banks are also comparatively high. Thus, throughout its history the river was able to build an extensive riverain flood plain, especially where the banks are low or ill-defined, i.e., between Kosti and El Alaga. West of this clay plain are sand dunes which are extensions of the goz of Western Sudan. On the eastern side lies the extensive Gezira clay plain where the Gezira Scheme and its Managil Extension have been developed.

Originally, the population of both sides of the river were semi-nomads. But the western side favoured livestock raising more than the eastern, primarily because of variation in the soil and the fact that extensive areas were [illegible]ually [illegible]ooded by the [illegible] The [illegible]ainly

Baza, and Gimi) used to move westwards to the goz during the rainy season. There they cultivated dura and grazed their animals. This movement was dictated by the fact that the White Nile flood plain was inundated by river water from July to October. During the dry season (October-July), and when there was no water on the goz, the nomads used to move eastwards to cultivate the areas from which the river water receded. There, they also found good grazing for the animals. The construction of Jebel Aulia dam in 1936 put large areas under water from July until April, thereby depriving the people of grazing and cultivable areas. But the raising of the water level made lifting of water easier and that was the start of large-scale pump irrigation schemes in Kosti and Ed Dueim regions. The irrigation made cotton the main crop but dura and wheat are also grown. Most of the people settled down and permanent villages grew. Yet the raising of livestock, mainly cattle and sheep, remained important and the east-west movements between the goz and the river continued, but under a transhumant system rather than a nomadic one. However, the establishment of pump schemes blocked the livestock routes to the watering sites on the river despite the fact that arrangements for corridors were made. Nevertheless, animals may reach the river in April after cotton is picked.

During recent years, two important changes have taken place:

1) The returns from cotton have become so low that the farmers are less interested in its cultivation, a trend which may facilitate the conversion of some schemes to fodder production. In fact this was one of the recommendations made by a high level conference held in 1982 to look into the future of the White Nile Pump Schemes;

2) The making of white cheese became an important activity on the goz from Kosti to near Khartoum, a fact that has encouraged many of the people to raise more cattle.

Due to the large number of animals raised by the local people, the continuous cultivation of the fragile sandy soil, and the large number of commercial cattle annually trekked to Omdurman, the goz of the White Nile has become seriously desertified. This, coupled with the Sahelian drought of the late 1960's to early 1970's has created a serious situation. In November, 1983 when the Team investigating the SSR visited the area between Omdurman and Tendelti, the Team observed that extensive areas were without vegetation cover and that many of the people moved with their animals southwards to Shirkeila, Gadid, and Abbassiya. The only exception where there was good vegetation cover was the area of Baja, southwest of Ed Dueim, and that was because the area is waterless during the dry season as it is a region of Basement Complex Formation. It is therefore recommended that the SSR avoid the western side of the White Nile.

The eastern side of the river is also highly overgrazed by the livestock of the river people and of the people of the Gezira Scheme who keep their livestock outside the scheme boundaries during the growing season (July-April). But the eastern side of the river has an advantage in that a tarmac road between Khartoum and Kosti is almost finished. This road can be used for transporting fodder from the proposed irrigated fodder farm to the livestock at their resting stations. Animals can also be transported by truck if need arises or by river transport or railway. The last alternative will make it pos [illegible] to utilize the [illegible] wagons more [illegible] as the [illegible] will be

CHAPTER II

SOCIO-ECONOMIC ASPECTS OF THE PROJECT AREA

Methods of Investigation

The project area of the Southern Stock Route (SSR) covers wide sections of western Sudan in Darfur and Kordofan regions as well as parts of the White Nile Province. The zone provides a large share of Sudan's agricultural production where most of the traditional products such as groundnuts, sesame, millet, sorghum, and gum Arabic are produced. Given the importance of the proposed stock route, impacts on social and economic development of the area must be considered. This section aims at discussing these impacts with particular emphasis on:

1. Identification of areas of social conflicts between sedentary and trekking herders;

2. Determination of how much land will be taken from traditional producers if trekking animals use water and pasture near villages;

3. Analysis of the impact of lost land or pasture on traditional producers and their animals;

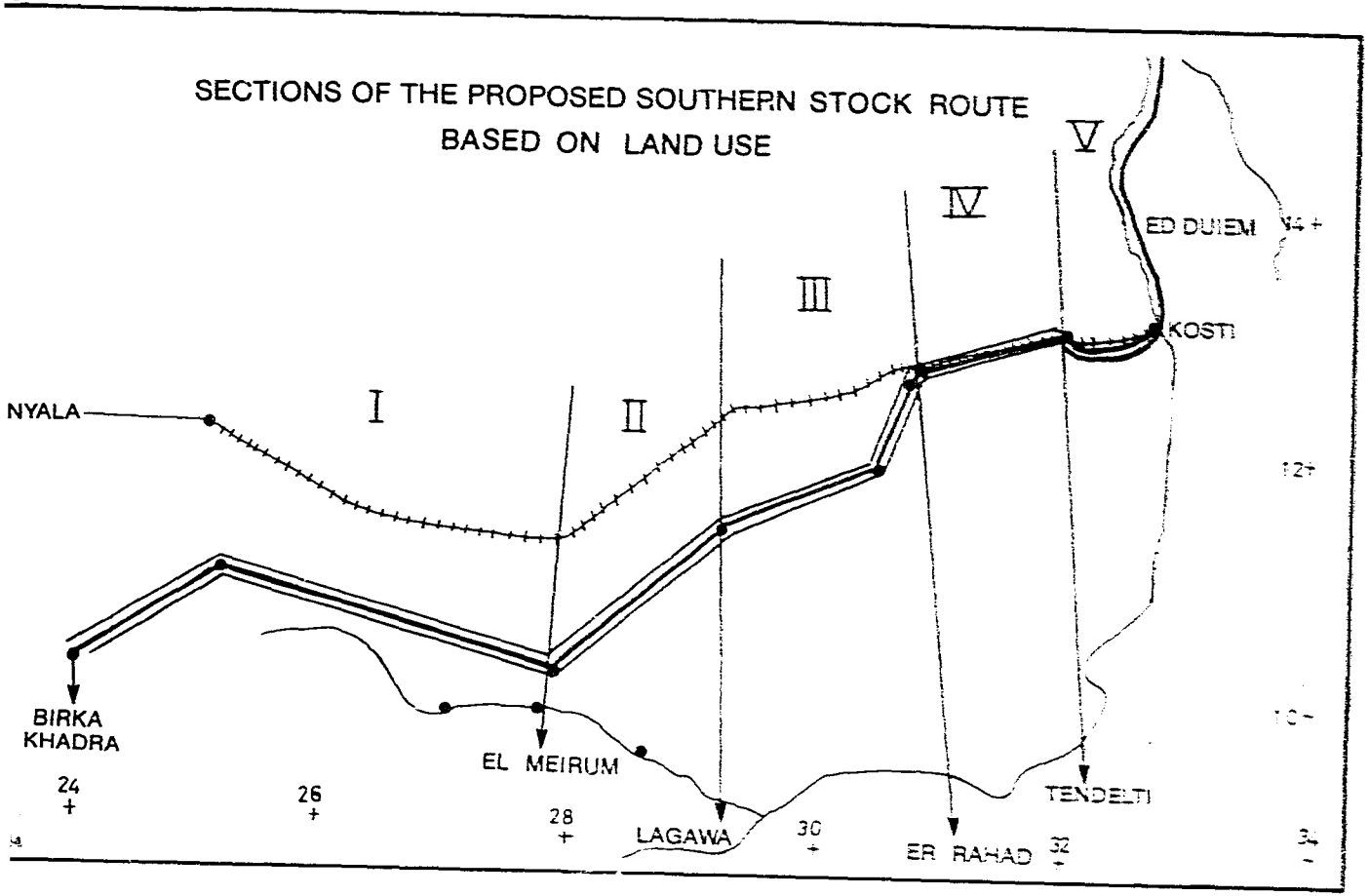
4. Assessment of the impact of adding water points and estimate of what control measures will be needed to reduce negative effects of increased water supply.

In the process of investigating these points, attention has been given to other relevant questions, such as how the settled inhabitants perceive the stock route and the benefits expected. This question raises the issue of local acceptance and security in the route. Both points were given consideration in the survey design. The ideas of the local producers and administrators were investigated and assessed before selecting the proposed route.

Division of the Area into Land Use Zones

In order to achieve the objectives of the study, issues related to land use, population distribution, water supply, environmental perception, and ideas on resource management shall be treated in the context of five zones (Figure 5). These five zones are actually an amalgamation of the eight zones which this study has used as a frame for the analysis of range and pasture aspects. This regrouping is arranged because the criteria used for the study of range and pasture are not appropriate for socio-economic considerations. Social and economic conditions are influenced by complex interactions of environmental and cultural factors which include the following elements:

ig.5


SECTIONS OF THE PROPOSED SOUTHERN STOCK ROUTE
BASED ON LAND USE
I
II
III
IV
V
NYALA
BIRKA KHADRA
EL MEIRUM
LAGAWA
ER RAHAD
TENDELTI
KOSTI
ED DUIEM
24
26
28
30
32
12+

Geologic formation,

Soils and surface hydrology,

Rainfall,

Vegetation,

Land use and human activities,

Settlement distribution,

Problems as related to stock movement,

Solutions recommended.

Based on the above elements, the five zones (Figure 5) are:

Zone I, Birka El Khadra - El Meiram (Regaba Repeating Pattern)

Zone II, El Meiram - Lagawa (Jebel and clay plain)

Zone III, Lagawa - Er Rahad (Jebel and clay plain)

Zone IV, Er Rahad - Tendelti - Kosti (sand and clay country incorporating Khor Abu Habl flood plain).

Zone V, Kosti - Khartoum

The main physical and some human aspects of these zones have already been discussed in Chapter I. The information which follows here will be confined to human factors that are related to questions of rural water supplies and land use.

Zone I, Birka El Khadra - El Meiram

The area constitutes the main dry season grazing of the Baggara of southern Darfur. This southern belt forms an integral part of the grazing cycle of the cattle complex economy, providing grazing and water supply in the most critical dry period (November - April). So far, these areas have not experienced severe pressure and still meet the grazing requirements of the nomads. However, in recent years, frequent conflicts have begun to appear among the Baggara as well as the Nilotes inhabiting the area to the south. At present there is only limited livestock movement from this area to the north during the dry season, so problems of trekking of livestock northward are minimal. With the anticipated increase in off-take as a result of the proposed SSR, some new conditions would have to be met. Trekking animals would require provision of new facilities, particularly water supply, security, and veterinary services.

Zone II. El Meiram - Lagawa

The zone is mainly utilised by Messeiriya nomads with the Zurug as the dominant section. The southern parts of the zone from the latitude of El Meiram and southwards form their dry season camping area, while the northern section is alternately used in the course of their movement between dry and wet season grazing. Except for very few sites in the southern and northern reaches of the zone, the area is sparsely populated. Under the traditional system of grazing, the southern parts of this zone have adequate rangelands to meet the requirements of the herds. However, there are signs of potential water shortage which could limit the full utilisation of the available rangelands.

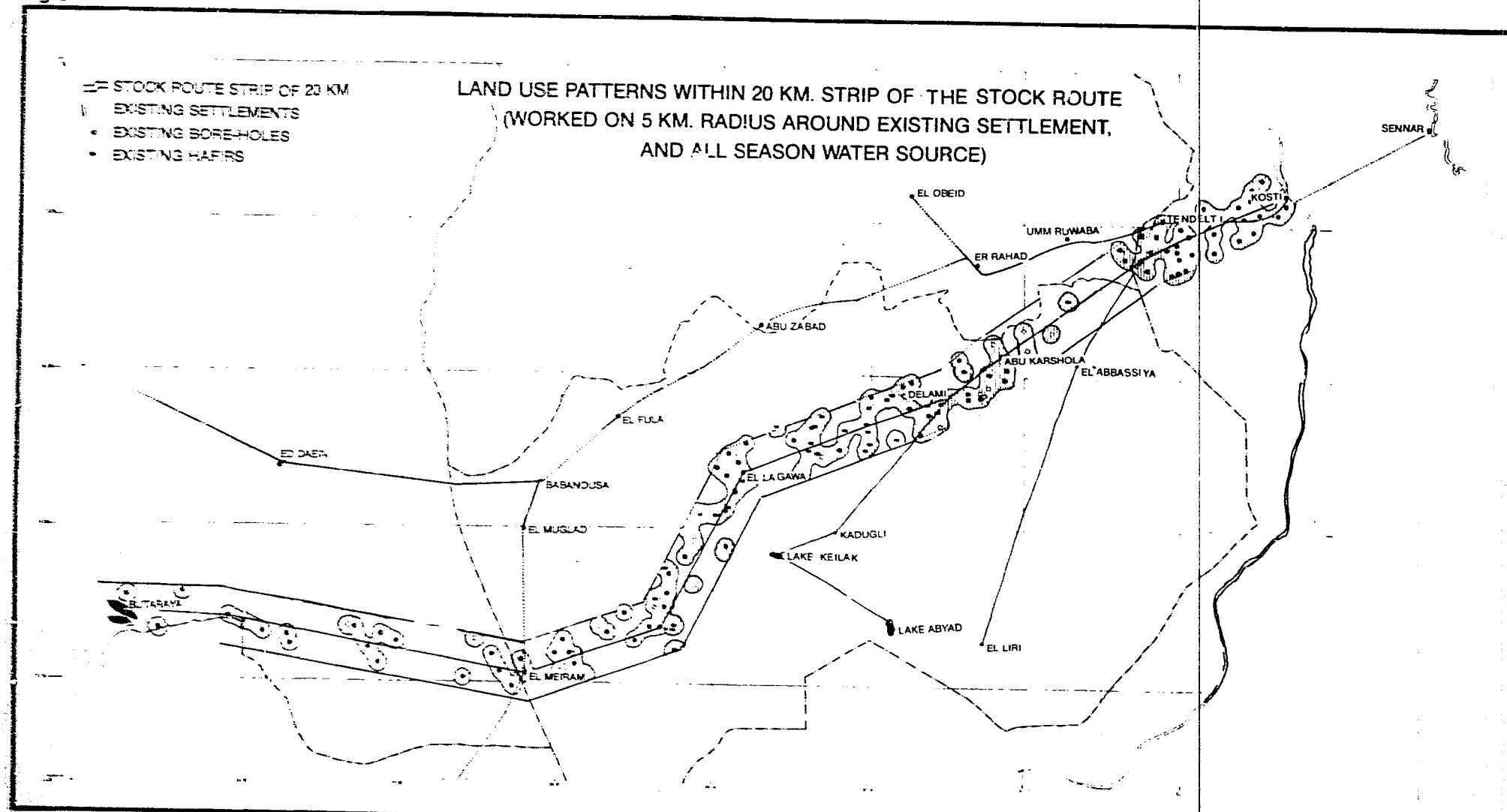
The increase in off-take following the operation of the proposed route would definitely require substantial provision of water sources, mainly hafirs along the stretch of the route between El Meiram and Lagawa. Again security will also require attention. Regarding fodder supply, there is adequate grazing to meet the requirements of the trekking animals. However, near Lagawa, trade stock will pass through relatively densely used areas occupied by traditional cultivators and mechanized farming activity. Here some conflicts may arise and the water supply and fodder situation will have to be resolved.

Zone III. Lagawa - Er Rahad

The tribal communities inhabiting the area can be categorized under three main groups. There are the Nuba Hill communities who occupy most of the area in small hill settlements or on hill slopes. They practice subsistence agriculture in fields close to the settlement and grow cotton as a cash crop. In the area between Dilling and Er Rahad, settled Hawamza are found in big villages. They practice a mixed economy (subsistence/cash/livestock). Around Er Rahad and to the east, are settlements of Gawamaa. These people are mainly cultivators who keep a few livestock. Along most of this stretch, the Hawazma transhumants use the available pasture and water supply, especially of the gradud country, during the rainy season. The same area is again used by the camel nomads (Shanable, Kababish, Kawahl, Hawawir, etc.) migrating from northern Kordofan during the dry season, relying on the Rahad Turda as a main source of water supply. Other than these traditional economies, this zone witnessed large expansion in mechanized rainfed farming in the last decades, especially in the central part of it east of Dilling.

Compared to the two previous zones described, Zone III is densely populated (Figure 6) with a better infrastructure in terms of marketing and other services facilities. Concerning commercial stock passing through this area, water supply sources, mainly in the form of hafirs, are required to meet the needs of trekking animals. The existing sources were initially designed to meet community needs and the requirements of mechanized schemes with only limited supplies left over for commercial stock. As for the fodder situation, the light settlement in western areas provides adequate rangeland that trekking animals can use. Parts of the eastern area, especially south of Jebel El Dair, may also provide adequate grazing. The central part, from Dilling eastward, is under mechanized farming schemes. Here some arrangements are needed to make use of the available crop residues. The critical section with respect to pasture availability is between Jebel El Dair and Er Rahad where signs of overgrazing are already evident.

Fig.6


STOCK ROUTE STRIP OF 20 KM
EXISTING SETTLEMENTS
EXISTING BOREHOLES
EXISTING HAFIRS
LAND USE PATTERNS WITHIN 20 KM. STRIP OF THE STOCK ROUTE
(WORKED ON 5 KM. RADIUS AROUND EXISTING SETTLEMENT,
AND ALL SEASON WATER SOURCE)
SENNAR
KOSTI
TENDELTI
UMM RUWABA
EL OBEID
ER RAHAD
ABU ZABAD
ABU KARSHOLA
EL ABBASSIYA
DELAMI
EL FULA
EL DAEIN
BABANOUSA
EL LAGAWA
EL MUGLAD
KADUGLI
LAKE KEILAK
BUTARAYA
LAKE ABYAD
EL LIRI
EL MEIRAM

This zone, being actively used, is vulnerable to future conflicts between commercial livestock owners and other users. To minimize such conflicts, corridors for livestock passage must be provided. This would require detailed surveys which would have to be planned in consultation with the local communities and authorities as well as supported by local ordinances.

Zone IV - Er Rahad - Tendelti - Kosti

In the gox country north of the railway line, the Gawamaa form the main groups while the Habbaniya, Gimaa and Awlad Humeid are found to the south. The economy of the settled population is based on production of commercial crops under traditional practices with livestock raising the most important. Nomads, including groups of the Habbaniya and Direhmat, migrate with the cattle to El Obeid in the west during the wet season, utilizing the grazing available along Khor Abu Habil on the return journey after the rains. On the other hand, camel raisers like the Shanabla and recently other groups from the Kababish area pass through this zone on their way to the Nuba Mountains.

As the sandy country and the alternating sand/clay areas are more densely settled with evident signs of degradation, it is proposed that the stock route should pass through the less utilized clay areas to the south. This would require provision of water sources in the form of boreholes and hafirs to meet the supplies needed by the trekked animals. Regarding range conditions, many parts of this zone are overgrazed and therefore rehabilitation programmes or alternative sources of fodder supply have to be considered. The extensive use of land in this area, either in cultivation or grazing creates situations of conflicts between trade livestock and traditional users. It is thus recommended that corridors for trade livestock be carefully demarcated.

Zone V - Kosti-Khartoum

The tribes inhabiting the area include the Hassaniya, the Gimaa, the Gimeiab, the Gumuiaa, the Shanabla, etc. These tribes practice different types of economic activities including rain cultivation, livestock raising, and pump irrigated agriculture. Present pasture barely meets the requirements of the local livestock, especially since the numbers of livestock have been increasing in recent years due to the expansion of dairy cattle for cheese production (Dueim area) and the pressure from drought-displaced nomads from Northern Kordofan. Currently fodder is not in substantial quantities to provide adequate surplus for the trade livestock.

The White Nile provides adequate water for trade livestock whether the route is oriented east or west of the river. However, fodder presents a problem. In this regard, the irrigated schemes provide a potential means to solve this shortage if adequate areas are put into fodder production.

Because of the dense use of land throughout this zone conflicts shall arise between trade livestock and the local users. Again and as recommended in the case of the last two zones (III and IV) corridors for the passage of livestock have to be catered for. Surveys for laying out these corridors are required and local ordinances to regulate the operation of the route must be passed and enforced.

Data Collection

Various techniques were employed in data collection. The Team examined reports, files and documents dealing with the problem in both central and regional departments. However, most of the information in this section came from interviews with villagers, producers, local leaders, and nomads.

For the purpose of the interviews two sets of questionnaires were prepared covering all aspects related to the SSR. The first questionnaire collected information from groups of people to get their collective views about the route. This village questionnaire covered aspects related to population, services in the village, water supplies, management of water sources, ecological perception, and degree of acceptance to the proposed route. Special consideration was given to the community's perception of the route and the benefits they expected. Possible areas of conflict were discussed and suggestions made to guide planning of the route in order to minimize tension between villagers and trekking, commercial livestock. In fact, through the village questionnaire, valuable information was gathered that enabled the Team as a whole to select the proposed route.

A second questionnaire collected data from household heads. It included questions such as material status, family size, and demographic aspects. These questions yielded background information before assessing land use patterns and other economic activities. Then several questions were asked to gain detailed information on water consumption and use. In this part, special questions focused on total water consumption per day, (domestic purposes and watering animals) and the costs. Answers to these questions enabled the Team to assess community water sources, its adequacy in meeting community requirements at present or in future, and needed water sources for the proposed stock route.

The household questionnaire also asked how water sources where managed and assessed villagers' views about their degree of involvement. Replies to these questions provided the Team with insights into the type of management needed to control water sources for the stock route.

Land use patterns and farming systems were also investigated to assess the impact of the route of crop production, community grazing resources, and areas of potential conflicts.

Beside this social and economic data, valuable information was collected regarding indictors of environmental change in the area, environmental perception, local aspirations, receptivity to the route, and possible control measures to reduce the negative environmental impacts.

The household questionnaire provided the bulk of the information on which this section is based. A total of 150 persons were interviewed, selected randomly from 25 villages located on the proposed stock route. In our view the sample provided a representative cross section of the population affected by the stock route.

Economic Activities: Population

The survey area lies within eight administrative districts in Southern Darfur, Southern Kordofan and White Nile Provinces. According to the 1973 census, these districts have the following populations, divided into three categories: rural settled, rural nomadic, and urban (Table 3).

The population affected by the SSR form a percentage in each of the mentioned districts although it is difficult to reach the exact figures. The picture is further complicated by the migratory habits of the nomads who utilize the area. All over the survey area, more than 90% of the respondents mentioned that nomads pass through their area both on their way northward and southward.

Out of the three listed categories of population, it can be safely assumed that the SSR will affect virtually all the nomadic groups, since the SSR moves from west to east and intersects all the north-south migration routes of the nomads. Also to be added are the camel nomads migrating from districts to the north of the SSR for dry season grazing.

TABLE 3

POPULATION BY PLACE OF RESIDENCE AND MODE OF LIVING

	Rural settled	Rural nomadic	Urban
Southern Darfur	274,442	127,627	38,616
Messeiria	103,720	108,409	31,474
Southern Jebels	213,217	14,134	18,468
Northern Jebels	149,167	22,030	19,216
Tegali	159,448	74,323	30,897
Eastern Kordofan	245,414	20,634	34,157
Kosti	195,427	70,586	50,645
Ed Dueim	427,852	60,662	13,100

Source: Department of Statistics, 1973 Census

Regarding the settled population, it is difficult to reach a precise figure. However, Figure 6 offers a good indication of the intensity of settlements along the proposed SSR. As mentioned earlier as one moves to the eastern section of the SSR, the density of settlements increases.

Village size and location vary considerably through the five zones. Generally speaking the sandy areas seem to be settled earlier when compared with the clay areas, largely because of the availability of drinking water, more healthy conditions throughout the year, and accessibility to traditional marketing centres. Conversely, clay areas, especially away from the hill settlement in the Nuba Mountains, have only recently been colonized. The new settlements result from expansion of water supply programmes, improved security, better services, and recent development activities such as mechanized farming. The dates of settlement create major differences between the clay and the sandy soils. Generally settlements are larger and services better in the sandy soil areas. The economies in the two areas, being mostly traditional, depend largely on available natural resources. There are few agricultural inputs or technologies to increase productivity or decrease land pressure. Given growing population in the sandy areas, resource degradation has become a problem and is likely to intensify as human and animal populations increase even more.

Villages are based on tribal affiliation. In the future this might change slightly in the small market centres where alien elements are sometimes attracted. Villages consist mostly of residential units with few services available. Residence is in extended family units which mushroom wherever available space allows. That is why almost all the villages lack any planned layout. Morphologically, the village components are clustered around a central point which may be a water source or similar service. For land adjacent to the village, agriculture and grazing activities have determined land use patterns. For agricultural areas, the prevalent land use is alternate parcels of cultivated fields and fallow. The fallow areas provide grazing for village animals.

The urban areas can be divided into two types: large and small. The former include the administrative headquarters and commercial centres. The services need to develop and support the SSR. These large centres will house the higher order services such as veterinary hospitals, administrative headquarters, and security facilities. Equally, the small centres will provide the lower order facilities such as water supplies, shopping, equipment, etc. Markets can be established at both levels.

Economic Activities: Main Occupations

Farming and animal husbandry are the most widespread activities in the area. The former mixed with livestock raising becomes more dominant as one moves east. Data obtained from the field surveys indicate that although the returns from farming have declined in recent years, more than 42.9% of the sampled population consider farming as their main occupation. Animal rearing as a main activity is practiced by 27.2% of the sampled population (Table 4).

Beside these main occupations, the respondents also practice other activities. Data show that trading, mainly during the dry season, is practiced by 28.5%. This activity forms the main secondary occupation along the area sur-

trading(18.5%), shepherding (13%), charcoal and firewood selling (7%), and gum collection (2.8%). It is worth noting that gum tapping, as a peasant activity, is rather limited.

These factors are very important for the operation of the proposed BBR. Consideration must be given to farming systems as a potential source of conflict and to the large number of animals kept by the sedentary communities as a potential source of permanent supply. The number of local animal traders reflects the willingness of local communities to sell animals.

TABLE 4

PERCENTAGE OF RESPONDENTS REPORTING MAIN OCCUPATION

Occupation	%
Farming	42.9
Animal rearing	27.2
Village merchant	10.0
Government employee	10.0
Local animal trader	8.5
Animal trader (agent)	1.4
Total	100%

Source: Survey

Economic Activities: Farming Systems

Throughout most of the survey area, rainfed agriculture is uncertain. Average rainfall is both sparse and non-uniform in its distribution, especially in eastern sections of the route and in the northern zones. During the period 1968-72, the rainfall over the survey area was generally 10-20 percent below average except in central and eastern Messeiriya where the rainfall appears to have been about 10 percent higher than the norm for 1941-70 (Hunting, 1976). But in 1983, rainfall declined in virtually every part of the project area. In most of the region, the length of the growing season is determined principally by the availability of water. Thus, the local communities exploit this climatic fluctuation by diversifying their activities and following farming strategies designed to minimize the impact of these fluctions.

Among these strategies is field fragmentation, especially in the north and east. There is alternatively, a tendency toward consolidated patterns in the south. The degree of field fragmentation and consolidation is supported by the survey finding which shows that 63.0% of the respondents reported consolidated plots and 36.1% fragmented fields.

Crop production in the project area is practised under one of three systems: traditional, commercial and mechanized. Traditional farming is the most prevalent in both the clay and sandy soils. It takes two forms: the proper family farm located away from the village and the housewife small plot, usually adjacent to the household. In the former, the main food and cash crops are raised while in the latter some quick maturing, staple crops and vegetables are produced.

Commercial farming has evolved from traditional farming and has gained momentum in recent decades. The main features of commercial farming are large farm size, intensive hired labour, and capital investment. Such activity is widely practised in Zones I and II, with groundnuts production.

The third system, mechanized farming, has been introduced to expand production in the clay plains of the Nuba Mountains. It takes one of four forms: government state farms, private, directed, and cooperatives. The main crops produced under this type are sorghum, cotton, and sesame, with emphasis on sorghum.

Despite the progressive development of commercial and mechanized farming in the last few years, traditional farming still forms the basis of the economy and employs the majority of the population. Though it plays an extremely important role, traditional farming has received few modern inputs and research.

The farming strategy of the family is shaped by a number of factors, including the accumulated experience of the family and inherited practices. This heavy reliance on traditional practices makes the whole system vulnerable to uncertainties of nature. It is also influenced by the price expectations of the farmer, normally based on prices received in the previous years. These expectations have direct effects on the crops grown and the areas under each crop. Since crop raising depends almost totally on manual labour, factors including family size, tools, and available labour merge as the most crucial elements determining production. Accessibility to rail and road networks is another important factor. In recent times the emergence of income generating activities outside the crop production sector such as wage employment, has pulled more labour away from farming. Services available, particularly water supply, have direct impact on farming. Through provision of water supplies, more land has become available for cultivation.

All of the above factors have direct impact on the decision-making process of the family regarding types of crops raised, farm size, distribution of plots, yield, income generated, and crop rotation. Plot fragmentation is a common strategy to maximize early rains. This feature, coupled with shifting cultivation, has led to extensive expansion of agriculture in the eastern areas which reduces land open for free grazing.

In most of the project area the farmer produces enough cereal crops to meet family food requirements. However, cash crops frequently fall short of satisfying a family's cash needs. The deficit is met from sales of livestock and the income generated from employment inside and outside the area.

Survey results confirmed this fact. It is found that 73.5% of the respondents produced enough staple food to supply their family needs while 26.5% had a deficit met by purchasing from the market. With respect to cash crops, 67.6% of the respondents reported producing less than their cash needs. To meet the family cash requirements, the respondents resort to secondary occupations (39.1%), selling animals (34.9%) and other petty jobs (26%).

Generally, most of the respondents think that farming is becoming less rewarding as a result of low yields. In 1982 about 45.7% of the respondents received low yields. They attribute this to low rainfall (58%), bad farming operations (21.4%), infertile soil (3.5%) and combination of the above (25%). This result and Table 5 support the arguments raised earlier that rainfall fluctuations make rainfed agriculture a marginal activity. In the last two years, rainfall was a major factor in crop failure. Signs of soil degradation are also reported with more than 84% reporting examples. The main indicators are encroachment of dunes, more frequent dust storms, increase of bare land, gullies, and extensive termite attack. These signs are more evident in the eastern sections of the route and around large village settlements (Table 6).

TABLE 5

ECOLOGICAL PERCEPTION OF RAINFALL IN RELATION TO CULTIVATION AND GRAZING (PERCENTAGE OF RESPONDENTS REPORTING)

Year	Rain in relation to cultivation		Rain in relation to grazing	
	Adequate %	Inadequate %	Adequate %	Inadequate %
1983	24.2	74.8	32.8	67.2
1982	54.2	45.8	55.7	44.3
1981	80	20	80	20
1980	70	30	80	20

Source: Survey

TABLE 6

PERCEPTION OF SOIL DEGRADATION (PERCENTAGE OF RESPONDENTS REPORTING)

Signs	%
Encroachment of dunes	22.0
More frequent dust storms	22.0
Increase in bare land	26.0
Appearance of gulley erosion	12.0
Extensive termite attack	17.0
Others	1.0
Total	100.00

Source: Survey

Livestock are another important element in the livelihood stystems throughout the project area. Of the survey sample, 73% own livestock which demonstrates the importance of animal raising to the settled communities in the project area. Cattle are the most dominant animal followed by goats and sheep. Animal figures indicate a general increase in numbers as a result of investment in animals and in natural growth. There is off-take from the herd mainly through annual sales. However, many respondents reported high mortality due to drought and poor pasture conditions in recent years which is more clear in the area to the east of Er Rahad. Village animals follow different grazing cycles from nomadic herds. For the majority of owners, animals are kept throughout the year in grazing lands near the village. The only exceptions are the large owners who send their herds away from villages during the dry season.

Respondents to this category give several reasons why thay undertake distant migrations. Inadequate grazing around the village (45.5%), fear of damaging crops (43.6%), and scarcity of water supply at the village (7.5%) are the most important. The inadequacy of grazing around villages is attributed to overgrazing (55.8%), shortage of rainfall (24.7%), and fires (19.5%). To supplement natural grazing, villagers resort to sources such as collection and storage of grasses (26.7%), useful trees (29.5%), crop residues (16.2%), fallen leaves (15.2%), bulbs and fruits (6.7%), and others (5.4%). Until very recent times, most of the above fodder sources were obtained from the fallow areas conserved within the cultivated plots. With the intensive penetration of nomads into these southern areas, especially immediately after harvest, such areas of once reserved fodder are being heavily devastated by nomadic herds. These encroachments deprive village communities of valuable sources of fodder. There are indications that more livestock raisers are resorting to collection (57.7%), and buying of hay (42.3%). The type of supplementary feed given to

animals includes, crop residues (25.3%), dura (25.3%), water mellons (17.3%), oil cakes (14.7%), cotton seeds (13.3%), and a combination of all above (4.0%). Of all respondents, 58.2% use supplementary feed because of bad range conditions while 41.8% use feeds for finishing animals for the market.

Nomads systematically utilize the grazing resources of the project area. Their movements are timed with the season. The Baggara nomads cross most of the project area on their northward migration for rainy season grazing while the Abbala (camel nomads) visit the area for grazing during the dry season. Almost all respondents confirm the effect of nomads on the pasture of the area. The impact of the camel nomads is more intensive on the area as reported by 53.4% of the respondents compared to the effect of cattle nomads as reported by 46.6% of the respondents.

Nomads, especially the Abbala, not only utilize the grazing resources of the settled communities, but as well share the available water resources as indicated by 94% of the respondents. The coming of the nomads to these areas results in conflicts between herders and the settled communities as confirmed by 79.4% of the respondents. Areas of conflicts embrace damaging of crops (57.6%), pressure on pasture land and available water sources (35.6%), and other forms of conflicts (6.8%). Nomads utilize the available grazing close to water sources (42.0%), as well as distant rangeland (48.0%). Usually conflicts between nomads and cultivators are resolved by paying compensations to cultivators for the damage done to private property such as crops.

The current situation in Zones III and IV provides potential sources of conflict between commercial livestock herders and the settled population. But as the SSR will operate during the dry season when most crops are harvested, there is a possibility to minimize conflicts. Still, in Zone II, where mechanized farms are found, there is a possibility of conflict, especially in the early months of operation of the route. Regarding traditional grazing involving hashab gardens and the use of community sources, there are indications that conflicts will arise between the route users and the local communities throughout the dry season, particularly in Zones III, IV, and V. Some of these conflicts can be minimized by providing special water sources for the trade livestock with allowance for the indigenous population to use them, especially in needy areas. As mentioned previously, special corridors for passage of animals to minimize conflicts over traditionaly used areas must be established. Through such measures, the route can be well received by the local communities as expressed by most of the respondents. Settled communities are expecting additional benefits from the route, voiced as improved services, as expressed by 60% of the respondents and better marketing facilities noted by 40%.

The economy of the settled communities is based on farming, livestock raising, and secondary occupations such as trading, wood cutting, and manual labour. It seems that each of the above economic activities contributes an equal share in family income. Of all individuals in the survey, 84.4% sell livestock annually. The figure increases in years of crop failures. Reasons given for selling include; need for cash (41.7%), change in herd structure (31.7%), occurrence of drought (13.3%), crop failure (8.3%), and other reasons (5.0%). Families sell animals throughout the year, as need arises. However, the frequency varies with the season. It is found that most of the selling occurs during the darat (October - December) as reported by 62.5% of the respondents.

Most of the selling during the *darat*, as the main livestock marketing period for the settled breeders, is timed with the crop production performance and expected return to the farm family. For example, people tend to sell more livestock in bad harvest years than in good. It is therefore expected that the livestock merchants can obtain more animals from the settled population, especially during the first months of operation of the route.

Sedentary livestock raisers usually sell at the nearest available market, as noted by 45.5% of the interviewed. However, good prices are a motivation for selling at distant markets, as stated by 34.5%. Overall, good prices are an incentive for selling and this usually occurs when merchants from outside the area visit local markets.

Water Supplies

The main water sources identified in the survey area are noted in Table 7.

TABLE 7

RESPONDENTS REPORTING THE MAIN WATER SOURCES USED (PERCENTAGES)

Water sources	% dry season	% wet season
Wateryards	65.6%	36.8%
Open shaft wells	14.4%	12.2%
Hafir	16.7%	5.6%
Pond	1.1%	19.9%
Jammam	2.2%	5.6%
Others	-----	19.9%
Total	100.0%	100.0%

Source: Survey

The use of these sources varies with the season, costs, and distance from the source. The most highly used watersource is the wateryard with a greater degree of dependency during the dry season. In recent years and as a result of mismanagement, wateryards have become less efficient in meeting domestic water requirements. Other sources, especially in the western sections of the route, can be rated as follows: open shaft wells, *hafirs*, ponds and *Jammam*. In the clay plains and the Nuba Mountains, *hafirs* and open shaft wells provide the main water needs of the local communities.

Water consumption is influenced by many factors such as costs and effort involved in fetching water. In this aspect, the distance of the household from the water source plays an important role. A high percentage (84.1%) of the respondents live within one kilometre of the source. Despite this fact there is wide variation with respect to source distribution throughout the survey area. More water sources are found in western and eastern sections of the route than in the middle.

Wateryards are the most favoured source for drinking. In the survey area, 80.0% of the respondents use the wateryard for drinking in the dry season and 54.3% use the same source in the wet season. When watering animals, significant proportions of the respondents use wateryards (62.5%) in the dry season and 20.3% in the wet season. This fact reflects the degree of dependence on the wateryard. The majority of the respondents use wateryards because they have no alternative or they think of them as good quality (Table 8). Few respondents mentioned factors such as distance, financial costs, and ease of getting water.

TABLE 8

REASONS FOR USING THE WATER SOURCES
(PERCENTAGE OF RESPONDENTS REPORTING)

Reasons	%
Only source	52.9%
Good source	42.9%
Others	4.2%
Total	100.0%

Source: Survey

Water fetching in the survey area is mostly the responsibility of women and children (24.2%), head of the household (2.44%), water vendor (12.9%), wives alone (12.9%) and other persons available. Still large villages and semi-centres depend on pipe connections (15.7%).

The amount of water consumed by the household varies according to family size, season, and location. Most of the households consume between 10-14 tins (one tin = 16 litres) daily (35.7%). Very few consume more than 20 tins daily (Table 9).

TABLE 9

AMOUNT OF WATER (16 LITRE TINS) CONSUMED PER DAY BY THE HOUSEHOLD
(PERCENTAGE OF RESPONDENTS REPORTING)

Number of Tins	Dry Season	Wet Season
1 - 4	6.8	2.9
5 - 9	29.9	18.6
10 - 14	35.7	18.6
15 - 19	17.1	7.1
20+	8.6	30.0
Do not know	10.0	22.9
Total	100%	100%

Source: Survey

Costs vary considerably within the study area, depending on factors such as season, availability of water, distance of source to the household, and type of water source. Generally, water from open shaft wells, hafirs, and other surface sources are free. Wateryards charge a fixed fee per tin. Almost half (47%) of the respondents pay more than 25 pt. a day for domestic water, consumed in the household. Also, the survey showed that 44% of the respondents pay between 10-24 pt. for their daily water consumption. The variations in water costs depend on family size and means of water collection.

Water costs also involve the time lost in water fetching. This aspect was investigated in the survey area and found that for water obtained by the head of the household or a member of his family, the average time spent is about one hour. In fact more than 60% of the respondents spent between 1-2 hours in fetching water. The majority of the respondents (55.8) make 1-2 trips per day to the source in case the source is in the village. As the source gets farther away, the frequency of trips decreases and in some cases, it becomes once every two days (Table 10).

TABLE 10

FREQUENCY OF TRIPS PER DAY (PERCENTAGE OF RESPONDENTS)

No. of trips	%
One trip every two days	2.8
One trip	24.3
1 - 2	55.8
3 - 4	14.3
4+	2.8
Total	100%

Source: Survey

Normally the average size family requires 10 tins per day of water for drinking and domestic use. This fact is reported by 54.3% of the respondents in the dry season and 38.6% in the wet season. Concerning water for animals, most of the respondents (55.9%) do not know the amount. This is so because most animal owners prefer to water their animals in open shaft wells of hafirs where the water is free of charge. Even for owners using wateryards, normally the charge is per head rather than per tin (Table 11).

The main factors which determine present consumption rates are: scarcity of water, difficulty in obtaining water, crowdedness of the source, high costs, poor quality of water, distance of source, and time wasted in water fetching. The amount of water consumed by the household would increase if water could be obtained easily (Table 12).

TABLE 11

WATER DEMAND FOR DOMESTIC LIVESTOCK
(LITRES)

Livestock	litres per head per day
Cow	20
Donkey	20
Camel	15
Horse	20
Sheep	9
Goat	9

Source: Survey

TABLE 12

NUMBER OF TINS CONSUMED IF WATER COULD BE OBTAINED MORE EASILY.
(PERCENTAGE)

Number of tins	%
1 - 4	2.9
5 - 9	4.3
10 - 14	8.6
15 - 19	17.2
20+	31.2
do not know	33.8
Total	100%

Source: Survey

The previous table indicates that if water is easily obtained, 48% of the respondents will consume between 15 - 20 tins compared to the majority (54.3%) who consume at present only 10 tins per day. With respect to future needs and demands, most respondents (85.7%) reported the inadequacy of the present sources to meet their anticipated requirements. The reasons stated included: growth of village population, pressure put by nomads on existing sources, the tendency of nomads to settle, the building of herds by settled population, services attracted more people, expansion of government agricultural shcemes, and the low performance of water sources, especially silting hafirs and wateryards (Table 13).

TABLE 13

REASONS BEHIND FUTURE WATER SHORTAGE (PERCENTAGE REPORTING)

Reasons	%
More nomads are settling	16.7
Growth of village population	29.2
People keep large number of animals	11.6
Nomads use the source	29.0
Services attract more people	6.5
Expansion in agricultural sources	2.9
Low performance of water sources	2.9
Others	0.7
Total	100%

Source: Survey

The respondents, as well as others interviewed, proposed a number of solutions for the expected water shortage. Most respondents (60.0%) thought that a new wateryard will provide an adequate solution. They feel that wateryards are dependable and provide adequate and easily obtained water. A sizeable number (40.0%) considered open shaft wells as appropriate.

These facts are very important for the operation of the stock route. The observations made in the survey area and the interviews suggest that the present water sources barely satisfy the needs of the local communities. Thus, for proper operation of the stock route, and to avoid possible conflicts separate water sources designed and constructed specificaly for the trekking animals will be needed.

Following the move in the mid-1970's to involve local communities in running wateryards, about 50% of the wateryards in the survey involved users in management while the rest are run directly by the government. The main bodies involved are village development committees, village councils, and special wateryard committees. The local bodies have several duties including: collect self-help money to buy petrol and spare parts; organize water collection; provide petrol; make necessary contacts with concerned technical departments for maintenance; and help in other management issues.

Failure to fulfill these wateryard management duties has caused widespread dissatisfaction with the present management system. Table 14 indicates the types of water management problems in the project area. It is hoped that water sources constructed for the SSR should avoid these drawbacks through a redesigned set of responsibilities for local water managers.

TABLE 14

TYPES OF WATER MANAGEMENT PROBLEMS FACED IN THE SURVEY AREA
(PERCENTAGE OF RESPONDENTS REPORTING)

Type of problem	%
No maintenance	36.0
Many breakdowns and no repairs	23.0
No petrol	23.0
Short operating hours	13.0
Superintendents not friendly	5.0
Total	100%

Source: Survey

Recent administrative changes in the Sudan have led to the creation of regions and regional governments with wide powers over resource use and management. The regional governments are now responsible for the provision of all social services and development activities. As a result of these changes, water supplies, veterinary services, and resource management are the responsibility of regional governments. On the other hand, some development projects are considered national and therefore managed by the central government. The Southern Stock Route (SSR) is conceived as a national project but its proper operation requires the installation of many local and regional services. Conflicts between the regional authorities may arise unless adequate measures are taken to define clearly the regional and the central government responsibilities.

The institutional development of the SSR should come through an integrated planning approach in which all the components involved in this project should complement each other. Based on this understanding, the project should come under one institutional authority, responsible for its development, management, and operation. Even though the project passes through a number of ecological zones and administrative regions, a single coordinating unit is essential.

Current experience at regional levels demonstrates lack of an integrated approach to developmental planning. Sectorial philosophies dominate the operation of the current programmes. Even within one programme (e.g. water supply), regional capacities and abilities are not providing adequate management. Thus, any institutional arrangement that divides technical, institutional, and administrative responsibilities will most probably lead to conflicts and confusion. Therefore, it is suggested that the project be implemented by one autonomous body, namely the L.M.M.C. However, it must be stressed that once this body is identified, it should immediately build institutional linkages with those regional agencies and local organizations that are directly concerned with the operation of the route. Such a vision will facilitate proper management, monitoring, and evaluation of programmes and environmental changes.

Conclusion

This chapter discussed the socio-economic situation of the sedentary population in the project area. The results of the survey indicate the possible impacts and the responses of the local inhabitants when the SSR becomes operational. The route will have both positive and negative impacts on the environment of the survey area and on the socio-economic structure of the local inhabitants. The expected negative impacts on the environment will be felt in the available pasture resources as these areas will be grazed by the nomads on their way northward and southward and by trekking trade livestock. Range and pasture studies carried out as part of this survey showed that the pasture resources in the area can accommodate large numbers of animals without being severely affected. Despite this fact, proper range management is highy recommended and the stock route management must provide adequate personnel and facilities to monitor range conditions.

The most serious negative impact will result from the competition of trekking livestock with local livestock on the limited grazing resources left by villagers in fallow areas. This competition becomes a potential source of conflict with the local inhabitants. Such conflicts could be avoided if facilities for trade livestock are located reasonable distances from densely settled areas.

With respect to the critical area, from Tendelti to Kosti, a more northerly direction is suggested in order to avoid the fragile sandy areas to the north. Future development activity in this zone, especially the suggested Kosti-El Obeid road, will create the necessary conditions for easy movement of fodder from the White Nile pump schemes to east Kordofan, thus lessening the effects of trekking animals on the environment.

In general, the survey findings reveal that the intensity of negative environmental impacts varies from one section of the route to the other. In the southern sections (Zones I and II) such impacts shall be less harsh on local resources and on the indigenous users as compared to the three remaining zones, because land there is sparsely utilised. It is recommended that a monitoring team be formed, composed of the managing authority of the route, local officers, veterinary officers, development officers, and a surveyor to assess the impacts arising from the route, develop proper range management procedures, and delineate corridors for easy and safe passage of trekking livestock. Where land is taken from traditional users, the local inhabitants must be compensated.

Socio-economic impacts of the route will also be either positive or negative. The negative impact will center around land use conflicts as a result of encroachment on community and private land rights which will affect local acceptance of the route and create security problems. With respect to the positive impacts and the benefits expected by the local inhabitants, survey results indicate aspects such as better livestock marketing facilities, provision of services which may be shared by the population where the route passes, strengthening of security in the area, flourishing shopping facilities, employment, and sale of crop residue. These impacts must be strengthened as additional assets of the project. They embrace acceptability and encourage animal sales by the local inhabitants.

CHAPTER III

LIVESTOCK IN THE PROJECT AREA

Introduction

The importance of livestock production in the project area cannot be overemphasized; livestock represents the major component of the total wealth in the area and provides a livelihood to a large segment of the population. When considering ways to stimulate the region's economy, livestock production stands out as the most effective, given increasing demands for animal products, availability of natural resources, and the presence of traditionally livestock-oriented people.

The major constraints for developing livestock production and expanding its export are:

Nomadic production relies on a generally north/south migration. The consequences of this migration are reduced efficiency of natural resources utilization, longer cycles of production, low grade products, and seasonality of supply;

The long distance between production areas and consumer/export markets, accompanied by seasonal lack of water and feed creates marketing problems. The lack of dry season stock routes intensifies the seasonality of livestock supplies to domestic and export markets;

The high incidence of fatal and wasting diseases represents a major obstacle for exploitation of livestock exports. The lack of appropriate measures, shortage of trained personnel, and inadequate facilities, and insufficient medicine results in lessened efficiency, increased mortality, and reduced off-take;

Inadequate capital, as shown by the lack of application of modern method of animal husbandry, management, and nutrition is responsible for the low levels of livestock production;

The lack of research in livestock production and diseases results in inadequate basic information on animal husbandry, pasture utilization, and livestock populations. This deficiency in turn restricts long term planning to improve the livestock sector.

Livestock Types

The livestock raised in the project area include indigeneous cattle, sheep, goats, donkeys, horses, poultry, and pigs. Pigs are raised on a small area in the southern part of the Nuba Mountains by non-Muslim households.

Cattle, sheep, and goats, appear all over the project area in large numbers. Their importance arises from the fact that, as ruminants, they utilize
little or no value other animal

Four distinct types (breeds) of cattle are found in the project area, including:

Baggara type. This is not a distinctive breed, but refers to various cattle found west of the White Nile, in Kordofan and Darfur Regions. The cattle are so called because they are owned by the Arabic speaking tribes, collectively known as Baggara. The cattle are mainly dark in colour although all shades, colours, and patterns exist. They are described by their owners as hardy, tough, and enduring. Cattle merchants recognise them as capable of walking long distances without lameness. Feedlot owners think of them as more responsive to finishing than other types of cattle.

Traditionally, Baggara cattle are considered the best beef type but research has indicated little or no difference between them and other types of cattle as far as efficiency of beef production is concerned. However, the Baggara cattle form the majority (80 percent) of the northern Sudan Bos Indicus cattle population and provide most of the beef consumed domestically and exported.

Under traditional management systems, Baggara bulls may attain body weights of 250-300 kg. at the age of 4-5 years. They are reported to finish at 400-450 kg. However, the Baggara cows are poor milkers.

Kenana type. The homeland of the Kenana cattle is the delta between the White and Blue Niles. This type is also found along the western and eastern banks of the White and Blue Nile respectively. They also appear in the northern parts of northern and southern Kordofan Provinces and as far as Abbassiya in the eastern part of the Nuba Mountains. They are so called because they are owned by the Gezira tribes among whom the Kenana is important. They are typically light grey, but dark grey and black colours also occur. Like so many other grey Zebus, the colour at birth is brown.

Kenana are better framed and produce more milk than the Baggara. Outside their homeland they do not do well. They are the highest milk producers in the Sudan. Under improved management systems they were reported to produce up to 2,600 kg. of milk per lactation. The average weight of yearling bulls and heifers at the Gezira Research Station was reported as 151 and 141 kg., respectively. At maturity, that is about 5 years old, the bulls weigh on average 500 kg. and the cows 400 kg.

Their relatively high capacity to produce milk provide their calves with much improved level of nutrition to the time of weaning. This together with their large frame constitute an obvious attraction for using the Kenana for beef breeding. However, Kenana type represent only about 12 percent of the northern Sudan Bos Indicus population of cattle.

West African long horn Bos Indicus. These cattle were introduced into Darfur Region by nomadic tribes from the nearby countries of Chad, Central Africa, and Nigeria. These cattle are designated by names related to the tribes [illegible] t[illegible] [illegible]nal homeland. The most common of these

The Umm Bororo cattle are predominently brown in colour. The head carries lyre shaped horns, giving the general impression of great size. The body is narrow and the legs are long. Cattle merchant in the area indicate that Umm Bororo cattle cover great distances at remarkable speed though they are not amenable to physical discipline. The average mature body weight is about 400 kg.

The Fulani cattle are mostly grey with black points. The body is compact and fleshy but is rather lean at the rump. The horns are of medium length.

Nilotic. The Nilotic belong to the Sanga which is a cross between the Hamitic and the long horn Bos Indicus or Zebu. The homeland of the Nilotic is the high rainfall area of Bahr el Ghazal and Upper Nile Regions. They are also found along Bahr el Arab and in the southern areas of southern Kordofan and Darfur Provinces.

Predominant colours include black, brown, and white dotted black. The cattle are narrow and leggy and are characterized by their excessively long horns. They are reported to be less resistant to rinderpest and parasitic infections, are not adapted to living in arid and semi-arid areas, and do not walk well, thus causing considerable losses when moved to the north.

Cattle merchants believe that Nilotic cattle do not respond well to finishing and that their meat is of low quality because of its dark colour.

Cattle Population Estimates

Livestock populations in the Sudan are usually estimated and reported on a provincial basis. There are no estimates of cattle on a district basis. Numbers of cattle in the districts, in the proximity of the project area, are estimated as in Table 15 from rinderpest vaccination records from 1983. It must be noted that intensive and thorough vaccinations campaigns were carried out following severe rinderpest outbreaks in the project area during 1981 and 1982. Therefore, the district veterinary officers advised that the adjusted 1983 vaccination numbers represent the best estimates possible in the respective districts and the project area as a whole.

The total number of cattle in the project area is estimated at 4.1 million head. This represents 27 percent of Sudan's total and 54 percent of the total White Nile, Southern Kordofan and Southern Darfur collectively as estimated by the 1976/1977 census. Approximately 66, 22, and 12 percent of the cattle in the project area are found in Southern Darfur, Southern Kordofan and the White Nile Provinces respectively.

There are no estimates available for the southern region's cattle near the project area. So they are not considered further in this report.

TABLE 15

ESTIMATED NUMBER OF CATTLE IN THE PROJECT AREA (000' HEAD)

Veterinary District or Province	Number of cattle vaccinated against Rinderpest in the year (a) 1981	1982	1983	Proportion of cattle (b) vaccinated in the year 1983	Estimated number (c) of cattle in the year 1983
, Buram and Ghanam			2,000	0.90	2,222
ein	170	300	412	0.85	484
usa	216	262	254	0.75	338
El Fula	-	183	202	0.75	269
li	-	-	139	0.80	173
siya	-	110	56	0.60	93
lti	-	-	40	0.50	80
	188	92	249	0.70	355
eim	-	-	55	0.70	97
			3,407		4,111
ıern Darfur of 1,2)			2,412		2,706
thern Kordofan m of 3,4,5 and 6)			657		873
e ,8, and 9)			344		532

rom records at the respective Veterinary district or province offices.
ed by District or province Veterinary officers.
ent of multiplying (a) by (b)
e estimated total number of cattle in this Table is less than the official estimates for the three provinces Southern Darfur, Southern Kordofan and White Nile, maybe because the Team did not visit all the regions of e three provinces.

Cattle Herd Structure

Herd structure varies considerably with the size of the herd, season of the year, the availability of pasture as affected by rainfall and location within the project area, and the incidence of fatal diseases. Large size cattle herds contain a higher proportion of bulls when compared to small ones. This is because the owners of the latter tend to sell bulls at an early age and replace them with heifers or young female calves. Under poor conditions of pasture and during drought years, male numbers in the herd fall drastically. Under such conditions, the males are disposed of, by selling or otherwise, irrespective of age or herd size. The proportion of males also decreases when the cattle market prices are abnormally attractive.

An average herd in the project area is composed of 65 percent females and 35 percent males. The details of the female and male proportions are:

Females (65%)		Males (35%)	
Breeding cows	40%	Bulls, over 3 years age	13%
Heifers 1-3 years age	14%	Bulls 1-3 years age	14%
Calves	11%	Calves	8%
TOTAL	65%	TOTAL	35%

The observed higher percentage of female calves (11 percent) as compared to male calves (8 percent) may be an indication of the owners preferential treatment of female calves. The proportion of bulls over 3 years age (13 percent) include breeding bulls which may constitute 2 percent of an average herd.

Cattle Breeding

Cows are serviced by bulls naturally. Four breeding bulls are allocated for every 100 breeding cows. The selection of bulls is usually on the basis of pedigree and the breeding characteristics selected are usually size and colour. Cattle owners endeavour to synchronize the service period by stopping or reducing the frequency of milking in an attempt to abolish lactation anaestrus. This procedure of synchronization is locally known as tahein or tawgeib (timing).

Normally open cows are bred in the northern parts of the migration area, 1-3 months after the start of the rainy season, usually from July to September. In this period the quantity and quality of pasture are maximum and the body condition of the cows is at its best. Approximately 50 percent of the open cows conceive during this period.

The cows conceiving during this period calve in the southern parts of the migration area from April to June. This is the time of showers and regrowth of [illegible] in those parts. This [illegible] milk for the newly born

Cattle Reproduction

Conception rate is defined as the number of services required to achieve conception. Under sedentary conditions (Ghassala Gawazat Research Station) in the western Sudan it was determined that 1.15 to 1.34 services are required. Researchers in that station estimate that 2.5 services may be necessary under nomadic conditions. The calving interval of cows in the Research Station averaged 15 months as compared to 18 months for cows of nomads.

The number of cows conceiving depends largely on their health, nutritional status, and the management system under which they are raised. Under favourable conditions and good management practises, 70 of every 100 cows become pregnant compared to 45 cows under unfavourable conditions. In the project area, conditions vary greatly from year to year and from area to area. However, 60 cows is considered a reasonable average.

Of the cows that conceive, normally 25 percent fail to maintain the fetus to full term (287 days) and abort, usually towards the end of the pregnancy period. Malnutrition, diseases, and their interaction were suggested as the main causes of fetus loss.

In the project area, cows breed for the first time at an average age of 30 months and calve for the first time at 40 months. The nomadic cattle owners indicated that cows may live as long as 14 years and suggested 10 years (120 months) as a reasonable average.

The productive life of a cow is defined as the duration between age of first calving and the senility age. From the above data, productive life could be calculated as 80 months. During this period, a cow will calve 6 times and produce 2.70 calves after making allowances for conception rate and abortion.

Reproductive performance data and mortality estimates of cattle under improved and traditional management systems are summarized in Table 16. Calculations based on these data indicate that an average herd in the project area increases by 8.4 calves yearly and that an average annual rate of increase is 4.4 percent.

Calf mortality in the project area is estimated to be 30 percent of the calf crop. It is particularly high between birth and weaning (preweaning mortality) and may amount to 67 percent of the total calf mortality and is attributed to malnutrition, diseases, and low birth weights.

Calf malnutrition results from inherent low milk production in some parts of the project area (Baggara cows produce 1.5-2.5 kg. milk/day) and excessive milking in some other parts (in White Nile Province milk is sold for cheese making). Preweaning mortality is higher among calves born in the dry season. It is believed that preweaning mortality is high among male calves because owners tend to over-milk the cows with male calves.

Diseases are responsible for the major part of preweaning mortality. Most calves are born at the beginning of the rainy season in an environment which

TABLE 16

REPRODUCTIVE COEFFICIENTS AND HERD DYNAMICS

Parameter	Estimated value under Improved Management system	Traditional management system
Reproductive coefficients		
Conception rate	1.2	2.5
Calving interval (month)	15	18
Cows conceiving (% of breeding cows)	70	60
Cows aborted (% of pregnant cows)	8	25
Age of first conception or pregnancy (month)	26	30
Longevity of cows (month)	144	120
Productive life (month)	108	80
Calf mortality (% of calves born)	14	30
Adult mortality (% of adults)	2	10
Herd dynamics		
Breeding cows	100	100
Day old calves	60	45
Weaned calves	54	36
Yearlings	51	31.5
Yearlings/cow productive life	3.67	1.40
Yearling/cow/year	0.41	0.21

Source: Ghazala Gawazat Research Station.

supports parasites and pathogenic microorganisms. Veterinarians and owners alike indicated that tick-borne diseases are the main cause of preweaning calf mortality.

Calves are weaned at an average of 7 months. However, female calves may be weaned at an older age. Thirty-three percent of the total calf mortality occurs immediately and in the few months following weaning (post weaning calf mortality). The unavailability of good quality pasture at or immediately after weaning and the susceptibility to fatal diseases are the main causes of post-weaning mortality.

Mortality of cattle three years of age and over (adult mortality) is estimated at 10 percent. The main causes of adult mortality are diseases, malnutrition, and senility. The interaction among the causes is believed to be the major factor in adult mortality.

Mortality among trekked cattle is estimated at 4 to 6 percent and is highest as the trekking season advances towards dryness. Most deaths occur in the outskirts of Omdurman as a result of the sudden change in the nature of the feed supplied to the cattle. Other common causes of mortality include exhaustion, hoof injuries, and outbreaks of infectious diseases.

Livestock Diseases

Livestock in the project area is susceptible to a large number of fatal and wasting diseases, (Table 17). There are several reasons why:

(1) Livestock populations exist in the form of mobile herds. If a herd is infected with a disease, the likelihood is that the herds sharing the same pasture and water source will contract that disease;

(2) The disease control measures adopted are ineffective, due mainly to the lack of infrastructure and shortages of basic veterinary facilities;

(3) The environment and climate (high temperature, high humidity, and clay soil) are conducive to the propagation of pathogenic microorgnisms, disease reservoirs, disease vectors, and parasites.

Veterinary staff in the project area were requested to identify and indicate the severity of the major cattle diseases in their districts. The results are presented in Table 17. The major cattle diseases are Rinderpest, Haemorrhagic septicaemia, Anthrax, Contagious bovine pleuropneumonia, Bovine farcy, tick-borne diseases, Trypanosomiasis, and internal parasites. Occurrence and severity of the disease varied considerably from one location to another. As example, the severity of Trypanosomiasis is highest in the southern parts and diminishes towards the northern parts of the project area.

The individual diseases include:

Rinderpest (Cattle plague)

Rinderpest is an acute specific, inoculative, and febrile disease of cattle. It is characterized by an ulcerative inflammation of the mucous membrane, specially those of the alimentary tract. The disease is caused by a deadly virus. Indeed it was estimated that when Rinderpest strikes a herd, nine out of every ten animals may die.

Cattle are by far the most susceptible animals, but sheep and goats occasionally become infected. Wild game may carry the infection to healthy cattle. The incubation period of the disease is from 3 to 9 days.

Control of the disease includes vaccination, quarantine measures, and salvage slaughter. In many parts of the world quarantine measures are relied upon to exclude the disease. In the event of an outbreak, immediate slaughter of all infected or in-contact cattle, sheep, goats or other ruminants are carried out and all movements of livestock are prohibited in a given area.

Haemorrhagic septicaemia

This disease is also referred to as pasteurallosis of cattle. Cattle are the most susceptible species though wild deer, hogs, horses, donkeys, and goats may contract it. The disease is caused by a bacterium Pasteuralla multocida. Isolated outbreaks occur from time to time, mainly in the rainy season. The organism lives in the soil and stagnant water may become infected. Incubation period of the disease rarely exceeds two days.

The disease runs a short course of from one to at the most 8 days, but the majority of affected cattle die within 3 to 4 days. Recovery is rare and 85 percent of infected cattle may die.

Treatment of the disease with a daily injection of 100 to 250 cc antiserum was reported effective but is obviously expensive. Therefore, cattle are usually protected by an oil-adjunct vaccine. Careful diagnosis is a must because the disease can be confused with Anthrax, Black quarter, Rinderpest and Contagious bovine pleuropneumonia.

Black quarter

Also called Black-leg, Black quarter is an acute specific disease of cattle and sometimes of sheep. It is characterized by the presence of rapidly increasing swelling containing gas, and occuring in the region of the shoulders, neck, thigh, and quarter. Certain locations (Table 17) are free of the disease while others are notoriously infected. The latter are mostly clay soils that are flooded during the rainy season. Young cattle between the ages of 3 months to 2 years are most susceptible although animals outside these limits are occasionally attacked.

The cause of the disease is Cloatridium chauvaei which lives in the soil until such time as it gains entry into the animal body, either with the food or

TABLE 17

INCIDENCE OF INFECTIOUS AND PARASITIC DISEASES IN THE PROJECT AREA

Location	Rinder-pest	Haemorr-hagic Septic-aemia	Black Quarter	Anthrax	Contag-ious Bovine Pleuro-pneumonia	Bovine Farcy	Tick-Borne Diseases	Trypanoso-miasis	Internal parasites
	xx	xx	xx	xx	xx	xx	xxx	xxx	xx
	xx	xx	xx	—	x	x	xxx	xxx	xx
d El Berdi	xx	xxx	xx	—	xx	x	xxx	xxx	xxx
Ghanem									
	x	xx	x	xx	x	x	xxx	xxx	x
ein	xx	xx	—	xx	x	x	xxx	xxx	xx
s									
rinka									
usa	xx	x	—	—	x	—	xxx	xxx	x
	xxx	x	x	—	x	—	xxx	xxx	x
	xxx	xx	x	xxx	xxx	x	xxx	xxx	xxx
l Fula	xx	x	—	—	x	x	xxx	xxx	x
	xx	x	—	xx	x	x	xxx	xxx	xx
nut	xx	x	—	xx	x	x	xxx	xxx	x
nuut	xx	x	—	xx	x	—	xxx	xxx	x
li	xxx	x	x	x	xx	xx	xxx	xx	xx
i	x	xx	xx	xx	—	xx	xx	x	x
imbeita	xx	—	—	—	x	xxx	xx	x	xx
haka	x	—	x	x	x	xxx	x	x	xx
arshoia	x	x	xx	—	—	xx	—	—	x
bassiya	xx	x	xx	—	—	x	xx	—	x
lti	x	xx	xx	—	—	—	—	x	x

TABLE 17 (continued)

Location	Rinder-pest	Haemorr-hagic Septic-aemia	Black Quarter	Anthrax	Contag-ious Bovine Pleuro-pneumonia	Bovine Farcy	Tick-Borne Diseases	Trypanoso-miasis	Internal parasites
Rukba									
i	x	x	x	xx	—	—	x	—	xxx
k	—	—	—	—	x	—	—	—	xxx
l	—	—	—	—	—	—	—	—	xxx
wa	—	—	—	—	—	—	—	—	xxx
ctina	—	—	—	—	—	—	—	—	xxx
ueim	xx	x	x	x	xx	—	x	—	xxx
uriga	xx	x	xx	—	x	—	xx	x	xx
ofi	x	—	x	—	x	—	—	—	xxx
heikh El Siddig	x	—	—	—	x	—	—	—	xxx

ley: x Mild xx Moderate xxx Severe (Epidemic)

Source: Survey

There is generally no opportunity to treat cases, since death occurs after only a few hours illness, but where the opportunity offers, success has been obtained with penicillin and antisera.

For prevention, young animals should not be grazed on lands that are suspected of harboring the organisms. Skin abrasions and wounds should be treated. A formalized vaccine gives very good protection against the disease.

Anthrax

The disease is caused by Bacillus anthracis. Under certain adverse conditions each rod-shaped bacillus is able to form itself into a spore. These spores resist drought for at least two years. They are able to live in bottom layers of the soil for as long as ten years. Consequently, pastures that have been infected by spilled blood from a case that had died are extremely difficult to render safe to stock and most particularly if these are at all wet or marshy. Spores are usually found in bones of dead animals as well as hides and skins.

The disease attacks all the domesticated animals and man but is most common among herbivora including cattle, sheep, and wild game. In some cases animals and man become infected by gaining access to parts of the carcass of other animals that have died from the disease or to bone meal. In cattle and sheep, it appears that infection nearly always occurs by way of the mouth in the food or with the drinking water.

Three forms of the disease are recognized: the pre-acute, the acute, and the sub-acute. It is not often that any one connected with the animal has an opportunity to observe the symptoms for in most cases the animal is found dead without showing any noticeable symptoms beforehand.

In-so-far as the prevention of the disease is concerned the important points to remember are: (1) the disposal of the carcass by efficent and safe means; (2) the careful observation of animals that have been in contact with the victim and their isolation from others if they show any rise in temperature; (3) the strict supervision of the carcass until such time as it can be disposed of, with efficient methods of sterilization of any blood or discharges that have been spilled; (4) vaccination to give a long immunity when outbreaks occur.

The prompt use of anti-anthrax serum in large doses has been useful. Penicillin and sulphathiozole could be used as treatment.

Contagious Bovine Pleuropneumonia (CBPP)

This disease has decimated cattle in many parts of the project area and probably has been responsible for death of more trekked cattle than any other single disease. The disease was of high incidence among cattle originating from near the borders of Chad, Central Africa Republic, and the southern regions of the Sudan.

The disease is caused by Mycoplasma mycoides, an infective agent from bacteria as well as from viruses. Infection occurs by direct contact. The

disease is characterized by a rather long incubation period that ranges between 3 weeks and 6 months.

The disease has achieved a notorious character in recent years for, unlike other diseases, it has proved difficult to control. Treatment of the disease with antibiotics was shown to be partially effective. A broth vaccine is used to protect cattle, however the protection with such vaccine lasts only for 6 to 9 months.

Bovine farcy

This is a chronic infection resulting from soilborne organisms of the genus Nocardia. The disease is characterized by nodular lesions and is fairly common in cattle in the western mountains, southern Kordofan and southern Darfur. Bovine farcy frequently is fatal, despite active and vigorous chemotherapy.

Tick-borne diseases

Ticks are responsible for the transmission of many bacterial, viral, and parasitic diseases. Apart from their role as vector and potential reservoirs of infectious diseases, heavy tick infestations can cause direct losses by damaging skins. In addition, many ticks are active blood suckers and can cause death from severe anemia. Heavy tick burdens cause restlessness and interfere with animal feeding, ultimately leading to reduced body weight.

The most common types of ticks in the project area include species of Ixodes, Boophilus, Amblyomma rhipicephalus, Darmacentor and Ornithodorus. It must be noted that the life cycles of these ticks vary widely. Some species pass their entire life cycle on one host, others pass different stages of the life cycle in successive hosts and others are parasitic only at certain stages. Although many ticks favour a particular host, they are usually not completely host specific and many ticks live on a wide variety of animals.

The diseases transmitted by ticks include Theileriasis, Babesiosis, Anaplasmosis, Brucellosis, Epizotic bovine abortion, and tick-borne fever. Some other unidentified syndromes and ailments may also be transmitted by ticks.

Individual animals can be treated by the application of any one of a number of insecticides applied as a spray or by dipping. The choice of insecticides depends largely on three factors:

1) The persistence of the insecticide on the skin and hair;

2) The likelihood of residues of insecticides toxic to man appearing in the milk or meat;

3) Whether or not the ticks in the area have developed resistance to the particular insecticide.

Arsenic is usually used as a dip containing 0.1-2 percent arsenic trioxide. The proportion of arsenic used is varied, depending on the fequency of dipping.

Two carbamates have also been used for tick control. Carbaryl has been in use for a long time and some ticks have developed resistance to it. Promacyl is reported to be active and without resistance at the present time.

Organophosphate and chlorinated hydrocarbon have been effectively used in the Sudan for the control of ticks.

Trypanosomiasis

The term trypanosomiasis is used to refer to a group of protozoan diseases of both animals and man, caused by species of the genus Trypanosoma. Transmission may be mechanical, i.e., carried directly from an infected animal to an uninfected one by a blood sucking fly or cyclical when the insect host is not infective for a definite period of time after ingestion of the parasite. In this case, the parasite passes a definite part of its life cycle in the fly. In many cases, transmission may be both mechanical and cyclical. Thus, the insect may have two infective periods, one immediately after biting a sick animal and the second sometime later (20 days) after the Trypanosoma has progressed to its infective stage along the normal lines.

The natural transmission cycle of tsetse (Glossina species) transmitted trypanosomes (T. vivax, T. congolense and T. evansi) involves wild animals which usually have symptomless infections. The trypanosomes become important when domestic animals become available as alternative hosts.

The pathogenicity of trypanosomes varies with the species of mammal infected, with breeds within domestic species, with exposure to stress including intercurrent diseases, with the strain of the trypanosome, and with the size and frequency of the infective dose or doses. Bovine trypanosomiasis is usually seen as a chronic wasting disease associated with the degree of anemia and intermittent fever, and diagnosis is best made on a herd or an area basis. Trypanosomiasis in all susceptible animals is most easily seen in the initial stages of infection or in acute cases.

It appears that Trypanosomiasis can be controlled by eradicating the tsetse vectors but this is not always practical. However, this could be partially achieved by destruction of the fly habitat or by the use of insecticides. Trypanocidal drugs are used extensively for the control of Trypanosomiasis but their use can only be palliative as reservoir infections in wild animal hosts are not being attacked. Another drawback to dry prophylaxis is the ease with which trypanosomes become resistant.

Internal parasites

The most economically important internal parasites in the project area are coccidiosis and liver flukes.

Coccidiosis or Red dysentery is a disease of cattle, sheep, and goats caused by species of Eimeria. Developmental forms of coccidia occur wholly in small and large intestines and the cecum where considerable destruction of the epithelium occur resulting in excessive hemorrhage. The disease is common in the very young stock and is reponsible for a large proportion of pre- and post-weaning mortality among calves, lambs, and goat kids.

Treatment consists of isolation and proper nursing of sick animals and administration of sulphamezathine or sulphaquinoxaline in daily doses for three consecutive days. Prophylaxis of clinical coccidiosis is based on controlling the intake of sporulated oocysts or sporocysts by young animals so that the infections become established in immunizing proportion without causing symptoms of the disease. Good feeding practices, good management, and attention to the principles of animal sanitation accomplish this purpose.

Fasciola gigantica, the most important trematode of domestic ruminants, is the most common cause of live fluke in some parts of the project area. It is endemic along the White Nile, Bahr el Arab, and around many other water streams and sources.

Eggs of the parasites passed in the animal feces develop to a larvae called meracidium in about 2 to 4 weeks. The meracidium, unable to feed itself, penetrates into lymnaea snails where ultimately it developes into a cercaria. After about two months development, the cercaria emerges from the snail and exists on water vegetation. After ingestion by the host, usually with herbage or drinking water, young flukes lodge in the bile ducts of the host.

The disease is rarely fatal in cattle but often fatal in sheep. Cases of chronic fasciolisis occur in all seasons and the signs include anemia, sub-mandibular edema, and reduced productivity. Control measures for fasciolisis are designed to reduce the number of flukes in the host animal and to reduce the snail population in the environment.

Disorders Common To Trekking Cattle

Trade cattle are vulnerable to specific disorders resulting from stress and physical influences of the environment. These disorders could be grouped as follows:

Muscle problems

Disorders of the musculosketelal or locomotive system. The disorders of the musculoskelatal system comprise lameness, bone fractures, inflammation of tendons, laminitis, and wounds of the hoof. The causes of these disorders are variable and include uncoordination of muscle action which occurs in tired animals, drinking of cold water by overheated animals, and shear stress and concussions from hard fast road walks. Approximately 2 to 4 percent of trekked cattle suffer from these disorders during the trip. The percentage of affected cattle depend on the type of cattle and type of soil of the route. Merchants indicated that Nilotic cattle are more inclined to lameness than other cattle. They also suggested that cattle suffer more from blisters and hoof wounds when trekked on sandy soils than when trekked on clay soils.

Cattle affected with disorders of the locomotive system may be unable to walk or must walk at a slower pace. Such cattle are disposed of by:

a) selling to butchers along the route for almost 1/2 price;

b) selling to villagers at 1/3 price;

c) leaving at the nearest water point;

d) leaving to die on the road.

When left at a water point, the merchant pays all costs of feed and labour. When the animal recovers, it continues the trip with another batch of cattle belonging to the owner or other merchants.

Circulatory ailments

Disorders of the circulatory system such as dehydration and electrolyte imbalance result from deficiency in water or heat stress. This disorder could be prevented by providing water and salt for trekked cattle at reasonable walking distance. Water (gallon/day) requirements of non-heat stressed non-lactating cattle amount to five to six percent of bodyweight per day. Water consumption may increase to nine to twelve percent of body weight per day when animals are heat stressed.

Heat stress

Disorders of the temperature regulatory system may result from high temperature and direct exposure to rays of the sun. These disorders include hyperthermia, heat stroke, heat exhaustion, and heat cramps. These disorders are prevented by walking cattle during evenings and mornings and resting them under shade at mid-day.

Food problems

Nutritional deficiencies result from inadequate food intake and poor feed quality. These deficiencies include energy, protein, phosphorus and calcium. Symptoms of these deficiencies include emaciation and bodyweight loss.

Veterinary Services

This section reviews the veterinary services and facilities available in the project area and points to the main inadequacies. It also suggests some necessary remedial measures to be taken as part of preparing for the SSR. It must be noted here that most of the present facilities are found in administrative centres north of the SSR, along the path of the Northern Stock Route. The Ministry of Agriculture and Natural Resources at both regional and central levels attaches great importance to veterinary services. This priority recognizes that no economic development can take place without the presence of effective veterinary services at the field level.

The objective of veterinary services has always been to control and eradicate infectious animal diseases. The means to accomplish this objective is the immunization and treatment of livestock against various diseases and the enforcement of established regulations and by-laws relevant to animal disease

Veterinary services are extended to livestock from stationary as well as mobile governmental units. Very recently the private sector entered into veterinary services on a limited scale. Among the functions of veterinary services at the field level are:

1) Diagnosis and treatment of non-infectious diseases as well as surgery, obstetrics and gynaecology;

2) Immunization of various types of livestock against the different infectious diseases predominant in the area;

3) Distribution of acaricides, insecticides, anthelmintics, and trypanocidal drugs to livestock owners;

4) Monitoring infectious diseases and livestock movements and reporting to higher level authorities;

5) Issuing of animal transport permits after carrying out the necessary actions. These actions include inspection, vaccination and, in some instances, quarantine measures;

6) Meat inspection which is important from a public health perspective as well as for disease monitoring.

Administration of veterinary services is the task of the nation's veterinary service. Each province is divided into a number of district veterinary offices. Veterinary services within the district are supervised by a district veterinary officer (DVO) who is responsible to the province veterinary office (PVO) at the top of the administration of the veterinary services within the province. Within the district, veterinary services are carried by stationary or mobile veterinarians, veterinary assistants, and nurses.

The duties of the PVO include:

1) liaison between the province and the regional ministry;

2) administration, planning, and supervision of veterinary services and activities with the province;

3) provide DVO with:

   vaccines, vaccination materials, and equipment;

   medicines, acaricides, insecticides, etc.

   surgical and diagnostic equipment and materials;

   transport of personnel as need arises.

4) Declaration of epidemics and restriction of livestock movements from and into an area on advice of the DVOs. The PVO is responsible to the Director General of the regional Ministry of Agriculture and Natural Resources.

Among the duties of the DVO are:

1) liaison between the district and PVO;

2) administration, planning and supervision of veterinary services within the district;

3) provide veterinary posts with:

   vaccine, vaccination materials, and equipment;

   medicines, acaricides, insecticides, etc.;

   surgical and diagnostic equipment and materials;

   transport of personnel as need arises;

4) organises programmes and supervises the activities of disease control mobile units.

Veterinary services are extended to livestock owners from stationary veterinary posts and/or disease control mobile units.

Stationary veterinary posts could be classified as veterinary hospitals and clinics, depending on the number and complexity of the cases handled. Veterinary hospitals are usually located with the DVO and are run by qualified veterinarians. Veterinary clinics are located at large villages and are run by veterinary assistants or nurses.

The following items are essential for a veterinary post to perform satisfactorily the assigned duties and functions:

1) vaccines, drugs, acaricides, anthelmintics, and cold storage facilities;

2) animal handling facilities for vaccine and drug administration. These include vaccination crushes, dips, quarantines, inpatient premises, etc.;

3) basic surgical and medical instruments including haemostats, scalpels, needle holders, needles, retractors, tissue forceps, suture material, cotton, bandages, etc.;

4) basic diagnostic equipment and materials including microscopes, glass microscope slides, appropriate size glass coverslips, materials including chemicals and blood stains;

5 buildings including office buildings, stores, and accommodation for staff. The latter is the determining factor for a staff member to stay in a veterinary post;

6) transport for long and short distances to extend veterinary services to the people at their premises. Transport is also essential for

livestock movement it could be provided by automobile, motorcycles, bicycles, and, in some localities, horses and donkeys.

Stationary veterinary posts extend veterinary services to resident population livestock, trade cattle, and to nomads' livestock enroute to seasonal homeland.

Because of the nomadic pattern of livestock production in Sudan, mobile units are used for inspection and vaccination of livestock. The mobile units extend veterinary services to livestock at localities beyond the reach of stationary veterinary posts or where the latter do not exist. These localities are usually points of seasonal concentration of livestock. Mobile disease control units perform this activity during the dry season and close down during the rainy season. The localities are visited by mobile units according to a time schedule programmed by the DVO's, in consultation with the executive council of the area. The programme is distributed on a wide scale at least one month in advance of the start of the arrival of the mobile units.

The main objective of the mobile disease control units is to vaccinate against Rinderpest, but the opportunity is also taken to vaccinate against other diseases endemic in the area. The opportunity is also taken to administer trypanocidal drugs and to distribute acaricides and anthelmintic drugs.

The following items are essential for a mobile disease control unit to perform satisfactorily the assigned duties and functions:

Transport

Transport vehicles, fuel, spare parts, maintenance services, and oils and lubricants are crucial. A six to seven ton truck is ideal for the purpose. Because of the remoteness of the areas of operation, fuel, oils, lubricants and spare parts must be provided from the start, and a mechanic must accompany each;

Camping gear

Camping equipment including tents, beds, lamps, and cooking utensils;

Medicine

Vaccines against diseases common in the area of operation; medicine including antibiotics, anthelmintics, acaricides and trypanocidal drugs;

Refrigeration

Cooling facilities such as refrigerators and deep freezers operating with kerosene. These are essential for the storage of the Rinderpest vaccine which must be frozen until immediately before use.

Animal restraints

Animal handling facilities for vaccine and drug administration. A mobile crush is necessary for such a job;

Personnel

Mobile disease control units are headed by veterinary assistants who are originally stationed in the district veterinary office. Members of the unit range between 4 and 8 veterinary nurses plus the truck driver and the mechanic.

Veterinary services of all types used to be given, free of charge, to livestock owners, provided that they brought the animals to veterinary posts or the camp of the mobile unit. Today, livestock owners have to pay the costs of all veterinary services extended to them except for vaccination of Rinderpest and one other infectious disease.

Veterinary service costs vary considerably among provinces and districts, as decided by the executive council within each jurisdiction. Surgical and obstetrical operation costs to owners are decided by heads of the veterinary posts, depending on the complexity of the operation. Rarely are surgical operations carried out in veterinary posts because of the lack of in-patient premises and feed.

Drugs including antibiotics, anthelmintics, acaricides, trypanocidal drugs, and insecticides are provided to livestock owners at cost, which includes central and local taxes. It must be noted that the private sector also has gone into the business of veterinary drugs and equipment importation and distribution. This is because it became clear that the veterinary services provided by the governmental bodies are in many cases inadequate as a result of lack of funds, drugs, or means of transport.

Animal health regulations prohibit animal movement across provincial boundaries and into the animal disease free zone unless vaccinated against all notifiable infectious diseases. The regulations also indicate that clinically sick animals must be quarantined until proven otherwise.

Veterinary posts are entrusted with the enforcement of these regulations. Experience has shown that it is difficult to enforce such regulations in a vast country like the Sudan where the producers are mainly nomads. Lack of facilities and shortage in personnel aggravate the situation.

Before trekking, trade cattle must be inspected and vaccinated against Rinderpest, Contagious bovine pleuropneumonia (CBPP), Haemorrhagic septicaemia (HS) and Anthrax. These vaccinations are provided at cost. Acaricides application and antheimentic and trypanocidal drug administrations are not compulsory. Sheep are vaccinated against Anthrax only. To safeguard against spread of diseases by trekked livestock and to ensure that they do not contract a disease while moving, vaccinations are recommended at the nearest veterinary post to the point of origin.

Livestock movement permits are issued and stamped at the post where inspections and vaccinations are completed. These permits must be kept throughout the journey and be shown when requested. The permits are issued at cost which varies among provinces and within a province.

Existing Veterinary Facilities

Provincial veterinary offices in the project area are located at Nyala (Southern Darfur), Kadugli (Southern Kordofan) and El Dueim (White Nile), (Figure 7). None of these PVOs lies immediately on the SSR but one of the feeder routes passes by Kadugli.

Within Southern Darfur Province, district veterinary offices (DVOs) nearest to the route are at Buram (Central District) and El Dueim (Eastern District). Both offices lie to the north of the main SSR. District veterinary offices within Southern Kordofan include Babanousa (Southern District), Rigl El Fula (Western District), Abbassiya (Eastern District) and Kadugli (Central District). Babanousa and Rigl El Fula are located north of the main route and Abbassiya and Kadugli to the south. However, two feeder routes originate from points south of, and pass by Kadugli and Abbassiya. Within the White Nile Province DVOs are located at Tendelti (Western District) and Kosti (Central District). Tendelti is to the north of the main route and Kosti lies immediately on it.

It is important to note that the part of the SSR route within Southern Darfur and Kordofan are far south of the existing administration offices. This is because the northern route takes its starting points from these administrative centres.

Existing veterinary posts (veterinary hospitals and clinics) in proximity to the project area are listed according to provinces and districts in Table 18. Veterinary posts in Southern Darfur and parts of Southern Kordofan are located to the north of the proposed dry season stock route. Veterinary services for areas free of veterinary posts are extended by mobile disease control units during the dry season.

Veterinary hospitals at Umm Brimbita, Kosti, Rabak, and Getina are located on the proposed route as are veterinary clinics at Delami, Abu Karshola, Gadid, Shawal, and El Kawa. Veterinary hospitals at Kadugli and Abbassiya are located on the proposed feeder routes.

Table 19 notes the buildings available at veterinary posts in proximity to the project area. Veterinary hospitals usually consist of a two room office building plus a pharmacy and a store. When a veterinary hospital is located at provincial headquarters, the number of offices may increase to six rooms as is the case in Nyala, Kadugli, and Kosti. However, at veterinary headquarters and hospitals, there is a shortage of office space. It was observed that veterinary hospital buildings are in good condition and well maintained.

Veterinary clinics consist of a single room, mostly built of local materials. This room is used as an office, pharmacy, and store. It is apparent that the clinic buildings have not been maintained for a long time.

TABLE 10

EXISTING VETERINARY POSTS IN THE PROJECT AREA

Location Province	District	Veterinary Hospital	Veterinary Clinic
SOUTHERN DARFUR	Central	Nyala	
	Southern	Buram	
		Id El Ghanam	
	Eastern	Ed Daein	Fardus
SOUTHERN KORDOFAN	Southern	Babanousa	Babanousa East
			Muglad
			Abyei
	Western	Rigl El Fula	Lagawa
			El Babair
			El Suomit
			Momo
	Central	Kadugli	
	Northern	Umm Bilbilla	Delami
			Abu Karshola
	Eastern	Abbassiya	
WHITE NILE	Western	Tendelti	Abu Rukba
			Gadid
	Central	Kosti	Shawal
		Rabak	El Kawa
	Northern	El Getina	

Source: Survey.

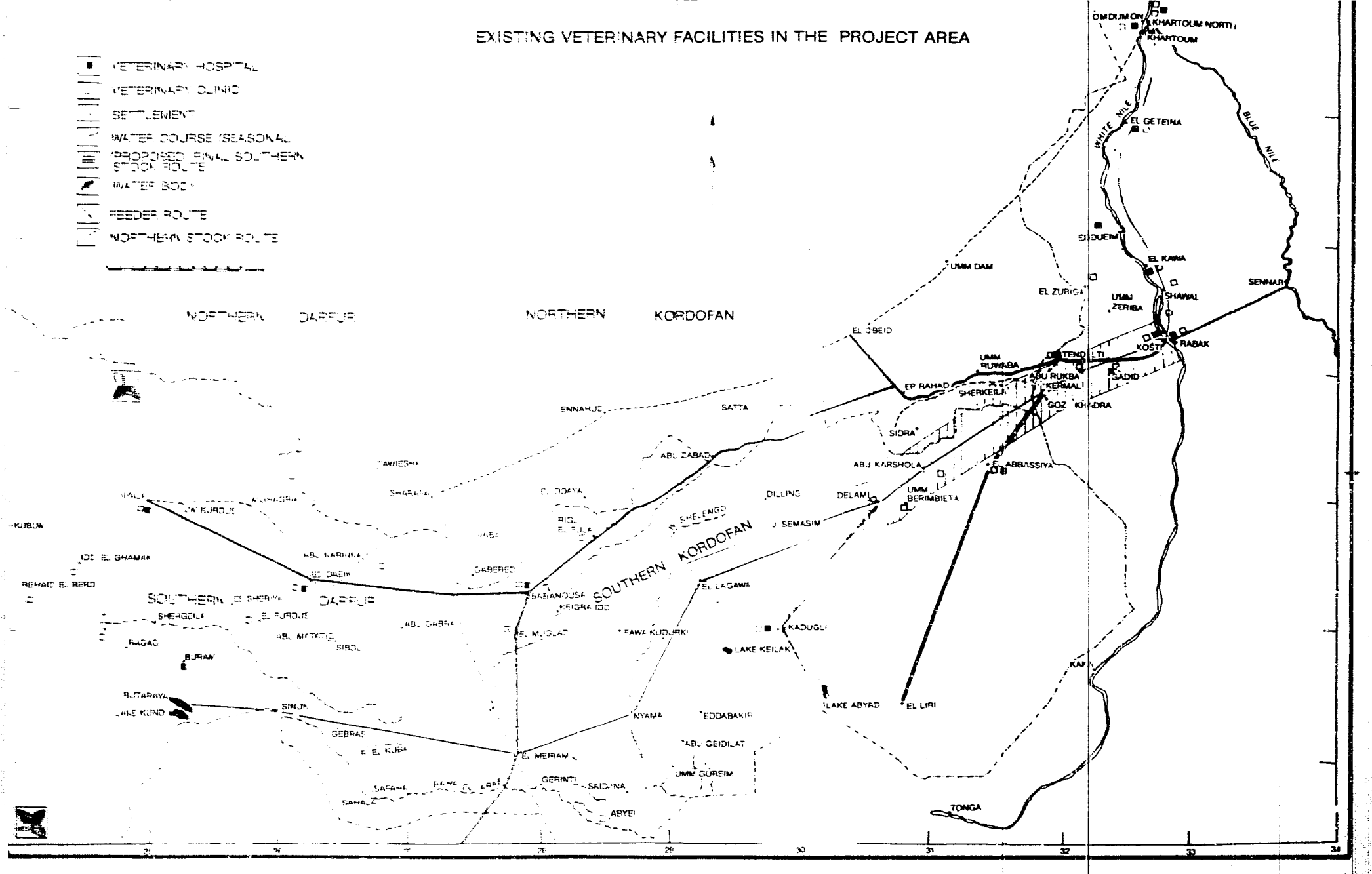
Veterinary posts lack the following facilities:

1) In-patient premises. Such premises are essential for veterinary posts, particularly when animals are operated upon, recumbent, or unable to walk. In-patient stalls could be used to keep those few trade cattle that for some reason may be incapable of walking further.

2) Vaccination Crushes: Crushes facilitate the vaccination procedures and ensure the safety of both staff and animals. Mobile disease control units do not have mobile vaccination crushes. Crushes are available in all posts in Souther Darfur and in Rigl El Fula and Kadugli in Southern Kordofan.

3) Quarantine premises: These are important to isolate sick and suspected cases with infectious diseases.

EXISTING VETERINARY FACILITIES IN THE PROJECT AREA



4) Acaricide dips: Cattle spread ticks and tick-borne diseases as they move from one locality to another. Dipping in acaricides is an important measure to control ticks and tick-borne diseases.

5) Diagnostic laboratories: Diagnostic laboratory buildings exist only at Nyala, Kadugli, and Kosti.

6) Furniture: Greatest needs are desks, chairs, and filing cabinets.

Availability of houses in remote veterinary posts is the determining factor for the stability and settlement of veterinary personnel. It was observed that veterinary staff tend to stay in towns and large villages where government or rented houses are available. To overcome the problem of housing shortages, veterinary authorities adopted the policy of employing semi-technical staff from among the residents of the area.

Table 19 shows the available houses at various veterinary posts. Houses at provincial and district offices consist of two rooms or more in addition to a kitchen and lavatories. Houses at locations of veterinary clinics consist of a hut built from local materials.

The veterinary staff consists of:

1) Qualified veterinarians with minimum qualifications of a university degree in veterinary medicine or sciences. Some of the veterinarians possess post graduate diplomas in animal health.

2) Veterinary assistants with a post-secondary school diplome in veterinary medicine. However, the majority of veterinary assistants start as veterinary nurses and are trained on the job and attend courses at Omdurman School for Veterinary Training.

3) Veterinary nurses with no training whatsoever when they start. Some of them might have had a chance to attend courses in Omdurman School of Veterinary Training.

4) Clerks and accountants.

5) Labourers including messengers and guards.

Table 20 shows the distribution of veterinary staff at the posts located in proximity of the project area. It indicates that the staff number is 491. The professionally trained peronnel (Qualified Veterinarian and Veterinary Assistants) represent 24.5 percent of the total work force. The total number

TABLE 19

OFFICE BUILDING AND STAFF HOUSES

Location	Office	Pharmacy	Store	House
	Number of Rooms			
Nyala	6	1	3	3
Buram	2	1	1	1
Id El Ghanam				
Ed Daein	2	1	1	1
Fardus	1	-	-	1
Abu Karinka	1	-	-	1
Babanousa	3	-	1	1
Babanousa East	1	-	1	1
Muglad	2	-	-	1
Abyei	1	-	-	1
Rigl El Fula	3	1	1	2
Lagawa	1	-	-	1
El Bohair	1	-	-	1
El Sunnut	1	-	-	1
Mogo	1	-	-	1
Kadugli	4	1	2	2
Delami	1	-	-	1
Umm Brimbita	2	1	1	1
Abu Karshola	1	-	-	1
Abbassiya	2	1	1	2
Tendelti	2	-	-	-
Abu Rukba	1	-	-	-
Gadid	1	-	-	1
Kosti	4	1	1	3
Rabak	2	-	-	-
Shawal	1	-	-	-
El Kawa	2	-	-	1
El Getina	2	-	-	1

TABLE 20

VETERINARY STAFF

Location	Qualified Veterinarians	Veterinary Assistants	Veterinary Nurses	Labourers
Nyala	11	26	37	64
Buram	3	3	6	14
Id El Ghanam	3	4	9	16
Ed Daein	3	2	6	9
Fardus	-	1	2	-
Abu Karinka	-	2	1	3
Babanousa	2	3	6	12
Babanousa East	-	1	5	1
Muglad	-	2	3	10
Abyei	-	1	1	4
Rigl El Fula	2	7	10	10
Lagawa	-	1	2	5
El Bahair	-	1	1	-
El Sunnut	-	-	2	1
Momo	-	-	1	1
Kadugli	5	6	20	32
Delami	-	-	1	1
Umm Brimbita	1	1	2	4
Abu Karshola	-	-	1	5
Abbassiya	1	2	-	4
Tendelti	1	2	4	7
Abu Rukba	-	1	-	-
Gadid	-	1	1	2
Kosti	16	2	15	10
Rabak	1	1	3	6
Shawal	-	-	1	-
El Kawa	1	1	1	-
El Getina	1	1	3	3
TOTAL	51	72	144	244
Percent of Total	10	14.5	29	45.5

and proportion of qualified staff suggest that the staff is adequate to carry out the duties assigned to it. However, improper distribution of veterinary staff suggests inadequacy. As an example 53, 39, 36, and 33 percent of qualified veterinarian, veterinary assistants, veterinary nurses and labourers respectively are found in Nyala and Kosti. This improper distribution of the available manpower is due mainly to the lack of necessary services, particularly housing, at remote veterinary posts.

Vehicles providing veterinary services at field level are usually located at PVO, DVO and veterinary hospitals. Table 21 shows the number, type, and condition of vehicles available for extension of veterinary services in the project area. Pick-ups are usually used for within town transport while trucks are used as mobile disease control units and for distribution of drugs and veterinary equipment to veterinary posts.

The number of trucks suggests that 28 mobile disease control units could be mobilized and would be adequate to provide vaccinations and disease control if fuel, oil, spare parts, lubricants, and maintenance are freely available. It must be emphasized that during the last three years, fuel and maintenance were the main constraints limiting the number and efficiency of veterinary services. They are only made available when outbreaks of a serious disease occur. The vaccination numbers reported earlier were achieved through the aid of other governmental and corporate units such as the Western Savanna Development Corporation. The latter came with trucks, fuel, and cash to aid veterinary services in Southern Darfur Province and is still doing so.

Drugs and other essential veterinary equipment are provided to veterinary posts by the PVO who obtains them from the Department of Veterinary Supplies in Khartoum. The lack of antibiotics, bacteriostatics, anthelmintics, acarcides, and trypanocidal drugs was evidenced at all the veterinary posts which the Mission visited. This was mainly due to reduced funding to the Department of Veterinary Supplies in the last few years. However, the private sector imported enough drugs to compensate for the shortages resulting from government budget outbacks.

Private sector veterinary pharmacies in the project area are located at Nyala, Ed Daein, Kadugli and Kosti. These pharmacies sell all types of veterinary drugs, but they are prohibited from distributing vaccines. It must be noted that all of them except Kadugli are far north of the proposed route as they used to serve the nomads during the wet season as well as the NSR.

Serious shortage of bacterial and mycoplasma disease vaccines is observed at all veterinary posts visited, although Rinderpest vaccine was very much available.

Vaccines are produced and distributed by the Veterinary Research Administration. None of the vaccines in common use in the country is imported. Table 22 shows the actual and targeted production of vaccines by the Veterinary Research Administration. The table indicates that while actual Rinderpest vaccine production exceeded the target, actual production of bacterial vaccine did reach 50 percent of the target. This is due to the lack of accessory equipment such as fermentors in CBPP vaccine production.

TABLE 21

VEHICLES PROVIDING VETERINARY SERVICES

Location	Pick-up	Truck (6-8 tons)	Condition of vehicle
Nyala	3	6	good
Buram	1	2	good
Id El Ghanam	1	2	good
Ed Daein	1	1	good
Babanousa	-	3	poor
Rigl El Fula	1	3	fair
Kadugli	2	3	good
Umm Brimbita	-	1	fair
Abbassiya	1	-	good
Tendelti	-	1	poor
Kosti	2	5	good
Rabak	1	-	fair
El Getina	1	1	fair
TOTAL	13	28	

Although sufficient doses of Rinderpest vaccine are produced, the main problem is difficulty of continuous distribution to provinces and thereafter to the remote veterinary posts. Rinderpest vaccine must be kept frozen until shortly before use. The lack of quick transport and cooling facilities aggravates the problem.

The Veterinary Research Administration has an ambitious plan to produce Rinderpest vaccine at the veterinary research laboratories in Nyala and El Obeid. This endeavour is aided by the British Overseas Development Agency (ODA).

Freezing and cooling equipment are essential for maintenance of a continuous supply of Rinderpest vaccine and for ice making. Table 23 shows the availability and distribution of freezing and cooling equipment at veterinary posts in the project area. Because of the lack of electric power, all refrigerators and freezers are kerosene fueled. The shortages of kerosene and improper maintenance resulted in the reduction of capacity and life of some of this equipment.

It must be noted that all refrigeration and freezing equipment is located at the province and district veterinary offices. Veterinary assistants and nurses must travel a distance to bring a vaccine in an area of inadequate roads and transport vehicles. In many veterinary clinics, accessory cooling equipment such as ice boxes and thermos-flasks are lacking.

TABLE 22

ACTUAL AND TARGETED VACCINES PRODUCTION

Vaccine	Doses in Bottle	Actual Production (000 dozens)					
		1978/79	1979/80	1980/81	1981/82	1982/83	Target
inderpest	200	5794	5421	6129	6302	9287	8000
BPP	100	55	721	1374	382	197	4000
nthrax	125	1726	2920	1425	1305	872	2000
	120	2193	2653	2113	1689	773	3000
	120	324	995	830	972	227	1000
frican Horse Sickness	10	1.5	1.4	—	4.5	0.6	—
ew Castle	400 or 100	1675	2187	2271	1929	2186	3000
owl Pox	100	179	235	277	211	359	600

CBPP = Contagious bovine pleuropneumonia
HS = *Haemorrhagic septicaemia*
BQ = Black Quarter

TABLE 23

FREEZING AND COOLING EQUIPMENT

Location	Refrigerator	Freezer	Ice Box	Thermos Flask
Nyala	4	4	6	4
Buram	1	1	3	2
Id El Ghanam	1	1	3	2
Ed Daein	1	1	2	2
Fardus	1	-	1	1
Abu Karinka	1	-	1	1
Babanousa	3	3	6	4
Babanousa East	-	-	-	-
Muglad	-	-	2	2
Abyei	-	-	2	2
Rigl El Fula	3	3	6	-
Lagawa	1	-	-	-
El Bahair	-	-	-	-
El Sunnut	-	-	-	-
Momo	-	-	1	1
Kadugli	4	2	6	-
Delami	-	-	-	-
Umm Brikbita	1	1	2	2
Abu Karshola	-	-	-	-
Abbassiya	1	-	2	1
Tendelti	1	1	-	-
Abu Rukba	-	-	-	-
Gadid	-	-	1	-
Kosti	4	4	3	-
Rabak	1	-	1	-
Shawal	-	-	-	-
El Kawa	1	-	-	-
El Getina	1	1	2	-
TOTAL	26	22	42	22

The number of refrigerators and freezers in the province and district offices determine the number and efficiency of mobile disease control units. For example, in Buram the number of trucks available for mobile disease control units is two but only one refrigerator is available.

The Mission observed that the following basic facilities are seriously lacking at all veterinary posts:

1) Diagnostic equipment including microscopes, stethoscope glassware (slides, test tubes), and stain chemicals;

2) Treatment equipment including veterinary kits, sterilizers, gross syringes, gross needles, and animal handling equipment (veterinary kits);

3) Surgery and obstetrics equipment including surgical and obstetric ware, analthetics, suturing materials, cotton, and linen cloth (surgical kits);

4) Drugs including antibiotics, bacteriostatics, anthelmintics, acaricides, analgestics and trypanocidal drugs;

5) Vaccines including those for bacterial and viral diseases. Supplies of Rinderpest vaccines are dependent on availability of refrigerators or freezers;

6) Office equipment including desks, chairs, and file cabinets.

Table 24 shows essential facilities available for mobile disease control units on a district basis. Shortage and improper distribution of facilities reduced the number of possible mobile disease control units from 27 to 21.

TABLE 24

ESSENTIAL FACILITIES FOR MOBILE DISEASE CONTROL UNITS

District/Location	Truck	Refrigerator	Number of Mobile Units possible
Nyala	6	4	4
Buram	2	1	1
Id El Ghanam	2	1	1
Ed Daein	1	3	1
Babanousa	3	3	3
Rigl El Fula	3	4	3
Kadugli	3	4	3
Umm Brimbita	1	1	1
Abbassiya	-	1	0
Tendelti	1	1	1
Kosti	5	3	3
Rabak	-	1	0
El Getina	-	1	0
TOTAL	27	28	21

The Mission observed the serious lack of camping equipment (tents, beds, etc.) for mobile disease control units. Province and district veterinary officers complained about the shortage of funds assigned for payment of travel allowances of the staff. They indicated that the shortage of funds usually results in cancellation of the mobile disease control units programme at critical stages. To speed up the vaccination process, they suggest that mobile disease control units be provided with mobile crushes.

Utilization of Increased Funding for Veterinary Services

Increased funding for veterinary services in the project area should be utilized to achieve two main objectives:

1) To ensure the health, well-being, and soundness of trade cattle trekked on the proposed route;

2) To prevent or at least reduce the seriousness of spread of diseases and the hazards of parasites and insects carried by trade cattle as they move from one environment to another.

These objectives involve the application of strict disease, parasite, and insect control and could be achieved by the implementation of the following programmes.

Establishment And Rehabilitation Of Veterinary Posts

This programme proposes the establishment of new veterinary posts (Figure 8). It also suggests reconstruction and rehabilitation of some of the existing veterinary posts along the proposed route. In addition to their main function of extending veterinary services, some of these posts would act as supply and administrative centres for veterinary services along the route. Veterinary posts would be placed at:

1) Locations where large numbers of livestock exist;

2) Locations where feeder routes join the main route;

3) Locations where relatively large livestock markets exist;

4) Locations near provincial borders;

5) At the start and end of the main and feeder routes.

The main feature of the programme is construction of offices and staff accommodations.

Infectious Disease Control Programme

Infectious diseases are controlled by vaccination of trade cattle and all types of sedentary and nomadic livestock in the project area. Efforts must be made to vaccinate all trade cattle at the point of origin of their trip which is usually the market place. Sedentary livestock must be vaccinated at their

premises or at the nearest water point. Nomadic cattle are to be intercepted before crossing the proposed route at the proper water points.

Cattle must be vaccinated against Rinderpest, Contagious bovine pleuropneumonia (CBPP) and Black quarter (BQ). Cattle, sheep, and goats must be vaccinated against Anthrax and Haemorrhagic septicaemia (HS).

The main features of the programme are provision of vaccines, mobile disease control units, vaccine storage, and animal handling facilities.

Tick Control Programme

This programme is designed to reduce the transfer of ticks from heavily infested areas to relatively tick-free environments. The programme should be directed toward trade cattle in the early stages but should gradually include sedentary and nomadic livestock. The programme should be closely related to the proposed water supply programme since acaricides, dips, and hand sprayers will not operate in the absence of water.

The main features of the programme are the construction of dips and dip monitoring facilities and provision of hand sprayers and acaricides.

Trypanosomiasis Control Programme

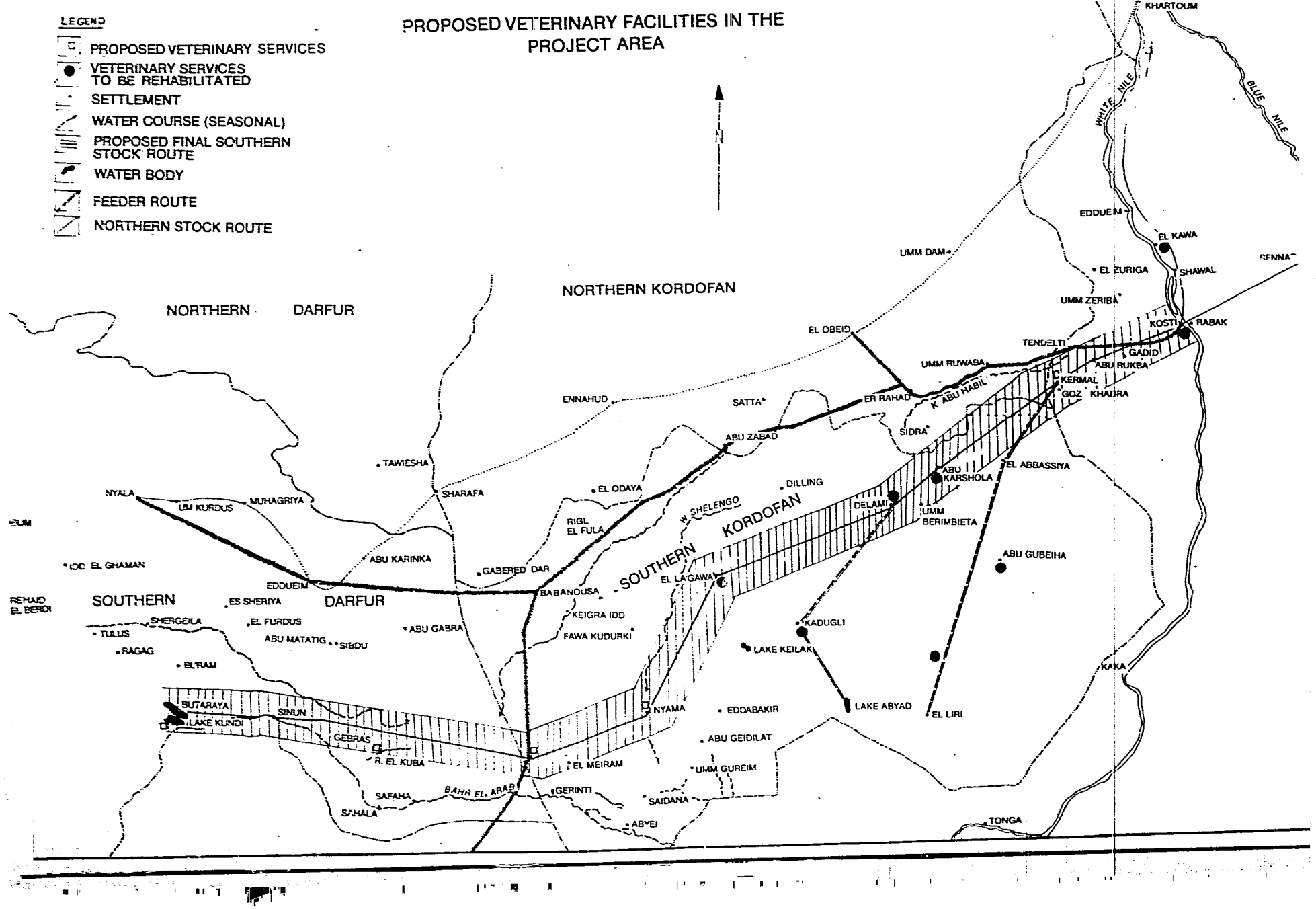
This programme is designed to control the spread of this disease to environments relatively free of it and to minimize losses incurred among trade, sedentary, and nomadic livestock in the project area. It is proposed that these objectives could be achieved by destruction of the natural habitat of the disease transmitting insect (tsetse as well as others) in conjunction with provision of curative and prophylactic drugs. The curative and prophylactic drugs should be administered at the beginning of the northward and southward migration of livetock. The main features of the programme are the provision of bush clearing tools and trypanocidal drugs.

Disease Treatment Programme

Treatment of trade cattle and sedentary and nomadic livestock forms unimmunizable diseases. These diseases include tick-borne diseases, enteric and blood parasites, noninfectious diseases and disorders common among trekked livestock. The main features of this programme are provision of antibiotics, bacteriostatics, and anthelmintic drugs as well as surgial equipment and inpatient premises.

Programme Justification

Diseases have plagued the livestock population for many years. Without an effective control programme, Sudan's livestock industry will not develop. The dissemination of pathogenic microorganisms by trekked cattle has always been a problem to veterinary authorities. Infectious and parasitic diseases cause considerable loss in numbers and productivity. It was estimated that 40 percent of the abortions and post weaning mortalities among calves is caused by the infectious diseases mentioned earlier. The diseases also have adverse effects on conception, calving rates, weaning weights, and body condition.


PROPOSED VETERINARY FACILITIES IN THE PROJECT AREA
LEGEND
PROPOSED VETERINARY SERVICES
VETERINARY SERVICES TO BE REHABILITATED
SETTLEMENT
WATER COURSE (SEASONAL)
PROPOSED FINAL SOUTHERN STOCK ROUTE
WATER BODY
FEEDER ROUTE
NORTHERN STOCK ROUTE
N
NORTHERN DARFUR
NORTHERN KORDOFAN
SOUTHERN DARFUR
SOUTHERN KORDOFAN
KHARTOUM
WHITE NILE
BLUE NILE
SENNAR
EDDUEIM
EL KAWA
SHAWAL
UMM DAM
EL ZURIGA
UMM ZERIBA
KOSTI
RABAK
EL OBEID
TENDELTI
GADID
UMM RUWABA
ABU RUKBA
KERMAL
GOZ KHADRA
ER RAHAD
K ABU HABIL
SIDRA
ENNAHUD
SATTA
ABU ZABAD
TAWESHA
SHARAFA
EL ODAYA
DILLING
ABU KARSHOLA
EL ABBASSIYA
NYALA
UM KURDUS
MUHAGRIYA
W SHELENGO
DELAMI
UMM BERIMBIETA
RIGL EL FULA
ABU KARINKA
GABERED DAR
ABU GUBEIHA
EDDUEIM
BABANOUSA
EL LAGAWA
ES SHERIYA
KEIGRA IDD
SHERGEILA
EL FURDUS
ABU GABRA
FAWA KUDURKI
KADUGLI
TULUS
ABU MATATIG
SIBDU
RAGAG
LAKE KEILAK
EL RAM
KAKA
BUTARAYA
SINUN
NYAMA
EDDABAKIR
LAKE ABYAD
EL LIRI
LAKE KUNDI
GEBRAS
ABU GEIDILAT
R. EL KUBA
EL MEIRAM
UMM GUREIM
SAFAHA
BAHR EL ARAB
GERINTI
SAIDANA
SAHALA
ABYEI
TONGA

If the programmes and measures proposed for disease control are implemented, the following production gains, estimated conservatively, may be achieved:

Calving rate will be improved by	5%
Calf mortality will be reduced by	8%
Adult mortality will be reduced by	3%
Trekked cattle mortality will be reduced by	2%
Weight losses wil be saved by	10%

In monetary terms, gains are estimated to be:

Calving rate improvement	£S 1,080,000
Calf mortality savings	216,000
Adult mortality savings	1,080,000
Weight losses savings	081,000
	£S 2,377,000

The consequential gain of an estimated £S 2,377,000 per year is an ample justification for the utilization of increased funding for the programmes profiled below.

A. Programme Title

Establishment and Rehabilitation of Veterinary Posts.

Programme Objectives

1) construction of offices and staff accommodations where they were originally lacking on the proposed dry season stock route. Veterinary posts are to be established at Lake Kundi, El Kubu, Nama, Kermal and Jebel Awlia.

2) construction of additional offices and/or staff accommodations at existing veterinary posts. Additional offices and/or staff accommodation buildings are requred at El Lagawa, Kadugli, Delami, Abu Karshola, Abbassiya, Kosti, and El Kawa.

3) maintenance of existing offices and staff accommodation buildings at Delami, Kadugli, Abu Karshola, Abbassiya, and Kosti.

Programme Location: (see Figure 8).

Programme Components: (see Table 25).

Programme Cost

1)	Construction of 3 four-room office buildings	120,000
2)	Construction of 3 three-room office buildings	90,000
3)	Construction of 5 two-room office buildings	100,000
4)	Construction of 15 three-room houses	450,000
5)	Construction of 27 two-room houses	540,000
6)	Construction of 58 one room houses	580,000
7)	Maintenance for existing buildings	70,000
	TOTAL	1,950,000

TABLE 75

DISTRIBUTION OF COMPONENTS TO ESTABLISH AND REHABILITATE VETERINARY POSTS

Location	Office (Room Number)			Staff (house room number)	Accommodation	
	4	3	2	3	2	1
Lake Kundi	1	-	-	2	3	6
El Kubu	-	-	1	-	1	3
El Meiram	1	-	-	-	1	6
Nama	-	1	-	2	3	6
El Lagawa	-	1	-	1	1	3
Kadugli	-	-	1	2	3	6
Delami	-	-	1	-	1	3
Abu Karshola	-	-	1	-	1	3
Abbassiya	-	-	-	2	3	6
Kermal	1	-	-	2	3	6
Kosti	-	-	1	2	3	6
Kawa	-	-	-	-	1	2
Jebel Awlia	-	1	-	1	2	4
TOTAL	3	3	5	15	27	58

B. Programme Title

Infectious Disease Control

Programme Objective

1) control of [illegible] of infe[illegible] in the project area. These [illegible] rderpest, [illegible] anthrax and CBPP. This is achieved b[illegible]nation of trade cattle and all other types of sedentary ad nomadic livestock in the project area;

2) monitor animal movement and disease incidence in the project area;

3) enforce regulations of animal movement in and out of the project area and issue health certificates when required.

Programme Location

Project area.

Programme Components

1) Provision of vaccines;

2) Provision of transport and mobile disease control units;

3) Animal handling facilities;

4) Camping equipment and materials;

5) Vaccine storage facilities.

The distribution of programme components in the project area is shown in Table 26.

Programme Cost

1)	F.W.D. vehicles	£S 325,000
2)	16 trucks (Mobile disease control units)	64,000
3)	Purchase of vaccines	300,000
4)	28 twelve cubic feet refrigerators	42,000
5)	15 seven cubic feet deep freezers	22,500

TABLE 26

DISTRIBUTION OF THE COMPONENTS OF THE INFECTIOUS DISEASE CONTROL PROGRAMME

Location	Transport (a)		Vaccine Storage Facilities (c)			Animal Herding Facilities	Camping Equipment		
	F.W.D.	Mobile Disease Control Units (b)	Refrig-erator	Deep Freeze	Ice Box	Crush	Tents	Beds	Lamps
ndi	2	3	4	2	10	2	15	25	10
	-	-	1	1	5	1	-	-	2
am	2	3	4	2	10	2	15	25	10
	-	-	1	1	5	1	-	-	2
	1	1	1	1	5	1	8	12	5
	2	3	4	1	10	2	15	25	10
	1	1	2	1	5	1	8	12	5
ola	-	-	1	1	5	1	-	-	2
-	1	2	3	1	8	2	10	16	8
	1	2	3	1	10	2	10	16	8
	1	1	2	1	10	2	10	25	10
	-	-	1	1	3	-	-	-	2
1 Awlia	2	-	1	1	5	2	-	-	-
TOTAL	13	16	28	15	91	19	91	156	72

nsport vehicles rquired by this programme also cater for other proposed programmes.
ile Disease Control Unit is a 7 ton truck provided with vaccine storage facilities and camping equipment.
rigerators and deep freezers operating on kerosine.

6)	91 ice boxes	18,200
7)	materials and construction of 19 crushes	113,000
8)	purchase of 91 tents	6,370
9)	purchase of 156 beds	7,020
10)	purchase of 72 lamps	1,440
	TOTAL	£S 1,495,530

C. Programme Title

Tick Control

Programme Objectives

1) control spread of ticks from heavily infested areas to areas relatively tick free;

2) control tick-borne diseases;

Programme Location

Project area

Programme Components:

1) construction of dips;

2) provision of hand sprayers;

3) provision of acaricides;

4) provision of dip strength monitoring laboratories.*

---

* The requirements and distribution of dips and dip strength monitoring laboratories are shown in Table 27. The equipment and material requirements for a dip strength monitoring laboratory are shown on Table 28. The dip strength monitoring laboratories could also act as disease diagnostic laboratories.

Programme Cost

1)	cost of materials and construction of 26 dips	£S 520,000
2)	cost of establishing 4 dip strength monitoring laboratories	140,000
3)	cost of purchase of acaricides (revolving)	200,000
4)	cost of purchase of hand sprayers (revolving)	25,000
	TOTAL	£S 885,000

D. Programme Title

Trypanosomiasis Control

Programme Objective

Control of Trypanosomiasis disease

Programme Location

Southerly parts of the project area

Programme Components

1) provision of curative and prophylactic drugs;

2) provision of bush clearing tools;

3) provision of seasonal casual labour to clear brush.

TABLE 27

DISTRIBUTION OF DIPS AND DIP-STRENGTH MONITORING LABORATORIES

Location	Dip(s)[1]	Dip strength monitoring laboratory
Lake Kundi	3	1
El Kubu	2	-
El Meiram	2	1
Nama	2	-
El Lagawa	2	-
Kadugli	3	1
Delami	2	-
Abu Karshola	-	-
Abbassiya	3	-
Kermal	3	-
Kosti	3	1
Kawa	-	-
Jebel Awlia	3	-
TOTAL	26	4

[1] specifictions for dip construction are:

	ft.	in.
Breadth at top	5	2
Breadth at bottom	3	3
Depth	7	6
Length at top	50	0
Length of well	30	0
Entrance slope	6	6
Exit slope	13	0
Depth of dip from bottom	5	6

TABLE 28

MATERIALS AND EQUIPMENT REQUIREMENT AND
COST FOR A DIP-STRENGTH MONITORING LABORATORY

Item	Cost (£S)
Laboratory building (one room)	14,000
2 incubators	2,000
Microscope	2,000
Dissection microscope	3,000
Glassware	7,000
Chemicals	6,000
Drugs for in Vitro study	1,000
TOTAL	35,000

Programme Cost

1)	cost of curative and prophylactic drugs (revolving)	£S 250,000
2)	cost of bush clearing tools	20,000
3)	cost of casual labour per year	50,000
	TOTAL	£S 320,000

E. Programme Title

Disease Treatment

Programme Objective

Treatment of trekked, sedentary, and nomadic livestock diseases.

Programme Location

Project area

Programme Components

1) drugs, including antibiotics and anthelmintics, etc.;

2) veterinary kits and tools including stethoscopes, needles, etc.;

3) surgical kits and equipment;

4) office equipment and furniture.

Programme Cost

1)	cost of drugs (revolving)	£S 250,000
2)	cost of veterinary kits	60,000
3)	cost of surgical kits	100,000
4)	office furniture and equipment	50,000
	TOTAL	£S 460,000

Personnel for all programs

Table 29 shows the requirements and distribution of the personnel required to implement the proposed programmes.

TABLE 29

REQUIREMENTS AND DISTRIBUTION OF VETERINARY SERVICES PERSONNEL

Location	Veterinarian	Veterinary Assistant	Veterinary Nurse	Clerks	Labour
.e Kundi	2	6	15	2	9
Kuku	-	1	3	-	3
Meiram	2	6	15	2	9
-	-	1	3	-	3
Lagawa	1	2	6	1	2
dugli	2	6	15	2	9
lami	-	1	3	-	3
u Karshola	-	1	3	-	3
bassiya	1	5	9	2	6
rmal	2	6	9	2	6
sti	2	3	6	2	6
wa	-	1	2	-	2
bel Awlia	2	4	6	2	4
TOTAL	13	43	95	15	65

Personnel listed include staff required for Mobile Disease Control Units.

CHAPTER IV

WATER SUPPLY

Water Resources

Several structural basins in the Basement Complex and Nubian Sandstone Formation of Sudan were formed during the mid and late Tertiary tectonic movements in East Africa. The best known examples along the Southern Stock Route are the Baggara and Bara basins. These basins underlie about 70% of the route length (Figure 9). The structural basins formed were filled during Pliocene and early Pleistocene time with fluvial and lacustrine deposits that now comprise what is known as Umm Ruwaba Formation.

Cambrian to pre-Cambrian Basement Complex rocks appear on the surface as Inselbergs forming the Nuba Mountains and they underlie about 30% of the route. The Basement Complex is impermeable and the part that lies along the Southern Stock Route is covered by clays that have low permeability.

Water availability along the proposed route depends on the geologic as well as on hydrologic conditions. Unlike in the case along the Northern Route, water can be made available along all sections of the SSR. The main water resources that can be utilized comprise the ground water and surface water from both perennial streams (White Nile) and seasonal streams and khors.

Along the SSR, ground water occurs both in deep sedimentary basins as well as in shallow aquifers along the seasonal streams. There are several sources. The Baggara Basin is a major source of ground water in Southern Darfur and the western part of Southern Kordofan. Within the basin there is one major aquifer, the Nubian-Umm Ruwaba. Since the aquifer underlies the territory currently populated by the Baggara peoples, and since boreholes supply these people, the term Baggara Aquifer Complex, has been denoted. This basin covers an estimated area of 65,000 sq. km.

Ground water occurs in a variety of sediments varying from coarse and well sorted Nubian to very fine and ill sorted Umm Ruwaba sediments, sometimes under moderately confining conditions. Depth of water varies from over 100 metres in the northern to less than 30 metres in the southern parts. However, there is a considerable overlap between the hydraulic properties of the two formations. Moreover, in general the two appear to form hydraulically a multi-layer aquifer system. The deepest part of the trough is believed to be at least 3.9 km. (Hunting Technical Services, 1973). New information obtained by Chevron Oil Company of Sudan proves the presence of fresh water down to a depth of 3 km. The water table assumes a trough shape with the major ground water flow tions south and southeast. The multi-layer aquifer system has transmissivity values ranging from 6.5 to 1,200 m^2/day with an average of about 500 m^2/day. Infiltration from wadi beds and inflow from outside the basin account for the bulk of the recharge to the aquifer and these are estimated to be in the order of 22 million cubic metres per year while the total aquifer storage to the depth of 500 metres is estimated to be 1,300 X 10 m^3 (Hunting Technical Service, 1977).

Ground water salinity within the basin ranges from 200 to 600 parts per million (ppm) and the ground water is almost universally suitable for human and livestock consumption. Borehole yield varies from 5 m^3 to 100 m^3/hour and the average is about 20 m^3/hour. Thus, borehole yield is reliable throughout the year, even during droughts, assuming that mechanical maintenance and fuel supply are secured. The present extraction rates are still far below the maximum potential yield and over-production is not foreseen in the near future.

The Bara Basin is filled by the Umm Ruwaba Formation and covers the area from north of the Nuba Mountains to the southern periphery of Khartoum. It consists of sub-basins extending almost north-south and is considered the second most important aquifer, after the Nubian Sandstone in Sudan.

Ground water occurs in this lenticular bed of mostly fine sands. These lenticular beds thin out in a short distance and the different water bearing horizons are hydraulically connected. The depth to the top of the aquifer ranges from 50 to 200 metres.

Due to the presence of clay lenses, ground water occurs locally under moderate pressure, but the shape of the water table indicates a regional water table condition (Figure 9). The regional ground water flow direction runs southeast from Bara and then turns north, passing west of the White Nile. Aquifer transmissivity values range from 6.7 to 293 m^2/day with an average value of 80 m^2/day and the storage coefficient is generally around 1%.

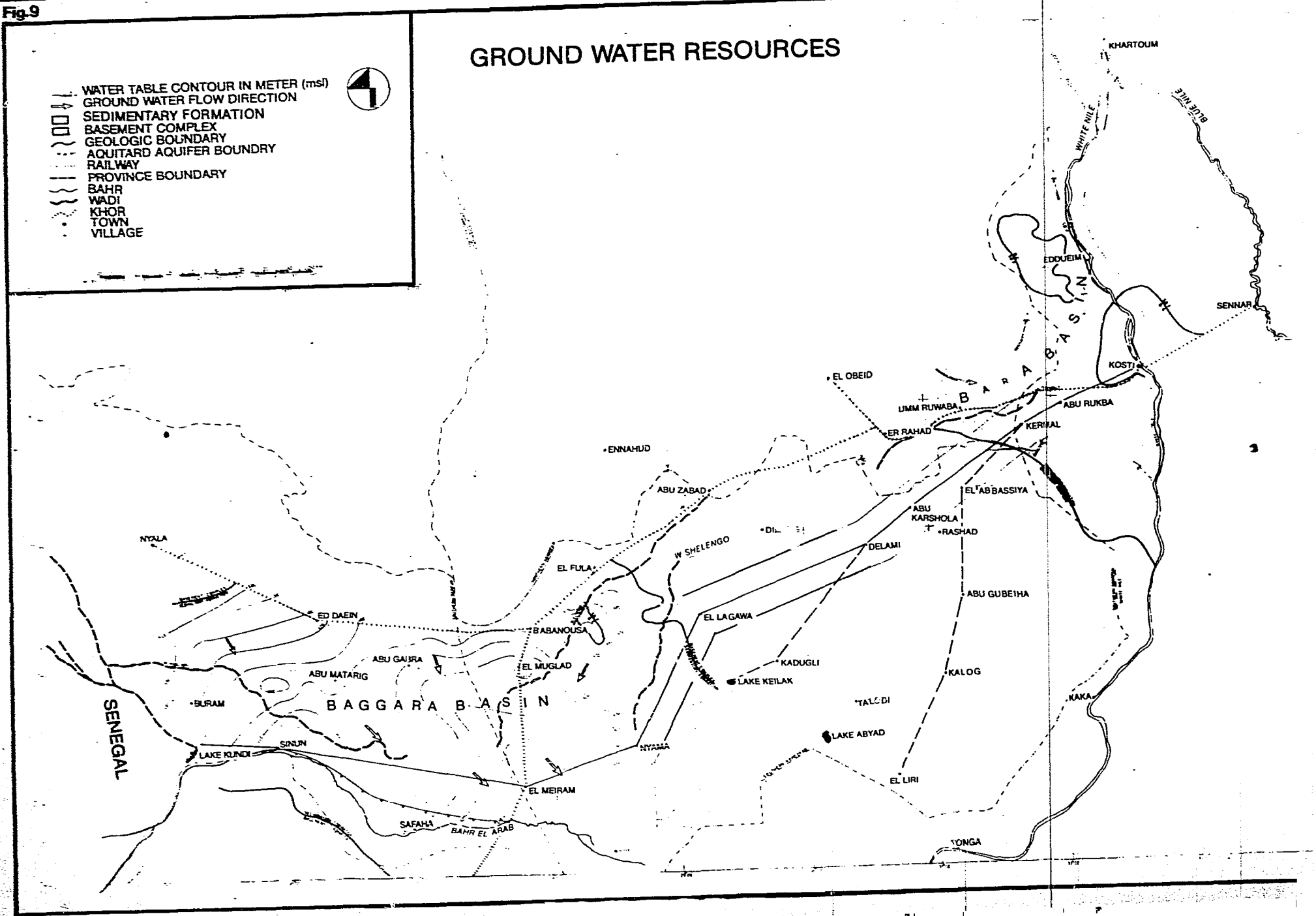
No assessment of the water resources of the whole basin has been made, but from the saturated thicknesses (1000 metres) and the fact that no fluctuation in the water table has been noticed over long periods, has been noticed, the total storage and annual recharge to the basin are believed to be immense. Salinity over the basin ranges from 600 to almost 6,000 ppm. Saline zones were believed to be partly due to the presence of low permeable and thick clay accumulations with evaporation deposits, and partly due to the long distance that ground water travels from areas of recharge.

Ground water from the Bara Basin can be considered fit for livestock, but the presence of high salinity accompanied with high concentrations of chlorides and sulphates renders the waters from a few areas unfit for human use. Moreover, the corrosiveness of the ground water from the saline zones has adverse effects on the metal of the pumps, pipe connections, and the storagetanks. Bore hole yield is variable but the minimum of 5 m^3/hour can be secured.

Shallow aquifers are another important source of ground water. Apart from the main sedimentary basins of the Baggara and Bara, ground water along the SSR occurs in several minor, local ground water bodies. Shallow wells exploit ground water from thin alluvial aquifers in the regaba areas around Bahr el Arab as well as along the major water courses of the seasonal streams of Wadi Ibra, Khadari, Ghalla, and Shalengo (all of which lie over the Baggara Basin), Wadi el Batha, Delami, Kadugli, Abbassiya and along the Abu Habil system that radiates from the Nuba Mountains. In topographic terms, low perched water bodies are tapped above the general zone of saturation in superficial sands as in Kermal, Gaddid, etc. in the White Nile Province. It is characteristic of

Fig.9

GROUND WATER RESOURCES



the sedimentary basin that occasional, isolated water-bearing sub-basins are located along the edges of the basin as is the case at Debbat Obeid in south-western Kordofan.

Ground water also occurs in Basement Complex rocks where the formation is highly weathered and fractured, occupying topographic lows, and where the source of recharge is near. These conditions prevail in many localities in the Nuba Mountains where rainfall is high. These aquifers are replenished annually, either by rainfall infiltration or by infiltration from surface flows during the rainy season. During the dry season, the water level in some localities drops and wells become dry, although in the majority of cases, wells sustain their yield throughout the dry season.

There is also a wealth of surface water including natural open surface bodies such as perennial and seasonal water courses, run off into man-made depressions (hafirs), and shallow wells.

Along the White Nile from Kosti to Omdurman, water availability is secured as long as the paths (mushraas) are arranged. At present, the White Nile Agricultural Scheme blocks most of the area and conflicts between the scheme owners and the trekkers are expected unless special arrangements are made.

There are a number of seasonal streams, especially in the west and central part of the route. Some of these streams have been gauged and the annual discharges of these khors are given in Table 30. Discharges of these khors (1974 million m^3) are utilized by the National Administration for Water through construction of hafirs and small dams of 6 million m^3 gross capacity. This means that only 0.3% of the water available in khors is utilized at the present.

The surface runoff is governed by rainfall type, size, and soils of the catchment area; and slope. Rainfall is directly or indirectly the source of useful water, while evaporation is the major factor contributing to water losses from surface water reservoirs. Figure 10 shows the distribution of rainfall and evaporation over the country.

Along the proposed SSR from Nyala to Tendelti, the mean annual rainfall ranges from more than 600 mm at Nyala to about 400 mm at Tendelti. The isohyets show low rainfall along the White Nile axis and high rainfall in the southwestern part of the country. The evaporation pattern is similar to that of the rainfall but the gradient is reversed. The mean annual evaporation ranges from about 2,000 mm at Nyala to 2,600 mm at Kosti. This means that the route lies in a zone of water deficit and that the deficit increases as one goes north.

TABLE 30

DISCHARGES OF MAIN GAUGED-KHORS
SOUTHERN KORDOFAN AND SOUTHERN DARFUR PROVINCES

	Stream	Gauged Station	Average Annual Discharge m^3	Province
1.	Wadi El Galla	El Nagaat	44,270,741	S.K.
2.	Wadi Shalango	Abu El Likry	103,395,106	S.K.
3.	Khor El Bordab	El Bordab	50,097,002	S.K.
4.	Khor Umborembita	Umborembita	89,169,020	S.K.
5.	Khor Abu Habil	Abu Habil	100,000,000	S.K.
6.	Bahr el Arab	Higeirat	607,222,187	S.D.
7.	Wadi Ab Likeilik	Ab Likeilik	97,652,519	S.D.
8.	Wadi Kaya	Idd El Ghanam	45,182,982	S.D.
9.	Wadi Ibra	Nashala	298,460,086	S.D.
10.	Wadi Bulbul	Timbusko	55,844,862	S.D.
11.	Wadi El Hamra	El Hamra	261,843,993	S.D.
			1,753,588,498 = 1,754 million m^3	

Source: National Authority for Water

Average rainfall and evaporation covering the period 1941-1970 for two representative towns (Kosti and Kadugli) are given in Table 31.

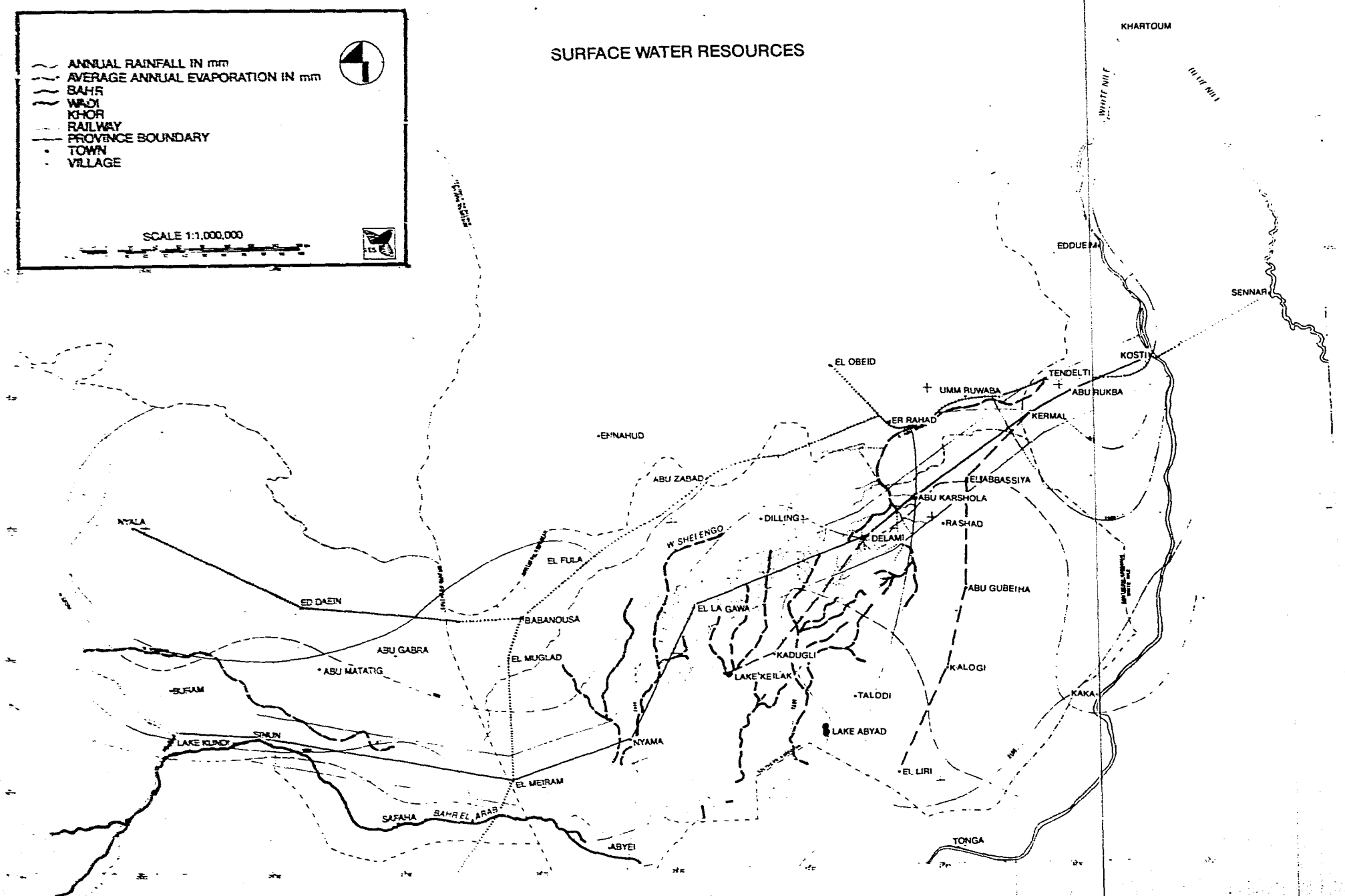

SURFACE WATER RESOURCES
ANNUAL RAINFALL IN mm
AVERAGE ANNUAL EVAPORATION IN mm
BAHR
WADI
KHOR
RAILWAY
PROVINCE BOUNDARY
TOWN
VILLAGE
SCALE 1:1,000,000
KHARTOUM
WHITE NILE
BLUE NILE
EDDUEIM
SENNAR
KOSTI
EL OBEID
TENDELTI
UMM RUWABA
ABU RUKBA
ER RAHAD
KERMAL
EN NAHUD
ABU ZABAD
ELABBASSIYA
ABU KARSHOLA
DILLING
RASHAD
DELAMI
W. SHELENGO
EL FULA
NYALA
ABU GUBEIHA
ED DAEIN
BABANOUSA
EL LA GAWA
ABU GABRA
EL MUGLAD
KADUGLI
ABU MATATIG
LAKE KEILAK
KALOGI
SUFIAM
TALODI
KAKA
LAKE ABYAD
LAKE KUNDI
SINUN
NYAMA
EL LIRI
EL MEIRAM
SAFAHA
BAHR EL ARAB
ABYEI
TONGA

TABLE 31

AVERAGE ANNUAL RAINFALL AND EVAPORATION
KADUGLI AND KOSTI TOWNS (1941-1970)

Month	Kadugli		Kosti	
	Rainfall mm/month	Evap. mm/month	Rainfall mm/month	Evap. mm/month
Jan.	0	178	0	151
Feb.	0	212	0	185
March	2	224	1	203
April	14	227	2	209
May	88	224	16	209
June	104	197	39	197
July	139	166	111	178
August	172	163	142	160
Sept.	139	172	63	166
Oct.	278	185	21	175
Nov.	2	185	1	169
Dec.	0	172	0	147
Total	731	2305	376	2151

Source: Department of Meteorology

Flow records of the seasonal streams in the area had been utilized by the Savannah Project Phase II for the analysis of run-off for catchments of various types of soils. The studies here revealed that the run-off coefficient in the heavy clay soil plains is as high as 7.5% whereas in the clay and loam plains, the run-off coefficient is about 3.8%. For sandy soils, the run-off coefficiency is as low as 1.7%.

The catchment area required to contribute to the flow that fills a hafir of a certain capacity is computed as follows:

$$Q = C.I.A.$$

where Q = Total capacity required to fill a hafir and is usually taken to be as 1.3 of the hafir capacity.

C = Run-off coefficient.

I = Total rainfall

A = Catchment area.

From these data the catchment area with an average annual rainfall of 400 mm of various soil types and slopes required to fill a hafir of 320,000 m^3 capacity is shown in Table 32.

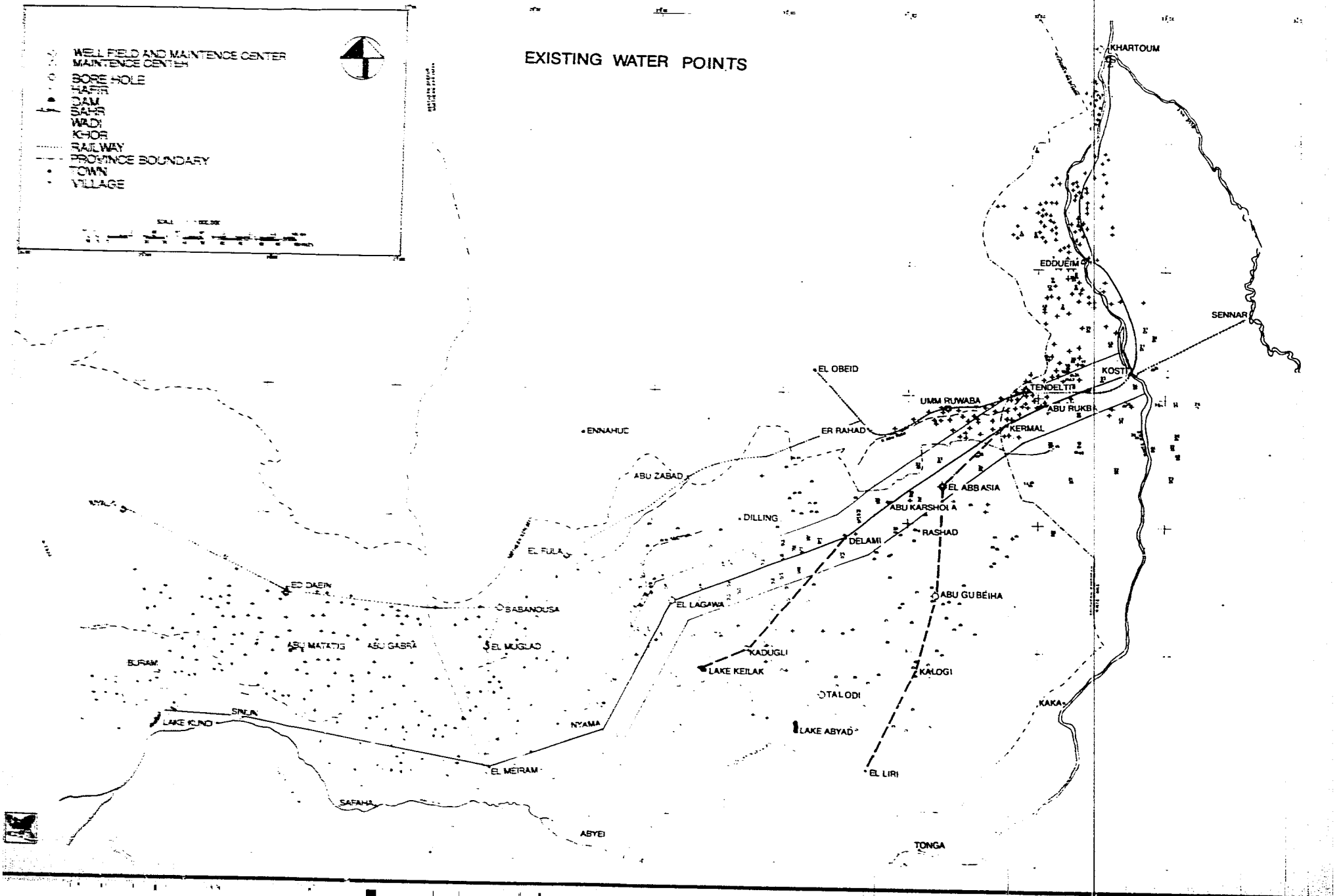
TABLE 32

CATCHMENT RUN-OFF

Type of Catchment Soils	Run-off Coefficient	Catchment Area in Km^2
1. Sandy Soils	0.017	4.40
2. Clay and Loam	0.038	1.70
3. Heavy Clay Soils	0.075	0.85
4. Jebel Catchment (Steep slopes)	0.11	0.59

Existing Water Services

Virtually all the ground water exploited from the Baggara and Bara basins is used for human and livestock consumption, while the ground water from the shallow alluvial aquifers is used mainly for small-scale irrigation, especially in the Nuba Mountains. Within the two deep sedimentary basins, water is supplied from wateryards in which one, two, or occasionally more boreholes are equipped with reciprocating pumps (Edeco or Schoeller) powered by diesel engines (5-8 B.H.P. Lister or Torpedo) supplying water via a 50 m^3 storage tank to a number of taps and water troughs. Larger settlements often have several wateryards. (Figure 11)


EXISTING WATER POINTS
WELL FIELD AND MAINTENCE CENTER
MAINTENCE CENTER
BORE HOLE
HAFIR
DAM
SAHR
WADI
KHOR
RAILWAY
PROVINCE BOUNDARY
TOWN
VILLAGE
KHARTOUM
EDDUEIM
SENNAR
KOSTI
EL OBEID
TENDELTI
UMM RUWABA
ABU RUKB
KERMAL
ER RAHAD
ENNAHUD
ABU ZABAD
EL ABBASIA
ABU KARSHOLA
DILLING
RASHAD
DELAMI
EL FULA
ED DAEIN
ABU GUBEIHA
EL LAGAWA
SABANDUSA
ABU MATATIS
ABU GABRA
EL MUGLAD
KADUGLI
LAKE KEILAK
KALOGI
BURAM
TALODI
KAKA
SNUN
LAKE KUNO
NYAMA
LAKE ABYAD
EL MEIRAM
EL LIRI
SAFAHA
ABYEI
TONGA

Although borehole yield can vary from 5 to 40 m^3/hour, most reciprocating pumps yield 4 to 6 m^3/hour (Appendix I). The production from a wateryard varies greatly according to season. Many wateryards are virtually unused in the wet season, since people can obtain free water from natural pools, wells, or wadis. Hours of wateryard operation vary from perhaps 3 hours/day in winter (Shita) to 12 to 24 hours in the late summer (Saif). The production for a typical wateryard is probably considerably more or less than this.

In addition, UNICEF had drilled more than 200 successful small diameter wells supplied with hand pumps to ensure safe water for human consumption in accordance with the water decade targets. These wells are mainly concentrated in the Nuba Mountains. Surface water in regions of low availability of ground water is collected in mechanically excavated ponds (hafira). The existing hafira along the proposed route are listed in Table 33 and shown in Figure 11.

The field survey revealed that 80% of the existing hafira have lost about 40% of their holding capacities due mainly to silting. Consequently 65% of these hafira become dry before the next rainy season. The silting problem is greater in hafira fed by local catchments, e.g. jebel catchments, due to erosion of hill slopes.

Measures to minimize losses due to silting were found impractical and expensive. The UNICEF suppported programme to rehabilitate existing hafira in South Kordofan has considered purchasing wet desilting equipment though it is found to be expensive and rather complicated.

The only practical solution for silt removal is dry desilting. This requires provision of twin hafira at each site to facilitate dry desilting and hence it is more expensive. Provision of twin hafira has been practiced by the National Administration for Water at many sites e.g. El Tash and Karkaraya.

Wateryard Management

The National Administration for Water (NAW) and Regional Water Authorities are responsible for the provision of water facilities, e.g. investigations, drilling, and erection of wateryards and hafir construction. The operation of these water points, e.g. fuel and lubricant provision, and revenue collection is the responsibility of the provincial administration while the regional water authorities maintain plant and equipment. The provincial administrations sometimes call for local contractors to run these water points. Out of 216 wateryards, with some 305 boreholes existing along the proposed cattle route, only 52 are considered to be operating well. The remainder are not operable either due to lack of spare parts, in turn due to unavailability of local funds and foreign currency, or to scarcity of fuel and lubricants.

At present, there is an official charge of 5-10 pt. per four gallon tin of water which is collected by the provincial authorities, who in turn pay for both operations (salaries, fuel, etc.) and maintenance. Because of weaknesses in the management sections of the provincial water administrations, money collected amounts to about half of funds spent on operating and maintaining wateryards. As a result of these inefficiencies, local users in many yards join together on a self-help basis and buy spare parts and fuel to ensure the

TABLE 33

EXISTING HAFIRS ALONG SOUTHERN CATTLE ROUTE

Serial No.	Name of Hafir	Province	Location coordinates LAT.	LONG.	Year of Construction	Depth (M)	Design Capacity (M^3)
1	Um Gumguma	Southern Kordofan	11° 09'	29° 50'	1948	6.00	5,817
2	Attash	" "	11 09	28 52	58	6.00	11,545
3	El Hambul	" "	11 09	28 58	58	6.00	9,395
4	Nabagaya	" "	11 05	28 55	55	6.00	15,000
5	Sagani	" "	11 07	29 04	58	5.00	10,363
6	Abu Dumua	" "	11 29	29 06	58	6.00	11,617
7	Dar Wair Razag	" "	11 23	29 21	57	6.00	15,000
8	Shag El Higlig	" "	11 28	29 22	58	6.00	12,609
9	Magdah	" "	11 39	29 32	57	6.00	18,000
10	Beidah	" "	11 40	29 35	48	6.96	8,982
11	Malaulu	" "	11 30	29 35	48	5.58	6,892
12	Zalataya	" "	11 27	29 39	58	(not known)	19,503
13	Feid El Awag	" "	11 24	29 35	50	3.70	7,086
14	El Kurgul	" "	11 34	29 46	(not known)		
15	Wad Abu Dahasha	" "	11 40	29 50	58	(not known)	18,381
16	Rigil El Marfean	" "	11 32	29 55	48	5.54	7,037
17	El Wedai	" "	11 33	29 59	48	5.82	7,144
18	Domaya	" "	11 41	29 58	43	6.00	5,639
19	El Shag Elafzar	" "	11 49	29 58	51	5.00	12,850
20	Shag El Zaraf	" "	11 47	30 06	55	4.50	15,000
21	El Qenai	" "	11 44	30 09	55	4.50	15,000
22	Andru Khashm El Kalib	" "	11 37	30 08	48	4.83	6.700
23	Kewekaya	" "	11 50	30 18	48	6.00	6,190
24	Gabr El Dar	" "	11 52	30 13	55	4.50	15,000
25	Tambeira	" "	11 51	30 29	(not known)		
26	Jebel Shaba	" "	12 03	30 37	50	7.00	9,240
27	Malabak	" "	12 01	30 37	57	(not known)	18,000
28	Khor El Tina	" "	12 08	30 45	48	6.00	4,297

TABLE 33

EXISTING HAFIRS ALONG SOUTHERN CATTLE ROUTE (continued)

Serial No.	Name of Hafir	Province	Location coordinates LAT.		LONG.		Year of Construction	Depth (M)	Design Capacity (M^3)
29	Sherak	Southern Kordofan	11°	56'	30°	53'	1948	7.10	9,248
30	Karashona	" "	12	13	31	01	48	6.00	4,297
31	El Muraib	" "	12	11	31	05	(not known)		
32	Gardud Abu Zeid	" "	12	27	31	05	(not known)		
33	Birka	" "	12	30	31	15	(not known)		
34	Abu Dom	" "	12	27	31	34	(not known)		
35	El Murat	" "	12	33	31	33	50	7.42	12,422
36	Feid El Aggal	" "	10	23	28	44	55	6.00	15,000
37	Um Shag Amir	" "	10	33	28	38	55	6.00	15,000
38	Abu Indrab	" "	10	45	28	40	55	6.00	15,000
39	Tewifra	Southern Darfur	10	37	25	25	54	4.29	12,577
40	Abu Weriga	" "	10	31	25	18	54	4.14	8,496
41	El Sefaraya	White Nile	14	19	32	20	76	5.00	30,000
42	El Manar	" "	13	41	32	12	65	5.00	15,000
43	El Akara	" "	13	14	31	59	70	5.00	15,000
44	Um Takal	" "	13	55	32	19	75	5.00	15,000
45	El Meneidreib	" "	13	50	32	19	72	5.00	20,000
46	Abu Shebaika	" "	13	55	32	18	76	5.00	20,000
47	Um Kewika	" "	13	05	32	16	65	5.00	25,000
48	Um Gudour	" "	12	50	32	19	65	5.00	20,000
49	El Dersaya	" "	13	10	32	16	66	5.00	20,000
50	Wad Shamam	" "	13	31	32	24	79	5.00	40,000
51	El Wasa'a	" "	13	03	32	30	76	5.00	20,000
52	Ummhani	" "	13	02	32	44	79	5.00	40,000
53	Dahar Geheina	" "	12	56	32	14	81	5.00	15,000
54	Ummsala	" "	13	06	32	12	80	5.00	25,000
55	Egeibish	" "	13	09	32	14	61	5.00	9,000
56	Goz El Atshan	" "	12	47	32	40	79	5.00	25,000

continuous operation of their wateryards. Such practices provide the wateryard operators and village leaders with an opportunity to raise water charges to more than 10 times the official charges.

Since the efficient and continuous operation of wateryards is a prerequisite to agricultural development in the savannah region, the Western Savannah Development Corporation (WSDC) is carrying out a rehabilitation programme of the wateryards in Southern Darfur with a total cost of US$ 1.2 million. The aims of this rehabilitation programme are:

1. to bring most of the wateryards up to a serviceable state;

2. to establish a long-term, viable management system for wateryards, and to introduce sound financial arrangements that can sustain future maintenance and operation;

3. to improve water issue and control arrangements as an essential step towards more effective financial arrangements and better hygiene.

As a result of the WSDC programme, the maintenance and operation sections are unified under the regional water authority, water charges are increased from 5 to 25 pts./4 gallon tin of water to ensure that wateryard users get an excellent service at the real cost, and in certain locations, wateryards are to be rented to village communities experimentally to find out the feasibility of such self administration of wateryards.

Livestock Water Requirements

Water requirements for livestock are based on an estimated movement of a maximum 300,000 cattle equivalents per year, each equivalent requiring 15 gallons (0.068 m^3) per day for an average trekking period of 40 days i.e. 2.72 m^3/head/40 days. Therefore a total of 816,000 m^3/40 days period or 5,444 m^3/day for 5 months is required.

It is proposed to construct 76 boreholes and 40 hafirs along the SSR. This is based on the assumption that each borehole or hafir will yield an average of 5 m^3/hour during an 18 hour day, the total yield being 90 m^3 per day. Therefore each water point will be capable of watering about 1,500 cattle equivalents per day.

Proposed Water Points

Depending on the kind of water resource available, the proposed water points form an integration between surface and ground water use. In areas underlain by sedimentary basins, ground water is preferable while in areas of Basement Complex, surface water is the only alternative to ensure sufficient grazing. The proposed water points are arranged on two parallel lines, 20 km apart and spacing of wells is kept around 20 km (Figure 12). Table 34 shows the coordinates and the expected depth of the boreholes.

If cattle are going to be trekked from Kosti to Khartoum along the eastern side of the White Nile, they can drink the Nile water directly as there is always accessibility to the Nile. However, if boreholes are needed in the

at distances of 40 km.

TABLE 34

PROPOSED WATER POINTS

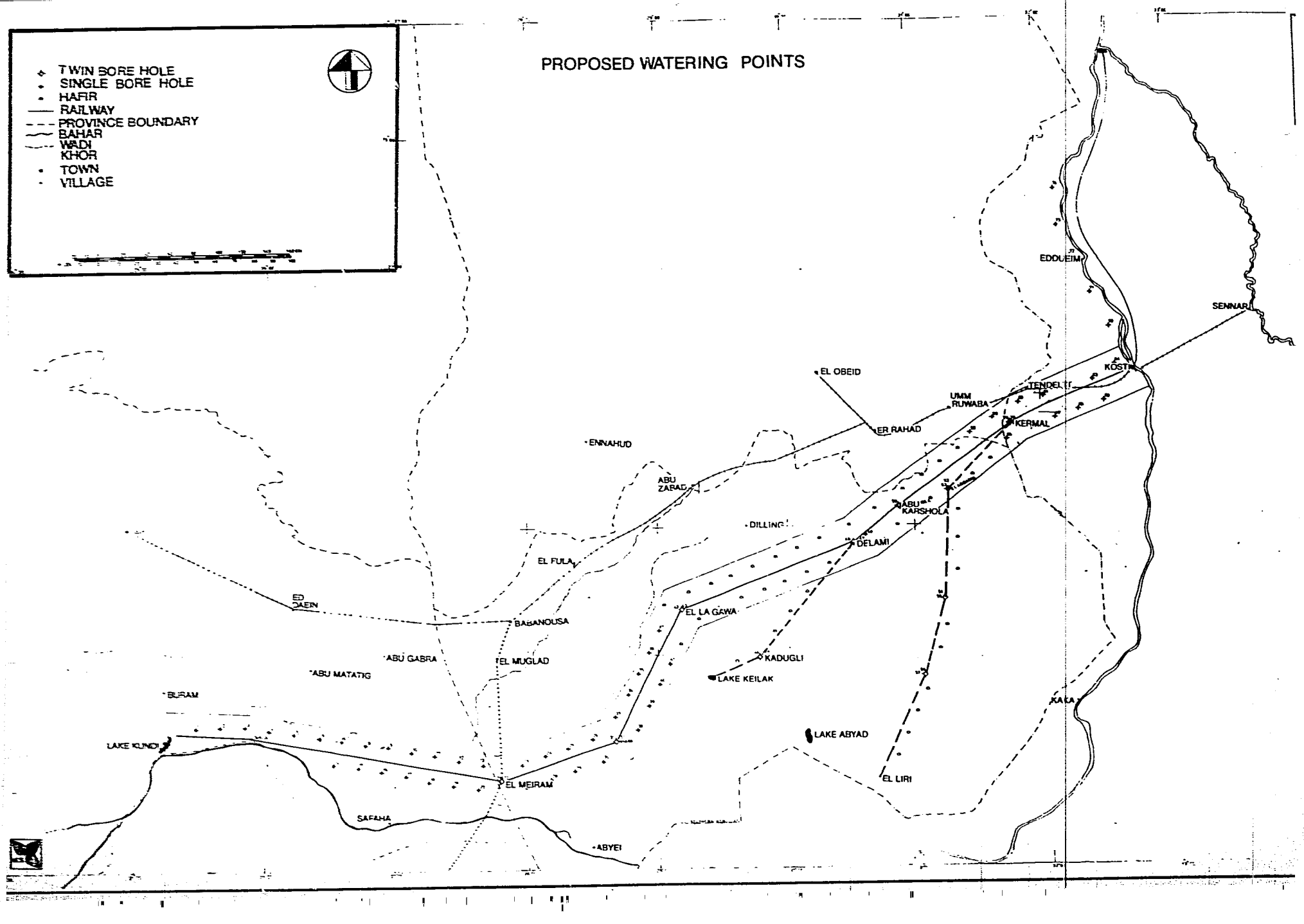
Borehole No.	Coordinates Long.	Lat.	Expected Depth (m)
1	25° 29'	10° 29'	200
2	25 40	10 29	200
3	25 51	10 29	200
4	26 01	10 27.5	200
5	26 13	10 25	200
6	26 25	10 24	200
7	26 35	10 22.5	200
8	26 41	10 20	200
9	26 57	10 20	200
10	27 07	10 16	300
11	27 19	10 15	300
12	27 30	10 12.5	300
13	27 40	10 10	300
14	26 30	10 11	200
15	26 42.5	10 10	200
16	26 54.5	10 08.5	200
17	27 05	10 06	300
18	27 16	10 03	300
19	27 27.5	10 01	300
20	27 39	9 59	300
21	27 50	10 03	200
22	27 50	10 03	200
23	27 57	10 10	200
24	20 07	10 14	200
25	28 18	10 17.5	200
26	28 30	10 21	200
27	27 59	10 00	200
28	28 10	10 04	200
29	28 21	10 07.5	200
30	28 35	10 11.5	200
31	28 40	10 20.5	200
32	28 40	10 20.5	200
33	28 40	10 31.5	200
34	28 45	10 42	200
35	28 51	10 51.5	200
36	28 56	11 01	200
37	29 00	10 11	100
38	28 51	10 25	200
39	28 56	10 36.5	200
40	29 00	10 46.5	150
41	29 05	10 56	100
42	29 10.5	11 21	30
43	29 10.5	11 21	30
44	29 46	10 58	30

TABLE 34

PROPOSED WATER POINTS (continued)

Borehole No.	Coordinates Long.	Lat.	Expected Depth (m)
45	29° 46'	10° 58	30
46	30 30	11 50	25
47	30 30	11 50	25
48	30 36	11 56	30
49	30 42.5	11 50	70
50	30 53	12 08.5	40
51	30 53	12 08.5	40
52	31 16	12 15	60
53	31 16	12 15	60
54	31 13	11 25	30
55	31 13	11 15	30
56	31 03	10 50	25
57	31 03	10 50	25
58	31 26.5	12 41.5	200
59	31 37.5	12 48	200
60	31 50	12 56	150
61	32 02	12 59	150
62	32 12.5	13 02.5	150
63	32 25	13 07.5	150
64	32 35	13 14.5	120
65	31 44	12 38.5	150
66	31 55	12 44.5	150
67	32 06.5	12 48.5	150
68	32 17.5	12 53	150
69	32 30	12 57	150
70	32 33	13 30	50
71	32 24	13 47	150
72	32 15	14 05	150
73	32 09.5	14 18.5	150
74	32 08	14 35.5	100
75	31 45	12 46	150
76	31 45	12 46	150

Source: Survey and Files of the National Authority for Water Development.


PROPOSED WATERING POINTS
TWIN BORE HOLE
SINGLE BORE HOLE
HAFIR
RAILWAY
PROVINCE BOUNDARY
BAHAR
WADI
KHOR
TOWN
VILLAGE
EDDUEIM
SENNAR
KOSTI
EL OBEID
TENDELTI
UMM RUWABA
KERMAL
ER RAHAD
ENNAHUD
ABU ZARAD
ABU KARSHOLA
DILLING
DELAMI
EL FULA
ED DAEIN
BABANOUSA
EL LA GAWA
ABU GABRA
EL MUGLAD
KADUGLI
ABU MATATIG
LAKE KEILAK
BURAM
KALA
LAKE ABYAD
LAKE KUNDI
EL LIRI
EL MEIRAM
SAFAHA
ABYEI

In Omdurman (Umm Badda) there is a group of high yielding wells owned by the Livestock Meat and Marketing Corporation (LMMC) which are already in use by trade cattle.

Borehole and Hafir Implementation

Borehole drilling and erection and hafir construction should be carried out by a contractor under the supervision of the National Administration for Water (NAW). The regional water authorities have well equipped maintenance centres at Khartoum, Dueim, Umm Ruwaba, Kadugli, Abbassiya, El Fula, Daein, and Nyala, as well as fairly well equipped centres at Tendelti, Talodi, Muglad, and Buram. These centres are evenly distributed throughout the project area. The SSR wateryards and hafirs can be maintained by the regional water authorities against certain fees. The cost of the SSR owning its own water facilities maintenance centres may turn to be very high.

For drilling and erecting boreholes, the following points should be taken into consideration:

1) Boreholes should be drilled to the expected depths (Table 34), with a hole diameter of 12 1/4 inches;

2) the casing diameter should be 6 5/8 inches with sizes suitable to the geologic conditions;

3) boreholes drilled in Basemet Complex and shallow sedimentary basins should be drilled by cable tool percussion rigs while those in deep basins should be drilled by rotary rigs;

4) boreholes should be installed to yield an average of 10 m^3/h (if possible) with the minimum possible drawdown and to ensure sand free pumped water;

5) well screens, pumps, and rising mains should be resistant to corrosion;

6) to avoid corrosion, the storage tanks and watering troughs should be made of fiberglass which is more durable, lighter, and cheaper than metal;

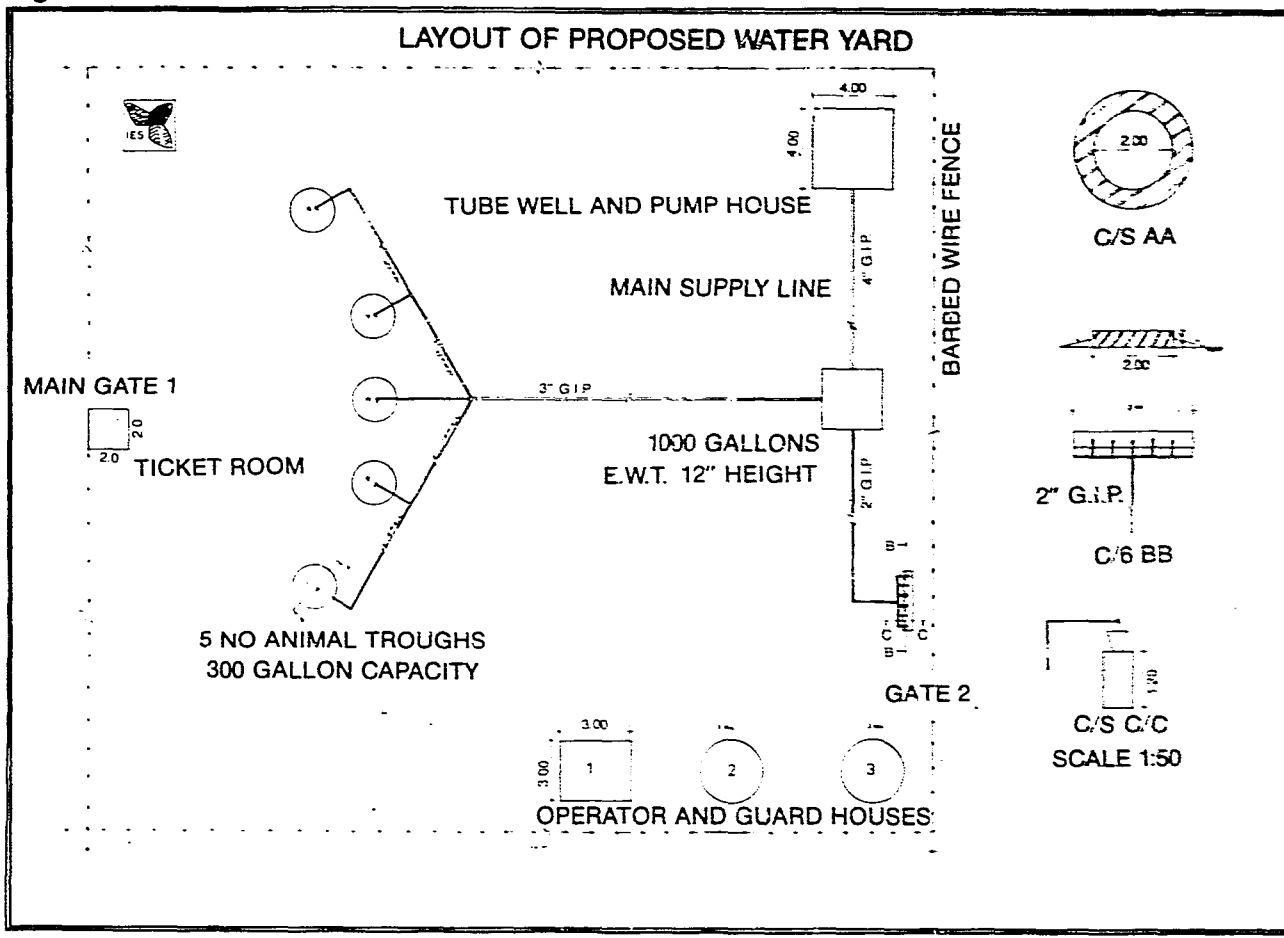
7) reciprocating pumps e.g. Schoeller and Bleckman 4" coupled with Torpedo (8 B.H.P.) are considered the most suitable for remote areas for the following reasons:

   a) relatively durable,

   b) low speed engines,

   c) simple and easy to maintain, and well known to Sudanese technicians. The layout of the wateryard is shown in Figure 13.

Fig.13


LAYOUT OF PROPOSED WATER YARD
TUBE WELL AND PUMP HOUSE
MAIN SUPPLY LINE
4" G.I.P
3" G.I.P
2" G.I.P
BARBED WIRE FENCE
MAIN GATE 1
TICKET ROOM
1000 GALLONS
E.W.T. 12" HEIGHT
5 NO ANIMAL TROUGHS
300 GALLON CAPACITY
GATE 2
OPERATOR AND GUARD HOUSES
C/S AA
2" G.I.P.
C/6 BB
C/S C/C
SCALE 1:50

Main components for hafirs should include:

1) diversion structures to direct water into the inlet of the hafir;

2) a settling pool to collect silt while hafirs is filled;

3) an inlet system to control flow of water to the hafir in a short time;

4) wing embankments to contain the required volume of water;

5) an outlet system to facilitate safe withdrawal and distribution of water;

6) a spillway to pass surplus water safely downstream.

The capacity of hafirs should be sufficient to cover:

1) drinking needs for cattle;

2) losses due to evaporation, silting, and seepage;

3) allowance for illegal use by others who may utilize the route. This may amount from 10% to 15% of the useful capacity;

4) allowance for water to be used by villagers;

5) wasting in the distribution system of 5% of the useful capacity. The losses due to evaporation in hafirs should be taken as the maximum average value recorded in the area e.g. 2.3 m/year in Kadugli (Table 31). Reduction of evaporation value during the rainy season (June to September) will bring this figure to 1.61 m/year. For a normal hafir of 4 m depth, the evaporation losses represent 40% to 45%. No exact measurement for seepage loss has been made for the existing hafirs though 5% to 10% is not unrealistic. NAW generally uses 50% of hafirs capacity as normal loss from evaporation and seepage. Allowance of 1.0 m for silting is normally made inside the hafir. For a hafir 20 x 75 m bottom dimension, allowance of 1,500 m^3 for silt is made. An amount of 5,000 m^3 (equivalent to needs for 1,000 inhabitants) could be reserved for villagers, assuming 4 gallons per head per day, and an allowance of 15% for illegal uses. Hence the gross demand is estimated as: 6,500 + (6,500 x 0.5) + 1,500 + 5,000 + (6,500 x .15) = 14,500 m^3.

Some improvements in conventional hafir construction and operation are required to increase efficiency. These could be achieved either through increasing intake efficiency, i.e., to maximize utilization of the water source, or through minimizing water loss.

To fulfill such conditions will require changes. The standard hafir (Figure 14) is shown. Possible improvements would include:

(1) an intake pipe O.D. double, 14" A.C. to fill the hafir up to the ground level (G.L.);

(2) an intake pump to fill the hafir and tank to the desired height above G.L;

(3) a circular brick, masonry, or concrete tank eight metres in diameter and one metre in height (50 m^3) placed at the ground level;

(4) a distribution system of steel troughs or circular brick lined troughs embedded in the ground to minimize spillage and losses.

For hafirs such as jebel catchments which are fed locally and subject to silting due to soil erosion, a twin hafir system is recommended to facilitate dry desilting.

As shown in Figure 14, a hafir of the following features can be adopted:

...bottom dimensions 20 x 75 m,

...depth 4 m for ground storage,

...depth 1.5 m for overground storage i.e. overall depth of 5.5 m.

...the ground storage capacity will be:

$$\frac{(75 \times 20 + 108 \times 36)}{2} \times 4 = 10{,}776 \ m^3$$

...overground storage capacity

$$\frac{(117 \times 42 + 126 \times 51)}{2} \times 1.5 = 8{,}505 \ m^3$$

...total storage capacity = 19,281 m^3

...earth excavations in hafir = 10,776 m^3

...guiding canal = 2,000 m^3

...settling pool = 3,000 m^3

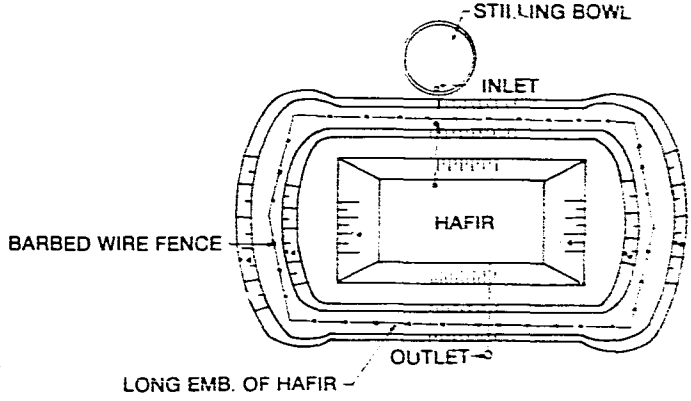
...total volume of earth excavation = 15,776 m^3 = 16,000 m^3.

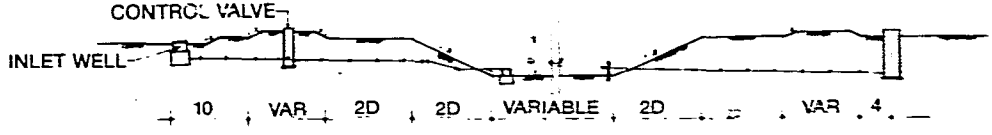
Fig.14

IES

STANDARD ARRANGEMENT FOR INLET AND OUTLET WORKS IN HAFIR

STANDARD HAFIR





Cost of Boreholes and Hafirs

To calculate water production costs, the following points should be taken into consideration:

1) capital investment;

2) the life span of the borehole and hafir is 25 years;

3) the life span of mechanical equipment is 10 years;

4. borehole drilling, erection, and hafir construction is to be carried out by a contractor under the supervision of NAW.

5) a cow will drink about 15 gallons of water each day;

6) a borehole yields 23,000 gallons (90 m^3) a day; a hafir provides between 75 m^3 and 90 m^3 a day for five months of the dry season;

7) this volume of water will supply roughly 1500 cows, daily (15 x 1500 = 22,500 gallons).

TABLE 35

COSTS FOR BOREHOLE WATER SUPPLY

Activity	Total Cost	Annual* Cost	Daily Cost	Total Daily
1. Drilling, casing & testing	$42,000	$1,680	$4.60	
2. Pump and Engine	30,000	3,000	8.22	
3. Storage tank & watering troughs	30,000	3,000	8.22	
4. Installation	20,000	2,000	5.48	
5. Supervision (10% of above)	12,220	1,220	3.34	
TOTAL CONSTRUCTION	$134,200	$10,900	$29.86	$29.86
6. Fuel (6 gal day x $3.00)		6,570	18.00	
7. Guards (3 x $960)		2,880	8.00	
8. Maintenance ($20 X 365)		7,300	20.00	
TOTAL OPERATION			$46.00	$46.00

TABLE 36

COSTS FOR HAFIR WATER SUPPLY

Activity	Total Cost	Annual Cost	Daily Cost	Total Cost
1. Machine excavation ($16,000\ m^3$ x $4.00)	$64,000			
2. Excavation inlet/outlet ($400\ m^3$ x 5.75)	2,300			
3. Construct inlet/outlet	3,750			
4. Dam	15,500			
5. Fencing (700 x 4)	2,800			
6. Guard houses (1000 x 3)	3,000			
7. Lift pumps (3750 x 2)	7,500			
8. Storage tank	23,000			
9. 20% contingency (.2 x 121,850)	24,370			
10. Survey & field investigation	4,000			
11. 10% for Supervision (.1 x 150,220)	15,022			
TOTAL CONSTRUCTION COST	$ 165,242	$6,609	$18.00	$18.00
12. 2 watchment and 1 clerk ($840 per year x 3)		2,520	7.00	
13. Fuel (70 gal per mo)		2,500	7.00	
14. Pump	4,000	400	1.00	
15. Maintenance		11,500**	32.00	
TOTAL OPERATION		$16,920	$47.00	$47.00
TOTAL DAILY				$65.00

DAILY OPERATION & CONSTRUCTION $\frac{65.00}{}$ = $.04 per cow per day for hafir.

The figures of $0.05 (borehole) and $0.04 (hafir) per cow per day require some additional clarification. The black market price in 1983/84 when the field work for this report was carried out was about 25 pt. for 15 gallons (one cow) of water. At the exchange rate then in effect, 25 pt. would equal about US $.19. Given costs of $.05 and $.04 for the borehole and hafir, there would be a savings of $.14 or $.15 per cow. Should 1500 cows be using the water points on any given day, the SSR savings in water costs alone would be over $200 (.14 x 1500). Assuming that upwards of 300,000 cows might use the route in the dry season, the money saved would be considerable and would justify investment in water facilities to support the SSR.

Another clarification concerns water days used each year. The figures of $.04 and .05 per 15 gallons are based on assumptions that water would be used all year long -- 5 months by trekkers and the remaining 7 months for domestic use, local livestock, and possibly for irrigation. Should non trekking use be less per day than cattle consumption, costs per gallon would rise, perhaps by as much as 25 to 35 percent. However, even the higher per gallon price is still well below the going market rate for water along the NSR and the unimproved SSR.

Cost of Water Provision

Given the above cost analysis, it appears that investment in 76 boreholes and 40 hafirs, as recommended, is not only cost effective but would result in considerable savings when compared with current costs of obtaining water for cattle. Although total financial outlays would seem to be high (76 boreholes x $165,000 = $12,540,000 plus 40 hafirs x $6,160,000), and although annual costs of maintenance and operation will be considerable (76 boreholes x $16,975 m/o/year = $1,290,100 plus 40 hafirs x $16,795 m/o/year = $671,600) the costs per cow per day are manageable. However, three important points must be made in conclusion. First, the figures are based on the assumption that the water points would be well managed and maintained with all fees being collected and used for operation, maintenance, and amortization. Second, one assumes a volume of 1500 cows per water point per day or an alternative income producing use, year round. Finally, one assumes that construction capital would be available at low interest or no interest loans. Given these assumptions, a cost effective water program is quite possible for the SSR.

CHAPTER V

GRAZING AND FEED RESOURCES

Background

The question of the availability of animal feed along the proposed SSR is of vital importance to the viability of the route. To assess potential needs a feed resources survey was taken between 23 November and 28 December 1983. The major objective of the survey was to evaluate the availability, production, and current condition of natural grazing and other feed sources along the proposed SSR, from Darfur to Kordofan to Omdurman.

In accordance with the project proposal, the proposed SSR is an alternative solution to the unpredictable traditional NSR which extends from Nyala via El Obeid, Umm Dam then through White Nile Province to Omdurman. Along the NSR, the total stock annually sold from areas of production (off-take) was estimated at less than 8 percent. Sales tend to take place during and a few months after the rainy season (July/December). This seasonal and low off-take has been attributed to the deteriorating condition of natural grazing, desertification, and inadequacy of water supply. The dry season sale of stock is limited, due to losses of stock on trek which may exceed 50 percent in the late dry season, and also because stock are moved southward during the dry season to their seasonal grazing near Bahr el Arab.

The proposed SSR will traverse the low rainfall savannah ecological belt extending along the northern fringe of the Baggara dry season areas of concentration and south of the rainy season grazing zone. The study area is grazed by the nation's major cattle owning tribes, namely the Rezeigat of Darfur, the Messiriya and the Hawazma of Kordofan, and the Baggara of the White Nile Province. These groups possess almost 50 percent of the country's cattle and sheep; they contribute almost 70 percent of stock consumed in central Sudan, they are responsible for 90 percent of those exported (See Table 37).

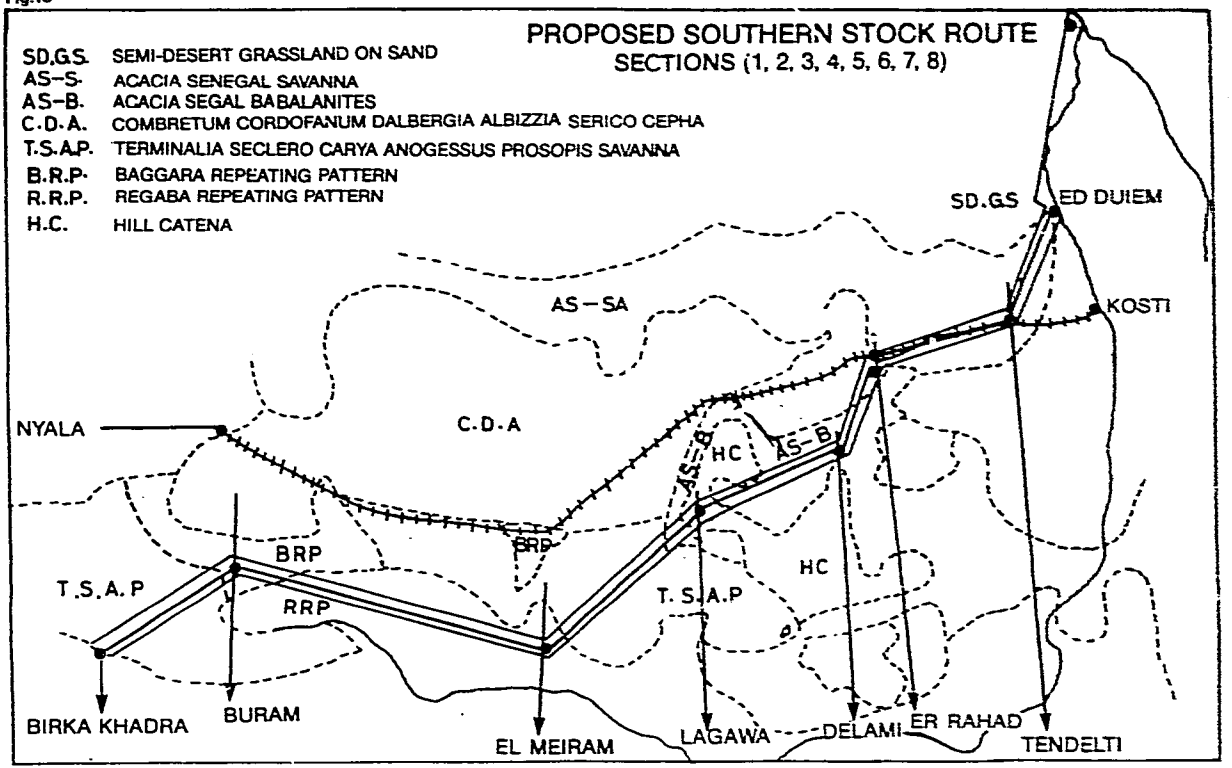
The Feed Resources Evaluation

The major objective of the vegetation survey was to collect, evaluate, and analyse all factors pertaining to range resources at a width of 40 km. along the proposed SSR and its two feeder routes. Data gathered included characteristics, formations, associations, density, frequency, species composition, degree of use, and an assessment of the carrying capacity of the rangeland along the route. In the absence of up-to-date, recent aerial photo coverage of the area, the Sudan Vegetation Map and the Savannah Phase II Vegetation Maps were used as data bases. To obtain accurate measurements data, the SSR was divided into eight sections, as shown in Figure 15 and noted in Table 38.

Approximately five sampling clusters per section were designated. The data collected were then used to set boundaries between different ecological and sub-ecological formations as well as to mark different associations along the proposed route, resulting in a vegetation map (Figure 16).

After the observations were related to soil, rainfall, and the predominant overstory vegetation, the 9.6 f^2 Hoop method was used to assess the percentage

Fig.15


PROPOSED SOUTHERN STOCK ROUTE
SECTIONS (1, 2, 3, 4, 5, 6, 7, 8)
SD.G.S. SEMI-DESERT GRASSLAND ON SAND
AS-S. ACACIA SENEGAL SAVANNA
AS-B. ACACIA SEGAL BABALANITES
C.D.A. COMBRETUM CORDOFANUM DALBERGIA ALBIZZIA SERICO CEPHA
T.S.A.P. TERMINALIA SECLERO CARYA ANOGESSUS PROSOPIS SAVANNA
B.R.P. BAGGARA REPEATING PATTERN
R.R.P. REGABA REPEATING PATTERN
H.C. HILL CATENA
SD.GS
ED DUIEM
KOSTI
AS-SA
C.D.A
NYALA
HC
AS-B
AS-B
BRP
BRP
BRP
HC
T.S.A.P
T.S.A.P
BIRKA KHADRA
BURAM
EL MEIRAM
LAGAWA
DELAMI
ER RAHAD
TENDELTI

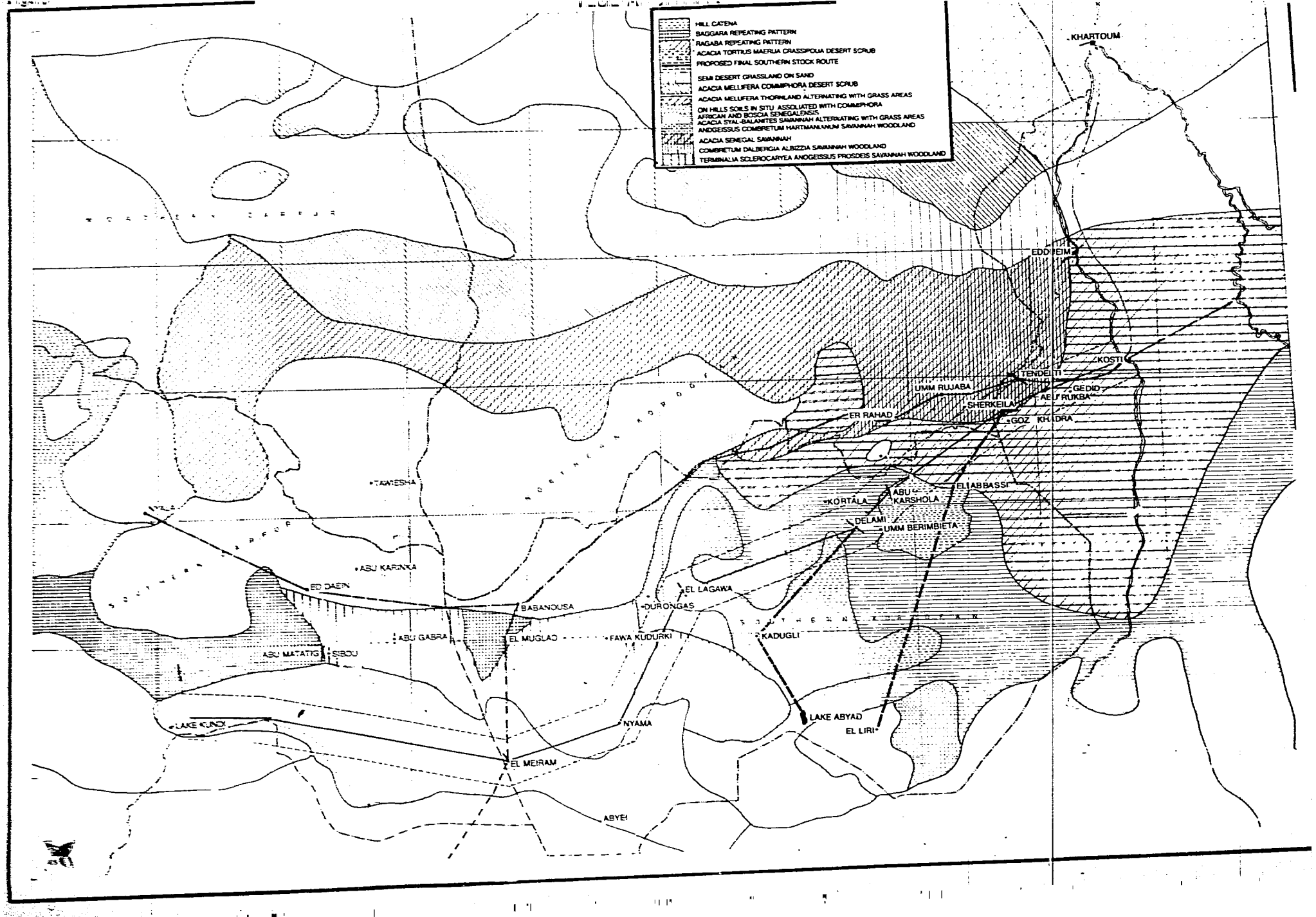

HILL CATENA
BAGGARA REPEATING PATTERN
RAGABA REPEATING PATTERN
ACACIA TORTILIS MAERUA CRASSIPOLIA DESERT SCRUB
PROPOSED FINAL SOUTHERN STOCK ROUTE
SEMI DESERT GRASSLAND ON SAND
ACACIA MELLIFERA COMMIPHORA DESERT SCRUB
ACACIA MELLIFERA THORNLAND ALTERNATING WITH GRASS AREAS
ON HILLS SOILS IN SITU ASSOLIATED WITH COMMIPHORA AFRICAN AND BOSCIA SENEGALENSIS
ACACIA SYAL-BALANITES SAVANNAH ALTERNATING WITH GRASS AREAS
ANOGEISSUS COMBRETUM HARTMANIANUM SAVANNAH WOODLAND
ACACIA SENEGAL SAVANNAH
COMBRETUM DALBERGIA ALBIZZIA SAVANNAH WOODLAND
TERMINALIA SCLEROCARYEA ANOGEISSUS PROSOEIS SAVANNAH WOODLAND
KHARTOUM
EDDEIM
KOSTI
TENDELTI
GEDID
UMM RUJABA
ABU RUKBA
SHERKEILA
ER RAHAD
GOZ KHADRA
TAWESHA
EL ABBASSI
ABU KARSHOLA
KORTALA
DELAMI
UMM BERIMBETA
ASU KARINKA
ED DAEIN
EL LAGAWA
BABANDUSA
DURONGAS
ABU GABRA
EL MUGLAD
FAWA KUDURKI
KADUGLI
ASU MATATIG
SIBOU
LAKE KUNDI
NYAMA
LAKE ABYAD
EL LIRI
EL MEIRAM
ABYEI

TABLE 37

NUMBER OF LIVESTOCK IN THE PROJECT AREA

Study Area Regions	Cattle	Sheep	% of total (study area)		% of total (Sudan)	
			Cattle	Sheep	Cattle	Sheep
Darfur	4,615,874	2,950,870	48.0	31.8	24.0	16.3
Kordofan	3,047,090	3,686,120	31.6	39.6	15.7	20.3
White Nile	1,981,428	2,465,526	29,4	27.5	10.2	13.6
TOTAL	9,644,392	9,101,716			49.9	50.2

composition of the understory vegetation, cover, frequency, and density. Then estimates were made of the total forage production in each of the sampling clusters. The detailed results of the survey appear in Annex II.

TABLE 38

LOCATION AND NAMES OF EIGHT SECTIONS USED IN VEGETATION SAMPLING

Section	Location	Distance	No. of samples recorded, as appear in Annex II
1	J. Aullia - El Duiem	400	No samples
2	Ed Duiem-Tendelti (Abu Rukba)	147	No samples
3	Tendelti - Abu Karshola	221	1,2,3,4,5
4	Abu Karshola - Delami	46	6
5	Delami - Lagawa	152	7,8,9,10,11
6	Lagawa - Muglad - El Meiram	299	12,13,14,15, 16,17,18
7	El Meiram - Abu Matarig - Buram	308	19,20
8	Buram-Kundi	80	Savannah

In this survey, the Harrison vegetation map (1958) was used as a base map, mainly to describe differential changes as recorded during the survey in plant associations, formations, and composition that have taken place since the Harrison survey.

Section I: J. Aullia to El Duiem (400 km.)

This area, located south of Khartoum and west of the White Nile up to El Duiem, encounters three subdivisions of the semi-desert ecological zone (Harrison, 1958). These subdivisions are:

i. *Acacia tortilis* - *Maerua crassfolia*
ii. *Acacia mellifera* - *Compiphora spp.*
iii. Semi-desert grassland on sand.

The range vegetation in this area is severely deteriorating due to heavy grazing, wood cutting triggered by recent drought, and desertification. A major occurrence of widely scattered *Acacia tortilis* trees and bushes was apparent. Dense stands of *Acacia tortilis* were few and were only in areas traversed by seasonal water courses where moisture and soil were adequate. The soils range from eroded clays with gravels on the surface to sand pockets, mainly along the *wadis* adjacent to their beds. All along the section of the route from J. Aullia to Ed Duiem the forage cover was entirely absent apart from frequent occurrence of a few unpalatable herbs of *Cassia italica*. The

area is becoming a desert. From a grazing point of view, this area is to be considered as a problem. Currently, trekked stock are fed supplementary forage hay, crop residues, and crop by-products which are produced in the White Nile irrigated schemes.

Section II: El Duiem - Tendelti - Abu Rukba (147 km.)

The route from El Duiem to Tendelti passes via Goz El Hur - Zureiga, Shantout, Um Zerieba, and Tuwiar up to Rahad El Sheikh. This area is situated in the semi-desert ecological zone. Due to continuous intensive grazing and farming by sedentary farmers and early grazing practices, this area is overgrazed, eroded, and in the process of being converted to desert. The small scattered overstory vegetation is mainly Acacia seyal. Most of this vegetation is confined to the clay pockets and depressions where soil moisture is adequate, compared with the surrounding sand goz. In these depressions, widely scattered overgrazed herbs of Indigofera oblongifolia (dabasir) exist. In the sedimentry sand dunes, widely scattered overgrazed tufts of Pennicum turgidum are found.

The area from Dewair-Zrieg-Rahad El Sheikh up to Tendelti lies in the low rainfall savannah belt (250-350 mm. rainfall). According to Harrison this area is dominated by Acacia senegal savannah in the northern sandy zone and by the Acacia mellifera alternating with grass areas in the southern zone near Tendelti.

Currently Balanites aegyptiaca, Acacia seyal, Acacia mellifera, Cadaba glandulosa and Boscia senagalensis form the overstory of the vegetation. Density of Acacia mellifera increases in natural depressions and where clay soil prevails. The herbaceous plant cover is completely absent due to severe overgrazing, soil erosion, and extensive cultivation in sandy soil and clay pockets.

The area between Ed Duiem - Tendelti has completely deteriorated over the last few years. Eventually it can be concluded that the area between Khartoum-Ed Duiem-Tendelti (Sections I and II) is to be considered a critical area, along the proposed route. Therefore, supplemental feed will be required for livestock passing through this area.

Section III: Tendelti-Abu Karshola (221 km.)

This section extends within the low rainfall savannah, encountering four major ecological regions: (1) Acacia senegal, (2) Acacia mellifera alternating with grass areas, (3) hill catena and (4) Acacia seyal/Balanites savannaheco-logical zones. Major dominant sub-ecological zones comprise five distinct formations, namely Boscia senegalensis, Acacia nubica, Balanites aegyptiaca, Acacia senegal, Acacia seyal, Dichrostachyus glomerata, Balanites, and Acacia seyal/Balanites formations. Five samples using Hoop Techniques were used to measure understory forage cover (Samples No. 1, 2, 3, 4 and 5) along this section. Detailed measurement data are recorded in the summary (Table 39) and the recording sheets attached as Annex II.

TABLE 39

DETAILED DESCRIPTION OF NATURAL FEED RESOURCES ALONG THE EIGHT SECTIONS OF THE SOUTHERN STOCK ROUTE

SECTION	SITE	DISTANCE Km.	VEGETATION DESCRIPTION							FORAGE PRODUCTION lb/feddd.
			MAJOR ECOLOGICAL ZONE	SUB-ECOLOGICAL FORMATION	HERBACEOUS COVER	Density	% Comp.	% Cover	Freq.	
I	J. Aulia - Ed Duiem	400	Semi-Desert: * Acacia tortilis-Maerua crassifolia - Desert scrub * Acacia mellifera - - Desert scrub * Semi-grassland on sand.	Acacia tortilis	Herbaceous cover is absent	-	-	-	-	-
II	Ed Duiem - Tendelti - Abu Rukba	147	Semi-Desert:- * Semi-Desert grassland on sand Low Rainfall Savanna Acacia senegal. Sav.		Herbaceous cover is absent	-	-	-	-	-
III	Tendelti - Abu Karshola samples (1,2,3,4,& 5)	221	Low Rainfall Sav. * Acacia senegal Savanna * Acacia mellifera/ grass areas * Hill catena Acacia seyal/ Balanites-Sav.	* Capparis decidua Boscia senegalensis * Acacia nubica/ Balanites aegyptiaca	Schoenfeldia gracilis Aristida funiculata Brachiaria spp. Bare soil	3 (1 r i o t k t e e n r)	75 10 5 10	80 - - -	100 100 100 -	750
				* Acacia mellifera * Acacia senegal	Schoenfeldia gracilis Aristida funiculata Oldandia senegalensis Bare soil	30 20 10 -	80 5 10 5	80 - - -	100 100 50 -	600

TABLE 39

DETAILED DESCRIPTION OF NATURAL FEED RESOURCES ALONG THE EIGHT SECTIONS OF THE SOUTHERN STOCK ROUTE Continued

SECTION	SITE	DISTANCE Km.	VEGETATION DESCRIPTION							FORAGE PRODUCTION lb/fedd.
			MAJOR ECOLOGICAL ZONE	SUB-ECOLOGICAL FORMATION	HERBACEOUS COVER	Density	% Comp.	% Cover	Freq.	
				+ Acacia seyal - Balanites aegyptiaca	+Cymbopogon nervatus	25	90	90	100	500
					Brachiaria obtusi - flora	5	5		100	
					litter	-	5		-	
				+ Acacia mellifera Dichrostachys glomerata Balanites aegyptiaca	Cymbopogon nervatus	20	80	80	100	550
					Brachiaria obtusi	2	5	-	50	50
					Schoenfeldia gracilis	3	5	-	50	50
					Bare soil	-	10	-	-	
				+ Acacia seyal - Balanites - Aegyptiaca	Cymbopogon nervatus	10	20	90	100	420
					Brachiaria obtusi	12	20	-	50	
					Aristida spp.	30	25	-	50	
					Litter	-	15	-		
					Bare soil	-	20	-		
										Av.=560
	Abu Karshola Sample No. 6	46	* Low Rainfall Savanna - Acacia seyal - Balanites - Acacia mellifera on dark cracking clay/Grassland.	+ Dalbergia - Combretum Balanites - Acacia gerrardii Lannea humilis	Hyparrhenia spp.	3	2	90	50	700
					Indigofera spp.	2	1	-	50	
					Schoenfeldia gracilis	20	30	-	100	
					Setaria spp.	3	7	-	50	
					Cymbopogon nervatus	30	50	-	50	
					Bare soil	-	5	-	-	
					Litter	-	5	-	-	

TABLE 39

DETAILED DESCRIPTION OF NATURAL FEED RESOURCES ALONG THE EIGHT SECTIONS OF THE SOUTHERN STOCK ROUTE Continued

SECTION	SITE	DISTANCE Km.	VEGETATION DESCRIPTION							FORAGE PRODUCTION Lb./Fedd.
			MAJOR ECOLOGICAL ZONE	SUB-ECOLOGICAL FORMATION	HERBACEOUS COVER	Density	% Comp.	% Cover	Freq.	
	Delami - El Lagawa	152	* Low Rainfall Savanna - Acacia seyal - Balanites Savanna - Hill catena	+ Acacia seyal/Balanites - Dichrostachys glomerata	Cymbopogon nervatus Schoenfeldia gracilis Pennisetum ramosum Bare soil Litter	10 35 3 - -	30 35 10 10 15	85 - -	100 50 20	450
	Samples (7,8,9,10&11)			+ Balanites - grassland	Cymbopogon nervatus Brachiaria obtusi Aristida spp. Pennisetum ramo. Bare soil Litter	10 15 40 3 - -	20 20 40 5 10 5	80 - - - - -	100 100 100 50 - -	500
				+ Acacia seyal - Acacia gerrardii Balanites aegyptiaca - Dichrostachys	Cymbopogon nervatus Brachiaria spp. Brachiaria obtusiflora Aristida funiculata Chloris pilosia Bare soil Litter	10 25 3 - - - -	30 20 5 10 20 5 10	65 - - - - - -	100 100 50 50 50 - -	500
				+ Acacia seyal-Balanites-Dichrostachys-Ziziphus Spinachristi	Cymbopogon nervatus Hyparrhenia spp. Aristida spp. Brachiaria spp. Pennisetum peddi Bare soil Litter	15 38 32 10 13 - -	20 30 20 10 10 5 5	90	100 100 100 50 50 - -	600

TABLE 39

DETAILED DESCRIPTION OF NATURAL FEED RESOURCES ALONG THE EIGHT SECTIONS OF THE SOUTHERN STOCK ROUTE Continued

SECTION	SITE	DISTANCE Km.	VEGETATION DESCRIPTION							FORAGE PRODUCTION lb./hadd.
			MAJOR ECOLOGICAL ZONE	SUB-ECOLOGICAL FORMATION	HERBACEOUS COVER	Density	% Comp.	% Cover	Freq.	
				Albizia - Acacia nubica - Combretum - Capparis decidua	Schoenfildia gracilis	40	30	65	120	650
					Hyparrhenia spp.	35	20	-	50	
					Aristida funiculata	45	30		120	
					Setaria pallidefusca	20	5		50	
					Bare soil	-	10	-	-	
					Litter	-	5	-	-	av.=543
	El Lagawa - El Merium via Muglad Samples (12,13,14,15, 16,17, & 18)	299	*Low Rainfall Savanna *Hill catena -Acacia seyal Balanites Savanna -Baggara Repeating Pattern	+ Acacia gerrardii - Adansonia - Albizia - Balanites - Anogeiss. Dalbergia	Schoefeldia gracilis	30	50	75	120	300
					Hyparrhenia spp.	30	20	-	120	
					Aristida funiculata	30	5	-	50	
					Sorobolus festivus	15	2	-	120	
					Bare soil	-	20	-	-	
					Litter	-	3	-	-	
			-Terminalia - selerocarya - Anogeissus, prosopis woodland Savanna	+Acacia seyal - Balanites zizphus - Acacia polyacantha	Brachiaria obt.	15	40	70	120	300
					Sorghum spp.	3	12	-	50	
					Bare soil	-	5	-	-	
					Litter	-	3	-	-	
			-Baggara Repeating Pattern	+ Albizia - Seclorcarya - Guirea - Boscia senegalensis	Cenchrus biflorus	20	40	40	120	300
					Eragrostis tremula	30	20	-	120	
					Andropogon - gayanus	1	5	-	20	
					Oldandia spp.	20	12	-	120	
					Bare soil	-	15	-	-	
					Litter	-	12	-	-	

TABLE 39

DETAILED DESCRIPTION OF NATURAL FEED RESOURCES ALONG THE EIGHT SECTIONS OF THE SOUTHERN STOCK ROUTE Continued

SECTION	SITE	DISTANCE Km.	VEGETATION DESCRIPTION							FORAGE PRODUCTION Lb./Fadd.
			MAJOR ECOLOGICAL ZONE	SUB-ECOLOGICAL FORMATION	HERBACEOUS COVER	Density	% Comp.	% Cover	Freq.	
				+ Combretum - Termin alia - Grewia - Anogeissus	Chloris spp.	20	30	50	100	300
					Cassia mimosoides	30	40	-	100	
					Aristida spp.	10	5	-	50	
					Bare soil	-	10	-	-	
					Litter	-	15	-	-	
				+ Albizia - Acacia gerrardii - Balanites - Tamarindus - + Combretum - Terminalia Guirea senegalensis	Schoenfeldia gracilis		-	40		250
					Aristida mutabilis		-	-		
					Sporobolus festivus		-	-		
					Oldandia spp.		-	-		
					Bare soil		60	-		
					Litter		40	-		
				+ Guirea - piliostigma - Balanites/ Dichrostachyus	Cenchrus biflorus	20	30	65	100	350
					Cassia mimosoides	10	20	-	100	
					Oldandia spp.	25	10	-	100	
					Eragrostis tremula	10	5	-	-	
					Bare soil	-	20	-	-	
					Litter	-	15	-	-	Av.=470
VII	El Merium - Abu Matarig - Buram Samples (19/20)	308	Low Rainfall Savanna - Baggara Repeating Pattern - Raggaba Repeating Pattern - Terminalia - Sociorcarya Anogessius-prosopis woodland savanna	+ Guirea - Albizia - Sederocarya - Dichrostachysis - Terminalia Balanites/Acacia senegal	Eragrostis tremula	35	20	80	100	450
					Cenchrus biflorus	20	35	-	100	
					Aristida pallida	5	10	-	100	
					Pennisetum pedicellatum	15	10	-	50	
					Andropogon gayanus	2	5	-	50	
					Bare soil	-	15	-	-	
					Litter	-	5	-	-	

TABLE 39

DETAILED DESCRIPTION OF NATURAL FEED RESOURCES ALONG THE EIGHT SECTIONS OF THE SOUTHERN STOCK ROUTE Continued

SITE	DISTANCE Km.	VEGETATION DESCRIPTION							FORAGE PRODUCTION kg/Hadi.
		MAJOR ECOLOGICAL ZONE	SUB-ECOLOGICAL FORMATION	HERBACEOUS COVER	Density	% Comp.	% Cover	Freq.	
			+ Guirea - Albizzia - Dalbergia - Combretum /Acacia senegal	Cenchrus biflorus	30	35	75	130	800
				Eragrostis tremula	22	30	-	120	
				Oldandia spp.	11	5	-	120	
				Pennisetum pedicelatum	9	5		52	
				Bare soil	-	22	-	-	
				Litter	-	5	-	-	av.=375
m - Kundi	80	Low Rainfall Savanna + Baggara Repeating Pattern + Raggaba Repeating Pattern + Terminalia - Seclercarya Anogeissus - prosopis Woodland Savanna		Brachiaria xantholuca Eragrostis tremula Cloris spp. Dactyloctenium aegyptiaca Hyparrhenia Articulata Echinochloa spp. Setaria verticellaria					950

Tendelti Kermal features a dominant overstory of Acacia senegal and Balanites aegyptiaca, while the understory is mainly composed of Cenchrus biflorus, Eragrostis tremula, Sesamum alatum, and Hibiscus species. The area is densely populated by sedentary cultivators. Distances separating villages and wateryards don't exceed 3 to 4 km. The envelopes surrounding these village are intensively cultivated in dukhn (millet), sesame, karkade (roselle) and water-melons. As a result of cultivation pressure, Calotropis procera (Dead Sea apple) is invading the area and forage cover only exists in areas located between cultivated fields.

Kermal-Sherkella's vegetation is mostly confined to the gardud soil and is composed of Capparis decidua, stunted Balanites aegyptiaca, Acacia nubica and Acacia mellifera on dark clay soil. The understory grass cover is mainly Schoenfeldia gracilis, Aristida mutabilis, and Brachiaria spp. Sample No. 1 was recorded 18 km. before Sherkella. Estimated soil cover was 80 percent with overstory density of 59 trees per feddan. Total forage production was estimated as 750 pounds per feddan (air dry matter).

Sherkella-Gardud Nama is a stretch where sandy soils prevail. The prevailing overstory vegetation encounters Acacia senegal, Acacia nubica, Boscia senegalensis, and Guiera senegalensis, while understory vegetation (grass cover) encounters Cenchrus biflorus and Eragrostis tremula which only exists in areas located between cultivated fields. At Elmayaa village (16 km. west of Sherkella) Hamarya soil (red sandy soil) prevails and is dominated by Lannea humilis (10 percent) Boscia senegalensis (80 percent), associated with Guiera senegalensis and Combretum cordofanum. Most of the understory cover was subjected to severe overgrazing.

At a distance of 26 km. west of Sherkella the vegetation overstory cover starts to improve and includes Acacia mellifera (90 percent), Boscia senegalensis, Balanites aegyptiaca while the understory grasscover is represented mainly by Schoenfeldia gracilis, Aristida funiculata and Oldlandia senegalensis. Sample No. 2 was taken 26 km. west of Sherkella. Soil cover was estimated at 80 percent and forage production estimated as 600 pounds per feddan (air dry matter).

Gardud Nama-Abu Karshola includes dense stands of Acacia mellifera, Cadaba, Boscia, Balanites and pockets of Acacia nubica. Ziziphus spinachristi prevails on clay soils. Shallow wells (Idda) occur in this area between Meikahya, Eddebker Mohamed Ali, and Gengaro, 27 km. towards the junction of the Easemih - Kadugli roads. Still, Acacia mellifera, Acacia seyal associated with Cadaba, Boscia, and Dichrostachya gloderate form the overstory cover. However, Cymbopogon nervatus and Brachiaria are the main species comprising the understory grass formation from the junction up to Abu Karshola.

TABLE 40

VEGETATION COMPOSITION IN SECTION III

Species recorded	Density	% composition	% Cover all sp.	Frequency	Average Total forage production pound/feddan
Schoenfeldia gracilis	7	32	66	70	
Aristida funiculata	4	3		40	
Brachiaria sp.	4	7		60	
Oldlandia senegalensis		2	2	10	
Cymbopogan nervatus	11	38		60	560 lb/feddan
Aristeda spp.	6	5		10	
Litter	4	4		-	
Bare soil (BS)	-	9		-	

Section IV: Abu ' rahola to Delami (46 km.)

This section of the route falls entirely within the low rainfall woodland savannah displayed in two major ecological regions: Acacia mellifera thorn bush on dark cracking clay soil that alternates with grass areas; and Acacia sp./Balanites savannah. Sub-ecological zones include Acacia mellifera, Cadaba glandulosa, Acacia seyal, Balanites aegyptiaca, Dalbergia combretum spp, Acacia gerrardii, and Lannea humilis. Only one sample (No. 6) was taken to estimate the understory vegetation herbaceous cover. In the same way, measurement data are recorded in the summary Table 39 as well as in the recording sheets attached as Annex II.

The overstory is dominated by Acacia seyal/Balanites aegyptiaca on the deep dark cracking clays whereas Acacia mellifera and its constant associate Cadaba glandulosa show their dominance on almost all the shallow cracked clays. The understory herbaceous cover is composed of annual Hyparrhenia species, Schoenfeldia gracilis, Setaria spp., and Cymbopogan nervatus. Indigofera spp. is the only legumenous herb.

On the cracking clay soil where the topography is flat and water is available in hafirs and idds, traditionally cultivated farms do exist with specific concentration on dura and sesame crops on 30 percent of the area. The remaining 70 percent comprises dense thickets, rangeland, and bush fallow (abandoned farms). Seasonal water courses and migration routes transverse the area in ways that can, with minimum input, reduce the fire hazards that occur due to conflicting uses of sedentary cultivators, cattle owners, and camel nomads.

Due to soil exhaustion caused by excessive cultivation of dura and sesame, the farmers are compelled to abandon the exhausted farms and open new areas for cultivation. The abandoned farms are recognizable by the open overstory vegetation and the dense understory cover in which almost a pure stand of Cymbopogan nervatus predominates. Overgrazing is very severe around water sources and settlement. Fire hazard along the survey route is a constant danger.

TABLE 41

VEGETATION COMPOSITION IN SECTION IV

Species record in one sample measured	Density	% composition	% cover all species	Frequency	Average Total forage production lb/feddan
Hyparrhenia spp.	3	2	90	50	
Indigofera spp.	2	1		50	
Schoenfeldia gracilis	20	30		100	700 lb/feddan
Setaria spp.	3	7		50	
Cymbopogan nervatus	30	50		50	
Litter	-	5		-	
Bare soil (BS)	-	5		-	

Section V: Delami - El Lagawa via Habila - Semasim - Gulud (152 km.)

This relatively long sector falls within two subdivisions of the low rainfall woodland savannah namely, Acacia seyal/Balanites savannah and the Hill catena, especially the area of low rainfall savannah around El Lagawa. These two major subdivisions of the low rainfall savannah on clay encounter four distinct formations:

(1) Acacia seyal/Balanites associated with Dichrostachys glomerata, Balanites aegyptiaca grassland,

(2) Acacia seyal and Acacia gerrardii,

(3) Balanites and Dichrostachys,

(4) Albiazia amara, Acacia nubica, Combretum glutinosum, and Capparis decidua.

Using the Hoop (9.6 ft^2) technique, five samples of the understory cover were measured (7, 8, 9, 10, and 11) between Delami and El Lagawa.

About 80 percent of the area in Section V is in mechanized farms of dura, sesame, and traditional fields of local varieties of dura. In this section,

Acacia seyal/Balanites forms dense stands in areas which are not under cultivation. Open grasslands of Cymbopogan nervatus, Schoenfeldia gracilis, Pennisetum spp., Brachiaria obtusiflora, Aristida spp., and Setaria pallide-fusca characterize the abandoned fields.

Sample 7 taken 7 km. away from Delami in an Acacia seyal/Balanites/Dichrostachys glomerata formation revealed the following results: overstory cover density was 65 trees per feddan, understory density 48 plants per hoop, the cover is 85 percent while the forage production was estimated to be 450 pounds per feddan, air dry matter.

Sample 8 measured 15 km. from Delami revealed that the overstory vegetation comprises Acacia seyal 80 percent, Balanites aegyptiaca 10 percent, and Anogeissus leiocarpus forming 5 percent of the stand density. At the sample site, the overstory density was estimated as 5 Balanites per feddan. The understory cover which comprises Cymbopogan, Brachiaria, Aristida, Hyparrhenia, and Pennisetum has a density of 68 plants per hoop. Cover amounts to 80 percent and total forage production is 500 pounds per feddan, air dry matter.

Sample 9 was measured 34 km. from Habila in an Acacia seyal/Balanites/Acacia gerrardii association. Tree density was found to be 155 trees per feddan while the understory cover measurements were: density 83 plants per hoop, cover 65 percent, and forage production 500 pounds per feddan. The dry matter are produced by the following herbaceous species: Cymbopogan nervatus, Brachiaria spp., Brachiaria obtusiflora, Aristida funiculata, and Chloris pilosa.

Sample 10 was measured 11 km. before El Semasim in an Acacia seyal/Balanites/Dichrostachys glomerata/Ziziphus/Spinachristi association. Overstory density amounts to 90 trees per feddan. The understory vegetation is represented by: Cymbopogan nervatus, Hyparrhenia spp., Aristida species, Brachiaria and Pennisetum spp. Measurements revealed the following information: A herbaceous cover density (understory) of 108 plants per hoop, a cover of 90 percent, and a forage production on air dry matter basis of 600 pounds per feddan.

The last sample along this section (Sample 11) was measured 25 km. after El Semasim where the site is occupied by Albizzia, Acacia nubica, and Capparis decidus association on gardud (non-cracking clay soil). The density of the overstory cover was estimated as 95 trees and bushes per feddan. The measurements of intact understory cover of Shoenfeldia gracilis, Hyparrhenia spp., Aristida spp., and Setaria pallide-fusca reflect the following information: density 140 plants per hoop, cover estimated as 65 percent, and a forage production of 650 pounds per feddan, air dry matter. Overgrazing and termite activity are quite clear, particularly in non-cracking clays.

Along this section, the mechanized schemes of Habila exist. The route must deviate either to the south or to the north as many farmers believe that the movements of cattle through the farms, even after harvests, encourage the spread of troublesome weeds.

The area from El Semasim to El Lagawa is characterized by the presence of many wadis (seasonal water course) running east and west. This phenomenon of the water courses could be of great benefit for building a grid of fire lines.

TABLE 42

TOTAL CROP AND CROP RESIDUES PRODUCTION IN THE PROJECT AREA

	SESAME STRAW			GROUNDNUT HULLS			GROUNDNUT STRAW			WHEAT STRAW			MILLET STRAW			SORGHUM STRAW			COTTON STRAW		
	Total Product (Ton)	% Residue	Total Residue (Ton)	Total Crop Residue (Ton	% Residue	Total Residue (Ton)	Total Crop Residue (Ton)	% Residue	Total Residue (Ton)	Total Crop Prod. (Ton)	% Residue	Total Residue (Ton)	Total Crop Prod. (Ton)	% Residue	Total Residue (Ton)	Total Crop Prod. (Ton)	% Residue	Total Residue (Ton)	Total Crop Prod. Ton	% Residue	Total Residue (Ton)
fur dofan	1000	100	1000	6000	42	2350	6000	26	1560	-	-	-	21000	100	21000	3000	120	3600	-	-	-
	60000	100	60000	80000	42	33600	80000	26	20800	-	-	-	91000	100	91000	94000	120	52800	-	-	-
fur dofan	61000	100	61000	86000	42	35950	86000	26	22360	-	-	-	112000	100	112000	47000	120	56400	-	-	-
S. Darfur	18000	100	18000	173000	42	72660	173000	26	44980	-	-	-	214000	100	214000	97000	120	116400	-	-	-
S. Kordofan	26000	100	26000	6000	42	2520	6000	26	1520	-	-	-	10000	100	10000	306000	120	367200	10000	100	10000
White Nile	3000	100	3000	6000	42	2520	7000	26	1820	3000	100	3000	20000	100	20000	113000	120	135600	-	-	-
S. Darfur S. Kordofan White Nile Total	47000	100	47000	185000	42	77700	186000	26	45820	3000	100	3000	244000	100	244000	516000	120	619200	10000	100	10000

SOURCE: Calculated from Table (5).

TABLE 43

TOTAL CROP RESIDUES AVAILABLE ALONG THE PROPOSED SSR SECTIONS AND THEIR NUTRITIVE VALUE

Crop Residue	Total Crop Residue Air Dry (Ton)	% DM	Total DM. (Ton)	% Digest PL BLE Protein DP.	Total DP. (Ton)	% TDN	Total Digestible Nutrients (TDN) (Ton)
Sesame straw	47,000	95	44,650	2.0	893	48	21,432
Groundnuts hulls	77,700	90	69,930	4.7	3,287	61	42,657
Groundnuts straw	45,820	95	43,529	1.6	696	43	18,717
Wheat straw	3,000	93	2,790	0.2	558	45	1,256
Millet straw	244,000	90	219,600	1.5	3,294	43	94,428
Sorghum straw	619,200	95	588,240	1.-	7,058	53	311,767
Cotton straw	10,000	28	2,800	1.3	36.4	48	1,344
	1,046,720						491,601

Fire lines are necessary in this area because fires damage extensive areas, particularly along the nomads' traditional migration routes.

Agricultural activities between El Somasim and El Lagawa do not constrain the trekking of trade cattle. The hill catena formation is characterized by the association of Boswellia/Anogeissus and Dalbergia/Sclerocarga which occur in the surroundings of El Lagawa on shallow soils covered by stones of varying shapes.

TABLE 44

VEGETATION COMPOSITION IN SECTION V

Species recorded in (5) samples measured	Density	% composition	% Cover	Frequency	Average forage (lb/feddan)
Cymbopogan nervatus	9	20	77	80	
Schoenfeldia gracila	15	13		30	
Pennisetum ramosum	1	3		14	
Brachiaria obtusiflora	6	5		30	
Aristida spp.	15	12		40	
Brachiaria spp.	7	6		30	Av. 540 lb/ feddan
Aristida funiculata	14	8			
Chloris pilosa	4	4			
Hyparrhenia spp.	14	10			
Pennisetum pedicellatum	2	2			
Setaria palide-fusca	4	1			
Litter	-	8			
Bare soil (BS)	-	8			

Section VI: El Lagawa via El Muglad - El Meiram (299 km.)

This is the longest section of the route, passing through Debat Obeid, Umm Gamal (wateryard), Shamber, Kigera Idd, Muglad, Magadama, Umm Sakina, Gwigeina, Idd El Fula, Er Rutrut, and El Meiram. It falls within five major ecological regions of the low rainfall woodland savannah namely: the hill catena, Acacia seyal/Balanites savannah, Terminalia, eclerocarya, Anogeissus, Prosopis woodland savannah, the Baggara Repeating Pattern, the Raggaba Repeating Pattern, and special areas of the low rainfall woodland. These major ecological zones display seven distinct vegetation formations;

(1) Acacia gerrardii, Adansonia, Albizzia/Balanites, Dalbergia, Acacia seyal/Balanites, Ziziphus,

(2) Acacia polyacantha,

(3) Albizzia, Sclerocarya, Guirea, Boscia senegalensis, Acacia nayal, Dichrostachys, Combretum cordofanum,

(4) Combretum, Terminalia, Grewia, Anogeissus, Leiocarpus,

(5) Albizzia, Acacia orrardii, Balanites,

(6) Tamarindus, Combretum, Terminalia, Guirea, and

(7) Guirea, Polliostigma, Balanites, Dichrostachys glomerata formations.

TABLE 45

VEGETATION COMPOSITION IN SECTION VI

Sample No.	Over-story density tree/ feddan	Understory Density plant/ hoop	Understory % cover	Forage production DM lb/feddan	Sample Location
12	100	105	75	800	11 km after Lagawa
13	123	20	70	800	11 km after Debat Obeid
14	165	81	40	340	28 km after Debat Obeid
15	52	110	60	500	64 km after Debat Obeid
16	50	60	50	300	61 km after Muglad
17	112	litter	40	250	9 km after Guwegina
18	145	65	65	350	18 km after Sample 17

In this section of the route, the estimated cultivated areas are about 40 percent corresponding with water availability in Lagawa, Drungas, Debat Obeid, and Shamber Kegira. The understory vegetation has great diversity as the route crosses different soil types such as cracking clays, nagaa, and sandy soils. Many seasonal water courses cross the area while overgrazing and sheet erosion occurs in areas where the stand of Cymbopogan is not dense and where termite activity is very severe.

Guirea senegalensis, an invader bush on sand soil, is replacing Terminalia brownii which is decreasing in density due to human misuse and old age. The stand of Guirea, wherever available, is found associated with Eragrostis termula, Oldlandia senegalensis and Etenium elegons.

The frequent fires that sweep the area annually play a major role in the vegetation compositional changes. Fires reduce the existence of Andropogon gayanus, favouring the prevalance of fire tolerant species such as Oldlandia

senegalensis and Cassia mimosoides. Dense riverine cover and understory vegetation is associated with the banks of seasonal water courses forming a strong barrier against fire spread. The Baggara Repeating Pattern land system which is used twice during the course of nomadic migration, experiences severe sheet erosion and heavy invasion of Guirea senegalensis and Acacia nubica.

TABLE 46

VEGETATION COMPOSITION IN SECTION VI

Species recorded in seven samples measured	Density	% composition	% cover of all species	% Frequency	Average forage lb/feddan
Schoenfeldia gracilis	11	11.4	60	30	
Hyparrhenia spp.	4	2.8		15	
Aristida funiculata	7	2.0		20	
Sporobolus festivus	4	0.3		15	
Brachiaria obtusiflora	4	11.4		15	
Sorghum spp.	1	1.4		8	
Cenchrus biflorus	5	10.0		30	
Eragrostis tremula	5	3.6		30	
Andropogon gayanus	0.1	0.7		3	
Oldlandia senegalensis	6	2.8		30	Av. 470 lb/feddan
Aristida spp.	5	2.0		20	
Brachiaria spp.	2	1.4		15	
Chloris spp.	3	4.3		15	
Cassia mimosoides	5	8.5		30	
Aristida mutablis	litter	litter		litter	
Litter	-	14.0			
Bare soil (BS)	-	23.0			

Section VII: El Meiram - Abu Matarig - Buram (308 km.)

This section of the route lies in two major ecological regions of Terminalia, Seclerocarya, Anogeissus, Prosopis savannah woodland and the Baggara Repeating Pattern of the low rainfall woodland savannah. Within these two major regions, specific formations were identified, including: (1) Guirea, Albizzia, Combretum, Seclerocarya, Dichrostachys, Terminalia/Balanites/Acacia senegal, and (2) Guirea, Albizzia, Dalbergia, Combretum/Acacia senegal formation. Only 2 samples (19 and 20) were measured, using the Hoop technique to determine the understory vegetation parameters.

In the Baggara Repeating Pattern where Nagaa and sand soil (stabilized dunes) alternate, these two soil types support a contrasting vegetation cover. In the Nagaa soils, Acacia nubica, Acacia mellifera, Anogessius leiocarpus, Lannea humilis and stunted Acacia seyal are well associated with Schoenfeldia

gracilis, Aristida, Sporobolus, and Hyparrhenia spp. Most of the Nagas soils along the nomadic migration routes and the areas adjacent to the seasonal water pools (Rahads) are severely affected by sheet erosion. On the sand soil (Atmour) where the cultivation of millet, groundnuts, and watermelon is practised, the existing natural vegetation is composed of Combretum, Sclerocarya, Boscia (increaser), Albizzia, Guiera (invader) associated with Cenchrus biflorus, Eragrostis tremula (increases after excessive cultivation) a few Andropogon gayanus/Brachiaria spp., and the aggressive but unpalatable invader Cassia mimosoides.

Although Terminalia, Sclerocarya, Anogeissus, Prosopis woodland savannah, Guiera senegalensis, Combretum, and Albizzia spp. are increasing in density, still the same understory vegetation of the Atmour prevails. In recent years, intensive cultivation started to occupy extensive tracts of land, particularly after the exploration of oil fields in the area. Burning the area as a first step in land preparation for sowing is attempted everywhere to get rid of trees and bushes. So far, the cultivated area along the survey route exceeds 50 percent of the total area.

Samples 19 and 20 were taken 7 km. and 45 km. after Abu Gabra respectively. The estimated data revealed that in Sample 19, the overstory density is 121 tree per feddan while the understory density is about 77 plants per hoop. Cover amounts to 80 percent and forage production on an air-dry basis is estimated as 450 pounds per feddan. For Sample 20, the overstory density is 95 trees per feddan, the understory density is 66 plants per hoop, cover is 75 percent and forage production amounts to 300 pounds per feddan air dry matter.

TABLE 47

VEGETATION COMPOSITION IN SECTION VII

Species recorded in 2 samples measured	Density	% Composition	% Cover of all species	Frequency	Average forage lb/feddan
Eragrostis tremula	28	25	78	100	
Cenchrus biflorus	25	35		100	
Aristida pallide	3	5		50	
Pennistem pedicullatum	11	8		50	Av. 375 lb/
Andropogon gayanus	1	2		25	feddan
Oldlandia senegalensis	5	3		50	
Litter	-	5		-	
Bare soil (BS)	-	17		-	

Section VIII: Buram - Kundi (80 km.)

This area was covered by the recent survey carried by Hunting Technical Services (HTS) in 1974 which included most of Southern Darfur Province. The dominant vegetation here belongs to the special area of low rainfall savannah sub-ecological zone, which is dominated by the Baggara and Raggaba Repeating Pattern systems. According to the vegetation classification established by HTS in 1974, the area is dominated by thorn shrubs and thorn savannah formation. The formation contains different sub-formations, sub-formation complexes, and association as follows:

1) Acacia mellifera thorn land sub-formation. This sub-formation contains two communities and one association:

   (a) Acacia mellifera, Acacia nubica association. This association occurs in depressional areas and is dominated by Brachiaria xantholeuca, Chloris spp., Dactylactenium aegyptium.

   (b) Acacia mellifera, Cordia ovalis community

   (c) Acacia mellifera, Caparis decidua community

(2) Acacia senegal savannah sub-formation (goz).

   This sub-formation exists in sand pockets in between clay soil and consists of pure stands of Acacia senegal which is confined to sandy soil. This sub-formation consists of mainly four sub-formation complexes:

   (a) Acacia mellifera, Acacia senegal complex,

   (b) Acacia senegal, Acacia seyal, Balanites aegyptiaca complex.

   The associated species with these complexes (a and b) are: Albizia amara, Guira senegalensis, Balanites aegyptiaca, Dalbergia, Melanarylon, Lannea humilis. Dominant grasses are mainly Eragrostis tremula, Chloris spp., Dactylactenium aegyptium.

   (c) Acacia senegal, Albizia amora, Combreum glutinosum,

   (d) Acacia melliera, Acacia senegal, Acacia seyal, Combretum complex.

3) Acacia Seyal thorn savannah sub-formation.

   In the sub-formation which dominates the Baggara Repeating Pattern, Acacia seyal is associated with Acacia mellifera and with Acacia senegal in another complex.

4) Thorn savannah and savannah woodland sub-formation in the Raggaba System.

Here there is no correlation between soil and vegetation in the Raggaba land system. This sub-formation contains different sub-formation complexes:

(a) Acacia Seyal savannah complex

This complex forms a pure stand of Acacia seyal, Balanites aegyptiaca and occurs through the Raggaba System, particularly near Abu Agaga Scheme. Dominant grass are: Hygrophila auriculata, Echinochloa spp., and Setaria verticilata.

(b) Acacia seyal, Combretum, Albizia, Dalbergia complex.

This complex occupies the majority of the Raggaba system and back swamp sub-system. Associated species are: Combretum glutinosum, Combretum hartmanianum, Dalbergia melanoxylon, Albizia amara, Acacia senegal, and Lannea humilis.

5) Acacia senegal, Acacia seyal, Combretum albizia, Dalbergia sub-formation.

Forage production amounts to 540 pounds per feddan. Useable forage (40 percent utilization cut) amounts to 324 pounds per feddan. Grazing conditions in this area are excellent.

Other Feed Resources

Three types of cropping are used for cereals production. These are irrigated cultivation, mechanized rainfed farming (MR), and traditional rainfed cultivation. Amongst the most important cultivate crops are: sorghum, dura, millet, sesame, wheat, and cotton. Table 48 indicates that the total area under cultivation amounts to 7.98 million feddans in South Kordofan and Darfur Regions (almost 50 percent of total area under cultivation in the whole country). The total area under cultivation around and with the area of the proposed SSR (South Kordofan, South Darfur and the White Nile Province) amounts to 3.95 million feddans which represents almost 50 percent of the total cultivated area in Kordofan, Darfur, and White Nile.

Traditional rainfed cultivation activities are mostly confined to the northern fringe of the low rainfall savannah, north and south of the railway line or where sandy soils are available. The loose texture of the sandy soil facilitates soil treatment and sowing of crops using traditional small hand implements which cannot be used to treat clay soil. The total area under traditional cultivation within the project area amounts to 3.54 million feddans which represent 88 percent of the total cultivated areas in South Kordofan, South Darfur, and the White Nile.

Table 43 indicates that crop residues production in South Kordofan, South Darfur and the White Nile Province amounts to 1,046,720 tons. The table also gives details of total residues produced by each crop in South Kordofan, South Darfur, and the White Nile Province.

TABLE 48

TOTAL AREAS CULTIVATED BY DIFFERENT CROPS AND TOTAL CROP PRODUCTION

TOTAL CROP PRODUCTION (TONS)						TOTAL AREA CROPPED (Feddan			SESAME			GROUNDNUT			WHEAT			MILLET			SORGHUM			COTTON			TYPE OF CROPPING	SECTION
Sesame Ton	Groundnut	Wheat Ton	Millet Ton	Sorghum Ton	Cotton Ton	Traditional	NFC	Irrigated	Aver. Prod. Kg. Fedd.	Prod. Ton	Area Feddan	Aver. Prod. Kg. Fedd.	Prod. Ton	Area Feddan	Aver. Prod. Kg. Fedd.	Prod. Ton	Area Feddan	Aver. Prod. Kg. Fedd.	Prod. Ton	Area Feddan	Aver. Prod. Kg. Fedd.	Prod. Ton	Area Feddan	Aver. Prod. Kg. Fedd.	Prod. Ton	Area Feddan		
1000	6000	-	21000	3000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Irrigation	
						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Mech. 2,7.	1. Darfur
						462	-	-	87	1	11	130	3	52	-	-	-	30	1	350	30	1	42	-	-	-	Transitional	
						462	-		87	1	11	130	3	52	-	-	-	30	1	350	30	1	42	-	-	-	TOTAL 1.	DARFUR
18000	173000	-	214000	37000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Irrigation	
						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Mech. 2,7.	2. Darfur
						2530	-	-	90	18	200	242	173	720	-	-	-	13.	214	70	550	37	443	-	-	-	Transitional	
						2530	-	-	90	18	200	242	173	720	-	-	-	13.	214	70	550	37	443	-	-	-	TOTAL 2.	DARFUR
60000	80000	-	91000	44000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Irrigation	
						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Mech. 2,7.	3. Kordofan
						2357	-	-	80	90	750	190	80	420	-	-	-	7.	9.	1270	10	44	430	-	-	-	Transitional	
						2357	-	-	80	90	750	190	80	420	-	-	-	7.	9.	1270	10	44	430	-	-	-	TOTAL 3.	
28000	6000	-	13000	30000	13000	-	704	-	190	4	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Irrigation	
						704	-	-	190	4	22	250	9	36	-	-	-	190	13	56	290	38	44	-	-	-	Mech. 2,7.	
						704	704	-	-	-	-	250	9	36	-	-	-	190	13	56	-	38	44	115	10	17	Transitional	
						704	704	-	-	-	-	250	9	36	-	-	-	190	13	56	-	38	44	115	10	17	TOTAL 3.	
						-	-	-	-	-	-	500	-	-	100	1	10	-	-	-	180	52	77	140	32	108	Irrigation	
						-	230	-	-	-	-	-	-	-	-	-	-	-	-	-	220	31	170	-	-	-	Mech. 2,7.	
						315	230	177	120	3	25	200	9	70	-	3	10	250	20	90	220	40	130	-	-	-		
						315	230	177	120	3	25	250	9	72	100	1	10	250	20	90	-	111	447	-	32	108	TOTAL 4	
						4868	934	177	AV. TOTAL																			

SOURCE. Agriculture statistics (Ministry of Agriculture and Irrigation 1983/1984)

All crops: 7.3 million
SE, S, K = 1.85 million = 50%
Total SE, S, K = 3.5 mi

Table 41 shows that the residues can yield a total digestable nutrient (TDN) equivalent to 491,601 tons per year. If it is considered that the feed requirement by an animal unit (AU) is equivalent to 1.0641 ton of TDN per year (AOAD, 1981), then AU feed requirement per six months will amount to 0.522 ton TDN/AU/6 m. Therefore, it can be concluded that the crop residues available for use can supplement the feed requirement of 985,202 AU/6 m.

Land Use and Carrying Capacity

The project area has the largest concentration of nomads in the Sudan. Figure 17 and Annex IV indicate that stock in this area are moved to graze in the south, close to Bahr el Arab, Lake Keilak and up to the boundaries of the Upper Nile Region during dry season (November-June), and then moved back north of the railway line to graze in sandy areas during the rainy season (August-November). But as a result of the 1983 drought, problems of desertification, and range deterioration, the traditional wet season grazing of the Baggara has shifted south of the railway line. Furthermore, the transitional areas between the wet and dry season areas and which previously served only as migration grazing for the Baggara are now occupied by camel and sheep owners (Gamala) from the degraded semi-desert grazing regions. These areas are identified in the recent FAO/UNDP/Sudan Government fact finding mission report (February '984) in both Northern Kordofan and Darfur Regions and comprise a total of approximately 400,000 km^2 (95 million feddans), mostly in the semi-desert and the northern fringe of the low rainfall savannah ecological zones.

The severely affected area in Kordofan amounts to 200,000 km^2. The total affected population has been estimated at approximately 1.8 million, with as many as 530,000 (nearly 50 percent of the population of Northern Kordofan) migrating and settling to the south in Rahad, Dilling, and El Fula districts. In Northern Darfur, the area situated between latitude 12° and 16° N and longitude 20° E and 28° E totals almost 200,000 km^2. This area is severely affected by drought and desertification. Out of the total population, one million inhabitants (166,000 families) have migrated with their livestock southward and resettled at Duiem, Nyala, Cersila, Idd El Ghanam, and Buram in Southern Darfur. Figure 18 indicates areas affected by desertification in the north and areas in the south now used for the resettlement of the migrants. During the drought, consequences that are relevant to this study include:

(1) the large-scale south migration, which added more livestock to the southern areas of Kordofan and Darfur and,

(2) the degradation of the NSR where severe desertification has taken place making the route unsuitable for large-scale stock trekking.

Another aspect of land use is crop residues which are important as supplementary feed. Rainfed traditional and mechanized cultivation are practised over extensive areas, while irrigated cultivation is practised mainly along the White Nile. Table 48 shows the total area cultivated by different crops and the total crop productions. This will give an idea about the available crop residues. This table should be compared with Tables 42 and 43.

Selection of the Route Based on Vegetation Resources

The criteria followed in the final location of the SSR and the two feeder routes were based upon the analysis of survey data, condition, and production of the natural feed resources as well as the details described earlier. In addition to natural feed resources, the following parameters were taken into consideration:

(1) availability of other feed resources near the selected route;

(2) passing close to the traditional nomadic dry season areas of concentration and traditional livestock markets. The two feeder routes were selected to connect the main SSR with other important areas of nomadic concentration in both Kordofan and Darfur Regions;

(3) avoiding conflict with existing mechanized or traditional rainfed cultivation;

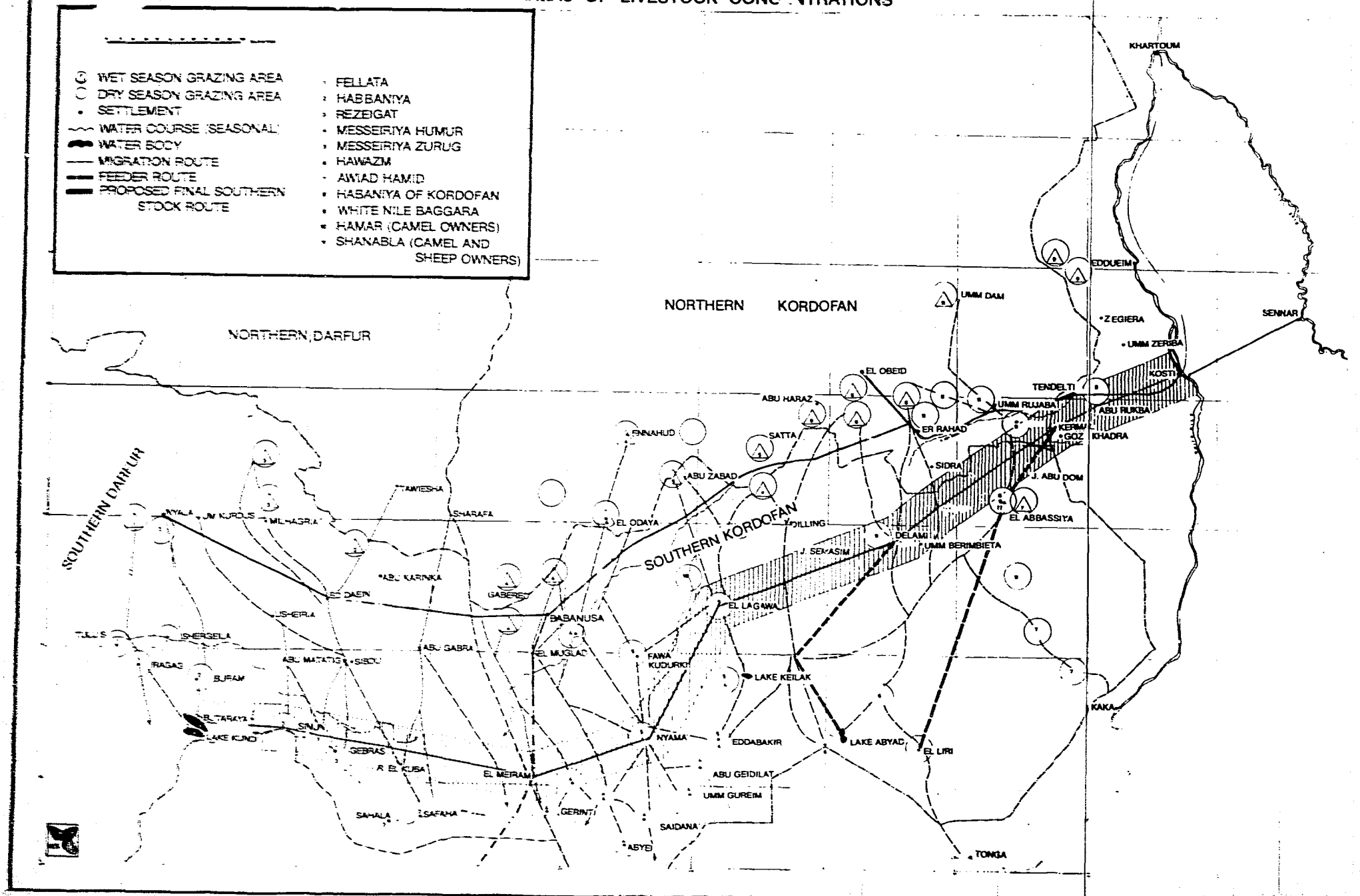
(4) proposing a zigzag type of movement for grazing purposes, mainly to provide enough grazing while stock are trekked along the route;

(5) finding feed resources along the critical area (semi-desert zone) which extends between Tendelti via El Duiem to Omdurman;

(6) identifying drinking water supplies at reasonable intervals along the sections of the SSR and its two proposed feeder routes.

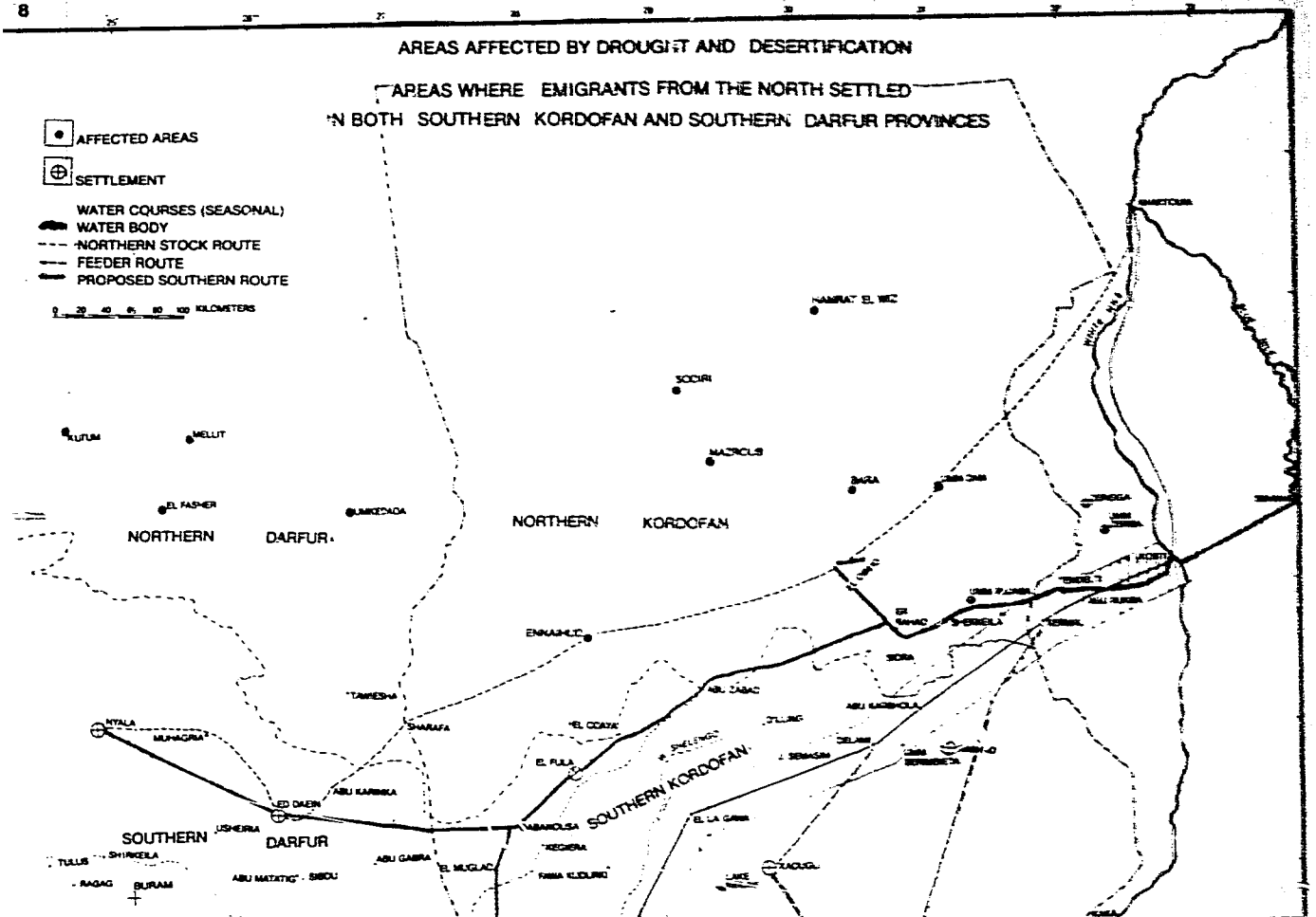
Subdividing the route into eight sections allows accurate measurements of vegetation. A number of random samples from each section of the route measured forage production. Forty percent utilization was used to deduct undesirable forage plant species. Table 49 shows estimates of average forage production per unit area (feddan) on an air dry basis.

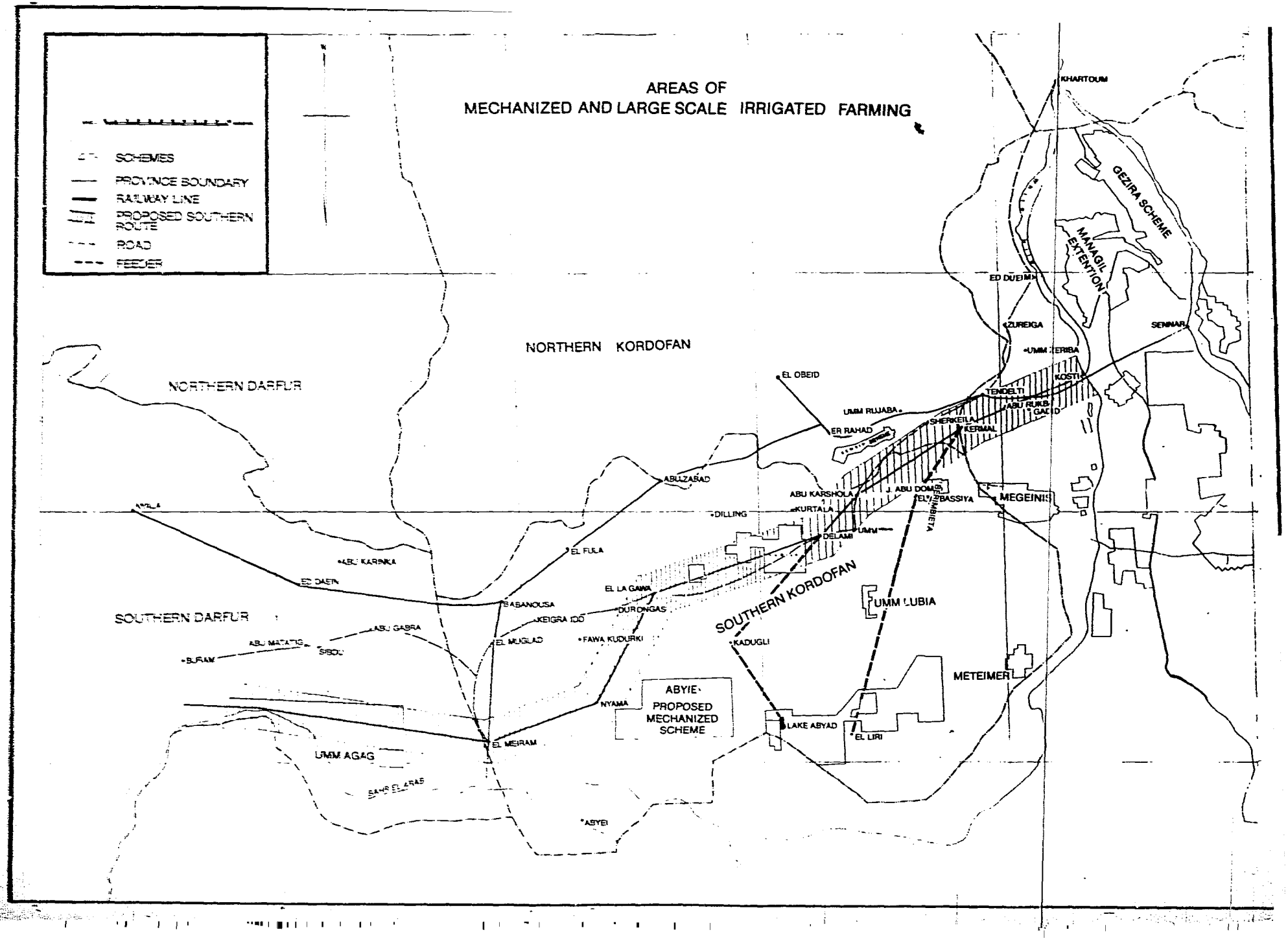
AREAS OF LIVESTOCK CONCENTRATIONS



AREAS AFFECTED BY DROUGHT AND DESERTIFICATION

AREAS WHERE EMIGRANTS FROM THE NORTH SETTLED IN BOTH SOUTHERN KORDOFAN AND SOUTHERN DARFUR PROVINCES




AREAS OF
MECHANIZED AND LARGE SCALE IRRIGATED FARMING
SCHEMES
PROVINCE BOUNDARY
RAILWAY LINE
PROPOSED SOUTHERN ROUTE
ROAD
FEEDER
NORTHERN KORDOFAN
NORTHERN DARFUR
SOUTHERN DARFUR
SOUTHERN KORDOFAN
KHARTOUM
GEZIRA SCHEME
MANAGIL EXTENTION
ED DUEIM
ZUREIGA
UMM TERIBA
SENNAR
KOSTI
TENDELTI
ABU RUKB
GAID
EL OBEID
UMM RUJABA
ER RAHAD
SHERKEILA
KERMAL
ABU KARSHOLA
J. ABU DOM
EL BASSIYA
MEGEINIS
KURTALA
DILLING
DELAMI
UMM
ABUZABAD
EL FULA
ABU KARINKA
ED DAEIN
EL LA GAWA
ABANOUSA
DURONGAS
KEIGRA IDD
UMM LUBIA
ABU GABRA
ABU MATATIG
SIBDU
BURAM
EL MUGLAD
FAWA KUDURKI
KADUGLI
METEIMER
ABYIE
PROPOSED
MECHANIZED
SCHEME
NYAMA
LAKE ABYAD
EL LIRI
EL MEIRAM
UMM AGAG
BAHR EL ARAB
ABYEI

NOMADIC CONCENTRATIONS, NORTHERN STOCK ROUTE, AND THE PROPOSED SOUTHERN STOCK ROUTE

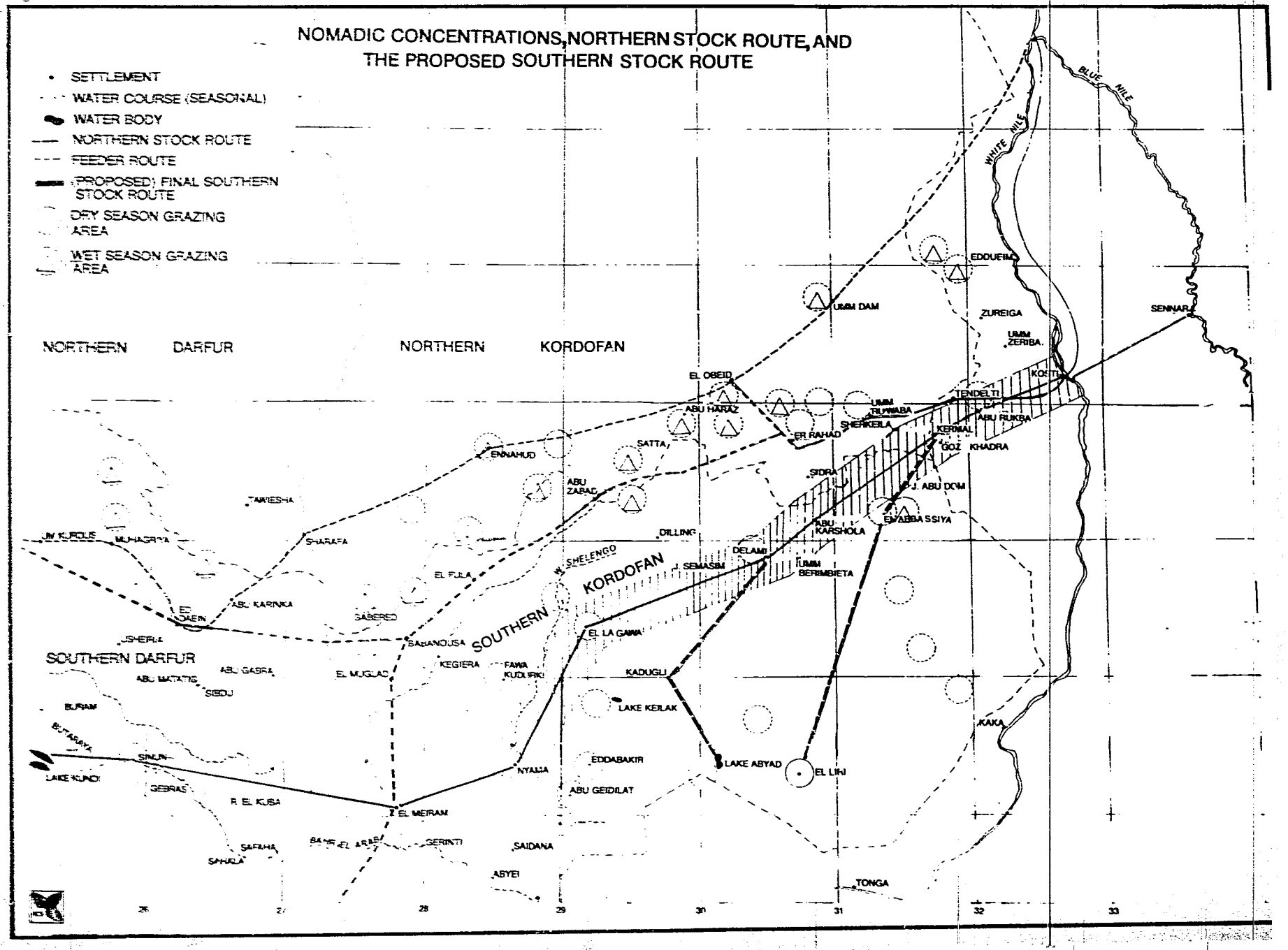


TABLE 49

ESTIMATED AVERAGE FORAGE PRODUCTION
PER UNIT AREA (FEDDAN ON AIR DRY BASIS)

Section No.	No. of Samples recorded	Average Forage Production (lb/feddan)	Average Useable Forage Production 40% cut (lb/feddan)	Average Useable Forage Production, air dry (ton/feddan)
1	-	-	-	Critical area
2	-	-	-	Critical area
3	5	560	336	0.150
4	1	700	420	0.189
5	5	540	324	0.146
6	7	470	282	0.127
7	2	375	225	0.101
8	-	950	570	0.26

Note: Detailed measurement data are recorded in Annex II.

As Table 49 indicates, forage from natural pasture is available all along the SSR at different rates of production, ranging between 0.1 to 0.26 ton/feddan air dry. Natural range forage is completely absent within the critical area along the route between Kosti or Tendelti up to Omdurman. Absence of range forage in this area is due to overgrazing, land misuse and desertification. For livestock moving through the critical area, whether on hoof or using transport, supplementary feed is essential to meet their requirements.

Carrying capacity is based upon the actual feed requirements of an animal unit (AU) per year in the form of total digestable nutrients (TDN), established as 1.0441 ton TDN/AU/Y (AOAD/1981). The assessment of the carrying capacity of the SSR, using the TDN concept, will require that the average production of air dry forage for each section, as indicated in Table 49, be converted to average production of TDN per feddan (ton/TDN/Fedd.).

To arrive at such a conversion, the average air dry forage production per feddan is multiplied by 90 percent, resulting in the average dry matter production (DM) per feddan. The TDN of the natural range forage plants is estimated as 31.4 percent of its dry matter (AOAD/1981). When the average dry matter production per feddan is multiplied by 31.4 percent we arrive at the assessment of the average TDN production per feddan for each section along the route. Using the established animal unit feed requirement in the form of TDN (1.0441 ton/AU/Y) the carrying capacity in the form of Fedd/AU/Y or Fedd/AU/six months can be determined. The carrying capacity here refers to the number of feddans of the rangeland that are required to maintain the food requirement of an annual unit during a year or six months period.

The carrying capacity (Fedd/AU/Y) when multiplied by the total grazing area with each section (total length of the section x 40 km.), determines stocking rate per year or six months period for each section. Table 9 shows the average rate of air dry forage production per section, TDN, the carrying capacity and the stocking rate that can be grazed in each section for six months during the dry season.

TABLE 50

RANGE FORAGE PRODUCTION AND STOCKING RATE ASSESSMENT

Section No	Section Name	Stocking Rate Total AU/Sec/ Six months	Remarks
1	J. Aulia - El Duiem	-	Critical Area
2	El Duiem - Abu Rukba (Kosti)	-	Critical Area
3	Tendalti - Abu Karshola	168,313	Grazing available
4	Abu Karshola - Delami	44,458	Grazing available
5	Delami - Lagawa	113,493	Grazing available
6	Lagawa - Muglad - El Meiram	196,308	Grazing available
7	El Meiram - Abu Matrig - Buram	162,897	Grazing available
8	Buram - Kundi	106,516	Grazing available
Total		791,985	

As indicated, the SSR (Kundi - Kosti) can accommodate 791,985 livestock units (AU) trekking on hoof from the western regions during the six months of the dry season, whereas trekking of stock on hoof following the traditional NSR is hindered by lack of both grazing and water supply.

Off-take Rates

National commercial off-take has been variously estimated as 6 percent for cattle by FAO (1971) and 9.7 percent for cattle and 24 percent for sheep by HTA (1974). Recently the Animal Resources Economic Administration (AREA) in 1980/1981 estimated the annual national off-take on the basis of the actual number of total stock exported and those consumed locally. These estimates are shown in Table 51.

TABLE 51

TOTAL OFF-TAKE ESTIMATES BASED ON EXPORT (OFFICIAL AND NON-OFFICIAL) AND TOTAL NUMBER OF STOCK SLAUGHTERED (OFFICIAL AND NON-OFFICIAL) FOR 1980/81

Item	Kind of stock			
	Cattle	Sheep	Goats	Camels
1. Export stock				
1.1 official export	13,000	416,000	4,000	1,000
1.2 non-official export	17,000	209,000	-	97,000
Total export	30,000	625,000	4,000	98,000
2. Total slaughtered official and non-official	1,723,000	3,560,000	2,424,000	10,000
Total exported and slaughtered	1,753,000	4,185,000	2,428,000	108,000
3. Total stock population	19,474,036	18,116,714	13,270,409	2,698,690
4. Percent of off-take	9.0	23.1	18.3	4.0

Table 51 indicates 9.0 percent off-take for cattle and 23.1 percent off-take for sheep. For western Sudan (Kordofan and Darfur) Hunting (HTS/1981) calculated 7.0 percent off-take for cattle and 24 percent for sheep, as noted in Table 52.

TABLE 52

OFF-TAKE IN KORDOFAN AND DARFUR

Region and Stock Type	Total head	(AU) Equiv.	Total	% Off-Take	Total (AU) Extracted
1. Kordofan					
1. Cattle	3,947,090	(0.7)	2,126,963	7	149,307
2. Sheep	3,686,120	(0.2)	737,224	24	176,934
2. Darfur					
1. Cattle	4,615,874	(0.7)	3,231,112	7	226,178
2. Sheep	2,950,070	(0.2)	590,014	24	141,603
	14,299,154		6,691,313		694,022

Source: 1. Stock population for Kordofan and Darfur (AREA 1980/81).
2. Animal unit equivalent (AU). AAD/1981.

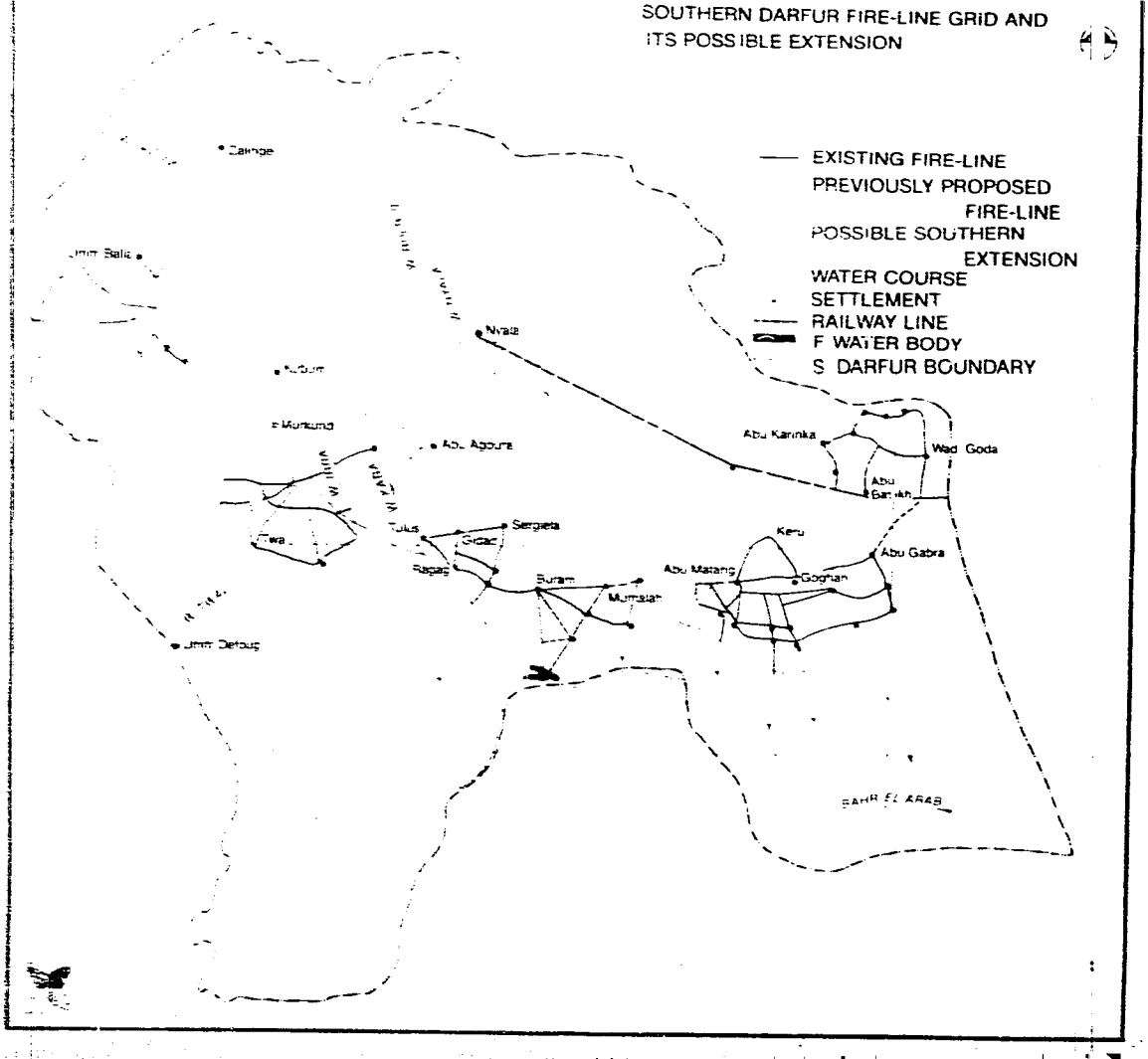
The total livestock actually extracted from the western provinces amounts to 694,022 AU. This number is far below the estimated stocking rate capacity of the SSR which amounts almost to 791,985 livestock units (AU) during the six months of the dry season. Therefore, it can be concluded that summer grazing is available in an adequate amount all along the SSR from Kundi to Kosti to meet the feed requirements of livestock to be trekked from western provinces. The actual stocking rate capacity of the SSR (791,985 AU) exceeds the normal annual off-take (694,022 AU) almost by 97,963 AU. In addition, the calculated total crop residues that can be made available amount to almost one million tons, air dry. This amount provides 491,601 tons of TDN which, if used as a supplementary feed, will meet the food requirement of 983,202 AU/6 months. This also indicates that the excess crop residues can be used as a supplementary feed along critical areas of the SSR.

Fire

Uncontrolled bush-fire outbreaks in the semi-desert and the low rainfall savannah ecological zones of the Sudan result either from carelessness or intentional reasons. The occurrence of such fires is annually reported in these ecological zones, immediately after the end of the growing season. Such frequent fires in the grazing areas of the country cause reduction in stock numbers and change in the floristic composition, i.e., increase of annuals, decrease in perennial grasses, and increase in fire resistant plants.

The recommended measures for range resources conservation against devastating fires include:

SOUTHERN DARFUR FIRE-LINE GRID AND ITS POSSIBLE EXTENSION



1. construction of fire-line grids;

2. appointment of fire guards to ensure protection of the route area from sweeping fires;

3. chemical herbicides that can be used in fire-line construction, particularly in the difficult heavy and wet soils. Herbicides like Ustilan 70 and Ustilant ATA achieve 100 percent ficiency when used in fire-lines at an experimental scale at Nyala o contrasting soil types such as clay, non-cracking clay, and sandy soils.

The areas that require fire lining along the SSR are:

1. between Sherkeila - Abu Karshola;

2. between Abu Karshola - El Lagawa;

   This part of the route, provides seasonal water courses that traverse the area and only some additional connecting lines are needed.

3. between El Lagawa - Nyama - El Meiram requires establishment of the previously executed fire lines that connect Nyama - Kegeira - El Muglad;

4. between El Meiram - Lake Kundi can receive effective protection when Chevron Oil Company patrol roads are extended further south to the Raggaba Region. Also the extension of Abu Matarig and Abu Gabra grids to the south gives more protection against uncontrolled fires.

Range resource rehabilitation can be achieved through:

1. reseeding of deteriorated areas with adapted species. Artificial reseeding undertakings can be carried in the area lying in the vicinity of Kermal, particularly on the southwestern part. Adapted species such as Dactyloetenium aegyptium, Brachiaria xantheluca, and Indigofera spp. are the most promising ones in the area. Seeding of the area must follow complete protection and thinning of Acacia mellifera. Kermal - Abu Rukba - Gadid - Kosti require the same treatment as the area southwest of Kermal. On the non-cracking clays (gardud) along Ed Gueim - Tendelti, natural regeneration under complete protection leads to good cover establishment. Artificial reseeding can be attempted in areas where remnants of desirable plants are lacking;

2. reservation of deteriorated areas where rainfall is high. The severely overgrazed areas near El Abbassiya need protection through reservation. Here the chances of improvement by natural regeneration are good;

3. bush thinning where the stand of thickets is dense. An area such as that from Jebel Ed Dair to Gardud Nama contains dense Acacia mellifera stands that will not allow penetration by animals. Here thinning of the bush should be taken to provide room for herbaceous cover establishment;

4. establishment of holding grounds near the traditional markets to reduce overstocking and overgrazing of the markets' surroundings.

Estimated Costs for Resources Conservation

Conservation can be achieved by construction of fire lines north of the proposed route and along the route. Taking advantage of the prevailing natural barriers, the roads, and the migration route, fire lines can be constructed by heavy mechanical means and maintained with light mechanical equipment. Fire lines are needed in the following sites:

Route sections	Grid of needed fire line (in linear km)
Sherkella to Delami	100
Delami to Lagawa	250
Lagawa to El Meiram via Nyama	150
El Meiram to Kundi (extension of Abu Matarig, Abu Gabra - Buram fire-line grids and maintenance of Chevron roads	200
TOTAL	700

Cost of constructing 700 linear kilometers of fire lines.

A. Capital cost
2 Hired motorgraders to execute the initial demarcation of the fire line grid in one month

3 Landrovers	£S 120,000
3 Tractors	150,000
5 Scrapers	35,000
5 Trailers	75,000
Camping equipment	15,000
Local tools	5,000
Total capital cost	£S 300,000

B. Running cost:
B.1 Technical staff:

2 Assistant range officers, 3 months	£S 1,200
6 Technical assistants	1,800
10 Technical labourers	2,400
5 Tractor drivers	1,500
3 Car drivers	810
30% Hardship allowance	2,313
60 Casual labourers: 60 x 75 x 3 months	13,500

Sub total	£S 23,523
B.2 Fuel, oil lubricants, maintenance and spare parts	
Fuel - gasoline	
5 x 20 gallons/3 months/ 4	7,200
Benzine	
5 x 150 x 3 x 5	6,750
Oil	
8 x 2 gallons/ 3 months/ 20	960
Lubricant	
8 x 5 kg x 3 x 5	600
Maintenance and spare parts	
50% of the fuel, oil and lubricants	7,755
Sub total running cost	23,265
Total running cost	46,788
Total cost	
A. Capital cost	100,000
B. Running cost	46,788
Total cost of constructing 700 linear km. of fire lines	£S 146,788

Range rehabilitation measures

Reseeding needed at the following locations:

a. vicinity of Kermal
b. between Kermal - Abu Rukba
c. Abu Rukba - Gadid
d. Gadid - Kosti
e. El Abbassiya - Kermal

In each of the five locations an area of 10 km. x 10 km. (23,800 feddans) needs to be protected by local fencing materials, e.g., Acacia mellifera branches.

The same tractors acquired for range resources conservation can be used for reseeding as long as the two activities are executed at different times. Range conservation starts immediately after the end of the rains while rehabilitation activity starts 3 months before the on-set of the rains.

A. Capital costs (Reseeding)

5 disc harrow	75,000
3 disc ploughs	20,000
9 tons seeds	10,000
TOTAL	£S 105,000

B. Running costs:

B.1 Technical staff:

2 assistant range officers (3 m)	ES 1,200
6 technical assistants (3 m)	1,800
10 technical labourers	2,400
5 tractor drivers	1,500
3 vehicle drivers	810
30% hardship allowance	2,313
80 x 75 x 3	1,800
Sub total	ES 20,023

B.2 Fuel, oil lubricants, maintenance and spare parts:

Gasoline, 5 tractors	ES 7,200
Benzine, 3 vehicles	6,500
Oil (tractors and vehicles)	960
Lubricants (tractors and vehicles)	600
Maintenance	7,755
Sub total running costs	ES 23,265

Total cost (rehabilitation)

A. Capital cost	ES 105,000
B. Running cost	51,288
	ES 151,788
Total cost of constructing fire lines	346,788
Total cost of range resource rehabilitation	151,788
Total cost	ES 498,576
i.e.	381,980

Supplementary Fodder (Kosti-Khartoum 140 km.)

It was indicated earlier that summer grazing (November through March) is adequate all along the SSR from Kundi to Kosti (1106 km.). The estimated stocking rate capacity of this section during the six months of the summer period amounts to 792,000 AU/6 months which exceeds the total annual off-take (654,000 AU/YR) by almost 14 percent.

Natural grazing is completely absent, however, along a critical area which extends between Kosti north to Omdurman (240 km.). The deterioration of the range resources in this area is attributed to overgrazing, extensive cultivation, drought, and desertification. Trekking of stock through the critical area, even during the rainy season, is becoming a serious problem due to lack of forage feed. feed (crop and forage hay) from

the Gezira and the White Nile is now used to feed livestock while passing through the critical area.

Trekking additional stock along the critical area will require supplementary feed. The provision of baled hay from Elbaga area is uncertain due to unpredictable rainfall. The production of forage hay,using irrigation and a sound forage rotation system along the stretch of the White Nile near Kosti, is to be considered the most practical solution to this problem. An irrigated forage farm can be designed in such a way as to provide a stable, adequate, nutritively balanced forage hay mix to supplement the livestock feed.

Feeding livestock while they pass through the critical area will require a series of feeding and resting lots along the entire length of the route. It is assumed that trekked stock can cover 40 km. walking per day, provided that they are allowed a day to feed and rest following each day they walk. Using this schedule, trekked stock are able to cross the critical area within 12 days (6 days walking and 6 days feeding and resting).

To meet the feeding and resting requirements, six holding grounds will be required. The size of the proposed holding ground is based on the assumption that the total possible off-take during the five months of summer time (300,000 AU) can be extracted at a rate of 60,000 AU/month. If it is assumed that the animal unit will require 20 x 20 metre space for feeding and resting. The size of the holding ground can be computed as:

$$\frac{300{,}000 \text{ per season}}{5 \text{ months}} = 60{,}000 \text{ per month}$$

$$\frac{60{,}000 \text{ per month}}{30 \text{ days}} = 2{,}000 \text{ animal units per day}$$

$$2{,}000 \text{ AU} \times 2 \text{ (safety factor)} = 4{,}000 \text{ total potential AU per day}$$

$$4{,}000 \times 20 \text{ m} \times 20 \text{ m} = 1{,}600{,}000 \text{ m}^2$$

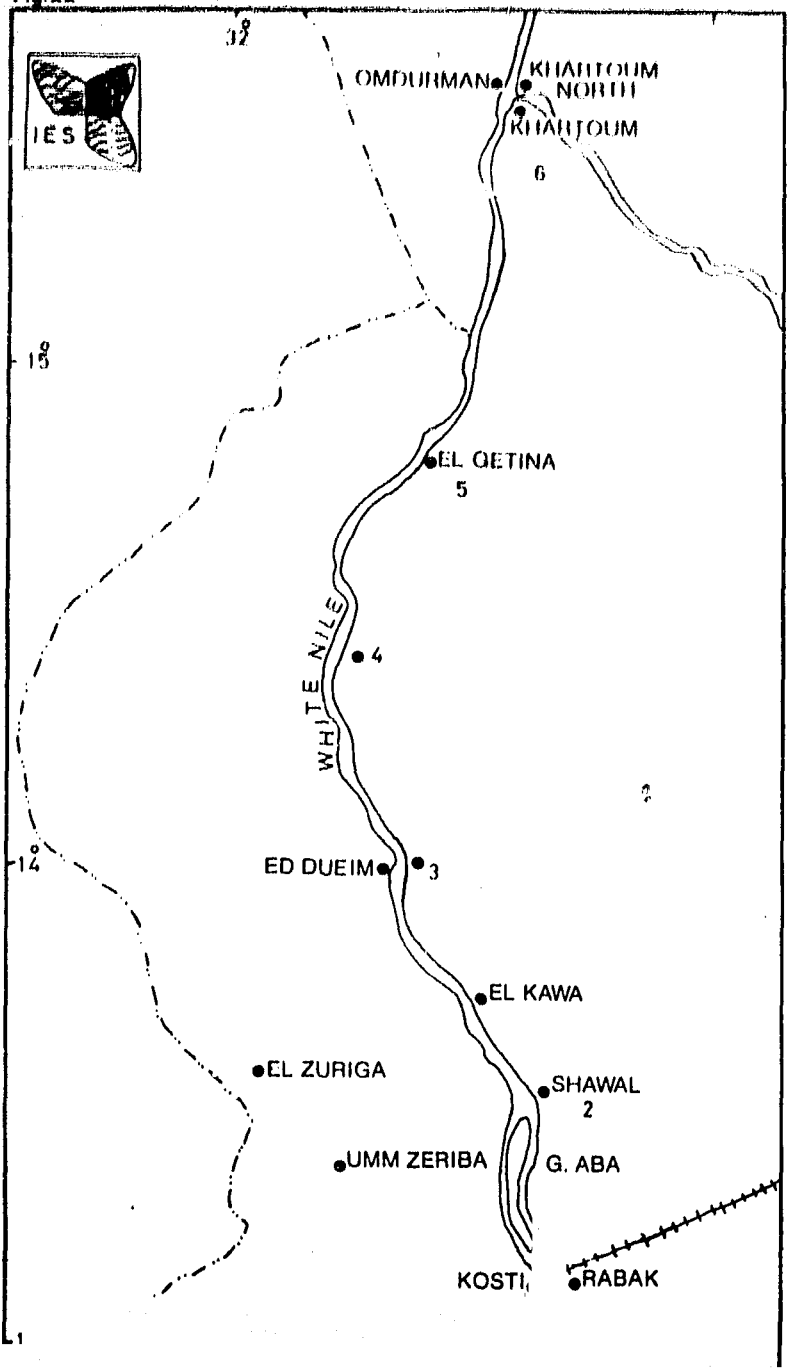
$$1{,}600{,}000 \text{ m}^2 = \text{length of } 1{,}000 \text{ m} \times \text{width of } 1{,}600 \text{ m OR } 1 \text{ km.} \times 1.6 \text{ km.}$$

It is recommended that the holding ground be increased slightly as a further safety factor to be something like 1.5 km. square and divided into four paddocks to facilitate a uniform distribution of arriving stock for feeding and resting.

The outer perimeter (6 km.) of the holding ground is recommended to be fenced using barbed wire and metalic posts. A store is to be built for the storage of the forage hay. A water centre is recommended to be installed at the middle of the holding ground with a capacity that is required to meet the water requirements of the trekked stock (15 gallons x 2,000 cattle = 30,000 gallons per day).

The possible off-take that can be extracted during the dry months (December through June) is estimated as 50 percent of the annual commercial off-take (600,000 AU/YR), i.e., approximately 300,000 AU/SM.

Fig. 22 FARMS AND SIX HOLDING GROUNDS



The extracted stock (300,000 AU/SM) will spend one day for feeding and resting at each of the six feeding and resting holding grounds, i.e., a total of six days at the six holding grounds. Since the maintenance feed requirement per AU per year is estimated to amount to 1.0441 tons of total digestable nutrient (TDU) per year, the feed that is required by the extracted stock (300,000 AU) during six days can be computed as follows:

1. AU feed requirement per 6 days
   $\frac{6 \times 1.04441}{360} = 0.018$ (ton/TDN/AU/6 days)

2. Total feed requirement in form of TDN for the extracted stock (300,000 AU/SM)
   $= 300,000 \times 0.018 = = 5,400$ ton/TDN/6 days

3. Amount of feed required to be available at each of the six stations to meet the feed requirement of the total extracted herd
   $= \frac{5,400}{6} = 900$ tons per holding ground.

In conclusion, the total feed that is required to support the extracted herd (300,000 AU) during five months of summer time so they are able to pass the critical area will amount to an equivalent of 5,400 tons of total digestible nutrients (TDN). To make this amount of supplementary feed available will require a permanent irrigated forage production farm in Kosti Region. Selected annual cereal and leguminous forage crops must be cultivated in this farm in a rotational system that sustains the production of a forage hay mix of roughly 5,400 tons per year.

The farm is proposed to be located close to the White Nile At Kosti Region and within easy reach of experts who will operate and supervise the farm. The recommended size is 4,000 feddans, cultivated with forage crop in a sequence that allows the cultivation of cereals to alternate with legumes in order to maintain soil fertility.

The recommended forage crops which have proved to be successful in the White Nile area are:

- Lubia (Vigna spp.
- Philipesara (Phaseolus trilbus)
- Abu sabein (Sorghum vulgar)
- Maize (Zea mays)

To design a forage rotation system, the farm area (4,000 feddans) must be divided into six equal divisions of 666.6 feddans each:

Division

1	2	3
4	5	6

A division is considered the rotational unit in which the cultivation of the legumes and cereal forage alternates. The division is further sub-divided into 33 holdings, 20 feddans each, throughout the construction of the irrigation channels and other layouts.

The following diagrams show the sequence of cropping in each division run for four years:

1st year

S	M/V	M/V
S/PH	PH	S

2nd year

S/V	V/M	S/pH
M	pH	S/pH

3rd year

S/Ph	M/V	S/Ph
S	M	M/V

4th year

M	S/Ph	S/V
Ph	M/V	S/Ph

	Crop name	Symbol	Sowing date	Harvest date
1.	Abu sabein (Sorghum vulgar)	(S)	April	June (70 days)
2.	Maize (Zea mays)	(M)	October	December (80 days)
3.	Philipesara (Phasouls trilobus)	(Ph)	July	October/December
4.	Lubia (Vigna spp.	(V)	March	May

Through such rotation, the farm area will be occupied by crops all year round except for two to three months (January through March), where the land is left unoccupied mainly for harvest and for land preparation for sowing according to the rotation.

Seed requirement for the first year cropping, according to the rotation, is calculated as:

TABLE 51

FIRST YEAR SEED REQUIREMENTS

Crop	Seed rate (kg/feddan)	No. of sections cultivated	Total area cultivated (feddan)	Quantity seed (tons)
Abu sabein	35	3	1999.8	70
Maize	40	2	1333.2	53.3
Philipesara	14	4	2666.4	37.3
Lubia	60	2	1333.2	80.0
Total	--	11	7332.6	240.6

Note: It is advisable to set parts of the cultivated areas specifically for seed stock production rather than purchasing annually seed required for cultivation. This will reduce running cost.

Irrigation Water Requirement

Crop	Watering intervals (days)	No. of waterings	Quantity of water (M^3/feddan) per watering	Quantity of water per year (M^3/fed/yr)
Philipesara	21	4-5	500	1,500
Abu sabein	10	7-8	400	3,200
Maize	10	7-8	400	3,200
Lubia	12	3	450	1,350

From the above data, the total water requirement of the farm can be calculated as:

1. Average number of waterings = 6

2. Average quantity of water required per watering for one feddan during the year for all crops = 387 m^3/yr

TABLE 54

EXPECTED TOTAL FORAGE HAY PRODUCTION FROM THE FARM

Year	Crop	Rotation	No. of Divisions Cultivated	No. of Cuts	Area cultivated (feddans)	Average (green) ton	Production (dry) ton	Total (Green)	Production (dry)
1st year	Abu sabein	S, M/V, M/V, S/ph, Ph, S	3	2	1999.8	8	3	15998.4	5999.4
	Lubia		2	1	1333.2	5	1.5	6666	1999.8
	Philipesara		2	2	1333.2	12	4	15998.4	5332.8
	Maize		3	1	1999.8	8	2.6	15998.4	5199.5
		Sub-total, year 1						54662.2	18863.5
2nd year	Abu sabein	S/V, V/M, S/Ph, M, Ph, S/pH	3	2	1999.8	8	3	15998.4	5999.4
	Lubia		2	1	1333.2	5	1.5	6666	1999.8
	Philipesara		3	2	1999.8	12	4	23997.6	7999.2
	Maize		2	1	1333.2	8	2.6	10665.6	3466.3
		Sub-total, year 2						57327.6	19464.7
3rd year	Abu sabein	S/pH, M/V, S/pH, S, M, M/V	3	2	1999.8	8	3	15998.4	5999.4
	Lubia		2	1	1333.2	5	1.5	6666	1999.8
	Philipesara		2	2	1333.2	12	4	15998.4	5332.8
	Maize		2	1	1999.8	8	2.6	15998.4	5199.5
		Sub-total, year 3						54662.2	18863.5
4th year	Abu sabein	M, S/Ph, S/V, ph, M/V, S/Ph	3	2	1999.8	8	3	15998.4	5999.4
	Lubia		2	1	1333.2	5	1.5	6666	1999.8
	Philipesara		3	2	1999.8	12	4	23997.6	7999.2
	Maize		2	1	1333.2	8	2.6	10665.6	3466.3
		Sub-total, year 4						57327.6	19464.7

3. Total area of the farm = 4,000 feddans.

4. Amount of irrigation water required by the farm during the year = 6 x 387 x 4,000 = 9.3 million cubic metres (M^3)

According to the estimated water requirement, pump design and canalization layout can be worked out by irrigation engineers.

Total expected production of forage hay mix is calculated in Table 54 which indicates that forage production in the first year will be about 54,661 tons. This will increase in the second year to 57,327 tons, but will return about 54,661 tons in the third year. In the fourth year, it will start to increase to become similar to the production level of the second year and so on. This sequence of production continues for 20 years or more, subject to the rotation. It can be said that rotation will reach its stability in the fourth year. The overall average production is thus taken from that of the first and second year $\frac{54,661 + 57,327}{2}$ = 55,994 ton/year green forage or $\frac{31,863 + 19,46}{2}$ = 25,664 ton/year air dry forage.

Crop	Av. Prod. green (ton)	% dry matt. (DM ton)	Total DM ton	% TDN	Total TDN ton
Abu sabein	15998.4	25	3999.6	55.2	2208
Lubia	6666	24	1599.9	55	880
Philipesara	19998	24	4799.5	56	2688
Maize	13332	25	3333	55.2	1840
Total	55994.4		3732.0		7616

The total nutritive value of the forage amounts to 7616 tons of total digestible nutrient (TDN). It is clear that the produced supplementary feed (7616 ton/yr) exceeds the requirement by 2216 tons of TDN which can be used as a reserve for next season or sold to market to generate revenue.

It is recommended that the forage production farm be established on a commercial basis. This needs cooperation of (a) the White Nile Pump Schemes Corporation that have the land, and (b) the Range and Pasture Department at Kosti which have the qualified staff to run such a farm. The revenue generated from the selling of forage hay will cover the running expenses and recover the capital expenses in about eight years. At present, forage farms near Omdurman are making good profit and the livestock merchants using the NSR are buying forage at high prices.

CHAPTER VI

THE SOUTHERN STOCK ROUTE AND THE MARKETING OF LIVESTOCK

Marketing Needs

The SSR can play a major role for the nation's marketing system including the producers, the traders, the consumers, and the exporters. It can also play an important role for the Sudanese economy, the public interest, and the Government. This section considers the contribution of the route to meet the expanding local and export demand for livestock and the solution for the seasonality of supply. Furthermore, the unique and complementary roles of the route among other alternatives is considered.

The consumption of meat is rising locally and internationally due to increasing population and rising per capita income. In the Sudan, the consumption of livestock is expected to be about 1.45 million head of cattle in 1984/85 and to increase to about 1.85 million and 2.78 million in 1989/90 and 1999/2000 respectively. The consumption of mutton is expected to rise from 4.15 million head in 1984/85 to 6.04 and 12.05 million in 1989/90 and 1999/2000 respectively.*

The export markets which are good prospects for Sudanese livestock and meat trade are also expanding. The markets in Saudi Arabia, the Gulf States, and Libya have rising consumption due to the increasing population and the rise of purchasing power. There are also expanding markets among the traditional customers in Egypt, Lebanon, Jordan and some African countries. Both the expanding local and export consumption of livestock requires adequate and regular transportation of the animals from the producing areas to consuming centres and ports of exports. The means of transporting these animals have so far been inadequate and contribute to the persistent problem of seasonality and shortages.

While Sudanese household consumption of meat is nearly regular throughout the year, the supply of livestock is seasonal. During the rainy season, livestock find sufficient water and pasture near the markets of Nyala, Ed Daein, El Fasher, En Nahud, El Obeid, and others. Animals can therefore be sold in these markets in large numbers. During the six months (January to June) dry season, water, and pasture become inadequate and the nomads and their animals move southwards towards Bahr El Arab where there are no organized cattle markets. Accordingly, only a few animals are sold there while in the largest cattle producer market at Nyala sales also drop. In 1980, dry season sales amounted to only 24% of Nyala's total cattle sales. Again for the same year Ed Daein and El Obeid producer markets had dry season cattle sales of only 24% and 36% respectively. A similar seasonality situation prevails for sheep. During the dry season of 1981, Nyala, El Obeid and El Fasher had 31%, 26% and 29% respectively of the total sheep sales for that year.

*Arab Organization for Agricultural Development, Livestock and Meat Marketing, August, 1983 (in Arabic).

The seasonality problem is also reflected in consumer markets. The largest consumer market in Omdurman had 36% of its annual cattle sales and 37% of its sheep sales during the dry season of 1981. Due to dry season scarcity, the retail prices for beef in 1981 were between £S 2.0 to £S 3.0 per kilo. These prices, however, dropped to £S 1.6 during September to December as large cattle supplies arrived from Western Sudan. For the dry season of the same year, mutton prices were rising and ranged between £S 3.0 and £S 4.0 but dropped £S 2.4 during September to December, with larger seasonal supplies of sheep coming to the market.

The dry season scarcity of animals and higher prices present problems to the consumers who express their dissatisfaction in the newspapers, social gatherings, and complaints to the authorities. Consequently, the Government has been attempting to find solutions to the problem. However, most of these attempts have failed and the problems remain. The proposed SSR is envisaged to allow regular flows of livestock during the off-season. These flows should therefore put an end to the shortages and higher prices during the dry period.

The SSR also has an important role in expanding export markets in the Arab and African countries. The demand for livestock and meat in these countries is rising continuously. The imports of cattle in Saudi Arabia increased from 113,000 head in 1979 to 135,000 in 1981; in Kuwait from 29,000 to 32,000 for similar years. Libya's consumption increased from 176,000 in 1978 to 200,000 in 1981. Beef imports have also been rising in Saudi Arabia from 19,000 tons in 1978 to 46,000 tons in 1981. Libya's beef imports rose from 10,000 tons in 1978 to 18,000 in 1981. Live sheep and mutton imports in these countries have also been rising very fast.*

Most of the imports of the Arab countries are obtained from producing countries such as Australia, New Zealand, Bulgaria, and Somalia. These countries are able to supply live animals and meat in regular quantities and at competitive prices. The Sudanese exports have been meager at about 20 tons, 29 tons and 62 tons of beef and 25 tons, 4 tons and 7 tons of mutton for the years 1979, 1980 and 1981 respectively. The exports of livestock have been weak, especially in cattle, with 13,000, 13,000 and 12,200 head for the same years. Live sheep exports have been picking up significantly from 221,000 head in 1979 to 747,000 head in 1981. In view of the substantial livestock potential in Sudan, much greater meat and live animal exportation is expected. Several Arab and European investors aim to develop Sudanese livestock projects for export. The SSR can support the drive for investment by providing an extra outlet for livestock movement towards traditional export channels and new project sites.

The role of the SSR among other alternatives should be given special consideration, including a rehabilitated NSR, the railways, trucks, and steamers. The SSR's location is unique in that it passes close to rich animal stocks in western and southern Sudan. It also penetrates the Baggara dry camping areas as well as opens dry season trekking directly to market destinations. In comparison, dry season purchases along the NSR require "storing" until the rainy season. Such seasonal interruptions will not exist with the SSR.

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*Data for livestock and meat imports of Arab countries are obtained from FAO Trade Year Books for the years 1978 to 1982.

It has been observed that some merchants and traders have been deviating from the NSR and are already using some sections of the proposed SSR. Interviews with merchants and trekkers indicated that NSR conditions had become so bad that substantial expenditures on feed were required to bring the animals back to their weights. Consequently, merchants gave up parts of the northern route and preferred southern routes for trekking through Er Rahad, El Abbassiya, Kosti or continuing from El Abbassiya to Tendelti, El Dueim and finally Omdurman.

The other important alternative for livestock transport is the railway which starts from Nyala and passes by Ed Daein, Dabanousa, El Fula, Abu Zabad, Er Rahad, Umm Ruwba, Tendelti, and Kosti to Khartoum. The railway also branches in Kordofan southwards to Muglad, El Meiram and continues in southern Sudan to Wau. At present the railway suffers from insufficient capacity and weak performance including delays and interruptions due to rains and loss of goods. However, the Livestock Meat and Marketing Corporation and the International Bank for Reconstruction and Development plan a project to invest in expanding the railway so that livestock can be moved in specialized double decked wagons. Project implementation has started and livestock are now moved by rail under the special arrangements of the project. When the project is completed, substantial livestock can be moved from western and southern Sudan. However, the total burden of transporting the animals in large, complicated, and spread in space. By its location and capacity, the rail transport can only move the animals from areas lying near the railway line in Kordofan and southern Sudan. The location of the SSR starting from Birka Khadra and Kundi in southern Darfur enables it to tap the greatest potential of livestock from the large areas of animal concentration.

Potential Livestock Surplus

This section is concerned with livestock surplus with the purpose of considering potential numbers of animals to utilize the SSR. This involves estimating the off-take and consumption in the provinces which are expected to provide the animals to the route and investigating the sales and motivation for producers to sell. Furthermore, dry and wet season sales are scrutinized to trace the potential for livestock which can be trekked along the route.

The rate of off-take for cattle has been subject to variations between 7.5% for the IBRD in 1977 and 13% used by the Livestock Meat and Marketing Corporation (LMMC) in 1981. More recent rates include the Government rate of 9.0% for 1980/81, while the IFAD and FAO used 8% in 1981. The trend has been for lower rates and in view of the droughts during the seventies and eighties and the threatening mortality of animals, producers have had to reduce the pressure of stocks on pastures and the limited drinking water. Consequently the rate of 9.0% is used in this study for estimating the off-take of cattle since 1980/81. The off-take is further adjusted by subtracting cattle consumed in those provinces. The difference is the net surplus available for export and for consumption in Khartoum and the Central Region. The net surplus for 1981 amounted to 196,300 head in Southern Darfur, 116,500 head in Northern Darfur, 81,000 in Southern Kordofan, 116,3000 in White Nile, and a deficit of -14,200 head in Northern Kordofan. The deficit was covered from the surplus of Southern Darfur and Southern Kordofan. When the SSR is established with water, foodstuffs, veterinary services, and market facilities, more and more trekking

1) Cattle which use the NSR during December to March. The high mortality risk as a result of water shortages and denuded pasture in normal years plus drought conditions of recent years compel the livestock merchants to trek by the SSR;

2) Cattle purchased late in the wet season and during the dry season and "stored" around large towns and cities of western Sudan waiting to be moved when the rainy season starts.

Given cattle surplus figures and the earlier mentioned NSR dry season lag in trekking, there could be a potential of 68,700 head that would utilize the SSR from Southern Darfur and 42,600 from Southern Kordofan.

Cattle surpluses in southern Sudan are raised under different social conditions from those of the West. Due to adverse environmental and husbandry conditions, the southern rate of off-take of 7.48% is noted in Table 55. During the field work, the Team for this study encountered several herds of southern cattle moving from Bantiyo and Tonja to Kadugli, and from Ellini and Kaka to Abbassiya. Interviews with merchants confirmed their activities of buying southern cattle and using the two feeder routes which pass through Kadugli and Abbassiya. Due to their importance for Southern Kordofan and southern Sudan, these feeder routes should be incorporated into the SSR with water points, animal feed, veterinary services, and [illegible]ting facilities to stimulate more of the Upper Nile and Jonglei cattle for trade.

There are also variations in estimating off-take for sheep. The IBRD estimate was 23% in 1976; the LMMC, IFAD, and FAO estimates were 25% in 1981 while the Government estimate for the year 1980/81 was 23.5%, a figure which is used in this study. A similar approach to that of estimating the surplus of cattle is applied for sheep. The off-take for sheep is calculated for each province from the 1980/81 sheep population. The net surplus or deficit is obtained by deducting sheep consumption from the off-take. The results are shown in Table 56. Dry season sales in the major markets of El Obeid, Meliet, and El Fasher were 48% which amounts to about 192,000 head needed to be transported to Khartoum as well as export markets.

Sheep, unlike cattle, cannot walk long distances as they cannot stand hardship for long periods. Hence trucks and railways are the preferred transport means. Another disadvantage for sheep along the SSR is the distant location relative to Northern Kordofan and Northern Darfur sheep. However, some sheep do use the stock routes for tolerable distances and the improvements of the SSR should attract more and more sheep to be trekked for at least short distances. These comments equally apply to the sheep surpluses from White Nile and southern Sudan (see Table 56).

Producer Attitudes

Livestock sales along the SSR depend on the decisions of the producers on the one hand, and the merchants and traders on the other hand. This section concerns producer perspectives; the next section considers attitudes of merchants.

TABLE 55

CATTLE OFF-TAKE CONSUMPTION, AND NET SURPLUS FOR WESTERN SUDAN, THE WHITE NILE AND SOUTHERN SUDAN PROVINCES.

Province	(1) Cattle Population 1981(Head)	(2) Cattle Off-Take (Head)	(3) The Human Population 1981 (Number)	(4) Beef Con-sumption (kilos)	(5) Cattle for Consumption (Head)	(6) Net Surplus or Deficit (Head)
rthern Darfur	1,149,406	103,455	1,242,958	13,051,059	87,007	16,448
uthern Darfur	3,466,378	311,474	1,652,744	17,353,812	115,692	196,282
Kordofan	1,187,573	106,882	1,729,927	18,164,235	121,095	- 14,213
Kordofan	1,859,517	167,357	1,233,449	12,951,214	86,341	81,016
e White Nile	1,981,428	178,328	886,482	9,308,061	62,054	116,274
per Nile	1,809,748	133,921	767,052	8,054,025	53,694	80,227
nglei	1,779,917	131,713	771,453	8,100,257	54,002	77,711
hr El Ghazal	1,555,808	115,130	1,400,055	14,700,538	98,004	17,128
Buhayrat	887,985	65,711	724,992	7,612,416	50,749	14,962
stern Equat.	1,010,977	74,812	1,370,579	14,391,279	95,942	- 21,128
stern Equat.	291	21	346,776	3,641,148	24,274	- 24,253

(1) Cattle population source is the Ministry of Agriculture, Animal Bulletin of Animal Resources Statistics.

(2) The rate of off-take is 9 percent in Darfur and Kordofan and 7.4 percent in Southern Sudan.

(3) From the 1983 census, data adjusted.

(4) Beef consumption at 10.3 kilos per person annually.

(5) Average carcass weight of 150 kilos per animal.

(6) Surplus or deficit = cattle off-take minus cattle for human consumption in the same province.

TABLE 56

SHEEP OFF-TAKE CONSUMPTION, AND NET SURPLUS FOR WESTERN SUDAN, THE WHITE NILE AND SOUTHERN SUDAN PROVINCES.

Province	(1) Sheep Population 1981(Head)	(2) Sheep Off-Take (Head)	(3) The Human Population 1981 (Number)	(4) Mutton and Lamb Consumption (kilos)	(5) Sheep for Consumption (Head)	(6) Net Surplus or Deficit (Head)
Northern Darfur	1,574,154	363,630	1,242,958	3,604,578	240,305	123,325
Southern Darfur	1,375,916	317,837	1,652,744	4,792,918	319,531	- 1,694
N. Kordofan	2,759,124	637,358	1,729,927	5,016,788	334,433	302,905
S. Kordofan	1,926,996	214,136	1,233,449	3,577,202	238,467	- 24,331
The White Nile	2,456,526	569,537	886,432	2,570,798	171,387	398,150
Upper Nile	1,169,800	270,224	767,050	1,191,763	12,794	257,440
Jonglei	1,195,013	45,048	771,453	192,863	12,858	32,190
Bahr El Ghazal	802,124	185,291	1,400,056	350,014	23,334	161,957
El Buhayrat	372,037	85,940	724,992	181,248	12,083	73,857
Eastern Equat.	1,021,662	236,004	1,370,579	342,645	22,843	213,161
Western Equat.	1,418	328	346,776	86,694	5,780	- 5,452

(1) Sheep population source is the Ministry of Agriculture, Annual Bulletin of Animal Resource Statistics, 1980/81, p. 1.

(2) The rate of off-take is 23.2 percent for all provinces.

(3) From the 1983 population census adjusted for 1981.

(4) Mutton and lamb consumption at 2.9 kilos for North Sudan and 2.25 kilos for Southern Sudan, i.e., consumption per person.

(5) Average carcass weight of 15 kilos per animal.

(6) Surplus or deficit = sheep off-take minus sheep for human consumption in the same province.

The new route provides opportunities for producers to sell increasing numbers to meet rising local and export demands. Furthermore, the new route with its facilities can contribute towards solving the producers seasonality problem. Table 57 indicates the intensity of seasonal fluctuation in the two largest markets in western Sudan.

TABLE 57

WET AND DRY SEASON SALES
IN NYALA AND EL OBEID MARKETS

	Dry season sales 1981	Wet season sales 1981
Nyala market:		
Cattle	24%	76%
Sheep	31%	69%
El Obeid market:		
Cattle	36%	64%
Sheep	26%	74%

Source: Calculation from data supplied by local council authorities during the field work by the Team of this study.

Under the present pattern of seasonality in sales, these two markets provide the major outlets for producers. During the dry season, the producers still need to sell part of their animals in the markets nearer to their southern migration limits, as reflected by the data in Table 58:

Similar sales patterns are confirmed for the same markets in other years. The new SSR will help to expand this market tendency for selling and buying during the dry season and allow the southern merchants to trek cattle even in the dry season.

Some writers, planners, and government executives maintain that nomads are reluctant to sell their animals. One view holds that during the dry season, the animal is weak and is bound to fetch a low price. This implies that the producer keeps such animals under improvement so as to attain higher prices. Such a situation can be true for some animals, but sale of a substantial number

TABLE 58

WET AND DRY SEASON SALES: SOUTHERN MARKETS

	Dry season sales 1981	Wet season sales 1981
Kadugli		
Cattle	70%	30%
Sheep	NA	NA
Abbassiya		
Cattle	44%	56%
Sheep	61%	69%
Kosti		
Cattle	56%	44%
Sheep	50%	50%

Source: Calculation from data supplied by local council authorities during the field work by the Team of this study.

A more balanced view, therefore, suggests that although producers may keep large numbers of animals for prestige purposes, they still maintain a commercial orientation. Hunting Technical Services investigated the composition of 51 cattle herds in Southern Darfur. The results revealed that 60% of the herd was female while only 31% was male. The females are clearly kept for production requirements. The age composition of the males is also of interest:

Below 7 months	7 months to 2 years	2-2 1/2 years	21/2 - 31/4 years	31/4 - 4 years	Over 4 years	Total
8.77%	8.4%	4.41%	3.07%	2.69%	3.86%	3.2%

Source: Hunting Technical Service. Adams, M.E.: "The Supply of Cattle from Southern Darfur." The Sudan Journal of Veterinary Science and Animal Husbandry, pp. 49-56.

It can be seen that 17.17 percent of the total herd is made up of males below two years of age, i.e. below the marketable age. For the remaining males, only [illegible] ercent of the total herd were between 2 years and 4 years and these were

the heaviest weights may only be reached at 6 years of age. This situation of keeping males under fattening also gives the producer the opportunity to maneuver with the market. He can sell some of the males underweight if the price is attractive and remunerative. With poor market conditions he can keep some of the males to fatten to make them more acceptable to the market.

Market sales also confirm the nomads' marketing practices. Producers' market data show that sales in all years consist mostly of bulls while cows and calves are sold in limited numbers. This structure of animal sales applies to all major producer markets like Nyala and El Obeid or primary ones like Babanousa and Kadugli. At Nyala market, during the years 1972 and 1973, the sale of bulls ranged between 50% to 73% of total market sales; that of cows amounted to between 12% to 28% while that of calves to between 15% to 28% (see Table 59). The same pattern of sales i.e. mainly the sale of bulls with some cows and calves is observed in Babanousa and Kosti (1982-83).

TABLE 59

NYALA MARKET SALES OF BULLS, COWS AND CALVES DURING 1972 TO 1973. (PERCENTAGES)

Period	Year	Bulls	Cows	Calves	Total
		(Percentages)			
Jan.-March	1972	62	15	23	100
Apr.-June	1972	73	12	15	100
July-Sept.	1972	50	22	28	100
Oct.-Dec.	1972	53	28	19	100
Jan.-March	1973	73	10	17	100
Apr.-June	1973	68	19	13	100
July-Sept.	1973	64	18	18	100
Oct.-Dec.	1973	60	24	16	100

Source: Calculated from Nyala Livestock Market Records 1972 and 1973.

TABLE 60

BABANOUSA MARKET SALES OF BULLS, COWS AND CALVES DURING 1982 AND 1983. (PERCENTAGES)

Period	Year	Bulls	Cows	Calves	Total
Jan.-March	1982	65	28	7	100
Apr.-June	1982	78	20	2	100
July-Sept.	1982	Na	Na		
Oct.-Dec.	1982	69	30	1	100
Jan.March	1983	87	11	2	100
Apr.-June	1983	48	41	11	100
July-Sept.	1983	44	29	27	100
Oct.-Dec.	1983	29	34	4	100

Source: Calculated from data supplied by Local Council Authorities.

The producers attitudes and intentions for selling can also be seen from the numbers of livestock they offer in their primary and major markets. For all years and markets, the producers offered livestock which by far exceeded the actual sales. The percentage of the livestock numbers that entered the markets of Nyala, El Muglad, El Obeid and Kosti to those sold is provided in Tables (62 -63) for the years 1979/80 to 1982/83. At Nyala, the percentage of cattle entered to those sold was 146% in 1980/81 and was at its highest at 224% in 1981/82. At Muglad market, there was an average of 167% of cattle entered to those sold during the period 1980/81 to 1982/83. At El Obeid market, the lowest was 185% in 1979/80 and the highest was 212%. Kosti also gives nearly similar results. With sheep at Nyala the percentage of those entered to those sold was 149% in 1982/83 and highest in 1980/81 when it was 221%. For El Muglad there was an average of 162% for both the years 1980/81 to 1982/83 while El Obeid percentages ranged between 135% in 1981/82 and 451% in 1980/81.

TABLE 61

KOSTI MARKET SALES OF BULLS, COWS AND CALVES DURING 1982 AND 1983. (PERCENTAGES)

Period	Year	Bulls & Cows	Calves	Total
Jan.-March	1982	89	11	100
Apr.-June	1982	82	18	100
July-Sept.	1982	89	11	
Oct.-Dec.	1982	93	7	100
Jan.March	1983	94	6	100
Apr.-June	1983	88	12	100
July-Sept.	1983	89	17	100
Oct.-Dec.	1983	94	6	100

Source: Calculated from data supplied by Local Council Authorities.

TABLE 62

NUMBER OF CATTLE ENTERED THE PRODUCERS MARKETS AND NUMBER SOLD
(IN THOUSANDS HEADS)

	Nyala			El Muglad*		
	Entered	Sold	%**	Entered	Sold	%**
1979/80	54.8	31.6	173	Na	Na	
1980/81	49.6	33.9	146	1.4	0.8	175
1981/82	74.8	33.4	224	2.1	1.3	162
1982/83	67.9	44.6	152	3.1	1.9	163

	El Obeid			Kosti		
	Entered	Sold	%**	Entered	Sold	%**
1979/80	54.0	29.2	185	47.7	38.7	123
1980/81	70.6	33.3	212	67.9	48.0	142
1981/82	73.9	37.2	199	161.2	94.9	170
1982/83	88.4	45.3	195	71.7	53.5	134

Source: (1) Livestock and Meat Marketing Corportation (LMMC) Khartoum, 1984

(2) *Collection from Local Council Authorities during field work by the Team of this study.

**Percentage of entered to sold

TABLE 63

NUMBER OF SHEEP ENTERED THE PRODUCERS MARKETS AND NUMBER SOLD
(IN THOUSAND HEADS)

	Nyala			El Muglad*		
	Entered	Sold	%**	Entered	Sold	%**
1979/80	65.5	34.4	190			
1980/81	93.0	42.0	221	2.5	1.5	167
1981/82	72.7	35.2	207	3.8	2.3	165
1982/83	94.3	63.2	149	5.5	3.6	153
	El Obeid			Kosti		
	Entered	Sold	%**	Entered	Sold	%**
1979/80	138.4	59.7	232	130.7	89.2	147
1980/81	338.4	75.0	451	129.8	88.4	147
1981/82	144.8	107.6	135	683.1	393.3	174
1982/83	172.2	125.2	138	179.2	141.5	127

Source: (1) LMMC, Khartoum, 1984.

(2) *Local Council Authorities, El Muglad

**Percentage of entered to sold

Nomad sales respond to several factors. The most important include the price they receive for their animals, rainfall, and the amount of grain harvested. There have been controversies concerning the nomads' negative or positive response to price. The former is said to be due to the limited and fixed cash required to cover the nomads' purchases. The assumption of fixed cash is retreating under the nomads' rising requirements for a variety of goods such as traditional and fashionable clothing, footwear, radios, and tape recorders, etc. They also need cash to pay for their settled members of the family and to purchase horses, gold, silver and to meet educational expenses.* The rains, drought, and grain harvested also influence sales in the same direction. Poor rains lead to poor supply of drinking water, pastures, and grain harvested. Such conditions compel the nomads to sell more of their

*Detailed nomads expenditures were collected in interviews with the nomad producers during field work in the project area.

animals to reduce pressures on poor pastures and water supply. More sales also yield more revenue to buy grain to augment the poor harvest. This sequence of events swings in an opposite direction with good rainfall which leads to good pastures and grain harvest. Consequently, good conditions allow nomads to reduce sales.

The two most influential factors on animal sales are therefore price and rainfall. Several attempts were made to determine the livestock supply function. Results revealed a positive relationship between supply and price and an inverse relationship between supply and rainfall. The relationship was estimated by Khalifa and Simpson (1970) and supply was proved to be elastic to price changes.*

For this study, more recent data are used to estimate the relationship between supply and deflated price of some major markets for the period 1958 to 1976. The results follow:

The coefficients of correlation between supply and deflated price:

	Cattle	Sheep
Nyala	0.5	0.5
El Obeid	0.5	0.4
Kosti Market	0.3	0.1

Animal slaughterings give a stronger relation than that of supply from individual producer markets. In conclusion, eleven out of twelve estimates indicate the positive relation between supply and producer price.

Marketing Networks and Transportation Cost Advantages of the SSR

The extent of trade and the growth of markets along the route determine the degree of the route's utilization. It is the trekking of livestock which ultimately measures the SSR's usefulness.

Livestock marketing includes buying, selling, transporting, risk bearing, and other marketing functions. These activities are difficult for the producers to pursue, given the demands of their nomadic life and tasks required in animal husbandry. Hence, very few producers carry on marketing activities. Instead they leave marketing to the merchants, agents, traders, and brokers.

Livestock merchants are the largest intermediaries in the trade and maintain offices in towns and cities. The largest merchants who sell on the domestic market and for the export trade live in Omdurman. These merchants deal with agents who are located in the important producer areas. The merchant provides capital for purchasing and transporting the animals. The agent arranges for buying the animals, assembling them in herds, and for trekking

*Khalifa, A.H. and Simpson, M. "Perverse Supply in Nomadic Societies." Oxford Studies, Vol. 1, No.1, 1972.

along the route to market. The agent is paid a specific amount of money per head for his services. Merchants continue the arrangement to sell the animals directly or keep them for fattening. These merchants, though few in number, maintain an active level of operation, and play a dominant role in the livestock trade.

The traders work independently and are numerous in cities, towns, and villages. They work on a small scale with limited capital. They buy livestock from the producer and sell it to the large merchant agents or to other traders. They are also well known for transferring the animals for short distances between villages and towns to benefit from price differences. For this latter activity they are called "Galaba." These traders are in a position to increase levels of trading activity if they had better access to credit and facilities.

Brokers act between the producers and the traders or merchant agents. They convey information about animal numbers, ages, specifications, and prices which help sellers and buyers to agree. The broker earns a sum of money for this job.

To investigate merchant and trader practices, interviews were carried out among a sample of 35 merchants and traders. They included individuals from Omdurman, Nyala, Ed Daein, Babanousa, El Muglad, El Meiram, Kadugli, El Abbassiya, Tendelti and El Daein.* Almost all thought the route and its pasture, water points, foodstuffs, veterinary services, and security measures would be most desirable during winter and summer periods. However, they expressed doubts and worries about security problems as the route crosses areas with severe tribal conflicts. Furthermore, the animals would be subject to theft along many sections of the route. Resolution of these problems requires money, thereby raising questions of comparing alternative costs and modes of trekking cattle. The principal choices include both the SSR and NSR as well as the railway.

The expenses are based on trekking from December to June. For the wet season (June-September), the animals migrate northwards using the NSR. The costs of utilizing the railways and trucks are also for the dry months i.e. December to June.

The cost items shown in Tables (64-66) include payments for herdsmen and their food, animal foodstuffs, water, loading and unloading, veterinary services, railway and truck fares, animal losses, and other expenses.

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*The merchants and traders survey was carried out during November - December 1983 when the Team of this study was doing field work in the White Nile Province, Kordofan, and Darfur Regions.

TABLE 64

THE COSTS OF UTILIZING THE SOUTHERN VERSUS THE NORTHERN STOCK ROUTES FOR TREKKING

Cost item for 50 head of cattle for 60 days		The Southern Stock Route (Birka Khadra-Omdurman) December-June	The Northern Stock Route (Nyala-Omdurman) December-March
		(£S)	(£S)
1.	Three herdsmen	360.0	360.0
2.	One chief herdsman	180.0	180.0
3.	Cattle assembly expense	40.0	40.0
4.	Herdsmen food and drink	360.0	360.0
5.	Water for the cattle[1]	108.2	375.0
6.	Feeding the cattle[2]	750.0	2000.0
7.	Salt	100.0	100.0
8.	Veterinary	25.0	25.0
9.	Animal losses (5% for the Southern and 10% for the Northern Route)	750.0	1500.0
10.	Loss of weight and reconditioning	100.0	1000.0
11.	Herdsman use of a horse and a donkey	140.0	140.0
	TOTAL	2913.2	6080.0
	Cost per head	£S 58.3	£S 121.6

1. According to merchants, cattle drink every other day. The rate per animal per day is U.S.$ .05, according to calculations in Chapter 4.

2. Feed cost along the NSR is more expensive due to more days trekking and the long cost of transporting straw from Omdurman.

TABLE 65

THE COST OF UTILIZING THE LMMC WAGONS FOR CATTLE

	A wagon (one deck) for 22 bulls for 3 days from Nyala to Soba (£S)	A wagon (one deck) or 100 sheep for 3 days from Nyala to Soba (£S)
Wagon fare	1400.0	900.0
One herdsman and food	45.0	45.0
Loading and unloading	15.0	10.0
Animal feed and drink	40.0	40.0
LMMC charges	25.0	25.0
Herdsman return trip	26.0	26.0
Animal losses 1/2% of herd	33.0	35.0
Instruments	25.0	15.0
TOTAL	£S 1609.0	£S 1096.0
Cost per head	73.1	11.0

The comparison reveals that from December to March, the cost per head of cattle is £S 58.3 for using the SSR and £S 121.6 for using the NSR at 1983 prices. The cost of cattle movement by the NSR is more expensive by 108.6%. This is attributed to the higher animal losses and more costly foodstuffs* and water along the NSR. The low cost of water and feed in the SSR will be possible under the investments and arrangements of this project. During the period April to June the NSR is almost unused due to the harsh environmental conditions which cause severe animal losses.

The railways provide a quick means of transport. Animal losses and herdsmen expenses are therefore, reduced substantially. On the other hand, the railway fare adds greatly to costs. Recently the railway charged £S 1,400 for 22 bulls. The cost per head for utilizing the railway therefore amounts to £S 73.1 which is also more expensive than using the SSR by 25%. Trucks are not used for moving cattle long distance due to physical damage to the animals caused along the rough roads.

The results from these comparative costs show the balance clearly in favour of using the SSR from December to June. Merchants and traders of cattle will be tempted by cost reduction to prefer the SSR.

*Omdurman livestock merchants who were interviewed reported that they had sent lorries from Omdurman, loaded with straw, to feed cattle at El Shigeig on the NSR. These cattle suffered from the few weeks trekking along that route during

TABLE 66

THE COSTS OF TRANSPORTING SHEEP BY LORRY AND BY THE STOCK ROUTES FROM UMM RUWABA TO OMDURMAN

Cost item		Proposed Southern Stock Route 100 Sheep for 15 days	Present Unimproved Southern Stock Route 100 Sheep for 15 days	By lorry 45 Sheep for one day
		£S	£S	£S
1.	Two herdsmen	60.0	60.0	50.0
2.	One chief herdsman	45.0	45.0	75.0
3.	Herdsmen food and drink	90.0	90.0	10.0
4.	Lorry payment	--	--	170.0
5.	Water for sheep	10.8	37.5	--
6.	Feeding	200.0	200.0	6.0
7.	Veterinary service	25.0	25.0	12.5
8.	Animal losses (3% for proposed SSR and 10% for the present unimproved southern route)	210.0	700.0	0.0
	TOTAL	642.8	1157.5	325.5
Cost per head		6.4	11.6	7.2

With sheep, the situation is different. Sheep, unlike cattle, cannot stand trekking long distances. They are therefore trekked for shorter distances by trucks and railways. Tables 64,65,and 66 show a comparative study of costs calculated for the SSR, NSR, trucks, and the railway. The costs of transporting one sheep from Umm Ruwaba to Omdurman by the proposed SSR, the present SSR (i.e. without improvement) and the truck are £S 6.4, 11.6 and 7.2 respectively. The present SSR is more expensive as it involves more animal losses due to limited pastures and water. Truck transport also costs more due to payment for the truck and the accompanying trader or agent.

SSR Marketing Benefits

The previous section documents economic benefits of the proposed SSR in comparison with alternative means of transport. These cost advantages should trigger benefits to the producers, merchants, stockmen, and consumers, as well as the Sudanese economy. The effects on producer, profit, livestock off-take, and new markets will be examined. If cost reductions and higher profits can be passed on to the producer, livestock supplies will be stimulated. Previous studies have revealed an elastic supply, with projected income as the most significant variable. New incomes derived from cost reductions are considered at three possible levels: 20%, 15% or 10% increase in producer income, based on 1980/81 livestock population data.

TABLE 67

PROJECTED INCREASE IN OFF-TAKE BECAUSE OF INCREASED PROFITS

	Producer income increase due to route transport savings	Cattle off-take in western Sudan and White Nile in 1980/81	Estimated increased off-take due to new income	Net increase in off-take
High projection	20%	868,000	1,041,600	173,600
Medium projection	15%	868,000	998,200	130,200
Low projection	10%	868,000	954,800	86,800

Projected increases in off-take, by different provinces is shown in Table 67.

However, observations of local markets indicate that all savings in transport costs will not be passed on to producers. Middlemen traditionally play a key role as they buy from the producer, negotiate for transport services, and sell to retailers who sell to consumers. Market data showing producer offers and middleman purchases indicate that only part of these offered are actually purchased Table 68. The average percentage sold is 57 for Nyala, 60 for El Muglad, and 51 for El Obeid markets. There are even lower percentages during the dry season with El Abbassiya market summer sales at 50% in 1981 and 55% in 1982 of those offered.

When the SSR is established the transport cost should decrease and middlemen including merchants, traders, and new investors should offer higher prices to attain greater cattle purchases. Consequently, more animals will be offered and the percentage of sales to numbers offered may change. How they will change is not completely clear.

TABLE 68

PERCENTAGE OF CATTLE SOLD TO CATTLE OFFERED (IN PERCENTAGE)

	Nyala	El Muglad	El Obeid
1979/80	58	Na	54
1980/81	68	57	47
1981/82	45	62	50
1982/83	66	61	51
Average	57	60	51

Merchants are few in number and operate large scale procurement and trade. Their oligopolistic position in the market is maintained through family business with access to large sources of capital and experience acquired over decades. The livestock trade has yielded large profits which have enabled merchants to diversify their activities to other branches of trade. As the local consumer demand for beef is generally judged to be inelastic, the merchants may be reluctant to supply greater quantities of beef as new supplies could weaken livestock prices. But the merchants' position will be different towards the export market which is expanding and where elasticity of demand for beef is high. However, merchants must also face keen competition from Somalia, Australia, Bulgaria, and other suppliers.

The traders or "Galaba" also operate with substantial experience and knowledge of the trade. With limited capital, an individual trader buys and markets a few cattle. However, there are many traders in villages, towns, and cities. As livestock supplies increase during the wet season, the traders earn profits on the increased trade. Through competition among themselves they offer higher prices to producers and lower prices to buyers. Consequently, trader profit percentages shrink though total profits may actually rise. During the dry season, their activity declines as the animals move to the remote Bahr El Arab. However, the SSR will change the traditional seasonality of the trade. Hence, the traders' of volume is expected to continue during the dry season with favourable effects on producer prices, livestock off-take, and consumer price.

Investors in livestock projects are newcomers to the trade and industry e.g. Seleit, the Arab Sudanese Livestock Development Company and others. They have substantial capital resources, but limited experience and knowledge of purchasing and trade. Their aim is to sell meat and live animals, partly in the local market but mostly in export markets. With these targets the new investors seek regular supplies of animals during both the wet and dry seasons. The SSR will be the basic factor to enable them to acquire summer supplies. Hence they will add to the favourable effects for higher producer prices and greater livestock off-take.

For the stockmen or herdsmen, the SSR will be extremely useful. Previously their employment has been limited to the wet season period after which they seek other jobs. With the establishment of the SSR they can continue in livestock trekking throughout the year. However, in the short run the demand for their labor will increase leading to higher wages. In the long run, more herdsmen will be employed and therefore the SSR will provide greater employment opportunities for the stockmen.

The final determination of how the cost savings will be distributed among producers, merchants, traders, trekkers, consumers, and new investors will adjust as market forces evolve. The main point is that the overall impact will be one of higher off-take, higher production, and increased benefit to virtually all participants in the system.

Increased volumes of cattle will almost certainly create favourable conditions for new markets. The present pattern of market locations in Southern Darfur serves the NSR. These markets are far away from the SSR with animal sales mainly during the wet season. At present, markets located along or near the SSR are few and have limited livestock sales. However, SSR markets have substantial potential for growth as SSR services should attract dry season sales amounting to as many as 100,000 head, estimated as follows:

1.	Southern Darfur current dry season sales (1980/81)	68,700 cattle
2.	Southern Darfur estimated sales increase due to SSR	31,200 cattle
	TOTAL estimate	99,900 cattle

This potential will stimulate the growth of markets in Birka Khadra, Lake Kundi and also in some new localities between Birka Khadra and the eastern boundary of the province. There will also be growing markets at Sinun, Safaha, Sahla, and Kubu. The sales in camps among producers, traders, agents, and brokers will flourish.

Sheep will also be sold in these markets. The sources for marketable sheep come from Southern Darfur and Bahr El Ghazal Provinces. As previously mentioned, the sheep will be trekked for short distances along the SSR.

Southern Kordofan also has a large number of current and potential markets. Important markets are located in El Meiram, Lagawa, Kadugli, Abu Kharshola, Shirkeila, and El Abbassiya. At present El Meiram is an important livestock market due to the railway station and the proximity of nomadic camping areas. The importance of other markets is reflected by their livestock sales. Kadulgi is the largest with 20,000 cattle sales in 1980, and 21,300 in 1981. Kadugli market also had 3,500 sheep sales in 1981. Lagawa market sales have been growing in recent years and reached 6,100 cattle and 7,100 sheep in 1982/83. El Abbassiya sales amounted to 9,700 cattle and 1,300 sheep in 1981. Abu Karshola which is less important had about 4,000 cattle and 3,000 sheep sales in 1981.

These and other small markets have been attracting livestock from the nomad producers. Traders and a ents bought t : anima ve -
to Obeid

place along the NSR to Omdurman. A substantial number of animals go to Umm Ruwaba, Tendelti, Kosti and ultimately to the consumer markets of El Gezira and Khartoum. Some animals are transported by railways and lorries to the consumer markets.

Traders also purchase the animals from sites which are further south, closer to Bahr el Arab. These sites include the nomad gathering areas in Nyama, Lake Keilak, Lake Abyad and other popular camping places. From these points cattle are gathered and moved to El Meiram, Kadugli, Lagawa, and El Abbassiya. During the dry season and with the services of the SSR, herds will be moving from those markets along the SSR rather than along the NSR.

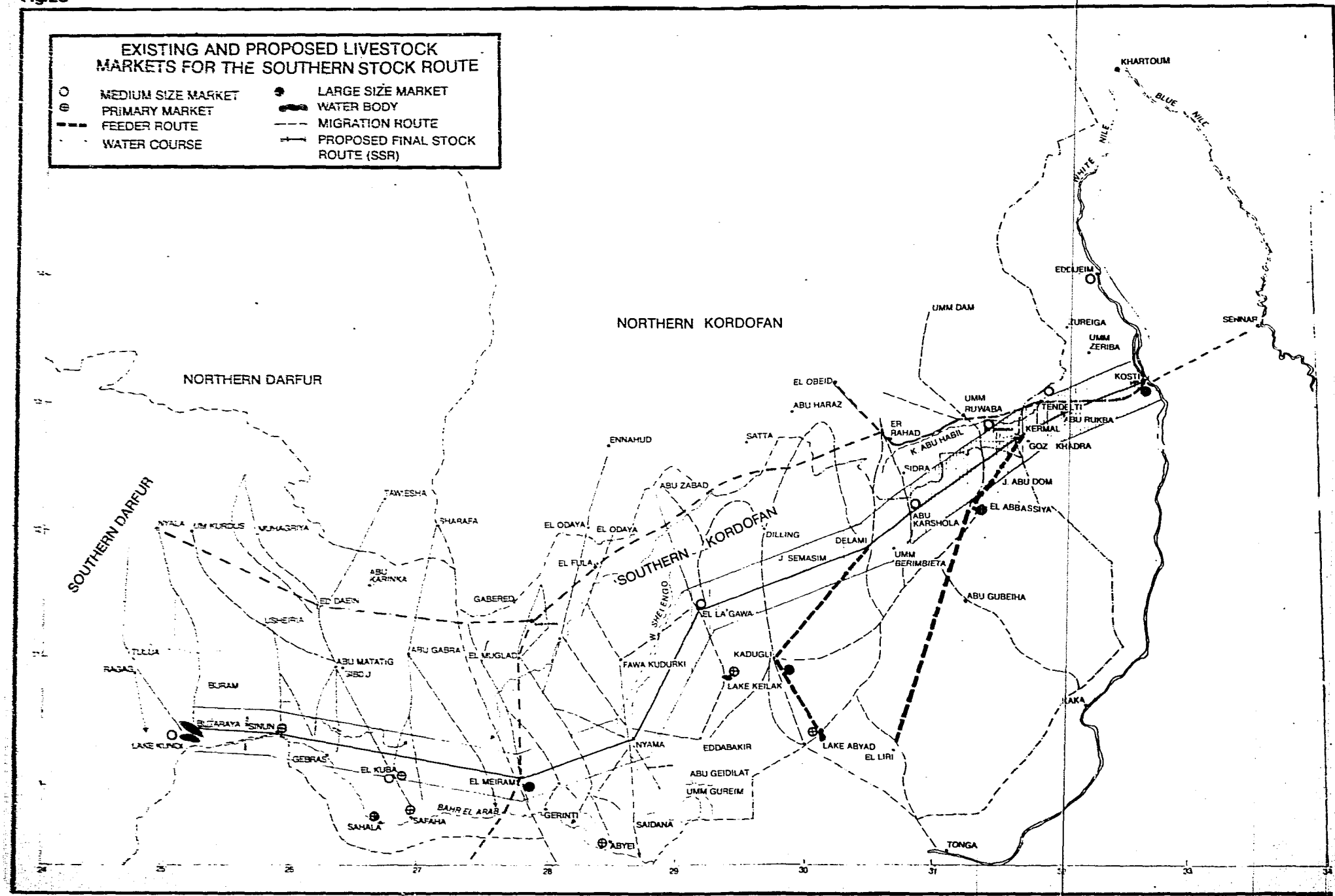
The markets of Southern Kordofan within reach of the SSR will be gaining importance and size. There will be more livestock coming through them from the following potential cattle surplus:

1.	Southern Kordofan current winter and dry season cattle sales (1980/81)	42,600 cattle
2.	Estimated increase of Southern Kordofan sales due to SSR	16,700 cattle
	TOTAL estimate	59,300 cattle

Furthermore, there is also a major potential surplus coming from Upper Nile and Jonglei Provinces. Despite the often-stated opinion that tribesmen of the South do not sell their animals, there have been considerable numbers which come from the South through feeder routes to Kadugli and Delami and from Elliri to Kadugli, Abu Gibeiha, El Abbasciya, and Kermal should receive services similar to those proposed for the SSR including water points, veterinary services, security arrangements, and market facilities. These services will stimulate more and more of the southern livestock potential surplus to proceed to Southern Kordofan markets and from there along the SSR to Kosti and finally to the consumer and export markets.

The important markets of White Nile Province are Kosti, El Dueim, and Tendelti from where the animal are moved to Omdurman and Gezira. These markets have had increasing sales of livestock during the seventies and eighties. In 1982/83 Kosti sales were 53,500 head of cattle out of 71,700 which entered the market. Sheep sales were 141,500 out of 179,200 which entered the market. El Dueim market sales during the early eighties were about 7,000 cattle and 30,000 sheep annually. Tendelti recorded a few thousand cattle and sheep sales.

When the SSR is established, these markets along the eastern portions of the SSR, namely Kosti, Tendelti and others, unlike the western SSR markets, will be outlets not only for dry season sales but also for the wet season. The present potential for cattle sales from White Nile is 116,200. Further, cattle off-take will be stimulated due to SSR benefits, to an estimated off-take of 17,800. Moreover, the White Nile markets will also receive dry season livestock trekked by traders along SSR. Due to the substantial increase in livestock numbers expected in the White Nile markets, adequate market facilities, veterinary [illegible]s, and feedstuffs should be made available.


EXISTING AND PROPOSED LIVESTOCK MARKETS FOR THE SOUTHERN STOCK ROUTE
MEDIUM SIZE MARKET
PRIMARY MARKET
FEEDER ROUTE
WATER COURSE
LARGE SIZE MARKET
WATER BODY
MIGRATION ROUTE
PROPOSED FINAL STOCK ROUTE (SSR)
NORTHERN KORDOFAN
NORTHERN DARFUR
SOUTHERN DARFUR
SOUTHERN KORDOFAN
KHARTOUM
BLUE NILE
WHITE NILE
EDDUEIM
SENNAR
UMM DAM
TUREIGA
UMM ZERIBA
KOSTI
EL OBEID
ABU HARAZ
UMM RUWABA
TENDELTI
ABU RUKBA
ER RAHAD
KERMAL
K. ABU HABIL
GOZ KHADRA
SIDRA
J. ABU DOM
EL ABBASSIYA
ABU KARSHOLA
UMM BERIMBIETA
ABU GUBEIHA
DELAMI
J SEMASIM
DILLING
SATTA
ENNAHUD
ABU ZABAD
EL ODAYA
EL FULA
TAWESHA
SHARAFA
ABU KARINKA
ED DAEIN
GABERED
LISHERIA
ABU GASRA
EL MUGLAD
ABU MATATIG
GISO J
TULUA
RABAS
BURAM
BUTARAYA
SINUN
LAKE KUNDI
GEBRAS
EL KUBA
EL MEIRAM
SAHALA
SAFAHA
BAHR EL ARAB
GERINTI
ABYEI
SAIDANA
NYAMA
EDDABAKIR
ABU GEIDILAT
UMM GUREIM
FAWA KUDURKI
W. SHELENGO
EL LA'GAWA
KADUGLI
LAKE KEILAK
LAKE ABYAD
EL LIRI
LAKA
TONGA
24
25
26
27
28
29
30
31
32
33
34

In conclusion, the total number of cattle expected to utilize the SSR on their way to Omdurman are:

	Estimated Cattle Numbers based on 1980/81 data
Southern Darfur Province	99,900
Southern Kordofan Province	59,300
The White Nile Province	134,000
TOTAL	293,200

Marketing Recommendations

1. The establishment of a Southern Stock Route is recommended because the route will:

   a) provide an important link with the expanding markets for livestock and meat inside and outside the Sudan,

   b) be an important outlet for livestock surpluses which are expected to use the whole route or sections of it,

   c) play the vital role of attracting and stimulating dry season livestock sales to solve the problem of summer livestock shortages for domestic and export markets attributable to the seasonality of present livestock supply,

   d) be the least expensive means of transport during the dry season while other means like the NSR, the railway, and trucks are much more expensive.

2. Although the cost reduction benefits of the SSR may result, through market forces, in higher producer prices, public policy should be formulated to assure higher prices for the producers.

3. To facilitate the buying and selling of animals along the proposed route, markets should be organized and supported with veterinary services, water points, pastures and feed, and security arrangements.

4. Location of these livestock markets should be based on the number of livestock in the sections and districts through which the route passes. Market buildings, arrangements for auctions, personnel, and facilities should be allocated accordingly.

5. Although Southern Darfur Province has the highest off-take, its markets on the SSR are few. Larger markets need to be organized at or near Birka Khadra, Lake Kundi and Safaha. There can also be more markets for intermediate sites between Birka Khadra and the eastern boundary of Southern

6. In Southern Kordofan, the livestock off-take is substantial. Markets need to be organized along or near the SSR and provided with facilities. These sites are El Meiram, Lagawa, Kadugli, Abu Karshola, Shirkeila, and El Abbassiya. The livestock markets of Kadugli and El Abbassiya should receive special attention as they lie on the feeder routes which link the SSR to southern Sudan livestock sources. Nomad producers gathering sites at Abyei and similar places should also receive services to stimulate supply to the SSR and its feeder routes.

7. In White Nile Province, Kosti market receives LMMC support, but Tendelti and El Duiem markets need better organization to handle larger animal sales not only from White Nile Province but also from western Sudan.

8. The small traders who buy livestock from producers for movement to markets along or near the SSR should be helped and encouraged by means of lending credit and providing market facilities which enable them to pursue their activities.

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ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE:

Southern Darfur and Northern Kordofan

The following information has been assembled from records available with various offices of the National Authority for Water Development. Although the team did not visit each wateryard, it is believed that the information is generally up-to-date as of 1984.

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: SOUTHERN DARFUR

ial	Location Name	National Well No.	Coordinates		Year Com-pleted	Total Depth m.	Static Water level m	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
			Long.	Lat.						Type	Capac-ity m^3/h	Condi-tions	Type	Condi-tion	Capac-ity m^3/h	Condi-tion	
1	Baggara I	2736	24-55	10-18	68/69	93.8	53.3	Low									
	" II	4346	" "	" "	71/72	98.5	46.6			Edeco	4.54	Good	Lister	Fair	50	Good	
2	Amergu I	2737	25-21	10-29.5	68/69	368.2	70.1			"	4.54	Good	"	Fair	50	Good	
	" II	5278	" "	" "	71/72	304.8	54.1			Schoeller	5.45	Good	Torpedo	Fair	-		
3	Abu Rega	3305	25-20.5	10-28	69/70	274.2	54.9		380	"	5.45	Good	"	Fair	50	Good	
4	Al Amud ElAkhaddr I	3306	24-37	10-22	69/70	272.2	103.6			Edeco	4.54	Good	Lister	Fair	50	Good	
	" " " II	5284	----	----	71/72	243.0	64.8			Schoeller	5.45	Good	Torpedo	Fair	-		
5	Hineiga I	3307	25-04	10-40.5	69/70	201.2	64.0		340	NO INFORMATION AVAILABLE							
	" II	5905	" "	" "	72/73	169.0	68.4	5.4		Edeco	4.54	Good	Lister	Good	50	Good	
6	Wad Haggam I	1176	24-43	10-42	60/61	199.0	88.4	5.5		Schoeller	5.45	Good	"	Good	-		
	" " II	1252	" "	" "	61/62	309.0	79.2	5.5		"	5.45	Good		Good	-		
	" " III	4345	" "	" "	70/71	309.4	-			Edeco	4.54	Good		Fair	50	Good	
7	Ghibebeish I	2181	24-54	10-34	67/68	103.6	-			Schoeller	5.45	Good	[illegible]	Fair			
	" II	2181A	" "	" "	67/68	145.1	67.1	6.5									
	" III	5270	" "	" "	71/72	134.1	54.9			Schoeller	5.45	Good	Torpedo	Fair	50	Good	
8	Geleizan I	2187	24-57	10-33.5	67/68	137.2	73.2	v.low		NOT YET EXPECTED							
	" II	4126	" "	" "	70/71	305.4	48.0	14.4		Schoeller	5.45	Good	Torpedo	Fair	50	Good	
	" III	-	" "	" "	71/72	230.1	48.3			Schoeller	5.45	Good	Torpedo	Fair	50	Good	
9	Tweifera I	4124	25-21	10-30	70/71	195.1	56.7	14.4	190	ABANDONED							
	" II	4536	" "	" "	70/71	39.0				NO INFORMATION AVAILABLE							
10	El Hallufa I	4127	25-05	10-27.5	70/71	292.9	54.2	4.8	200								
	" II	5296	" "	" "	71/72	304.8	50.9			Schoeller	5.45	Good	Torpedo	Fair	50	Good	
11	Ligedeiba	4166	24-44	10-35	70/71	368.2	70.6	14.4	330	"	5.45	Good	"	Fair	50	Good	
12	Goweheina	4167	24-43	10-31.5	70/71	219.5	69.0	14.4	480	"	5.45	Good	"	Fair	50	Good	
13	Mellem	4992	24-54	10-40	70/71	224.6	70.4	14.4	540	NO INFORMATION AVAILABLE							
14	Ragaba Ayadi	5244	24-59.5	10-30.5	71.72	307.2	-										
15	Seroub I	5899	24-50	10-35	72.73	189.0	69.8	5.4		Edeco	4.54	Good	Lister	Fair	50	Good	
	" II	5900	" "	" "	72/73	211.8	70.2	5.4		Schoeller	5.45	Good	Torpedo	Fair	-		

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: SOUTHERN DARFUR Continued

1	Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
			Long.	Lat.						Type	Capacity m^3/h	Conditions	Type	Condition	Capacity m^3/h	Condition	
	Buta Angara I	5901	25-10	10-41	72/73	188.4	62.8	5.4		NO INFORMATION AVAILABLE							
	" " II	5902	" "	" "	72/73	199.6	62.8	5.4									
	Shurrab I	2471	24-49	10-40.5	67/68	68.0				ABANDONED							
	" II	2682	" "	" "	68/69	308.8	85.3			ABANDONED							
	" III	-	" "	" "	71/72	286.5	80.5			NO INFORMATION AVAILABLE							
	Garrasa	-	25-05	10-30.5	NO INFORMATION AVAILABLE												
	Aaleila	4989	25-13	10-42	70/71	204.2	60.2	14.4	400	Schoeller	5.45	Good	Torpedo	Fair	50	Good	
	Tagriba I	3308	25-22	10-45	69/60	214.9	62.2		320	"	5.45	Good	Torpedo	Fair	50	Good	
	" II	5282	" "	" "	71/72	225.5	59.1			NO INFORMATION AVAILABLE							
	El Beida	4132	25-28	10-44	70/71	242.6	56.4	13.1	240	Edeco	4.54	Fair	Lister	Fair	50	Good	
	Goz El Suheib	2433	25-40	10-47	67/68	149.3	51.8		340	Schoeller	5.45	Good	Torpedo	Fair	50	Good	
	Es Sarig I	3303	26-01	10-39	69/70	249.9	68.3		320	Edeco	4.54	Fair	Lister	Fair	50	Good	
	" " II	4352	" "	" "	70/71	201.2	61.0	4.0		Schoeller	5.45	Good	Torpedo	V.Good			Not Operatin
	El Feid Baga'a	2050	26-08	10-37	68/69	137.2	54.9			Edeco	4.54	Fair	Lister	Fair	50	Good	
	Habib Suliman	3130	26-15.5	10-35	68/69	179.2	53.6	5.5	440	NO INFORMATION AVAILABLE							
	Martenda	2733	26-23	10-27	68/69	132.6	57.9			NO			NO		50	Good	Not Operatin
	Umm Harefaya I	3284	26-28	10-28	69/70	152.7	44.7	6.6	160	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	
	" " II	5294	" "	" "	71/72	153.0	44.2	3.4	820	Schoeller	5.45	Good	Torpedo	V.Bad			
	Tarawaya I	4121	26-39	13-24	70/71			12.0	40.0	NO INFORMATION AVAILABLE							
	" II	4333	" "	" "	70/71			5.4									
	Hayames I	4105	26-31	10-14	70/71	251.4	38.6	14.4	200	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	
	" II	4331	" "	" "	70/71	250.8	36.6	4.0		"	5.45	Good	"	V.Bad			
	Nabagaya I	3283	26-36	10-04	69/70	181.0	37.1		200	"	5.45	Good	"	V.Bad	50	Good	Not Operatin
	" II	4350	" "	" "	70/71	309.4	36 6	9.6		"	5.45	Good	"	V.Bad		Good	Not Operatin

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: SOUTHERN DARFUR Continued

Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
		Long.	Lat.						Type	Capacity m^3/h	Condi-tions	Type	Condi-tion	Capacity m^3/h	Condi-tion	
Gardud Dimsu I	4324	26-50	10-14	70/71	332.2	38.1			Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Operat
" " II	-	" "	" "		-	-			"	5.45	Good	Slavic	V.Bad		-	Not Operat
Taror	4118	26-52.5	10-21	70/71	296.3	36.8	14.4	320	"	5.45	Good	No	-	50	Good	Not Operat
Umm Agag West I	4325	26-58.5	10-04	70/71	310.0	33.5				5.45	Good	Torpedo	V.Bad	50	Good	Not Operat
" " II	5243	" "	" "	71/72					NOT YET ERECTED							
" " III	5249	" "	" "	71/72												
Umm Agag I	4099	27-04	10-01	70/71	337.4	30.2	14.4	300	Schoeller	5.45	Good	Torpedo	Fair	50	Good	
" " II	-	" "	" "						NOT YET ERECTED							
Umm Harahur I	4139	27-06	10-07	70/71	239.3	37.3	10.3		Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Operat
" " II	4335	" "	" "	70/71	311.9	38.1	4.5		"	5.45	Good	"	V.Bad			
Zarzaraya I	4103	27-04	10-12	70/71	337.4	34.1	14.4	300	Schoeller	5.45	Good	No	-	50	Good	Not Operat
" II	4326	" "	" "	70/71	-	-	5.9		"	5.45	Good	No	-			Not Operat
El Har	4330	27-01	10-20	70/71	370.8	38.4	3.7	340	Schoeller	5.45	Good	No	-	50	Good	Not Operat
Ragabat El Dud	4112	27-10	10-21	70/71	193.2	58.9	9.0	500	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Operat
Andella I	4135	27-11	10-19	70/71	193.2	58.2	14.4	400	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Operat
" II	4137	" "	" "	70/71	257.6	58.2		-	ABANDONED DUE TO INCLINATION							
" III	4353	" "	" "	70/71	265.2	67.1	4.4	500	NO INFORMATION AVAILABLE							
Aradeiba I	3119	27-10	10-15	68/69	115.2				Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Operating
" II	4140	" "	" "	70/71	307.7	29.3	9.0		NOT YET ERECTED							
Gardud Eneimat I	4138	27-10	10-09	70/71	319.1	29.7	14.4		Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Ope
" " II	4354	" "	" "	70/71	331.1	36.6	4.0		"	5.45	V.Bad	"	V.Bad			Not Ope
Dahal	5918	27-09.5	10-05	72/73	399.1	52.1	4.5	280	NO INFORMATION AVAILABLE							
Dawano I	4097	27-13	10-02	70/71	313.1	28.8	12.0	340	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Operat
" II	4323	" "	" "	70/71	295.8	35.7	5.6		NOT YET ERECTED							
Hegleig El Detta I	4101	27-09	10-01	70/71	349.6	29.0	14.4	300	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Operat
" " " II	4385	" "	" "	70/71	350.3	35.1	5.6		"	5.45	Good	"	V.Bad			Not Oper

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: SOUTHERN DARFUR Continued

ial	Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
			Long.	Lat.						Type	Capacity m^3/h	Conditions	Type	Condition	Capacity m^3/h	Condition	
5	Abu Namna I	4096	27-18	10-06.5	70/71	314.9	28.1	12.0	300	Schoeller	5.45	Good	No	V.Bad	50	Good	Not Operating
	" " II	4322	" "	" "	70/71	317.6	36.3	4.0	500	NOT YET ERECTED							
6	Kudi	4109	27-23	10-17	70/71	290.6	31.1	12.0	500	ABANDONED DUE TO PROBLEM OF FINE SAND							
7	Alunna	4108	27-16	10-22	70/71	219.1	58.1	14.3	400	Schoeller	5.45	Good	Torpedo	V.Good	50	Good	Not Operatin
8	Kurkuri I	4110	27-28	10-16	70/71	292.6	44.0	6.0	320	Schoeller	5.45	Good	No	-	50		Not Operatin
	" II	-	" "	" "	70/71	246.4	47.9	4.8		NOT YET ERECTED							
9	Merair I	4095	27-28.5	10-05.5	70/71	287.9	27.2	12.0	260	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Ope
	" II	4321	" "	" "	70/71	288.1	39.6	4.0		"	5.45	Good	"	V.Bad			Not Ope
0	Timeis I	4102	27-30.5	9-59.5	70/71	267.4	28.4	9.0	340	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Ope
	" II	4328	" "	" "	70/71	267.4	45.1	4.0		" 3	5.45	Good	"	V.Bad			Not Op
1	Shadadi El Doleib I	4116	27-35.5	10-08	70/71	221.0	43.4	14.4	360	grundps3	13.6	Good	No	-	No		Not Ope
	" " " II	5713	" "	" "	71/72	221.0	57.9	11.4	560	Schoeller	5.45	Good	No				Not
2	Korga El Debba I	4100	27-36	10-05	70/71	246.7	33.9	12.0	400	Edeco	4.54	Good	Lister	V.Bad	No		Not
	" " " II	-	" "	" "	-	246.7	33.9			Schoeller	5.45		Torpedo	V.Bad			Not
3	Meiram I	2193	27-50	10-05.5	67/68	191.4	39.7	5.5	320	Schoeller	5.45	Good	Torpedo	Good	22.7	Bad	Ope
	" II	-	" "	" "	-					Edeco	4.54	Good	Lister	Good			Ope
4	Khushein	3249	27-53	10-16	-	212.7	-		320	Edeco	4.54	Good	Lister	V.Bad	50	Good	Not
5	Dawas	2211	28-07	10-02.5	-	203.0	-		345	Edeco	4.54	Good	Lister	Fair	22.7	Good	Not
6	Abu Humeira	4519	28-17	10-24	70/71	267.9	36.3	7.6	400	Edeco	4.54	Good	Lister	Fair	50	Good	Not
7	Antilla	3833	28-14	10-00	69/70	-	-	14.5	350	Edeco	4.54	Good	Lister	Fair	50	Good	Not
8	El Ogud I	3250	28-06	10-10.5	-					Edeco	4.54	Bad	Lister	Fair	50	Good	Not
	" " II	3842	" "	" "	69/70	246.3	74.9	10.03		NO INFORMATION AVAILABLE							
9	Umm Shaag	3560	28-48	10-33	-	-	-		260	NO INFORMATION AVAILABLE							
0	Debbat Obeid	5569	28-55	11-20	71/72	171.0	64.3	29.9		Edeco	4.54	Fair	Lister	Fair	50	Good	Not Operating
1	Kirkir	4555	29-03	11-03	70/71	183.0	53.4	4.5	260	Edeco	4.54	Fair	Lister	Fair	50	Good	Not Operating
2	Abu Likri	3258	28-55	10-56	69/70	289.3	-		460	Edeco	4.54	Fair	Lister	Good	50	Good	Not Operating

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: SOUTHERN DARFUR Continued

:ation Name	National Well No.	Coordinates		Year Com-pleted	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
		Long.	Lat.						Type	Capac-ity m^3/h	Condi-tions	Type	Condi-tion	Capac-ity m^3/h	Condi-tion	
	2414	29-11	11-22	67/68	29.3	2.4		320	Monoz	9.0	Good	Lister	Good	50	Good	Oper. Satis.
;os,ital)II	-	" "	" "				5.5		Edeco	4.54	Good	"	Good	50	Good	Oper. Satis.
:kinat I	1899	27-48	10-10	65/66	283.5	57.9	4.5	140	NO INFORMATION AVAILABLE							
" II	3237	" "	" "	71/72	222.7	60.0	9.0		Edeco	4.54	Fair	Lister	Fair	50	Good	Not Operating
a El Udam	3250	28-00	10-04	69/70	246.3	-			NO INFORMATION AVAILABLE							
:ula	3845	27-59	10-19	69/70	204.9	90.9		300	ABANDONED DUE TO FINE SAND							Not Operating
	5528	29-01	11-25	71/72	67.0	18.0		960								
	5568	28-56	11-25	71/72	74.0	47.8										
Elfas)	-	29-06	11-35													
	2126	30-30	11-52	-	25.1			256	Edeco	4.54	Good	Lister	Good	50	Good	Oper. Satis.
	-	" "	" "	-	-				"	4.54	Good	"	Good	-	-	Oper. Satis.
ita	2716	30-35	11-52.5	-	27.3	10.6		320	Monoz .5"	10.5	Good	Petter	V.Bad	50	Good	Not Operating
la	2716?	30-48	12-08	-	40.3	12.1		320	Edeco	4.54	V.Good	Lister	Fair	50	Good	Not Operating
	4598	31-01	12-10		68.3	45.5		320	Edeco	4.54	Good	Lister	Fair	50	Good	Not Operating
	3952	30-43	11-62		63.6	-	5.5	600	Schoeller	5.45	Good	Lister	Fair	50	Good	Not Operating
	GROUP OF BOREHOLES (18) WORKING SATISFACTORILY FOR TOWN WATER SUPPLY															
	3553	30-41	10-04		19.7		6.6	680	ABANDONED LOW YIELDING							
	3555	31-05	10-51		22.7		5.8	600	NO INFORMATION AVAILABLE							
a	6350	31-15	11-26		26.9		4.9	240	NO INFORMATION AVAILABLE							
	1630	31-20	12-20		75.8	37.9	5.5	440	Schoeller	5.45	Good	Torpedo	V.Bad	50	Good	Not Operating
I	1631	" "	" "		57.8	36.6	5.5		"	5.45	Good	Anderia	Good			Oper. Satis.
II	1632	" "	" "		58.0	38.2	3.0		"	5.45	Good	Torpedo	V.Bad			Not Operating
IV	-	" "	" "		-	-	5.5		"	5.45	Good	"	V.Bad	50	Good	Not Operating

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: NORTHERN KORDOFAN

Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dissolved solids ppm.	Pump			Engine		Storage Tank		Remarks
		Long.	Lat.						Type	Capacity m^3/h	Conditions	Type	Condition	Capacity m^3/h	Condition	
ia		31-12.5	12-40.5						ABANDONED DUE TO FINE SAND							Not Operat
s		31-28.5	12-45													
ekrat		31-25.5	12-42.5													
ariya		31-23.5	12-41						Edeco	4.54	Fair	Lister	Fair	52	Collapsed	Not Operat
		31-26	12-41.5						Edeco	4.54	Fair	Lister	Good	52	Good	Not Operat
aggas		31-23	12-42						Schoeller	5.45	Good	Lister	Fair	22.7	Good	Not Operat
		31-28.5	12-47.5						Edeco	4.54	Fair	Lister	Good	52	Good	Not Operat
aomran		31-32	12-47						Edeco	4.54	Fair	Lister	Fair	52	Good	Not Operat
hadi		31-38	12-47						Edeco	4.54	Good	Lister	Good	52	Good	Oper. Sati
		31-39	12-44						Schoeller	4.54	Fair	Lister	Fair	22.7	Good	Not Oper.S
Kitir	4865	32-25	13-02		194.0	50.0	3.6		Zarafa	4.54	Bad	Sherra	Fair	22.7	Good	Not Operat (Salinity
cika	10	32-16	13-00	1919	75.8	66.7	3.0		NO INFORMATION AVAILABLE							
I	668	32-04	13-00		128.8	75.8	4.4		Edeco	4.54	Good	Lister	Good	-	-	Not Operat (Salinity
II	-	" "	" "						Schoeller	5.45	Good	Torpedo	Good			
I	-	31-57	13-01						Edeco	4.54	Fair	Lister	Fair	22.7	7.3ad	Not Oper S
II	3476	" "	" "		163.0	63.6	10.9		Schoeller	5.45	Good	Torpedo	Fair	22.7	Fair	Not Oper...
	-	31-53	13-01	1960	153.6	75.7	3.6		Zarafa	4.54	7.3ad	Lister	Fair	22.7	7.3ad	Not Operat
leiga I	1050	31-46	12-59						ABANDONED DUE TO FINE SAND							
" II	1092	" "	" "		169.4	100.0										
eirat I		31-50	12-58						Zarafa	4.54	7.3ad	Lister	Fair	52	7.3ad	Not Operat
" II		" "	" "						Schoeller	5.45	Good	Torpedo	Fair			Not Oper.S

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: NORTHERN KORDOFAN Continued

Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
		Long.	Lat.						Type	Capacity m^3/h	Conditions	Type	Condition	Capacity m^3/h	Condition	
Maleih		31-49	12-56						Edeco	4.54	V.Bad	Lister	V.Bad	22.7	Good	Not Oper.Sat.
ţalona		31-52	12-55						Schoeller	5.45	Good	Torpedo	Fair	50	Good	Not Oper.Sat.
Rawiga I		31-55	12-54						Zarafa	4.54	V.Bad	Lister	Fair	22.7	Good	Not Operating
" II		" "	" "						NOT YET ERECTED							
im	4743	32-43	12-21		132.4	50.9	3.6		NO INFORMATION AVAILABLE							
rmal I		31-45	12-48						Schoeller	5.45	Good	Lister	Fair	50	Good	Not Oper.Sat.
" II		" "	" "						"	5.45	Good	"	Fair			Not Oper.Sat.
Ajgheein I	1022	31-46	12-51	1959	159.1	97.0			Schoeller	5.45	Good	Lister	Good	50	Good	Oper. Sat.
" II		" "	" "						ABANDONED WELL							
ar El Cufur		31-41	12-46						Edeco	4.54	V.Bad	Lister	V.Bad	22.7	Good	Not Oper
beldya		31-40	12-41						Schoeller	5.45	Good	Torpedo	Bad	50	V.Bad	Not Oper
z Khadra I	1199	31-44	12-42	1960	163.6	86.4			Edeco	4.54	V.Bad	Lister	Fair	50	V.Bad	Not Oper.
" II	1240	" "	" "	1961	163.0	95.5			MECHANICAL UNITS REMOVED AND WELL ABANDONED							
amaleika I	283	31-52	12-20	1952	134.0	63.6			)							
" II	284	" "	" "	"	218.2	97.0			) VERY LOW YIELDING WELLS							
" III	327	" "	" "	1953	225.5	-			)							
" IV	414	" "	" "		223.2	50.3			)							
[illegible] Dam		31-50	12-44						Edeco	4.54	Fair	Lister	V.Bad	22.7	V.Bad	Not Oper.
aigil		31-56	12-50						Schoeller	5.45	Good	Torpedo	Fair	50	Good	Not Oper
z Habil		31-58	12-47						Edeco	4.54	V.Bad	Lister	B.Bad	22.7	V.Bad	Not Oper
Fewwila		31-54	12-56						Schoeller	5.45	Good	Lister	Good	22.7	Good	Not Oper
Naam		31-58	12-59						Edeco	4.54	Fair	Lister	Fair	22.7	V.Bad	Not Oper
u Rukba I	1911	32-03	12-55	1966	142.4				Edeco	4.54	V.Bad	Lister	V.Bad	50	Fair	Not Oper
" " II	2902	" "	" "						Schoeller	5.45	Good	Torpedo	V.Bad	22.7	Good	Not Oper- (Fi[illegible]
Bat.[illegible]n	2888	32-03	12-55						Schoeller	5.45	Good	Lister	Fair	22.7	V.Bad	Not Oper.

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: NORTHERN KORDOFAN Continued

Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Borehole yield m^3/h	Total dissolved solids ppm.	Pump			Engine		Storage Tank		Remarks
		Long.	Lat.						Type	Capacity m^3/h	Conditions	Type	Condition	Capacity m^3/h	Condition	
Taiba		32-04	12-53						Edeco	4.54	V.Bad	Lister	V.Bad	22.7	V.Bad	Not Oper.Sat
Sabaa	4859	32-33	12-52		252.4	50.0	2.5		[illegible]	4.54	V.Bad	Lister	Fair	22.7	Fair	Not Oper.Sat
Gunga		32-55	12-58						Edeco	4.54	Good	Torpedo	Fair	22.7	Fair	Not Oper.Sat
El Rashidi		32-40	12-13						Schoeller	5.45	Good	Torpedo	Fair	50	Fair	Not Oper.Sat
Aghsel	2391	32-35.5	13-11		121.2											
Tendelti				(1922-1981 GROUP OF BOREHOLES OPERATING SATISFACTORILY FOR THE TOWN WATER SUPPLY												
Umm Kalagi	2368	32-19	14-58.5		151.5	78.5			NO INFORMATION AVAILABLE							
El Sheikh ElSiddig I	2369	32-19	14-56.5		109.1	55.8	4.4									
" " " II		" "	" "		191.0	55.8	-									
Abu Sinegeid I		32-21.5	14-55.5		78.8	24.2	-									
" " II	6642	" "	" "	74/75	110.6	23.2	22.7									
El Madina	6646	32-19	14-55.5	74/75	96.7	18.2	36.2									
Goz Abu El Hassan	6644	32-18	14-54.5	74.75	105.5	57.6	27.3									
Ideid Sagheiron I	1804	32-07	14-44	1965	153.0	38.8	4.5									
" " II	1869	" "	" "	"	161.8	20.9	4.5									
Abu Hareira	5121	32-10	14-42		110.3	10.3	14.5									
El Shatawi	2364	32-07	14-38.5		109.1	21.8	4.4									
Wad Nimir I	1868	32-08	14-32.5	1965	45.5	20.9			Adler	4.54	Fair	Doetz	Fair	50	Good	Not Oper.Sat
" " II	1928	" "	" "	1966	81.8	18.2	2.8		Schoeller	5.45	Good	Torpedo	Good			Oper. Satis.
El Sufei I	1785	32-07.5	14-32	1965	102.0	22.7	6.8		Schoeller	5.45	Good	Lister	Good	22.7	Good	Oper. Satis.
" " II	1803	" "	" "		71.5	22.7	4.5		Adler	4.54	Good	Doetz	Good	-		Oper. Satis.
" " Hospital III	-	" "	" "	74/75	192.4	22.7	5.8		"	4.54	Good	"	Good	50	Good	Oper. Satis.
El Reheidat	4721	32-08	14-28		151.5	20.6	5.5		BOREHOLE WATER VERY SALINE CHEMICALLY UNFIT FOR HUMAN USE							

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: NORTHERN KORDOFAN Continued

Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
		Long.	Lat.						Type	Capacity m^3/h	Conditions	Type	Condition	Capacity m^3/h	Condition	
Goz El Mabeid		32-08.5	14-26.5		156.1	25.5			NO INFORMATION AVAILABLE							
Abu Gurad I	2367	32-08.5	14-24.5		142.4	57.6			CHEMICALLY UNFIT FOR HUMAN USE							
" " II	6315	" "	" "		130.0	57.6	4.4		CHEMICALLY UNFIT FOR HUMAN USE							
Goz El Leid	6314	32-08.5	14-24.5		145.0	47.9	9.0		Zarafa	4.54	V.Bad	Lister	Fair	22.7	Good	Not Oper.Sat.
Wad Samuri		32-09	14-23		122.7	11.8			NO INFORMATION AVAILABLE							
Goz El Marafein	2884	32-09	14-21		151.5	28.8	4.6		CHEMICALLY UNFIT FOR HUMAN USE							
El Turaa El Khadra		32-07	14-18.5		143.9	25.5			Edeco	4.54	Good	Lister	Good	22.7	Good	Oper. Satis.
El Usheira		32-09	14-17		122.7	27.3	18.0		NO INFORMATION AVAILABLE							
Abboud	5178	32-08	14-13.5		155.5	45.5			NO INFORMATION AVAILABLE							
El Mandareib	2985	32-09	14-12		84.2	21.8	3.4		CHEMICALLY UNFIT FOR HUMAN USE							
Areik	7313	32-13.5	14-11.5		93.6	27.9	23.0		NO INFORMATION AVAILABLE							
El Sefeiran		32-11.5	14-11		75.8	-			NO INFORMATION AVAILABLE							
Shabasha I	1830	32-14	14-08	1965	48.2	4.5	-		Schoeller	5.45	Good	Torpedo	Good	50	Good	Oper. Satis.
" II	1863	" "	" "						Adler	4.54	Good	Doetz	Fair			Not Oper.Sat.
" III	-	" "	" "	1965	54.2	21.2	10.0		Schoeller	5.4	Good	Torpedo	Good	50	Good	Oper. Satis.
El Talha	2360	32-17.5	14-04		86.4	7.0	4.6		NO INFORMATION AVAILABLE							
Abu Nail I	2887	32-12.5	14-03		97.0	27.9	4.4		CHEMICALLY UNFIT FOR HUMAN USE							
" " II	3006	" "	" "	68/69	75.8	34.2	4.4		CHEMICALLY UNFIT FOR HUMAN USE							
El Mansoura	2398	32-13	14-01		130.3	16.7	4.6		CHEMICALLY UNFIT FOR HUMAN USE							
El Shabouna		32-16.5	14-01.5		90.9	19.7			NO INFORMATION AVAILABLE							
ElShawfa ElAhamda	2402	32-12	13-57		242.4	41.2	7.3		NO INFORMATION AVAILABLE							
ElMagham ElMashoura	2356	32-18	13-54.5		95.5	17.0	4.5		CHEMICALLY UNFIT FOR HUMAN USE							
El Mekefei	6818	32-17	13-52		89.5	21.5	8.2		Edeco	4.54	Good	Lister	Good	22.7	Good	Oper. Satis.
El Kerida I	2215	32-20	13-50	67/68	62.1	4.5	45.4		Grundfa	10.0	Good	Buck	Good	22.7	Good	Oper. Satis.
" " II	6303	" "	" "	73/74	30.0	5.5	4.5		NO INFORMATION AVAILABLE							
Wadi Afu	7669	32-16	13-50	76/77	57.0	-	-		ABANDONED BOREHOLE BASEMENT COMPLEX (B.C.)							

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: NORTHERN KORDOFAN Continued

Serial	Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
			Long.	Lat.						Type	Capacity m3/h	Conditions	Type	Condition	Capacity m3/h	Condition	
	Mabruka	5135	32-24	13-47.5		140.9				LOW YIELDING (B.C.)							
	Goz Beni Garrar	2358	32-19	13-46		106.1	25.5	3.3		CHEMICALLY UNFIT FOR HUMAN USE							
	Kiteir Balla I	2426	32-26	13-45	67/68	90.9	25.5	4.6		NO INFORMATION AVAILABLE							
	" " II	5794	" "	" "	72/73	104.5	18.2	6.5		Schoeller	5.45	Good	Torpedo	Good	50	Good	Oper. Satis.
	Eweiwa	3040	32-24.5	13-45	68/69	107.0	25.8	23.0		Edeco	4.54	Good	Lister	Good	22.7	Good	Oper. Satis.
	El Debeiba	5117	32-27	13-43		91.2	26.4	14.5		Schoeller	5.45	Good	Torpedo	Good	50	Good	Oper. Satis.
	Galgala I	1874	32-32	13-34	1965	64.5	37.3	6.4		NO INFORMATION AVAILABLE							
	" II	1876	" "	" "	"	65.5	37.3	4.6		NO INFORMATION AVAILABLE							
	Galli	6280	32-26	13-31	73/74	29.4	5.2	5.4		Mono	4.54	Good	Petter	Good	50	Good	Oper. Satis.
	El Alsga	2366	32-09	14-47		147.0	24.2	6.6		NO INFORMATION AVAILABLE							
	Umm Gar West	7671	32-24	13-39	76/77	121.2	31.3	4.6		NO INFORMATION AVAILABLE							
	Wad El Zaki I	1796	32-12	14-28	1965	86.4	36.3	10.0		NO INFORMATION AVAILABLE							
	" " " II	1833	" "	" "	"	83.0	21.2	10.0		NO INFORMATION AVAILABLE							
	ElKaru ElSenetays	2404	32-40	13-19		242.4	-	-		NO INFORMATION AVAILABLE							
	El Gezira Abba	-	32-38	13-21.5	1972	50.6				ABANDONED WELL (B.C.)							
	Abu Shatein		32-31	13-40		42.4	7.6	-		NO INFORMATION AVAILABLE							
	El Marabeia	7659	32-39	13-26	76/77	157.0	42.0			CHEMICALLY UNFIT FOR HUMAN USE							
	El Malaha		32-38	13-26		4.8				ABANDONED WELL (B.C.)							
	Umm Gar East	4741	32-27	13-49		203.0	9.1	5.4		CHEMICALLY UNFIT FOR HUMAN USE							
	El Shawal I	6279	32-40	13-35	73/74	30.0	4.5	6.4		NO INFORMATION AVAILABLE							
	" " II	7677	" "	" "	76/77	53.0	8.8	4.5		NO INFORMATION AVAILABLE							
	El Kunuz	2749	32-31.5	13-39	68/69	165.2	13.6			NO INFORMATION AVAILABLE							
	El Kawa I	2060	32-30	13-43	1967	36.4	12.1	5.5		NO INFORMATION AVAILABLE							
	" " II	6164	" "	" "	72/73	54.5	7.6	4.1		NO INFORMATION AVAILABLE							
	" " III	5793	" "	" "		42.4	9.1			NO INFORMATION AVAILABLE							
	Ed Dinegeila	2801	32-22	13-50	68/69	68.8	13.6	13.6		NO INFORMATION AVAILABLE							

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: NORTHERN KORDOFAN Continued

ial	Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
			Long.	Lat.						Type	Capac-ity m3/h	Condi-tions	Type	Condi-tion	Capac-ity m3/h	Condi-tion	
76	Abu Gumun	4636	32-24.5	13-52	70/71	51.5	19.7	4.5		CHEMICALLY UNFIT FOR HUMAN USE							
77	El Merebheira	7664	32-20	14-05	76/77	66.4	7.6	9.0		NO INFORMATION AVAILABLE							
78	El Debasi	6027	32-15	14-13	72/73	45.5	8.2	5.3		NO INFORMATION AVAILABLE							
80	El Sayal	2796	32-16	14-15.5	68/69	62.4	12.1	23.1		NO INFORMATION AVAILABLE							
81	El Sagia El Sagein	5126	32-16.5	14-18		158.8	22.4	18.0		NO INFORMATION AVAILABLE							
82	El Hashaba I	1847	32-13	14-18.5	1965	72.7	30.4			NO INFORMATION AVAILABLE							
	" " II	1871	" "	" "	"	97.3	21.2			NO INFORMATION AVAILABLE							
83	Wad Salman	2502	32-17	14-23	67/68	121.2	37.3	16.0		NO INFORMATION AVAILABLE							
84	ElShiteib ElMasgid	4625	32-12	14-22		293.9	23.6	5.5		NO INFORMATION AVAILABLE							
85	El Laota East	2795	32-25	14-25	68/69	113.3	15.2	3.6		CHEMICALLY UNFIT FOR HUMAN USE							
86	Abu Hubeisa	5127	32-21	13-59		133.9	17.9	16.0		NO INFORMATION AVAILABLE							
87	Goz Abu Kilab		32-27	14-54		353.0	14.8	-		NO INFORMATION AVAILABLE							
88	El Geteina I	1773	32-22	14-52	64/65	95.8	6.1	10.0		NO INFORMATION AVAILABLE							
	" " II	1786	" "	" "	"					NO INFORMATION AVAILABLE							
	" " III	1789	" "	" "	1965	60.6	7.6	10.0		NO INFORMATION AVAILABLE							
	" " IV	6165	" "	" "			-	-		NO INFORMATION AVAILABLE							
	" " V	7563	" "	" "	76/77	119.4	4.5	10.0		NO INFORMATION AVAILABLE							
189	El Hebeika	2697	32-18	14-45	68/69	43.9	11.2	6.4		NO INFORMATION AVAILABLE							
190	El Gabour	-	32-32	14-42.5	-	115.2	21.8	-		NO INFORMATION AVAILABLE							
191	El Daradir I	2148	32-14	14-40	67/68	78.8	6.7	2.3		NO INFORMATION AVAILABLE							
	" " II	-	" "	" "		74.2	10.6			CHEMICALLY UNFIT FOR HUMAN USE							
192	Goz El Rakaba	7564	32-14	14-39	76/77	149.1	30.3	5.4		NO INFORMATION AVAILABLE							
193	Elgarsa I	2117	32-12	14-37	67/68	69.1	9.4	6.4		NO INFORMATION AVAILABLE							
	" II	5007	" "	" "	70/71	48.5	8.2	7.6		NO INFORMATION AVAILABLE							
194	Naeima I	1580	32-15	14-40	1960	78.3	-	4.5		NO INFORMATION AVAILABLE							
	" II	1697	" "	" "	1964	78.3	-	40.0		NO INFORMATION AVAILABLE							
195	Wad El Hag	7566	32-15	14-45	76/77	192.7	13.6	7.6		NO INFORMATION AVAILABLE							

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: NORTHERN KORDOFAN Continued

rial	Location Name	National Well No.	Coordinates		Year Com-pleted	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
			Long.	Lat.						Type	Capac-ity m^3/h	Condi-tions	Type	Condi-tion	Capac-ity m^3/h	Condi-tion	
196	Tounaya	-	32-17	14-34		229.4	24.2	-		NO INFORMATION AVAILABLE							
197	Wad Shalaeia I	2811	32-13	14-35		112.4	12.1			NO INFORMATION AVAILABLE							
	" " II	-	" "	" "		78.8	16.3	-		NO YET ERECTED							
198	Wad El Kereil West	-	32-25	15-06						NO INFORMATION AVAILABLE							
199	Wad El Kereil East	-	32-28	15-07						NO INFORMATION AVAILABLE							
200	Wad Garenabi	-	32-29	15-11						NO INFORMATION AVAILABLE							
201	J. Aulia East	2664	32-30	15-15	1972	166.7	11.8			Mono	12.0	Good	Kerlosko	Good	22.7	Good	Oper. Satis.

ANNEX I

EXISTING WATERYARDS ALONG THE SOUTHERN STOCK ROUTE: KHARTOUM PROVINCE (West of the White Nile)

ıl	Location Name	National Well No.	Coordinates		Year Completed	Total Depth m.	Static Water level m.	Bore-hole yield m^3/h	Total dis-solved solids ppm.	Pump			Engine		Storage Tank		Remarks
			Long.	Lat.						Type	Capac-ity m^3/h	Condi-tions	Type	Condi-tion	Capac-ity m^3/h	Condi-tion	
	Sandunab	6447	32-26	15-12	1975	72.1	8.1	31.8		Grundfos	15.0	Good	Bouch	Good	22.7	Good	Oper. Satis.
	Mugdab	2602	32-26.5	15-16	1968	45.5	9.7	6.5		Mono	12.C	Good	Torpedo	Good	22.7	Good	Oper. Satis.
	Amurat	5220	32-25	15-17.5	-	139.4	9.1	4.4		Zarafa	4.54	Bad	Lister	Fair	22.7	Good	Not Oper.Sat.
	Et Tina	-	32-27	15-18.5		33.3	9.1	-		NOT YET ERECTED							
	Goz Suleimaniya	5217	32-28.5	15-20	1972	119.7	14.5	19.2		Grundfos	15.0	Good	Bach	Good	22.7	Good	Oper. Satis.
/	Esh Shigeila I	5009	32-27.5	15-21	1971	120.9	13.6	22.9		Grundfos	15.0	Good	Bach	Good	22.7	Good	Oper. Satis.
	" " II	5238	" "	" "	1972	97.0	23.0	16.7									
8	Es Samara	5026	32-23.5	15-21	1971	133.0	36.4	34.5		Grundfos	15.0	Good	Bach	Good	22.7	Good	Oper. Satis.
9	Baraka	-	32-28	15-22	-	-	-	-		Grundfos	15.0	Good	Bach	Good	22.7	Good	Oper. Satis.
0	Qoz Niseir	-	32-38.5	15-21.5		53.0	9.1			NOT YET ERECTED							
1	Et Treis	5010	32-27	15-23.5	1971	59.1	12.2	14.5		Grundfos	15.0	Good	Bach	Good	22.7	Good	Oper. Satis.
2	Umm Uweina	6060	32-26.5	15-24	1973	72.7	12.1	3.5		ABANDONED WELL (LOW YIELD)							
3	El Kedei	-	32-25	15-27.5	1983	157.6	46.9	-		NOT YET ERECTED							
4	Ghamarab	2206	32-26.5	15-29	1968	170.0	80.3	6.5		Edeco	4.54	Fair	Lister	Fair	22.7	Good	Oper. Satis.
5	Wadi El Sedeir	-	32-26.5	15-28	1983	121.2	39.4	-		NOT YET ERECTED							
6	Essheikh ElBasheirI	5215	32-26	15-13.5	1972	72.7	14.4	7.5		Zarafa	4.54	Bad	Doetz	Bad	22.7	Good	Oper. Satis.
	" " II	5216	" "	" "	"	71.2	13.6	-		Mono	10.0	Good	Torpedo	Fair	22.7	Good	Oper. Satis.
7	Umm Budda I	8543	32-29.5	15-38	1980	181.8	57.0	43.6		Kabrain	)						
	" " II	8544	" "	" "	1980	144.5	36.4	40.0			)	NO INFORMATION AVAILABLE					
	" " III	8635	" "	" "	1981	157.6	37.3	78.9			)						
	" " IV	-	" "	" "	-	-	-	-	-		)						

ANNEX II

FIELD DATA SAMPLES
Vegetation Measurements

MAIN ROUTE OF PROPOSED SOUTHERN STOCK ROUTE

This annex describes the understory and overstory vegetation along with other vegetation circumstances at twenty sample sites along the proposed SSR. The sample sites represent the diversity of the entire SSR and give an indication of the types of vegetation conditions that can be expected along the full length of the route.

Once the sample sections were located, data were gathered and then related to soil, rainfall, presence of man-made incursions, and grazing conditions. For actual vegetation measurements, the 9.6 square foot hoop method was used to determine the percentage of composition of the understory, cover, frequency, and density.

For more details on the methodology and analysis of the sample sites, see Chapter V.

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 3

Sample Site Number: 1 (18 km. east of Sherkeila)

Species

Dominant Overstory Species	% Composition	Density
Cappaire decidua	30	14
Boscia senegalensis	5	10
Acacia nubica	60	20
Balanites aegyptiaca	5	15
TOTALS	100	59

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Schoenfeldia gracilis	75	60	Broken	100
Aristida funiculata	10		Broken	100
Brachiaria spp.	5			100
Litter				
	100	60	-	-

Forage Production (pounds/feddan): 750

Soil Type: Non-cracking clay

Topography: Almost flat

Land Use: Grazing/cultivation in adjacent sand soil

Migration Routes: None

Cut-out Areas: Cultivated farms; sheet erosion

Grazing Condition: Good

Water Availability: Available - single borehole

FIELD DATA SAMPLES
Vegetation Measurement

Section Number: 3

Sample Site Number: 2 (26 km. west of Sherkeila)

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Acacia nubica	60	20	Schoenfeldia gracilis	80	80	30	100
Acacia mellifera	5	7	Aristida funiculata	5		20	100
Boscia senegalensis	25	15	Oldlandia spp.	10		10	50
Balanites aegyptiaca	5	13	Bare soil	5		-	-
Acacia senegal	5	10	Litter	-		-	-
TOTALS	100	61		100	80	60	-

Forage Production (pounds/feddan): 600

Soil Type: Non-cracking clay

Topography: Flat to gently sloping.

Land Use: Grazing

Migration Routes: None

Cut-out Areas: Roads; extensive sheet erosion; dense regeneration of Acacia nubica and Boscia senegalensis.

Grazing Condition: Good/Fair

Water Availability: Remote

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 3

Sample Site Number: 3

Species

Dominant Overstory Species	% Composition	Density
Acacia seyal	60	140
Balanites aegyptiaca	30	20
Bare soil	10	
TOTALS	100	160

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Cymbopogon nervatus	90	90	25	100
Brachiaria obtusiflora	5		5	100
Litter	5			
	100	90	30	

Forage Production (pounds/feddan): 500

Soil Type: Non-cracking clay with scattered stones.

Topography: Flat to gently sloping.

Land Use: Grazing

Migration Routes: None

Cut-out Areas: Meandering seasonal water courses.

Grazing Condition: Fair/Poor

Water Availability: None

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 3

Sample Site Number: 4

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Acacia mellifera	40	90	Cymbopogon nervatus	80		120	100
Dichrostachys glomerata	20	50	Brachiaria spp.	5		2	100
Balanites aegyptiaca	10	30	Schoenfeldia gracilis	5		3	100
			Bare soil	10			
TOTALS	100	170		100	80	125	

Forage Production (pounds/feddan): 550

Soil Type: Cracking clay

Cut-out Areas: Migration route

Topography: Low-lying

Grazing Condition: Fair/Poor

Land Use: Grazing/browsing/farming (dura)

Water Availability: None

Migration Routes: Close to sample site running north/south.

FIELD DATA SAMPLES
Vegetation Measurements

Number: 3

ple Site Number: 5

Species

Dominant Overstory Species	% Composition	Density
Acacia seyal	60	70
Balanites aegyptiaca (seedlings)	40	38
TOTALS	100	108

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Cymbopogon nervatus	20	90	10	100
Brachiaria spp.	25		12	100
Aristida spp.	35		30	100
Litter	15		-	-
Bare soil	5		-	-
	100	90	52	

Forage Production (pounds/feddan): 400

.l Type: Dark cracking clay

Cut-out Areas: Frequent burning

ɔpography: Flat

Grazing Condition: Fair/Poor

and Use: Grazing/dura cultivation

Water Availability: Available

Iigration Routes: None

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 3

Sample Site Number: 6

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Dalbergia melanoxylon	50	20	Hyparrhenia spp.	1	90	3	100
Combretum spp.	10	7	Indigofera spp.	2		2	100
Balanites aegyptiaca	10	8	Schoenfeldia gracilis	30		20	100
Acacia gerrardii	20	10	Setaris spp.	7		3	100
Lannea humilis	10	30	Cymbopogon nervatus	50		30	100
			Bare soil	5		-	-
			Litter	5		-	-
TOTALS	100	75		100	90	58	

Forage Production (pounds/feddan): 700

Soil Type: Hard sand, similar to naga'a (non-cracking)

Cut-out Areas: Road

Topography: N/A

Grazing Condition: Good/Fair

Land Use: Grazing/cultivation

Water Availability: No sign

Migration Routes: None

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 5

Sample Site Number: 7 (7 km. west of Delami)

Species

Dominant Overstory Species	% Composition	Density
Acacia seyal	60	35
Dichrostachys glomerata	30	20
Balanites aegyptiaca	10	10
TOTALS	100	65

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Cymbopogon nervatus	30	85	10	100
Schoenfeldia gracilis	35		35	50
Pennisetum ramosum	10		3	50
Bare soil	10		-	
Litter	15			
	100	85	48	

Forage Production (pounds/feddan): 450

Soil Type: Dark cracking clay

Topography: Flat

Land Use: Grazing/dura cultivation

Migration Routes: None

Cut-out Areas: Areas swept by bush fires

Grazing Condition: Fair

Water Availability: Available

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 5

Sample Site Number: 8 (15 km. west of Delami)

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Balanites aegyptisca	90	5	Cymbopogon nervatus	20	80	10	100
(Open grassland)			Brachiaria obtusiflora	20		15	100
other species have been			Aristida spp.	40		40	100
cleared for cultivation			Pennisetum ramosum	5		3	100
			Bare soil	10		-	-
			Litter	5		-	-
TOTALS	90	5		100	80	68	

Forage Production (pounds/feddan): 500

Soil Type: Dark cracking clay

Cut-out Areas: Burnt areas

Topography: Flat

Grazing Condition: Good

Land Use: Previously under dura; grazing; animals tracks observed

Water Availability: Available (Hafir)

Migration Routes: None

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 5

Sample Site Number: 9 (34 km. west of Habila)

Species

Dominant Overstory Species	% Composition	Density
Acacia seyal	40	70
Acacia gerrardii	20	20
Balanites aegyptiaca	30	25
Dichrostachys glomerata	10	40
TOTALS	100	155

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Cymbopogon nervatus	30	65	10	100
Brachiaria spp.	20		25	100
Brachiaria obtusiflora	5		3	100
Aristida funiculata	10		25	100
Chloris spp.	20		20	100
Bare soil	5		-	-
Litter	10		-	-
	100	65	83	

Forage Production (pounds/feddan): 500

Soil Type: Clay soil with shallow cracking

Cut-out Areas: Burning by both nomads and farmers

Topography: Flat, stoney surface

Grazing Condition: Good

Land Use: Grazing/cultivation

Water Availability: 30 km. away (Habila)

Migration Routes: Near to sample site west/east
Shannabla, camels and sheep

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 5

Sample Site Number: 10 (11 km. east of El Semasin)

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Acacia seyal	30	20	Cymbopogon nervatus	20	90	15	100
Balanites aegyptiaca	5	7	Hyparrhenia spp.	30		38	100
Dichrostachys glomerata	30	38	Aristida spp.	20		32	100
Ziziphus spina-christi	35	25	Brachiaria spp.	10		10	100
			Pennisetum spp.	10		13	100
			Bare soil	5		-	-
			Litter	5		-	-
TOTALS	100	90		100	90	100	

Forage Production (pounds/feddan): 500

Soil Type: Dark-cracking clay

Topography: Flat

Land Use: Cultivation/grazing

Migration Routes: North/south 5 km. west of sample site.

Cut-out Areas: Migration routes; roads; burnt areas

Grazing Condition: Good

Water Availability: Plenty

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 5

Sample Site Number: 11 (25 km. west of El Semasim)

Species

Dominant Overstory Species	% Composition	Density
Albizia amara	15	10
Acacia nubica	20	40
Combretum spp.	15	10
Capparis decidua	25	20
Anogeissus leiocarpus	25	15
TOTALS	100	95

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Schoenfeldia gracilis	30	65	40	100
Hyparrhenia spp.	20		35	100
Aristida funiculata	30		45	100
Setaria-pallide-fusca	5		20	100
Bare soil	10		-	-
Litter	5		-	-
	100	65	140	

Forage Production (pounds/feddan): 650

Soil Type: Naga'a (hard sand with stones of different sizes)

Topography: Undulating

Land Use: Grazing

Migration Routes: Sheet erosion; overgrazed areas; roads

Cut-out Areas: None

Grazing Condition: Fair

Water Availability: Not available

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 6

Sample Site Number: 12 (11 km. west of Lagawa)

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Acacia gerrardii	30	40	Schoenfeldia gracilis	50	75	30	100
Adansonia digitata	5	3	Hyparrhenia spp.	20		30	100
Albizia amara	20	15	Aristida funiculata	5		30	100
Balanites aegyptiaca	10	12	Sporobolus festivus	2		15	100
Anogeissus leiocarpus	15	10	Bare soil	20		-	-
Dalbergia melanoxylon	20	18	Litter	3		-	-
TOTALS	100	98		100	75	105	

Forage Production (pounds/feddan): 800

Soil Type: Non-cracking/sandy clay; stoney

Cut-out Areas: Sheet erosion

Topography: Almost flat

Grazing Condition: Fair/Poor

Land Use: Grazing

Water Availability: Not available

Migration Routes: None

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 6

Sample Site Number: 13 (11 km. west of Debat Obeid)

Species

Dominant Overstory Species	% Composition	Density
Acacia seyal	70	90
Balanites aegyptiaca	10	15
Ziziphus spina-christi	10	10
Acacia polyacantha	10	8
TOTALS	100	123

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Brachiaria obtusiflora	80	70	15	100
Sorghum spp.	10		5	100
Bare soil	5		-	-
Litter	5		-	-
	100	70	20	

Forage Production (pounds/feddan): 800

Soil Type: Black cotton soil with accumulated litter

Topography: Low sites receiving more moisture

Land Use: Grazing/charcoal/hunting

Migration Routes: None

Cut-out Areas: Water channels

Grazing Condition: Good

Water Availability: Moderate

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 6

Sample Site Number: 14 (28 km. west of Debat Obeid)

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Albizia amara	20	30	Cenchrus biflorus	40	40	20	100
Sderocanya birrea	10	20	Eragrostis trennula	20		30	100
Guirea senegalensis	60	85	Andropogon gayanus	5		1	20
Boscia senegalensis	10	30	Oldlandia spp.	10		20	100
			Bare soil	15		-	-
			Litter	10		-	-
TOTALS	100	165		100	40	71	-

Forage Production (pounds/feddan): 300

Soil Type: Sand Goz

Cut-out Areas: Overgrazing/bare area

Topography: Flat

Grazing Condition: Poor

Land Use: Grazing/cultivation

Water Availability: Not available

Migration Routes: None

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 6

Sample Site Number: 15 (64 km. west of Debat Obeid)

Species

Dominant Overstory Species	% Composition	Density
Acacia seyal	60	29
Dichrostachys glomerata	30	15
Combretum spp.	10	8
TOTALS	100	52

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Aristida spp.	10	60	30	100
Schoenfeldia gracilis	30		50	100
Brachiaria spp.	10		10	100
Aristida funiculata	10		20	100
Bare soil	30		-	-
Litter	10		-	-
	100	60	110	

Forage Production (pounds/feddan): 500

Soil Type: Non-cracking clay; sand

Topography: Almost flat

Land Use: Grazing; firewood; charcoal

Migration Routes: None

Cut-out Areas: Sheet eroded areas

Grazing Condition: Good/Fair

Water Availability: Not available

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 6

Sample Site Number: 16 (61 km. west of Muglad)

Species

Dominant Overstory Species	% Composition	Density
Combretum spp.	60	20
Terminalia brownii	10	5
Grewia tenax	20	20
Anogeissus leio carpus	10	5
TOTALS	100	50

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Chloris spp.	30	50	20	100
Cassia mimosoida	40		30	100
Aristida spp.	5		10	100
Bare soil	10		-	-
Litter	15		-	-
	100	50	60	

Forage Production (pounds/feddan): 300

Soil Type: Non-cracking sandy clay

Topography: Low lying

Land Use: Grazing/hunting

Migration Routes: Close to site of sample

Cut-out Areas: Overgrazed areas

Grazing Condition: Good/Fair

Water Availability: Not available

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 6

Sample Site Number: 17 (9 km. west of Guwegina)

Species

Dominant Overstory Species	% Composition	Density
Albizia amara	10	15
Acacia gerrardii	40	35
Balanites aegyptiaca	10	10
Tamarindus indica	5	8
Combretum spp.	15	18
Terminalia brownii	5	6
Guirea senegalensis	15	20
TOTALS	100	112

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Schoenfeldia gracuis	Litter	40	Litter	
Aristida mutablis	Litter		Litter	
Sporobolus festivus	Litter		Litter	
Oldlandia spp.	Litter		Litter	
(Cattle seen colleting the litter)				
		40		

Forage Production (pounds/feddan): 250

Soil Type: Non-cracking clay

Topography: Flat, gently sloping towards a big Rahad

Land Use: Grazing/cultivation

Migration Routes: Close to sample site

Cut-out Areas: Sheet erosion; migration route roads

Grazing Condition: Fair/Poor

Water Availability: Idd and borehole (Elmerium)

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 6

Sample Site Number: 18 (18 km. west of Sample 17)

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Guirea senegalensis	70	90	Cenchrus biflorus	30	65	20	100
Pliostigma reticulata	10	20	Cassia nemosoides	20		10	100
Balanites aegyptiaca	5	10	Oldlandia senegalensis	10		25	100
Dechrostachys glomerata	5	25	Eragrestis tremnula	5		10	100
			Bare soil	20		-	-
			Litter	15		-	-
TOTALS	100	145		100	65	65	

Forage Production (pounds/feddan): 350

Soil Type: Sand soil (Goz)

Cut-out Areas: Burnt areas

Topography: Flat

Grazing Condition: Good/Fair

Land Use: Grazing/cultivation

Water Availability: Available

Migration Routes: Nearby site of sample

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 7

Sample Site Number: 19 (7 km. west of Abu Gabra)

Species

Dominant Overstory Species	% Composition	Density
Guirea senegalensis	50	70
Albizia amara	10	0
Combretum glutinosum	10	8
Sederocayna birrea	5	3
Dichrostachys glomerata	10	8
Terminalia brownii	5	10
Balanites aegyptiaca	5	5
Acacia senegal	5	10
TOTALS	100	122

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Eragrostis tremula	20	80	35	100
Cenchrus biflorus	35		20	100
Aristida pauide	10		5	100
Pennisetum pedicellat	10		15	50
Andropogon gayanus	5		2	50
Bare soil	15		-	-
Litter	5		-	-
	100	80	77	

Forage Production (pounds/feddan): 450

Soil Type: Sand soil (Goz)

Cut-out Areas: Burnt and cultivated areas

Topography: Flat

Grazing Condition: Good/Fair

Land Use: Grazing/farming

Water Availability: Available, single deep borehole 8 km. west

Migration Routes: Close to sample site

FIELD DATA SAMPLES
Vegetation Measurements

Section Number: 7

Sample Site Number: 20 (45 km. west of Abu Gabra)

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Guirea senegalensis	55	40	Cenchrus biflorus	35	75	30	100
Albizia amara	10	10	Eragrostis tremula	30		20	100
Dalbergia melanoxylon	10	15	Oldlandia spp.	5		10	100
Combretum gultinosum	15	10	Pennisetum pedicellat	5		6	50
Acacia senegal	10	20	Bare soil	20			
			Litter	5			
TOTALS	100	95		100	75	66	

Forage Production (pounds/feddan): 300

Soil Type: Land (Goz)

Cut-out Areas: Burnt areas

Topography: Flat

Grazing Condition: Fair/Poor

Land Use: Grazing/farming

Water Availability: Available (Sibdu) Abmatarig

Migration Routes: Nearby

ANNEX III

FIELD DATA SAMPLES
Vegetation Measurements

MAIN ROUTE OF PROPOSED SOUTHERN STOCK ROUTE

Data on the two sites contained in this annex are taken from sampl[illegible] along the feeder routes for the proposed SSR. Methodologies used in compiling these data are identical to those used for the samples along the main route and are explained in Chapter V as well as on the cover page for Annex II.

FIELD DATA SAMPLES
Vegetation Measurements

Section Number:

Sample Site Number: 1 (Umm Ruwaba - Abbassiya)

Species

Dominant Overstory Species	% Composition	Density
Acacia mellifera	60	12
Boscia senegalensis	30	5
Balanites aegyptiaca	5	2
Acacia nubica	5	1
TOTALS	100	20

Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Schoenfeldia gracilis	45	70	30	100
Aristida hordeace	20		12	100
Sporobutus festivus	15		20	100
Baresoil	10		-	-
Litter	10		-	-
	100	70	60	

Forage Production (pounds/feddan: 550

Soil Type: Non-cracking clay

Topography: Flat

Land Use: Grazing

Migration Routes: None.

Cut-out Areas: Roads; sheet erosion; trampling.

Grazing Condition: Good/fair

Water Availability: Available

FIELD DATA SAMPLES
Vegetation Measurements

Section Number:

Sample Site Number: 1 (Abbassiya - Kosti)

Species

Dominant Overstory Species	% Composition	Density	Understory Vegetation Species	% Composition	% Cover	Density	Frequency
Acacia seyal	60	5	Schoenfeldia gracilis	30	50	35	100
Acacia nubica	35	3	Brachiaria Xan thelura	15		15	100
Grewia tenax	5	1	Sporobotus festivus	5		20	100
			Bare soil	20		-	-
			Litter	30		-	-
TOTALS	100	9		100	50	70	

Forage Production (pounds/feddan): 300

Soil Type: Non-cracking clay

Cut-out Areas: Sheet eroded areas many and extensive

Topography: Flat

Grazing Condition: Good/fair

Land Use: Grazing

Water Availability: Not available

Migration Routes: Trade cattle route following the road

ANNEX IV

LIVESTOCK MOVEMENTS AND SEASONAL AREAS OF CONCENTRATION IN THE PROJECT AREA

ANNEX IV

LIVESTOCK MOVEMENTS AND SEASONAL AREAS OF CONCENTRATION IN THE PROJECT AREA

	TRIBE	WET SEASON GRAZING	DRY SEASON GRAZING	MIGRATION ROUTE(S)
	Fellata	South west of Nyala - W. Bulbul and Goz Abu Seiala south east Nyala	Tulus-Ragag - Shergeila El Hanbali and Bahr El Arab	- Dalal Angara - Abu Agoura - Tuwal - Rulus - Ragag —— El Hanbali---Bahr El Arab
	Habbania	South of Nyala - Bobaya and Goz Abu Selala North east Nyala	Arround Buta Raya - Lake Kundi Bahr El Arab. (Radom) El Fifi, when Tsetse flies permit	- Abu Salala - Bobaya - El Fordus - Essumia Bashar - Buta Raya - Kundi - Abu Salala - Gorida - Buram - Buta Raya - Kundi - Bahr El Arab
	Rezeigat	- North of Gadid Ras El Fil and south of El Fasher - North of Muhagria	Along the northern bank of Bahr El Arab - at Sahala - Buru. Gebras-Sinum El Kubu	S Migration from the dry to the west season grazing area. They pass through: (1) El Fordus (2) Genailaya (3) Keliki Abu Salama (4) Es Daein and (5) Abu Gabra
	Awlad Bilala	North of El Mazroub and south of El Sharafa	Raggabt El Kubu and Bahr El Arab	El Mazroub - Abu Gabra - Khrobala - El Kubu - Bahr El Arab.
5	Messeria 4:Humur 5:Zurug	- North of Babanousa - El Tibun - El Odaya - Abu Zabad Eddwikat Till Abu Haraz - South of Abu Zabad Babanousa - Nyala Railway Line	- Bahr El Arab - El Gerinti Myama Siddana - Dabakir - Lake Abyad Lake Keilak -Kegeria - El Lagawa	(1) Abu Haraz - Eddiwkat - El Fula - Dabakir (2) El Odaya - El Fula, Dabakir. (3) Babanousa - El Muglad - Magadma-El Sulaf El Gerinti (4) El Maggadma Abyei (5) Abu Haraz - Abu Zabad - El Lagawa Lake Abyad (6) El Lagawa-Lake Keilak

ANNEX IV

LIVESTOCK MOVEMENTS AND SEASONAL AREAS OF CONCENTRATION IN THE PROJECT AREA Continued

TRIBE	WET SEASON GRAZING AREA(S)	DRY SEASON GRAZING AREA(S)	MIGRATION ROUTE(S)
Hawazma	Birka - Abu Zabad El Obeid Area	-South eastern Kordofan (Abbassia - Tegali) -Between Kaka - Kadugli -Lakes Keilak and Abyad -Touga - Kaka	(1) Abu Zabad - Dilling - Kadugli - Lake Abyad (2) El Obeid - Abu Haraz - Delamlo - Talodi - El Leri - Touga (3) El Obeid-Birka - Umm Berembeta - Kalogi Kaka
White Nile Baggara	El Baga area north west of Ed Dueim	Tendelti and White Nile Banks.	Elbaga - J. Abu Rada's - Zeriga - Umm Zerieba-Tendelti-Abu Rukba.
Hammar (Camel breeders) (Baza'a)	North of En Nahud	Wadi Shelenga	They follow different routes every year
Shenabla Camel and Sheep breeders.	Umm Dam, Shershar - Elga'a Umm Badr - Umm Gozein.	Rashad - El Abbassia - Umm Ruwaba - Er Rahad - El Obeid - Kaka - Sa'afa and Kuwei	- Umm Gozein - Umm Badr - Sodari-Elgaa-Shershar Umm Dam - Umm Ruwaba - El Abbassia - Rashad - Umm Gozein - Umm Badr - El Harroub. Ban Gadid Er Rahad - Umm Ruwaba——Abbassia - Umm Gozein - Umm Badr - Umm Defis-Abu Haraz El Ban Gadid——Abbassia.