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DATA AVAILABILITY REPORT  
SUDAN COUNTRY REPORT

PART OF IIMI- IFPRI PROJECT ON:

DEVELOPING CRITERIA FOR ASSESSING THE PERFORMANCE OF  
IRRIGATION SYSTEMS



SUBMITTED BY:

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Dec. 1989

H 11770

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## 1-BACKGROUND

### 1.1) GENERAL:

The Sudan covers an area of 2.5 millions square kilometres situated between latitudes 3° and 23°. It has a population of approximately 25 millions, increasing at an annual rate of 2.8%.

With regards to the climate, The Sudan has a predominantly tropical continental climate. The north third of the country is almost a desert with a total annual average rainfall of about 20 millimetres, the rainfall increases steadily from the north to the south to reach a maximum of 1 800 millimetres per year in the extreme south. The potential evapotranspiration (ET) in most of the country exceeds 1 450 millimetre per year, which corresponds to 4 millimetres per day. Areas with ET less than 1 450 millimetre per year are confined to the high elevations. The ET follows a reverse pattern as that of the rainfall with its maximum of 2 600 millimetre per year in the north and decreases steadily to 1 400 millimetre per year in the south.

Table (1) shows the normals of some climatic parameters for some representetave cities of the country.

The River Nile and its tributaries represents the most prominent physical feature of the country. It has an average total annual yield of 85 milliards cubic meters of water as measured at Aswan in Egypt, of which The Sudan share is 18.5 milliards ( 20.35 milliards as measured at Sinnar). The present water consumption of the country is in the order of 15.5 milliards, which constitutes around 73% of the average available water resources of the country.

In addition to the River Nile and its tributaries there is a number of seasonal flashy streams in the eastern and western parts of the country.

As concerning ground water resources, the water bearing

geological formation covers 48.6% of the country area most of it contains a good quality water for both human and irrigation uses, the remaining 51.4% of the country area is covered either by rocks or by a non-water bearing geological formations.

Ground water is used extensively for drinking purposes and it constitutes the major source for such supply for a large part of the country, particularly in the rural areas.

#### 1.2) THE AGRICULTURAL SECTOR IN THE SUDAN:

The agricultural sub-sector is the most dominant sector in the sudanese economy and will continue to be so for many years to come. Agriculture accounts for about 35% of the total Gross Domestic Product (GDP), about 70% of the labour force is directly employed in agriculture and related activities, and most of the industry is based around agricultural products as raw material. The country economy is wholly dependent on agricultural exports (raw or processed) for foreign exchange earning, over 90% of the foreign exchange earning stem from agricultural products with cotton contributing around 40% of all exports earning, followed by gum arabic 15-20% and then sesame and groundnut.

It has been estimated that; in The Sudan, the gross cultivatable land amounts for 26 millions feddans (approximately 12 millions hectares), of which 4.5 millions feddans (approximately 1.9 millions hectares) is under irrigation and 5.5 millions feddans (approximately 2.3 millions hectares) is under rain-fed mechanized farming, the remainder is either under traditional farming or forms part of the long fallow rotation. Pasture is estimated to cover an area of around 34 millions feddans (13.7 millions hectares) and the production forests covers an area of 7 millions feddans (2.9 millions hectares) mostly producing gum arabic.

Dura (sorghum), being the staple food of the Sudanese population, is cultivated in over one third of the cropped area, mostly in rain fed mechanized and traditional farming areas. Within the irrigated areas, cotton is the dominant crop followed by groundnut, wheat, dura and sugar cane.

### 1.3) THE IRRIGATION SUB-SECTOR:

The irrigation sub-sector plays an important role in the Sudanese agriculture, and irrigation represents the most important single input for agriculture in The Sudan. Although the irrigated area constitutes less than 20% of the cropped area in the country, it produces around 50% of the production, depending on the variation of the rainfall quantity and distribution from year to year. All the Sudan wheat and 90% of the cotton production are produced by the irrigated sector. With its 4.5 millions feddans (1.9 millions hectares) the irrigation sub-sector in The Sudan is the largest in sub-sahara Africa.

Irrigation development took place in The Sudan under broadly similar climatic and soil conditions, most of the agricultural developments are in the central clay plains of the eastern part of central Sudan, which is enclosed by the White Nile, the Blue Nile and Atbara River. In these plains the average total annual rainfall ranges between 350 and 550 millimetres and, as such, supplementary irrigation is essential for secured crop production. Cotton, groundnut, wheat, dura (sorghum) and sugar cane are the main crops grown in these plains.

Other than these central clay plains, irrigation also exists along the Main Nile, where rainfall is very low and crops are totally dependent on irrigation. More diversified cropping pattern can be found in the irrigation systems along the Main Nile, with beans, wheat, fruits and vegetables and date palm being the most dominant crops.

In addition to the irrigation from the Nile and its tributaries, ground water and seasonal flashy rivers are also used. Ground water utilization for irrigation is confined to the small scale private enterprises, mainly along the Main Nile and the Blue Nile where water is extracted using hand dug wells. The only government ground water scheme is Sag En na'am project in Northern Darfur of western Sudan. Seasonal flashy rivers are utilized for irrigation of mainly vegetables and fruits in the Gash and Tokar rivers Deltas in the northern part of eastern Sudan.

Generally irrigation is by surface methods, with furrow irrigation being the most widely used, small basin irrigation can also be found particularly for vegetable crops. No pressurized or drip irrigation exists in The Sudan, probably because of the flat nature of the ground and the low permeability of the soil type in which irrigation developments took place.

TABLE (1): REPRESENTATIVE CLIMATIC NORMALS 1941 - 1970

| Station                                  | Parameter                     | Jan           | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|--|-------------------------------|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| Khartoum<br>( Northern<br>Sudan )        | Rainfall ( mm )               | 0             | 0   | 0   | 0   | 0   | 0   | 13  | 23  | 4   | 1   | 0   | 0   | 41   |
|  | Evaporation ( mm/day )        | 5.3           | 6.6 | 8.2 | 8.8 | 9.3 | 9.1 | 8.6 | 8.3 | 8.1 | 7.4 | 6.1 | 5.4 | 7.6  |
|  | Air Temp. ( C )               | 20            | 22  | 26  | 30  | 33  | 35  | 34  | 34  | 34  | 32  | 26  | 22  | 29   |
|  | Sunshine Duration ( % )       | 91            | 93  | 88  | 88  | 85  | 80  | 83  | 79  | 81  | 89  | 94  | 95  | 87   |
|  | Solar Radiation ( cal/cm /d ) | NOT AVAILABLE |     |     |     |     |     |     |     |     |     |     |     |      |
| Wad Madani<br>( Central<br>Sudan )       | Rainfall ( mm )               | 0             | 0   | 0   | 1   | 15  | 29  | 116 | 133 | 48  | 19  | 1   | 0   | 362  |
|  | Evaporation ( mm/day )        | 5.6           | 7.3 | 7.8 | 8.3 | 8.8 | 8.9 | 7.8 | 6.9 | 7   | 6.5 | 6.3 | 5.9 | 7.3  |
|  | Air Temp. ( C )               | 24            | 25  | 28  | 31  | 33  | 32  | 29  | 28  | 29  | 30  | 27  | 24  | 28   |
|  | Sunshine Duration ( % )       | 92            | 93  | 87  | 86  | 80  | 73  | 60  | 61  | 76  | 85  | 92  | 94  | 82   |
|  | Solar Radiation ( cal/cm /d ) | 487           | 540 | 574 | 595 | 578 | 554 | 517 | 523 | 550 | 521 | 493 | 474 | 537  |
| Wad Madani<br>( South Central<br>Sudan ) | Rainfall ( mm )               | 0             | 0   | 7   | 21  | 102 | 109 | 149 | 167 | 144 | 82  | 6   | 0   | 787  |
|  | Evaporation ( mm/day )        | 6.7           | 7.8 | 7.4 | 7.5 | 6.7 | 5.9 | 5.4 | 5.5 | 5.7 | 5.8 | 6   | 6.7 | 6.4  |
|  | Air Temp. ( C )               | 27            | 28  | 31  | 31  | 30  | 28  | 26  | 26  | 27  | 28  | 27  | 27  | 28   |
|  | Sunshine Duration ( % )       | 83            | 82  | 73  | 70  | 60  | 45  | 39  | 45  | 50  | 60  | 79  | 89  | 65   |
|  | Solar Radiation ( cal/cm /d ) | 481           | 527 | 530 | 534 | 496 | 447 | 440 | 469 | 480 | 484 | 499 | 496 | 490  |
| Juba<br>( Southern<br>Sudan )            | Rainfall ( mm )               | 4             | 8   | 51  | 95  | 156 | 112 | 136 | 150 | 114 | 115 | 38  | 9   | 988  |
|  | Evaporation ( mm/day )        | 4.8           | 5.2 | 5.9 | 5.2 | 5.7 | 5.4 | 4.6 | 5   | 5.5 | 5.2 | 5.2 | 5.2 | 5.2  |
|  | Air Temp. ( C )               | 28            | 29  | 30  | 29  | 28  | 27  | 26  | 26  | 26  | 27  | 28  | 28  | 27   |
|  | Sunshine Duration ( % )       | 78            | 69  | 58  | 54  | 63  | 60  | 48  | 56  | 64  | 62  | 66  | 79  | 64   |
|  | Solar Radiation ( cal/cm /d ) | 443           | 449 | 446 | 433 | 480 | 456 | 413 | 460 | 503 | 474 | 455 | 444 | 455  |

NOTES: EVAPORATION IS PENMAN OPEN SURFACE EVAPORATION

SOURCE: SUDAN METROLOGICAL DEPARTMENT

## 2- IRRIGATION SYSTEMS CLASSIFICATIONS

### 2.1) HISTORICAL BACKGROUND:

Until the turn of this century, when modern irrigation methods began to be introduced, the irrigation practice in The Sudan was based on the traditional basin flood irrigation and irrigation using sagia (water wheel) and shadoof (buckets). Basin flood irrigation was simply relying on the residual soil moisture left on the soil, after the river flood season, in the low lying areas adjacent to the river. Sagia is the Persian Wheel and shadoof is a hand operated water lifting device suitable only for small plots of vegetables.

Since the beginning of this century, modern irrigation methods was introduced. In 1904 the first diesel pump was erected in Ez'Zedab scheme on the Main Nile. Following the success of Ez'Zedab the number of pumped irrigation schemes along the Main Nile, the Blue Nile and White Nile increases steadily by both the government and the private sector.

Large scale gravity irrigation started in early 1920's with the commission of the Gazera scheme, which later increased in area to become, by far, the largest irrigation system in the country and constitutes almost 50% of the irrigated area, and almost 10% of all cultivated area, in the country.

### 2.2) SYSTEMS SAMPLING FOR THE DATA SURVEY:

Table (2) gives some basic data on the irrigation systems in The Sudan. With reference to the level of the performance of the management of the system and the level of services provided to the water users, several categorization of the irrigation system can be made:

#### a) BY METHOD OF WATER PROVISION:

Here three types exists; gravity, pumped and flood basin irrigation systems. With gravity irrigation, although exists in only two systems ( Gazera and New Halfa), but has the biggest share of the area under irrigation in the whole country (58%) followed by pumped irrigation (38%) and then



flood basin irrigation (2%). With respect to the level of performance, with gravity irrigation using a storage dam, the water provision is more secured than with the case of pumped irrigation systems with its problems of siltation of the inlet channels, lack of spare parts for the pumps, fuel shortages and power cuts. Flood irrigation, on the other hand, is performing at a much lower level of satisfaction because its total reliance on the level of the flood peak.

b) BY SIZE:

Government involvement in the management of irrigation systems in The Sudan is confined to large and medium size irrigation systems, leaving small scale systems to the private sector, and within the government systems, more attention and better level of support services, of water and non-water inputs, is given to large systems such as the Gazera, New Halfa and Rahad. than for smaller ones, and as such, the level of performance is expected to be related to the size of the scheme.

c) BY TYPE OF OWNERSHIP:

Categorization by the type of ownership has the greatest relevance to the study of the performance of irrigation management, because of the difference in the style of management between the government and private systems.

2.3) BASIS FOR SAMPLING:

Table (3) shows the classification of large and medium size irrigation systems in The Sudan and the systems chosen for the data availability survey of this report using the three criterion mentioned in the previous section. Annexes (1) to (5) gives a summary of the data availability for the five systems selected. In selecting these systems for the survey, the following points were taken into consideration:

- a) All the small size systems in the country are owned and run by private owners, and probably because of their sizes, no data is recorded on these schemes. For this reason it difficult to include these type of system in the study of management performance, and therefore they are excluded from

this data survey.

- b) In our selection of the systems, it is necessary to take into consideration the difference in soil type and environmental setting in which these irrigation systems are operating and try to represent all these different conditions. In this regard, mainly three such groups of schemes exists; The Main Nile irrigation systems, the White Nile irrigation Systems, and the Blue Nile and River Atbara irrigation systems. Each of these groups should be represented in our data survey
  
- c) Sugar schemes, whether private or government owned, deserves special consideration because they differs from other irrigation systems in that; in sugar states the management employs direct labour, instead of tenant farmers, for all agricultural operation and therefore have a complete control over all activities in the scheme.

TABLE ( 2 ): GENERAL DATA ABOUT MAIN EXISTING IRRIGATION SYSTEMS  
IN THE SUDAN

| No. | SCHEME                                    | YEAR OF<br>COMM I-<br>- TION | CROPPED<br>AREA<br>( Ha ) | CROPS<br>GROWN                  | ANNUAL<br>CWR<br>million cum | WATER<br>SOURCE |           |
|-----|---|------------------------------|---------------------------|---------------------------------|------------------------------|-----------------|-----------|
| 1   | GAZERA                                    | 1925/69                      | 924000                    | cotton/wheat/<br>groundnut/dura | 5500                         | BLUE NILE       |           |
| 2   | NEW HALFA                                 | 1966/69                      | 193000                    | cotton/wheat/<br>sugar cane     | 1450                         | ATBRA<br>RIVER  |           |
| 3   | GENIED                                    | 1954                         | 33000                     | cotton/groundnut/<br>sugar cane | 540                          | BLUE NILE       |           |
| 4   | RAHAD                                     | 1976                         | 126000                    | cotton/dura/<br>groundnut       | 1000                         | BLUE NILE       |           |
| 5   | HAGAR<br>ASSALAYA                         | 1977                         | 14700                     | sugar                           | 310                          | BLUE NILE       |           |
| 6   | SUKI                                      | 1971                         | 35700                     | cotten<br>groundnut             | 275                          | BLUE NILE       |           |
| 7   | ABU<br>NA'AMA                             | 1973                         | 12600                     | kenaf                           | 110                          | BLUE NILE       |           |
| 8   | N. W.<br>SINNAR                           | 1973                         | 13440                     | sugar                           | 300                          | BLUE NILE       |           |
| 9   | WHITE NILE<br>AGRICULTURAL<br>CORPORATION | -----                        | 184000                    | cotten<br>groundnut<br>dura     | 1132                         | WHITE NILE      |           |
| 10  | BLUE NILE<br>AGRICULTURAL<br>CORPORATION  | -----                        | 132000                    | cotten<br>groundnut<br>dura     | 690                          | BLUE NILE       |           |
| 11  | NORTHERN<br>AGRICULTURAL<br>CORPORATION   | -----                        | 37600                     | beans<br>wheat<br>vegetable     | 300                          | MAIN NILE       |           |
| 12  | KENANA                                    | 1977                         | 35700                     | sugar                           | 960                          | WHITE NILE      |           |
| 13  | SELEIT                                    | 1979                         | 8400                      | feeders                         | 92                           | BLUE NILE       |           |
| 14  | BARIAB                                    | 1985                         | 2100                      | vegetable                       | 35                           | BLUE NILE       |           |
| 15  | MAIN NILE<br>PRIVATE PUMPS                | -----                        | 87000                     | vegetable<br>fruits             | 1651                         | MAIN NILE       |           |
| 16  | BLUE NILE<br>PRIVATE PUMPS                | -----                        | 27000                     | vegetable<br>fruits             | 55                           | BLUE NILE       |           |
| 17  | WHITE NILE<br>PRIVATE PUMPS               | -----                        | 12600                     | vegetable<br>fruits             | 250                          | WHITE NILE      |           |
| 18  | WAD HAM I D<br>BASIN                      | 1918                         | 4200                      | vegetable<br>dura               | }                            | MAIN NILE       |           |
| 19  | SALAWA<br>BASIN                           | 1918                         | 2100                      | vegetable<br>dura               |                              | MAIN NILE       |           |
| 20  | LUTTY<br>BASIN                            | 1918                         | 4200                      | vegetable<br>dura               |                              | 750             | MAIN NILE |
| 21  | SULAIM<br>BASIN                           | 1918                         | 23100                     | vegetable<br>dura               |                              | MAIN NILE       |           |
| 22  | GASH<br>DELTA                             | -----                        | 33600                     | vegetable<br>dura               |                              | GASH<br>RIVER   |           |
| 23  | TOKAR<br>DELTA                            | -----                        | 25200                     | cotton<br>dura                  | BARAKA<br>RIVER              |                 |           |

TABLE (3): CLASSIFICATION OF IRRIGATION SYSTEMS IN THE SUDAN

| size              | large (>100 000 ha)  |                       |                      |                      | medium (>1000 ha, and <100 000 ha) |   |                      |  |
|-------------------|----------------------|-----------------------|----------------------|----------------------|------------------------------------|---|----------------------|--|
| water provision   | gravity              | pump                  | flood                |                      | gravity                            | pump  | flood                |  |
| type of ownership | priv-govern-ate-ment | priv-govern-ate-ment  | priv-govern-ate-ment | priv-govern-ate-ment | priv-govern-ate-ment               | priv-govern-ate-ment  | priv-govern-ate-ment | priv-govern-ate-ment                                     |
| schemes           | Gazera<br>N.Halfa    | WNAC<br>BNAC<br>Rahad |                      |                      |                                    | Sale Geneid<br>Ken H. Assalaya<br>Bari Suki<br>A. Naama<br>NW. Sinnar<br>NAPC |                      | W. Hamid<br>Salawa<br>Lutty<br>Suleim<br>Elgash<br>Tokar |
| %from total area  | 58%                  | 23%                   |                      |                      |                                    | 2%  | 15%                  | 2%   |
| systems selected  | Gazera               | Rahad                 |                      |                      |                                    | Ken/papc/mn   |                      | Salawa   |

Note: WNAC = White Nile Agricultural Corporation  
 BNAC = Blue Nile Agricultural Corporation  
 NAPC = Northern Agricultural Production Corporation

### 3-INFORMATION GATHERING ORGANIZATIONS

#### 3.1) INTRODUCTION:

The extent of data availability on irrigation systems in the Sudan is related to the degree of involvement of the government organizations in the management of the system, this<sup>is</sup> because generally data is available on the inputs and services provided by the government organizations and in activities and farming practices controlled by these organizations.

Several government organizations are involved in the management of irrigation systems and their support services and collect and keep data. The main organizations which gather informations related to this study are the following:

- The Ministry Of Irrigation, (MOI).
- Schemes Agricultural Corporation.
- Sudan Metrological Department, (SMD).
- Soil Survey Adminstration, (SSA).
- National Rural Water Corporation, (NRWC).

The function and type of informations collected by each of these organizations is disscussed in the next sub-sections. In addition to these information gathering organizations, there are several organizations which collects usefull data and study reports which are relevant to this study. Some of these are:

- The Hydraulics Research Station, (HRS), of the MOI, ( Wad Medani).
- The Agricultural Research Corporation, (ARC), (Wad Medani).
- The Sudan Gazera Board, (SGB), liberary, (Barakat).

#### 3.2 The MINISTRY OF IRRIGATION, (MOI):

The MOI is the government body responsible for the supply of irrigation water to all the government irrigation systems in the country (with the exception of the Northern Agricultural Production Corporation (NAPC) scheme which are fully operated by

the NAPC itself).

The functions of the MOI in a typical government scheme includes the following:

- Planning, design and construction of new irrigation systems.
- Operation and maintenance of the dam or pumping stations.
- Operation and maintenance of main canal and major canals.
- Maintenance of the drainage system.

Fig.(1) shows the organization structure of the MOI.

In addition to data on water levels, gate openings and discharges at the key points in all irrigation systems, the MOI runs the hydrological networks of the Nile and its tributaries and the non-nilotic rivers. The data of 29 of these stations is published annually, in the "Hydrological Year Book" of the Nile Water Directorate of the MOI, since 1970. Copies of this book can be available from the MOI office in Khartoum.

Data on water levels, gate openings and discharges at key points of individual irrigation system can be available from the MOI field engineers offices at each scheme, but this data is not always of good quality. The MOI field engineers offices also keeps records of the areas planned for irrigation, areas actually irrigated, the indent of water from the agricultural authorities using the water and water released at all key points.

The Hydraulic Research Station of the MOI, Wad Medani, has ~~has~~ conducted some research and collected some data which may be useful for this study. various investigation and study reports can also be available from the MOI library, Wad Medani, and the MOI archive, Wad Medani.

### 3.3) SCHEMES AGRICULTURAL CORPORATIONS:

For each individual government irrigation system in the country,

there is a central independent management body which is responsible for the management of the system, ( For example: The Sudan Gazera Board,(SGB), for the Gazera Scheme, Es Suki Agricultural Corporation, (SAC), for the Es Suki scheme .....and so on). Although the exact responsibility and the degree of control imposed by these corporation on the farmers differs form one irrigation system to the other, but in principles these management bodies is responsible for all the agricultural and infra-structural aspects in their irrigation systems.

In a typical government scheme the managing corporation duties includes the following:

- Allocation of tenancies.
- Land preparations.
- Supply of seeds and seeds treatment.
- Supply and application of fertilizers, insecticides and pesticides.
- Collection and marketing of groundnut crop.
- Transport, storage, ginning and marketing of cotton crop.
- Maintenance of road in the scheme area.
- Supply of credit to the farmers.
- Operation of the irrigation system below minor canal off-take including preparation of water indent from the MOI.
- Contribution in the general services to the area of the scheme.

For administrative purposes, usually the agricultural corporation will be divided into groups and blocks, Fig.(2) shows the organization structure of a typical government scheme managing corporation.

The agricultural corporations in their schemes keeps detailed records, by farmer, and by crop, on the data concerning planned and actual cropped areas, quantities of all the non-water inputs provided by them, farming systems and farming practices, land tenures .....etc. For data on crop production and crop yield, the management corporations usually keep reliable records for cotton

and wheat. For other crops such as ; dura (sorghum), groundnut, vegetables ...etc. and because they are considered as " farmers crops", some estimate and statistics of the crop yields can be found with the management corporation, but the data is usually less reliable than that for cotton and wheat, this is because the farmer may be reluctant to give exact informations on his crop yields.

Some of these management corporations publish annual reports including summary and some statistics on the data of their schemes. Summaries of this data of all agricultural schemes also appears in the Ministry Of Agriculture (MOA) reports.

#### 3.4) SUDAN METROLOGICAL DEPARTMENT, (SMD):

The SMD is part of the Ministry Of Defence and have its headquarters at Khartoum. It runs 48 first order and 41 second order metrological stations installed mainly in big towns all over the country.

In 1957, the agro-climatological section of the SMD was established and is now running some metrological stations for measuring all the parameters necessary for determining crop water use by Penman method, there are now over ten of these stations distributed in areas representing all the important climatological zones of the country.

Daily readings data of all the parameters measured in the stations, can be available from the stations sites or from Khartoum SMD headquarters office. The SMD also publish regular repots, some of the SMD regular reports are:

- The Monthly Agro-metrological bulletin, which contains data from all the agro-climatological stations in the country.
- The Annual Agro-metrological Report.
- The SMD Annual report, which contains data from all metrological and agro-metrological stations.
- Pentad rainfall, which is published every five days, and contains data on rain fall all over the country.



These publications can be available from the SMD headquarters office at Khartoum.

### 3.5) SOIL SURVEY ADMINISTRATION:

The SSA is part of the Ministry Of Agriculture, its headquarters office is at Wad Medani, and has two other offices one in the northern part and the other in the western part of the country.

The SSA conducts all soil surveys in the country, three types of soil surveys are conducted:

- i) Detailed Soil Survey: with an intensity of one observation point for every 25 - 45 feddans area (approximately 10 - 19 hectares). This type of survey is conducted in special cases when detailed informations of some area is needed. The data of this type of surveys is usually plotted in a 1:20 000 scaled maps.
- ii) Semi-detailed Soil Survey: with an intensity of one observation point in every 45 - 120 feddans (approximately 19 -50 hectares), and the data is plotted in a 1:50 000 scaled maps. This type of survey is conducted prior to the construction of any irrigation scheme in the country, whether private or government scheme.
- iii) Reconnaissance survey: this has a much lower sampling density and is conducted for general reconnaissance purposes.

Out of these soil surveys two type of maps are usually produced:

- Soil Map: This is for describing the chemical and physical characteristics of the soil.
- Land Suitability Map: This shows the degree of suitability and limitations of the soil type surveyed.

In 1976, the SSA produced their own manual for classification

of soil according to its suitability for agriculture. Their Classification is similar to that of the United States Bureau of Reclamation. Soils are divided into four classes, class one to class four, which respectively corresponds to good, moderate, poor and very poor. Class four soils includes lands of coarse textured unsuited for surface irrigation but possibly for sprinkler irrigation.

Reports and maps of all the soil surveys conducted in the country can be obtained from the SSA headquarters office at Wad Medani.

### 3.6) NATIONAL RURAL WATER CORPORATION, (NRWC):

The NRWC is part of the Ministry Of Energy and Mining. It has its headquarters office at Khartoum, and has regional offices in all main towns in the country. The NRWC is responsible for ground water supplies all over the country. This ground water is used mainly for drinking purposes in rural areas .

The NRWC keeps separate record for every single well dug in the country. In this record informations on water depths , water quality and the geological formations encountered is kept. In some cases, selected wells are used for continuous water level monitoring.

The NRWC through it ground water research unit ( Kilo 10, Khartoum) produces reports and maps of ground water depth, annual floctuations and water quality for selected areas in the country.

ANNEX (1)

DATA AVAILABILITY SURVEY

OF

NORTHERN AGRICULTURAL PRODUCTION CORPORATION SCHEMES

FIG. (1): ORGANIZATION STRUCTURE OF THE MOI IN A TYPICAL IRRIGATION SCHEME

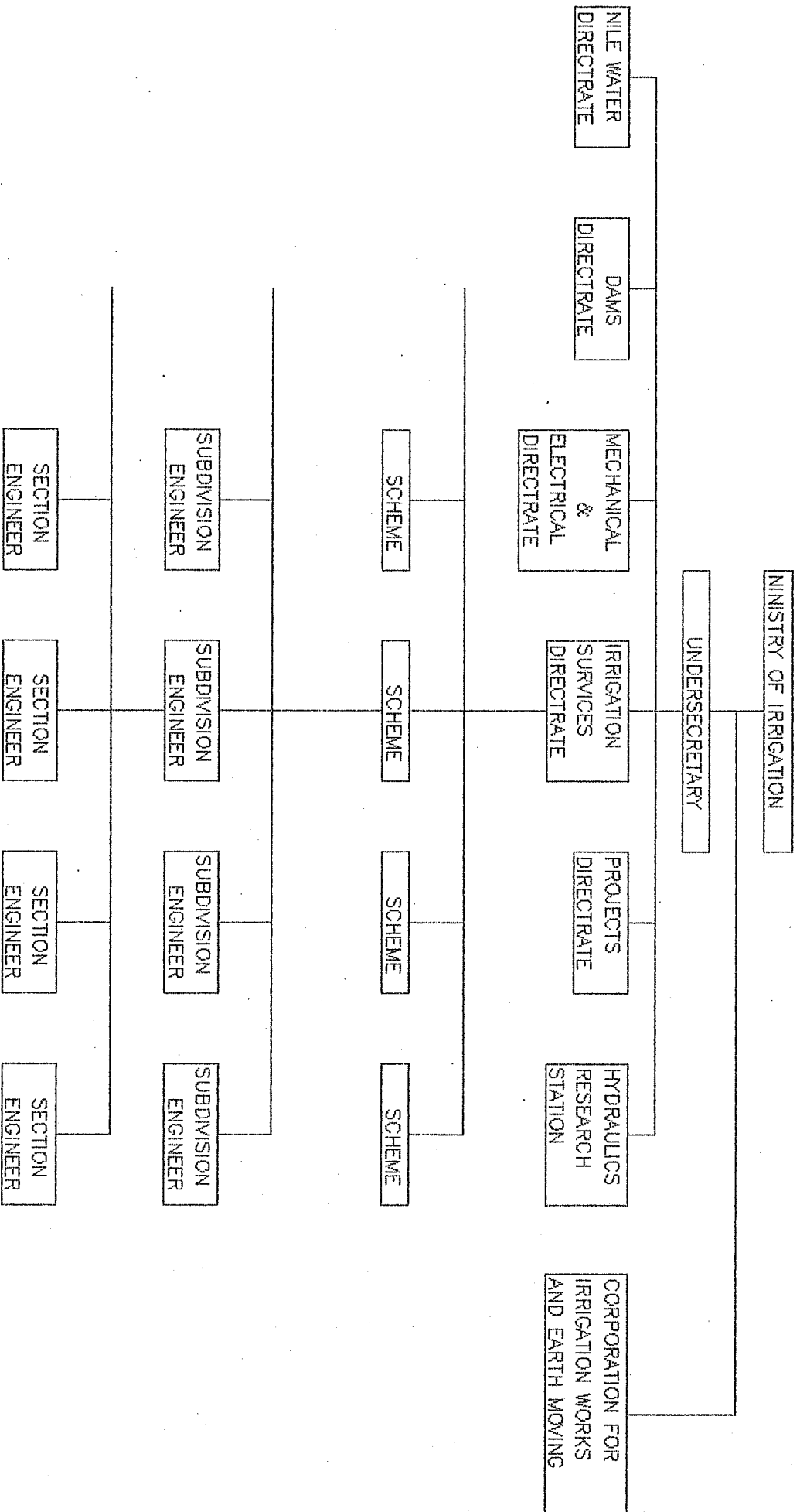
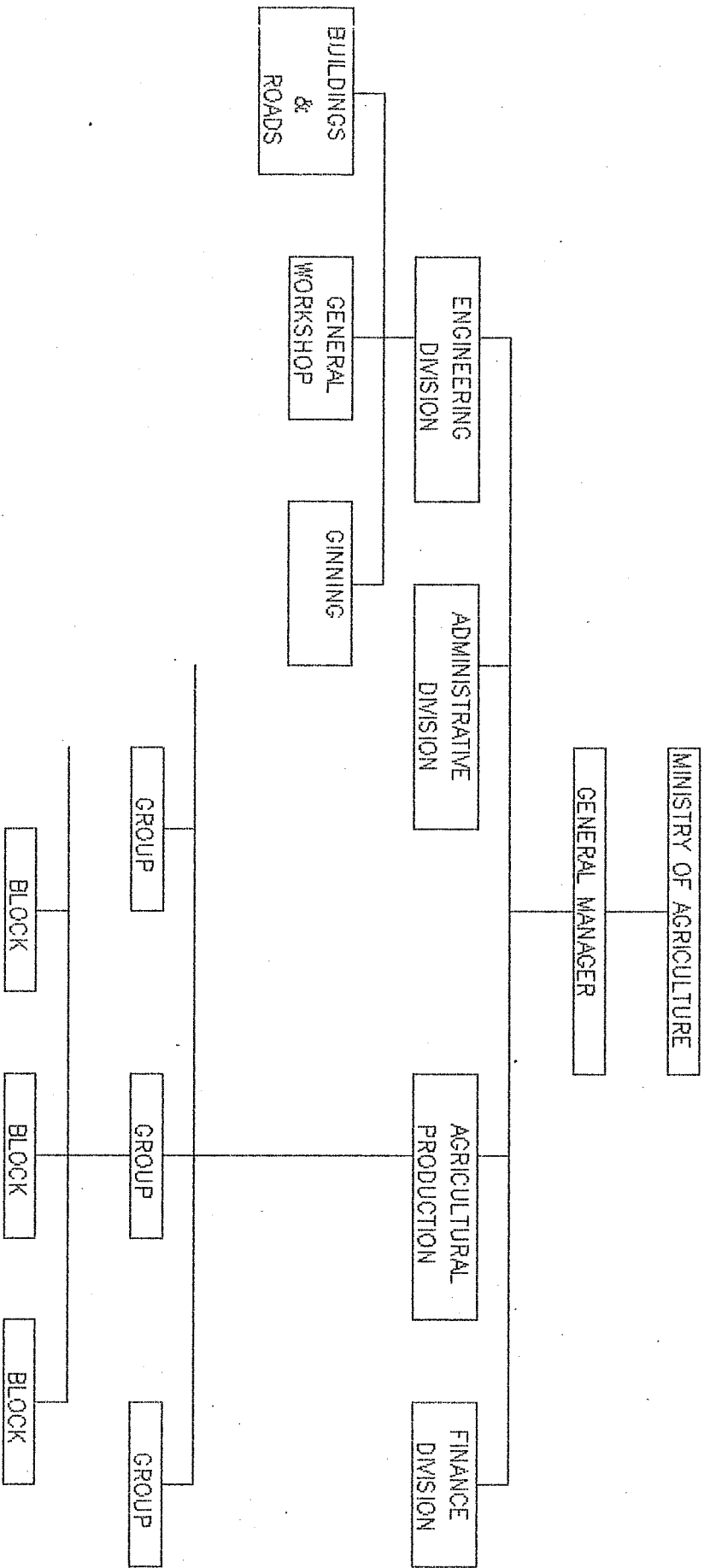


FIG. (2) : ORGANIZATION STRUCTURE OF A TYPICAL SCHEME MANAGING CORPORATION



#### 4- CONCLUSION AND RECOMMENDATIONS

1) The quality and reliability of the data availability differs from one organization to the other and from one irrigation system to the other. But in general most of the data under consideration in this study is of good quality, this is particularly true for large government controlled irrigation systems. However, it may be necessary some times, to check the quality of the data. For example; for water discharge data at lower level of the system, it may be necessary to check the physical conditions and the calibration of the measuring structure.

2) Most the data available in The Sudan is recorded and compiled by hand<sup>and</sup> only available in papers, no computer data bases exists. This means that; time and efforts may be needed if this data is to be checked, or if additional compilation or desegregation is required before its use in this study.

Although the majority of the data and reports are available in English language, but the are important data items and reports which are written in Arabic only, this is particularly true for official government departments reports which are published in Arabic, the official language of the country.

3) Usually there is no legal restriction on the availability of the type of the data required for this study, although in some departments, a permission ~~may be needed~~ from some authorized person in the department may be needed before copies of the data or reports can be acquired. Similarly, government organizations annual reports are usually distributed free, but usually the number of copies is very limited, and it is usually difficult to find copies of older reports.

4) In the main survey, where the actual data should be collected, and specially where a lot of data is to be acquired from one single organization as in the case of the MOI, SMD or one of the schemes managing corporations; in these cases, it may be a good idea to have somebody from the organization itself involved in the data collection exercise. This can be done, if possible, for

example, by paying him a small fees, in the form of incentive, for his involvement in the collection, compilation or desegregation of the data if this is needed. This should be done carefully after the necessary consultation and permission from the authorities in his organization or department. This involvement may be necessary as in many case the required data may not be available off-the-shelf and should be gathered from discrete sources and sections within the organization or department. It is much easier and quicker for somebody from the organization itself to gather these infirmations, to find the missing bits and know if these is any analysis or check which has already been done to the row data.

For the overall coordination and supervision of the data collection program in the main survey and for the application of the resulting methodology for the evaluation of irrigation management, several organizations and personnel can be qualified and are willing to collaborate in this project. The most obvious is the Hydraulics Research Station (Wad Medani), its staff has been involved in many research programs on irrigation management by its own or in collaboration with other institutes. A study like this falls within the general area of their interest. The specially good contacts between the HRS staff and IIMI office in The Sudan also nominates them for this job.

ANNEX (2)

DATA AVAILABILITY SURVEY

OF

THE GAZERA SCHEME



# NORTHERN AGRICULTURAL PRODUCTION CORPORATION SCHEMES

## INTRODUCTION:

The Northern Agricultural Production Corporation, (NAPC), is part of the MOA, and is responsible for the management of all the government schemes irrigated from the Main Nile from Khartoum to the borders with Egypt. There are 14 such schemes, each with its own pumping installation, they cover an area of 92 308 feddans (37 600 hectares). Main crops grown in these schemes are wheat, dura (sorghum), beans, fodders and vegetables and fruits.

The headquarters office of the NAPC is located at Ed Damar, the capital city of the Northern Region, however, the NAPC irrigation department is at Shendi town. In addition, the NAPC has a local management office in each of its schemes.

Unlike any other government scheme in the country, The MOI is not involved in the management of the NAPC schemes, instead, the NAPC operates and maintains all its pumps and canals.

## DATA AVAILABILITY:

### 1) HYDROMAT DATA:

Several of the metrological stations run by the SMD exist in the main towns in the NAPC scheme area. At these stations; temperature, humidity, wind speed and rain fall are read and recorded daily. The data can be available from the stations sites or from the SMD headquarters office, Khartoum.

Evapotranspiration, however, is only measured at the Agro-metrological Stations, El Hodiba station, which is located at Hodiba Agricultural research Station, at about 300 Km. north of Khartoum, is located daily in the middle of the schemes.

### 2) HYDRAULIC DATA:

The NAPC, through its field offices at all individual schemes,

keeps records of the daily pumping hours to each of its schemes, the daily river water level upstream each of the pumping stations. These information can be used together with the pump characteristics to estimate the daily total volume of water delivered to the whole area of each scheme. No other information are available on water delivery to individual lateral, distributary or farm outlet. Pumping hours and river water level data can be obtained from the NAPC field offices.

For the data concerning command area and size of the canal, the following table summaries the data availability for a typical NAPC scheme.

| DATA REQUIRED          | DATA AVAILABILITY |           | SOURCE                |
|------------------------|-------------------|-----------|-----------------------|
|                        | SYSTEM BASIS      | SUBSYSTEM |                       |
| Size of Planned area   | available         | available | NAPC (Scheme offices) |
| total length of canals | "                 | "         | "                     |
| total area of canals   | "                 | "         | "                     |

### 3) WATER DISTRIBUTION:

The following table summarizes the availability of data concerning the water distribution in a typical NAPC scheme:

| INFORMATION NEEDED | PAST & CURRENT INFORMATION | SOURCE                        |
|--------------------|----------------------------|-------------------------------|
| Source of water    | available                  | NAPC (Shendi & scheme office) |
| Nature of flow     | "                          | "                             |
| Type of regulation | "                          | NAPC, (Scheme office)         |
| Type of canal      | "                          | "                             |

|  |   |   |
|--|---|---|
| Type of flow                                     | " | " |
| Scheduling procedure                             | " | " |
| Method of calculating crop water requirement     | " | " |
| Planned command area by crop & season            | " | " |
| Organizations responsible for water distribution | " | " |
| Complaint Handling procedures                    | " | " |
| Mechanism for checking water supply fulfilment   | " | " |
| How to know farmer satisfaction                  | " | " |

#### 4) IRRIGATED AREA:

The NAPC, through its offices at each individual scheme collects water charges from the farmers, the values these water charges depends on the area and type of crops being irrigated and as such the NAPC keeps detailed records of the planned and actually irrigated areas for each individual scheme, each farmer and each part of the scheme.

#### 5) AGRICULTURE:

As concerning production and yield from the scheme, no formal information are available for any of the NAPC schemes. The Agricultural research Stations at Shendi and Hodiba and the Agricultural Extension office at Shendi and Ed'damar have an informal estimates of the yield for different crops grown in scheme, these estimates are, however, unreliable and cannot be used for irrigation performance evaluation.

Similarly no formal reliable information are available on the quantities of non-water agricultural inputs such as seeds, fertilizers, insecticides, tractors hours ....etc. Although the Agricultural bank keeps records of the quantities of fertilizers (and seeds for some crops) sold to some the farmers, but still,

it is not necessary that the farmer will use the same quantities supplied by the bank.

#### 6) SOIL TYPE AND GROUND WATER DATA:

As part of the Roseries Soil Survey in 1963 -1967, the SSA conducted a semi-detailed soil survey in both banks of the Main Nile. The survey had been confined to the land lying within the first 20 m. contour above the river, on either banks of the Main Nile, and as such it covers all the NAPC schemes areas. Reports and a 1:50 000 scaled maps of these surveys can be obtained from the SSA (Wad Medani). Copies of these reports and maps are also available from the MOI library at Wad Medani.

As concerning ground water data, the National Rural Water Cooperation, (NRWC), which is the organization responsible for the drinking water supplies to the villages from ground water wells, keeps records of ground water depths of all the wells dug in all the villages in the scheme area. These information can be available from the NRWC offices in the main towns of the scheme area, but no informations are available on seepage and deep percolation losses from the soil type in the scheme area.

#### 7) COST ELEMENTS AND MANPOWER:

##### 7.1) OPERATION AND MAINTENANCE COST:

Although The NAPC collects water rates from the farmers, these water rate does not necessarily reflects the actual cost of operation and maintenance of its schemes, as the government policy towards these schemes is to consider them as subsistence schemes. The collected water rate goes to the Ministry Of Finance and Economic planing (MOFEP) and in turn the MOFEP provides the NAPC with an annual budget to cover all it expenses. As this budget is approved and provided by the MOFEP, it has to be drawn up in lines with the Government Of Sudan (GOS) structures of annual budgets for government departments. Using these structures the NAPC budget consist of three separate parts or chapters:

Chapter I: This covers items such as salaries, wages and other

allowances for all the staff.

CHAPTER II: This covers the cost of operation and routine maintenance, it includes the cost of items such as; petrol, spare parts, rents, building material ...etc.

CHAPTER III: This part of the budget is for development, it includes items such as building of new houses or offices, purchase of new cars or vehicles ...etc.

The budget is allocated for all the NAPC as one organization and no information is available on how much is the budget allocated for or the actual expenses of each individual scheme.

#### 7.2) REHABILITATION:

A rehabilitation program is now being undertaken in all the NAPC schemes, detailed informations on the cost of each item of this rehabilitation can be found from the NAPC rehabilitation unit office at Shendi or Ed damar.

#### 7.3) MAN POWER AND ORGANIZATIONS INVOLVED:

A part from the farmer the only organization involved in the actual management of NAPC scheme is the NAPC. Although some assistance are available to the farmers from organizations such as the Agricultural Extension Department of the Ministry Of Agriculture and the Sudan Agricultural Bank, but they are not involved in the decision making of the scheme. Detailed information on the numbers and classification of the NAPC manpower and farmers can be available from the NAPC headquarters at Ed damar.

#### 8) FARMING SYSTEM:

The following table summarizes the farming system data availability for NAPC scheme:

| INFORMATION NEEDED | CURRENT & PAST<br>DATA | SOURCE |
|--------------------|------------------------|--------|
|--------------------|------------------------|--------|

|   |               |                           |
|---|---------------|---------------------------|
| Farm size statistics                    | available     | NAPC,<br>(Ed'amar)        |
| Type of farming<br>and crops grown      | "             | NAPC, (scheme<br>offices) |
| Type of machinery<br>used               | "             | " "                       |
| Seed used                               | "             | " "                       |
| Seeding and transplantation<br>practice | "             | " "                       |
| Economic basis of farming               | Not available | -----                     |
| Farm income                             | "             | -----                     |
| Land Tenure                             | available     | NAPC, (scheme<br>offices) |
| Ownership size                          | "             | " "                       |
| Family size                             | Not available | -----                     |
| Source of farm labour                   | "             | -----                     |

#### 9) FARMERS ORGANIZATION:

Some form of farmers organizations exists in the NAPC schemes, informations on their activities and effectiveness can be available from the NAPC schemes offices.

## GAZERA SCHEME

### INTRODUCTION:

The Gazera scheme, which lies in the triangular area between the Blue Nile and the White Nile immediately south of Khartoum was commissioned in 1925 and since then its cultivatable area has expanded gradually to its present area of 2 100 000 feddans (Approximately = 882 000 hectares). The Gazera scheme is considered the largest single enterprise in the Sudan, it has been estimated that it contributes 7 to 10 percent of the GDP of the country. The main crops grown are cotton, wheat, groundnut, dura (sorghum) and vegetables. The annual water consumption of the scheme is 5.5 milliard cubic metres of water, this water is supplied by gravity from Sennar Dam on the Blue Nile through twin main canals of total maximum discharge capacity of 31 millions cubic metres per day.

Two government organizations are involved in the management of the scheme; The Ministry Of Irrigation (MOI) and the Sudan Gazera Board (SGB). The MOI supplies and distributes the irrigation water up to certain point in the system, from that point and down the management of the water is controlled by the SGB and the farmers. The SGB is the agricultural administrator of the system, it has its head office at Barakat and has a number of field offices, In addition to the distribution of the water it controls and supervises most of the agricultural activities in the scheme.

Because, probably, of its age, exceptionally large size and its importance to the economy of the country, the Gazera scheme is, by far, the best documented irrigation system in the Sudan, and as such it would be the most suitable for application of the proposed model for evaluation of irrigation management.

### DATA AVAILABILITY SURVEY:

#### 1) HYDROMAT DATA:

A principal agro-meteorological station was established in Wad

Medani in 1957, since then daily measurements of all the parameters needed for determining crop consumptive use by Penman method are taken and recorded. This station is situated fairly in the middle of the scheme area, and if it is necessary to cater for the variation of these parameters in different parts of the scheme then use can be made of the data collected in three other first order metrological stations situated almost in the three corners of the scheme at Kosti, Sennar and Khartoum (Shambat station). Data of each of these station can be available from the site of the station or from the Metrological department headquarters office at Khartoum.

As concerning rain fall data, in addition to the daily readings from the four stations mentioned above, the SGB and the MOI run more than 100 rain gauges distributed all over the scheme area, but it has been noticed that recent rain fall data recorded outside the metrological stations may be unreliable.

## 2) HYDRAULIC DATA:

Irrigation water to the Gazera scheme is provided by gravity from SENNAR DAM on the Blue Nile at about 300 Km. upstream of Khartoum. From the dam irrigation water is carried by twin MAIN CANAL each about 200 Km. long. From the MAIN CANAL water is diverted to 107 MAJOR CANALS. Typically a MAJOR CANAL is 16 Km. in length and command an area of 8 000 hectares. The MAJOR CANALS divert the water to some 1 500 MINOR CANALS which are of average length of 6 Km. and command an average area of 600 hectares. From the MINOR CANAL irrigation is diverted to a standard sized fields of 38 hectares in area, called a NUMBER, through a FIELD OUTLET PIPE (FOP).

The following subsections summarizes the hydraulic data availability for each stage of the distribution system in the Gazera scheme. All the data available are available for at least the last ten years.

### 2.1) RESERVOIR AND RIVER DATA:



| DATA REQUIRED      | FREQUENCY | SOURCE                  |
|--------------------|-----------|-------------------------|
| River discharge    | Daily     | MOI (Sinnar & Khartoum) |
| River water level  | Hourly    | MOI (Sinnar)            |
| Reservoir out flow | Daily     | MOI (Sinnar & Khartoum) |
| Reservoir storage  | Ten days  | MOI (Sinnar & Khartoum) |

## 2.2) MAIN CANAL:

The total volume of water released from the Dam to the whole scheme area is read and recorded daily and can be available from the MOI (Sinnar). In addition to that water level upstream and downstream and the gate openings of all the intermediate regulator of the main canal is read and recorded three times a day, recent calibration of some of these structures was conducted by the Hydraulics Research Station (HRS) and can be available from HRS Wad Medani.

## 2.3) MAJOR CANALS:

Water level upstream and downstream and the gate openings of all the head and intermediate regulators of the majors are read and recorded three times a day by the MOI field engineers. Some limited number of current-meter measurements of the discharge at some points in some of these majors were taken by the HRS.

## 2.4) MINOR CANALS:

The minor canals off-takes is the point where water control responsibility is handed over from the MOI to the SGB. The water entering these minor canals passes over a weir type structure and at this point the MOI field engineers records the head over the weir three times a day in addition to the weekly water request from the SGB. The HRS has taken a limited number of current meter discharge measurements of the water entering some of the minors in the scheme.

## 2.5) FIELD OUTLET PIPES (FOPs):

The only data available on the FOPs flows is an hourly measurements taken by the HRS for a full season in nine of these

FOPs in 1986/87 season using automatic measuring devices, apart from that there is a very limited isolated measurements taken by earlier by the ARC.

As concerning the originally planned ~~area~~ <sup>area</sup> command data can be available from the SGB headquarters at Barakat, or the MOI offices at Wad Medani.

As concerning canal length and surface areas, data can be available from the MOI field offices or at Wad Medani.

3) WATER DISTRIBUTION:

The following table summarizes the availability of the water distribution data in the Gazera scheme:

| INFORMATION NEEDED                           | CURRENT & PAST AVAILABILITY | SOURCE                 |
|--|-----------------------------|------------------------|
| Source of water                              | available                   | MOI, (Sinnar)          |
| Nature of source                             | "                           | "                      |
| Nature of flow                               | "                           | "                      |
| Type of regulation                           | "                           | MOI, (Field engineers) |
| Type of canals                               | "                           | "                      |
| Any lining                                   | "                           | MOI & SGB              |
| Type of flow                                 | "                           | " "                    |
| Scheduling procedure                         | "                           | " "                    |
| Method of calculating crop water requirement | "                           | " "                    |
| Size of originally planned command area      | "                           | " "                    |
| Organizations responsible water distribution | "                           | " "                    |
| Complaint handling procedures                | "                           | " "                    |
| method of checking if CWR are satisfied      | "                           | " "                    |

|                                 |   |                    |
|---------------------------------|---|--------------------|
| How to know farmer satisfaction | " | SGB, (field staff) |
| Planned and actual total supply | " | MOI, (Sinnar)      |

4) IRRIGATED AREA:

The SGB field staff keeps detailed records of areas planned for irrigation, areas actually irrigated and the sowing dates, for each individual farmer and each individual crop. This data can be available from the SGB field staff offices. Summary and some statistics of this data is published by the SGB in their annual report.

5) AGRICULTURE:

For the crops grow in the scheme, the government is most concerned about cotton and to a lesser degree wheat and for these crops the SGB provides the farmer with all the agricultural inputs, and according to the system of management of the scheme the farmer have to sell all his cotton and wheat crop yields to the government through the SGB. The SGB field offices keeps detailed record of all the agricultural inputs and yield for the cotton and wheat crops for each individual farmer and each individual farm, a summary and some statistics of this data can be found in the SGB annual reports.

For other crops however, they are considered as "farmers crops" and although the SGB, through its Economic and Social Research Unit (ESRU), collect and publish some summary and statistics on yield and agricultural inputs for these crops, the data is less reliable than that of cotton and wheat.

6) SOIL TYPE AND GROUND WATER DATA:

A semi-detailed soil survey covering all the Gazera scheme area was conducted in 1970 by the SSA. A detailed soil survey in the scheme area is now, (Non. 1989), also being undertaken by the SSA, most of the Gazera area was now covered and the survey is expected to be finished in three years time. Reports and soil

maps of these two surveys can be obtained from the SSA office at Wad Medani.

## 7) COST ELEMENT AND MANPOWER:

### 7.1) OPERATION AND MAINTENANCE COST:

Both the MOI and the SGB which are involved in the management of the scheme are government organizations and as such their annual budget have to be proved and provided by the MOFEP and, therefore, it have to be drawn up and recorded using the standard structure of the Government Of Sudan, GOS.

The standard structure of the GOS's system of recording expenditure is to put these expenditures under one of the three "chapters";

CHAPTER I: This consists of salaries, wages and all other allowances for all the staff.

CHAPTER II: Recurrent expenditure for the operation and routine maintenance of the system, such as fuel, spare parts, building materials ...etc.

CHAPTER III: Non-recurrent expenditure, such as building of new houses or offices, purchase of new vehicles and cars ...etc.

Data on each item of these three chapters can be available from the respective organizations, but these items are coded for each organization for the whole Gazera area and therefore some desegregation is needed if the cost of sub areas in the scheme is needed.

### 7.2) REHABILITATION:

A major rehabilitation program is now going on in the scheme, the total cost of this program is in the order of 300 million american dollars. Separate offices had been set up in both the MOI (Wad Medani) and the SGB (Barakat) to coordinate this

program. These are in addition to the Gazera Rehabilitation Management Unit (GRPMU) main office at Khartoum.

Detailed informations about the elements and cost of this program can be found from these offices.

### 7.3) MANPOWER:

Detailed informations on the classification, number and type of manpower and job description for each of the SGB and the MOI can be obtained from their respective offices for the Gazera scheme as whole and for each sub-area of the scheme.

### 8) FARMING SYSTEM:

The following table summarizes the farming system data availability for the Gazera scheme:

| INFORMATION NEEDED                   | CURRENT & PAST DATA | SOURCE        |
|--------------------------------------|---------------------|---------------|
| Farm size statistics                 | available           | SGB (Barakat) |
| Type of farming and crops grown      | "                   | " "           |
| Type of machinery used               | "                   | " "           |
| Seed used                            | "                   | " "           |
| Seeding and transplantation practice | "                   | " "           |
| Economic basis of farming            | "                   | " "           |
| Farm income                          | "                   | " "           |
| Land Tenure                          | "                   | " "           |
| Ownership size                       | "                   | " "           |
| Family size                          | Not available       | -----         |
| Source of farm labour                | "                   | -----         |

### 9) FARMERS ORGANIZATION:

There exists some farmers organizations which are involved, somehow, in the management of the scheme, informations on their

jobs and effectiveness can be obtained from the SGB field staff or the SGB headquarter office at Barakat.

ANNEX (3)  
DATA AVAILABILITY SURVEY  
OF  
KENANA SUGAR SCHEME

## KENANA SUGAR SCHEME

### INTRODUCTION:

Kenana sugar scheme which lies in the eastern side of the White Nile some 300 Km. upstream of Khartoum, was commissioned in 1977. It has a net cultivatable area of 85 000 feddans (approximately 35 700 hectares). The irrigation water to the whole scheme area is supplied by pumping from the white Nile to irrigate its only crop, sugar cane. The main pumping instillation at the river has seven units each of a pumping capacity of 5.6 cubic metres per second.

The scheme, together with its sugar factory, are a private enterprise owned by Kenana Sugar Company (KSC), the Government of the Sudan being only a share holder in the company.

### 1) DATA AVAILABILITY:

#### 1) HYDROMAT DATA:

KSC runs a metrological station as part of its Agronomic Research Unit, the metrological station is situated inside the scheme area. In this station Temperature, Humidity, wind speed, rainfall and evaporation are measured daily and published in the weekly KSC report.

#### 2) HYDRAULIC DATA:

Irrigation water to the whole scheme area is pumped from the White Nile by Pump Station 1 (PS1) into a feeder canal 13 km. long and then passed through a series of three other pump instillation along the main canal. From the main canal the water is diverted into a number of primaries through a weir type regulator. The primary canals supply field canals which irrigate the sugar cane fields. The average area of a typical sugar cane field is 150 feddans (63 hectares). Long furrow irrigation is practised in the fields and irrigation water is supplied to these furrows by a syphon pipes.



Unlike any other irrigation system in the Sudan, facilities for draining excess irrigation water are provided in Kenana scheme, and although there is no measurement of the volume of water drained back to the river, it has been estimated that these losses are considerable.

There is no discharge measurement at any level of the irrigation system, however, pumping hours and water levels in the river are recorded daily. This data can be used with the pump characteristics for the estimation of the daily volume of water supplied to the scheme area. Similarly, the head over the weirs at all the intermediate structures of the main canal and the primary canals off-takes is recorded daily and can be used for estimating the volume of water delivered to each of these primaries.

For the data concerning the planned command area and the size and length of the canals, the following table summarizes the data availability for Kenana scheme:

| DATA REQUIRED          | DATA AVAILABILITY |            | SOURCE                |
|------------------------|-------------------|------------|-----------------------|
|                        | SYSTEM BASIS      | SUBSYSTEMS |                       |
| Size of planned area   | available         | available  | KSC, (field managers) |
| total length of canals | "                 | "          | "                     |
| total area of canals   | "                 | "          | "                     |

### 3) WATER DISTRIBUTION:

The following table summarizes the availability of the water distribution data in Kenana sugar scheme:

| INFORMATION NEEDED                           | CURRENT & PAST AVAILABILITY | SOURCE |
|--|-----------------------------|--------|
| Source of water                              | available                   | KSC    |
| Nature of source                             | "                           | "      |
| Nature of flow                               | "                           | "      |
| Type of regulation                           | "                           | "      |
| Type of canals                               | "                           | "      |
| Any lining                                   | "                           | "      |
| Type of flow                                 | "                           | "      |
| Scheduling procedure                         | "                           | "      |
| Method of calculating crop water demands     | "                           | "      |
| Size of originally planned command area      | "                           | "      |
| Organizations responsible water distribution | "                           | "      |
| Complaint handling procedures                | "                           | "      |
| method of checking if CWR are satisfied      | "                           | "      |
| How to know irrigators satisfaction          | "                           | "      |
| Planned and actual total supply              | Not available               | -----  |

#### 4) IRRIGATED AREA:

For the agricultural and irrigation management purposes, the scheme area is divided into a number of subareas or sections, each managed by a section manager. The section manager in his section keeps detailed record, by field, of the planned areas for planting sugar cane, areas actually planted, planting dates and total area irrigated each year.

#### 5) AGRICULTURE:

Section managers of the KSC keeps detailed records of all agricultural inputs, machinery working hours and labour and staff

man-hours for their section each year. For yield, however, data is usually coded for the whole scheme area.

#### 6) SOIL TYPE AND GROUND WATER DATA:

The SSA has conducted a semi-detailed soil survey in the scheme area as part of the planning stage of the scheme. Soil map and soil suitability map can be available from the KSC or from the SSA offices at Wad Medani.

No informations are available on the ground water average depth or annual fluctuations in the scheme area.

#### 7) COST ELEMENTS AND MANPOWER:

##### 7.1) OPERATION AND MAINTENANCE:

As KSC is a private company, its budgetary system doesn't have to follow the GOS system of coding and recording expenditure. The company is organizationally divided into four specialized units; Agricultural Administration Unit, Workshop, Harvesting Unit and the Sugar Factory. Each of these units has a special job to do and accordingly it is allocated a budget to be able to carry out that job.

Although each specialized unit keeps records of all its expenditure, and because these units provide services for all the scheme area, some desegregation is needed if this expenditure are needed as per hectare or for individual section of the scheme.

##### 7.2) REHABILITATION:

Since the commission of the scheme in 1977, no rehabilitation has taken place .

##### 7.3) MANPOWER:

No farmers are involved in the running of the scheme, instead, the company employ direct labour for all agricultural, irrigation and other jobs in the scheme. Each unit in the company keeps detailed records of the number and classification of the manpower

used. Again if data on the number and classification of the manpower by canal of section is needed, then some desegregation is needed.

8) FARMING SYSTEM:

The following table summarizes the farming system data availability for the Kenana sugar scheme:

| INFORMATION NEEDED                   | CURRENT & PAST DATA | SOURCE |
|--------------------------------------|---------------------|--------|
| Farm size statistics                 | available           | KSC    |
| Type of farming and crops grown      | "                   | "      |
| Type of machinery used               | "                   | "      |
| Seed used                            | "                   | "      |
| Seeding and transplantation practice | "                   | "      |
| Economic basis of farming            | "                   | "      |
| Farm income                          | Not available       | -----  |
| Land Tenure                          | Available           | KSC    |
| Ownership size                       | -----               | -----  |
| Family size                          | Not available       | -----  |
| Source of farm labour                | "                   | -----  |

9) FARMERS ORGANIZATION:

No farmers are involved in the scheme.

ANNEX (4)  
DATA AVAILABILITY SURVEY  
OF  
SALAWA BASIN

## SALAWA FLOOD BASIN SCHEME

### INTRODUCTION:

Salawa basin scheme lies in the western side of the Main Nile at about 40 Km. upstream of Shendi town, (about 110 Km. down stream of Khartoum). It has a net cultivatable area of 5 000 feddans (2100 hectares). Main crops cultivated in the basin are dura (sorghum), beans and vegetables. The scheme rely on flood water for irrigation.

### DATA AVAILABILITY:

#### 1) HYDROMAT DATA:

The nearest metological station to the scheme area is located at Shendi town and is run by the Sudan Metrological Department (SMD). At this station temperature, humidity, wind speed and rainfall are read and recorded daily. The data can be available from Shendi metrological station or the metrological department, Khartoum.

Evapotranspiration, however, is not measured at Shendi station, but is measured at Hodiba agro-climatological station located 100 Km. north of the scheme, and at Shambat agro-climatological station at about 100 km south of the scheme.

#### 2) HYDRAULIC DATA:

The scheme area is divided into three hods ( basins): Salawa basin (1 400 feddans), Tabga basin (2 6000 feddans) and Shaigiya basin ( 1 000 feddans). The three basins are separated from each other by an embankment and stop-log type regulator. The basins are supplied with the flood water by means of an inlet channel 4 Km. in length. There is also two out drains for passing excess water and draining flood water back to the river when cultivation is to be started in the basins.

In the river flood season (August-September), flood water is

allowed in to the basins through the inlet channel and is left there until mid-October ( or on request of the farmers if they need to cultivate earlier) and the water is drained back to the river.

During this period ( beginning of flood to the draining of the water from the basins), the MOI records the water level in the basin daily. This is the only hydraulic data available for this scheme, and can be available from the MOI office at Shendi.

In years when the flood level is low, farmers and land owners operate their own pumps to irrigate part of the area or to suppliment the flood irrigation.

3) WATER DISTRIBUTION:

The following table summarizes the availability of data concerning the water distribution in Salawa Basin:

| INFORMATION NEEDED                               | PAST & CURRENT INFORMATION | SOURCE       |
|--|----------------------------|--------------|
| Source of water                                  | available                  | MOI (Shendi) |
| Nature of flow                                   | "                          | "            |
| Type of regulation                               | "                          | "            |
| Type of canal                                    | "                          | "            |
| Type of flow                                     | "                          | "            |
| Scheduling procedure                             | "                          | "            |
| Method of calculating crop water requirement     | -----                      | -----        |
| Planned command area by crop & season            | Not available              | -----        |
| Organizations responsible for water distribution | AVAILABLE                  | MOI (Shendi) |
| Complaint Handling procedures                    | "                          | "            |
| Mechanism for checking water supply fulfilment   | NOT available              | -----        |

How to know farmer  
satisfaction

Not available

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4) IRRIGATED AREA:

The area which can be cultivated each year depends on the flood hight on that year, and no data is available on the area actually flooded or actually cultivated every year.

5) AGRICULTURE:

Because no government is involved in the field management, no data is available on what crops are grown, how much area, what agricultural inputs were used or what is the production or yield in these basins.

6) SOIL TYPE AND GROUND WATER DATA:

A semi-detailed soil survey was conducted in the Salawa basin scheme by the SSA as part of the Roseries Soil Survey in 1963 - 1967. Informations on this soil survey can be obtained from the SSA offices at Wad Medani. As concerning informations on the ground water depth or annual fluctuations the NRWC has detailed records of the ground water depths in all the wells dug in the villages in the vecinity of the basin. These informations can be available from the NRWC office at Shendi.

7) COST ELEMENTS AND MANPOWER:

The only government organization involved in the running of Salawa basin is the MOI. Even the MOI responsibility is confined to maintaining the embankments, and operating the stop-locks and outlet drains. Any other job is totally the responsibility of the farmer without any control imposed on him or any assistance from any government organization apart from services from non-decision making organization such as the Agricultural Extension Department and the Sudan Agricultural Bank, which are readily available for private schemes.



The MOI does its job in these basins as part of other jobs, and as such, it is difficult to separate exactly, how much was spend in the scheme or the manpower employed by the MOI in the scheme.

8) FARMING SYSTEM:

As the government has no control or responsibility on the cultivation and farming practice, no informations are available on this.

9) FARMERS ORGANIZATIONS:

No farmers organizations exists.

ANNEX (5)  
DATA AVAILABILITY SURVEY  
OF  
THE RAHAD SCHEME

## RAHAD SCHEME

### INTRODUCTION:

The Rahad scheme lies in the eastern side of the Rahad River (east of the Blue Nile) at about 250 km. south east of Khartoum. It was commissioned in 1976 and has a total cultivatable area of 300 000 feddans (126 000 hectares). The main crops grown in the scheme are cotton, groundnut, sorghum and vegetables. The scheme water supply is pumped from the Blue Nile near Maina Village, east of Singa town and about 75 km. upstream of Sinnar Dam. The pumping station is equipped with eleven electrically driven pump units having a total discharge capacity of 105 cubic meters per second.

The Scheme is managed by the Rahad Agricultural Corporation, (RAC), with its headquarters office at El Fao Town, inside the scheme area.

### DATA AVAILABILITY:

#### 1) HYDROMAT DATA:

A metrological station exists inside the scheme. At this station; temperature, humidity, wind speed and rainfall are measured and recorded daily. For evaporation data, however, measurements taken at Wad Medani agro-climatological station ( about 80 km from the scheme centre), and Sinnar Agro-climatological station ( about 70 km. from the scheme centre) can be obtained.

#### 2) HYDRAULIC DATA:

Water is pumped from the Blue Nile into a 84.4 km. long feeder canal which syphons under the River Dinder to discharge in the river Rahad just upstream of the Rahad Barrage, (at Abu Rakham). The main canal of the scheme receives gravity supply from the barrage, this water is a combination of water pumped from the Blue Nile and the seasonal flow of the Rahad River. From the main canal water is delivered to a number of major canals and then to

minors before it enters the fields through the Field Outlet Pipes (FOP's).

The following hydraulic data is available from the MOI & field engineers:

- At the pumping station; daily water levels and pumping hours, for use with the pump characteristics to estimate the daily volume of water pumped into the scheme.
- Daily water levels and water releases from The Rahad Barrage.
- Upstream, downstream and gate openings of all intermediate regulators of the main canal. major canals and minor canals off takes. The quality of data here is not always good as some of the level gauges are not in position.

3) WATER DISTRIBUTION:

For the data concerning command area and size of the canal, the following table summaries the data availability for the Rahad scheme.

| DATA REQUIRED          | DATA AVAILABILITY |            | SOURCE                  |
|------------------------|-------------------|------------|-------------------------|
|                        | SYSTEM BASIS      | SUBSYSTEMS |                         |
| Size of planned area   | available         | available  | MOI, (Fao) & RAC, (Fao) |
| total length of canals | "                 | "          | "                       |
| total area of canals   | "                 | "          | MOI, (Fao)              |

3) WATER DISTRIBUTION:

The following table summarizes the availability of the water distribution data in the Rahad scheme:

| INFORMATION NEEDED                              | CURRENT & PAST AVAILABILITY | SOURCE                     |
|---|-----------------------------|----------------------------|
| Source of water                                 | available                   | MOI, (Fao)                 |
| Nature of source                                | "                           | " "                        |
| Nature of flow                                  | "                           | " "                        |
| Type of regulation                              | "                           | " "                        |
| Type of canals                                  | "                           | " "                        |
| Any lining                                      | "                           | MOI, (Fao) &<br>RAC, (Fao) |
| Type of flow                                    | "                           | MOI, (Fao) &<br>RAC, (Fao) |
| Scheduling procedure                            | "                           | MOI, (Fao) &<br>RAC, (Fao) |
| Method of calculating crop water demands        | "                           | RAC, (Field staff)         |
| Size of originally planned command area         | "                           | "                          |
| Organizations responsible water distribution    | "                           | MOI, (Fao) &<br>RAC, (Fao) |
| Complaint handling procedures                   | "                           | "                          |
| Mechanism to check that water demands satisfied | "                           | RAC, (Field Staff)         |
| Knowledge of water users satisfaction           | "                           | " "                        |
| Planned and actual supply                       | "                           | MOI, (Field staff)         |

#### 4) IRRIGATED AREA:

The RAC, through its field staff, keeps detailed records of the areas planned for irrigation, area actually irrigated and area harvested for each individual farmer and each individual crop.

#### 5) AGRICULTURE:

Of the crops grown in the scheme area, reliable data on the yield is available only for cotton. Cotton yield data can be available for each farmer in the scheme from the RAC headquarters office at El Fao, or from RAC field staff. For other crops, however some statistics can be available from the RAC, headquarter office at El Fao, but the data is less reliable than in the case of cotton.

The RAC also supply most of the agricultural inputs to the farmers and, as such, data can be available on all inputs supplied or applied by the RAC.

#### 6) SOIL TYPE AND GROUND WATER DATA:

A semi-detailed soil survey was conducted in the whole scheme area prior to its construction, informations on this soil survey, including soil maps and soil suitability maps can be available from the SSA headquarter office at Wad Medani.

For ground water informations, however, most of the scheme area lies on the top of a basement complex rocks which is a non-water bearing formation.

#### 7) COST ELEMENT AND MANPOWER:

##### 7.1) OPERATION AND MAINTENANCE COST:

Both the MOI and the RAC which are responsible for the management of the scheme are government organizations and as such their annual budget have to be proved by the MOFEP, therefore, this budget have to be drown up and recorded using the standard structure of GOS for recording government organizations expenditure.

The standard structure of the GOS's system of recording expenditure is to put it under one of the three "chapters";

CHAPTER I: This consists of salaries, wages and other allowances.

CHAPTER II: Recurrent expenditure for the operation and routine maintenance of the system, such as fuel, spare parts, building materials ...etc.

CHAPTER III: Non-recurrent expenditure, such as building of new houses or offices, purchase of new vehicles and cars ...etc.

Data on each item of these three chapters can be available from the respective organizations, but these items are coded, for each organization, for the whole Rahad area and, as such, some desegregation is needed if the cost of sub-areas in the scheme is needed.

7.2) REHABILITATION:

No rehabilitation has taken place in the scheme since its commition in 1976.

7.3) MANPOWER:

Detailed informations on the classification, number and type of manpower and job description for each of the RAC and the MOI can be obtained from their respective offices at El Fao town. Data on this manpower can be available for the system as whole and for each sub-area of the scheme.

8) FARMING SYSTEM:

The following table summarizes the farming system data availability for the Rahad scheme:

| INFORMATION NEEDED              | CURRENT & PAST DATA | SOURCE     |
|---------------------------------|---------------------|------------|
| Farm size statistics            | available           | RAC, (Fao) |
| Type of farming and crops grown | "                   | " "        |
| Type of machinery used          | "                   | " "        |
| Seed used                       | "                   | " "        |

|                                      |               |                 |
|--------------------------------------|---------------|-----------------|
| Seeding and transplantation practice | "             | RAC & ARS (Fao) |
| Economic basis of farming            | Not available | -----           |
| Farm income                          | "             | -----           |
| Land Tenure                          | available     | RAC, (Fao)      |
| Ownership size                       | "             | " "             |
| Family size                          | Not available | -----           |
| Source of farm labour                | "             | -----           |

9) FARMERS ORGANIZATIONS:

There exists some farmers organizations which are involved, in some way, in the management of the scheme, informations on their jobs and effectiveness can be obtained from the RAC field staff or the RAC headquarter office at El Fao Town.



ANNEX (6)  
DATA AVAILABILITY SURVEY  
OF  
NATIONAL LEVEL DATA

## NATIONAL LEVEL INFORMATION

### TUBE WELL:

The use of ground water for irrigation in The Sudan is very limited . This is probably because; usually the ground water exists in deep layers and will be expensive to pump. In recent years (5 - 10 last years), there is an increasing trend for the use of small, hand dug, well for irrigation near rivers banks where ground water is relatively shallow. The <sup>use</sup> of these wells is confined to small scale (5 - 10 hectares) privately owned schemes, and are used for irrigating high value vegetables and fruits crops near big towns where the high prices of these crops justifies the high pumping cost.

No data exists on the number of these well, their average command areas or the types of pumps used. Local councils have some data on the number and areas of the ground water pumps, as they have to get licensed by these councils, but in most cases the actual irrigated area in these schemes is different from the licensed areas and some of the licensed schemes are not operating.

### NATIONAL IRRIGATED AREAS AND PRODUCTION:

The MOA collects, compiles and publishes data on the annual planned areas for irrigation, area actually irrigated in all the country, the national agricultural production and yield of both irrigated and rain-fed agriculture. These infirmations can be available as by individual scheme and by crop, and can be obtained from the MOA, Khartoum, or can be compiled from the MOA and MOFEP reports.

In these data, the infirmations from the government controlled irrigation systems is usually real and was taken formally from these systems. In the case of private systems and rain-fed agriculture, however, the data represents only estimates of the areas and productions, as real data is difficult to acquire even by the MOA.