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**COMPREHENSIVE STRATEGY FOR THE FOOD PROCESSING  
INDUSTRY OF SUDAN**

**NC/SUD/94/01D**

**THE SUDAN**

**Report**

*Prepared for the Government of the Sudan under UNDP-financed TSS-1 facility*

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## **INTRODUCTION**

### **Country profile**

Sudan is the largest country in Africa with an area of 2.5 million square kilometres or one tenth of the total area of Africa. According to the 1993 census the population of the Sudan is 26 million with an annual growth rate of about 2.6%. As compared to the growth of the rural population (1.5%), the annual growth rate of the urban areas (7.5%), gives an idea of the urbanisation trend affecting the country. This trend has started around the mid 1980's, mostly as a consequence of negative factors such as drought, desertification and political insecurity. The population is very unevenly distributed with half living on just 15% of the land, in particular along the Nile River. The population is highly mobile and mostly rural. The economically active population reached 9.3 million in 1990 of which almost 80% living in the rural areas. About 45% of the population is young under the age of 15. The Sudan shares borders with Egypt, Libya, Chad, Central African Republic, Zaire, Uganda, Kenya, Ethiopia and Eritrea. A federal system of governance was introduced in 1991, dividing the country into 9 states. In 1994, this system was adjusted to 26 states each of which headed by a Governor ("Wali"). A number of government functions have been decentralised to the state level. Including Khartoum North and Omdurman, the population of the Great Khartoum - Khartoum state reaches about 1.4 million people. Port Sudan, the country's main port, is located on the Red Sea, 1,200 km north-east of Khartoum. The Sudan ranks 151 of 173 countries in the 1994 Human Development Report and has high illiteracy rates, high maternal and infant mortality rates. Only 50% of the population has access to safe water and 70% to health services. Average life expectancy is only 52 years. Nutrition is also a critical indicator, especially in the rural areas, which explains the importance attached by the Government to the objective of the national food security. Contributing factors have included natural disasters from persisting droughts to floods as well as civil conflicts. This has resulted in the displacement of about 3 million Sudanese, and hundreds thousands being at risk of starvation.

In addition, the Sudan is the home of more than one million refugees from neighbouring countries.

### **Economic situation**

As shown in table 1 below, agriculture together with livestock represented in 1994/95 43.6% of the GDP of the Sudan while services came second with 40.4% and industry only third with 16%.

**Table 1. Gross Domestic Product at constant prices (81/82) by type of economic activity 1992/93 - 1994/95 in Million Sudanese Pounds (Ls.)**

Activity	Year					
	Value Ls	%	Value Ls	%	Value Ls	%
Agriculture	3,188	38	3,592	40	4,254	43.6
Irrigated	1,861	10.3	991	11	1,116	11.4
R a i n f e d Mechan.	389	4.6	206	2.3	274	2.8
R a i n f e d Traditional	329	3.9	366	4.1	655	6.7
Livestock	1,379	16.4	1,754	19.5	10,909	19.6
Forestry & others	230	2.7	275	3.1	300	3.1
Industry	1,467	17.5	1,480	16.5	1,558	16
Mining&Quarry	12	0.1	12	0.1	12	0.1
Manufacturing	851	10.1	794	8.8	850	8.7
Electricity & water	192	2.3	209	2.3	212	2.2
Construction	412	4.9	465	5.2	484	5
Services	3,734	44.5	3,917	43.6	3,945	40.0
Govt. services	656	7.8	704	7.8	603	6.2
Other services	3,078	36.7	3,213	35.7	3,342	34.3
Gdp, Factor cost, const. prices	8,389	100	8,990	100	9,957	100
Annual change		12.7		7.2		8.5
Gdp deflat.	10,252		19,479		30,193	
Gdp, Factor Cost, Current price	860,090		1,751,151		2,945,765	

Source: Ministry of Finance and Economic Planning 1995

The three-year Economic Recovery Programme initiated in 1990/1991 has ended with little achievements towards strengthening the national economy. Prices of basic food commodities are rising quickly applying real burden on the poor which covers the majority of the population sector in a country whose per capita income is less than US\$ 400 per annum. The Sudan is greatly dependent on agriculture and the cash crops and is thus highly vulnerable to variations in rainfall (drought as well as floods).

The GNP per capita was estimated at US\$ 401 in 1991. The country's currency is Sudanese Pounds (LS) and the Sudanese Dinar (1 LS = 10 Dinars). An important factor in the economy has been the remittances of Sudanese workers abroad. However, during the Gulf War, a large portion of the immigrant workers had to return to Sudan. MVA per capita is estimated at US\$ 36 as compared to US\$ 62 in Africa and US\$ 208 in the developing countries on average. The external debt is huge: US\$ 13.2 billion in 1991, and estimated at US\$ 16 billion in 1995.

Over the last two to three years the Government of the Sudan has introduced a range of measures to improve the economy. These include floating of the currency, price liberalisation and privatisation. By 1994, subsidies were lifted from almost all commodities, except sugar and petroleum products. A priority concern for the Government is the impact of the measures on vulnerable groups including these (10-200,000) in danger of being laid off in conjunction with privatisation and those laid off as a result of institutional reforms in the Government and restructuring of large state-owned enterprises.

The economy generally is recovering with real growth rates recorded at 7% in 1992/93, 5% in 1993/94 and 3.5% in 1994/95. Agriculture is the basis from which socio-economic development of the Sudan should move ahead, by producing staple foods for the local population, generating foreign currency from the exported products (either as raw materials or as processed products) and by supplying the necessary raw materials for the national agro-based industries. Including livestock, agriculture accounts for 95% of exports and provides the livelihood for two-thirds of the population. While the total arable area is estimated at 84 million hectares, only 15% of it is utilised. Modern irrigated and mechanised rain-fed crop production accounts for over 65% of the agricultural production. The main crops are cotton, sorghum, sesame, gum Arabic, groundnuts and sugar cane. Until the 1984/85 drought, the rain-fed sector provided most of the nation's food requirements while the irrigated sector focused on cash crops for export. In an attempt towards self-sufficiency, the profile of Sudanese agriculture is being radically changed by the Government's Ten year Comprehensive National Strategy (1993-2002), which aims to further diversify the production. Cotton and sugar cane production are still considered to be "strategic sectors" in which the Government maintains full control. The country's livestock resources constitute not only an important element of wealth and prestige to the owner, but forms the basis for exports of live animals and a large production of hides and skins also for exports. A major danger for the country and for the agricultural development in the Sudan is the increasing process of desertification and deforestation.



## **SECTION I.**

### **A. THE AGRICULTURAL SECTOR**

As already said, agriculture is the backbone of the Sudanese economy. Its social importance is also preponderant, as it provides jobs for 75% of the labour force including other sectors such as transportation, services, processing and trade, all of which depend on it. Strategic Government Plans (Ten Year Comprehensive National Strategy 1992-2002) are aimed at food security, export promotion, import substitution and industrialisation. Food processing industries are being increasingly developed and at present account for 78% of all industrial establishments. Agriculture plays a pivotal role by producing the raw materials for food industries, which operate at low capacity, mainly due to the poor performance of the agricultural sector. This in turn, has resulted in high increases in production costs. Additionally, several food industries have been established at national and regional levels without definite linkages between industrial capacity and an assured raw material supply.

#### **1. Land and water use.**

According to the Statistical Department of the Ministry of Agriculture, Natural Resources and Animal Wealth; land utilisation in the Sudan comprises 94 million feddan of desert, 57 million feddan of pasture land, 218 million feddan of forests, 12 million feddan of traditional rainfed farms, 15 million feddan of mechanised rainfed farms and 4.1 million feddan of irrigated farms. This totals to 400 million feddan. The remainder of the area of the country, over 150 million feddan, is not classified.

The Nile and its tributaries is the most important source of water for irrigation. The available supply to the Sudan (20.5 billion cubic metres) is governed by the 1959 water agreement with Egypt, which is not yet fully in application. Utilisation of this water for irrigation is controlled by four dams; two on the Blue Nile (El Roseires, near the Ethiopian border; and Sennar to the south), one on the White Nile just south of Khartoum (Jebel Awilia), and one on Atbara River (Khashm Elgirba). The largest irrigated scheme is the well known Gezira scheme, covering some 2 million feddan and producing 60 percent of Sudan's extra long staple cotton and 70 percent of the country's wheat. The second largest irrigated scheme is New Half, whose 400,000 feddan are under wheat, medium staple cotton, groundnut, fruits and vegetables. The two areas are served by gravity irrigation systems. Other schemes are the Raha (300,000 feddan), (150,000 feddan), and the Blue Nile and White Nile schemes (200,000 feddan). Flood irrigation is used in Delta Toker and Gash in the Eastern part of the country.

#### **2. Farming systems.**

Farming systems have mainly evolved as a function of agro-ecological conditions, acquired technology, market, and socio-economic conditions. Major farming systems in the Sudan comprise irrigated, traditional rainfed and mechanised rainfed farming. Sources of water for irrigation include the Nile and underground water. Other farming systems, which are limited

to relatively small areas, include sugar cane production in Kenana. Livestock production is of varying importance in each of these systems as it is in the traditional specialised livestock based systems. It should be noticed that, while in the farming systems where livestock production is practised an initial although elementary integration exists between agriculture and animal breeding, in the traditional livestock based system any element of integration between the two sectors is completely absent.

### **2.1 Irrigated farming.**

Irrigated farming systems account for over 4 million feddan and receive their water from the Nile, either by gravity or through pumping stations. Because of the high cost of pumping water, farms the crops irrigated through pump schemes tend to result more expensive. However, most of the existing irrigated schemes in the Sudanese gravity irrigation. A description of the farming system of the Gezira is presented further on as typical of all other systems in the Sudan based on irrigated farming.

Although farm size varies, the most common sizes are 15 feddan (Gezira scheme) and feddan (Managil extension). All land either arable or not belongs to the State; so the farmers are only tenants who pay, in addition to a fee to rent the land, also management fees and water charges. Not all tenants live in the scheme: many are resident in Khartoum and use hired labour to cultivate their land. Crop production is often based on a five-course rotation: cotton (or wheat, or sorghum) /groundnuts/vegetables, fodder and fallow. Each farmer has a three to four feddan plot in each course. Plots in a given course are continuous so that a single crop is normally grown over 30 plots, amounting to 90-120 feddan. This area is irrigated by a single canal. Water and some farm operations, such as spraying, are provided by the Gezira Board for the entire area. While there are requirements on farmers to grow cotton, wheat, and in some years groundnuts and sorghum, there are some flexibility in the system. Moreover, farmers are free to decide the area and type, if any, of vegetables to be grown.

Tenants receive extension services from supervisors and other staff of the Gezira Scheme. This farming system is the first user of agricultural inputs in the Sudan, in particular of chemical fertilisers. The Farmers Bank is now the major supplier of credit to farmers in the irrigated systems, supplying inputs and receiving repayment in the form of crops. The usual funding method is Bai'Salam with adjustments made in the share of profits/losses between the Bank and the farmers when crops are sold. Currently implicit interest rates are reported to be about 30%.

Crop yields in the irrigated system are both higher, on average, and less variable than in the other farming systems. However, they are still low when compared to similar production systems in other countries. In addition to the traditional agricultural activities currently undertaken, there are attempts to encourage the integration of these activities with animal production, based in particular on cattle and goat raising. These activities are made possible by the inclusion of fodder crops in the rotations. Although the irrigated farming system has been practised for many years, its stability depends largely on its institutional and management systems. The impending privatisation of the major irrigation systems may have far-reaching consequences for the evolution of appropriate farming systems.

## **2.2 Mechanised rain-fed farming.**

The mechanised rainfed farming system has traditionally been practised on the heavy clay soils (vertisols), in areas with average rainfall of 400-700 mm per annum. Exceptionally, rainfall may be as low as 300 mm or as high as 1000 mm. The mechanised system can be conveniently divided into three categories as follows: farms on demarcated land established by the Mechanised Farming Corporation (MFC); farms on demarcated land established by the Investment Public Corporation (IPC) since 1990; and farms on un-demarcated land.

According to available information, a total of 5,739 farms had been established on demarcated land prior to 1990, occupying some 8.57 million feddan. By far the most common farm size is 1,000-1,500 feddan. This group accounts for about 65% of farms and 44% of the mechanised rainfed farming area. Farms pertaining to the largest size, namely over 2,000 feddan, represent less than 1% in number of the total, but account for about 23% of the area. These statistics do not provide a complete picture of the existing situation, since some farms are managed by groups and may be internally divided into smaller holdings while others are run by co-operatives whose members have a 1,000 feddan farm each. As a result of MFC demarcation procedures, these farms are located on clay soils areas with reasonable average rainfall. Much less information is available on mechanised farming in the un-demarcated areas, although it is believed to have a similar farm size distribution and to occupy about 9.5 million feddan. Environmental damage appears to be huge in the non-demarcated areas as a consequence of irrational farming, grazing and fuel wood collection.

Regardless of the type of land on which the farm is located, 1,000 to 1,500 feddan is the most common size for the farms of this system. These farms represents about 65 percent of the total number on demarcated land. The dominant crop is sorghum which accounts, on average, for about 85% of the cropped area and is therefore, frequently grown as a monocrop. The second most important crop is sesame, which accounts for about 10%. Minor areas of other crops such as millet, cotton and sunflower are also grown although usually confined to a limited number of farms. Crop yields are usually satisfactory during the first few years but thereafter drop to low levels. The average overall yield, based on the planted area, is about 200 kg per feddan for sorghum and 90 kg per feddan for sesame. Annual yield fluctuations are relatively high due to climatic variations and are also influenced by the fact that significant areas are often not harvested due to, among other factors, labour shortage and crop failure.

## **2.3 Traditional rain-fed farming.**

The cropped area within the traditional rainfed farming system varies according to climatic conditions. The traditional system is mainly practised in the provinces of Northern Kordofan, Southern Kordofan and Southern Darfur. However, the system is found over a wide area of the Sudan, including small farms in the clay plains. Farm sizes range from less than 10 feddan up to 30 feddan. Main crops grown are sorghum, sesame, groundnuts and millet with some local production of other crops where conditions are suitable. The traditional sector is also a major producer of gum Arabic and livestock.

The traditional farming system is generally characterised by: land abundance, low population density, simple technology, arid or semi-arid climate, short growing season, sandy soils and high production risk. The land is usually cleared of acacia (gum Arabic) and cropped for up to five years. During that time the natural fertility decreases and the acacia starts growing again. When conditions are no longer suitable for crop production because of the exhaustion of the soil fertility, the land is abandoned and further areas are cleared. Abandoned land returns to the production of gum Arabic. Crop yields are extremely low, with average 150kg per feddan for groundnuts, 125 kg per feddan for sorghum, 50 kg per feddan for sesame and 55 kg per feddan for millet. Crop yields are also extremely variable, having a coefficient of variation based on aggregate data of about 40 percent.

Production of sorghum and millet is largely for self subsistence, with any excess production being marketed. Marketed amounts might reach 40 percent of the crop production in good years. Sesame and groundnuts are the typical cash crops. The agricultural products are marketed either through local traders who travel around the region purchasing grains from farmers or, when production area is close enough to the market, through brokers. Many farmers also harvest gum Arabic which may be obtained either from swilled trees or specially grown gum gardens. Gum Arabic may constitute a large percentage of farmers' income. Many male workers move to the irrigated and mechanised rainfed areas for seasonal work to supplement the family income, leaving their wives in charge of the farm activities. These movements tend to increase during the bad agricultural seasons. During the good ones, the farmers are less inclined to seek seasonal work out of their farm and wage levels increase dramatically. This is an indicator that the labour in the agriculture is somehow a structurally limiting factor which only episodically turns to become overabundant.

Farmers in the traditional areas are poor and have little access to formal credit due to lack of rural banking services, poor communication and lack of familiarity with the credit system. Under these conditions they have to rely on the traditional "sheil" credit by which crops and gum Arabic are sold to traders prior to harvesting, and occasionally prior to planting, in return for the required consumption goods. Typical interest rates applied can vary in this system from 50 to 200% over the period for which the loan is required.

### **3. Agricultural production.**

Tables 2 and 3 illustrate the utilisation of the arable land over the last years by kind of agricultural speculation. As already said, the total area under crops represents not more than 15% of the arable land showing that, contrary to manpower, the physical resource is not a structurally limiting factor for the development of the Sudanese agriculture.

**Table 2** Area Production and yields of major crops

Area: 1000 Feddan  
 Production: 1000 Tons  
 Yields: Kg/Feddan - Kantar/Feddan (for cotton)

CROP PRODUCTION BY SECTOR	Average for 89/90			Average for 90/91			Average for 91/92		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
<b>1. SORGHUM</b>									
Irrigated	755	392	519	930	316	340	1376	886	644
Rained Mechanized	5,830	853	146	4,080	540	132	3,165	2,428	265
Rained Traditional	2,464	291	118	1560	124	79	1,600	217	136
<b>2. WHEAT</b>									
Irrigated	614	409	666	1,102	686	623	903	838	928
<b>3. MILLET</b>									
Rained Mechanized	139	18	129	25	5	200	136	25	184
Rained Traditional	3,568	142	40	1,575	54	34	2,520	281	112
<b>4. GROUNDNUTS</b>									
Irrigated	159	119	748	128	101	789	134	114	851
Rained Traditional	1,136	99	87	403	22	55	412	66	160
<b>5. SESAME</b>									
Rained Mechanized	966	75	78	669	66	99	976	85	87
Rained Traditional	1,656	65	99	1,104	80	72	313	12	38
<b>6. SUNFLOWER</b>									
Irrigated	----	----	----	----	----	----	----	----	----
Rained Mechanized	145	22	152	234	23	98	75	11	147
<b>7. COTTON</b>									
Irrigated	672	401	597	425	236	555	36	----	----

Table 3 Area Production and yields of major crops

Area: 1000 Feddan  
 Production: 1000 Tons  
 Yields: Kg/Feddan - Kantar/Feddan (for cotton)

CROP PRODUCTION BY SECTOR	Average for 92/93			Average for 93/94			Average for 94/95		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
<b>1. SORGHUM</b>									
Irrigated	1221	769	630	904	602	666	1,181	726	615
Rained Mechanized	10,041	2,687	268	7,896	1,473	187	9,730	2,044	210
Rained Traditional	3,500	586	167	2,352	311	132	4,392	878	200
<b>2. WHEAT</b>									
Irrigated	777	445	573	85102	475	558	693	520	764
<b>3. MILLET</b>									
Rained Mechanized	184	47	249	162	27	166	766	10	132
Rained Traditional	3,510	398	113	2,381	193	81	7,630	958	126
<b>4. GROUNDNUTS</b>									
Irrigated	298	235	784	293	254	867	299	262	876
Rained Traditional	10006	145	145	1,565	174	111	1,814	452	249
<b>5. SESAME</b>									
Rained Mechanized	2,067	204	99	1,281	93	73	1,534	105	68
Rained Traditional	1,140	62	54	1,650	82	50	1,672	65	39
<b>6. SUNFLOWER</b>									
Irrigated	6	2	338	26	9	346	78	38	487
Rained Mechanized	215	38	177	118	23	195	95	19	200
<b>7. COTTON</b>									
Irrigated	295	150	508	438	254	591	----	----	----

### **3.1 Cotton, cereals, sesame and groundnut.**

The planted area of all types of cotton has declined rapidly over the period from more than 1 million feddan in 1983/84 to about 360,000 feddan in 1992/93. Yields have remained fairly stable at about 270 kg per feddan. The overall result has been a decline in production of more than 50 percent.

The areas of all non-cotton crops have fluctuated considerably over the period with groundnuts showing a downward trend, sesame and sorghum remaining relatively constant throughout the 1980s and wheat and millet increasing. The areas of all crops increased remarkably in the early 1990s, particularly in 1992/93. The yield of wheat, the entire area of which is irrigated, has tended to increase over the period. Any trend in the yields of other crops over the past ten years has tended to be masked by the high level of variability, although analysis over a longer period indicates a gradual decline. However, it is clear that the recent dramatic increase in the global value of crop production can only be explained, in the lack of a corresponding increase of the cultivated areas, by a sharp recovery of the production yields.

Production data analysed by agricultural compartment are indicative of some significant trend. In the irrigated sub-sector, the areas of wheat and sorghum have increased at the expense of cotton and groundnuts, especially towards the end of the period. In 1992/93 there was also a significant increase in the area of groundnuts which recovered the levels which were usual at the beginning of the period. Yields in this sub-sector are the most stable and no evidence appears of any change in the usual production trend. In the mechanised rainfed sector, the total area has almost doubled in the last two years as compared to the first two years of the period. However, yields of sorghum while widely fluctuating have remained, more or less, around their average of about 203 kilogram per feddan. On the other hand, yields for sesame fluctuated very little, with only a small negative trend. The huge increase of the cropped areas have however, brought to a rising trend of the total production. Traditional agriculture experienced wider fluctuations in areas and yields. However, as in other farming systems, there is evidence of an increase in the surfaces planted in 1992/93 together with a recovery in yields, with an exception for groundnuts.

**Table 4** Average non-cotton crop yields and their variability by sub-sector (1992/93-1993/94).

<b>Sub-sector/Crop</b>	<b>Average yield (kg/Feddan)</b>	<b>Coefficient of Variation (%)</b>
<b>Irrigated</b>		
Groundnuts	759	7
Wheat	619	19
Sorghum	554	8
<b>Mechanised Rainfed</b>		
Sorghum	201	41
Sesame	91	28
Millet	58	15
<b>Traditional Rainfed</b>		
Groundnuts	153	41
Sorghum	126	42
Sesame	52	48
Millet	56	36

Source: Mission's estimate

### 3.2 Fruits and vegetables.

Horticultural crops occupy about 1,8% of the total area under crop, or 2.5% of the irrigated land. The production is mainly concentrated along the banks of the Nile and its tributaries. Among fruit crops the most common are dates, limes, mangoes, melons and guava. Fruit and vegetables are also being produced with traditional systems near the urban centres in small plots of 1 to 5 feddan. Table 5 here below shows the surfaces under production of fruits and vegetables in the Sudan over the period 1993-95. The areas concerned by this kind of production are very modest (2%) as compared with those of other crops. However, economy-wise this agricultural compartment is very significant, as it represents in value 12% of the agricultural GDP as compared to 21% and 8.6% for the cereals and the oil crops respectively.



**Table 5** Surfaces under fruits and vegetables in the Sudan in 1993-95 (000 feddan).

Region	Vegetables			Fruits		
	92/93	93/94	94/95	92/93	93/94	94/95
Central	135	150	175	45	55	65
Northern	85	95	105	75	80	88
Khartoum	112	120	145	23	25	30
Eastern	68	70	75	40	45	50
Kordofan	70	55	80	28	30	35
Darfour	55	65	80	30	35	42
<b>Total</b>	<b>525</b>	<b>585</b>	<b>660</b>	<b>241</b>	<b>270</b>	<b>305</b>

Source: Horticultural Department 1995

The average crop losses are estimated at 25%. However, for some horticultural crops stored using traditional methods, they can be as high as 50%. The reasons for such losses are mainly:

- i) lack of technical skill with regard to production, harvesting, grading and packing;
- ii) unsuitability of the traditional methods of transportation which make use of tins and plastic bags;
- iii) lack of cold chain from product harvesting to consumption, which is detrimental, in a hot country like the Sudan taking into consideration the perishability of the product.

### 3.3 Gum Arabic.

Gum Arabic (Acacia Senegal) deserves a special attention. The Sudan is the largest producer of Gum Arabic in the world (85%) and is one of the major exporting commodity. In 1994 the Sudan exported 22,000 tons of Gum Arabic for a total value of US\$ 76 million. Gum Arabic is a unique product, whether in its natural habitat as a tree and part of a dynamic ecosystem or as a commodity, used in a wide spectrum of industries and providing incomes to subsistence farmers at a time. It is also a source of many social, economic and ecological

benefits on account of its qualities summarised as follows: it is an easy tree to plant and to propagate, and a soil improver as it fixes nitrogen; it is also a soil protector and therefore can be used to fight desertification, it finally generates a precious revenue in an environment generally characterised by scarcity of natural and economic resources.

The restocking of gum belt project in the Sudan have had an immense response from many organisations and governments (FAO, World Bank, EEC, G.A.R, Finnish Project, W.F.P, USAID, UNDP, ITC, Japanese Project). In 1994/1995 the planting programme was completed at 113% with 80,000 trees planted.

#### **4. Animal production.**

##### **4.1 Livestock.**

Sudan is a country with rich animal resources. It is estimated that almost 90% of the animal population is privately owned by herders. While the contribution of the agricultural sector in total GDP during the first three years of the comprehensive national programme was 39%, 40% and 44%, the animal sector in the agricultural GDP for the same period accounted for 43%, 52% and 51%. The bulk of the livestock in the Sudan are supported by vast rangelands estimated at about 117 million hectares, or about 47% of the total area. About 50% of the livestock are owned by nomads. Most of the remainders are owned by small sedentary and semi-sedentary farmers as well as urban producers.

The nomads move their herds from one area to another, in search of natural pastures and water. Herd sizes average about 200 cattle, 100 sheep and 20 goats. Production yields are much dependent on climatic conditions. However, there has been considerable resource degradation as a result of overstocking, leading to desertification and lowering production. Yet nomads continue to increase their herds in line with their tradition which makes of the herds' size a sign of social status. The farmers involved in rainfed or irrigated agriculture are used to supplement their income by keeping sheep and goats, some cattle and poultry. The animals are fed on crops residues and graze on crop fallows. This system is widely practised, and represents an important source of animal proteins in the country. The producers do not develop their methods because they are not provided with appropriate extension services.

Finishing lean cattle trekked from the western regions is slowly developing. The fattening period varies from 60 to 90 days and is based on crop residues, green fodder and concentrates. No advisory services are recorded on the cost effectiveness of these methods. The animal sector is the least dependent with regard to imported inputs. It satisfies the totality of the domestic requirements of meat and most of the milk ones. Providing that a modernisation process is carried out to raise its production yields, minimise the human workload and upgrade the quality of its products and by-products, the impressive animal resources together with the physical ones (grazing lands), the potential to produce any kind of required fodder's (also by making use of the agricultural by-products) can provide a considerable prospect for further development. During the first three year Comprehensive National Program 1992/93 - 1994/95 this sector witnessed an impressive increase in the animal population, which grew from 60 million heads (cows, sheep, goats and camels) to 100 million head by the end of the program (see table 6 below). This has been reflected in an

increase in the production of red meat (see table 7) and of the sectors' contribution in the total GDP and in the export earnings. Considerable improvements have been recorded in the dairy, poultry and fish sectors during the first three year Comprehensive National Program 1992/93 - 1994/95.

**Table 6.** Animal wealth in thousand heads during the First Year programme of the Comprehensive National Strategy 1992/93 - 1994/95

Year	Cows	Sheep	Goats	Camels
1992/93	25,092	26,518	22,693	2,849
1993/94	27,571	30,977	27,567	2,886
1994/95	30,077	37,145	33,319	2,903

Source: Department of Animal Wealth of the Ministry of Agriculture, National Resources and Animal Wealth

**Table 7.** Targeted and Actual Production for red meat during the first three year programme of the Comprehensive National Strategy 1992/93 - 1994/95.

Year	Targeted red meat prod. 000 tons	Actual red meat prod. 000 tons
1992/93	426	867,5
1993/94	530	1136,5
1994/95	679	1294,7

Source: Department of Animal Wealth, Ministry of Agriculture.

In addition to the traditional extensive methods of nomadic or semi-nomadic animal raising planned interventions are aimed at developing and modernising the livestock production sector by intensifying the production methods, and developing horizontal integration with agriculture as well as vertical with the secondary (processing industry) and tertiary (market) sectors. These interventions have taken the form of animal production projects using modern or improved technologies, under both private and public initiative. Under the recent privatisation policy measures however, the Government has started to privatise several of such projects, which include:

- i) The Mechanised Farming Corporation
- ii) Animal Traction

- iii) The Animal Production Public Corporation
- iv) The Livestock and Meat Marketing Corporation
- v) The Western Savannah Development Corporation.

This restructuring and privatisation action has witnessed the establishment of the Animal Wealth Bank. Producers have also established the Animal Production Bank, as well as strong trade unions. Planned interventions were also witnessed within the irrigation sector in Gezira, Rahad, New Halfa and other irrigation schemes. Independent private investments were also encouraged for both local and export markets. However, for a number of socio-economic reasons, among which the high cost and the scarce availability of production inputs, the modernisation of the sector has been so far rather slow and quite an expensive exercise. Thus, in spite of the planned support interventions, the contribution of the livestock sector to exports and to local consumption market remained low as compared to its potential. Therefore, the main source of cattle meat and red meat in general remains the traditional nomadic animal raising sector, while mixed farming and feed lots are still playing a minor role in quantitative terms.

Concerning milk production, it must be pointed out that the insufficiency of the infrastructures, combined with the harsh climate, the adoption of traditional extensive methods and the low yields tend to create unfavourable conditions for the development of this important sub-sector. The dairy products are however, important food items in the Sudanese diet: figures of milk production during 1992/93-1994/95 show that actual milk production fall short of targeted production during the same period (see table 8) .

**Table 8.** Targeted and actual production of milk during the first three year programme of the Comprehensive National Strategy.

<b>Year</b>	<b>Targeted production in 000 tons</b>	<b>Actual production in 000 tons</b>
1992/93	3,993	3,457
1993/94	5,198	4,071
1994/95	6,559	-

Source: Department of Animal Wealth.

Outside the traditional animal husbandry system based on nomadism, whose milk production is mostly destined to meet the self consumption needs, at farm level commercial intensive dairy production is undertaken using irrigated fodder and animal feeds. Herds are either cross-bred or selected local breeds Kenana or Butana. Herd sizes average between 10 to 20 head. Milk production is constrained by several factors, the most important are the following:

- i) Lack of genetic improvement materials and technologies;
- ii) Unavailability of animal feeds in quantity and quality;

- iii) Unfavourable socio-economic conditions for the development of milk production and consumption.

Either for meat or for milk production, livestock has yet to be “structurally” integrated into large agricultural schemes based on irrigation to reach the desired levels of technical and economic performance which are needed to meet the increasing demand and fully develop the immense production potential. Horizontal integration between the agricultural and the animal raising sectors should be regarded as a fundamental component of their structural change bearing in mind the objective of their modernisation. An important component of this process is represented by the specialised production and utilisation of animal feeds. The animal stock in the Sudan derive 86% of their nutritional needs from rangelands, 10% from crop residues and only 4% from irrigated forages and concentrates. But the country, although not being a producer of soybean (by far the most important ingredient of the animal feeds formulas all over the world) produces considerable amounts of suitable cereals, like sorghum, different oilseed cakes and molasses, part of which are being exported. With the only exception of the soybean cake, whose production can be developed by including this crop among the others grown within the frame of the irrigation schemes, the Sudan can produce all the necessary raw materials for an intensive feeding of its animal stock, and therefore for the modernisation of both agricultural and animal raising sectors.

Concerning egg and broilers production, the actual production during the first three years of the Comprehensive National Program have fallen short of the projected targets (see table 9).

**Table 9.** Targeted and actual production of eggs and broilers during the first three years of the Comprehensive National Program.

Year	Targets in 000 tons		Production in 000 tons	
	Eggs	Broilers	Eggs	Broilers
1992/93	27.5	19	23.7	12
1993/94	31	27	25	16
1994/95	31	27	25	16

*Source: Department of Animal Wealth.*

Layer production is based on imported parent stock, and is developing rapidly. Poultry farms are different in size, but the norm is between 2,000 and 3,000 units. Upgrading of production is constrained by irregular supply of day old chicks, vaccines and super concentrates.

#### **4.2 Fishery.**

Remoteness of the production areas and their dispersion over the national territory make the available production data rather doubtful. However, the available figures show that the potential for inland fisheries range from 105,000 to 180,000 tons per year (Henderson, 1975). FAO

estimates the inland fishery resources between 75,000 and 100,000 tons (van der Bossche and Bernawek, 1991). Potential areas include the Sudd swamps (75,000 tons), Jebel Awlia dam (15,000 tons) lake Nubia (15,000 tons) in addition to Rosieres dam (15,000 tons), Sennar dam (1,200 tons) and Khashm el Girba dam (800 tons). According to Chakraborty (1984) 96% of fish catches come from sweet water, 55% of which from White and Blue Nile, Atbara river and Lake Nubia.

Present fish supply areas include the Sudd swamps (13,000 tons), the area south of Jebel Awlia dam (800-1,000 tons), Lake Nubia (800 tons) and other potential areas including the Red Sea, the major dams, etc. According to the Fishery Department of the Ministry of Agriculture the production figures during the first three years of the comprehensive national program 1993, 1994 and 1995 were 28,000, 30,000 and 33,000 tons respectively (see table 10 below).

**Table 10.** Water bodies, production data in 1993 and potential increase.

<b>Water body</b>	<b>Production in 1993</b>	<b>Potential increase</b>
Lake Nubia	1,000	4,000
Jebel Awlia reservoir	9,000	4,000
River Nile	1,600	400
Reseires reservoir	1,000	200
Sennar reservoir	1,000	---
Khashm el Girba reservoir	500	300
Western Sudan	300	700
Southern Sudan	12,000	22,000
Red Sea	1,600	5,400
Fish culture	---	---
<b>Total</b>	<b>28,000</b>	<b>37,000</b>

Source:

The second three year programme for 1996, 1997 and 1998 envisage an increased fish production of 46,000, 50,000 and 57,000 tons respectively. Several factors affect fishing yields. They include distance between production areas and markets, absence of landing, lack of transport and proper storage facilities in addition to the traditional ones. Although the envisaged strong demand for fish may encourage the development of combined fishery and agriculture in the irrigated areas, the exiting potential can be endangered by the environmental changes consequent to the increased demand of water for agricultural use. As an example, the expected change in the Sudd swamps when Jungle canal is finished is likely to affect the fish catchment in the area. The Arab Group for Investment and Acquisition (AGIA) is sponsoring a US\$ 165 million integrated fisheries project to be located on the Red Sea coast. The Canadian Development Agency has also developed a number of sectoral studies as part of its

technical assistance.

## **5. Production inputs.**

The basic production inputs utilised on the farm are seeds, fertilisers, pesticides, animal vaccines, machinery, fuel and sacks. Acquisition of imported inputs used to be dominated by the agricultural production corporations, the Agricultural Bank of Sudan and the Crop Protection Department of the Ministry of Agriculture, Natural Resources and Animal Wealth. Now, with the liberalisation policy in effect, many companies have started to procure supplies for distribution to the private sector, although most acquisitions remain through the ABS and Farmers' Bank, which supplies inputs under credit at a low interest rate.

Almost all seeds utilised in the Sudan are open pollinated varieties saved by producers from previous harvests, or acquired from neighbours and markets. Formal seed multiplication and certification in the Sudan takes place on a limited scale and satisfies only 15% of the demand. This is done by the Seed Research Corporation, which is in charge of the activities of multiplication and distribution to producers. Improved seed quality and the increased adoption of hybrids provide the opportunity to upgrade production yields and economic profitability. In order to achieve this objective, the seed industry must be expanded and modernised.

Availability of spare parts for tractors and equipment has traditionally been, and remains, a major problem although stipulations have occurred regarding the provision of spare parts when import permits were issued by the Ministry of Commerce and Industry. Since these were not maintained, most equipment could not be fully used over the long run for lack of spare parts. With the liberalisation of the economy, policies related to import of spare parts should have been eased. However, the mission's discussions failed to identify either a clear policy or standard procedures with respect to import of these items. It appears that taxes on imports of spare parts are approximately 40 to 50 percent of their value, with prices based on the free market exchange rate. In addition to imports, there is a limited amount of locally manufactured/assembled machinery, which is either concentrated around Khartoum and few other major centres or has been developed as a component of the various rural development projects. These centres concentrate largely on the manufacturing animal-drawn implements. Most of these implements are produced under contract. Some assembly of wide level discs, with limited local content, has taken place but this is restricted, due to the local unavailability of materials. Plans are currently being formulated for the expansion of local assembly and manufacture, on the basis of joint ventures with international companies.

Tractor and equipment repair is currently undertaken by a range of enterprises throughout the major agricultural production areas. Within the irrigated sub-sector, the mechanisation department of the irrigation scheme's administration runs workshops and provides service to the farmers. Within the rainfed sector, repair shops are privately owned and are often founded on the needs of large farmers. All spare parts are imported through the local agents of the international manufacturers.

Importation and distribution of fuel is controlled by the Government through the public sector and international companies. Agriculture receives high priority in the allocation of available

fuel. The quantities required by the irrigated and rainfed mechanised farms (demarcated and non-demarcated) are estimated based on plans for the areas to be planted as provided by the corporations and MFC, respectively. If fuel is insufficient for the planned area, the additional fuel must be purchased on the free market. No fuel is allocated to the traditional farming sub-sector.

Most grain crops are marketed in sacks of about 90-100 kg capacity. When grain crops are delivered to ABS in sacks, they are frequently emptied for storage in silos and the crop must then be re-bagged if so required to be subsequently transported by road. Although sacks are imported by ABS, frequently shortages have been reported. They currently cost about Ls 100 each.

## **6. Marketing aspects.**

Prices for major crops and livestock are collected on a regular basis by the Department of Agricultural Economics and Statistics of the Ministry of Agriculture, and reported as monthly averages during marketing periods.

### **6.1 Cereals and oil seeds.**

Sorghum prices at Gedaref have declined from about Ls 1,650 per sack in early 1991 to about Ls 900 per sack in early 1993. Sesame prices which was about Ls 320 per Kantar in early 1990, have risen to about Ls 900 in early 1991 to Ls 1,700 in 1992 and further to Ls 2,000 in early 1993; an increase which barely keep pace with inflation. At El Obeid market, a good indicator for the traditional sub-sector, sesame prices have shown similar increases while groundnut prices have increased from about Ls 800 per kantar in early 1991 to Ls 1,100 in early 1993. These data reflects significant decreases in the real prices for grains, which had their effect on the incomes and welfare of the farmers.

### **6.2 Fruits and vegetables.**

The phenomenon of seasonality tends to dictate, on the internal markets, the level of prices as a function of the scarcity periods. Per caput consumption figures by region (table 11) is in line with relative importance of production, revealing that the highest production regions are also the highest in consumption.



**Table 11.** Per capita consumption for vegetables and crops by area..

Area	Per capita consumption for vegetables (kg)	Per capita consumption for fruits (kg)
Khartoum	65	60
Central	60	50
Northern	55	50
Eastern	50	40
Kordofan	20	15
Darfour	10	7

Source: Prof. A. Abdalla. Towards better horticultural production for local consumption and exports.

Export figures (table 12) are very modest, especially if compared to production: major constraints to export are the high costs of the air transports, the irregularity of supply, the high costs and the poor quality of the packaging material.

**Table 12.** Exports of fruits and vegetables in tons.

Type	1991/92	1992/93	1993/94
Mango	6,370	7,206	4,704
Lemon	647	1,196	299
Banana	73	40	5
Grapefruit	56	67	31
Hennah	41	19	19
Musk melon	73	345	175
Vegetables	150	300	62

Source: Horticultural Department. 1995.

### 6.3 Gum Arabic

Gum Arabic seems to be the only agricultural commodity that was able to keep pace with inflation. Its prices in Gedaref and El Obeid increased from about Ls 450 per kantar in 1990 and early 1991 to about Ls 1,000 in early 1992 and by early 1993 had reached almost Ls 9,000 per kantar. The Sudan is the main exporter of gum Arabic in the world (85% of the world total trade). As it can be seen from the table 13 below, the exports of gum Arabic have nearly doubled from 1993 to 1995.

Table 13. Sudan exports of Gum Arabic.

Season	Gum Hashab (tons)	Gum Talh (tons)	Total (tons)	Value in Dollars
1984	29,603	3,632	33,235	45,389,076
1985	12,618	14,210	26,828	26,784,204
1986	16,482	2,253	18,717	48,727,158
1987	16,099	1,645	17,744	78,791,426
1988	16,672	1,931	18,603	55,713,290
1989	17,385	1,967	19,352	46,786,994
1990	22,960	3,952	26,912	54,594,740
1991	21,543	3,435	24,978	50,818,664
1992	8,198	5,870	14,068	23,446,654
1993	9,925	5,805	15,730	40,039,583
1994	18,339	4,396	22,735	76,089,121

Source:

#### 6.4 Livestock and meat.

The nomads are the main suppliers of livestock for the domestic and export markets. Most of the animals are sold alive. An important part of this market escapes any possibility of statistical control due to the nomadism which often brings the pastoralists to perform their sales across the national borders. Meat consumption is influenced by factors which dominate livestock production, such as: - seasonality of supply, - year round local demand for fresh meat and, - time lag due to the distance between production and consumption areas. Supply of livestock from producing areas is related to seasonal migration of nomads. As a consequence, an increases supply is recorded during the following months (see table 14):

Table 14. Production areas and increased supply periods.

Production area	Months
Nyala	July-December
Kosti	August-December
El Obeid	August-December
El Fashir	September-March

Source:

Due to the seasonality and the remoteness of the production areas marketing channels are

highly complicated and involve the participation of middlemen at different levels.

## **7. Prospects and recommendations.**

A recent FAO mission in Sudan expressed some prospects, options and recommendations for sustainability of agricultural development. Some are summarised below:

### **7.1 Agricultural employment.**

Special attention should be given to incorporating traditional farming and grazing areas in the mainstream of development, as most of the population will depend on these sub-sectors for a long period. Measures to this end include the allotment of land to small farmers, improvement of extension service and promotion of appropriate rural development programs. In addition, small scale agro-industry should be promoted within rural areas to provide additional income and employment opportunities for small farmers and other so far marginalised vulnerable groups. The irrigated and rainfed agricultural sub-sectors would absorb more labour through intensification, crop diversification, improved harvest and post harvest practices and possibly, as substitute for mechanisation.

### **7.2 Land and water use.**

Due to the vastness of their national territory the Sudanese incline to consider their land resources as unlimited. This idea needs to be thoroughly reviewed, because the interests on mechanised rainfed farming, traditional farming, animal husbandry and forestry are engaged in a heavy competition, which is causing both immediate and lasting damage on the resource. Sustainable land use in combination with a regulatory system has to be designed. Technical assistance would be helpful in this respect. Conflicting interests can be reconciled by strengthening and consolidating the agricultural and livestock sectors through policies aiming at remodelling their structures by intensifying, specialising and mutually integrating their production.

As a matter of fact, the real constraint on production is not the extension of the areas devoted to agriculture and livestock, but the extensiveness of the production practices which penalises the labour productivity. Correcting this structural handicap requires an overall national strategy, supported by incentives for the growers in terms of economic and social benefits, and a number of complementary integrated actions aimed at fostering the modernisation, such as a permanent technical assistance and an easy access to production inputs and technical information.

At central level, a complete inventory is required of the country's land and water capabilities and use, as well as of human resources, infrastructures and institutions. This would give the basis for a national planning exercise in terms of integrated land use. Traditional imbalances have to be rectified, such as inappropriate use of the land resource with regard to soil vocation and position in respect of the markets. Then comes the identification, based on the ascertained potentials, of the new productive options involving diversification (and possibly

introduction of new agricultural speculations: soybean) and intensification of production practices, introduction of combined agricultural and animal husbandry activities, technological upgrading through application of modern productive methods based on utilisation of production inputs (fertilisers, selected seeds, animal feeds, etc.).

At a sectoral level programs can be subsequently formulated bearing in mind the objective of the vertical integration of the production chains that link primary production to market through storage, processing and distribution. Moreover, infrastructural and rural development are needed to support agriculture: production activities should be integrated within environmental, institutional and spatial dimensions.

### **7.3 Horizontal expansion.**

The benefits of horizontal expansion have to compensate deriving from the change of the traditional production methods for the original users of land. It is important to note that both gum Arabic producers and livestock breeders account for a sizeable percent of agricultural exports and that traditional farming provides a livelihood for the largest segment of the population in form of fresh non processed food products. Besides being of high ecological value, forest is an indispensable source of timber and firewood. The fact that this resource is being increasingly depleted is a sign of its unsustainable use. Horizontal expansion is only justified after due consideration of the benefits and costs in a broad sense, taking into account present rights and the cost of compensating present users. Mapping of existing rights and economic and ecological value is a pre-requisite for it as well as a necessity. Expansion of irrigation through unutilized water resources would provide attractive additional returns. However, tripling the irrigated area within 10 years, as foreseen by the present development plan, seems un-feasible. It might even be considered undesirable, as it would not allow for balanced development under a technical and economic points of view to occur. It would be rather advisable to start with a general master-plan to outline priorities for irrigation development commensurate with potential land and water resources, as well as with socio-economic and ecological considerations.

Alternative farming systems for the mechanised rainfed sub-sector should be tested, in particular with regard to their sustainability and viability. The introduction of fodder crops and livestock makes sense and deserves further investigation and implementation. In certain cases a rotation of 4 to 6 years mechanised rainfed farming and 15 to 20 years silvo-pastoral land use could be considered.

The mission feels that the loss in production resulting from the interruption of the horizontal expansion programme could be compensated by consolidating vertical integrated development and by re-allocating un-utilized land resources.

### **7.4 Land use and livestock management.**

Land development for agriculture on one side and desertification on the other side have taken their toll at the expense of the rangelands. In addition to the considerable amount of

rangelands taken for horizontal expansion of crop production, the seasonal grazing patterns extending from the dry zone to the wet zone have been disrupted. If timely corrective measures are not taken, the livestock sector will be further depressed and ecological and climatic degradation will keep on progressing. The mission would propose that the Department of Range and Fodder should start preparing a plan for rangelands restoration and management, and policies for their implementation. It would also propose to study, within the frame of a plan to fight desertification, a program for the recovery to forestry, agriculture and animal husbandry production of "marginal lands" with the aim to assure the necessary socio-economic conditions for the local populations to be sedentarized and fixed within the concerned rural environments and provide at the same time the labour force for the implementation and control of the schemes to fight desertification. A second measure for developing livestock production would be to start an intensive breeding and management programme to improve herd productivity. Research and extension have to plan an important role here. The third promising measure would be to integrate animal husbandry with mechanised rainfed and irrigated agriculture. This is already practised to some extent and is worth being further expanded. In addition to increasing livestock productivity, the introduction of fodder crops will help maintain land productivity.

#### **7.5 Research and Extension.**

There is a major need for promoting, expanding and increasing the effectiveness of the local research activities to develop agricultural production in all sub-sectors. Research is needed for all aspects of production in different sub-sectors. Of particular importance is the development and introduction of improved seeds and planting material. Research on new species and varieties should be undertaken for all agricultural products. The Government should take necessary measures to protect the quality of the multiplication up to a certain level and stimulate the sufficiency and geographic spread of nurseries and multiplication farms. Production of improved seedlings can also be privatised. Agricultural practices compatible with the local environment should be further developed through the introduction of innovative and appropriate technologies such as the mechanised water harvesting method of prof. V. Vallerani whose applicability has proven successful for reforestation and agricultural development programs in rainfed areas with up to 200 mm. min. rainfall.

A comprehensive review of the Agricultural Extension Service is badly needed to achieve efficiency and effectiveness in its operations. Shortage in extension personnel will continue for some time and therefore, intensive training is needed. To cater for shortages in extension workers in the short run, some farmers could be trained to work as extension contract agents who should be guided and monitored by the standing State Extension Service. Benefits and possibilities of integrating extension services for plants production, livestock production, on farm water use, forestry and possibly also for community development should be investigated.

Introduction of fertilisation, plant protection and other innovative methods in the traditional sub-sector are key elements for its development. It is also worth to review the practice of air spraying in irrigated sub-sector for its technical, economic and environmental implications. Generally, the use of pesticides could be based on more selective and cost effective basis,

a matter that requires further research and extension work.

#### **7.6 Infrastructure.**

Most of the Sudan territory consists of areas of difficult access. The long run development strategy for such areas should include the necessary infrastructure to facilitate accessibility. However, in the shorter run the policy should concentrate on self sufficiency and the export of indigenous products of comparatively high value and low transport cost. Local processing of products such as cheese, butter and leather can support this orientation. Whereas remote areas have a disadvantage in the delivery of goods they have an advantage when they produce for their own market. This fact may open opportunities for the local manufacture of simple machinery, implements and consumer goods. Adequate telecommunication can be realised within a reasonable time and it is recommended to facilitate decentralised government and private enterprise.

#### **7.7 Harvest and post-harvest policies.**

In the prevention of harvest and post-harvest losses a lot of cost effective benefit can be realised. The introduction of simple materials like improved bags and plastic sheet material would be a possible venture for farmers co-operatives. Large benefits could be realised from a shift in transport policy from sacks to bulk handling. Bulk handling should be seriously considered. It is true that establishing necessary grain storage and handling equipment will require large amounts of foreign exchange, which is likely to be limited for the foreseeable future. However, expected gains would justify investment. Any way, given continuation of the government's market liberalisation policy, the demand for grain storage and handling equipment will have to compete with other demands for foreign exchange.

### **B. FOOD INDUSTRIES**

#### **1. Production potential of the food industry sector.**

In general terms, Sudan is quantitatively well equipped, but as it will be explained, an infinity of constraints are hindering an efficient utilisation of the existing food industry installed capacities. The food processing industry sector can be summarised as follows.

Table 15. Food industry's installed capacities and production.

Type of Industry	Production capacity	Actual production	Capacity utilisation
Fruit and vegetables processing. Tomato paste	6,850 t/y	1,730 t/y	25%
Jams	4,825 t/y	1,847 t/y	38%
Vegetables packing	3,900 t/y	645 t/y	16.5%
Oil Mill	2,200,000 t/y	370,000 t/y	17%
Flour mill	3,870 t/d	2,200 t/d	56.5%
Biscuits	55,000 t/y	5,000 t/y	9%
Sugar	670,000 t/y	470,000 t/y	70%
Sweets confectionery	24,000 t/y	10,137 t/y	42%
Tahini	144,000 t/y	9,000 t/y	6%
Dairy	240 t/d	27 t/y	0,35%
Bakeries	--	600,000 t/y	--
Macaroni	--	30,000 t/y	--
Meat	9 t/d	1 t/d	11%
Chicken	2,100 t/y	1,780 t/y	85%

Source:

In order to understand the reasons for the under-utilisation of the food processing industry, it is necessary to analyse separately each sub-sector.

### **1.1 Fruit and Vegetables processing industry.**

This sub-sector includes 8 factories with a total capacity of about 14,000 tons/y. The actual output is however only 4,200 tons/year, which means an utilisation of the installed capacity of about 30%. Tomato paste is the dominant product. The demand is estimated at 4,800 tons per year, which would require approximately 25,000 tons of fresh tomatoes. The sub-sector has a processing capacity of 6,850 tons but only 1,700 tons per year are produced and the country imports about 500 tons of tomato paste from Libya. The market for jams is rather limited due to pricing system. However in 1994 Sudan was importing 191 tons of jam. One of the major factors inhibiting the development of the jam industry in Sudan is represented by the high price of the sugar (3 times the world market price).

Fruit and vegetables processing industry would deserve in the Sudan an articulated approach, linking together within the frame of a common integrated strategy the primary production, in particular that from the irrigated farming sector, with:

- cold store and packing houses dealing with storage, grading, packing and distribution of the fresh products;
- the processing industry, bearing in mind the opportunity to process the second grade products which do not meet the minimum standards and the unsold production and to diversify and upgrade the quality of the processed products; so as to enter new markets and fully utilise the existing installed capacity;
- the industry of the packaging and canning material and glassware.

Besides, solar drying of fruit and vegetables at farm level should be encouraged as a mean to extend the shelf life of the exceeding production and reduce the wastes. The dried products could be further processed into powder and/or conditioned using appropriate methods and packing materials at an industrial level both for internal and foreign markets.

### **1.2 Flour milling industry.**

Traditionally cereal grains are being milled in stone mills and consumed in different areas of the country. The common cereal grains for flour making are wheat, sorghum and millet. Wheat and consequently wheat flour are mainly used in the urban areas. Sudan has 20 flour mills distributed over 7 states of the country (see table 16) with a total capacity of 3,890 t. per day but operating at 2,200 t/day, producing flour (72%) and bran (28%).



Table 16. Flour mill factories in the Sudan

Nr.	Name	Location		Production capacity (t/day)	Actual production (t/day)	Remarks
		State	Town			
1	Khartoum FM	Khartoum	Khart. North	600	340	
2	Ahua FM	Khartoum	Khart. North	500	290	
3	Zein el Abdin FM	Khartoum	Khart. North	120	90	Newly rehabilitated
4	Al Arabia FM	Khartoum	Khart. North	40	20	One line out of production
5	Aroos el Remal FM	Khartoum	Khart. North	100	50	
6	Al Bagair FM	Gezira	El Bagair	300	280	
7	Goz Kabro FM	Gezira	Goz Kabro	240	90	
8	El Mekashfi FM	Gezira	El Menagel	120	90	
9	Gezira FM	Gezira	Wad Medini	200	80	
10	Blue Nile FM	Gezira	Wad Medini	300	100	
11	Ruffaa FM	Gezira	Ruffaa	120	80	
12	El Nahrain FM	Gezira	Hassahesia	150	80	
13	White Nile FM	White Nile	Kosti	120	60	
14	Abu el Faid FM	N. Kordofan	El Obeid	120	60	
15	Al Obeid FM	N. Kordofan	El Obeid	100	60	
16	Abu Rabo FM	Red Sea	Port Sudan	240	120	
17	New Halfa FM	Kassala	N. Halfa	200	100	
18	Abd el Mutti FM	Kassala	N. Halfa	40	30	
19	New Atbara FM	Nahr el Neil	Atbara	200	150	
20	Atbara FM	Nahr el Neil	Atbara	80	30	
	<b>Total</b>			<b>3,890</b>	<b>2,200</b>	

Source: Cereal Investment &amp; Development Co. Khartoum (CIDCO)

The average performance of all flour mills in 1991/92, 1992/93 and 1993/94 was 53%, 44.5% and 42% respectively, whereas the actual national consumption of flour is 600,000 tons/day. The estimated total amount of wheat needed to produce flour enough to satisfy the national demand is approximately 840,000 tons (based on a Grain/flour yield of 72%); hence a deficit of 240,000 tons which has to be supplemented by wheat import. The poor performances (56%) of the sub-sector are due to:

- Lack of foreign exchange to rehabilitate or replace machinery,
- The price control imposed by the government on wheat flour, not compensated by subsidies,
- Insufficiency of the national production of wheat,
- Non-industrial utilisation of local drought resistant cereals (sorghum, millet) in the milling and composite flours production process.

### 1.3 Vegetable oils industry.

This is the oldest food industry in the Sudan. Sesame and groundnut were crushed in the "Assara", a primitive camel driven mill long time ago. Nowadays over 128 oil mills are installed with a theoretical crushing capacity of 2.2 million tons of seeds. Two factories only are equipped with a solvent extraction installation. Only thirty plants have a crushing capacity superior to 100 t per day. The performance of the oil milling industry is governed by the raw materials availability and supply. In the past three years, the average supply to the industry of oil seeds per year was as follows:

cotton seed:	100,000 t.
groundnut:	200,000 t.
sunflower:	30,000 t.
sesame:	40,000 t.

The utilisation is approximately 17% of the total crushing capacity. The actual oil production is approximately 60,000 tons/year of refined oil as opposed to a market demand of 180,000 per year based on a 7 kg/caput consumption. The solutions to assure the raw materials supply to the industry are therefore, either to supplement oil seeds by importing them or to stimulate the local production through crops intensification and diversification (large scale introduction of soybean in the irrigated farming schemes) and through its better integration with the industry itself. Surprisingly, instead of trying to satisfy the local potential demand, the country has exported in 1993/94 about 42,000 t. of oil seeds and 30,000 tons of oil. On account of the stimulatory effect induced by the possibility to increase the internal offer of seed oil cakes as a by-product of the vegetable oil processing and consequently fostering the industrial production of animal feeds, an integrated articulated program to strengthen the agro-industrial chain of the vegetable oils should be regarded in combination with parallel programs to modernise and upgrade the livestock sector, and to develop the animal feed industry. Within the frame of this approach, the animal feed industry would play a double multiplicatory effect for the national economy, by:

- creating an additional market for the vegetable oils industry (through the demand created by its utilisation of the vegetable oils cakes);
- stimulating the development of the livestock sector by the provision of an abundant and diversified source of animal feeds, inputs which are absolutely vital for the modernisation of the sector.

Hence, the strategic importance of the animal feed sector for the structural change of the Sudanese agricultural and food industry, based on an integrated development approach aiming at its modernisation.

#### 1.4 Bread, macaroni and pastry production.

These activities depend on the wheat flour supply. Over 250 bakeries are distributed in the country. The national wheat flour consumption is about 50,000 tons per month. The installed capacity of the macaroni and pastry production is little or not at all utilised (see table 17).

Table 17. Sweets, halwa, biscuits and macaroni factories.

Nr.	Name of the factory	Location		Production capacity		Capacity utilisation
		State	Town	design (t/y)	actual (t/y)	
1	Saad Sweet	Khartoum	Khartoum	7,000	4,000	
2	Tola Sweet	Khartoum	Omdurman	3,466	1,550	
3	El Brair Sweet	Khartoum	Khartoum North	4,800	2,440	
4	Blue Nile Sweet	Khartoum	Khartoum North	510	402	
5	Rehab Sweet	Khartoum	Omdurman	330	245	
6	Rea Sweet	Khartoum	Khartoum North	4,000	750	
7	Krikab Sweet	Khartoum	Khartoum North	4,000	750	
	Total sweet factories			24,106	10,137	42%
	Total biscuit factories			55,000	5,000	9%
	Total Tahini factories			144,000	9,000	6%
	Total macaroni factories			30,000	0	0%

Source:

### 1.5 Sugar industry.

The development of this industrial sub-sector, which comprises 5 plants with a total capacity of 670,000 t of sugar per year (see table 18) started in the early sixties.

Table 18. Sugar factories in the Sudan.

Nr.	Factory name	Location		Crushing capacity (t/d sugar cane)	Production (000 t/y)		Remarks
		State	Town		Design	Actual	
1	El Genaïd	Gezira	El Genaïd	4,000	60	60	Started product. in 1962/63. German equipment
2	New Halfa	Kassala	New Halfa	5,000	75	75	Started prod. in 1965/66. German equipment
3	Sennar	Sennar	Sennar	6,500	110	80	Started prod. in 1976/77. British equipment
4	Assalay	White Nile	Rabak	6,500	110	60	Started prod. in 1979/80. British equipment.
5	Kenana	White Nile	Rabak	18,000	315	300	Started prod. in 1979/80

Source: Sugar Production Co.

The Kennana sugar factory is a joint-venture between the Government and private investors. It has a design capacity of 315,000 tons of sugar/year and operates at about 90% of its capacity. The factory exports sugar and molasses to finance its requirements of spare parts and foreign expertise.

The other 4 plants are publicly owned and have a total designed capacity of 355,000 tons per year and a production of 173,000 tons for the 1994/1995 season. With the exception of El Genaïd whose sugar cane supply is based on small farmers' production, all other factories are fully integrated with primary production as they own and manage their own plantations. In spite of an important production of molasses (a by-product that could be used as an input to produce bakery yeast) the Sudan imports the entirety of the national requirements in yeast for its bakery industry.

The better performances of the Kenana factory are attributed to the fact that it is privately owned and managed. Molasses are not only an input for the bakery yeast production industry. They can also be transformed into animal feeds, alcohol and a number of other interesting industrial products. Before extending the analysis of the project to a further phase of techno-economic feasibility of the selected option, an opportunity study would be needed to identify the best industrial utilisation of this by-product in the light of the specificity of the Sudanese

economy.

The sub-sector has a designed capacity of 168,000 tons including the tahini factories (144,000 tons) but only produces 19,000 tons (9,000 tons tahini).

### **1.6 Meat and poultry processing.**

Sudan has very large animal resources (100 million heads) which are partly exported as living animals. The current trend is to export dressed carcasses which necessitates after slaughtering further treatment such as chilling, freezing and storage. There are only 2 factories processing meat with a total capacity of 9 tons/per day but operating at only one day per week. Nevertheless, the country has exported 896,700 heads for a total value of 81 million US\$ in 1993/94.

There are two companies involved in poultry production and processing, one of which, a large chicken farm producing nearly 2 million chicken per year and having plans to produce 6.3 million broilers and 45 million eggs (actual production: 11 million eggs/year).

### **1.7 Dairy Industry.**

It is one of the most promising industries due to the large population of cattle, sheep and goats that supply raw material for processing milk and milk products. The installed capacity in Khartoum area is 240 tons/day while the actual production is 27 tons/day (only 10% utilisation).

A milk dehydration plant was installed at Babanusa in 1960 with a daily design capacity of 50 tons/day raw milk, but due to lack of raw material is not operating. It is foreseen to reconvert and use it to process karkadé or even gum Arabic by spray drying them into powder.

## **2. Problems and constraints.**

The problems and constraints affecting the integrated development of the food industry sector in Sudan are numerous and often interconnected. There is no sustainable Food Processing Industry development without its integration with the agricultural production process. This problem will be addressed in this report because the lack of raw material to feed the food industries represents the major constraint for the sector in Sudan.

The mission identified various constraints described below. Whenever possible a tentative recommendation was done to improve the situation.

### **2.1 General and specific policies affecting the industrial sector.**

Many of the current problems of the individual industrial enterprises can be traced back to insufficient feasibility studies at the time of conception and to over-optimistic market assumption. In addition, unsuitable technologies were imposed by suppliers. These factors have led to a good number of "White Elephants" which ever since have drained financial resources, including numerous investigations and studies, and investment for rehabilitation,

reconversion, etc.

To mention a few, this would include Babanousa Milk Factory, established in 1962 with Soviet technology. During the 1980's and to date many attempts have been made to reconvert this factory into a "Karkade Powder Production Plant". Other examples include Kenaf jute bag factory, Sudan Ren Fertilizer Plant (a US\$ 85 million factory which never entered into production), a tomato paste factory situated 1,000 kilometres away from the nearest tomato production area, plastic sacks factory.

## **2.2 Availability of raw materials.**

This is the major constraint to the development of the food industry sector and the consequence of a low productive and diversified agriculture, representing the evidence that without a modern agriculture no agro-industrial development in modern terms is possible.

Nearly all segments of the food industry suffer from lack of raw materials but this does not necessarily imply that they are not produced in Sudan. Sometimes the problem is originated by the lack of an appropriate planning, capable to make available the raw materials for the food industry at the right place, time and price: as an example, the oil industry sub-sector operates at 20% of its capacity but Sudan exports large quantities of oil seeds. The meat industry operates at 11% of its capacity but Sudan exports one million heads of live-stock per year.

Although the Sudan exports more than 250,000 tons of molasses it has a yeast factory closed which never entered into production. As a consequence, all the yeast required by the country in particular for the bakery industry is currently being imported.

## **2.3 Industrial efficiency.**

Number of enterprises are operating with old and obsolete machineries resulting in a poor yield and needing more raw material to produce finished products. This is a consequence of other constraints such as lack of trained and skilled labour force or lack of financial resources to purchase spare parts. It is the case of most of the food industry sub-sectors.

## **2.4 Infrastructural facilities and support services.**

Most industries in the Sudan suffer from unstable and high cost electricity supply. Furthermore, the size of the country makes transportation cost another major constraint. In the whole of Sudan there are only 20,000 km of roads and 4,800 km of railways. Support services for industries are very limited. There has been therefore a tendency of each large public corporation towards "self-sufficiency" with regard to production of spare parts, maintenance services, training, and labs capabilities, etc.

The Kenana Sugar Factory has an excellent workshop, training centre, and even a hospital. However, this strategy has not been sufficiently successful due to lack of financial resources and skill to carry out all tasks at hand.

## **2.5 Financial facilities.**

Access to credit for the industrial sector has been limited to the Sudan Industrial Bank and the Sudan Development Corporation. These financial institutes provide credits and own resources - eventually from another business like trade - and are the customary sources of finance for the sector. The difficult access to foreign exchange is a particular problem that has caused constant production brakes due to lack of industrial inputs and spare parts. Unless access to credit is restored and simplified, the food processing sector has little chance to be rehabilitated, modernised and diversified.

## **2.6 Managerial constraints.**

Development administration and operational management norms in the Sudan have often become a burden towards sustainability. Multiplicity of conflicts between Government institutions have been seriously affecting the agricultural development process. Poor reconciliation between public and private interests, resulting in loss of sustainable use of technical and financial resources is also an indication of poor development and administration management. Moreover, the continuing underpayment of government employees along with the recurrent military expenses have impoverished the quality of the civil servants system. In recent years the agricultural sector has been deprived of a significant numbers of enterprising producers, especially within the traditional farming system. Even large-scale irrigated and mechanised rainfed schemes have been operating without qualified and experienced managers. As a result, land and water management schemes have deteriorated.

## **2.7 Competitiveness and protection.**

The lack of competitiveness is a consequence of a number of other constraints and does not encourage entrepreneurs to produce more, to raise their industrial performance, to extend their business and to employ more people. A good example of the above statement is given by the production of jam and tomato paste: the producing enterprise has to buy sugar at a price imposed by the government which is 3 times higher than the international market price. Obviously, the local production cannot compete with imported jam also in spite of the availability of cheap sources of fruits to be used as raw materials. The situation is worsened by the lack of suitable containers (cans, glass jars).

Tomato paste is imported from Libya (where it is produced under an Italian license) at a very low price and with low import duties, which obviously destimulates the local production whose current use is only meant for fresh consumption.

Without an appropriate development policy to create competitiveness and protect the national production whenever necessary, duly supported by the necessary technical and financial resources so as to create favourable conditions of growth, the food industry would stay as it is, i.e. structurally constrained and penalised by internal and external conditions, and incapable not only to export but also to guarantee the full supply of the internal market.

## **2.8 Taxation.**

The new policy calls for simplifying and reducing taxes on exports and imports. However,

the introduction of many other forms of taxation, predominantly local taxes, that were raised and levied on all goods passing through the state, region or even village has been observed.

Under the October 1993 policy changes, these local taxes have been lifted. However, the implementation of this policy may prove to be difficult, particularly because the states which were formed under the new federal system of government are lacking funds for their activities. Yet appropriate taxation mechanisms must be found which do not have a negative impact on development.

There is a need for a major review of the current taxation system, both formal and informal. While there is need for more Government revenues and for giving the newly formed states sufficient sources of revenue, the Government policy should ensure that the burden of taxation on agriculture does not weigh too much and work as a disincentive to agricultural production. Other sources of income for the Federal and State Governments should be sought.

Taxes and levies should be limited to income profit taxes. Other taxes and levies should be cancelled. Maintaining these other taxes and levies would hinder investments in the formal food industries sector. Therefore, taxes and levies should only be applied to the informal sector to destimulate it for the benefit of the development of a modern food industry sector. The proposed measure would attract more people that are capable of paying income profit taxes and invest in the food industries.

## **2.9 Trade regulations and custom duties.**

The application of the Government trade regulations currently impose some major constraints. With regard to imports, this situation is largely due to the confusion surrounding the current regulations rather than the regulations themselves. It seems that importers are getting different instructions on import requirements and are often requested to follow different procedures. The result is that one dealer may find it relatively easy to import a specific item whilst another finds it almost impossible.

Government trade policies and regulations, including those related to taxes and duties need to be simplified and clarified. Importation of all industrial inputs required, spare parts in particular, must be facilitated and import regulations should be made simple and clear.

Local investors should be exempted from paying custom duties on equipment, machinery and spare-parts imported for establishing and running industrial activities related to food industry. Agricultural, livestock, fishery and packaging activities should also be included. Custom duties on imported raw materials should be exempted only on a selective basis to encourage utilisation of the locally produced raw materials to the maximum extent possible. Custom duties on intermediate raw material such as sugar, soda, etc. should be reduced to a minimum.

## **2.10 Utilities.**

Power and water cuts are frequent, and responsible for 25% of the time lost. Also lack of fuel causes stoppages. So, the entrepreneurs must have their own water storage and stand-by generator. Investors should be given the right to import fuel to satisfy their needs to generate



power. Minimum custom duties are recommended.

### **2.11 Packaging material.**

Industrial inputs, packaging material in particular, are scarce and expensive in the Sudan and represent a serious problem for the food industries. Very few enterprises are producing packaging material and are facing import difficulties (hard currency, import formalities). The packaging industry should be given special consideration and incentives based on an assessment of the national requirements in quantity and quality.

### **2.12 Political stability.**

Political stability which would, inter-alia, improve the investment climate and encourage national and international investors and entrepreneurs and re-attract the highly qualified professional who live and/or work abroad is beyond the scope of this study. However, it is worth noting that the prospects and apparent feasibility of all aspirations on sustainable development would be sheer wishful thinking unless political stability and law and order are achieved to a level and an extent which is acceptable to all citizens. It is also worth noting that, in the case of the Sudan, political unity and stability is an important, not only political but also socio-economic objective as it would stimulate integration and complementarity between the different local economies and cultures.

### **2.13 Market constraints.**

Almost the entire grain crop of the Sudan is marketed in sacks, an item for which there is a huge shortage. It is widely admitted that unavailability and high cost of sacks are major constraints which suggest the expansion of bulk handling and transport, particularly for the export market. When investigating into this problem, the mission has been informed that the major causes of grain losses, which often amount to as much as 40%, include:

- improper sealing of sacks which can result in total loss of their content during transport;
- damage to sacks during transport from short edges on trucks; and insect damage due to improper chemical protection during storage.

Introduction of bulk handling would require considerable investment in combined harvesters with silos, bulk transporters and storage facilities, all of which require foreign exchange, and might also result in redundancy of existing equipment. In addition, there would be a need to change loan agreements which specify repayment in sacks of grain, a change which might be difficult to implement.

The free trade market has little positive effects on small farmers and herders. Merchants buying their produces at low prices often serve as their bankers providing credit at high interest rate.

### C. NUTRITION AND FOOD SECURITY

At the International Conference on Nutrition held in Rome in December 1992, Sudan presented a paper showing that during the period 1987 - 1989, the average calorie available/caput/day was 2,121. A summary of the food balance sheet is given below:

Table 19. Food Balance Sheet for Sudan, Average 1987 - 1989

	kg/year	calories/ year	proteins. gm/year	fats gm/year
Grand total		2,121	60.6	65.1
Vegetable products		1,771	40.1	41.5
Animal products		350	20.2	23.9
Cereals	136.8	1,169	33.1	11.9
Wheat	32.6	227	8.1	1.5
Rice	2.2	19	0.1	--
Maize	1.7	15	0.1	0.2
Millet	11.2	101	2.7	1.2
Sorghum	89.0	753	21.5	9.0
Starchy foods	6.7	19	0.2	--
Sugar crops	9.3	8	0.1	--
Sweetness	19.8	193	--	--
Pulses	4.7	27	2.0	1.5
Oil crops	1.1	61	2.5	5.3
Vegetable oils	8.1	197	--	22.2
Vegetables	28.1	19	1.0	0.1
Fruits	31.2	50	0.6	0.3
Beverage crops	0.8	1	0.2	--
Meat	15.7	87	0.1	6.6
Animal fats	1.0	21	--	2.3
Milk	118.9	232	12.1	11.1
Eggs	0.9	3	0.3	0.2
Fish	1.0	2	0.3	0.1

These figures are not completely satisfactory when referred to the recommended

daily intake summarised as follows; especially with regard to energy (caloric) intake:

**Table 20. Recommended daily intake**

	Body weight kg	E-n-e-r-g-y (kcal)	Proteins (kg)
<b>Children</b>			
Under 1 year	7.3	920	14
1-3 years	13.4	1,360	16
4-9 years	20.2	1,833	20
7-9 years	28.1	2,190	25
<b>Adolescent boys</b>			
10-12 years	35.9	2,600	30
13-15 years	51.3	2,900	37
16-19 years	62.9	3,070	38
<b>Adolescent girls</b>			
10-12 years	32.8	2,350	29
13-15 years	49.9	2,490	31
16-18 years	54.4	2,310	30
Adult males (moderately active)	65.0	3,000	37
Females (moderately active)	55.0	2,200	25
last half of pregnancy	--	2,550	38
Lactating	--	2,750	45

Consequently it can be assumed that the Sudan is today not completely self-sufficient with regard to food and nutrition. Nevertheless food supplies in the Sudan are characterised by seasonal fluctuations depending on rainfall since most of the food is derived from rainfed areas. Doubtless there are seasonal food shortages according to the rain situation.

Food security represents for the Sudan one of the most important objectives for the future. The current nutritional imbalances should be corrected. Besides, food production should keep pace with the demographic growth: this means that on a short term basis (5 years) the availability of food must be raised by at least 14% on an average, on the medium term (10 years) by approximately 29% and on the long term (20 years) by approximately 67%. Under

the current production patterns of the Sudanese agriculture especially in the rain-fed areas, the above increases cannot be assured either by the expansion of the areas under cultivation (the labour's productivity representing a limiting factor) or by the increased number of farmers (on account of the current trend towards and increased urbanisation of the rural population). As a consequence, one can conclude that the food security objective should necessarily stand on the assumption that the agricultural productivity is raised through a general effort of modernisation of the sector, and both animal and agricultural productions are better utilised through reduction of post harvesting losses and improved handling, transport, storage and processing conditions. The role of the irrigated sector. This derived objective calls for:

- an increased role of the irrigated sector in the national food production for the internal market, also considering the pilot function possibly played by it on the national agriculture as a whole;
- better integration between the primary, secondary and tertiary sectors thanks to the establishment of fully integrated food chains;
- development and consolidation of the food industry for the national market and for export through expansion, diversification and full utilisation of the existing processing capacities;
- at an institutional level, improved sectoral policy making and planning capabilities, inspired in a common development strategy setting food security as priority objective one.

## **SECTION II.**

### **Approach for the establishment of a Comprehensive Prospective Strategy for Sustainable Integrated Development of the Food Industry of the Sudan.**

#### **1. Development potential and constraints.**

A general overview of the Sudan's situation has been described in the previous section. It has been said that the Sudan is today self-sufficient with regard to food production, due to the vast potential of the country, but shows also signs of nutritional deficiency. This situation can further deteriorate if the food production does not keep pace with the demographic growth (2.6% p.a.).

Being the Sudan extremely rich in arable land, especially if referred to its population, water (at least in its areas not affected by the process of desertification) and renewable resources (livestock and fish) the possibility to substantially increase the food production is realistic although, being the country relatively little populated, it will depend more on the upgrading of labours' productivity and of the technological level than on the expansion of the cropping areas and pastures.

This means that the increase of the food production can only be envisaged through a process of modernisation of the concerned primary sectors (agriculture, livestock and fishery), aiming at raising their productivity as referred to both labour and physical resources. The modernisation process will represent a real "structural" change, implying the need to abandon the traditional management practices for more modern, time-saving and performing ones based on the utilisation of appropriate technologies and production inputs.

Not to repeat the errors of a recent past, the role of the industry in support of the primary production sectors will have to be regarded, at least during the first period of the implementation of the strategy, in connection with their development programmes so as to stimulate their growth. It goes without saying that the food processing industry will only develop as a result of the consequent increased availability of national raw materials, and the development of raw material production needs a strong market outlet which could represent a strong food industry.

The comprehensiveness of the strategy will stand basically, from one side on the vertical integration of the food chains, from the other on the horizontal integration between the different components of their 3 "platforms" (primary production, processing industry and market), and between the same platforms and their external environment, in an attempt to remove the "structural" constraints (or bottlenecks) which prevent establishing the necessary interconnections between the different production sectors and services supplying areas, public institutions and private companies, and all other parts intervening in the development process within the frame of a coherent integrated national policy.

The implementation of the strategy will necessarily have to be supported by adequate financial and human capabilities, and promotional and monitoring mechanisms and structures. Among the structural constraints, the following ones can be identified as playing a major role in affecting the integrated development of the food chains:

- a) current low productivity of the primary production sectors (agriculture, livestock and fishery, hereafter defined ALF ) and lack of permanent (non conjunctural) surpluses to feed (in quality and quantity) the processing units as a result of the extensive production practices, as well as of the low level of technology, in particular in the “traditional” sector;
- b) in some sub-sectors of the food industry, excess of under-utilised processing capacity as a result of a development model which neglects the importance of the vertical integration of the food chains;
- c) lack of national industrial capabilities to produce abundant and cheap inputs and production factors for ALF and for the agro and food industry (fertilisers, pesticides, selected seeds, packaging material, etc.) which is one of the main causes for the low productivity mentioned under a);
- d) insufficient development of the basic infrastructures (roads, electrification, telecommunications..) in particular in the rural areas, which hampers the development of the economic activities all along the food chains;
- e) also, insufficient national capabilities to provide the necessary basic services (credit, technical assistance) required by both rural and industrial sectors;
- f) lack of an integrated coherent national development policy to elaborate strategies and identify priorities in line with the national interests and vocations, develop general and sectoral, national and local planning capabilities and set up the necessary technical, financial, legislative support programmes and measures for the integrated development of the different levels of the food chain;
- g) hypertrophic presence of the public sector in the economic activities and insufficient dynamism of the private sector, as a consequence of the non incentivating financial and legislative environment;
- h) reduced participation of the R&D institutions in the development process and their disintegration from the economic and productive sectors as a consequence of the lack of a satisfactory national reference model of development and of the insufficient technical and financial resources.

## **2. The proposed strategy.**

In the light of the immense agricultural, livestock and fish resources of the Sudan, a central, pivotal element of the strategy will be played by the agro and agro-related industries, on account of the role they play in the social and economic life of the country, and therefore in the enhancement and acceleration of its development process. Far from becoming an artificially injected element of the strategy, the development of these industries in the Sudan is perfectly consistent with the country’s realities and development expectations.

Besides, it is an indispensable tool for the modernisation of the primary sector on which the national economy stands and is expected to further develop, as well as for the capture of that

added value which is today lost by simply exporting raw materials. Denying the importance of this role would mean, in the short and even more in the long term, to condemn the country to a progressive, implacable degradation of its physical, social and economic environment. In the light of the errors occurred in the a recent past for lack of a suitable development model, a derived basic feature of the strategy will be the setting up of an articulated model based on the development of the food chains and on the full vertical integration between their different levels. ALF will be the platform from which the development moves ahead. Based on it, a development model will be designed as a reference framework for the national planning of the agricultural and food chains, that will be defined therefore "ALF model".

It will be elaborated according to a space and time-related approach, so as to lead space-wise, to the definition of a macro-model at national scale and a number of micro-models according to the locally ascertained socio-economic realities and productive vocations. The time-related definition of both macro and micro models will be allowed by the simulation of their evolution on short (5 years), medium (10 years) and long (20 years) term through the development of different scenarios (basically a tendencial, a voluntary and a "full-development" scenario) reflecting the expected effectiveness of the national planning action as well as the intensity of the technical, human and financial resources injected in the development process.

On account of the traditional lack of horizontal integration between agriculture and livestock in the Sudan, another fundamental element of the strategy for the establishment of the ALF platform will be represented by the setting up of strong "structural" linkages between these two production sectors, so important for the socio-economic development of the country. This element is an absolute pre-requisite for the structural change leading to their modernisation, to the increase of their productivity in terms of quantity and quality and to the establishment of healthy and stable conditions for any further development of the platform as well as of the food chains that lean on it. Another feature of the strategy will be represented by the objective of the national food security, in consideration of the basic role it plays in the establishment of minimum welfare conditions of both rural and urban population, which in turn represents a very clear and vital development priority. Therefore, the agro-industrial production of basic foods will be encouraged in the attempt to provide on the short term, a permanent solution to the problems of under-nourishment and nutritional deficiency, and to set up on the long term, better conditions for the improvement and diversification of the national diet.

The conservation of the abundant natural resources being increasingly jeopardised in the Sudan, as in many other African countries, by the progression of desertification, the utmost importance of the environmental sustainability will be taken into consideration in the elaboration of all development programmes suggested by the strategy, bearing in mind the objective of identifying, selecting and implementing development and management models fully compatible with the national realities in a spirit of respect, protection and reconstitution of the environmental resources. An implicit tool of the environment protection strategy will be represented by the modernisation of the primary sector leading to a reduction of the damage on the natural resources (overgrazing, soil depauperation, deforestation, desertification) caused by the extensive production practices (transhumant animal raising, nomadic agriculture), and therefore to combined positive repercussions ecology and economy-wise

The abundance of the natural resources in the Sudan is such that it can be realistically expected that the country will be able to achieve, through the application of an articulated and country-specific development strategy for the food industry sector, not only the satisfaction of its own internal requirements in a relatively short period of time (5 to 10 years) but also a condition of permanent “structural” over-production to feed the country’s reserve stock and ensure important earnings in foreign currency from the export activities in the long (20 years) term.

The current lack of rational, articulated policies for the best utilisation and valorisation of the huge natural resources, centred on the defence of the national interests, is another diagnostic element suggesting the application of strategically conceived socio-economic and technical sectoral and intersectoral policies, the strengthening of the existing institutional mechanisms and resources and the establishment of new ones in support of the planning and monitoring activities related to their implementation. Appropriate measures and mechanisms are also required to regulate and stabilise the internal markets in an attempt to correct price fluctuation and de-stimulate excessive speculation, both detrimental factors for the incentivisation of satisfactory production and consumption patterns, and promote “vocational export” by incentivating production and trade of export-oriented products, especially in the case they incorporate an important added-value component, and by discouraging the importation of un-necessary, easily replaceable imported foods and the export of raw materials which are strategic for the national food industry.

Finally, the infrastructural integrated development, especially of the rural and most inaccessible areas of the country will be another important element of the proposed strategy, in an attempt to stimulate production and facilitate its access to the market, as well as for the establishment of better conditions of political integration within the country.

Along the same lines, a special attention will be devoted to the upgrading of the national human resources through technical assistance, extension and training, and to employment with special regard to women's employment generation in particular and skill upgrading in the rural areas.

For the reader to attain a synthetic vision of the proposed strategy and better appreciate its comprehensiveness, its main constitutional elements which in turn represent as many priorities and objectives, will be summarized as follows:

- food industries development through expansion, restructuring and diversification;
- vertical integration of the food chains;
- horizontal integration between agriculture and livestock;
- food security and permanent solution of nutritional problems at national and local level;
- environmental sustainability;
- valorisation of natural resources;
- sectoral policies elaboration, sectoral development planning and monitoring, and institutional strengthening;
- stabilisation of the internal market;
- promotion of vocational export;
- infrastructural development;



- socio-economic national integration;
- human resources upgrading;
- employment generation;
- women's socio-economic development.

### **3. Proposal for a national plan for the implementation of the strategy.**

The strategy will be implemented along the lines of the methodology proposed by UNIDO on the occasion of sectoral missions to other African countries (Tchad, R.C.A.), and already under application by the Popular Republic of Congo, called PIDA (Plan for the Integrated Development of the Agro-industries). This methodology implies that the planning exercise starts from the initial execution of a detailed diagnostic and prospective study of both resources and production capabilities in the concerned agro-industrial chains. In the case of the Sudan, only the food industry chains would be concerned. Based on the results of this study, a long term strategic vision of the ALF model will be elaborated, from which the medium and short term development strategies and objectives are to be derived.

The establishment of the planning capabilities necessary to further develop, implement and consolidate the strategy will be achieved gradually and will start with the setting up of a supervision and monitoring structure at central level, based in Khartoum. The diagnostic study provides the basic information for:

- the assessment of the production potential,
- the assessment of the existing production capabilities and performances,
- the identification of the development constraints all along the food chains,
- the definition of the comprehensive macro and micro models based on the assessment of the most relevant socio-economic and technical indicators,
- the simulation of the prospective development scenarios on the long term (20 years) and their transfer on the medium and short term (10 and 5 years respectively).

The micro models will be elaborated based on the socio-economic realities and productive vocations locally ascertained and will allow to identify and characterise the different geographic environments composing together as a puzzle, the general framework at national level, defined as macro model.

After the initial planning exercise has been started at central level, antennas will be established in each of the geographic environments identified as micro models, so as to enable:

- to transfer the general planning instructions formulated at national level into derived local strategies, to identify and promote development programmes and projects coherent with them,
- to enable monitoring development programmes at local level, upgrade the information and circulate it so as to allow the feed back of the results obtained at local level as a consequence of the planning measures and implementation activities undertaken.

Two major indicators, demography and nutrition will be initially studied and their curves projected according to the basic assumptions of the simulated scenarios, so as to define and calculate the corresponding development objectives in terms of production and productivity,

consumption, processing and marketing; characterise and quantify development policies and programmes and ascertain the relevant technical and financial implications.

With all evidence, the reliability of the basic information, and in particular of the technical and economic data collected at national and local level will be an essential pre-requisite for the effectiveness of the simulation exercise and for the quality of the diagnostic study and all other planning activities as well.

Once the development scenarios have been fully elaborated and all basic development solutions simulated inputs and outputs-wise, a policy paper will have to be prepared to indicate to the Government the possible alternatives and their political and financial implications. Among them, one will be finally retained, whose implementation will start as soon as the relevant technical and financial resources are made available.

During the first implementation phase, also defined pilot phase (of a five year duration), all strategies and planning actions and programmes proposed, and projects identified thereof, will be tested under practical conditions within the frame of pilot projects horizontally and vertically integrated for the purpose of identifying, against the ascertained potential, the general and specific constraints to development, and elaborate practical integrated policies and mechanisms for their removal.

All concerned socio-economic sectors and institutions, including the private sector, will be requested to participate in the planning exercise and in the monitoring activities of the follow-up programmes and projects identified by the Plan, in a spirit of full collaboration between public and private sectors. Along these lines, a steering committee will be set up to integrate all components of the public and private sectors (concerned Ministries and institutions, chambers of agriculture, industry and trade, technology development institutions) to supervise on a regular basis the promotional and implementation activities under the co-ordination of the Ministry of Planning.

UNIDO will be instrumental in this process, by providing assistance for the setting up of the initial structure of the Plan in Khartoum, and for the implementation of the main activities proposed for the pilot phase, which include: training of the national staff, technical assistance to the execution of the diagnostic study, provision of the consultancy services in other areas of activity such as: policy development and institution building, elaboration of sectoral strategies and programmes, managerial and entrepreneurship development, project identification and formulation, technical and managerial supervision of project monitoring, upgrading of managerial and entrepreneurial skill.

Additional assistance will be provided by UNIDO to:

- the training, managerial and technical supervision for the implementation of the pilot projects proposed to test under practical conditions the comprehensiveness, and techno-economic sustainability of the proposed strategy during the pilot phase of the Plan;
- the promotion of the policy-based programme and project initiatives suggested by the Plan vis-a-vis the international funding organizations;

- the coordination of the planning and project implementation activities with the concerned international organizations (in particular FAO).

UNIDO's assistance will be discontinued upon expiration of the pilot phase, when sufficient and appropriate human, technical and financial national capabilities have been guaranteed for the taking over of the development planning process over the medium and long term phases, also as a result of the financial resources generated during the first phase of the Plan as a result of its economic self-sustainability.

#### **4. Pilot Project to reflect and test the Comprehensive Prospective Strategy for the Sustainable Development of the Food Industry.**

The pilot project proposed will have the same duration of the pilot phase of the Plan (five years). Its main objective will be to test under practical conditions the applicability of the development strategies, and socio-economic and technological solutions promoted by the Plan. Therefore, the pilot project will stand on the same components of the comprehensive strategy, such as the following ones:

- environment protection and rational utilisation of natural resources (land, water);
- food security and upgrading of the nutritional standards;
- skill development and employment generation, alleviation of women's workload;
- vertical integration of the food chains and horizontal integration between agriculture and animal raising sectors;
- development and/or application of appropriate labour intensive and low capital-intensive technologies;
- integration of marginalised socio-economic sectors into market economy;
- cost effectiveness and economic sustainability.

On account of the integrated character of the project, encompassing nearly all sectors of socio-economic activity, all concerned international and national organisations will be requested to provide assistance to the project, in the respective fields of competence. They will be co-ordinated by the steering committee of the Plan.

#### **Technical and organisational approach.**

To test the effectiveness and the comprehensiveness of the strategy the project will integrate all vertical steps of the food chains starting from its basic one, which is the ALF platform.

Actually, the need to incorporate aspects like "environment protection and physical resources optimisation" and "integration of marginalised socio-economic sectors into market economy" will push even further its verticality. It will therefore, incorporate an additional step, which is: land reclamation.

#### **Basic pre-requisites.**

For the establishment of the pilot project, the following pre-requisites will be required:

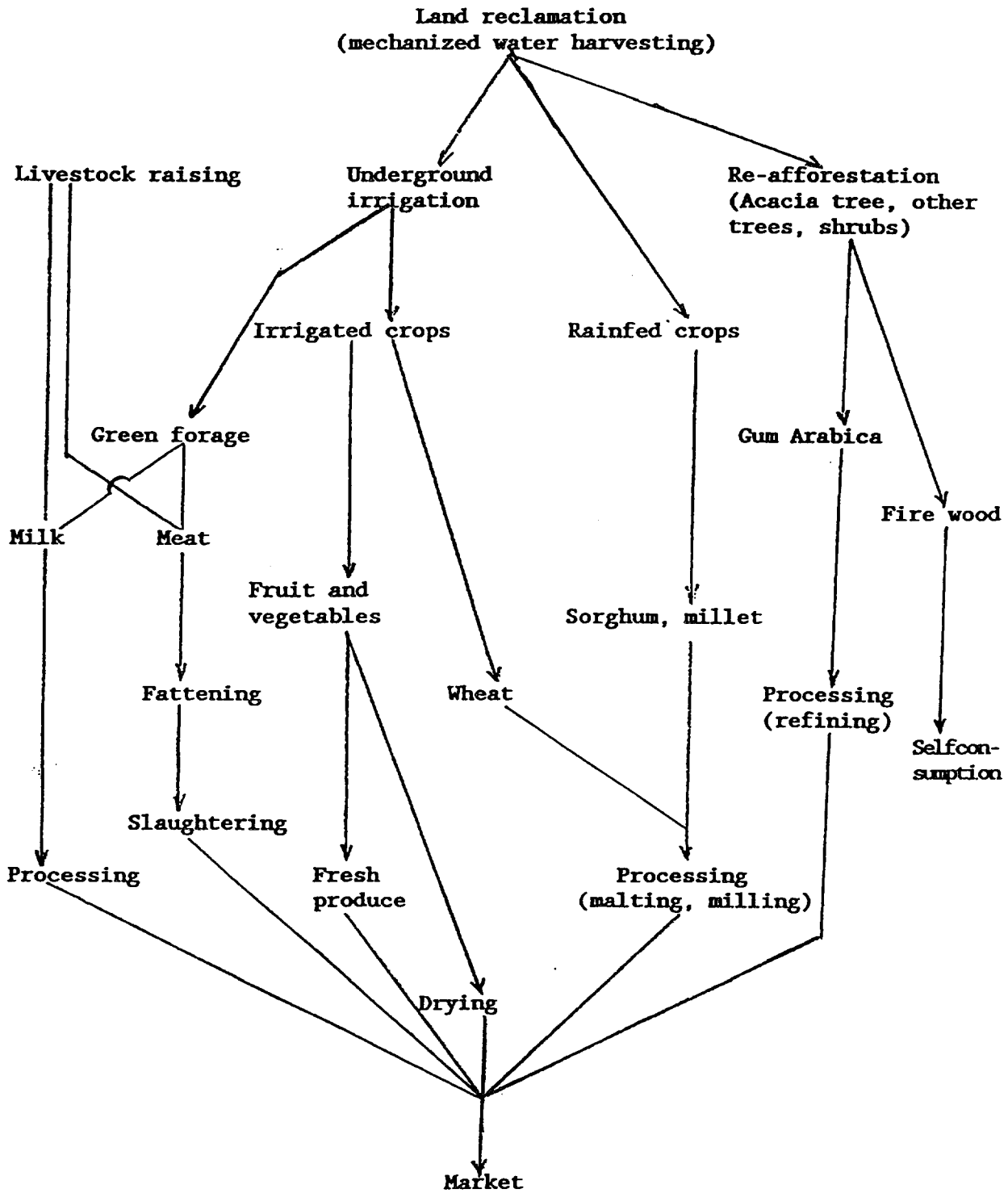
- the land available for ALF development activities at the project site should be at least 1,000 has;
- this land should be "marginal", i.e. not or only sporadically utilised for ALF production;
- the minimum average rainfall per year should be 250-300 mm.;
- suitable water should be available in the project's site for underground support irrigation;
- the project site should be near an inhabited area showing conditions of socio-economic marginalisation, under-employment and nutritional imbalance;
- the existing road network should be such as to enable the flow of merchandise to and from the project's site all over the year.

Besides, housing facilities should be made available in the site or in its immediate surroundings to house the national and international staff and shelter the project technical and administrative services.

**Project description.**

The following flow-chart allows to visualise the technical and managerial development assumptions on which the pilot project is based.

Pilot project's production flow chart.



### **Land reclamation.**

The activities of land reclamation, through the adoption of a mechanised "water harvesting" system will allow to reverse the current trend towards an increasing desertification by protecting the environment and retrieve the land resources to semi-intensive and, in combination with underground irrigation, intensive animal raising and farming.

The mechanised water harvesting system proposed stands on the utilisation of a special plough, called dolphin, invented by an Italian animal production specialist, Prof. V. Vallerani, whose function is to dig crescent-shaped holes of the required depth, able to collect the rain water, store it and protect from evapo-transpiration on account of the shelter provided by the fragmented upper soil. This result is achieved by a second essential tool of the system, a special ripper called "Scarabeus". The system has been successfully tested on different occasions with spectacular results in terms of environment protection (re-afforestation) and land reclamation for annual crops sowing, tree and shrubs planting: in Niger from 1986 to 1989 within the frame of the "Projet intégré de rehabilitation du Demergou" financed by FAI (an Italian technical assistance Fund) and in the peninsula of Sinai in 1990-91 within the frame of the "Integrated R&D project of North Sinai" jointly financed by the Italian and Egyptian Governments. The system is as interesting economically as it is technically, since the cost of the land reclamation by using it hardly exceeds 100-120 US\$ on an average per ha.

The reclaimed area can be made more productive by combining the water harvesting system with support underground irrigation, so as to allow intensive production of annual and tree crops all over the year like in a naturally hydroponical environment. The only pre-condition is the availability of water of a quality suitable for irrigation. This water is simply conveyed to the underground holes by submerged pipes and poured into them. Although this system has never been tested yet in combination with the mechanised water harvesting proposed above, it can be expected that it will allow an easy implementation (on account of its simplicity) and spectacular results in terms of inputs economy (low water and fertilisers consumption) and productivity.

### **Primary production patterns.**

The main productive and environment protection activities envisaged are the following:

- protective and productive afforestation (i.e. *Acacia Senegalensis* for production of gum Arabic, *Eucaliptus* or other suitable tree species for production of fire wood),
- semi-intensive farming, through rainfed production of: tropical cereals (sorghum, millet), cotton, sesame, chick peas and other low water demanding annual speculations according to the average annual rainfall;
- intensive farming through rainfed production technologies complemented by underground support irrigation for production of the same speculations as above, as well as wheat, fruit and vegetables and green forages;
- intensive fattening of animal species (cattle, sheep and goats);
- fishing and aquaculture if the existing environment allows this kind of speculation.

**Post-harvesting, processing, distribution and marketing.**

Full valorisation of animal and crop production will be sought through an intelligent combination of post-harvesting, processing, distribution and marketing strategies, based on the global objective of minimising the wastes, optimising the commercial value of the food products and generate employment through the application of appropriate low capital-intensive and high labour-intensive technologies.

**Gum Arabic.**

The gum Arabic will be refined if an interesting commercial output is found for this product under the production scale allowed by the project, otherwise it will be marketed as a raw product.

**Fruit and vegetables.**

This production will be partly devoted to fresh seasonal consumption market, partly "sun-dried" for internal and external markets. The drying technology based on the utilisation of the solar radiation represents, in conjunction with the water harvesting and underground irrigation systems already described, the ideal combination to achieve an optimum utilisation of the human (employment), financial (low investment) and natural limited resources (water). Among the different de-hydrated or semi-dehydrated products which can be made by utilising the sun-drying technology, a special importance will be attached to the production of tomato powder, regarded as an interesting substitute for tomato paste on account of its limited production cost (little investment, no energy consumption, minimum packaging requirements).

**Cereal milling and malting. Derived products.**

The cereal production will be devoted mainly to human feeding through mechanised small or medium scale flour milling technology, so as to alleviate the women's workload and improve yields and quality of the flour. The by-products will be used for the production of animal feeds.

An interesting solution to add value to the sorghum production and enable at the same time the transformation of this raw material into a natural, nutritionally enriched product will be provided by the technology for production of sorghum malt based on the so called "outdoor system", by soaking the cereal in water, and then germinating and drying it in a malting box (easy to construct and little expensive) working as a germinator and a sun-dryer at the same time.

Sorghum malt is a very interesting product nutrition-wise, because it is rich in enzymes (alpha and beta amylases) which facilitate the hydrolysis and therefore, the digestion of the starch. Its utilisation as an ingredient of cheap and easy-to-prepare weaning and highly nutritional foods, especially if a suitable protein component is added to them, is envisaged to upgrade the nutritional standards of those population layers which are most exposed to the consequences of nutritional imbalances (weaning children, pregnant and lactating women, etc.).

Other important applications of the malted sorghum either as a flour or as an extract, can be envisaged for the Sudan, such as: production of malted beverages, bakery products and biscuits, and confectionery products.

#### **Additional solar drying applications.**

The flexibility of the solar drying technology in adapting to the most different conditions with regard to location (rural or industrial environment), size (small, medium or large scale) and products (all kinds of perishable foods) suggests to expand its utilisation to the widest range of agricultural and animal food products. The following ones, which are of particular relevance for the diversification of the economic speculations promoted by the project, open at the same time interesting fields of research and development, production and market:

- dried karkadé, to be further processed into powder or concentrated syrup;
- other dried vegetables (okra, onions, hot Chile, garlic);
- dried fruit (mango, papaya, pineapple), eventually in combination with a previous semi-dehydration technology;
- roots (cassava, ginger);
- aromatic plants and spices;
- meat and fish.

#### **Animal products.**

The animal raising activities will be given a special attention on account of the strategic importance for the Sudan to achieve an optimum integration between agriculture and livestock. This objective will be achieved by keeping the animal stock on natural grazing during the rainy season, when feed grass is abundant, on non reclaimed lands and by feeding it with green (either fresh or dried) forages during the dry season.

The verticality of the animal production chain will be achieved by setting up a fattening centre, integrated with an animal feed plant and a slaughterhouse, and a small dairy plant to make rational use of the milk in excess.

#### **Fish production.**

If the environmental conditions of the project site allow, for the presence of natural or artificial water basins, rivers or swamps, the fishery activities will also be developed using simple and easy-to-implement technological tools. The local population will be made acquainted with the profession of fisherman, as well as with fish production and consumption patterns.

#### **Storage and conservation, packaging and distribution.**

The problem of perishable foods will be solved by setting up appropriate multi-purpose cold storage, packaging and distribution facilities.



**Quality standardisation and control.**

The qualitative aspects will be monitored by a central laboratory in which the standards of all project's inputs and outputs will be checked. Conformity of the quality standards of the food products to ISO 9,000 norms will be sought in an attempt of having them internationally certified and guaranteed under a quality label, which could even be a green label on account of the environmentally friendly technologies promoted and utilised by the project.

### **SECTION III.**

#### **Programmes and projects for immediate implementation.**

The Sudan has a great potential in terms of agricultural production and food processing and food export development possibilities. Yet, the performance of the country is of a quite low standard when compared with other African countries. This is due to number of problems and constraints mentioned in this report. This report has in the previous chapter provided guidelines for a comprehensive strategy for the development of the food industry of the Sudan. However, also on the short term the recommendations to be made are numerous and concern almost all sub-sectors. On the other hand, to build-up a competitive food industry is an enormous task requiring not only planning but also political will and decision making capabilities. Also to restore the confidence of the entrepreneurs is an urgent task that should not be underestimated. The top priority for the Sudan should immediately fix as an objective an annual growth of at least 5% of the agricultural production. Such a trend will allow the Sudan to improve its food self-sufficient and to revitalise its food industry which in return will boost the agricultural production further up. Due to the complexity and the dimensions of the task it is recommended that UNDO sets up, under the supervision of the team assisting the Ministry of Plan to implement the comprehensive integrated prospective strategy for food industry development an "Umbrella Project" to assist the Government.

The project will be multi-disciplinary and will play an active role in:

- i) Helping the Government to overcome all major institutional and legal constraints hindering the harmonious development of the food industry.
- ii) Co-ordinating the action to remove the constraints between all parties concerned: ministries, industries, farms, R&D institutions, etc.
- iii) Conducting the first priority studies and surveys necessary for an optimal utilisation of the raw materials for the food industries.
- iv) Developing sectoral programmes and punctual projects, such as those shown below, within the frame of a short term sectoral development strategy. All main food commodities will be studied in the light of the best return for the farmer, the best profit for the country in terms of foreign exchange, the interest within the frame of an import substitution scheme (wheat), the possibilities of an added value from their finished or semi-finished products (gum Arabic, livestock, groundnuts).
- v) Assisting the GOS and the enterprises to identify a market for finished and semi-finished products and carry out training programmes on sectoral planning and project development on behalf of government officer and private entrepreneurs.
- vi) Assist in the implementation of the programme and project activities.

This UNIDO assistance is foreseen for a minimum of five years. Whenever possible it will employ national experts and consultants. It is obvious that UNIDO will have to work in close

collaboration with FAO, IFAD and other international and national institutions dealing with agricultural and rural development. As an initial task, the following sectoral programmes will be foreseen.

### **1. Sectoral programme 1: “Modernisation of the animal raising sector through vertical integration”**

The livestock sector in the Sudan deserves a special attention due to its share in the economy which represents: 22% of GDP, 22% of the export (live animals, meat, hides and skins) and 16% of the Sudanese diet (meat, milk, fat). The growth potential of the sector is quite promising but should not be achieved at the expense of other important development opportunities. It must be remembered that Soybean for example, produces per acre 18 times more proteins than those obtained if that acre is given over to grazing beef cattle or growing their fodder. The actual national stock is estimated at 65 to 100 million heads (equivalent of 35 to 50 million cattle units). The vast grazing resources of the Sudan (estimated in 250,000 square kilometres) are utilised by the nomadic pastoralists, sedentary and transhumant livestock owing tribes (40% of total population). Nomadism is defined as the regular systematic movements of the nomadic families with their stock in search for grazing and water. Such movements are seasonal and in most cases tend to be regular in South/North direction.

#### **a) Traditional ranching**

In the past the traditional pastoral system has been immensely successful in the utilisation of the vast grazing resources to produce meat and milk out of the rangeland that would not have been utilised otherwise. Under this system the livestock production is actually confined to the possible seasonal off-take from the nomadic area. Although Sudan is endowed with more than 100 million heads of sheep, cattle, goats and camels yet prices of meat are high. This paradox is due to the fact that producers capitalise on animals and sell only to meet their basic needs and no more. Besides, livestock is not always available near the market as search for water and grass take shepherds away. Finally, the hard environment reduce fertility and number of births.

#### **b) Modern ranching**

Modern ranching is not a complete change of the old system; it is actually a modified or improved system. Efforts are being made to provide animals with water and animal feeds in the dry season (6 months), and adequate veterinary services. Otherwise, the system is in line with the old one. The managerial approach for modern ranching has now become obvious. With a more intensive management, not only meat can still retain natural flavour and taste but even improve its quality on account of an increased tenderness and palatability. With little additional care with respect to the traditional systems the fertility rate can be raised dramatically, up to 60% to 90%. Besides, 3 births in two years instead of two only can be made and the extra income would cover the additional cost, and prices would of course dramatically diminish due to the increased offer. Obviously it would be easier to produce what the market needs at the time it actually needs it. The modern ranch would act as a model for the traditional animal raising sector on its way towards a speedy modernisation. It would also represent a suitable social environment, by providing with necessary services

of education, health care...etc people who usually lack them dramatically.

The establishment of the slaughterhouse would provide added value to the economy of the primary production sector, at the same time ensuring a regular and continuous supply to the market. Besides, the additional existing infrastructures would allow to produce meat and derived products, thus contributing to stop the current practice to export live animals and start instead new interesting commercial trends based on exporting high value processed products. Incidentally, it should be reminded that the Sudan is marketwise very well situated due to its proximity to important meat consumption markets such as Saudi Arabia and the Gulf Emirates: only in 1993 the neighbouring countries imported from Sudan approximately 528,000 tons of meat for a total value of 836,000 million dollars.

Marketwise, the livestock sector is characterised by a growing demand for all kinds of animal productions (mostly cattle, sheep and goats). With regard to management, by the expansion of rainfed farming in rangelands. A project should be envisaged to operate at three different levels, encompassing all basic steps of the modern animal production chain within the frame of a strategy aiming at establishing conditions of vertical integration:

1. At primary production level, by setting up open breeding ranches such as the one for sheep breeding depicted below;
2. at finishing level, by developing fattening centres;
3. at processing level, by developing slaughtering and meat processing capacities.

#### **1.1 Programme component one: open breeding ranches**

The concept of an open breeding ranch in the Sudan has been developed by the Animal Resources Bank with the assistance of Dr. Ali Daraj.

The UNIDO mission fully supports the idea of such a programme which entirely meets the Government expectations. Such a project has to be considered as a demonstration unit and should be implemented by the Animal Resources Bank because of its experience and its specific assets testified by the ownership of the following production, marketing and services enterprises:

- (a) **Livestock Route Co.**  
This company was financed by the World Bank to provide services along a route of 1500 km length running all the way from production areas to Omdurman central animal market. The company owns 60 water stations along this route. The service stations are connected with a sophisticated communication network.
- (b) **Mawashina Company**  
This company is also fully owned by ARB to deal with animal export and production.
- (c) **Animal Resources Services Company.**  
This is the third daughter company, which has been established to provide modern veterinary services.

The bank itself has an initial capital of three billion Sudanese Pounds (30% owned by the

Government and 70% by private investors). Main objective of the programme is to produce live animals for slaughtering, so as to supply the modern consumption market with high quality products being sold at a competitive price.

As an example, the following project concept of a sheep open breeding ranch is given:

The ranch will be established in the northern Savannah belt. Average production in year four is estimated at 40,000 heads, corresponding to approximately 25,000 female sheep. The grazing paddock will be designed to accommodate a rest rotation grazing system. Production will be continuous.

The estimated average forage production 500 gm/sq.m. = 300 gm/sq.m. of usable forage, roughly corresponding to 1,26 tons/feddan. The animal feed requirements for sheep (9 months life) are estimated at 0.5 ton, while the carrying capacity is estimated at 1.26 sheep/feddan/year. Based on the objective of 25,000 female sheep, the size of the open ranch can be determined using the carrying capacity 0.4/Fed totalling 10,000 feddan or 42 sq.km. Rest rotation grazing system: the ranch total area must be divided into three equal sections (paddocks), each one to be grazed for 3 months during the year. The project may be financed in the form of a partnership between ARB and local private investors, under UNIDO technical assistance during the preparatory phase. Elements of project costing are given above. However, more accurate cost investigation is needed to accurately define the project site, the patterns for integration of its different components, and identify all technical and financial parameters involved, thus enabling to carry out a full fledged feasibility study which only may indicate the viability conditions of the project under objective and concrete terms. The execution of the project will be the responsibility of the investors under UNIDO's technical assistance.

## **1.2 Programme component two: cattle fattening centres.**

The Animal Production Research Administration, in Kuku, Khartoum has been successfully involved in research on fattening since 1961. It started with some assistance from USAID (chilling room and small abattoir) and in 1986 FAO injected 25,000 US\$ to improve the diet of cattle during the dry season. The fattening unit was financed from the profit generated by the previous projects. Today the centre is a self supporting unit working with the Informational Livestock Research Institute in Addis Ababa. It owns now 300 heads of cattle, 120 goats and 50 sheep. And the value of the centre is now estimated at 45 million, demonstrating the effectiveness of such a project. The basic composition of the fattening diet is the following: molasses (52%), wheat bran (39%), groundnut cakes (5%), urea (3%), salts (1%), essentially using by-products of the Sudanese food industry. It is proposed to multiply those centres at the rate of at least one new centre every year. For this purpose, a preliminary study is needed to investigate the following areas:

- Location and relevant criteria;
- Availability of animal feeds ingredients (molasses, wheat bran);
- Existence of slaughtering facilities or necessity to create additional ones; Investment; inputs to set up the centres: personnel, finance (and relevant sources).

### 1.3 Programme component three: multipurpose slaughtering and meat processing facilities.

ARB is considering setting up a 10 million dollars slaughterhouse with a finance from the PTA Bank. Negotiations with the PTA is half-way and the ARB trusts that the idea will materialise. In spite of the enormous meat potential of the country there is practically no meat processing industry in the Sudan. There is no doubt that such an industry would boost the production of high quality meat and it is believed that there is an important demand for processed meat.

### 1.4 Proposed UNIDO assistance for sectoral programme 1.

It is proposed that UNIDO fields a six week mission to Sudan, composed of a consultant in integrated agro-industrial development in his capacity as mission leader, a consultant in animal production, one in agriculture and another in meat processing to work in collaboration with a national team in the definition of a ten year national program for modernisation of the livestock sector through an integrated development strategy which would generate a number of implementation programs and projects. The detailed terms of reference for the mission should be further prepared by UNIDO and submitted to the Government of Sudan for approval. UNIDO would possibly contribute in financing the mission provided that half of the required investment, estimated in 80,000 US \$ as a total (excluding the national component) is provided by a national (ARB) or international source.

### 2. Sectoral programme two: "For the expansion of the raw materials production for the national food industries".

All available data indicate that out of the 4.1 million feddan of irrigated land only an average of 2.6 million feddan (63%) have been utilised during the last six years, distributed as follows:

Table 21. Utilisation of irrigated land.

	fedd'000	(%)	yield (kg/f)
Sorghum	1,061	40.0	569
Wheat	823	31.0	685
Groundnut	218	8.4	820
Cotton	419	16.2	562
Sun flower	37	1.4	389

Out of the 15 million feddan allotted to the rainfed mechanised agriculture only 9.3 million (62%) feddan were utilised during the last six years, distributed as follows:

Table 22. Land utilisation in the mechanised agriculture sector.

	fedd'000	(%)	yield (kg/f)
Sorghum	7,740	83.7	201
Millet	121	1.3	176
Sesame	1,248	13.42	84
Sun flower	147	1.58	161

Out of the 12 million feddan allotted to the traditional rainfed farms only 8.5 million (72%) were used, out of which:

Table 23. Land utilisation in the traditional farming sector.

	fedd'000	(%)	yield (kg/f)
Sorghum	2,644	31	138
Millet	3,530	41.6	84
Sesame	1,255	14.9	59
Groundnut	1,055	12.5	134

The production by sector can be summarised as follows: (in % of the total production for the last 3 years).

Table 24. Agricultural production rate by sector.

	Irrigated (%)	Mechanised (%)	Traditional (%)
Sorghum	20.81	61.57	17.62
Wheat	100	--	--
Millet	--	5.14	94.86
Groundnut	49.34	--	50.66
Sesame	--	65.79	34.21
Sun flour	37.98	62.02	--
Cotton	100		

Surprisingly very few figures are available concerning the estimated costs of production and estimated revenues for the farmers. The following information was collected from Rainfed Mechanised Farming in 1994.

**Table 25.** Farmers' revenues by type of crop.

	<b>cost/feddan in Ls</b>	<b>farmer revenue per feddan in Ls</b>
Sorghum	10,432	9,765
Sesame	10,429	37,500
Sunflower	15,073	25,600

The information compiled above allows to make recommendations for a better utilisation of the available land and consequently for the increase in the agricultural output. The first and immediate measure to implement is to take all necessary action for a maximum utilisation of the irrigated land. An average of 1.5 million feddan (37%) has not been utilised during the last six years. If this area could be used to produce for example: sorghum (500,000 feddan) and groundnuts (500,000 feddan) it could give an additional production of 284,500 tons of sorghum and 410,000 tons of groundnuts. A similar measure should be taken to increase the cultivated area of the mechanised rainfed farms from 9.3 million to 12 million feddan with for example 1.5 million feddan to produce 126,000 tons of sesame and 1.2 million feddan to produce 241, 200 tons of sorghum.

Those two measures would have an immediate result. If the examples taken proved to be feasible (see below) and were implemented over a period of two years , they would:

- i) Increase the production of groundnuts from an average of 540,000 tons to 950,000 tons (75.9%) and would contribute to a better utilisation of the installed oil-mills capacities.
- ii) Increase the production of sorghum by 540,000 tons which represents an average increase of 16% during the period, so strongly contributing to the improvement of the food security conditions in the Sudan.
- iii) Increase the production of sesame from an average of 220,000 tons to 380,000 tons (54% increase) that if exported would bring an increase of about US\$ 70 million.

What described above was only an example. An in-depth study should be conducted to verify and calculate the costs of production and the revenues for the farmers. The study should include all commodities planted under different conditions and permit to determine which type of farming and cropping technology is more appropriate for each commodity. The study should also include soil analysis.



A few examples are given below:

- Groundnuts planted under traditional rainfed conditions gives a yield of 134 kg/feddan but 820 kg/feddan under irrigated farming conditions, i.e more than six times increase. This indicate that groundnut should have a larger share in the irrigated scheme, with positive repercussions on the degree of utilisation of the installed capacity of the oil mills.
- Sesame's yield are 59 kg/feddan in the traditional system and 84 kg/feddan in the mechanised system. However, the costs of production are not known, so no recommendation can be made.
- Is it more important to increase the production of wheat to become less dependant on importation while producing less groundnut or sun flower? Or is the option to drop the local production and import more wheat a better alternative if it allows to produce more acclimatised crops such as groundnut or sunflower for the local vegetable oil industry and for export? The need for hard currency can be satisfied by an increased export of groundnut

In conclusion, a better utilisation of the arable land in the Sudan would greatly improve the agricultural output thus enabling to reach the following objectives: higher returns for the farmers, improved condition of food security for the country, increased supply in raw materials for the existing food industries and improvement of the socio-economic indicators of the rural population.

To increase the agricultural production other important measures are needed such as the following:

- Strengthening of the production of certified seeds;

A top priority for the Sudan should be to satisfy 100% of the national demand for certified seeds and hybrids within a period of 10 years. The Seed Research Corporation is currently responsible for the production of certified seeds but can only satisfy 15% of the national demand. The production of seeds should be decentralised and the responsibility left with the private sector although co-ordinated by the Ministry of Agriculture.

- Development of fertilisers' production.

A study including soil analysis is recommended as a basic pre-condition for a better utilisation of the arable land. Such a study would make recommendations on the utilisation of fertilisers according to the type of soil and the cropping patterns. Most of the agricultural inputs are currently purchased through the Agricultural Bank of Sudan and the Farmers Bank, under credit at a low interest rate. The Government should encourage the involvement of private companies in the production and marketing of the agricultural inputs.

- Improvement of harvesting and post harvesting methods.

According to various sources, the losses can reach up to 40% under certain circumstances. As said in a previous section, improved bags and plastic sheet material should be introduced. A techno-economic feasibility study should be conducted for the setting up of a factory to produce bags and tarpaulins; it will also study the cost-effective benefit that could be realised. As said, bulk handling should be considered, including storage and handling facilities. A pre-investment study should then be conducted. Although the investment might be high, the expected benefit would be very important. To conduct such a study however, would be a waste of time if a source of finance has not been previously identified.

- Elaboration of sectoral policies with emphasis on trade.

Figures on the exports and imports of the most important commodities are given in the tables 26 and 27 here below.

Table 26. Exports by commodities in 1993 - 1994 (value in 000s US\$).

Commodity	Unit	1993/94		%
		Quantity	Value	
Cotton combed	bales	456,436	88,672	5.10
Cotton waste	mt.	2,750	690	0.12
Gum Arabic	mt.	2,954	68,431	11.65
Groundnuts	mt	12,938	5,441	0.92
Sesame	mt.	167,939	88,859	15.13
Sorghum	mt.	397,755	38,233	6.51
Sunflower	mt.	12,020	2,391	0.40
Sena pods	mt.	1,380	500	0.08
Hibiscus flower	mt.	16,511	18,625	3.17
Hena	mt.	544	524	0.09
Edible Vegetables & Fruits	mt.	6,542	2,716	0.46
Edible Vegetable Oils	mt.	30,076	19,419	3.31
Cake & meals	mt.	126,333	15,459	2.63
Water melon seeds	mt.	26,143	11,820	2.01
Dukhn	mt.	2,152	255	0.04
Sugar	mt.	144,980	42,823	7.29
Molasses	mt.	283,556	15,682	2.67
Livestock	heads	83,900	99,272	16.90
Meat	mt.	4,947	19,133	3.27
Hides & Skins	mt.	3,424	103,533	1.76

Source:

Table 26: Summary of imports in 1993-1994 (value in 000s US\$)

Commodity	Unit	Quantity	Value
Wheat and wheat flour	mt.	488,127	112,928
Tea	mt.	16,326	24,795
Coffee	mt.	4,318	7,726
Other food stuffs	mt.	121,477	72,375
Beverages & Tobacco	mt.	1,399	10,255
Petroleum products	mt.	1,794,558	238,999
Other crude materials	mt.	126,005	32,235
Medicines	value	--	27,447
Other chemical products	mt.	107,341	76,521
Manufactured goods	mt.	658,228	209,120
Machinery and equipment	value	--	209,120
Transport equipment	value	--	95,521
Textiles	mt.	5,119	17,227
<b>Total</b>		<b>1,161,478</b>	<b>--</b>

Source:

It appears that the whole marketing strategy of the country has to be re-examined. There is no doubt that the Sudan needs to generate foreign currencies to finance its imports, mainly represented by mineral oil and derived products. For this purpose, it is absolutely necessary for Sudan to promote the export of finished or semi-finished products through incentives at all levels of the food chain. That will not only give added value but would also boost the food industry sector, that in return would involve a higher demand for raw materials with positive repercussions on the agricultural sector.

Various commodities should be considered within the frame of this strategy. This aspect will also be developed further on under the programme "for a better utilisation of the Sudanese resources". The main commodities to promote in view of an increase of the Sudanese export are the following:

### **1) Sesame**

It is a major export item for the Sudan representing about 15% of the total due to the fact that the importers are demanding mostly seeds, to be used in the bakery industry. And for that reason any industrial processing of this commodity is not recommended unless for the internal market. On the other hand the growing of sesame should be encouraged on the traditional rainfed farms. It does not compete with other crops, gives a reasonable income to the farmers and has a reasonable yield when compared to other crops produced by the mechanised rainfed sub-sector.

### **2) Cotton**

With a contribution of about 18% of the exported value, cotton represents the second commodity after meat and livestock. Cotton is planted on 16% of the irrigated farming area and is a traditional export item for the Sudan. Nevertheless, in socio-economic terms it might not be the best option for the country.

### **3) Gum Arabic**

As already said the Sudan is the largest producer of gum Arabic in the world (85%). IN 1993/94 the Sudan exported gum Arabic for a value of US\$ 72 million. Most of the gum Arabic is exported without any processing. A very small quantity (about 5% of the production) receive a first treatment through the Gum Arabic Exporting Company which increases the value of the exported product by 1000/US\$ per ton. But the process to produce a ready-to-use product is entirely done outside the Sudan. Such a process would increase the value of the products by 4 to 6,000 US\$ per ton. Therefore, all efforts should be made to process its production of gum Arabic so as to add value to this previous raw material.

It would allow not only to generate a very important income in terms of foreign currency, estimated at US\$ 400 million a year (if all the production was processed) but it would also be a booster for the farmers that could be offered a much better price. A pre-investment study should be conducted, ideally in collaboration with one of the existing foreign processing company. Also, the international markets need to be explored having in mind the interest to diversify the sales and directly reach the processing industries which are the final users of the product, which is not presently the case.

### **4) Groundnuts and derived products.**

In spite of its very large oil-mill industry operating at a very low capacity, the Sudan still exports ground-nuts as a raw material. This is certainly not the best way to promote the Sudanese industry. Large quantities of cakes are exported, when they could be used as animal feed ingredients in combination with other raw materials produced in the country. The same considerations apply to the national sunflower seeds production.

### 5) Sugar.

Kenana sugar company usually exports part of its production to finance the purchase abroad of spare parts and cover the costs of foreign technical assistance. The price of the national sugar in the internal market is three times higher than the world price. As a consequence, those sub-sectors of the food industries which consume huge amounts of sugar (jam industry and confectionery, beverage industry, etc. are being penalised by this situation. Besides, huge quantities of molasses, a by-product of the sugar cane processing are being exported at a low-price when they could be used for bakery yeast and/or for animal feeds production. A sectoral study would need to examine the technical and economic situation of the sugar industry in the Sudan, find out economic alternatives to the export of sugar and examine the economic viability of processing locally the existing by-products of this industry.

### 6) Livestock and meat.

This is the main export item of the Sudan and doubtless the sub-sector could greatly increase its performances through an integrated development programme involving open ranch-fattening units, slaughterhouses, freezing and processing plants as described earlier. As the modernisation of this sector is impossible without a deep horizontal integration with agriculture, the conditions for such an integration should be analysed within the frame of an ad hoc study, in particular focusing on the development of agricultural and agro-industrial sources of raw materials for animal feeds production. The objective of the modernisation of this sector may also call for the reconsideration of some traditional cropping patterns and for the introduction of more effective speculations such as for example, soybean.

### 7) Sorghum.

When the rain is sufficient, the Sudan exports large quantities of sorghum as production exceeds domestic consumption. Almost null is the industrial utilisation of this raw material which can be used as a raw material in substitution of wheat flour in the preparation of many foodstuffs such as bread (in the form of flour), baby foods (as flour, either malted or not), beverages (as a malted or un-malted syrup) etc.

In conclusion, if one of the priorities of the Government of Sudan is represented by the development of the exportation of processed or pre-processed agricultural and food products, it appears nevertheless that this option with the only exception of the cotton, is lacking appropriate political and managerial back up. In spite of the important export potential of Sudan the current situation is as a consequence, very disappointing. Practically nothing is being done to take advantage of the existing favourable physical and geographic conditions to develop the agricultural production and create stable production surpluses so as to sustain and further develop the national processing industry, meet the requirements of the internal market and promote the export : no incentives are being provided for the local utilisation of the national raw materials nor penalties are applied for their exportation, nor priorities are set for the final destination of the national food commodities based on an in-depth evaluation of the national and international market demand and national socio-economic interests.

Within the frame of the programme, it is therefore suggested to carry out an in depth marketing study focusing on the analysis of the national and international trends and perspectives for the main food commodities produced in the country or, bearing in mind the priority that should be given to the locally grown raw materials in the development of the national food industry, possibly being developed by it in a spirit of diversification of the national production. Although not well received as a policy tool by most of the international technical assistance and development financial institutions, import substitution should be regarded (on account of the enormous productive potential of the country) as a priority at least on the short and medium term, although through a selective and graduated approach assuring space enough and adequate support to the activities of export promotion and development, which as already said are essential to guarantee the financial resources which are needed to sustain the development of the national food industry.

### **3. Sectoral programme three: "For a better industrial utilisation of the national existing agricultural resources".**

Some punctual projects with a strong R&D and "entrepreneurship development" orientation will be carried out within the frame of this programme, whose main objectives are to enable the industrial valorisation of so far under-utilised national raw materials and by-products, such a sorghum and molasses, and to upgrade the national skill and technology in the preparation of foodstuffs showing a particularly valuable social and economic interest for the country. It is recommended to implement in collaboration with the FRC (Food Research Centre). The FRC is a quite well equipped institution, also endowed with a highly skilled professional staff. It has a 2 ton multipurpose milling plant and a pilot bakery and a fully equipped food laboratory. The cost of the additional equipment needed and of other necessary inputs will be further estimated by the Sudanese-UNIDO team in charge of the assistance to the Ministry of Planning while carrying out the preparation of a more detailed programme and relevant project proposals.

#### **3.1 Sorghum.**

Sorghum is the main agricultural crop in the Sudan. It is utilised as a staple food and very little of it is industrialised. The only industrial use out of it is made by the Arab Company for Agricultural Production and Processing (ACAPP) in the production of glucose and starch. Many sorghum-based products are well known. Main objective of the project will be to develop technologies that can be easily applied in Sudan. It is recommended to associate potential entrepreneurs to the project activities so as to assure a quick transfer of its results into a practical scale. The success of this project in terms of creation of small enterprises will boost the agricultural production where the sorghum processing units are set-up, improve the diet of the population, create employment and add value to the primary production. The following sub-projects are being envisaged:

##### **3.1.1 Sorghum malt production and utilisation.**

Traditional malting methods for sorghum and millet are well established, but no attempts are

being made to upgrade the process to industrial scale. This is due to the limited utilisation of this raw material by the industry. An exception is represented in Africa by Nigeria, which is making use of huge amount of sorghum, and sorghum malt, in its brewing and food industry. It is worth underlining that the development of this industrial sub-sector in Nigeria is the direct consequence of the ban placed by the Nigerian Government on the imports of barley malt.

The Sudan produces approximately 4 million tons of sorghum annually. There are more than ten varieties of good quality sorghum, mainly white and brown. The red varieties are popular in other areas of the southern states. To enable sorghum malt production and utilisation, it is necessary to introduce it into baked products such as biscuits, cakes, or in food mixes like composite flour and baby foods. Sorghum malt is traditionally used in Hullmur, Abre and various beverages (alcoholic and non-alcoholic).

The malting technology of sorghum and millet is known but to implement it on an industrial scale, the appropriate technologies and equipment such as small scale malting plants are needed. The incorporation of sorghum/millet malted and un-malted flour into cereal-based food products improves their nutritive value and flavour. Biscuit and bread industries will benefit from the addition of good quality sorghum malt.

The Sudan being quite an advanced country in sorghum breeding world-wide, it has a huge collection of genotypes showing interesting malting characters. The development of a national production of sorghum malt would allow to incorporate an important value added into this raw material, so essential for the country's rural economy. Besides, once satisfied the national consumption, the surplus malt can be exported, thus generating important earnings in terms of foreign currency.

Main objectives of this project will be to develop prototype malting equipment which can be manufactured locally according to different scales of production: artisanal, semi-industrial, full industrial scale. Also, to select and promote the diffusion of sorghum cultivars suitable for production of good quality malt. To investigate through a market and technological study all possible industrial applications in the food industry of the Sudan. Finally, to carry out a techno-economic feasibility study of a full scale sorghum malting plant.

The expected situation at the end of the project will be represented by the transfer to the local entrepreneurs concerned of a package comprising technology and technical assistance to training, and plant start up and operation. Besides, the development of new technologies, food products and hardware (the malting prototypes) and specialised expertise would represent for the Food Research Centre an important acquisition to be capitalised to support the R&D activities of this institution.

### **3.1.2 Upgrading of the technology of Kisra processing.**

Kisra or Sudanese bread is a staple food in Sudan. It is made of a very thin sheet prepared from baked fermented sorghum flour (batter). Kisra quality can be described as follows:



moisture 35-40%, thinness 0.04-0.015 cm, the dough is made of evenly distributed fine grains, supple, semi-elastic, not crummy, low to medium stickiness, acidic taste (pH 3.8-4.5), characteristic flavour etc. It is eaten with vegetable-meat stew, sometimes with fresh and fermented milk yoghurt, peanut butter, vegetable salads, sugar, salt etc. Kisra can be kept for one day. The surplus Kisra is normally sun dried and used in the same way as fresh, which is preferred during journeys. In the batter preparation part (1/3) of the sorghum flour is added with water and a started and fermented overnight, the rest of sorghum is then added to the fermented dough and water to adjust its consistency and left to ferment for 2-3 further hours until acidic taste. Finally, it is baked in a hot plate.

The traditional equipment for Kisra making is fabricated locally and the process by using it has been found to be cumbersome. The existing Kisra machine has no regulators or controls for drum speed, gas flow rate, and diesel. There are no proper regulators for batter deposition and distribution. The heat distribution is poor. The oiling of the drum is tedious and the surface is hot. There is need to develop a prototype of Kisra machine to address these problems. Besides, energy consumption must be given serious consideration especially with regard to its cost and availability.

The project will study the possibility of improving the design of the existing Kisra machines to be fabricated locally.

### **3.1.3. Fortified cereal based mixes and composite flours.**

During the last 15 years, Sudan suffered unfavourable conditions that directly affected its food production and distribution. These included natural disasters which was further aggravated by shortages of foreign exchange. Sorghum, millet and legumes were less affected than other agricultural products. Sorghum and millet are the major staple crops in the country, with 3-4 million tons and 0.6-0.8 million tons respectively. Also brown beans, lentil, chickpea, cow pea, phaseolus are widely consumed in the Sudan. The house-hold insecurity caused by fairly low purchasing power aggravated the nutritional problems in the country. Nutritional problems are reported such as Protein-Energy Malnutrition (PEM) and Micronutrients Deficiency of iron, iodine, vitamin A especially in the most vulnerable groups. In spite of these problems, Sudan still has great potentials for food production to satisfy its needs and hence partially solve the nutritional problems. Effort are now being made to produce sweet potatoes which is a cheaper carbohydrates source with a vitamin A precursor in the coloured varieties.

One of the recommendations of the international Conference on Nutrition (ICN, FAO, Rome 1992) was to strengthen the food processing capabilities by conducting R&D on processing local food commodities. This in turn will ensure wholesomeness of the foods with uniformity to all consumers. Sudan with all existing human resource and large production of food grains does not manufacture food which are specially conceived for vulnerable groups such as infants, pre-school children, pregnant and lactating women, low-income and displaced populations.

The project is aimed at producing food mixes of a high nutritional value based on sorghum/sorghum malt and legumes that will contribute in fighting the existing nutritional deficiencies, and to develop new technologies which are suitable to process local crops (cereals, legumes). Also, to upgrade indigenous house hold and rural technologies that can be transferred into industrial practice to promote production of high quality cereals and legumes. In Sudan, proteins from vegetables are represented in the diet twice as much those from animal sources -FAO Food Balance Sheets (1987-89).

Sorghum, millet and wheat are the most important cereal crops in the Sudan. Generally sorghum production exceeds demand and the surplus is exported. Wheat production cannot satisfy the demand and more than 50% of the needs have to be imported. In order to overcome the shortage of wheat flour and to reduce its import the FRC carried out research to investigate the partial substitution of wheat flour by sorghum flour both for bakeries and biscuit factories. A lot of work has been carried out in the world to produce composite flours and there is no need for additional research on the subject. But the FRC should now promote the utilisation of composite flour by investigating under the technical, economic and commercial point of view the practical applicability to the Sudan's conditions of the results of the research works.

### **3.2 Molasses.**

Sugar-cane molasses is an important by-product of the sugar industry produced by the existing factories at El Genied, El Girba, Sennar, Assalya Kenana. Total production in 1993 was approximately 175,000 tons out of which 75-90% were exported in spite of the difficulties with regard to its transport and storage during the production season. Local uses include ethanol production, and utilisation as an ingredient for animal feed. Sugar-cane molasses contain appreciable amounts of inverted sugar and important minerals which can be utilised in the production of bakery yeast. In 1993, bakery yeast was imported for a total value of US\$ 2,762,000, corresponding to 1,255 ton of dry product. Two decades ago, a factory was established in Hesaheisa (150 km. south of Khartoum) by the Sudanese Fermentation Industries Co. The factory is out of operation and is searching for an investor to make a joint venture and to rehabilitate the factory. The characteristics of the enterprise are the following:

Name: Sudanese Fermentation Industries Co.  
 Location: Hesaheisa Town - 150 km. south of Khartoum.  
 Nominal capacity: 920 tons/year:  
 Actual processing capacity: 800 tons/year.  
 Existing fixed assets:

A complete installed plant for producing Instant Active Dry Yeast, comprising main production building, administration building, a power plant of one MW capacity, storing capacity for molasses, water, fuel and finished product of 1000 tons, 450 tons, 40 tons and 100 tons respectively, two bore holes and an enclosing fence.

The value of the existing assets is estimated conservatively at US\$ 5.5 million. The estimated additional investment in equipment and machinery is estimated at US\$ 1.5 million which are mostly needed to upgrade the cooling capacity, molasses treatment, drying and packaging. All machineries and equipment are in good condition, the sewage system and civil works are rectified to fit the industry. Pre-set equity capital is as follows: private sector 66.7%, public sector 33.3%.

The average yeast consumption in Sudan is estimated above 1,600 tons/year. Sudan sugar factories collectively produce over 500,000 tons of sugar annually, making available huge quantities of black strap molasses. Yeast industry utilise molasses as the main bulk input. Approximately for each ton of yeast produced, five tons of molasses are needed. Sugar-cane molasses is available in sufficient quantities and at a low price. It is of course obvious that the rehabilitation of the Hesaheisa factory could be an important achievement for the Sudan and it proposed that UNIDO makes an appraisal for the rehabilitation of the plant and eventually initiate a search for a partner.

### **3.3 Vegetable oils and cakes.**

To improve the efficiency of the oil mills it is recommended to conduct a technical study aiming at increasing their yield through modernisation and rehabilitation, and better vertical integration with the primary production. The study should also consider the utilisation of the vegetable oil cakes by the national animal feed industry and the aspect of sub-sectoral diversification through introduction of new agricultural speculations like soybean. The study will finally make specific recommendations for the production of sun flour oil and propose solutions to overcome the problem represented by the bottling material faced by the sub-sector.

**Based on the work of:**

Mr. U. Antinori (UNIDO)  
Ms. Shadia Yousif Bakhait (UNIDO)  
Mr. J.H.W. Thomas (UNIDO Consultant)  
Mr. Phillipe C. Bauchau (UNIDO Consultant)  
Mr. G.F. Van Der Veen (UNIDO Consultant)

**and**

**National Experts:**

Mr. Tagelsir Mohamed Suleiman  
Mr. Suleiman Abdel Rahman Shugeiry  
Mr. Ismail Ahmed Ismail Bukhari  
Mr. Mohamed Osman Hashim Ismail

Backstopping Officer: U. Antinori/A. Ouaouich  
Agro-based Industries Branch

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