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INDUSTRIAL DEVELOPMENT ORGANIZATION

ESTABLISHMENT OF A TRAINING CAPACITY AND CAPABILITY IN THE FIELD OF DESIGN AND PRODUCTION OF AGRICULTURAL MACHINERY AND IMPLEMENTS IN CAMEROUN, SUDAN, AND TANZANIA

FINAL REPORT

UNIDO PROJECT RP/RAF/85/605

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0. INTRODUCTION

0.1 Background

The Lima declaration and Plan of Action, adopted by the second General Conference of UNIDO in Lima, Perù, in March 1975, and subsequently endorsed by the UN General Assembly in September of the same year stressed, inter-alia, the development of efficient agricultural-related industries in order to achieve a high degree of integration between the expansion of agriculture and industry in the developing countries. In this context, the creation of integrated production units like agricultural machinery plants, appropriate engineering industries and repair and maintenance services are emphasized.

Accordingly, UNIDO convened the first Consultation Meeting of the Agricultural Machinery Industry in Stresa, Italy, 15-19 October 1979, at which sixty countries were represented. The Consultation recommended a series of action oriented follow-up measures to address specific problems raised at the meeting and to pave the ground for a subsequent Consultation Meeting. As a priority among these measures, the Consultation directed UNIDO to establish a Working Group on Training in the Industry and to initiate appropriate actions to address industry training needs.

In 1982 a regional consultation was held in Addis Ababa.

Main recommedations were, interalia,:

- agricultural development should be a priority area in the national development policy.

  Establishment and support of local production of agricultural

machinery and improved training and education should be decisive factors in such a policy.

- The regional technical institutions should be strengthened.

- The national and subregional programmes should enjoy the technical support of UNIDO, FAO, ECA, and OAV. Financing for such programmes should be sought in the framework of existing procedures within the U.N. system as well as through bilateral volontary contributions.

On these basis a consultant was selected in July 1985 to carry out a survey of the present situation of agricultural machinery industry and relevant training needs in order to establish and/or strengthen a training capacity and capability in the field of design and engineering of agricultural machinery and implements in Cameroun, Sudan and Tanzania. The missions were carried out in August, September and October 1985.

0.2 The present status of agricultural machinery industry and relevant training capabilities in the three countries

In all three countries that have been visited agriculture and agro-industry have a large contribution to the formation of GNP. Major industries, operators, maintenance workshops, research centres, education institutions involved in the agro-mechaniza-

tion field operating in the three countries have been visited. Some but few information on the present situation are provided in the following paragraphs:

0.2.1 Cameroun

One industrial plant and a number of small workshops provide the majority of handtools and implements needed by the country. A design and engineering capability exists at the national research centre for agro-mechanization CENEEMA. This institution is also conducting training courses for agro-mechanization operators.
It is suggested that a number of training aids (publications, equipment, etc.) be bough for this centre.

0.2.2 Sudan

No factory for the production of agricultural machinery is presently operating in Sudan and also the spare parts are imported. The artisanal sector is providing the majority of handtools and simple implements needed by the farmers.
Two agromechanization training centres at Tamboul and Masad have been choosen to establish a first capability to equip design and development engineers. In this case too a number of publications and training aids have been recommended for purchase.

0.2.3 Tanzania

In Tanzania there are several industries involved in the production of hand tools, animal and tractor drawn implements and for the assembling of tractors.

There is also a very active artisanal sector that manufactures an important share (up to 20-25%) of the total demand of hand tools and simple equipment. Two important institutions operate in the field of design, engineering and development of agricultural machinery, the TEMDO and the CAMARTEC.

For both a number of training aids have been proposed for purchase.

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OVERVIEW OF THE PRESENT SITUATION OF THE AGRICULTURAL MACHINERY INDUSTRY IN AFRICA AND NOTES FOR ITS DEVELOPMENT

1. Background

The Lima Declaration and Plan of Action on Industrial Development and co-operation, adopted in 1975, drew world attention to the gap in industrial output that existed between the developed and the developing countries and the need for concentration on training personnel for industry was emphasized; the developing countries were exhorted to "... establish training programmes to cover the needs of their industrial development...".

When the Third General Conference of UNIDO was convened in New Delhi in 1980, the Conference emphasized the need to focus on human resource development. Training was seen to be "essential to the industrial development of developing countries. It provides the most effective vehicle for technology transfer and the creation of indegenous technological capability".

New Delhi Declaration and Plan of Action adopted by the Conference therefore contained a number of complementary recommendations for action in this field by the developing countries, the developed countries and UNIDO.

Within the context of co-operation among the developing countries, those countries were exhorted, among other things, to:

- establish and improve industrial training facilities on regional interregional and sectoral levels
- finalize long-term programmes of co-operation for the exchange of experience and skills between developing countries
- co-ordinate and improve existing national "centres of excellence" for industrial training and management; and

- make available and improve existing training facilities to meet the special needs of trainees from other developing countries.

These points are also stressed by the Lagos plan of action and by the resolution adopted by the IV UNIDO General Conference.
In particular the "agricultural revolution" has been called for by the Lagos Plan of Action but it cannot come about except, amoung other conditions, as a result of a well supported development of local production and of the use of farming implements and plants suited to the multiple requirements of agriculture, the farmers and the enviroment. (1).
At present the industry of agricultural machinery in Africa is far from satisfying the above conditions. An overview of the situation is provided in the following paragraphs:

(1) Present situation, prospects and strategical choices for the development of agricultural machinery in Africa in the context of the Lagos Plan of Action, UNIDO document ID/WG.365/1, 1982

2. AN OVERVIEW OF THE PRESENT SITUATION OF THE AGRICULTURAL MACHINERY INDUSTRY IN AFRICA

Africa has now more or less 400 million inhabitants and more than 750, according to recent estimates(1), at the end of the century. Agriculture is not meeting current demand, the continent's dependence on other countries is equivalent to 20% of food needs and is going to rapidly increase in case no dramatic changes take place immediately in the agricultural sector.

On the other side, despite overall food production having increased, the per capita quantity produced during the decade from 1970 to 1980 has decreased by 10% as average.

These are the main facts that are on th basis for the urgent need of increasing the agricultural output ir order to meet the demographic pressure. The role that an efficient agricultural machinery industry can play in development of the agricultural sector to attain food self-sufficiency is vital and it has been recognized during the First Regional Consultation Meeting on the Agricultural Machinery Industry held by UNIDO at Addis Ababa, Ethiopia, in April 1982.

(1) Agricultural mechanization and the demand for agricultural machinery and equipment in Africa to the year 2000.
First Regional Cultivation on the agricultural Machinery Industry, Addis Ababa, 5-9 April 1982.

The consultation made, interalia, the following main reccommendations:

A. The situation of the agricultural machinery industry in Africa is critical but not hopeless provided that urgent coordination efforts at the national and international level are made.

B. Agricultural development should be a priority area in the national development policy.
Establishment and support of local production of agricultural machinery and improved training and education should be decisive factors in such a policy.

C. Substantial savings in human and other resources could be achieved through proper selection and standardization of equipment and specific raw materials to be used, adopted or manufactured in developing countries.

D. The conditions prevailing in Africa calls for the adaptation of imported equipment; this is already being done for certain equipment.
However, there is a need for vastly improved capacity for such adaptation.

E. There is ample untapped scope for co-operation between Africa and the rest of the world, as well as among African Countries themselves. Several direct forms of cooperation among African Countries can be initiated rapidly without elaborated intergovernmental arrangements.

F. International co-operation should be developed in order to contribute to the implementation of African agricultural mechanization programmes. The National and Subregional programmes should enjoy the technical support of UNIDO, FAO, ECA and OAU.

G. The development of African capacity for the design and manufacture of agricultural and rural equipment should be strenghtned as soon as possible.

In the following paragraphs a short description of the present situation of the agricultural machinery industry in Africa is provided.

2.1 THE AGRICULTURAL MACHINERY INDUSTRY IN AFRICA

Industrial producers of agricultural machinery in Africa are few in number, mostly small in size and able to make only a corresponding small contribution to total supply. In all developing African Countries there are only about 100 industrial or semi-industrial companies, even including those for which agricultural machinery and equipment are not the main products. As a rough estimate they employ 15,000 workers to manufacture equipment valued at $ 150 million and with a value added of only $ 50 mill. per year (1). On the other hand imports have been evaluated at 850 $ million (average annual value in the period 1978-1980) giving a market estimate of around $ 1 Billion (1).

(1) Agricultural Machinery and Rural equipment in Africa, a new approach to a growing crisis, UNIDO/IS.377, March 1983.

That means that the manufacturing sector that should be of greater importance for the development of agriculture and therefore of food self-sufficiency is only covered for 15% by local production. The situation is worse if the sub-Saharian countries are considered alone, excluding Algeria and Egypt, by far the largest producers of agricultural machinery in the Continent.

It has been previously seen that added value is very low and this is due to the fact that many production units carry out assembly work and easy operations only and the imported components and raw materials often account for as much as 60 to 80% of the production cost.

Integration at the national level is often difficult to achieve because of the absence of local suppliers of raw materials, a lack of companies in the engineering sector and, even more important, a lack of training of staff in the existing ones.

Furthermore, as a general rule, there is a little design and product development capabilities at producer level and this also prevents design and adaption of machinery to local needs.

According to a recent diagnosys study carried out by UNIDO (1), the main difficulties faced by an African producer are:

- the difficulty in obtaining local supplies of quality raw materials and semi-finished goods;
- the need to import production machinery and equipment;

(1) Agricultural machinery and rural equipment in Africa, March 1983.

- shortage of skilled local labour;
- difficulties in setting up networks for maintenance and supply of spare parts;
- the inability of national engineering groups to adopt or design agricultural equipment to suit both the conditions of demand and the technologies and equipment available with local agricultural machinery producers;
- the inadequacy of existing systems for aiding, promoting and providing technical assistance to small and medium sized companies.

An other very important subsector, involved in the production, repair and maintenance of agricultural machinery is the artisanal one.

Blacksmiths and small workshops are mainly producing hand implements. The same have started the production of simple animal drawn implements, copying the imported ones.

The material used for making such implements derive primerily from scrap metam from cars, lorries etc.

In this field the artisanal sector is divided in two sub-sectors, namely:

- small workshops;
- traditional blacksmiths.

A. Small Workshops

These workshops are usually located in large villages and in the outskirts of towns and use simple production equipment, in many cases obsolete, but generally kept in good order by self-made artisans, in several cases without formal training but in possess of a good empiric experience.

As the case of industry two major problems are faced while dealing with agricultural machinery:

- lack of raw materials and parts;
- lack of specific training and knowledge in the field of agricultural machinery;
- lack of financing to improve production equipment and to expand activity.

B. Traditional Blacksmiths

Village balcksmiths are very active in the field of agricultural implements and in the past have been nearly the sole suppliers of agricultural machinery and implements.

They continue to provide a good percentage of the total input to the agricultural sector in terms of handtools, simple implements and equipment, animal drawn implements, repair, maintenance and spare production.

Traditional blacksmiths are typified by a limited and poor quality equipment and by the absence of formal training.

On the other hand the artisanal sector is also facing the competition of industrially made agricultural implements (in

many cases of imported origin) having better quality and is therefore facing difficulties and needs help to keep its very important role in producing inputs to the agricultural sector. One of the way to keep the sector providing input to agriculture is, beside the improvement of their equipment, to provide training to increase the quality of the products and to experiment forms of cooperation as already done in Benin, Tanzania, Niger, Upper Volta etc.

A list of the major factories, firms and enterprises making agricultural machinery in Africa is provided in Annexe B while Annexe C provides the situation of handcraft production.

2.3 Scenario for its development

A study carried out by United Nations provides a scenario of what is foreseen to be the demand for major agricultural machinery by year 2000.

Handtools requirements will increase from a total value (for whole Africa) of 226 Million $ in 1980 to 293 Mill $ per year by year 2000. (at constant value)

An important increase is expected in the development of demand for animal traction equipment, as shown by the following table.

TABLE 2: DEVELOPMENT OF DEMAND FOR ANIMAL TRACTION EQUIPMENT IN AFRICA 1980 TO 2000 IN PRICES OF 1975 (SCENARIO A)

Year	Gross Investment p.a.					
	1980		1990		2000	
Country Group	Mill. US $	Replacement (%)	Mill. US $	Replacement (%)	Mill. US $	Replacement (%)
North	65	98.5	62	98.4	59	98.3
Sahel	21	71.4	28	78.6	34	79.4
West/Centr.	21	80.9	25	84.0	28	85.7
Ethiopia	84	96.4	87	96.6	90	97.6
East/South[a)]	87	82.8	100	80.8	112	88.4
Africa total	279	91.0	301	91.4	324	91.4

a) Without Ethiopia.

(1) Agricultural mechanization and the demand for agricultural machinery and equipment in Africa to the year 2000, 1982.

Even higher is expected to be the annual demand increase for tractors and associated equipment.

According to the most conservative of the two scenarios developed by FAO, the number of tractors should increase from 40,200 units operating in Africa in 1980 to more than 170,000 by year 2000, as follows:

	1980 (units)	2000 (units)
North Africa	26,500	93,900
Western/Central	5,700	34,600
Eastern/Southern	8,000	45,400
AFRICA TOTAL	40,200	173,900

The data that have been provided above show an impressive development that cannot be made possible without adequate facilities and availability of qualified labour.

Even considering that simple hand tools and animal drawn equipment can be easily produced locally, the progressive tractorization of the agriculture, at least in some areas, means the production of huge quantities of spare parts and maintenance and repair facilities. This again means that the human resources must be developped very rapidly.

A simplified development model for the agricultural mechanization could be envisaged as follows:

- identification of the agricultural mechanization model most appropriate for each country taking into account the main crops, the soil conditions, the social situation (size of farms, rural income etc) the traditions, the existing and planned infrastructures etc. This comprehensive analysis lacks in the majority of African States.

- Design indigenous implements/equipments that fit into the envisaged mechanized model and/or modify imported items to make them suitable to prevailing local conditions.

- Production of the majority of hand-tools, implements and equipment by means of:

  . industrial plants
  . workshops
  . blacksmiths

- Create and/ or strenghten a network of maintenance and repair workshops.

- Strengthen the existing engineering industry to attain a better integration with the agricultural machinery producing industry, in order to supply raw materials, components, spare parts and services.

A number of urgent actions are urgently needed in order to easy the implementation of this ambitious development programme:

- Establish and/or strengthen agricultural mechanization centers that can carry out, in cooperation with other national agencies, a comprehensive study on the mechanization model for the country These centers should have also the task of designing and building prototypes of implements/equipment, testing and modifying locally made and imported ones etc.

There is the urgent need of training their staff, strengthen the laboratories and workshops and increase the exchange of information and of common work among centres in the same region, to create an agricultural machinery regional network similar to the one existing in ASIA that proved to operate very well.

- Create and/or strengthen the skill of a core of engineers that will be in charge of the production of implements/equipments in the Country. There is need of:
  . design specialists
  . production engineers
  . personnel for the maintenance of production equipment
  . extension officers that can disseminate skill among blacksmiths and the small workshops

- Increase the number and the skill of staff in charge of maintenance and repair of agricultural machinery.
- Sensibilize and provide adequate inputs to the engineering industry in general to better integrate it with the agricultural machinery design, production and maintenance system. That means, for instance, to provide the design engineers of this industry with the necessary background to understand the peculiarities of an agriculture machine/implement with respect to its characteristics, raw materials needed, quality etc.: to finance the installation of additional equipment that can made the existing engineering industry suitable to produce spare parts, components, and to provide services (heat treatment for instance) to the "agricultural machinery complex".

3.3 Proposed future UNIDO activities in Africa in the field of Agricultural machinery.

From the above consideration and taking into account the experience of 15 years of operation in Africa the following UNIDO activities are proposed for the assistance to the development of the agricultural machinery field in Africa.

A. Contribution to the formulation of national plans for the development of agricultural mechanization (in cooperation with FAO and other national and international agencies).

B. Assistance to national governments to strengthen research/development/design and testing centres for agricultural machinery by training staff and supplying equipment.

C. Strengthen local engineering industries, at least the units that could be used by the agricultural machinery industry (parts, components, services, raw materials. etc) by assuring better training (especially for project and design engineers, production supervisors etc.)

D. Assure the establishment and/or strengthen local agricultural machinery industry by providing technical assistance improved design techniques, and, particularly, training of staff.

E. Provide technical assistance for the development of networks of small workshops to improve their operations as well as of the village blacksmiths.

F. Provide technical assistance, staff training and equipment for the creation of Regional network of Agricultural Machinery in order to coordinate activities in the field of agricultural mechanization.

4. AN OVERVIEW OF UNIDO ACTIVITIES IN AFRICA IN THE FIELD OF AGRICULTURAL MACHINERY INDUSTRY

UNIDO has been involved for long time in assistance to African countries in the field of agricultural machinery.

This assistance assumed various forms:

- planning
- country studies
- sectorial studies
- system of consultation
- assistance in industrial operation
- training (group training programme, fellowships, and stay tours).
- supply of equipment and training aids.

4.1 Technical assistance and training

UNIDO has been involved, in the period 1970-1981 in more than 150 projects at National Level, in 44 African Countries and around 40 projects are in pipeline for the period 1982-1986.

However, during 1970/80 around 30-40 projects for which specific Government requests were received, project document prepared, but could not be implemented due to lack of finances.

At sub-regional/regional levels the magnitude of projects involved around 35 projects and 8 are in pipeline (period 1982-86) and around 8 could not be started during 1970-80 due to lack of finance (1).

Furthermore the Governments of the developing countries of Africa,

with the assistance of UN have established an "African Regional Centre for Design Manufacturing" at Ibadan, Nigeria. The Africa

(1) UNIDO activities in the field of agricultural machinery industry ID/WG.365/4, 1982

Regional Centre for Design and Manufacturing has given a priority for promotion of appropriate agricultural machinery.
("However, there is a great need to link the activities of this institution with appropriate subarea institutions which would be the nucleus for promoting national level activities within the framework of a subarea regional programme") (1).

Considering all the technical assistance projects (both implemented and pipeline) the following machinery/product has been taken into consideration:

85% In hand tools, animal drawn implemented and manually operated equipment.

5 % For intermediate power machinery (primary small tractors) and tractor drawn implements.

4 % standard tractor

1 % for other items like silos

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5 % of the request involve basic facilities (foundry, forge, heat treatment etc) especially for agricultural machinery

(1) UNIDO activities in Africa in the field of agricultural machinery, ID/WG. 365/4

The four major areas of technical assistance requested, around are:

60% constitutes overall feasibility study and agricultural machinery sectoral development.

15% constitutes repair and maintenance

20% constitutes pilot manufacture and manufacturing assistance.

5 % constitutes engineering design and development.

In addition some training programmes have been recently completed or are underway:

- In 1982-1983 a survey has been carried out in Sudan and Tanzania to identify training needs in the industry for agricultural machinery.
- In 1985 a training programme in the field of design and engineering of agricultural machinery started. The programme included the supply of training aids to strengthen existing institutions.

4.2 **The system of consultation**

Following the recommendations of the First Consultation, UNIDO organized, in April 1982, the first

Regional Consultation meeting on the Agricultural Machinery Industry at Addis Ababa where the following issues were submitted:

- Present situation, prospects and strategic choices for the development of agricultural machinery in Africa, in the context of the Lagos Plant of action.

- Measures for promoting the agricultural machinery production capabilities in Africa.

- Tentative proposal for the formulation of an African development plan for agricultural machinery and equipment.

116 participants from 49 countries and 9 international organizations attended the consultation.
Main recommendation were, interalia:

- Agricultural development should be a priority area in the national development policy. Establishment support of local production of agricultural machinery and improved training and education should be decisive factors in such a policy.

- Incentive and tax policies, as well as trade regulations, should be developed at an early stage to suit the development of new agricultural machinery industry.

- The regional technical institutions should be strengthened.

- The national and subregional programmes should enjoy the technical support of UNIDO, FAO, ECA and OAV. Financing for such programmes should be sought in the framework of existing procedures within the U.N. system as well as through bilateral volontary contributions.

- As far as the subregional programmes is concerned, the following concrete areas were proposed:
  - coordination of existing manufacturing units
  - research and development
  - training
  - information dissemination

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ANNEXE A

MAIN TYPES OF IMPLEMENTS,

MACHINERY AND EQUIPMENT

USED IN AGRICULTURE

TABLE 1: MAIN TYPES OF IMPLEMENTS, MACHINERY AND EQUIPMENT USED IN AGRICULTURE

AGRICULTURAL OPERATION	IMPLEMENTS, MACHINERY AND EQUIPMENT FOR INCREASING DEGREE OF MECHANIZATION INCREASING MECHANIZATION			
Land Development				
Clearing and cultivation	Simple implements	Brush-clearing and forestry implements and equipment	Scrapers, graders, levellers Compactors Forestry tractors	Bulldozers, hydraulic shovels
	Multipurpose handtools		Heavy tractors and ground-breaking equipment	Subsoil machinery, drain-layers, drain-cutters, drainpipelayers
Ground and soil improvement	Multipurpose handtools		Rotary breakers, rippers, chisels, heavy 4-wheel-drive tractors	
	Irrigation equipment (valves, mains)		Pump and water-distribution equipment	
Land development (chiefly irrigation)	Simple irrigation machinery and processes: bucket chains augers, handpumps etc. Handtools and supplies for fences	Motor pumps Electric fencing	Permanently Installed irrigation equipment	
Farming				
Crop farming: Soil cultivation	Multipurpose or specialized handtools	Handsprayer, sulphur sprayers, animal-drawn ridgers	Self-propelled cultivators	
Sowing, fertilization, vegetable conditioning		Seeders, fertilizer distributors, trailed sprayers.	Tractor and specialized machines	
Harvesting (horticulture)	Horticultural tools and equipment	Specialized buildings	Mechanized pickers	Self propelled reaper-threshers vineyard machinery

TABLE 1 (contd)

AGRICULTURAL OPERATION	IMPLEMENTS, MACHINERY AND EQUIPMENT FOR INCREASING DEGREE OF MECHANIZATION			
	INCREASING MECHANIZATION			
Stock farming:				
As above	Cultivation and moving implements	As above - Movers and fodder handling equipment		
Foddering operations	Simple-multipurpose buildings	Specialized buildings and equipment	Specialized non-industrial stock-farming equipment	Industrial stock-farming (automatic feeders and feed conditioners equipment
Sorting and packing	Tools	Manual discontinous sorters and packers	Specialized batch sorters and packers	Continous sorting packing equipment (washers, weighers, baggers)
Conditioning and preparation for consumption		Crop-conditioning equipment (screeners, winnowing-machines, shredders strippers)	Apparatus and equipment for particular techniques (sun-drying, dehy-dratation)	Preserving appliances (refrigeration, boiling vacuum)
	Specialized implements (e.g. milkbeaters) for food production	Preserving equipment		
Transport handling	Load-carrying equipment (baskets, vats, wheel-barrows)	Wagons, carts and other equipment drawn by men or animals. Manual discontinuous handling equipment	Low and medium power multipurpose tractors Motorized discontinuous handling	Lorries Specialized transport equipment (for milk, meat, grains) Motorized continuous handling

TABLE 1. (contd)

AGRICULTURAL OPERATION	IMPLEMENTS, MACHINERY AND EQUIPMENT FOR INCREASING DEGREES OF MECHANIZATION			
	INCREASING MECHANIZATION			
Product conditioning, preservation and other operations				
Storage	Storehouse, shelters, shed	Buildings with specialized equipment in traditional farming (silos, barns, cribs)	Industrialized modern buildings	Buildings with highly specialized equipment: grain compartments, flat-type silos, grain augers, silage unloaders, pumps etc.
Handling and transport	As for farming	As for farming	As for farming	Specialized transport equipment for liquid (vats) or solid (crates) food products.
Energy production and utilization of waste	Man-and animal power (round-abouts) Water bucket-chain and windmill power	Windmills, watermills hydraulic rams simple digesters Simple Sunlight-catchers	Small multipurpose motors: petrol, diesel, electrical Power take-off of tractor to operate machines	Electricity generators and large specialized motors. Continuous digesters solar panels, etc

(2) Source: Agricultural machinery and rural equipment in Africa, a new approach to a growing crisis, UNIDO/15.377,1983

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ANNEXE B

FACTORIES, FIRMS AND ENTERPRISES

MAKING AGRICULTURAL MACHINERY

IN AFRICA

FACTORIES, FIRMS AND ENTERPRISES MAKING AGRICULTURAL MACHINERY IN AFRICA BY COUNTRY AND SUBREGION, 1981

Country	Industrial enterprise (starting date)	Legal status	Employees	Production: Sole product line[a/]	Production: Main activity	Types of agricultural equipment manufactured	Annual output (units per year)	Capacity utilization (%)	Special features
North Africa[b/]									
Algeria	Sonacome (units in Constantine, Sidi Bel Abbès and Lna)	Public	5 960	no	Metalworking and engineering	Tractors Motors Harvesters Tractor equipment	3 200 8 000 238 1 400[d/]	8 000	Total employees, [illegible]
	Sacra	Private	...	no	Agricultural machinery	Tractor equipment	6 500[_/]		
	Dahoun	Private	100	no	Agricultural machinery	Tractor equipment	5 800[e/]		
	Onama	Public	...	yes		Tractor equipment	5 700[_/]		Mainly imports of agricultural machinery
Egypt[c/]	Behera	Public	500	no	Foundry work and engineering	Tractor equipment			
	Tanta Motor Co	Private	200	no	Agricultural machinery	Tractor equipment and motors mounted	4 500[h/]	100	Tractor imports
	Nasco	Public	...	no	Vehicles and motors assembly				
	El Sallam Works	Private	...	no	Agricultural machinery	Tractor assembly, trailers	2 500[h/]	...	Total employees, [illegible]
	Sisman Co	Private	...	no	Agricultural machinery	Tractor equipment	...	...	
Morocco	Atmar	...	c. 60	yes	Engineering	Tractor equipment	c. 8 000	c. 30	
	Comagi	...	...	yes	Tractors and equipment assembly	Disc harrows trailers	200 30	...	Import and assembly of Massey Ferguson tractors and equipment
	International Harvester	...	c. 60	yes	Tractor assembly and equipment manufacturing	Disc harrows	50-100	...	Import and tractor assembly
	Frendo	...	13	yes	Engineering	Disc harrows Sprayers	400 30-40	not fully realized	Import of [illegible] Import and assembly of [illegible] tractors
	Stokvis	...	45	yes	Assembly		...		
	Bondy-Maroc	...	60	no	Mining equipment	Trailer bars, frames of disc harrows	60	60	
Sudan	No industrial production					...	...	...	
Tunisia	Sotumo	...	90	no	Motor assembling	Diesel engines for irrigation pumps	4 400	60	Project: mechanical engines for 2 [illegible] tractors, [illegible] 700 agricultural machines 6 250 diesel engines
	AMS	Public	...	no	Metal parts manufacturing	Handtools	...	...	
	Stia	...	...	no	Car and vehicle assembling	...	...	70	Several small scale industries and mechanical workshops; [illegible]
	Sicame	Private	200	no	Transport equipment assembling				

Total North Africa c. 19 enterprises employing approximately 9000 persons.

(CONTINUED)

Country	Industrial enterprise (starting date)	Legal status	Employees	Production: Sole product line[a]	Main activity	Types of agricultural equipment manufactured	Annual output (units per year)	Capacity utilization (%)	Particular characteristics
West Africa[b]									
Benin	Cobemag (1972)	Handicraft cooperative	650	no	Agricultural machinery	Animal-drawn equipment	...	...	Central workshop and 7 district branches
Cape Verde	No industrial production					...	...	...	
Gambia	Cham Secka	...	...	no	General metal work	Handtools	...	...	
Ghana	Agricultural Engineers Limited	Private	200	yes	Agricultural machinery	Ploughs, harrows, tools, hoes	...	...	Major activity: food processing equipment
	Crocodile Matchet	Private	...	yes	Agricultural machinery				
Guinea	Unspecified	...	...	...	...	...	...	...	
Guinea-Bissau	No industrial enterprise								
Ivory Coast[c]	AHI (1960)		50	no	Foundry and railroad equipment	Pumps, machetes, axles, animal-drawn	...	...	Absorbed Ivoir-Cutils ... of c. ...
Mali	Smecma	Public	160+	yes	Agricultural machinery	Animal-drawn equipment	23 000[b]	65	
Mauritania	No industrial enterprise					...	...	...	
Niger	Darma	Handicraft cooperative	12 ...	yes	Agricultural machinery	Animal-drawn equipment and handtools	...	...	Each central ... with 3 secondary ... and village workshops
	Acrema	Handicraft cooperative	...	yes	Agricultural machinery	Animal-drawn equipment and handtools	...	...	
	Ucoma	Handicraft cooperative	...	yes	Agricultural machinery	Animal-drawn equipment and handtools	...	...	
	Sefamag (1978)	Private	20	yes	Agricultural machinery	Animal-drawn equipment and handtools	...	...	
	Sonofame (1965)	Private	300	no	Agricultural machinery	Animal-drawn equipment and handtools	...	...	Former blacksmiths cooperative
Nigeria[c]	John Holt Agricultural Engineering	Private	...	...	...	Hand tools, fixed equipment, ploughs	...	...	Two units engaged at present in tractors assembly
	Nigeria Engineering Works, Sarma Prod.	Private	...	...		Ploughshares and fixed equipment	...	...	
	Ex Serg. Abb's Carpentry	Private	...	...	...	...	...	...	
	Jauro Makeri's Plough Ind.	Private	...	...	...	...	...	...	
Senegal[c]	Siscoma (1964) Sismar (1982)	Mixed[i]	350+		Agricultural machinery	Animal-drawn equipment and various machines	123 000[d]	...	30% of production exported. Closed operations in Sept. 1981 reopened under present name
Togo[c]	Uproma (1980)	Cooperative	15+	yes	Agricultural machinery	Animal-drawn equipment	700[b]	60	

Total for West Africa c. 33 enterprises employing approx. 2000 persons.

(CONTINUED)

Country	Industrial enterprise (starting date)	Legal status	Production: Employees	Production: Sole product line[a/]	Production: Main activity	Types of agricultural equipment manufactured	Annual output (units/year)	Capacity utilization (%)	Special features
Central Africa[b/]									
Angola	two unspecified					Animal-drawn equipment	...	...	
Burundi[c/]	Bujumbura Unit	Public	25	yes	Agricultural machinery	Handtools	80 000		Never yet operated
Republic of Cameroon[c/]	Tropic (1966)	Private	254	no	Agricultural machinery	Handtools, animal-drawn equipment	1 670 tons[c/]	90	Exports 30% to other countries of CEPA
Central African Republic		...	...	...	...		...	...	
Chad	Somat	Private	...	yes	Agricultural machinery	Animal-drawn equipment	...	...	Production interrupted by civil war
Congo	No industrial production	...	...	...	...	...	...	...	
Gabon	No industrial production	...	...	...	...	...	...	...	...
Rwanda	No industrial production								
Sao Tomé	No industrial production								
Zaire[c/]	Chanimetal	Subsidiary[m/]	...	no	Foundry work	Handtools	744 000[k/]	...	
	Umaz	Public	243	yes	Agricultural machinery	Handtools	1 440 000[k/]	...	1 400 employees
	Acmefon	Private	66	no	Engineering	Handtools	...	...	
	Fiat Zaire	Subsidiary[n/]	...	no	Vehicle assembly	Tractors	26	...	
	Inzal	Subsidiary[n/]	...	...	...	Tractors	7	...	Irregular production
	Magirus Deutz Zaire	Subsidiary[c/]	...	...	...	Tractors	26	...	400 units assembled in [illegible]

Total Central Africa c. 20 enterprises employing approx. 1000 persons.

(CONTINUED)

Country	Industrial enterprise (starting date)	Legal status	Employees	Production: Sole product line[d/]	Production: Main activity	Production: Types of agricultural equipment manufactured	Production: Number of units produced/year	Capacity utilisation (%)	Special features
East and Southern Africa									
Bostwana	1 unspecified	...	...		Agricultural machinery	Handtools	...	...	
Ethiopia[c/]	Ethiopian Hand Tools Factory	Public	120	no	Agricultural machinery	Handtools	600 tons[d/]	100	Belongs to National Metal Works Corporation
Kenya[c/]	12 small and medium enterprises	Private	...	...	...	Handtools, animal-drawn tractor equipment, fixed equipment (mills)	...	...	Ex. K.Kay Engineering, Services Hammers Engineering, Aroob Engineering
Madagascar	Sidema	Public	250	no	Engineering	Animal-drawn equipment handtools	12 800 144 000[h/]	... ...	
	Toly	Public	150	no	Foundry	Tractor equipment	1 500[i/]	...	
	Barday	Private	100	no	...	Animal-drawn equipment	4 000	...	
Malawi	Agrimal	...	170	yes	Agricultural machinery	Motorized equipment Hoes, ploughs, cultivators	800 000 2 000		
Mauritius	Bell Limited	Private	...	yes	...	Motorized machines for sugar	45	...	
	Taylor Smith Limited	Private	...	no	Steel products	Sugar machinery, spare parts for transport equipment			
Somalia	No industrial production								
Swaziland	National Industrial Development Organization	...	...	yes	Agricultural machinery	Tractors (Tinkabi)	...	...	Capacity: 1000[g/]
Tanzania[c/]	UFI	Public	700	yes	Agricultural machinery	Animal-drawn equipment, handtools	4 000[j/] 1 100 000[n/]	... 50	Close co-operation between UFI
	Tamtu	Public	150	yes	Agricultural machinery	Animal-drawn equipment tractor equipment	10 000 and 3 500		
	2 small enterprises unspecified		...	...	...	transport equipment			
Zambia[c/]	Northland Engineering	Private	80	no	...	Animal-drawn equipment handtools, mills	70 000 40 000	...	
	Shonga Steel	Private	...	no	...	Animal-drawn equipment, handtools	3 000 and 300 000	...	
	Lenco	Public	...	no		Carts and agricultural trailers	1 000 and 1 000	50	
	12 small and medium enterprises (unspecified)	Private	...	no		Animal-drawn equipment, handtools, fixed equipment			ex.: Rucan Industries Scaw Limited, Demer
Zimbabwe	United Spring and Forging	...	...	yes	Agricultural machinery	Hoes, handtools			
	Bulawayo Steel Products	...	...			Heavy forged parts	...	...	
	Zimplow Limited	...	...			Animal-drawn equipment	90 000		Assembly of Massey Ferguson tractors
	Tinto Industries					Animal-drawn equipment	800 000		
Total East and Southern Africa[m/]	ca. 35 enterprises employing approx. 3500 persons.								
TOTAL AFRICA[c/]	ca. 77 enterprises employing 15500 persons.								

Sources: UNIDO case studies and country reports

a/ Where agricultural equipment vs sole product manufactured

b/ No information was available from the Comoros, Djibouti, Equatorial Guinea, the Libyan Arab Jamahiriya, Mozambique, Réunion or Seychelles.

c/ Selected for special study

d/ Data for 1979

e/ Data for 1981

f/ Estimated data

g/ Data for 1977

h/ Data for 1980

i/ Data for 1978

j/ Mixed with private management

k/ Data supplied by M. Mitra, September 1980

l/ Local subsidiary of TNC

m/ Excludes the Republic of South Africa and Namibia

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Short Time Projects

Plans for new investment in the agricultural machinery field are underway in several countries; some of them are listed here below:

- Algeria is expanding the Sidi Bel Abbes factory and is planning to produce power tillers and mini-tractors.

- Tunisia in the "design" phase of a factory to produce 25,000 small diesel engines, mainly for agricultural applications.

- Cameroun is planning to increase the range of products locally manufactured.

- Tanzania has recently built a tractors assembling line and expanded the installed capacity for the production of hand tools and implements.

These are only few examples but showing that some efforts are made toward an increase of the portion of the demand satisfied by local production even if what is presently done is only a small part of what should be done urgently.

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ANNEXE C

AGRICULTURAL MACHINERY PRODUCTION IN AFRICA

- ARTISANAL SECTOR -

HANDICRAFT PRODUCTION IN AFRICA (1981)

	Structured handicraft production			Traditional handicraft				
	Coordinating institutions	Number of craftsmen	Main activity	Number of blacksmiths	Main activity	Type of product	Annual output	Remarks
North Africa								
Algeria	..	...	...	...	Traditional forging, repair work	Handtools, animal-drawn equipment	...	Supplies from private traditional agricultural sector, not touched by the agrarian revolution
Egypt	...	...	...		Traditional forging	Handtools	...	Average quality
Sudan	...	...	...	...	Traditional forging	Handtools	...	Substantianl production
West Africa								
Benin	Coop. Beninoise de Matériel Agricole (Cobemag)	650	Cutting, forging, welding, plating, carpentry	...	-	Animal-drawn equipment	...	Central workshop (industrial production); 7 district workshops for assembling and subcontracting works); village workshops (carrying out maintenance of animal-drawn equipment)
Ivory Coast	Office National de la Promotion Rurale (ONRP)	...	Progressive technology	...	Traditional forging	Handtools, animal-drawn carts	...	...
Mali	Comp.Mal.Développement Fibres Textiles (CMDFT)	160	Repair work with modern tools	-	-	Spare parts, animal-drawn equipment	FM 200 millions	Installation of mills to make electric welding equipment profitable
	Op. Arach. et Cultures Vivrières (OARCB)	150	Repair work with modern tools	-	-	Spare parts, handtools	...	Production of all spare parts necessary for the animal-drawn equipment
	-	-	-	3 000[a/]	Traditional forging, low level technology	Handtools, animal-drawn equipment		Scattered blacksmith farmers cover demand in handtools. 5% of production is animal-drawn equipment
Niger	Centre de la Div. de l'Artisanat Rural et du Machinisme Agricole de Dosso	12	Cutting, drilling, welding, assembly	...	-	Animal-drawn equipment (delivered in kits)	Covers most of the national production	Darma central workshops (semi-industrial production); 3 subsidiaries (APR) carrying out assembly; 37 village workshops for maintenance operations and subcontracting
	Atelier de Constr. et Réparation de Matériel Agricole de Tahoun (Acrema)	...	Machining, welding, assembly	...	-	Animal-drawn equipment (delivered in kits), wire fencing	...	Acrema central workshop (semi-industrial production; 3 subsidiaries and village workshops
	Union Coopérative de matériel agri-	...	Cutting, welding assembly		-	Animal-drawn carts	...	Central workshop with master craftsmen; 3 subsidiaries (assembling); 13 village workshops

(CONTINUED)

Country	Structured handicraft production: Co-ordinating institutions	Number of craftsmen	Main activity	Traditional handicraft: Number blacksmiths	Main activity	Type of product	Annual output	Remarks
Nigeria	...	...	...	...	Traditional forging	Handtools, animal-drawn equipment	...	Decline due to competition from imported products
Senegal	National Service (SONAPI)	...	Progressive technology; modern tools bought on credit	...	Traditional forging	Handtools, animal-drawn equipment	...	500 craftsmen trained in the Centre of Kafrine from 1965 to 1979; handtools requirements are covered; retail price of animal-drawn equipment 30% less than industrial prices
Togo	Opération Nord Togo	...	Assembly of animal-drawn equipment	...	-	Animal-drawn equipment	...	Training of craftsmen (6-week duration)
	Opération AFAC/ORPV	...	Assembly of animal-drawn equipment	...	-	Animal-drawn equipment	...	Assembling of Arcoma kits manufactured in Upper Volta (foreseen at Upper...)
	-	...	-	...	Traditional forging	Hand tools	...	
Upper Volta	Centre National de Promotion de l'Artisanat Rural	10 x3 5 x11	Cutting, drilling, welding, assembly, painting, repair works	... ...	-	Animal-drawn equipment (delivered in kits)	Covers most of the national production	3 Arcoma central workshops (semi-industrial production; 11 Coroma subsidiary workshops (assembly shop and storage of spare parts)
	Service Assistance Conseil et Soutien	...	Subcontracting repair work			Animal-drawn equipment		Village workshops (subcontracting for Arcoma
Central Africa								
Burundi	Ministère Jeunesse, Sport et Culture	213	...	8 000	Traditional forging (using scrap and ore)	Handtools	760 000 units	Strong competition from imports, covering 30% of demand
United Rep. of Cameroon		-	-	-	Traditional forging	Handtools and animal-drawn equipment	3 to 4% of industrial production	Some important agricultural workshops (one serves the whole Northwest of the country)
Zaire	Centre de Développement Communautaire (CEDECO)	20	Forging, forge welding		Traditional forging	Handtools	5% of the production	Important role played by religious missions

(CONTINUED)

	Structured handicraft production			Traditional handicraft				
	Co-ordinating institutions	Number of craftsmen	Main activity	Number of blacksmiths	Main activity	Type of product	Annual output	Remarks
East and South Africa								
Ethiopia	Coopérative d'Addis Ardis	86	...	-	-	Handtools, animal-drawn equipment	1,440 tons	-
	Projet Arussi Devel. Unit (Ardu)	...	...	-	-	Animal-drawn equipment, hand threshers	-	-
	Project in Bako	...	...	-	-	Animal-drawn equipment	-	-
	Institute of Agricultural Research	...	-	1 000	Traditional forging	Irrigation pumps, shellers, handtools	-	Output accounts for most of national production
Kenya	Rural Industrial Development Centre	...	...	...	Traditional forging	Handtools for small farms	-	Production of modest quality; competition from imported products
Madagascar	...	...	...	... -	Traditional forging, maintenance operations	Tools, animal-drawn equipment	5 to 10% of the market	Farmer blacksmiths regrouped in villages; retail prices set at half industrial prices
United Rep. of Tanzania	Small Ind. Dev. Organization (SIDO)	70 x 25	...	14 000	Traditional forging	Handtools and simple machinery	5.5 million	70 groups of craftsmen scattered over the territory meet 15 to 20% of total demand
Zambia	...	...	...	...	Traditional forging, maintenance operations			

Source: UNIDO case studies.

THE STATUS OF THE AGRO-MECHANIZATION

AND OF THE RELEVANT INDUSTRY

IN CAMEROUN

SUMMARY

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1. General outlook of the agricultural sector

Cameroun lies between 2° and 13° latitude north with considerable climate difference between south and north.

From the subtropical and saharian types climate of the north to the equatorial one in the south, characterized by a very high pluviometry (3,000 mm in the inner area and 6,000 mm on the coast while in the north the pluviometry is ranging between 500 and 1,000 mm).

Cameroun soil is generally suitable for agriculture with the only notable exception of the Adamaova mountains. In fact soil is of vulcanic origin around the Adamaova mountains and of alluvial origin in the rest of the country.

Eolic sedimentation soil, typical of several african regions are nearly absent.

Prevailing soil is therefore clayey and can be classified as medium to heavy mix type; its productivity can be high but the low content in organic matter makes the use of fertilizers necessary also considering that peasant are using the technique of burning the crop wastes instead of digging them in.

Vegetation is clearly influenced by climate:

- equatorial type forest in the southern provinces (south west, littoral, centre-south, east)
- forest, decreasing surface because of the agriculture, in the central provinces (north west, west, part of centre south of east ones)
- savana and steppe in the northern provinces

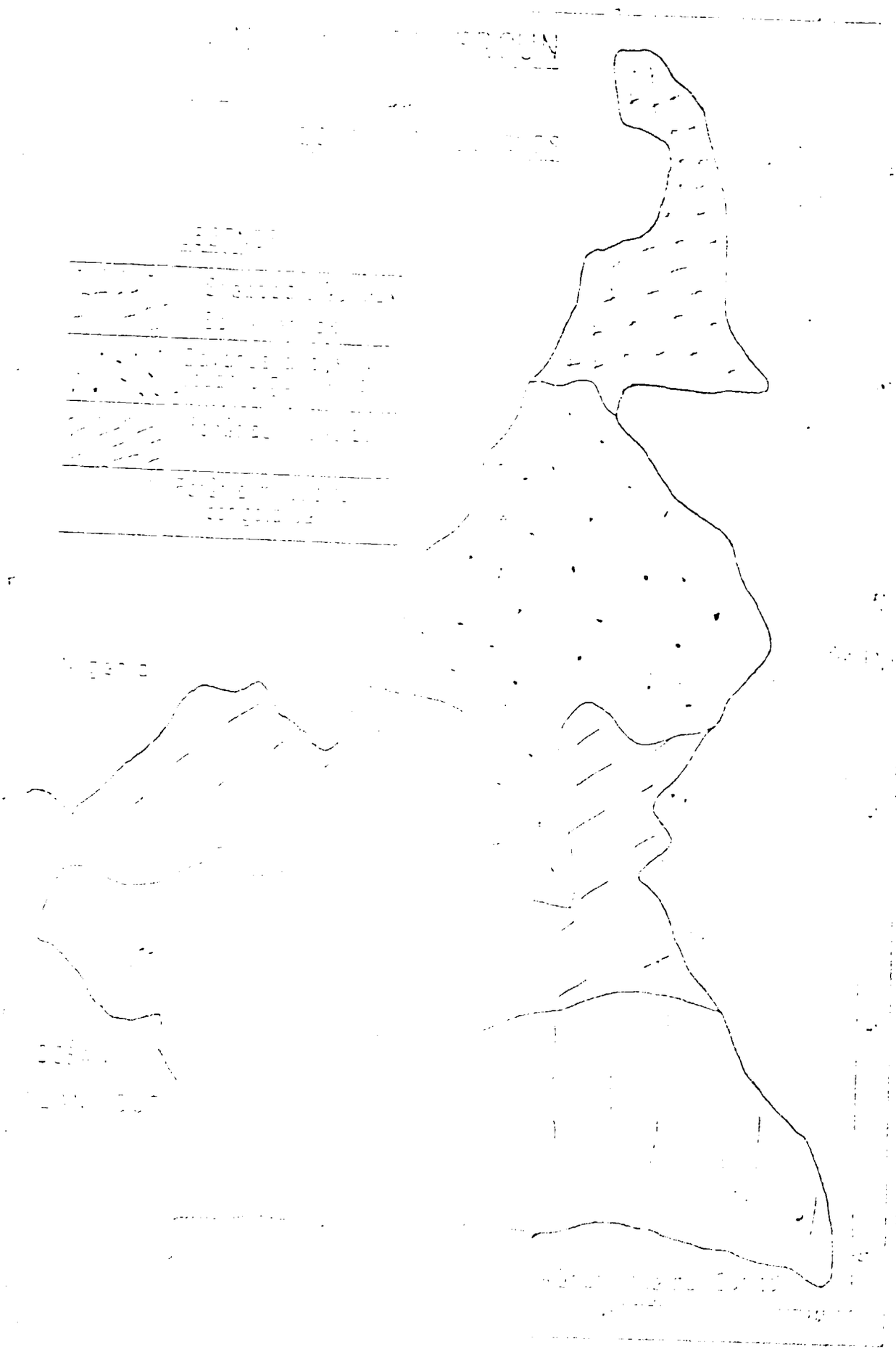
The total population of Cameroun was assessed at 7,661,000 inhabitants

[illegible] is expected to be nearly 10 million by [illegible]. Density rises to a nearly [illegible] inhabitants per sq.Km. The proportion of urban population assessed at 29.6% in 1976 is now estimated to be 39.5% in 1986.

The agricultural sector accounts for an important share of GNP even if in continuous decrease due to the development of industry and of the tertiary sector (trade, tourism etc, as well as to the rural exodus). The share of agriculture in GNP was 29.8% in 1979-80, 28.4% in 1980-81, 26.1% in 81-82 and 24.8% in 1982-83 (data for the last two years are estimated).

The above information show that there exist the problem of rural exodus and its impact on food production is considerable.

The following table, shows the estimated situation of food production/need in the country foreseen for 1985.



Tableau

All values are expressed in 1000 tons	CONSOMMAT. 1990	1995 RURAL EXODUS	DEMAND	EXPECTED SUPPLY	DIFFERENCE
Millet-sorghoum	346	low	365	399	34
		high	362	369	7
Maize	354	low	414	453	39
		high	410	422	12
Rice	79	low	112	72	- 40
		high	115	71	- 44
Wheat	100	low	127	-	- 127
		high	129	-	- 129
Banana plantain	1.533	low	1611	1720	109
		high	1582	1546	- 36
Cassava	402	low	432	446	14
		high	424	402	- 22
Sweet Potato	44	low	45	49	4
		high	45	45	0
Igname	270	low	278	320	42
		high	278	295	17
Macabo/Taro	525	low	554	589	35
		high	550	530	- 12
Potatoes	16	low	19	21	2
		high	19	20	1
Peanuts	60	low	71	74	3
		high	71	68	- 3
Beans/peas	17	low	20	21	1
		high	20	19	- 1
Grains	35	low	46	39	- 7
		high	47	35	- 12
Sèsame	4	low	4	4	-
		high	4	4	-
Banane sweet	557	low	674	618	- 56
		high	670	571	- 99
Fruits et		low	79	58	- 21
legumes	67	high	79	53	- 26
		low	119	129	10
Edible oils	107	high	122	126	4

* Official source, Cameroun Government

[illegible] production [illegible] producing cash crop, mainly cocoa, coffee, cotton, bananas, pineapples, palm oil, etc.

2. The present status of Agro-mechanization

It is worth mentioning that the economy of Cameroun is in the hands of the private sector and is based on the free competition. The existence of some large state owned enterprises, mainly devoted to the cultivation, treatment and international trading of cocoa, coffee, cotton, palmoil, timber, does not significantly influence the situation: all the agricultural products come from a very large number of small and very small farmers, whose extension is variable from 5 to 1 ha. The farmers are able to produce enough quantity of products to satisfy the needs of their family and to sell the surplus in some cases.

This situation offers some advantages (the farmers, working for themselves, are incentivated to work harder and very often they are able to have two crops per year) and are constraint, due to lack of financial resources that does not allow the purchasing of agricultural machinery, which, on the other hand, would not be justified for small farms.

At present, the activities of cultivation: preparation of the land for the seeding, the seeding, the welding, etc, are carried out manually, using hand implements; the plowing is carried out using hoes.

The little use of animal drawn equipment is due to:

- there exist a not separation between the cattle breeding sector and the agricultural activities
- cattle race is of small size and, alike many other African countries they suffer the plague of tze-tze fly
- the number of animal is small, if compared to the one that would be needed to substantially improve the animal based agriculture.

Tractors and agricultural implements are imported, mainly from France and Germany; the existing statistical data indicate an import of 50 to 60 tractors per year for the whole country, which leads to estimate in approximately 1000 the number of tractors imported since 1970.

Considering that the 75% only of all tractors is actually utilized in the agriculture, whereas the 25% is utilized for transport, maintenance of roads, etc; considering, also, that some of tractors have been exploited to a maximum of their life, that the maintenance is not properly done, that then is not the required turnover of spare parts, it can be assumed that the number of tractors in good conditions accounts to 400 units only.

The major portion of this tractors is the property of those enterprises (state owned and multinational) that are the sole organizations that can use them in cultivating the lands assigned to them.

Statistical data on implements used with these tractors are not available, but the main one is the plough.

3. Possible development of agricultural mechanization

The agriculture, in Cameroun, is based on the use of hand tools. This consideration leads to consider, as the most appropriate development model, the simples transfer of the experience many countries had with a gradual passage to animal drawn implements and then to motorized agro-mechanization.

On the other hand the availability of suitable cattle for an animal based agro-mechanization is difficult in Cameroun:

- health is a problem because of tze-tze fly plague
- cattle is not raised by farmers and, in any case, there would be a problem of feeding them and the need of stables, fodder storing facilities and other infrastructures too expensive for the small farmer
- the prevailing characteristics of the soil does not encourage the cultivation by means of animal drawn implements because it does not allow the required deep ploughing and, hence, the digging of the waste of previous cultivations to increase the amount of organic matter in the soil for seeding in the shortest time (also in order to cope with variable lenghts of the short dry seasons, the best time for seeding).

The farmers of the great provinces of west but also those of the provinces of Littoral often complain the loosing of crops, because they were not able to seed in time. It is worth mentioning that these two provinces are the most inhabited of the country and all suitable soil is under cultivation; it is here that it is possible to have two crops a year, although the soil preparation is done manually and the use of fertilizers is very limited.

In Cameroun there are four seasons: the great rain season, which, normally starts, by mid August and ends in October/November; the great dry season (November/April); the small rain season (May/July); the small dry season (July-August).

The right period for the seeding is the small dry season. In the event that the period of the dry season is shorter than the normal (and this year happened exactly that) the farmers have to substantially increase their efforts if they want to avoid that the crops are badly affected in terms of quality and quantity.

No doubts that this kind of problem would be overcome very easily, having the possibility to carry out the soil preparation and seeding by using animal drawn or tractor drawn implements, however, this is not possible, because the farmers are not in a position to make any investment in this way and animals are not available.

Various solutions have been taken into consideration, in order to allow the farmers to solve their problems, without making any investment. Among these solutions, the one that seems to be the proper one is the hiring of the agricultural machinery. An example that support the above, is the use of the tractors and implements of CENEEMA (a State owned Institution, better described in the following chapters), which rent the tractors at 2.500 F.CFA per hour, cost of driver included. This cost is very reasonable and, in our opinion, is, by the way, not remunerative for CENEEMA.

All the above leads to conclude that the power mechanization is the next step for the agriculture in Cameroun and this could be done by creating a number of agro-mechanization centres providing the services of an appropriate tractors fleet with relevant implements to the farmers of the area.

4. The present status of the industry of agricultural machinery

There is only one industrial enterprise involved in the production of agricultural implements and machinery, the TROPIC, Societe des Forges Tropicales, established in 1964. In addition there is a number of craftsmen that manufacture hand tools and animal drawn equipment which represent approximately 5% of the total supply of basic equipment.

A detailed description of Tropic is provided in the following paragraphs:

4.1 Tropic

Tropic, Societè des Forges Tropicales, is a company with a capital of 390 Millions Francs CFA, subscribed by private investors and by SOFICAL, a governmental investment company.

It owns a factory at Dovala that started production in October 1965 and supplies the majority of agricultural tools, implements and machinery to the Cameroonese agriculture and even exports a relevant portion of its production.

The factory is on an area of 24,400 sq.mt, 6,300 sq.mt of which covered by production and administrative buildings. The production departments include more than 100 equipment and machines, including: a forging unit, a milling machine, 16 presses from 5 to 250 tonnes, 15 ovens (oil fired and electrical) etc.

Main implements/machines produced are:

- plough model AT 38, animal drawn, ploughshare 9-10 inches

Bellagio

- plough model AT 3, animal drawn, ploughshare 9 inches
- various other types of animal drawn ploughs
- cultivator, animal drawn, ploughshare 9-10 inches
- metallic harrow, 2 elements, animal drawn, 1.6 mt wide
- metallic harrow, 3 elements, tractor drawn, 2.4 mt wide
- various types of carts, animal drawn
- manual three banks seeding machine
- weeding hoes
- threshing machine for rice, millet, sorghoum
- hand sprayer, 16 liters
- manual coffee processing machine, 250 Kg/h, it can be motorized
- groundnuts processing machine, manual, 65 Kg/h
- tractor drawn carts
- hand tools, including: . shovels
  . pickaxes
  . spades
  . hoes
  . rakes
  . axes

The statistics on production are shown in the following table.

IV Tropic: production in quantities (Kg)

EQUIPMENT/IMPLEMENT	72-73	73-74	74-75	75-76	76-77	77-78	78-79	79-80
Matchets	366621	328415	305734	803380	910033	691973	615934	48[illegible]
Shovels	224804	321170	202290	191070	299918	254841	241002	251[illegible]
Hoes	86491	74183	83970	83970	85970	110696	79267	[illegible]
Axes	36587	25622	22892	31173	27425	28957	17[illegible]	[illegible]
Sprayers	9945	8915	10585	6698	8989	13451	2031	[illegible]
Cultivation equipment	72366	292217	119249	122812	184623	184691	199574	[illegible]
Harvesting equipment	-	-	-	174	-	20	157	[illegible]
Carts	6716	240	6067	5985	15319	12743	4308	[illegible]
Coffee processing machines	-	-	-	-	-	166	150	[illegible]
Various	85835	129043	110948	194750	121423	129976	3020	[illegible]

4.2 Artisanal sector

A number of artisans are active in the production of agricultural machinery, two of the largest workshops belonging to this type are described in the following paragraphes:

4.2.1 M. Anguh workshop, Big Babanki

The workshop supplies several customers (primarily the cooperatives) in the whole North-West Province. The manufacturing facilities include the following main equipment:

. 2 lathes
. 3 grinding machines
. 3 hydraulic presses
. 1 forge
. 6 cutting machines
. 3 welding units

The production capacity is the following:

- coffee processing equipment: 1,200 units per year
- hoes: 1,000 pieces per month

4.2.2 M. Fontuoh workshop

The workshop is supplying agricultural machinery to several customers located mainly in the west and north-west provinces. It is equipped with forge, hydraulic presses, welding units and other

equipment suitable to process the metal scrap that represents the main raw material used.

The workshop started operations in 1979 and produces several types of machinery:

- hoeing machines for rice
- threshing machines for rice
- rice transplanter
- hoeing machines for pineapples
- threshing machines for maize
- mixers for fodder
- coffee processing machines
- etc.

5. Research, Design, Development and testing

The industrial and artisanal sector are involved in the design and engineering of the implements/equipment they produce while at governmental level the following institutions are concerned with agriculture, agro-industry and/or, specifically, with agricultural machinery:

- IRAF, Institute for agriculture and forestry
- IRZ, Research institute for zootechnical research
- CENEEMA, Institute for the study and development of agricultural machinery

The first two institutes belong to the Ministry of Planning through the National Bureau of Technical and Scientific Research and are

concerned with the development of agricultural machinery only as far as their find use and application or, in the case of IRAF, in the case of post harvesting equipment, while the CENEEMA is specifically involved in this field.

The CENEEMA has been established in 1974 and has the following main tasks:

- testing and certification of all imported agricultural machinery
- research on the adoptation of agricultural equipment, on the improvement of farming methods and on the use of non conventioned energy sources (Biogas etc)
- design, development and testing of agricultural implements/machinery, specially suited to local requirements and prevailing agricultural conditions
- promotion of small scale agricultural mechanization workshop by training and craftsmen responsible for manufacturing agricultural implements/machinery conceived and designed by CENEEMA
- training of agro-mechanization operators, maintenance and repair personnel
- training of supervisory staff specialized in agricultural mechanization (up-dating, etc)

The CENEEMA design and manufacture prototypes of machines like ox-carts, peanuts hullers, palm presses, cocoa huskers, planters, etc in many cases particularly conceived to fulfil the requirements of small farms.

The centre has the assistance, both technical and financial of the German Federal Republic. It is worth noting that CENEEMA sells consultancy services to the farms and rural development boards as well as machines and equipments produced in the existing workshop

centre's these sales account of approximately 40% of the total financing needed by the Institution.

6. Training of agro-mechanization personnel

Three institutions are providing training in the field of agriculture and agro-mechanization namly:

- ENSA, the national school of agronomics
- ITA, the institute of agricultural tecniques
- CENEEMA

6.1 ENSA

This institution has been established in 1960 and train agro-engineers on a 5 years course. During last year course students can specialize in one of the following topics:

- vegetable production
- animal breeding
- agro economics and extension
- rural development and rural equipment

The school is attended by more than 200 students and receives technical assistance from France, Belgium and Holland.

On the other hand ENSA has trained foreign students too, including trainees coming from Congo, Chad, Burkina Faso and Benin.

ITA offers two different courses:

- agro engineering, 3 years with the same specialization of ENSA
- for agro technicians, 3 years, equipping trainees with specific practical training.

6.3 CENEEMA

The centre for agricultural mechanization is providing training courses for the agro engineers and technicians graduated from ENSA and ITA as well as for agromechanics and tractor drivers.

The courses for agro-engineers is primarily concerned with the organisational aspects of the management and maintenance of a fleet of tractors and other agricultural machinery.

The courses for agrotechnicians, agromechanics and tractor drivers are essentially devoted on the operation, maintenance and repair of the tractor and relevant drawn implements and other machinery.

The CENEEMA is the only institution in Cameroun providing this type of training and offers, on regular basis, two courses:

- 6 months course for tractor drivers
- 1 months course for agromechanics/agro-technicians

All the trainees are employes of farm that are sent for up dating their specialization. Unfortunately the number of trainees that can attend the CENEEMA courses is limited by:

- lack of suitable areas and infrastructures

- lack of trainers
- lack of teaching equipment

In fact only 16 trainees per time can be hosted in the guest house of the centre, the classrooms and the laboratory are not large than 80 sq.mt. (all together) and the trainers staff includes only two agro-engineers and one agro-technician, assisted by few workers. The teaching equipment include two old engines, few panels with pictures and drawings and few tractors and relevant drawn implements for practical training (one Deutz, one Selüter, a new FIAT, a very old Massey Fergusson).

On the other hand there tractors are used also to provide services to nearby farms and therefore are not always available for training.

7. Institutions to be assisted and equipment to be provided

The institution that has been selected for this project is the CENEEMA that is the only institution in Cameroun that is both active in agricultural machinery design and testing as well as in training activities (for both agro-engineers and agricultural machinery operators). The equipment proposed have been agreed upon with the CENEEMA management and will include:

Documentation for Design and Products Engineering Training

Standards for ferrous and non ferrous materials

Standards for bolts and nuts

Standards for piping, rods, structural steel

Standards for electrical components (for civil and mechanical applications).

The following manuals and handbooks are suggested:

1. MARK'S STANDARD HANDBOOK FOR MECHANICAL ENGINEERS
2. MATERIALS HANDBOOKS
3. FLUID POWER TRANSMISSION HB
4. MATERIAL HANDLING LIBRARY
5. STD HB FOR FASTENING AND JOINING
6. PUMP HB
7. TOOL AND MANUFACTURING ENGINEERS HB
8. METAL FORMING HB
9. AMERICAN MACHINISTS HB
10. MACHINERY HB
11. HB OF PLASTIC AND ELASTOMERS
12. PAINT HB
13. ENGINEERING CALCULATIONS HB
14. LUBRICATION ENGINEERS
15. STD HB FOR ELECTRICAL ENGINEERS
16. MAINTENANCE ENGINEERING HB
17. HANDBOOK OF FIXTURE DESIGN
18. DIE DESIGN HB
19. TECHNIQUES OF PRESS WORKING SHEET METAL

Bibliography

20. PLASTIC TOOLING AND MANUFACTURING HANDBOOK

21. FUNDAMENTALS OF TOOL DESIGN

22. CHEMICAL ENGINEERS HB

23. INDUSTRIAL ENGINEERING HB

24. HB OF PRACTICAL GEAR DESIGN

25. HB OF HYDRAULICS

26. PROCESS INSTRUMENTS AND CONTROLS HB

The handbooks are all available from:

LINEAL PUBLISHING COMPANY

23 LEROY AVENUE

DARIEN, CT 06820, U.S.A.

TEL. 203-655-7676

TELEX 643-438 LINEAL CO. DARN

Annex III

n. 1 Video camera and recording group to be used for a number of tasks including visualization of the cynematics of various parts, field testing of equipment etc. Complete with 10 videotapes. VHS system - Any brand (Sony, Hitachi, Grundig etc.).

n. 2 Arc welding sets, complete with transformer-rectifier unit, basic and acid electrodes for iron, steel and engineering cast iron welding.
180 Ampere output.
Power supply 220 or 380 V.
Suppliers: Cloos (Germany) Miller (U.S.A.) Messer Grieshein (Germany) Esab (Sweden) or equivalent.

n. 1 Wire seam welding unit. Power 180 ampere output
Power supply 220/380 V.
Suppliers: as above.

n. 3 Oxy-acetylene welding units - Standard model complete with dolly for oxigen and acetylene cylinders, 40 liters cylinders with pressure reducers, various cutting and welding blowpipes, tools for circular cutting, all piping and spare parts.
Supplier FRO (Italy) or equivalent.

n. 1 Battery charger designed for use with one battery only per time - Voltage: 12 and 24 V.; suitable for operation with large size

batteries (for trucks and tractors).

n. 1 Reciprocating air compressor, capacity: 2,000-3,000 liters/hour, pressure: 8 Bars, electric motor driven, complete with relief valves, intake filter, water trap.
Power supply 220/380 V.
Suppliers: Ingersoll Rand , Atlas Copco, Ceccato (Italy) or equivalent.

n. 10 Tool kits for mechanical works, complete with hammer, tongs, screw-drivers, wrench set, threader etc.
Suppliers: Gedore (Germany) Usag (Italy) or equivalent.

n. 5 Tool kits for electrical work, complete with wire-nippers, wire strippers, insultated screw drivers, tester etc.
Suppliers: as above.

n. 1 Slide projector with manual control, complete with standard size screen.
Suppliers:

n. 1 Projector for transparent drawings, tables, etc. Size A4
Suppliers: 3M (USA) or equivalent.

n. 1 Maquette of the engine ignition system for a gasoline engine, operating at variable speed.
Supplier: Cemagref (France)

n. 1 Maquette of a diesel engine injection system including feeding pump, injection pump (Bosh type), piping etc.; all parts in operation will be electrically driven.
Suppliers: Cemagref (France), Bosh (Germany).

n. 1 Maquette of a diesel engine injection system using a rotative type pump (CAV type)
Suppliers: Lucas/Cav (UK) Cemagref (France).

n. 1 Maquette of an hydraulic rockshaft device of a tractor, manually operated mouvable parts complete with colour pictures showing linkages and oil system.
Suppliers: Cemagref (France).

n. 1 Picture showing compressed air braking system for trailers.
Supplier: Westinghouse.

Tractor, 4 wheels drive 70 - 80 CV complete with hydraulic rockshaft, three points linkages, withous cab.
Model : FIAT 670 - 780 or SAME Corsaro/Panther or Landini 7500 or Lamborghini 674 - 754 or John Deere 2030 - 2130 or Ford 6700 or International Harwester 654 or equivalent.
The tractor will be employed for field testing of various implements, demonstrations etc.

n. 4 Drawing boards , supplier Zucco (Italy) or equivalent.

n. 1 Table type copying machine on manual paper, A4 and A3 sizes;

possibility of reduction.

Suppliers: Mita, Minolta, Rank Xerox, Toshiba).

n. 1 Cyclostyle

8. Proposed training activities

Two agro-engineers, will be exposed to a specific training in the production of medium and small scale agricultural machinery and implements.

These agro-engineers could came from CENEEMA and/or from TROPIC, the only industry presently involved in the production of agricultutal machinery.

These engineers will be trained also in training methodology, so that can organize, in turn, their own courses. The courses have to be held in such a manner as to instill not only the basic of designing itself, but also the principle of material and operation testing as well as knowldege about marketing and products. The courses will last one-two months and should deal with the following main topics:

a) Hints for design

- the implements as a part
- the systematic approac elopment of a technical product; the special model
- the accelerating development work in the Third Wo
- strategies of the acceleration of the process of innovation

- basic conditions
- the different aspects of "quality"

b) A strategy of mechanization

- introduction
- definition of the role of mechanization
- the need of a strategy
- planning: elements, process, objectives, goals, determination
- policy-issue: development and integration

c) The design of an agricultural machinery versus agricultural conditions and soil characteristics

d) Special items on engineering design

design and heat treatment

- design of castings
- directives for engineering parts and details, from the point of view of material, manufacturing and use, on the aspects of availability, cost, waste, capabilities, surface and enviromental influences.

e) Ergonomics in machine design

- theory and application
- application exercises in the drawing room

f) Materials

- iron steel, cast iron and other metals, plastics
- mechanical properties and tests: composition, breaking point, fatigue resistence to chemicals and temperature

g) Piping and pumps

- definition of viscosity (Newton), Poiseuille-current, Reynolds number, resistance pipe system, calculation of pump pressure and need of power

- calculation of a screw pump, design approach

h) Transmission

- theory and comparison of beltdrive, V-belt, chain drive timing belt drive
- theory of the propeller shaft

j) Workshop technology

- contribution processes
- metal cutting and machining
- jigs and fixtures
- numerical control

k) The use of renewable sources of energy and other non oil based fuels

l) General machanics

- basic principles and endothermic motors
- basic principles of electric motors
- basic principles of transmission system from driving to output unit
- defining external forces acting or the equipment and the consequent interrelating forces between components parts
- basic principles for calculating these parts
- analysis of experimental data

m) Definition of characteristics of equipment

- definition required function and working conditions
- collecting information concerning analogue equipment on the market and examining the same
- analysing technical solutions adopted and technology employed on machines operating in ancillary sectors, outlines of basic characteristics of the equipment

n) Development of equipment

- studying theory of general machine design
- defining external forces acting on driving or working parts
- calculating the internal forces acting on both stationary and moving parts of equipment whilst in relation to about mentioned external forces.

o) Testing of equipment

- making the first prototype using any kind of material available
- carrying out the first round of tests to check that equipment meets requirements as far as operation and material quality is concerned
- studying tests result together with those in previous stage
- making two project types from materials equipment to those foreseen for industrial production
- carrying out two drawn of tests to check results of modifications
- giving go ahead for pre-qualification
- quality control of the same
- final go ahead for industrial production

p) Industrial production

- studying final design
- budgeting of production cycles
- identification of tools and equipment necessary for the production
- possible revision of design in view of machining requirements
- estimating investment required
- estimating fixed and variable costs

- carrying out pre-production with production materials

9. Additional technical assistance

Both trainees should carry out the following further recommended activities:

9.1 Practical tests

The training programme to be conducted in a foreign institution should include also some practical tests to be carried out on various types of machinery. Some of the suggested tests are indicated below:

- draw-bar test to evaluate the tractor's drawbar performance in accordance to slip and specific fuel-consumption
- P.t.o. test to evaluate the pto performance in accordance to the specific fuel-consumption of the given tractor
- I.C. engine testing

  Test of the engine with variable compression ratio to find the relation between compression and specific fuel consumption
- Pump test

  Test of a pump turbine
- Etc

9.2 Visits to manufacturers and institutions

Some visits should be organized to:

- Manufacturers of agricultural machinery and implements
- agricultural machinery testing institutes
- laboratories of agricultural engineering department of universities.

9.3 Visit to a developing country

It is suggested that at the end of the course the trainees, together with two of the lecturers will visit a number of industries and agencies in a developing country where the agricultural machinery field is particularly large. India could be selected because this country has developed appropriate technology in this field and has also supplied design of agricultural implements to various countries including Tanzania.

The study tour should last two weeks and should include:

- major institutions devoted to agro-mechanization design, experimentation and testing
- major industries involved in agriculture equipment engineering and production
- major engineering industries producing spare parts for the agriculture machinery

4.4 Technical Follow-up

Once the trainees have returned back to their institutions they will need some technical follow-up to better apply the foundamentals they got during the training to specific topics related to their day to day duty. For this reasons it is suggested that two experts in agro-equipment design, production and testing will be posted in Cameroun for a period of six months. One expert will focus his attention on the production aspects while the second will deal with testing, identification of most appropriate design characteristics etc. Main goals for this mission would be:

- to provide technical expertise to solve specific application problems together with the trainees
- to organize in cooperation with CENEEMA, an extension service for the rural workshop to transfer the know-how on the production of agricultural implements/machinery
- to revise, together with the trainees, the design of some machinery and/or implements currently manufactured, introducing, where possible and needed, improvements to semplify their production and/or to make them more suitable to local conditions
- to provide necessary inputs and technological back-up improve existing production systems, quality control and routine maintenance procedures
- to organize a workshop to the Government decision makers to revise major guidelines of agricultural machinery application in the country and identify the most appropriate level of agro-mechanization in the country.

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THE STATUS OF THE AGRO-MECHANIZATION

AND OF THE RELEVANT INDUSTRY

IN SUDAN

SUMMARY

1. General outlook of the agricultural sector

Sudan is the largest country in Africa, covering about 2.5 million sq.mt. The population is estimated at about 19 million.

Much of the country is scarcely populated and although a large part of the country is desert or semi-desert, Sudan has great potential for agricultural development.

Agriculture is in fact, by far, the most important production activity, employing 22% of the total population, contributing approximately 40% of the GDP and accounting for 95% of the total exports.

The total arable land is estimated to be in the region of 84 millions hectares but presently only 7 million ha are under crop.

The availability of water (from the White and Blue Nile rivers) has enabled the implementation of large-scale irrigation schemes (total irrigated area being approximately 2 million ha) the largest one being approximately 2 million ha) the largest one being the GEZIRA scheme. Historically, these schemes were conceived for the cultivation of cotton as the only cash crop. Two other crops were cultivated for substistence purposes, usually a crop for fodder, to complement cotton in the rotation of the land, and a cereal crop for marginal land. In 1974, however, there was a change in the orientation of the Government's agricultural policy, following the sharp rise in the world prices for cereals. A decision was taken to expand the cultivation of cereals, in order to increase self-sufficiency in the basic foodstuffs, and to expand the production of other cash crops (notably groundnuts) in order to

reduce dependence on cotton. Between the 1974/75 cropping season and the 1978/79 season the proportion on land in the Gezira scheme cultivated with cotton fell by about a quarter, with the acreage diverted to the cultivation of wheat and dura (sorghum).

Apart from the large irrigation schemes, the majority of agriculture is centred around the rainfed agricultural areas (5 million ha). Approximately 4 million ha in the areas are divided into small farms, 1 to 2 ha in size, using traditional tecniques while 1 million ha belong to large mechanized farms.

In the following table No.1 the agricultural output is shown.

Table 1 - Agricultural output (1000 metric tons)

PRODUCT	1969/71	1979	1980	1981	1983/84	1984/85
Wheat	134	177	231	180	169	79
Rice (paddy)	5	7	7	8	NA	NA
Maize	31	45	45	50	NA	NA
Millet (dukhun)	424	550	450	500	314	178
Sorghoum (dura)	1,525	2,408	2,200	2,800	1,806	1,110
Cotton					629	649
Groundnuts					413	380

The principal food staple commodities in Sudan are dura and dukhn. Wheat and rice are the other main cereals crops. The production of

wheat had traditionally been restricted to the northern Nile region while rice had been cultivated under rainfed and flood irrigation in the southern region. Both crops require large quantities of water and are not particularly suited to cultivation in most areas of Sudan.

The droughness that hit Sudan in these years has considerably affected cereals production. Meanwhile in 1985 rains are abundant and chances of getting better yelds are high.

Oilseeds, mainly groundnuts and sesame, are the most important export crops after cotton. The area under groundnuts has been expanded in the rainfed areas and in the irrigation schemes where yields are much higher.

2. Agricultural mechanization in Sudan

2.1 Generalities

In the sixties the problem of increasing the agricultural output became urgent, for both domestic consumption and export and particular emphasis was given to this topic by the Authorities concerned.

The solution to the problem was to irrigate the areas which were inherently fertile but suffered from insufficient rainfall and from too low degree of mechanization in agriculture to make up for the shortage of labour. A substantial proportion of the population in Sudan lead a nomadic existence, particularly in the peripheral or

more arid regions and therefore only cultivate a sufficient amount of land to produce enough food for their subsistence and minor bertening of other commodities.

Whilst on the one hand the techniques of irrigation were rapidly grasped by the farming population due to their custom of watering the fields when it didn't rain and the simplicity of the irrigation equipment used, the methods of mechanized seed preparation and harvesting using over sophisticated machinery to replace the centuries old manual methods caused a series of set-backs due above all to:

- the incorrect use of tractors and equipment
- the lack of daily servicing
- repairs carried out badly or not at all due to the unavailability of spare parts.

The total area under cultivation has risen, but at the same time the foreign currency annual requirement for tractor, equipment and spare part purchase has also risen with the result of off setting if not exceeding the benefits of increased exports of agricultural products.

The adoption of alternative policies are now being considered to increase agricultural production.

As regards irrigation, the available water resources have all been tapped already and the new canal being built to redirect water from the marshlands in the extreme South into the White Nile catchment will increase water available by only 10%.

As regards mechanization, the newly purchased tractors and equipment put in the hands of unproficient operators quickly become unserviceable. More emphasis is therefore being given to:

- development of animal traction
- the use of selected and hybrid seeds which are more resistant to adverse atmospheric conditions and insect attak to increase yields
- the reduction of wastage in the crop storage silos

  (a loss of 20% of the harvest due to wastage in storage after only four months is presently considered normal and it would therefore be sufficient to cut these losses by half in order to have a production increase of about 10% without any extra work and few extra costs). It would seem therefore that Sudan is heading towards a more rational agricultural policy.

As mentioned above the attempt was made years ago to pass in one jump from an agriculture based on manual labour to an agriculture based entirely on mechanized methods, without however taking steps to provide the necessary infrastructure i.e., to train machinery operators, teach mechanics to carry out repairs as well as organizing a service and spare parts network.

The policy adopted by Sudan in this respect, similar to that in nearly all other developing countries, had the effect of destroying within a few years those machines which had been donated or acquired on favourable terms. The country has then forced into spending the income from exports for the purchase of replacement machines or an enormous quantity of spare parts in the effort to maintain al least a proportion if not in good condition at least in working order.

The authorities are becoming aware of these short comings and are now considering:

- the development of animal drawn implements rather than mechanical
- cropping of new land on an extensive rather that intensive basis
- rehabilitating of previously created farms and installed machinery

so as to increase productivity and maintain machinery in good working order

In addition the training of proficient operators expert mechanics and competent farm managers, which would be carried out in schools, institutes or specialist training centres is being considered and the support of international organisations for their creation and continued functioning being sought.

Theoretically this new policy would appear to be sound and the request for international cooperation reasonable.

It is certainly more advisable to teach the Sudanese how to drive a tractor, operate agricultural equipment, carry out routine serving and repairs and construct the more elementary spare parts rather than continue with shipments of machinery which soon remains unused due to breakdowns and is then cannabalized to repair other machines.

Another aspect is the lack of skilled labour; there are in all only 8 vocational Training Centres for specialist workers.Each centre trains on average 100 workers per year but of the national total of 800 trained per year there is no one for the field of agricultural machinery.

For a country of over 18 million inhabitants these figures are very low.

2.2 Hand tools

Hand tools, primarily used by the "traditional subsector" (over 4 million ha under crop scattered in the whole country) consist mainly of axes, hoes, shovels, sickles and knives.

Several items are provided at village scale by blacksmiths and small

workshops.

2.3 Animal drawn implements

These include the plough, "Kamara" for crushing clods and levelling, harrows and rollers; lelling beard "Qussabia" for levelling and raising of irrigation banks and ridgers.

Harvesting of crops is done manually. The animals used to operate these implements are oxen, horses, camels and donkeys.

Animal drawn implements are very popular in the northern provinces. The animal power is used for land preparation, harvesting of some crops and transport of farm products. Since the average farm size in these areas is usually very small, less than 2 ha, the immediate introduction of powered machinery will lead to inefficient utilization of such machinery.

Great emphasis is now being given to this kind of implement.

Indeed not only is the purchase of tractors and agricultural machinery far beyond the means of the farming population, many regions of Sudan also have soils which are unsuitable for mechanization due to soil structure or aridity, even if some regions have quite different soils, i.e. wetter and clay soils. It would however be advisable to replace the present manual seed preparation, sowing and harvesting equipment with implements based on animal traction, which would not represent any problem as regards animals (camels, horses and oxen) size or number.

Sudan has medium or medium to large sized draught animals (horses and oxen) of sufficient numbers, as compared to other developping

countries, at its disposition.

In those areas where this type of mechanization has been introduced based on implements made by village blacksmiths and copied from equipment imported from abroad, above all from France, it can be seen that the farmers do not tend to work less but rather to increase the area under crop and therefore work as much as before.

The material used for making such implements derive primarily from scrap metal from cars and above all lorries. Wood is in adundant supply in the South but very expensive in the North of the country.

These implements, constructed by local craftsman could nevertheless be notably improved, both as regards performance (the machinery from which they are copied not always being ideal for soil conditions in Sudan) as well as the technical construction as hence the cost and working life.

2.4 Motorized mechanization

Mechanized farming in the Sudan was introduced in 1946 for the large scale production of Sorghoum. The area devoted to mechanized agriculture slowly increased to over 1 million ha as shown in the following Table 3.

Table 3: Total areas and average yield of main crops in traditional and mechanized sub-sector (1974/75)

CROP	TRADITIONAL		MECHANIZED	
	AREA IN HA	AVERAGE YIELD T/HA	AREA IN HA	AVERAGE YIELD T/HA
Sorghum	1,129,149	0.595	1,141,224	0.879
Groundnut	631,134	0.690	160,159	1.976
Sesame	219,450	0.324	94,710	0.290
Cotton (short staple)	46,919	0.267	20,500	0.371

The size of mechanized farm holdings ranges between 420-630 ha. The following Table 4 shows the number of agricultural tractors and agricultural machinery imported in Sudan in the period 1970-80.

Table 4: Number of agricultural tractors and machinery imported in Sudan, 1970 - 1980

TYPE OF MACHINERY	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
Tractor (wheel)	1,271	800	130	1,940	2,047	662	1,722	792	711	545	532	11,152
Disc plough	193	187	550	100	510	1,206	292	-	416	-	-	3,454
Ridger	385	425	-	-	400	29	500	90	100	-	-	1,929
Wide level disc with seedbox	1,130	520	500	500	147	65	97	75	132	-	-	3,166
Off-set disc harrow	35	70	20	64	213	32	132	56	-	-	-	622
Multi-purpose blade	25	19	8	-	-	-	32	-	-	-	-	84
Planter	-	120	-	3	76	206	12	-	13	-	-	430
Fertilizer distributor	10	2	-	10	10	-	1	-	-	-	-	33
Groundnut digger	-	-	-	-	70	131	121	120	-	-	-	442
Grain combine	118	135	50	20	220	387	187	106	30	-	-	1,253
Pick-up baler	20	35	10	-	5	-	-	-	-	-	-	70

In the last two/three years the number of tractor imported was approximately 1,000 per year.

It is estimated that approximately 50 to 60% of the machines imported are still in operation. All these motorized machinery and relevant implements are imported and they are nor therefore ideally suited to specific Sudanese conditions.

For instance seedbed preparation is carried out by means of a wide level disc, but its effectiveness is doubtful particluraly as far as weed control, moisture and soil conservation is concerned.

2.5 Reserach and development

The production of agricultural machinery in Sudan is limited to few hand and animal drawn implements on artisanal level.

Therefore the research and development activity is small and is probably limited the Centre of Tamboul (150 Km. South East of Khartoum) where the Government has set, in cooperation with the French government, a research and Training centre for the agriculture mechanization in irrigated areas and to the training centre of Masad.

Among the goals of these centres are:

- test and selection of all imported agricultural machinery (in order to select whether or not appropriate for the local characteristics)
- application of the machinery
- improve the agriculture techniques to make them suitable to the mechanization and irrigation
- training of personnel

Both centres have workshops but their use, is limited to the training of personnel for the maintenance of the tractors.
In a previous mission (1982) the consultant noted a small engineering activity carried out by the Faculty of Agriculture of the Khartoum University (students design and construct simple prototypes) but this activity, if not abandoned, did not develop into a concrete action to help the creation of an industry devoted to the production of agricultural machinery/implements.

3. The present status of the industry of agricultural machinery

There is no industrial plant operating in this field.
An assembling line for Massey Fergusson tractors did not materialize few years ago for financial problems.
Hand implements only are produced locally by blacksmiths and small workshops. The same have started the production of simple animal drawn implements, copying the ones imported.
Nearly all spare parts are imported too.

4. Use and maintenance of agricultural machinery

Every year a number of tractor and other agricultural machinery are put into the Sudanese market, which are produced in countries such as the U.S.A. or Europe where soil conditions, precipitations and

temperature levels are very different from those prevailing in Sudan and are therefore not always well suited to the local conditions. This is particular true for land preparation implements and harvesting equipment.

It is obviously advantageous, if not to say necessary, to subject the machines to be imported to practical field tests in test centres in the area they will be used in with technical staff available to suggest the necessary modification should the machinery be unsuitable for local conditions.

Although there already exists for tractors at any rate, the testing centres of Tamboul and Masad (and also the University of Khartoum) where tractor models undergo a performance test in order to qualify for import Licences. This test is however merely a repetition of those at Nebraska (the official test centre in the U.S.A) and aimed at establishing the engine rating and available drawnbar pull at various speeds and therefore of no value as regards determing the suitability of machinery to use under local conditions.

Secondly there is a lack of specialized personnel capable of operating correctly out routine servicing and repairs when necessary. The students coming from the secondary school and university only have theoretical knowledge and are therefore not in a position to carry out, teach how to carry out possible modifications of machinery or even undertake a study of the same. The few practicable technicians coming from the existing specialist training centres either seek employment in a government department or go abroad to work in other Arab countries (due to much better pay than in their own country).

Information and comments on some mechanization centre and repair

workshops are provided in the following paragraphes:

4.1 Sarkis Izmirlian Corporation Ltd (John Deere importers)

The repair workshop situated in the industrial estate to the North of Khartoum has a total area of about 6000 m^2, of which 1500 are under covers as well as officies, canteen, a testing department for engines, a covered area for tractor disassembly, a spare parts department (very poorly housed but well organized), a repairs workshop (with 1 lathe, 1 small drill, several electric welders) and a small separate covered area which has recently been added for the repair of Land-Rovers.

In the workshop repairs ordered by clients are carried out as well as reconditioning of old tractors and the assembly of a small number at high h.p. tractors and C.K.D. tractors from Europe.

The personnel on the stop floor come from the Vocational Training Centres and have a good standard of proficiency.

At intermediate level i.e. qualified worker and foreman the standard is below that required which is partly attributable to the Educational institutions that offer little practical and too much theoretical training and partly because the most capable personnel go abroad.

4.2 Ministry of Energy and National Water Administration

Workshop for overhands and structural steel work at Khartoum. The workshop situated about 10-15 Km. from Khartoum has a total area of

20,000 m^2 respectively and a total staff of 250 with only a small number of managerial staff.

The first, most important and better equipped department consists of the repair workshop for all wheeled vehicles (cars, lorries, trucks and mobile drilling units) as well as the actual mechanical and machining workshop for the repair of damaged parts consisting of about 50 horizontal lathes, one large sized lathe with a five meter lathe bed, distance beneath the centres of 1 meter and equipped for the manufacture of irrigation or borepipes, 3 drills, 2 milling machines, 1 planning machine, 1 grinding machine, 1 oxy-acetylene cutter and other minor equipment. The second department, housed in a partly unwalled building with a hard earth floor, is for carrying out steel work construction above all large cylindrical tanks of 10,000 gallons capacity with the relative supporting framework. The equipment consists of a good number of continuous band welders, 1 three meter shearing machine, 1 rolling machine, hacksaws and other minor equipment.

A small area in this department is used for the carpentry section where patterns in wood are constructed for those castings for parts which are made in the mechanical workshop.

The shop floor personnel come from Vocational Training centre and have a good level of proficiency, although a subsequent advanced training course within the workshop itself is required.

At managerial level, as above, there is a lack of staff as graduated from the secondary schools are sent abroad for advanced training courses.

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4.3 Private sector workshops

The consultant visisted a number of private sector workshops located at Omdurman where establishments of this type are very numerous. They produce a number of miscellaneous items even if metal processing is the most common operation (forging, machining, medium light carpentry).

Main raw material used is metal scrap and structural steel of local production.

Machine tools and other production equipment are simple and consist mainly of centre lathe, milling machines, drilling machines, arc type welding units; some small furnace for aluminum and pig iron are also present.

Some of these workshop are also engaged in the production and maintenance of agricultural implements/machinery.

They produce handtools like hoes, spades, small mills foe cereals etc.

Main workshops visited are:

- Kahmis zaki workshop, mainly involved in trucks and tractors maintenance
- Mohmad yussif workshop, manufactures bodies of buses and small carpentry works
- Saad Mohmad Saad workshop, produces various types of implements and one model of small mill for cereals
- Mozamal abbas workshop, engaged in the maintenance and repair of any kind of agricultural machinery

4.4 Agricultural mechanization centre of Soba

The consultant had the opportunity to visit in 1983 the centre of Soba, set up as part of a Fao project with the cooperation and financial backing of the Italian government.
It had a fleet of 75 tractors for both training of drivers, machinery operators and mechanics and for work for third parties.
The centre seems non no longer in operation (1985).

5. Education and training

The school system in Sudan consists of six years of primary or elementary school and three years of junior secondary or intermediate school which are obligatory. Thereafter there is the choice of 2 years at a Vocational training centre to become a specialized worker, 3 years of high secondary school for general higher education or 4 years of high technical secondary school leading to a technical diploma. The last category is attended by more than 18,000 students who specialize in commerce, industry or agriculture.
There are 8 vocational training centres attended by one thousand students who are trained as specialist workers for various branches of industry (diesel and petrol engineers car and vehicles mechanics, welders, builders of steel structures and electricians) but not for agriculture.
Government policy does however foresee the creation of Vocational Training Centres to train specialist workers for the agricultural

Training Centres to train specialists workers for the agricultural machinery sector and 15 new centres of 100 students each in various parts of the country and with financial backing of the World Bank are planned. The present 6 year plan provided also for the creation of 7 educational institues for training agricultural mechanics but due to the lack of funds this plan is far from being carried out.

Training in agro-mechanization is provided by:

5.1 Agricultural engineering administration

The training and testing division of the Ministry of agriculture coordinates the activities of the following 3 training centres.

- Tosi Training Centre the first to be founded (1973) and largest in size which trains 100-120 tractor operators every year.
- Tamboul Training Centre, which was founded with the cooperation of the French government and Renualt.
- Masad Traning Centre, the most recently founded which is backed by the Italian government and FIAT.
- White Nile Rice Project Training Center, specialized in the training of operators of machines specialized in rice cultivation.

These centres have as their main objective the training of tractor drivers and machinery operators in Agriculture.

5.1.1 Tosi centre

The courses hold at Tosi last about six months, are conducted by 5 or 6 instructors and attended by around two hundred

students from the junior secondary shool. The instruction combines theory and practic with an emphasis on the latter, particularly as regards cultivation techniques, use and handling of machines and apparaisal of the same.

Students who finish the courses at Tosi mostly find employment on the largest sized farms (in the rainfed area there are farms of a thousand feddans, about 240 ha), where as in the rainfed areas the maximum size allowed is 40 feddans (about 16 hectares).

5.1.2 Tamboul centre

The Tamboul centre is located at approx. 150 Km south Khartoum over an area of 450 Feddans (185 ha approx) 20 of which covered by construction in good conditions including classroom workshops and storehouse, houses, etc.

The centre offers two different types of training. The formal promotion training is specific for the training of operators of agricultural machines and tractor drivers. They last four months and are attended to full time students coming from the primar school without other specific preparation.

The second type of training courses are devoted to the practical training of agro-engineers coming from the Khartoum university. Such courses last 1 month and the maximum attendancy is of 40 full time students. The workshop of the centre is very limited in size and quality of the machines. It

includes one centre lathe a drilling machine two electric welding units and few other equipment located in a 200 sq.mt building. The kind of equipment available makes difficult the training of 40 engineers part-time. The center has a staff of 19 teachers but 9 are full time engaged in the activity of testing the imported tractors and agricultural machinery. This testing procedure is mandatory for all imported tractors and agriculture machines: it consists in a 1° testing period lasting 3 months during which the main characteristic are checked and at yet of which a first import permit is issued with a limit of 20 pieces. The second period testing lasts approx. 6 months during which the characteristics of the machines under actual use are analysed. If the machines pass this exame the import of a second batch of 50 mm is allowed.
The third period, additional 9 months is devoted to other tests under actual use in order to finalize the information on the availability of the machine to the Sudanese requirements. At the end the final permit for import without limit of quantity maybe released at if modifications are needed these are suggested by the Centre engineer and must be done on all further machines imported. During the visit che consultant had the opportunity to see a number of tractors under test, all in good order, including 2 Renault, 1 Massey Fergusson, 1 Fiat, 1 Belarus, 1 Valmet, 1 Iseki and 1 Yanmar all having medium to high power.

5.1.3 Testing and training centre in Masad

The centre is located approx 200 Km south east of Khartoum, in the El Gezira district over an area of 60 ha out of which, 6 are covered by various buildings including classrooms, workshops, housing schmes, store houses, etc, all in good order; the workshop building is completely new.

In particular the centre relies for a part of its activity to the system of the Italian Government for the training of personnel spacialized in kattle breading and forage cultivation within the development programme at the Gezira board (the agriculture development of more than 1 million ha area between the Blue Nile and White Nile. The board has divided the area in a number of farms, 16 ha each one divided in 4 parts, 1 for cotton cultivation, 1 for peanuts 1 for cereals while the 4th is left for the necessary crop rotation). The workshop has been built within this assistance programme it is quite complete and includes, interalia, a centre lathe, willing machines, drilling machines, welding machine, both at arc and continuous wire, working benches etc. The centre has the task to train agro-mechanics and operators at high level, the 1° year only 20 trainers will be admitted after a carefull exame. Trainers are coming from the intermediate school, the courses will last 3 years.In the future the centre foresees the establishment of training courses also for agro-engineers graduated in the Khartoum university. Last but not least the centre is also involved in the testing of tractors and agriculture machinery

following the same procedure decribed for the Tamboul centre.

5.1.4 Malakal Centre

The first Agricultural Machinery Training Centre was opened in 1983 at Malakal. Malakal is a small town in South Sudan about three fligh hours from Khartoum. The centre provides a practical training for medium level staff (operators and technicians) who will be using tractors and agricultural machinery and carrying out routine servicing and repairs.
The students are youngsters from the area in which the centre is located (for obvious reasons of cost it is not feasible to accept students coming from more distant areas).
It is essential that similar training centres be set up in other parts of Sudan.

5.2 **Wad Medani Training Center**

The centre Wad Medani comes under the Labour department and Ministry for Internal Affairs. It was founded in 1969 with the collaboration of the ILO and covers a total surface area of about 14,000 m^2 of which a third are under cover.

The buildings consist of offices, lecture rooms and the following workshops:

- a teaching workshop for agricultural mechanics for disassembly and overhauling of tractors, agricultural machinery, including combine harvesters, earth moving machinery, diesel motors and injection pumps, with the relevant testing bench.
- a workshop for the training of mechanics equipped with about 40 horizontal lathes of small dimensions for teaching purposes, some milling machines and drills and a large bowing machine.
- a workshop for training blacksmiths and welders with anvils, forges, welding stands for arc welding, band welding and spot welding.
- a workshop for car machanics (specialized in car and lorry repairs) with disassembly and overhauling of cars and lorries and repairing of the relative electrical equipment.
- a workshop for training panel beaters equipped with shearing and bending machines, burnishing and other equipment.
- a small workshop for electricians (training for electrical installation in the building industry).

The total number of students at the centre is about 700, of which less than 100 are trained in agromechanization and all of which come from the secondary schools. The course lasts three years and is completely free of charge. The first two years consist of theoretical and practical instruction at the centre, the third year is spent away from the centre in workshops or in farms. All students come from the surrounding area and will probably return home to work after finishing their training.

The centre is not specifically designed for training only personnel for industry or only personnel for agriculture but this is not considered to be a disadvantage.

In fact it is planned rather than to increase the number of training centres in existence, to increase the number of students attending them, to improve the equipment in the centres and above all to improve the training and teaching standards of the teachers. At this centre also the teaching staff must receive training abroad to become qualified in both the practical as well as the organisational aspects. As far as the training centre at Wad Medani in particular is concerned, which is situated right in the centre of the best agricultural area in Sudan, the delivery of some mobile units is foreseen, with the purpose of training students for field repairs as well as providing the tractor drivers and machinery operators with an extension service, even if this is outside the centres educational objectives, in such a way as to encourage slightly more diligent routine servicing than at present practised and the optimization of their equipment in the field.

The centre is without doubt one of the best of its kind which the consultant has seen in Africa and the Middle East.

5.3 Department of agricultural engineering - Faculty of agriculture Khartoum Univerisity

The faculty of agriculture at the university of Khartoum is at

present the only one existing in Sudan although two other faculties of agriculture namely at Wad Medani and Juba are planned. The course in agriculture at the univerisity lasts five years and offers above all a theoretical approach. The following facilities are however available:

- a workshop equipped with assembly and disassembly workbenches for diesel engines and tractors transmissions as well as testing bench for injection pumps
- a workshop in which the students can construct models of simple agriculture machine of their own design.
- a sizeable park of machines and equipment which are however almost exclusively used for static demonstration purposes.

The last year of the course is attended by approximately 60 students from the Faculty of Agriculture and 10-15 students from the Faculty of Engineering who are specializing in agricultural engineering.
The university is also cooperating with the Tamboul and Masad centres as far as testing of imported agricultural machinery is concerned.

6. Institutions to be assisted

The survey of the present status of the agro-mechanization and relevant industry in Sudan has shown that no industrial production of agricultural implements/machinery is presently undertaken. Also the majority of spare parts are presently imported.
On the same time the design, engineering and development activity in

this field is negligible. Meanwhile the consultant has identified two training centres for agro-mechanization that could be assisted to create the first capabilities to train design/development engineers as well as to strenghten their training possibilities for agro-mechanics, agro-engineers etc, namly the centres of Tamboul and Masad, both belonging to the training and testing division of the ministry of agriculture.

Considering the present situation of agro-mechanization in Sudan the consultant deems necessary the training of engineers in design and development/engineering of:

- animal drawn implements
- spare parts for tractors/imported agricultural machinery
- post harvesting equipment.

All these items can be produced on small/medium scale even in workshops and the so trained agro-engineers could provide an extension service to them and to blacksmiths, improving the quality of the material presently used and reducing their cost.

The following preliminary steps have been identified:

- equip a number of trainers
- strenghten the equipment (both reference literature, audiovisual and workshops) of the two centres of Tamboul and Masad.

6.1 Assistance to Tamboul Centre

The purchase of the following items is suggested:

- Video camera and recording unit, portable type, VHS system, complete with 50 videocassettes.

- Film projector 16 mm

- Slide projector, 35 mm

- Universal milling machine, size 4, complete with dividing head, power supply 380 V:

main motor	10 HP
translation motor	3 HP
table dimensions	1550 x 350 mm
longitudinal stroke	1150 mm
transversal stroke	330 mm
vertical stroke	440 mm
wheight	3500 Kg

Suppliers: Rambaudi (Italy), Cincinnati (USA), Bridgeport (UK).

- Column type drilling machine for holes up to 25 mm diameter.
Supplier: Caser (Italy) or equivalent.

- Wire welding machine, 2 pieces, 180 ampere output.
Power supply 220/380 V.
Suppliers: Cloos (Germany) Esab (Sweden), Miller (USA) Messer Griesheim (Germany).

- Grinding machine (for external grinding), 2-3 KW,
  Power supply 220/380 V.

- Reciprocating air compressor, capacity:
  2,000-3,000 liters/hour, pressure 8 bars, electric motor driven, 220/380 V. power supply, complete with relief valve, intake filter, water trap.
  Suppliers: Ingersoll Rand, Atlas Copco, Ceccato (Italy) or equivalent.

Reference handbooks

1. MARK'S STANDARD HANDBOOK FOR MECHANICAL ENGINEERS
2. MATERIALS HANDBOOKS
3. FLUID POWER TRANSMISSION HB
4. MATERIAL HANDLING LIBRARY
5. STD HB FOR FASTENING AND JOINING
6. PUMP HB
7. TOOL AND MANUFACTURING ENGINEERS HB
8. METAL FORMING HB
9. AMERICAN MACHINISTS HB
10. MACHINERY HB
11. HB OF PLASTIC AND ELASTOMERS
12. PAINT HB
13. ENGINEERING CALCULATIONS HB

14. LUBRICATION ENGINEERS
15. STD HB FOR ELECTRICAL ENGINEERS
16. MAINTENANCE ENGINEERING HB
17. HANDBOOK OF FIXTURE DESIGN
18. DIE DESIGN HB
19. TECHNIQUES OF PRESS WORKING SHEET METAL
20. PLASTIC TOOLING AND MANUFACTURING HANDBOOK
21. FUNDAMENTALS OF TOOL DESIGN
22. CHEMICAL ENGINEERS HB
23. INDUSTRIAL ENGINEERING HB
24. HB OF PRACTICAL GEAR DESIGN
25. HB OF HYDRAULICS
26. PROCESS INSTRUMENTS AND CONTROLS HB

The handbooks are all available from:

LINEAL PUBLISHING COMPANY
23 LEROY AVENUE
DARIEN, CT 06820, U.S.A.
TEL. 203-655-7676
TELEX 643-438 LINEAL CO. DARN

6.2 Assistance to Masad Centre

The purchase of the following items is suggested:

- Video set as above (C.1.1)

- Film projector 16 mm

- Slide projector 35 m

- Maquette of a diesel engine injection system including feeding pump, injection pump (Bosh type), piping etc.; all parts in operation will be electrically driven.
  Suppliers: Cemagref (France) Bosh (Germany).

- Maquette of a diesel engine injection system using a rotative type pump (CAV type).
  Suppliers: Cemagref (France) Lucas/Cav (UK)

- Maquette of an hydraulic rockshaft device of a tractor, manually operated mouvable parts complete with pictures showing linkages and oil system
  Supplier: Cemagref (France)

7. Proposed training activities

Two agro-engineers, identified by the Ministry of agriculture and belonging to its training and testing division will be exposed to a specific training in the production of medium and small scale agricultural machinery and implements.
These engineers will be equipped in training methodology too, so that they can organize, in turn, their own courses. The courses have to be

held in such a manner as to instill not only the basic of designing itself, but also the principle of material and operation testing as well as knowldege about marketing and products. The courses will last one-two months and should ded with the following main topics:

a) Hints for design

- the implements as a part of a system
- the systematic approach of the development of a technical product; the special model
- the accelerating development work in the Third World
- strategies of the acceleration of the process of innovation
- basic conditions
- the different aspects of "quality"

b) A strategy of mechanization

- introduction
- definition of the role of mechanization
- the need of a strategy
- planning: elements, process, objectives, goals, determination
- policy-issue: development and integration

c) The design of an agricultural machinery versus agricultural conditions and soil characteristics

d) Special items on engineering design

design and heat treatment

- design of castings
- directives for engineering point and details, from the point of

view of material, manufacturing and use, on the aspects of availability, cost, waste, capabilities, surface and enviromental influences.

e) Ergonomics in machine design

- theory and application
- application exercises in the drawing room

f) Materials

- iron steel, cast iron and other metals, plastics
- mechanical properties and tests: composition, breaking point, fatigue resistence to chemicals and temperature

g) Pumping and pumps

- definition of viscosity (Newton), Poiseuille-current, Reynolds number, resistance pipe system, calculation of pump pressure and need of power
- calculation of a screwpump, design approach

h) Transmission

- theory and comparison of beltdrive, V-belt, chain drive timing belt drive
- theory of the propeller shaft

j) Workshop technology

- contribution processes
- metal cutting and machining
- jigs and fixtures

- numerical control

k) The use of renewable sources of energy and other non oil based fuels

l) General machanics

- basic principles and endothermic motors
- basic principles of electric motors
- basic principles of transmission system from driving to output unit
- defining external forces acting or the equipment and the consequent interrelating forces between components parts
- basic principles for calculating these parts
- analysis of experimental data

m) Definition of characteristics of equipment

- definition required function and working conditions
- collecting information concerning analogue equipment on the market and examining the same
- analysis technical solutions adopted and technology emplyed on machines operating in ancillary sectors, outlines of basic characteristics of the equipment

n) Designing of equipment

- studying theory of general machine design
- defining external forces acting on driving or working parts
- calculating the internal forces acting on boin stationary and moving parts of equipment whilst in relation to about mentioned

external forces.

o) Testing of equipment

- making the first prototype using any kind of material available
- carrying out the first round of tests to check that equipment meets requirements as far as operation and material quality is concerned
- studying tests result together with those in previous stage
- making two project types from materials equipment to those foreseen for industrial production
- carrying out two dran of tests to check results of modifications
- giving go ahead for pre-qualification
- quality control of the same
- final go ahead for industrial production

p) Industrial production

- studying final design
- budgeting of production cycles
- identification of tools and equipment necessary for the production
- possible revision of design in view of machining requirements
- estimating investment required
- estimating fixed and variable costs
- carrying out pre-production with production materials

8. Additional technical assistance

The creation of a design, research and development centre in the field of agricultural machinery in Sudan is suggested. This centre should have the following main tasks:

- develop a national plan for agromechanization, by identifying the types and characteristics of the implements/machinery that better fit with the actual requirements of the Sudanese agriculture.
- Design and test the modifications that have to be made to imported implements/machinery to make them suitable to the prevailing Sudanese conditions
- design and develop simple/medium implements/machines specifically made to meet with local requirements
- identify the local engineering industries that could manufacture these items, train their design/production staff and provide the necessary technical assistance
- cooperate with similar agencies at national and international level.
- organize extension courses for blacksmiths and workshops that are presently involved in the production/maintenance of implements and agricultural machinery
- because a source of reference and assistance for the establishment of an engineering industry devoted to agriculture machinery in the Country.

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THE STATUS OF THE AGRO-MECHANIZATION

AND OF THE RELEVANT INDUSTRY

IN TANZANIA

SUMMARY

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5.2 Centre for agricultural mechanization and rural technology CAMARTEC

5.3 S.I.D.O - Dar Es Salaam

6. Institutions to be assisted and equipment to be provided

7. Proposed training activities

8. Additional technical assistance

8.1 Practical tests

8.2 Visits to manufacturers and institutions

8.3 Visit to a developing country

8.4 Technical follow-up

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1. General outlook of the agricultural sector

The United Republic of Tanzania covers an area of 945,000 Km2. It comprises three main climatic regions:

- the coastal belt north of Dar-es-Salaam with annual rainfall figures ranging from 1,000 to 1,900 mm in two rainy seasons
- the region bordering Lake Victoria, with lower (750 to 1000 mm/year) and almost uniformely distributed rainfall
- the northern and southern mountain areas, the central plateau and the coastal zone to the south of Dar-es-Salaam, where heavy rainfall concentrates between December and April (between 750-1.250 mm/year in the mountain areas, and 250-750 mm/year in the rest).

The country has two great catchment basins, one of them oriented towards Lake Tanganyka and the other towards the Indian Ocean.

The total population reaches approx. 18,000,000, very unevently distributed, with an average density of 19 inhabitants/Km2. The annual growth rate is 2%.

About 90% of the population are peasants.

The arable surface has been estimated at about 10 Million ha, of which only 6 actually cultivated.

Government forecasts show an annual increase of cultivated land of 5%.

Approx 2.2% of the cultivated areas are irrigated (133,000 ha) with a forecasted annual increase of 10,000 ha. Agriculture is extremely diversified owing to the special climatic and geolocical characteristics of the country.

Table 1 shows the major crops, the surface occupied by each of them, global and single production figures for the period 1969-71 and for 1981.

We can gather from it that, during the mentioned period, production has remained generally constant, which means a tangible decrease, comparatively, per inhabitant, especially with regard to some crops (maize, cotton, sisal, etc.)

Situation gradually improved and the 1984-1985 results seem quite provvising.

2. Agriculture mechanization in Tanzania

2.1 General aspects

Tanzania's agricultural mechanization is still essentially based upon manual farming by means of hoes. Approx. 80-85% of the land is farmed in this way. On-drawing is limited to some areas traditionally devoted to cattle-breeding. It affects about 10-15% of the arable land but it is increasing rapidly with the larger availability of ploughs.

Nevertheless, only a small part of the livestock (3-4%) is used in farming. Tractors are used in the revamping 5% of cultivated land. The use of automatic harvesting machines is quite negligible.

All the same and with regards to sugar cane, machine are to be partially used to get over difficulty of finding cutters in some harvesting periods, while some state-controlled cereal farms (NAFCO)

normally use combine harvesters.

Since small farms are so numerous, it will be evidently necessary to develop mechanization, mainly ox-drawn and, eventually, the use of engine driven cultivators.

All the studies carried out on this subject agree on this fact.

A World Bank report (1), analyzing a sample of 290 individual holdings, shows that hire service would be justified only in 11% of the cases using a tractor.

This report emphasizes, however, that ox-drawing is still the best solution.

This policy is universally shared, even at government level.

In fact, the use of tractors is only recommended where favourable conditions can be found, since large scale farming system are conditioned by the availability of spare parts, training programmes for maintenance and selection of implements.

Note 1: appropriate technology in Tanzania agriculture: some empirical and policy conclusions (1977).

Therefore, successive priorities will be:

. local manufacture of improved hand tools and ox-drawn implements;

. small processing machines;

. tractor mechanization (2)

T A B L E N.1

MAIN CROPS (FROM FAO)

CROPS	1969 - 1971 AREA	1969 - 1971 PRODUCTION	1969 - 1971 YIELD	1981 AREA	1981 PRODUCTION	1981 YIELD
Wheat	59,000	65,000	1,113	50,000	70,000	1,400
Rice	114,000	172,000	1,189	150,000	200,000	1,333
Maize	1,005,000	817,000	813	1,300,000	750,000	577
Millet	211,000	140,000	663	220,000	140,000	636
Sweet potatoes	39,000	234,000	6,053	53,000	330,000	6,226
Cassava	695,000	3,373,000	4,854	950,000	4,650,000	4,894
Groundnuts in shell	49,000	32,000	662	94,000	56,000	596
Sunflower seed	30,000	13,000	426	80,000	40,000	500
Sesame seed	43,000	11,000	260	260	55,000	15,000
Seed cotton	425,000	210,000	490	378,000	167,000	442
Sugar cane	39,000	1,141,000	29,600	42,000	1,287,000	30,600
Bananas	-	539,000	-	-	790,000	-
Cashewnuts	-	109,800		-	72,280	-
Coffee	107,000	49,000	459	110,000	68,000	618
Tea	10,000	9,000	897	18,000	10,000	914
Sisal	240,000	198,000	824	140,000	81,000	579
Cotton lint	-	71,000	-	-	57,000	-
Tobacco	19,000	12,000	657	32,000	21,000	647

2.2 Hand tools

No certain data are available on the quality and importance of the demand of hand tools since, together with national production and imports, there is a noticeable contribution of artisanal products at village level.

An appraisal founded on the number of units for each enterprise and on the average life of some tools leads to the figures shown on Table 2.

Note 2: It should be noticed, too, that a document (Structural Adjustment Programme 82/83/84/85, June 82) gives priority to animal drawing as the basis for the development of the agricultural mechanization in Tanzania (see Table n.2).

The Ministry of Industry and N.D.C. (National Development Corporation) estimates the following yearly need for the most common hand tools:

Hoes	4,800,000	units
Matchets	4,400,000	units
Axes	745,000	
Showels	310,000	
Grass slashers	130,000	

2.3 Animal drawn tools

An important future development has been foreseen for this sector. Indeed the passage from handwork to animal drawing allows to increase eight times the arable surface and besides, is economically acceptable to the farmers.

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Nevertheless, since we are dealing with a traditionally pastoral population, we must keep in mind that the peasants have scarcely any knowledge of this agricultural technique and even the necessary tools are not easily found in the market.

These reasons may explain why oxenisation has had no easy development up to now, even though about 60% of the cultivated land allows the use of animal drawn tools.

These tools, then, are particularly present in the Shinyanga, Tabora, Singida and Arusha regions where approx. 8 - 15% of the cattle is used to that purpose.

This cannot be said of many other regions where that figure does not even reach 1%.

There are about 100-150,000 ploughs and lower quantities of harrows, planters, cultivators, carts, etc.

The annual requirements of ploughs and other ox-drawn implements have been estimated at approx. 40,000 units.

Local production is now very close to satisfy the demand considering the new production units and the fact that UFI (the largest factory in the country) has considerably increased its output up to 20,000 ploughs/year (in 1982 the prtoduction was 12,000 units only).

TABLE 2 - MAIN HAND TOOLS - QUANTITY PRESENTLY AVAILABLE

TYPE	QUANTITY (x 1000)	AVERAGE LIFE (Years)	UNIT PER FARM (Pieces)
- Hoes	8,500	3 - 4	3.1
- Matches	4,900	4 - 5	1.5
- Axes	3,700	4 - 5	1

2.4 Tractors and related implements

There are presently approx. 10,000 tractors (the Ministry of Agriculture supplied the figure of 8952 registered in 1982, 4396 of which are out of use) from a varied range of manufacturers, equally distributed among state, government-controlled and private enterprises. It has been estimated, though, that 50% of them cannot be used, since they are out of order or lack spare parts.

The average power of the tractors is 55 to 70 HP, but in some instances (large government-controlled farms) big articulated tractors are used.

They can even reach 270 HP and are employed when large size implements (especially chisels) are necessary. The average annual utilization (about 400 hours) is widely under the optimum. Moreover, it can be assumed that most of the time they are not used in strictly farming operations but for transports on short and middle-lenght distances.

The situation is now improving because of the start of production of the VAL MET modul 604 tractor by TRAMA. Already more than 1,000 tractors have been assembled less than 3 years.

Yet the output of the plant is not enough to meet plants that account for an average need of 1,500 tractors per year from 1985 through 1988.

2.5 Harvesting machines and processing machines for treatment of products

Harvesting is presently a wholly manual operation. There is only the

exception of some large wheat farms under the management of NAFCO (National Food Corporation) which avail themselves of about a hundred combined harvesters.

A similar situation affects the first tretament of products. Treshers, shellers, mills, etc. have been estimated at about 2000-3000 units, manually and sometimes mechanically operated. This sort of machinery is being distributed to the T.R.D.B. (Tanzanian Rural Development Bank) cooperative villages by means of low-interest rate financing. The aim would be to supply each one the 8229 established villages with a product treatment unit.

The present production (approx. 1000 units per year) comes from 6-7 different manufacturers. These are mostly artisans and small private workshops whose output does not cover demands.

2.6 Mid-level mechanization

There is no important example of the application and experimentation of power tillers and simplified low-power tractors (1-20) able to farm on a surface of 10-12 ha.

Such a degree of mechanization, however, between animal drawing and conventional mechanization could easily be introduced in the country together with the related implements, thus allowing the development of areas not especially suited for cattle-breeding (tse-tse infested areas).

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TABLE N. 4

DEMAND - SUPPLY BALANCE

(Number '000)

HAND TOOLS

ITEM	1985	1986	1988
1. Hoes			
Demand	4800	4890	5100
UFI	2400	2400	2400
Mbeya Plant	750	750	750
Mwanza Plant	60	80	100
Supply Gap	1590	1660	1850
2. Matchets			
Demand	4400	4430	4660
UFI	300	300	300
Mbeya Plant	900	900	900
Mwanza Plant	48	64	80
Supply Gap	3152	3216	3380
3. Grass Slashers			
Demand	130	140	160
UFI	60	60	60
Mbeya plant	-	-	-
Mwanza plant	-	-	-
Supply gap	70	80	100
4. Hand sprayer			
Demand	33	36	40
UFI	-	-	-
Mbeya plant	20	20	20
Mwanza plant	6	8	10
Supply gap	7	8	10
5. Spade			
Demand	310	340	415
UFI	-	-	-
Mbeya plant	-	-	-
Mwanza plant	63	84	105
Supply gap	247	256	310

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TABLE N. 5

DEMAND - SUPPLY BALANCE

(Number '000)

ANIMAL DRAWN IMPLEMENTS

ITEM	1985	1986	1988
1. Plough			
Demand	87000	94000	109000
UFI	20000	20000	20000
Mbeya plant	10000	10000	10000
Mwanza plant	6000	8000	10000
Supply gap	51000	56000	68000
2. Harrow			
Demand	2265	2490	2740
UFI	-	-	-
Mbeya plant	1000	1000	1000
Mwanza plant	2400	3200	4000
Supply gap	-	-	-
3. Ridgers			
Demand	870	910	1000
UFI	-	-	-
Mbeya plant	-	-	-
Mwanza plant	-	-	-
Supply gap	870	910	1000
4. Cultivators			
Demand	985	1085	1300
UFI	-	-	-
Mbeya plant	-	-	-
Mwanza plant	2400	3200	4000
Supply gap	-	-	-
5. Planters			
Demand	2265	2490	2740
UFI	-	-	-
Mbeya plant	-	-	-
Mwanza plant	1200	1600	2000
Supply gap	1065	890	740

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TABLE N. 6

DEMAND - SUPPLY BALANCE

(Number '000)

TRACTOR DRAWN IMPLEMENTS

ITEM	1985	1986	1988
1. Plough			
Demand	1700	1800	1900
UFI	-	-	-
Mbeya plant	800	800	800
Mwanza plant	600	800	1000
Supply gap	300	200	100
2. Harrow			
Demand	740	780	920
UFI	-	-	-
Mbeya plant	500	500	500
Mwanza plant	660	880	1100
Supply gap	-	-	-
3. Cultivators			
Demand	460	530	700
UFI	-	-	-
Mbeya plant	200	200	200
Mwanza plant	595	794	993
Supply gap	-	-	-
4. Furrowers			
Demand	1700	1800	1900
UFI	-	-	-
Mbeya plant	-	-	-
Mwanza plant	786	1048	1310
Supply gap	914	752	590
5. Seed drills			
Demand	10	10	10
UFI	-	-	-
Mbeya plant	-	-	-
Mwanza plant	-	-	-
Supply gap	10	10	10

6. Shellers

Demand	260	260	260
UFI	-	-	-
Mbeya plant	-	-	-
Mwanza plant	-	-	-
Supply gap	260	260	260

7. Planters

Demand	240	260	290
UFI	-	-	-
Mbeya plant	-	-	-
Mwanza plant	300	400	500
Supply gap	-	-	-

3. The present status of the industry of agricultural machinery

The present situation of the sector can be outlined as follows:

3.1 Hand tools and ox drawn implements

Local production has developped lastly since the late sixties and includes various types of hoes, axes, matches, grass slashers, knives, ox ploughs, harrows, cultivators.

The great majority of the products comes from one industrial plant (Ubungo Farm Implements Co. Ltd located in Dar Es Salaam). Nevertheless, there is a number of minor manufacturers at artisan level which offer a more diversified range of tools (e.g. specific types of hoes). There is scarce information about the artisanal sector but it seems represented by village blacksmiths evenly distributed all over the regions.

According to figures elaborated by the Ministry of Industries there are 14.000 blacksmiths and 70 artisan groups.

Furthermore two new industrial plants were built in Mbeya (4,000 tons/year when at full production rate) and in Mwanza (4,600 tons/year). Information on some of the main producers of hand tools and ox drawn implements are provided in the following paragraphs.

3.1.1 UFI, Ubungo Farm Implements Manufacturing Co.

UFI is presently the largest manufacture of farm implements in the country. It is state own and it was established in 1968 with the assistance of the People's Republic of China that supplied equipment

and technical know-how.

The production of UFI includes:

- hoes : 2.4 Million pieces/year
- Ox drawn plough : 20,000 pieces/year
- Grass slashers : 12,000 pieces/year

With this production volume UFI can satisfy a large portion of the present apparent demand of hoes and ploughs.

The factory has the following production lines:

- 2 lines of production (alternating hoes and other parts)
- 1 machine shop
- 1 foundry (earth casting with one cupola)
- 1 plough assembling section
- 1 quality control laboratory

The machinery and equipment installed are obsolete but simple to operate and to maintain.

3.1.2 TEMI, Farm Implements, Arusha

TEMI is a private own company and produce animal drawn multirole tool bars (plough, planter, cultivator) and carts.

TEMI is receiving assistance by U.S. Aid within the Integrated rural development programme. The factory has been built in 1982.

The production programme is:

- 650 carts/year (produced as kit and delivered not assembled)
- 500 tool bar/year
- 2,000 shares/year as spare parts (made of mild steel)

They have designed and produced the prototypes that have been tested for two years in the Arusha region (implements have been given to local farmers for practical testing).

TEMI has purpousely modified the original tool bars design to make them suitable for the use of the mould boards produced by UFI (nice example of standardization).

Main production equipment include:

- 4 machine tools
- 1 furnace
- 1 small foundry operating with pig iron scraps.

3.1.3 Mbeya Farm Implement project, Mbeya

The plant has started production in 1983. It will produce (beside tractor drawn equipment):

- hand tools

. jembes	750,000 pieces/year
. pangas	900,000 pieces/year
. axes	250,000 pieces/year
. pick-axes	20,000 pieces/year
. sickles	75,000 pieces/year
. shovels	50,000 pieces/year
. hand sprayers	20,000 pieces/year

for approx. 2815 Tons/year

- animal drawn implements

. mould boards ploughs 10,000 pieces/year

. harrows (6 discs) 1,000 pieces/year

. plough spares

At full capacity operation the plant has a staff of 400.

The factory has been built with Indian know-how.

3.1.4 Mwanza, farm implements plant, Mwanza

The factory produces the following items:

- hand tools (spades, picks, crescent hoes, hoes, panga, broad axes, hand operated sprayers) for a total of 559 tons.
- Animal drawn equipment:
  - . plough 10,000 pieces/year
  - . cultivator 4,000 pieces/year
  - . toothed harrow 4,000 pieces/year
  - . planters 2,000 pieces/year
- Irrigation equipment (irrigation pumps, etc).

3.2 Tractor drawn implements

Information on companies operating in this field are provided in the following paragraphes.

3.2.1 Burns and Plane, Dar Es Salaam

It is one of the largest company operating in this field (after that

at Mbeya and Mwanza; its main products are carpentry, tanks and trailers.

It can produce up to 400 units of tractors drawn trailers per year.

3.2.2 Mbeya Farm Implements project, Mbeya

Besides the production mix foreseen for the hand tools and animal drawn implements, the factory produces the following tractor drawn implement:

- disc plough	800 pieces/year
- disc harrows (12-14 discs)	500 pieces/year
- cultivators (9-11 types)	200 pieces/year
- disc spares	6,000 pieces/year

3.2.3 Mwanza farm implement plant, Mwanza

The following tractor drawn implements are produced:

- disc plough	550 pieces/year
- cultivator	490 pieces/year
- disc harrow	1,100
- planter	500 pieces/year
- furrower	1,300 pieces/year
- rotary cultivator	550
- universal coffe ploughing	275

3.3 Tractor production (assembly)

Since 1978, however, the government had been considering the possibility of establishing an assembling plant in joint-venture with the finnish firm of Valmet.

The project has been implemented through the new company of Trama which has set up its assembling facilities in Dar Es Salaam (20% Valmet, 80% State Motors Corporation).

The unit presently produced is the type 604.

The 1,000th tractor assembled in this factory has been delivered in summer 1985.

It is a modern tractor and quite advanced from the technological point of view. Its power and characteristics make it suitable for operation mainly in average size farms.

The problems that could face are mainly in the area of maintenance (some components of the tractor are sophisticated and the maintenance structure in Tanzania is not yet enough developed).

3.4 Processing machinery

A handful of small scale manufacturers have undertaken a local production of mills and other types of essential machines such as hullers, winnovers, shellers, heavy presses, of rather efficient design and anyway suited to local products.

The consultants have ascertained that these manufacturers have developed a rather high degree of selfsufficiency which makes their activity less sensitive than bigger companies one to cronical shortages (e.g. by casting some parts instead of welding them).

Moreover, the companies involved in this production are characterized by an artisan-like outlook and internal organization, being the owners designers, supervisors and administrators at the same time.

Hence, there is reason to assume that they sistematically minimizing the costs.

Only exception to this trend is the Mang'Ula Mechanical and Machine Tools Co. Ltd, originally established for supporting a major railway construction and subsequently converted to other activities.

Information on the major companies operating in this field are provided in the following paragraphs:

3.4.1 Manik engineers, Arusha

This company is privately owned and it was established in the early seventies. It is specialized in hammer mills production.

The owner is designer/manager/supervisor at the same time.

Installed machinery includes Centre lathes (5) drills (2) power hacksaws (2) guillotine (1) welding equipments and minor ones.

All the machines are either new or excellently maintened.

Total labor force consists of approximately of 20 workers of which 12 skilled or semi-skilled.

Installed capacity should enable the production of 720 mills per year in 4 different sizes.

3.4.2 United engineering works Ltd, Arusha

This company is privately owned and it was established in the late

sixties. It is now producing hammer mills and rice hullers, but previously has undertaken the production of farm implements, spring tined harrows on RAU (W. Germany) design and disk ploughs, and even some machine tools.

The machines are fairly old but nevertheless efficient: centre lathes (3) shaper (1) power presses (3) Pullmax machine (1) welding and fabrication equipments.

The UEW management found necessary to set up a pit furnace of homemade type in order to make the required castings (i.e. mills casings).

Total labour force consists of approximately (20 skilled) and 3 managers/supervisor including an Indian expatriate.

Installed capacity is enough to produce 1,200 mills per year and 360 rice hullers.

3.4.3 Daram Singh Hanspaul & Son - Arusha

This company is privately owned. Although it has been existing for many years only five years ago it has initiated the manufacturing of shellers hammer mills, huskers, winnovers.

Their machinery is rather old and some have been modified to keep the pace with the present production. A bending machine has been made and an ingenious pit furnace built ex novo.

There are 25 workers and the owner shows a versatile talent in developing and ineteresting range of machines.

B.S.H. are able to produce two models of maize shellers (one power

driven and one hand operated), one husker, one winnover, plus a number of wheel barrows and U-belts.

Annual production should reach few hundred units.

The obsolescence of the machinery is well balanced by the efforts of the company in making as many parts as possible by casting the available scrap (cast iron and aluminium).

The factory is also actively involved in the repair of any kind of agricultural machinery, including tractors and by producing many necessary spare parts.

3.4.4 M.M.M.T., Mang'Ula Mechanical and Machines Tools - Mang'Ula

The company is owned by the Tanzania Government.

The factory was originally built in 1969 by the Government of the People's Republic of China and basically aimed to provide service and repair support to the equipment used during the construction of Tanzania - Zambia railway up to 1974.

The plant has then been not utilized until 1977, when it was nationalized and used to produce spare parts for industrial machinery and automotive industry.

The plant includes the following departments:

- the foundry suitable for iron and non ferrous castings.
  The cupola has a capacity of 5 tons/day but is used only at 20-25% of the actual capacity;
- the forging shop, equipped with four pneumatic hammers of 560 Kg, 150 Kg. and 75 Kg capacity and with three oil fired heating furnaces;

- the machine tools shop is equipped with lathes of various sizes and with shaping machines, milling machines, surface grinders, boring machines, etc.;
- the maintenance shop carries out repairs of medium size and heavy vehicle as well as the production of several types of spare parts;
- the oxygen production department that is equipped with an air distillation plant, having a capacity of 100,000 cubic/meter year.

Total staff is 630.

The production level has been very low so far, and the major activities are:

- the maintenance of the equipment and vehicles of a nearby sugar mill and sugar cane plantation and the production of oxygen.

  The low utilization of the plant, in an area with no other industrial plant and with heavy logistic problem to overcome (is connected to Morogoro, the nearest town, by means of a non-paved road).

  In order to increase factory utilization, the M.M.M.T. has started the production of simple post-harvesting processing machines and of water pumps.

  Present and future production is shown in the following table.

PRESENT AND FORECAST PRODUCTION OF MMT

Product n items	1984	1985	1986
Light engineering products:			
Rice hullers (")	400	500	600
Maize grinding mills (")	240	300	360
Coffee pulpus (")	360	360	360
Water pumps (")	300	400	500
Sorghum hellers (")	30	40	50
Platform balance (")	200	300	400
Vehicles repairs (Dar -es-Salaam)	164	164	164
Spare parts:			
Automotive (1000 Shs)	6,000	7,200	7,200
Industrial (1000 Shs)	4,200	5,500	5,500
Steel structures (tons)	250	300	300
Low pressure boilers (tons)	70	80	100
Blanks (tons)	50	50	50
Oxygen (m3)	8,000	8,000	8,000

3.4.5 National Engineering Company Ltd, NECO, Dar Es Salaam

The Company operates in the field of design and production of mechanical equipment and spares, output ranging from carpentry to irrigation pumps.

It is one of the largest engineering company in Tanzania and it is equipped with a mechanical workshop, well organized, including several machine tools (vertical and horizontal lathes, pillar drill, sensitive drill, milling machines etc).

The plant is also equipped with a large foundry suitable for production of pig iron castings of weight up to 1,000 Kgs (this department has recently started the production of low head irrigation pumps, on the basis of design prepared by TEMDO).

Tanks for water, fuel etc to be trolley mounted represent an other important output of the plant.

NECO is also producing, on demand, non ferrous (bronze and aluminum) castings and their machining.

NECO is perfectly equipped to produce several kind of agricultural machinery, provided that a suitable design is provided.

NECO has its own engineering division able to industrialize a prototype but it needs more specific training particularly in the field of rationalization of parts production cycles, identification of most suitable materials etc, in order to reduce production costs and increase quality.

4. USE AND MAINTENANCE OF AGRICULTURAL MACHINERY

4.1 Operators

The total number of tractor operators existing in Tanzania is not known exactly but by knowing the number of tractors in operation it is realistic to assume that their number ranges between 6,000 and 8,000.

Tractor operators do not appear very often in statistics and they have been neglected in most of the training schemes as if they are not in need of training.

It has to be considered, to this concern, that most of the mechanical breakdowns which contribute to bring the average life of tractor down to a mere 1,000 hours, are explained with the low skill and technical knowledge of the operators.

On the other hand it has been observed that when the operators have been given a training a sudden improvement has been recordered as tractors have been running without any major breakdown for years at the respectable rate of even 1.000 hours in a year.

Considering therefore the reliability of modern tractors, the importance of daily maintenance and the high returns of this kind of training in a country where no less than 40-50% of the existing tractor are in need of repairs in spite of low hour meter readings, the urgent need for a mass level training of the operators cannot be overemphasized.

It is recorded that a scheme for the specific training of the operators was started at Nyegezi in the early seventies with some success.

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In more recent times a training programme both at theoretical and practical level has been fullfilled within the M'Kongo Agromechanization Project (Rufiji) implemented with Italian bilateral assistance.

The most common faults occuring during operation of agricultural machines affect in order of importance the following components:

- implements, due to insufficient or wrong lubrification and to careless operations in unsuitable conditions (e.g. stumpyfields).
- the hydraulic system, due to mistaken adjustment (e.g. not known use of drought/position control) and to use of unsuitable fluids (i.e. gearoils).
- three point thich, due to long off-the-road trips with the implements in working position (i.e. raised but with untightened chains and top link).
- electrical system, due to unproper battery maintenance and unawareness of alternators faults prevention (i.e. not to disconnect the alternator when the battery is removed or during welding).
- injector pump, due to delay replacement of filters and use of contaminated fuel (e.g. with some water content)
- tires due to careless operation on stumpy fields
- gearbox, due to unproper or frequent unnecessary use
- engine, due to delayed change or insufficient oil refill.

4.2 Maintenance and maintenance personnel

4.2.1 Maintenance to agricultural machinery is provided by different structures and at various levels:

- the large farms are becaming self-sufficient as far as maintenance is concerned, by implementing workshops with personnel of medium-good level.
- operators for third party, common in several regions (Mwanza, Shinjinj'anga etc), usually owning 1-2 tractors provide ordinary maintenance with the help of local artisans and blacksmiths, particulary as far as implements and processing machinery.
- agricultural machinery dealers operate a number of small maintenance workshops and few large ones at Dar Es Salaam for complete overhauling.

  Some dealers have special maintenance task forces that can operate in the countryside when local skill is not enough

4.2.2 Machinery maintenance personnel to this concern

No reliable figure are available due to eterogeneous situation caracterizing the repair facilities in the country.

In the statal and parastatal sectors, however, it seems likely the ratio mechanics/tractors to be 1 to 50.

Repairs of tractors are undertaken by a number of institution such as the Public works garages, agricultural authorities workshop, dealers firms, and often by the private owners themselves.

The origin of this mechanics seems to be eterogeneous with a

prevalence of on the job trained ones in the private sector, while in the statal/parastatal sector, where all the recruits have to undergo a trade test complying with government rules, the situation is almost opposite.

Most common sources of school training have been the technical schools, vocational training centres, technical colleges and curriculums are predominantly automotive oriented. However, if the availability of skilled labour force in the automotive repairs sector is scarce, in the agromechanical one, it is critical.

There are two institutes in Tanzania presently training personnel in the agromechanical field.

There are the M.A.T.I. (Ministry of Agriculture Training Institute) located at Nyegezi (Mwanza) and Milingano (TANGA). Theoretically the same, these institutes became increasingly differentiated since the West German assistance to Nyegezi M.A.T.I. made possible there the build up of advanced technical facilities and effective training.

On the other hand, the output of approximately 60 diplomates per year (40 from Nyegezi, 20 from Milingano) is far from having an impact).

The private firms which commercialize agricultural machinery in Tanzania are in their majority involved in other sectors as well, ranging from earth moving machinery to small cars. Generally speaking they have recycled capable mechanics by training them on the additional repair producers required by moden tractors.

With the support of their mother companies (i.e. overseas in plant training).

5. RESEARCH, DESIGN AND DEVELOPMENT

These activities, in the field of agricultural machinery, are mainly carried out by the following companies and/or institutions:

- Mang'ula mechanical and machine tools Co.
- Ubungo farm implements Ltd, Dar Es Salaam
- Centre for agricultural mechanization and rural technology, CAMARTEC, Arusha
- Tanzania Engineering and manufacturing design organization TEMDO, Arusha.

While the research, design and development activity of the two factories (M.M.M.T. and U.F.I.) are primarily devoted to implements and machinery to be produced in their factories, the other organizations are specifically operating in the design and engineering of agricultural machinery and their parts.

5.1 TEMDO - Arusha

5.1.1 Origin of TEMDO

The idea of creating an "Engineering Design Centre" to promote the development of machine design capabilities was first realised during the charting out of the country's third five year development plan (1975/76-1980/81).

The Plan also realised that lack of engineering design capabilities in industry was a serious constraint in the overall efforts towards industrialization.

The Plant therefore recommended the establishment of an Engineering Design Centre. Working on this recommendation and other subsequent studies, the Government established TEMDO through Parliament Act No. 23 of 1980 which became operational in July 1982.

TEMDO is under the Ministry of Industries and Trade.

5.1.2 Functions

The main objective of TEMDO is to design and to promote engineering design and adaptation of machinery for manufacture in Tanzania. In addition, TEMDO will provide technical consultancy services in mechanical engineering.

The detailed functions of the Organization are:

a) to design and promote the designing of products and processes for Tanzania industry in accordance with national industrial development policy;

b) to adapt foreign designe of machinery and equipment to suit local conditions of manufacture, use and maintenance;

c) to manufacture and develop prototypes and spare based on designs produced by the Organization as well as those which may be brought to the Organization;

d) to design tools, dies, jigs and fixtures required by the industrial sector;

e) to provide technical extension services including training aimed at increasing the skills of technical manpower at all levels and establishments in the country and enabling industry to produce the products or processes for mass marketing;

f) either alone or in co-operation with other bodies, to assist the industrial sector in solving production bottlenecks for the purposes of increasing productivity, capacity utilization and quality of products;

g) to provide relevant information and advice to the industrial sector relating to production, purchase and supply, quality control, marketing and other related areas;

h) to identify and conduct short courses in so far as it is within the competence and capacity of the Organization, to co-operate with other institutions in the conduct of such courses;

i) to give on-the-job training to engineers in designing, production engineering, foundry technology, metodology and metallurgy;

j) to conduct a systematic on-the-job training in tools, dies, presswork, specialized welding, design, draftsmanship (mechinical and structural machinery maintenance), and for industrial electricians and electronic technicians;

k) to offer consultancy services on material testing, metodology design and other technical undertakings;

l) to act as the national link with other international institutions engaged in activities related to the function of the Organization;

m) to do such things incidental or conductive to the fulfilment of the objectives of the Organization as the Board may decide.

5.1.3 Organization structure

For the purpose of carrying out its functions, TEMDO will be orga-

nized into FOUR directorates in addition to the office of the Director General.

These will include:

- Design Directorate
- Prototype Development and Testing Directorate
- Technical Extension Services Directorate
- Finance and Administration Directorate.

5.1.4 Location

The headquarters of TEMDO is Arusha. The Government has already allocated land for the construction of offices, workshops, laboratories and staff houses. At present the offices of TEMDO are housed at the Arusha International Conference Centre.

5.1.5 Planned staff strenght

It is planned that at full operational stage TEMDO will have a total staff strenght of 310 personnel.

Sixty percent of these will be engineers, technicians and artisans.

The other staff will consist of adiministrative personnel.

5.1.6 Facilities

TEMDO will be equipped with fully fledged design offices, workshops will as far as possible be self-contained to facilitate easy manufacture of prot[illegible] Staff houses will also be constructed.

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5.1.7 Links with other organizations

In the performance of its functions, TEMDO will, wherever possible establish close working relationship with local and foreign institutions or companies engaged in activities related to design activities or promotion of machinery design and manufacturing for exchange of information.

5.1.8 Modalities of work and financial resources

In addition to providing technical consultancy services in the field of mechanical engineering, TEMDO designs or prototypes will be passed to industry for commercial production. TEMDO will charge fees for the technical consultancy services that it will render to its clientele and it will also charge fees in the form of royalties for designs that will be passed to interested commercial manufacturers.

TEMDO will also receive funds from the Government in the form of subvention to meet development and operational expences.

5.1.9 Present staff

The technical staff is presently including six engineers, one technicians plus two egyptian engineers who provide technical assistance on a programme financed by the Egyptian Fund for Technical cooperation for Africa.

Even if TEMDO will work for a wide spectrum of industries high

priority will be given to the design, engineering and Technical assistance to the production of agricultural machinery and implements.

Additional information on TEMDO are provided in the annexe A.

5.2 Centre for agricultural mechanization and rural technology CAMARTEC

The centre for Agricultural Mechanization and Rural Technology (CAMARTEC) was established by an Act of Parliament in November, 1981. The aim of the centre is to improve the quality of rural life through development, adaptation and implementation of appropriate technologies in the fields of agricultural mechanization water supply, building construction and sanitation rural transport and energy.

CAMARTEC which officially started its operation in July 1982 is a merger of two saparate Institutions one formerly known as Tanzania Agricultural Machinery Testing Unit (TAMTU) and Arusha Appropriate Technology Project (AATP). TAMTU used to test agricultural machinery for their suitability to Tanzania conditions. TAMTU activities date back from 1955.

AATP was started in 1977 as a project under Small Industries Development Organization (SIDO). The functions of the project were to do research and development in building materials, rural transportationn energy and water supply. Both institutions apart from their station activities, had extension and production responsibilities to ensure that the developed technology reaches the people

in the field.

The Centre is located in Arusha region, northern Tanzania. The centre is 16 Kilometers from Arusha municipality on the Old Moshi Arusha road and railway. The location of the centre offers a good working environment with cool temperatures and average rainfall. Located on 80 hectares of level land, there is enough room for residential area, offices, workshops, testing ground and recreation.

5.2.1 Function of the centre

The functions of the centre include:

a) to carry out applied research designed to facilitate the designing, adaptation and development of machinery and equipment suitable for use in agricultural and rural development.

b) to develop and manufacture approved prototypes, components and cultural tecniques and technologies, and evaluate their suitability for local adaptation;

c) to adopt foreign designs of agricultural machinery and equipment to suit local conditions of manufacture and maintenance.

d) to perform tests on all types of machinery and equipment intended for use in agricultural and rural development in the United Republic and to publish their results.

e) to conduct short training courses designed to provide practical training and knowledge to village communities in the use and maintenance of agricultural machinery and other appropriate technology devices.

f) to offer consultancy services on the designing, testing and other technical aspects of agricultural mechanization.

g) to act as the National link with other national and international institutions engaged in activities related to the functions of the centre.

5.2.2 Organizational structure

The centre is a parastatal organization under the Ministry of Industries. The running of the centre is directed by the Board of Directors under a Chairman appointed by the President of the United Republic of Tanzania.

The day to day management of the centre is directed by the Director General also appointed by the President.

There are three directorates under the Director General; these include:

a) Directorate of Technology Development

b) Directorate of Testing and Production

c) Directorate of Extension and Training

5.2.3 Services offered

The centre has quite a number of proven technologies in the fields of Agricultural Mechanization and Rural Technology which can be adopted for use any where in Tanzania. The centre can presently offer both centre-based and field training as well as consultancy services for the production and the use of:

a) Farm implements

1. Hand planter
2. Cultivator
3. Kifaru plough
4. Seed attachment
5. Kifaru plough with seed attachment
6. Ground nut sheller
7. Winnover
8. Spike tooth harrow

b) Rural transportation

1. Ox-cart with pneumatic wheels
2. Ox-cart with metal wheels
3. Complete axle with pneumatic wheels
4. Ox-cart accessories with pneumatic wheels
5. Complete set for ox-cart accessories with metal wheels
6. Donkey cart
7. Hand cart
8. Wooden wheel-barrow
9. Metal wheel barrow

c) Low cost house construction

1. Cinva ram machine

d) Water

1. Ferro cement tank for water catchment and storage
2. Hand pump
3. Rope washer pump

4. Cement water jar
5. Windmill

c) Energy

1. Bio-gas designs and gas holders
2. Solar water heaters and driers

5.2.4 The main activity of CAMARTEC is the Extension Service for the farmers in various villages and it operates in two directions:
The introduction of new, but simple tools (as for instance the manually driven water pumps, the wheelbarrows, the bycicle or animal driven cart, the production and use of bio-gas) and the realization, with simple means, using cheap and easy available materials of already known and used machines (as the wooden beam plow, the irrigation water pump, made mainly of wood.

For this reason the Directorate of Technology Development is divided in two Sections:

a) Section for Agricultural Mechanization
b) Section for Rural Technology

It is a practical type training carried out in two main forms:

- The first called Central Training and consists in concentrating a certain number of farmers having interest in new equipment and/or machines designed and developed by CAMARTEC (an exemple is the

bio-gas producing unit developed by CAMARTEC and already reproduced in considerable number for use in villages both for lighting and cooking). During this training the characteristics and the operation of the equipment in subject are discussed.

- The second type of training, rural training, is more or less a form of extension.
  CAMARTEC experts visit the villages, carry out tests on equipment and train local peasants to carry out maintenance and repairs on machines already in use, tractors included.

CAMARTEC does not provide to village blacksmiths and workshops the blueprints of the equipment designed, because the recepients have not enough technological capability; it supplies the artisans with samples that are then copied in the various villages.
Drawings prepared by CAMARTEC are of course always available from file.
CAMARTEC activity covers the whole country, even if obviously concentrated, for the time being, in the Arusha region; the establishment of CAMAPTEC subsidiaries in the various regions is now under consideration.
CAMARTEC is also accomplishing the testing on the imported tractors and agricultural machinery.
As a general impression the consultant feels that the CAMARTEC personnel have good specific knowledge and are able to obtain fair results in spite of the scarce means.

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5.3 S.I.D.O. - Dar es Salaam

The small Industries Development Organization is not directly involved in the field of design and development of industrial products but plays an important role in the development of the small medium sizes industry in Tanzania by providing low-interest financing as well as technical assistance in several fields (like maintenance).

It is backed by SIDA that is also engaged in organizing transfer of know- how from similar Swedish companies.

The SIDO, that has a staff of 35 experts, organizes also training courses meetings, on specific topics and finances training abroad.

SIDO is also planning to expand the training activity by cooperating with existing infrastructures (National Vocational Centres, Technical Colleges etc.).

5. Institutions to be assisted and equipment to be provided

The institution that have been selected for this project are:

- Tanzania Engineering and manufacturing Design Organization, TAMDO
- Centre for agricultural mechanization and rural technology, CAMARTEC

As described in the previous paragraphes, both institutions are active in the field of design and engineering of agricultural machinery and implements.

The equipment proposed are:

Drafting tables complete with adjustable chair to use in design offices. Size 62x103 cm.

Suppliers: Zucco (Italy) or equivalent.

Drafting tables complete with adjustable chair. Track type with base cabinets to use in design offices. Size 100x200 cm.

Suppliers: Zucco (Italy) or equivalent.

Drawing copying machine (to prepare blue prints), ammonia or ammonia free operation - working width 120 cm.

Suppplier: Océ (Holland) or equivalent.

Storage cabinets for drawings storing Flat-plan type.

Size A1 and A0.

Suppliers: Neolt or Facomet (Italy) or equivalent.

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Drawing filing cabinets for storing drawings - Vertical type. Size A1 A0

Suppliers: as above.

Photostating machine for copying drawings. Automatic toner control: Model DD 5511 Toshiba or equivalent.

Reports, trimming and binding equipment for binding design reports up to 30 cm. length.

Supplier: GBC (Germany).

Projector for transparent drawings: size A4 for educational or demonstration purposes.

Supplier: 3M (USA)

Film projector 16 mm. for educational or demonstration purposes.

Calculators scientific for use by design engineers.

SHARP EL - 5101 (Casio FX 710 P) or equivalent.

Drawing equipment/instruments - Drawing instruments sets; other drawing aids. For use by engineers and draughtsmen.

Tracing paper for tracing drawings - Rolls size A1 and A0.

Blue printing paper for producing drawings blue prints.

Rolls Size A4 A1 and A0.

Transparent paper for use with projector (Item n. 8)

Reams: size A4.

Personal computer for engineering design work complete with video set and printer, 300-500 Kbyte memory.

Suppliers: Hewelett Packard, Olivetti, Apple or equivalent.

Video recorder VHS system portable type for playing educational programmes.

Suppliers: Sony, Hitachi, Grundig or equivalent.

Video camera VHS system portable type for photographing live educational programmes in industry.

Suppliers: as above.

Video cassettes for recording educational programmes.

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CONSULTING ENGINEERS

Design office reference handbook

1. Mark's standard handbook for mechanical engineers
2. Materials handbook
3. Fluid power transmission HB
4. Material handling library
5. STD HB for fastening and joining
6. Pump HB
7. Tool and manufacturing engineers HB
8. Metal forming HB
9. American machinists HB
10. Machinery HB
11. HB of plastics and elastomers
12. Paint HB
13. Engineering calculation HB
14. Lubrification engineering
15. STD HB for electrical engineers
16. Maintenance engineering HB
17. Handbook of fixture design
18. Die design HB
19. Techniques of pressworking sheet metal
20. Plastic tooling and manufacturing handbook
21. Fundamentals of tool design
22. Chemical engineers HB
23. Industrial engineering HB
24. HB of practical gear design
25. HB of hydraulics
26. Process instruments and controls HB

The handbooks are all obtainable from:

Lineal Publishing Company

23 Leroy Avenue

Darien, CT 06820, U.S.A.

Tel. 203 - 655 - 7676

Telex 643 - 438 Lineal Co. Darn.

B. Equipment for "Centre for agricultural mechanization and rural technology - CAMARTEC

B.1 Audio visual equipment for training including:

- video camera
- portable recorder
- TV set
- video cassets, 60 pieces
- film projector 35 mm
- camera, reflex 35 mm

B.2 Library materials

The same already listed for TEMDO

B.3 Training machinery and equipment

- sedimentation analysis equipment complete with glass cylinder 1000 MLS with marks for particle size distribution, rubber stopper, soil hydrometer, graduated 0.995 to 1.030, monographic chart for determination of "stoke law".

- continuous arc welding equipment

- stop watches 4 pieces
- grooving tool (with setting gauge)

In addition CAMARTEC would like to receive a mobile workshop equipped with simple machines and tools for maintenance of agromachinery in the field. We think that it would be useful but probably too expensive (over 15,000 DOLL.) and not completely within the scope of this project. If funds are avilable a reconditioned second hand unit could be considered. CAMARTEC already agreed on this idea.

7. Proposed training activities

Two design engineers, one belonging to TEMDO and one to CAMARTEC will be exposed to a specific training in the design and production of medium and small scale agricultural machinery and implements These engineers will be trained also in training methodology so that can organize, in town, their own courses.

The courses have to be held in such a manner as to instill not only the basic of designing itself, but also the principles of material and operation testing as well as knowledge about marketing and products.

The courses will last one-two months and should deal with the following main topics:

a) Hints for design

- the implements as a part of a system

- the systematic approach of the development of a technical product; the special model
- the accelerating development work in the Third World
- strategies of the acceleration of the process of innovation
- basic conditions
- the different aspects of "quality"

b) a strategy of mechanization
   - introduction
   - definition of the role of mechanization;
   - the need of a strategy
   - planning: elements, process, objectives, goals, determination
   - policy-issue: development and integration

c) the design of an agricultural machinery versus agricultural conditions and soil characteristics

d) special items on engineering design
   design and heat treatement
   - design of castings
   - directives for engineering point and details, from the point of view of material, manufacturing and use, on the aspects of availability, cost, waste [illegible] ies, surface and enviromental influences

e) ergonomics in machine d[illegible]
   - theory and application
   - application exercises in the drawing room

f) materials

- iron steel, cast iron and other metals, plastics
- mechanical properties and tests: composition, breaking point, fatigue resistance to chemicals and temperature.

g) pumping and pumps

- definition of viscosity (Newton), Poiseuille-current, Reynolds number, resistance pipe system, calculation of pump pressure and need of power
- calculation of a screwpump, design approach

h) transmissions

- theory and comparison of beltdrive, V-belt drive, chain drive timing belt drive
- theory of the propeller shaft

j) workshop technology

- contributory processes
- metal cutting and machining
- Jigs and fixtures
- numerical control

k) the use of renewable sources of energy and other non oil based fuels.

l) general machanics

- basic principles of endothermic motors

- basic principles of electric motors
- basic principles of transmission system from driving to output unit
- defining external forces acting or the equipment and the consequent interrelating forces between compontnt parts
- basic principles for calculating these parts
- analysis of experimental data

m) definition of characteristics of equipment

- definition required function and working conditions
- collecting information concerning analogue equipment on the market and examining the same
- analysis technical solutions adopted and technology employed on machines operating in ancillary sectors, outlines of basic characteristics of the equipment

n) designing of equipment

- studying theory of general machine design
- defining external forces acting on driving or working parts
- calculating the internal forces acting on both stationary and moving parts of equipment whilst working in relation to about mentioned external forces
- determining dimension of different parts of equipment
- designing the same
- redesigning as a result of initial test data
- drawing-up final plans after second test phase

o) testing of equipment

- making the first prototype using any kind of material available
- carrying out the first round of tests to check that equipment meets requirements as far as operation and material quality is concerned
- studying tests result together with those in previous stage
- making two project types from materials equipment to those foreseen for industrial production
- carrying out two drawn of tests to check results of modifications
- giving go ahead for pre-qualification
- quality control of the same
- final go ahead for industrial production

p) industrial production

- studying final design
- budgeting of production cycles
- identification of tools and equipment necessary for the production
- possible revision of design in view of machining requirements
- estimating investment required
- estimating fixed and variable costs
- carrying out pre-production with production materials

8. Additional technical assistance

Both institutions need to train at least two more engineers. In addition all trainers should carry out the following recommended activities:

8.1 Practical tests

The training programme to be conducted in a foreign institution should include also some practical tests to be carried out on various types of machinery. Some of the suggested test are indicated below:

- drawn bar test to evaluate the tractor's drawnbar performance in accordance to slip and specific fuel-consumption
- P.T.O. test to evalutate the pto performance in accordance to the specific fuel-consumption of the given tractor
- I.C. engine testing
  test of the engine with variable compression ratio to find the relation between compression and specific fuel consumption
- pump test
  test of a pump turbine
- etc

8.2 Visits to manufacturers and institutions

Some visits should be organized to:

- manufacturers of agricultural machinery and implements
- agricultural machinery testing institutes
- laboratories of agricultural engineering department of universities.

8.3 Visit to a developing country

It is suggested that at the end of the course the trainees, together with two of the lectrurers will visit a number of industries and agencies in a developing country where the agricultural machinery field is particularly large. India could be selected because this country has developed appropriate technology in this field and has also supplied design of agricultural technology implements to various countries including Tanzania.

The study tour shuold last two weeks and should include:

- major institutions devoted to agro-mechanization design, experimentation and testing
- major industries invlolved in agriculture equipment engineering and production
- major engineering industries producing spare parts for the agriculture machinery.

8.4 Technical follow-up

Once the trainees have returned back to their institutions they will need some technical follow-up to better apply the fundamentals they got during the training to specific topics related to their day to day duty. For this resason it is suggested that two experts in agro-equipment design, production and testing will be posted in each country for a period of six months. One experts will focus his attention on the production aspects while the second will deal with

testing, identification of most appropriate design chacacteristics etc.

Main goals for this mission would be:

- to provide technical expertise to solve specific application problems together with the trainees;
- to lecture local medium rank engineers on some topics like product engineering, quality control, testing procedures etc
- to revise together with the trainees, the design of some machinery and/or implements currently manufactured, introducing where possible and needed, improvements to semplify their production and/or to make them more suitable to local conditions
- to provide necessary inputs and technological back-up to improve existing production systems, quality control and routine maintenance procedures
- to organize a workshop to the Government decision makers to revise major guidelines of agricultural machinery application in the country and identify the most appropriate level of agro-mechanization in the country.