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AGRICULTURAL MACHINERY: CASE STUDIES OF ETHIOPIA, MOROCCO AND ZIMBABWE*

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Summary

Agriculture in Africa is permanently facing a number of technological problems, which are not necessarily always common to all countries, however, there are some common situation that can be found as affecting most of the continent.

These are in the fields of mechanization that is not yet widely applied and to the limited access to industrially produced implements, that a large portion of the peasants population, still has, whether in the field of animal drawn equipment or hand tools, due to their inability to produce surplus in their farming production, an exception can be made with the northern countries, where mechanization is more widely implemented.

Another most important reason is the continues loss of agricultural land caused by land erosion, which is being helped by the large deforestation and by the minimum irrigation schemes that exist in those countries.

As for the mechanization, the general situation looks in the continent as follows:

Tractors.

The agriculture in Africa is, with only very few exceptions, wholly dependant on imported tractors, the production in some places is only limited to local assembly

from SKD or CKD packages, which is not helping to promote the local manufacture of parts and is only producing higher purchases costs for the farmers, thus, the objectives of installing assembly plants are not being obtained.

Implements.

Mechanization, although, intensive in some farming areas in some countries, has not yet changed the general pattern of the demand, that continues being mostly dependant on animal drawn equipment and hand tools, due to the fact that the largest portion of the farming population is still working in smaller farms poorly rainfed.

The supply, in those types of equipment, is being satisfied by some locally well established manufacturers, who are capable of producing good quality implements, but, still is greatly dependant in the local village blacksmiths working many a time with scrap material, if the formerly mentioned formal manufacturers do not expand their facilities to produce more quantities, it is because the market does not seem to have the capacity to buy more.

The design in actual use by those manufacturers. was almost invariably obtained many years ago, from european manufacturers and corresponds to technologies that was used in that continent, last century or is at least 50 years old, this, however, is by no means a detriment to be consider appropriate for the farmers, who use them daily satisfactorily.

Maintenance.

This is an aspect that always affects the mechanized sectors of agriculture, the lack of spare parts and the insufficiently trained technicians, creates a permanent problem, for the obtention of proper and on time repairs.

The lack or defficient supply of spare parts is mainly due to the heavy limitations imposed by the scarcity of foreign exchange and very often, also, due to inefficient management or administration of the stocks, that under those circumstances where the distance from the sources of supply impose even more difficulties, require to be a lot more technical, that what it would be otherwise.

Land use.

The land has to be preserved from further deterioration, for which it will be necessary to start most active reforestation projects and to be able to use more lands, poorly rainfed, it appears as the only viable solution to start implementing projects for irrigation using the underground water, that, according to opinions received from different experts, is quite abundant in most african subsoils.

The use of subsoil waters, always bring general concern among people that some way or another have been able to receive reports of water tables going dangerously down after some years of application, however, there is today

enough technical knowledge to evaluate, not only the resources available at any given moment in any one place, but, also to evaluate the replenishment of those water tables. Such is the case of Morocco, that with the aid of a US satellite now can have a map of the country showing the underground water resources, and with the aid of funds from the PNUD are at the moment evaluating the water resources of the country, not only on rivers and lagoons, for dam building or other more conventionnal irrigation schemes, but also for replenishment of the underground water tables.

However, once the underground water resources have been evaluated, it will be necessary to prepare the appropriate bore holes and to install the pumping systems, but in turn, this will create a new situation, where, the energy requirements will have to be made available.

The energy, poses a major problem for almost all african countries, where, they are either dependent on hydropower, that although it could be made abundant in some countries, it will still take a long time before it can be made available, or, almost invariably they are net importers of petrol with large expenditures of foreign exchange.

The explotation of those water resources, will still be a major endeavour for those countries, even in the case of hydropower or thermally generated electricity availability, the transmission lines would have to reach the farm lands, generally away from the urban areas, will demand important investments that the countries can not do today, only to

supply relatively small power requirements of a few hundred kilowats.

Under these circumstances, alternate sorces of energy will have to be applied, and there appears as if the only viable solution is to use the wind energy, to generate elctricity.

There are good reasons to believe that the resources are available, the records of wind activity in some areas prove it, although, almost inevitably taken near the urban areas purely for climatological forecasting.

According to those records, average speeds of 20 km/hr or more can be obtained in many areas, enough to obtain, with well designed large windmills 250 kw and more, sufficient energy to pump enough water to irrigate an important farm size all the year round.

This possibility is open to all african countries and it will be necessary to prepare new records in especially selected areas, with the aims of generating electricity within or near the areas most suitable for farming development, with the use of underground waters.

Research and development of agricultural implements.

It has also been observed, that most african countries maintain, research centres for evaluation of agricultural equipment, including tractors and implements, tractor and animal drawn, and also for manual tools, however, it must be highlighted that in only very isolated cases, the results of these investigations are being made known to the farmers or to tne people involved in the production of said implements or equipment. It seems essential that good and more effective programmes will have to be implemented, to spread that knowledge and the results of those experiences within the farming environments.

Introduction.

In accordance with the terms of the consultation contract with regards to the forum that UNIDO will hold in Africa, visits were made to thre african countries : Ethiopia, Zimbabwe and Morocco.

To comply with the requirements of the survey, during the months of May and June 1989, visits were made to government entities, farmers, local manufacturers, importers of equipment and other entities conecerned or related with the agricultural sector in those three countries.

The experiences and observations obtained during that time, are being presented in the following pages in four different section, the first has the intention of presenting a general picture of the problems that affect to those countries, and in a way could also be drawing the picture of the problems that look to be common to the continent.

Following that brief summary, a report on each one of the three countries is presented highlighting the main aspects that are related to the technological development of agricultural equipment and implements, to their supply as well as to other aspects directly connected with the technological development, required to promote the agricultural sectors.

1. ETHIOPIA

Generalities or General enviroment for agriculture.

The Land.

The country covers a total area of 1.22 million km2 with a population of approximately 47 million, where more than 85% of the population lives in rural areas. There are approximately 110.1 million hectares of agricultural land, out of which approximately 13.9 million hectares cover the arable land, including that with permanent crops.

According to verbal reports received from government officers, about 96 % of the arable land is being cultivated by the peasants sector, using old traditional means and techniques, wooden hoes in many cases or other animal drawn equipment, while only about 300,000 hectares are being cultivated with tractors and modern mechanized equipment and implements, and some even with up to date equipment, such as combines for harvesting and other heavy equipment for land preparation.

It is estimated that approximately 200,000 hectares are being worked by the Ministry of State Farms Development and the remaining 100,000 hectares by the producers cooperatives who work their own lands, in the surplus producing areas, with the assistance of the Agricultural Mechanization Services Corporation, who provides mechanization support with tractors and implements services at a fixed rental cost.

During the 1988/1989 campaign, 87,000 hectares were worked by this Corporation under the system described above, on land preparation, plowing and discharrowing.

The yield per hectare for approximately 94 % of the land under cultivation is well under 1 ton per year and for the remaining 6 % it only goes as high as 1.5 tons per year.(a)

note (a): Source: Ministry of Agriculture.

Education.

The low productivity is attributed in many ways but not only, to the general low level of education in the whole country and in particular in the rural areas where only minimal or no education at all is provided.

The modern technology is almost non existent in the rural areas and in the urban cities only a limited number of students have access to higher levels of education and not always to up to date standards, this general low level in the proffesional population is reflected in the poor scientific agricultural management.

There is a general complain at all levels of management and at government entities concerned, that the level of skill of technicians, in all areas required in the country and in particular in the agricultural sector, is extremely low,

this includes tractor operators, mechanics and maintenance personnel in general.

Transports and Communications.

The transport and communications system of a country play a most important role in the agriculture, especially the road transport without which assistance the agricultural supplies such as seeds, fertilizers and chemicals will become costly and difficult to obtain and the products will, very often, not be able to be moved to the markets on time.

The paved roads in the country are limited to the urban areas and to a few intercity highways, leaving most of the country and the rural areas in particular, where most of the agricultural activities are taking place, innaccesible by road of any type.

The vehicles are insufficient and unable to attend all the country transportation needs.

Other important communications system such as telephones, required for todays economic activities are insufficient and of low efficiency, leaving some most important offices for the agricultural activity isolated from the capital or other important centres, as well as with the farmers that require their services.

No statistical figures were obtained regarding roads systems and vehicles park in the country, however the national maps differentiate the all weather roads from those that can only be used during the dry season.

As regards to railways is concerned, two lines are shown in the maps, one running from the capital Addis Abbeba to the neighbouring country Djibouti and the other up in the northern part of the country in the Asmara Region, running westwards from the coastal city of Mitsiwa.

Energy.

The energy requirements in the country are being satisfied only to cover the most basic essential needs, there exist some hydroelectrical power stations and a number of thermal power stations as well, burning coal and petrol, few are also burning sugar cane bagaze and all the needs of petrol are being satisfied by importat. ns, since the country does not count with oil or gas deposits of their own.

One of the main sources of energy, used by the peasants population to satisfy their supply problems, comes from wood burning, contributing to a great extent to the vast deforestation and soil erosion that the country is undergoing. Statistics provided by the ECA office in Addis Abbeba indicate that approximately 93 % of the forestry production of the country in 1986, equivalent to more than

37 million cubic meters were accounted for fuel wood and charcoal and mentioned consumption figures have been increasing at an average rate of 2.4 % per year since 1961.

The country has some important geothermal sources, but, still unexploited, some research is also being done for the use of other non conventional systems such as the biogas; the wind, an important source of energy that is only used in very few cases to pump water from wells to satisfy some domestic needs, the solar energy is not being used to generate electricity.

Irrigation.

No major irrigation projects or others worth mentioning have been implemented in the country during recent years and on the contrary it can be said that the country relies almost entirely on rainfalls.

Some statistics indicate that the variation of areas under irrigation has varied as follows during recent years:

year	1971	1976	1981	1986
1000 Ha	155	158	160	162

what shows that the variations ocurred have been in the low range of 0.28 % per year in average

Verbal reports have been received that there could be some very important resources of underground water that could be used for irrigation purposes, in almost all areas of the country, however, they are only used to a very limited extent by some farmers where the electricity is available near the urban areas and in some others by the use of windmills that can give only little more that what could be required to cover for domestic applications.

It has to be taken into account that the country has suffered two very recent drought periods, one that lasted two years between 1984-1985 and another minor one in 1987, and also that most of the country's territory is very badly affected by extremely serious land erosion due to rainfalls, that wash out the ground making it almost unworkable in some areas.

Equipment, machinery and implements.

The country relies for their agricultural work mostly in hand tools and implements drawn by animals, the latter being mainly oxen and donkeys, and also some mules and camels, it is reckoned that Ethiopia has one of the largest oxen population with approximately 5'000,000 heads.

The mechanization is obtained by tractors mainly in the 70 to 100 Hp range, in 4 x 2 and 4 x 4 versions.

Tractors.

According to some statistical figures obtained, the tractors park during the last years has been varying as follows:

year	1961	1965	1970	1975	1980	1985
quantity	250	800	2,913	3,600	3,950	3,900

Since August 1984, date of the inauguration of the Nazareth Tractor Assembly Plant to the end of april 1989 some 1,500 tractors have been incorporated to the park all of them of 80 HP about 40 % in the 4 x 2 version and the remaining 60 % in a 4 x 4 version, these are of USSR origin.

To date, the largest single owner of these tractors is The Agricultural Mechanization Services Corporation that has 1,244 tractors in the 75 and 100 HP ranges, 90 % of which are 100 HP, and the fleet is split in almost equal number in 4 x 4 and 4 x 2 versions. They also have some heavy units as Caterpillar and Komatsu, the latter one or two years old, used for land preparation.

The Combines.

These machines mainly harvesters and threshers are 100 % imported and come from different manufacturers, also from different countries, they are used by the large state farms

and also in some comunal areas, where large extersions of arable lands are available and permanent crops are cultivated.

The Agricultural Mechanization Services Corporation owns some 135 of these machines, providing services to the surplus producing areas.

Implements.

This section deals with the agricultural implements used mainly for land preparation and are drawn either by tractors or animals, and for the particular case of Ethiopia hand tools used by the peasants population extensively.

-Tractor drawn:

There exists a large variety of tractor drawn implements that could be listed, from plows and harrows, through subsoilers and scrapers to planters and sprayers, almost all of which types are in use in the ethiopian farming industry, always imported from different sources, constituting a considerable variety of up to date technology as well as traditional conventional tractor drawn implements park.

The cereals and sugar plantations in the state farms and in the surplus producing areas are almost the only users of these modern mechanized equipment.

The Agricultural Mechanization Services Corporation maintains to date some 800 plows and 600 harrows for providing services to the Production Cooperatives.

There are also some other mechanically operated equipment used by the smaller farmers, such as the corn and maize shellers, as well as flour hammers mills and water pumps for irrigation purposes, most of these implements and equipment are of imported designs from different sources and some are now being developed locally

-Animal drawn :

It is in this category that is possible to find most of the ploughs, used in the country, nowadays, in agriculture, with some degree of production technology incorporated, that means most, of the structural and support elements are made of steel, and the cutting edges and wear parts can even be made of some steel alloys, the handles and draw bars are some times made out of wood that are obtained by the farmers themselves, cut from trees that used to abundant in most areas of the country.

Amongst this category of animal drawn implements, it is the plow beyond any doubt the soil working tool most widely used in the country, followed by the spike tooth harrows, the former presents sometimes the alternative of reversible plows to save time in the land preparation operations.

Ocassionally it is also possible to find some farmers using planters and seeders drawn with the help of animals, or flour mills, pumps and other ancillary equipment using animal power as prime movers.

-Manual use :

A very large percentage of the population in this country works the land with hand tools and it is not possible to set figures or percentages for the number of peasants that are still using hand native primitive tools, in many cases only the result of obtaining a branch from a nearby tree chosen by the shape it has, that can be used for a specific application in their agricultural life.

Whether said selection of a branch tree can be called technology, it would be a matter for lengthy and bizantine discussions, reason for which it was thought unnecessary to review same.

However, it does exist also an important sector of the farming population that works the land with hand tools made of iron or steel.

The range of tools that can fall into this category is the widest in the country, the shovels, hoes, rakes and chisels can be found in many different forms and sizes, receiving a different denomination for each particular form - metrebia, dengora, gesso, gojjam maresha - either one side tool or some times a combination of two types, one at each end of the same tool, all of them are used attached to a handle bar that there again can take different lengths and shapes, from short sticks to rather long straight or curved handles.

in this category can also be found a long list of more conventional tools, such as machettes, axes, pickaxes, crowbars, shovels, rakes, chisels and others.

-Transportation

For transportation purposes the most common means are the road vehicles, which in agriculture take most of the times the form of trailers of different sizes hauled either by trucks, tractors or animals, from the large conventional all purpose 40 - 50 tons capacity low bed trailers, used by the large farmers to transport their heavy equipment from field to field and products to the industrial plants in large volumes, to the small capacity steel wheels cart to be pulled by one animal and the small wheel barrows and other wheeled and not wheeled carts that are pulled by persons.

Supply of equipment.

The supply needs of mechanized equipment and agricultural implements in the country, is being satisfied almost entirely by importations, which includes not only the designs but mainly the equipment themselves, the production plants that can be seen today in the country are all of recent acquisition and most of them are, at the moment of writing this report, at very initial stages of production or being commisioned or still under construction.

For the purpose of looking into the local supply of industrially produced goods, the government of Ethiopia has established an entity called The National Metals Work Corporation which includes some 22 factories divided in 5 groups, one of which deals with Agricultural machinery and eq ipment and operates 5 factories for that purpose:

- Nazareth Tractor Assembly Factory
- Kotebe Metal Tools Factory
- Ethiopian Sickles Factory
- Akaki Pump Factory and
- Kalitii Metal Factory

a new large industrial complex is being built, under an assistance programme from the Italian government, which is at the moment being commissioned, The Akaki Spare Parts & Hand Tools Factory, which includes quite comprehensive installations for foundries and forgings, machining and

grinding as well as chrome and nickel plating and other finishing operations, with most of the necessary support facilities, such as, design and pattern making, automatic moulding and sands recuperations, as well as, tool making room, metrological and metalurgical laboratories.

This factory was established for the purpose of manufacturing hand tools and mill balls, but recently the decision has been taken that this factory should also produce some of the spare parts required by the agricultural sector.

The government officers interviewed advise that among the projects of the National Metal Works Corporation there is one to be implemented with UNIDO's assistance to develop an enginnering design and a tool centre, the civil engineering design is now completed and the construction should begin during 1989 and be completed in 1 1/2 years and includes a prototype shop and a tool room

The same corporation informs that another project to make a factory for the production of tractor and animal drawn equipment is under way, the construction should begin during the current year, some prototypes of animal and tractor drawn implements are at present under test, which should be completed in about two month, before they actually go into durability tests.

Tractors.

In a place called Nazareth, located at about 100 km from Addis Abbaba, an assembly plant was erected, using an area of 73,000 m2 with a total covered area of 4,700 m2 and employing some 120 persons.

This plant, established with the assistance of the USSR, has been set up for the purpose of assembling tractors that are received in SKD (semi knocked down) packages, and has a capacity for assembling 1,000 tractors per year and per shift. The project is for developing the factory in three stages, the first one to include assembly, the second the production of some parts, not yet identified or programmed, and the third the production of more parts until reaching 100 % of local content.

All units within the production programme have normally aspirated 80 HP at sea level engines and come in two versions, being the production split 40 % in 4 x 2 and 60 % in 4 x 4.

Production records show that from inauguration in August 1984 to the end of June 1987, 1,588 tractors had been assembled and some 1027 had been sold to different organizations, to the end of April 1989 production figures reached to 1,757 units with some 300 finished tractors in the stockyard awaiting to be sold.

The operations at this plant include unpackaging, assembly and painting of the tractors before delivery for sale. The plant does not look into the supply of spare parts, task which is being undertaken by the Agricultural Equipment and Mechanization Services Corporation.

Combines.

The combines and other modern equipment, described as harvesters and threshers and balers as well as other seeders, planters and sprayers in use by the large commercial farming are entirely imported mostly from european countries, through agents, some of which maintain dealership offices in Addis Abbeba, the most important of which is the firm Ries Enginnering Share Company that maintains the representation in Ethiopia for world wide known firms such as Caterpillar, Massey Ferguson, Perkins and others, providing technical support and maintenance and repair facilities when required.

Other purchases are done nowadays by means of bilateral agreements or by calling international bids for the supply of the equipment specified.

Implements.

The situation of supply of implements is somehow similar to the existing for tractors and combines, where all of the

mechanized equipment of relatively modern technology is obtained from importations and much of the animal drawn equipment in existance in the country was obtained in the same way.

However, there are at the moment some factories being implemented for the local manufacture of animal drawn implements and manual.

The Kotebe Metal Tools Factory:

This is a rather old plant and with a complicated layout, however, it has the facilities required to produce an interesting variety of hand tools, it counts with an excentric press of 160 tons capacity among others of less capacity, a drop hammer 150 tons among others smaller, a furnace burning diesel # 6, 3 large diameter (1.5 m) grinding wheels, a reasonably well equipped tool room to produce their own dies, and a carpentry shop to produce handle bars, although most of the tools are sold without handles.

It was established for the manufacture of agricultural and construction hand tools and has been producing different designs of shovels and spades, sickels, axes, machettes and hoes, ploughs, rakes and spike harrows, as well as, chisels and trowels and pliers, spanners and screwdrivers; however, these hand tools for the construction industry have

recently been dropped from the production line to be passed to the new Akaki Spare Parts Factory.

The Kalitii Metal Factory.

This a new plant that begun operation in January 1989, it is located at about 20 km from Addis Abbeba and is working as an annex to one of the plants reserved for the purpose of producing construction material, whose main production is in the line of corrugated galvanized sheets, other roofing and wall cladding sheets, rectangular and round pipes, windows and door profiles, slotted angle shelves with plates and accesories, wheel barrows and furniture, among other things, is has now becomed also involved in the production of maize shellers with capacities of 500 to 1,000 Kg/hr and mills for grains (teff, maize, wheat, pepper, etc) with capacities ranging from 150 to 400 Kg/hr, using castings produced at the nearby pumps factory. At the time of visiting the plant last may, a brand new press 450 tons capacity, of italian origin was being installed.

The Akaki Pump Factory:

This recently completed project has been developed and installed with the assistance of the North Korean People's Democratic Republic, who have provided all plant equipment and raw materials (pig iron), as well as the designs for a hand pump and a family of centrifugal pumps.

The plant has a capacity to produce 1,500 centrifugal pumps and 3,000 hand pumps per year, to date some 200 centrifugal pumps have been produced and a new design of hand pumps to suit the local needs is being developed with the assistance of UNIDO.

The plant is nicely set and comprehensive, it includes shops for model making, earths treatment, a 1 ton capacity furnace (daily production capacity 800 - 1,000 Kg of molten steel), the electric motors and diesel engines used as prime movers come from different sources of supply: West Germany, England, North Korea, Holland, Bulgaria and others.

Most of the country's water supplies come from deep wells, however, this factory does not have any future programmes to produce submersible pumps.

Research and Development.

In the area of design of new or improved equipment and development of tools and implements, there are at the moment several projects working in the country.

Besides the programmes that are the moment under study or being implemented with UNDP/UNIDO support, such as the Engineering Design and Manufacturing Technology Centre and the Pilot Plant for Agricultural Machinery and Implements

manufacture, there exist entities within the country that are doing research work, producing protypes and running tests on different types of equipment.

The Rural Technology Promotion Department from the Ministry of Agriculture has set three main targets,

- the Promotion of Rural Technologies, to assist agroproduction and national consumption,
- to Assist Small Scale Rural Industries, providing managerial services to support the small village blacksmith, 7 zones have been established in the country with workshops to develop designs, 6 or 7 implements have been developed during the last 4 years, among which it can be found threshers, maize shellers (50 quintals/hr),
- to develop Farmers Technology Testing and Promotion Centres, with EEC assistance funds some 140 centres to produce, maintain and repair equipment and implements, have been established by the Service Corporation with 30,000 - 40,000 Birrs investments in each case, where training is offered for periods of two to three months.

This Department has been working in this area of developing products for some time and on december 1968 produced a document where pictures of some of the implements and equipment developed by them are presented, same implements as well as others can also be seen at their research centre near Addis Abbeba, their work includes hoes, seeders and planters, for manual use, improved mould board ploughs,

reversible ploughs, spike tooth harrows, wooden and metal wheeled carts and other animal drawn implements, as well as, corn and maize shellers, mud straw silos, flour hammer mills, engine, tractor or electric motor driven, a wheel barrow, a beehive and a charcoal stove.

Another government institution concerned with industrial development and promotion of the small industries sector, working on agricultural implements development, is the entity called HASIDA (Handicrafts and Small Scale Industries Development Agency), established to promote small scale industries as well as cooperatives and to provide licenses to small industries and register them. Currently they are working at a shop in Addis Abbeba where the assistance of two yugoslavian (UNIDO) experts (one of them a design engineer), is allowing 4 ethiopian mechanical engineers and some workers to be trained in a sheet metal workshop, a foundry and in forging, while developing some tools and implements and the tooling required for their production, all for the small scale sector.

Maintenance.

The subject of maintenance is without question one the major problems that a country with strong limitations in foreign currency and a rather limited number of skilled operator and trained maintenance personnel, like Ethiopia, has to face.

The large state farms rely on their own mechanical equipment, operators, maintenance personnel and spare parts stocks or purchases; the other users of mechanical equipment concentrated mostly in the Agricultural Mechanical Services Corporation are running an important fleet of tractor and implements relying on a central maintenance and workshop facilities.

The park has in recent years more activity in far distant areas from the main central office of the Corporation, in Addis Abbaba, than what they used to have, this as a result of the relocation programme of people to new settlement areas following the government agricultural development policy.

The Corporation is now operating in two areas, but has not yet been able to establish a repair and maintenance network to provide the required service near the places where the mechanical units are working, this difficult situation to provided efficient maintenance services becomes complicated with the difficulty for obtaining the spare parts on time; the lack of a good network of maintenance wokshops, added to the fact that operators and mechanics are mostly insufficiently trained, thus, producing premature failures and faulty or inadequate repair works, creates additional needs for maintenance, repairs and spare parts.

The Corporation headquarters maintain a central and only warehouse in the country for their fleet, with some 30,000 items in stock, considered insufficient to satisfy the needs of a fleet with a great variety of sources of supply and models, although, a computerized system is now being introduced for the control of movements in the stock, however, same has not yet been implemented for forecasting needs, establishing minimum and maximum stock levels or preparing purchase orders based on consumption rates, lead time for supplies and other technical aspects of a proper parts stock maintenance.

Some estimates indicate that for keeping the fleet of units under one private representation company in the country some US $ 5'000,000 per year would be required, on the other hand if the actual fleet of tractors in the country is in the range of some 5,000 units, if US $ 500 per year per unit are allocated in average for major and minor repairs and for maintenance parts, this would require a national budget of foreign exchange of US $ 25'000,000.

Production Technology.

The production technology for agricultural equipment in the country is sufficiently developed for the production of hand implements and for some animal drawn equipment, hoewver, for the purpose of producing some tractor drawn implements which at the moment are only imported, it has

been observed that the required technology already exists in the country and perhaps with proper drawings and appropriate technical direction some satisfactory results could be obtained within a relatively short time.

New equipment and new technologies are being introduced into the country at a very rapid pace, which if properly learned and absorbed by the local engineers within the short time that the foreign experts will be in the country at the installation and commissioning stages, could help the rapid introduction of new lines of products for the benefit of the agricultural sector.

However, it can not be overlooked, the fact that some drawings and designs received in later years, have proved to be not the most appropriate for the use they were intended in the agricultural sector, reason for which, it will have to be strongly recommended that in the future, the negotiators purchasing those designs, will have to consult through the corresponding channels, the appropriateness of the designs, not only from the manufacturing technologies points of view, but, also for the applications they are intended and for the skilled required for the operators, in order to avoid them having to go through lengthy processes of redesign before they can really be of use to the sector or for training of personnel for their operation and further maintenance.

Reports have been received, for instance, that the studies previous to the selection of the units to be assembled at the new plant in Nazareth, called for tractors with power ratings of 80 HP at the altitudes where they intended to be used, where the larger extensions of agricultural lands are in actual use, at approximately 2500 m above sea level, however, the tractors selected were of 80 HP sea level range, without taking into consideration that at 2,500 m altitude the power losses for a diesel engine are of the order of 20 - 25 %, in which case the selection should have been of power ranges of 100 - 120 HP at sea level for normally aspirated engines or the installation of superchargers should have been envisaged, to compensate for the losses due to altitude.

Another recent case has been that of the hand operated pumps, that were selected for production at the Akaki Pumps Factory, that were found not suitable and had to undergo a complete redesign process, that now is being done with the assistance of UNIDO.

Land erosion.

Perhaps the biggest problem that this country is facing nowadays is the land erosion, affecting almost the entire agricultural lands, which unprotected naturally or by the action of the population that is deforesting the country, are being degraded at a most rapid pace, this can be easily

appreciated from aspect the land presents to the traveller from the air or travelling by land, not only in far or remote areas, but also, within relatively short distances of the capital city Addis Abbeba, the aspects of the water running through the rivers also present the image of being heavily loaded with soil.

This situation is not unknown to the ethiopians, however, little or nothing is being done to avoid this loss of fertile lands, too few irrigation or drainage or reforestation projects are taking place and unless something is done and soon the availability of arable lands will be reduced dramatically in the near future.

Other energy sources.

The country needs urgently to find alternative sources of energy to satisfy its requirements.

The country does not have own resources of fuels and relies to a large extent in petrol imported from the neighbouring countries, which is refined partially in the country.

Some industrial plants, such as, those processing the sugar cane are using the bagaze to burn in boilers to generate electricity, but a major source of energy for the peasants population is the wood and charcoal which amounted to some 37 million cubic meters in 1986, however, the cotton stocks

are still being burned in the fields purposeless, it is believed that some research could be done to use same as fuel for some special applications.

Another source of energy still unexploited in the country is the wind energy, it has been observed, that some small windmills are being used to extract water from the subsoil, however, the country has no known projects to use this source of energy to generate electricity and although no records of energy activity have been collected, there exist very strong reasons to believe that the wind velocity required to install windmills capable of generating 200 - 1000 KW or more is available in many areas of the ethiopian territory, that could help to solve many problems and to provide the necessary energy to pump water for irrigation purposes, thus, making productive for all the year round extensions that otherwise can only rely on rainfall.

The biogas has not yet proved to be effective for industrial generation of electricity and the solar energy through photovoltaic cells is still extremely expensive for third world countries.

Reforestation.

The area covered by forests and woodlands has been decreasing during last years in the country, records on hand prove that some 2.4 million of Ha were lost between

1961 and 1985 and no records of reforestation projects have been collected.

This situation, beyond any doubt will have to be changed, for the country to stop the land erosion and to recuperate some of the land that will soon be lost, oherwise.

Importation.

The countries importation policies have to be more agricultural oriented, if the agricultural is to be fostered in the country, the industry has to be helped in order to reduce to some extent those implements that the country is capable of producing and the importation of spare parts to maintain the actual tractors park has to helped with more agile means and approval procedures to maintain the stocks and to obtain urgently required items.

Statistics.

The obtention of certified statistical information is not easily available; almost all the national figures obtained, have been the result of very inquisitive questions put forward to government officials in the different offices visited, at the Ministry of Industries and at the Ministry of Agriculture in particular.

The national figures are mainly obtained by word of maouth from those officials always willing to cooperate, but only seldom confirmed by national official or semi-official documents, that can be used as reliably as figures from a National Statistical Office could be.

Some manufacturers have provided precise figures regarding teir own fields of responsibility.

The ECA (Economic Commission for Africa) with headquarters in Addis Abbeba has furnished some national figures for Ethiopia, which are have been used in this report.

II MOROCCO

Generalities or general enviroment of agriculture.

The agriculture is one of the determining factor of the economy in Morocco, it represents 17 % of the GNP and provides occupation for approximately 50 % of the active population.

Much the same than in other third world countries, the agriculture is still dependant mostly on rainfalls and the land distribution follows a similar pattern, large farming is done in heavy rainfall areas with modern mechanized equipment and the small farming with relatively less developed technology in other areas.

The land use statistics provide the following data:

Land use in 1,000 ha

Type of land	a)1977	b)1982	b)1987
total agricultural land	69,000		
-unusable - desert	32,635		
-pastures - ranch land	20,900		
-forest+degraded forest	7,400		
-forestation completed	345		
-arable land	7,720	7,967	8,275
under cultivation	5,494	5,633	6,661
cereals	4,832	4,478	5,056
under irrigation	754		

sources: a) Le Message-publication from the Ministry of Agriculture
b) Annuaire Statistic du Maroc - 1988

Arable Land Distribution by Users

Type of land	number of explotat.	surface ha
explotation w/out usable land	450,240	1,900
less than 5 ha	1'089,090	1'820,300
from 5 ha to less than 10 ha	219,790	1'537,500
from 10 ha to less than 20 ha	114,050	1'559,100
from 20 ha to less than 50 ha	43,840	1'244,700
from 50 ha to less than 100 ha	7,720	532,400
from 100 ha to more	2,520	742,400
	1'927,500	7'438,100

source : The Agriculture Marrocaine - M.A.R.A. - April 1983

Although these latter statistic belong to 1983, they were provided by the Ministry of Agriculture and Agrarian Reform (M.A.R.A.) and it is not expected that the percentages may have varied a great deal during recent years.

However, it must be highlighted that the government is giving maximum priority to the agricultural sector, which is almost entirely in private hands, providing subsidies directly to the farmers to encourage mechanization, these cover almost all aspects related with agriculture, not only for purchases of equipment, but also for fertilizers, seeds, land preparation, herbicides and other related items, that will not be detailed in this report, but, only mentioned when relevant to the subject in question.

Requirements.

The needs of the farmers vary mostly according with the area where they are located, and although there still exist remote areas where mechanization has somehow not reached, with the prospects now on hand, it is expected that they will soon be modernized with the aid of mechanization.

Under the current circumstances, the type of equipment vary according to type of crops under cultivation, while the large farmers can now own and are currently using the most advanced equipment in the world market, thanks to the soft credit lines made available to them, the medium and small farmers working together in cooperatives are also having rapid access to mechanized equipment.

Many smaller farmers, although within cooperatives, own their own tractors and equipment, satisfying their needs for combines or other more expenxive equipment by renting or hiring services, apparently at a very reasonable prices.

The main needs of the smaller farmers seems to be of technical or professional advise for seeding, for the use of fertilizer or other chemicals or farming techniques.

Although the high level of mechanization that farming is reaching in the country, the needs for animal drawn equipment and hand tools, will still remain, especially for maintenance and in those areas where there are still too many stones.

Tractors.

For some time, the country has relied almost entirely on imported tractors, since the assembly plant was dismantled around 1975, under these circumstances the tractor park in the country presents a variety of sizes, makes and models; due to the new promotion policies put in practice by the government, more than 50 % of the existing fleet was obtained during this decade, the latest statistics show the growth of this park as follows:

year	imports (a)	total
1979	2,675	23,029 (c)
1980	1,771	28,544 (c)
1981	1,724	26,880 (c)
1982	3,944	31,616 (c)
1983	2,432	36,543 (b)
1984	1,949	38,674 (b)
1985	2,401	41,612 (b)
1986	2,841	44,671 (b)
1987	1,579	47,041 (b)
1988	2,511	

Source: (a) AMIMA - Association Marrocaine de Importeur Agricole.

(b) Annuaire Statistique de Maroc - 1988.

(c) Statistical Office - Ministry of Agriculture and Agrarian Reform (M.A.R.A.)

The park separated by types and powers, presents the following status to the end of 1984:

Tractors Park

by type and power

	1980	1981	1982	1983	1984
with chains					
up to 35 CV	23	33	79	79	93
35 to 55 CV	358	384	327	251	237
55 to 80 CV	1,331	1,325	1,267	1,153	900
80 CV to more	337	348	365	363	526
sub-total	2,049	2,094	2,038	1,846	1,756
with wheels					
up to 35 CV	653	463	609	561	497
35 to 55 CV	5,640	5,800	5,013	5,306	4,937
55 to 80 CV	15,776	20,604	21,326	22,763	22,962
80 CV to more	560	756	1,534	1,171	1,636
sub total	22,629	29,769	30,592	31,616	30,032
hand tractors	45	63	72	59	95
TOTAL	24,723	29,769	30,592	31,616	31,883

source : Statistical Office Ministry of Agriculture and Agrarian Reform (M.A.R.A.)

The data presented offers many possibilities of analysis, however, the most important conclusions are, that it can show the rapid growth of the park in recent years, evidently, as a result of the promotion policies; as well

as, the sizes and types with more demand among the farming population.

It has to be mentioned that, since 1988, farmers that purchase tractors of less than 40 HP, are entitled to an especial direct subsidy of 25 % in cash, of the actual value of the tractor, subsidy that can be realized in a fairly short time, through the CNCA (l'Casse Nationale de Credit Agricole); after one year of application of this policy, the sales of tractors within that power range has increased considerably.

During the last two or three years, with the aid of the new promotion laws, some large farms are also beginning to appear (2,000 ha and more), mainly with local capital, which is bringing a new size of 100 to 180 HP 4WD tractors into the market, especially into the region south of Casablanca.

Implements.

The variety of implements used in moroccan agriculture is quite wide, due to the facilities provided for imports, and purchases in general, the sales, that otherwise could be concentrated in the large and richer farming sector are now extended to the smaller and medium size farmers; the small producers in cooperatives receive more assistance to buy equipment than the single small producers, this with the purpose of encouraging the association in cooperatives.

The mechanization covers the use of self powered and tractor drawn combined harvesters, which today are being extensively used, even by small farmers, the reversible discs plows and cover crops are common thing, as well as, harrows, chisels, subsoilers and scarifiers, cultivators and planters; however, the animal drawn equipment has not lost its importance for the agricultural sector and the mould board ploughs as well as other hand equipment are still very widely used not only by the small farmer in remote areas, but also by the larger farms for special soils or land maintenance.

In the following page, an extract is presented of the statistics supplied by the Ministry of Agriculture and Agrarian Reform, where the situation of how the equipment and implements park in the country looked from 1980 to 1984, later information is not yet available, as regards to those implements.

However, it can be said without mistaking, that those figures are changing very rapidly, moving into more mechanization.

Another technological aspect that is rapidly changing the image of agriculture in Morocco, is the aspect related to irrigations, from underground sources and from the new dams and irrigations schemes that are being implemented, and the introduction of an original moroccan design of farming under cover, especially bananas, where more than 1,000 ha are now being cultivated.

Equipment and Implements

	1980	1981	1982	1983	1984
plows wood+metal	702,375	764,288	943,097	1107586	933,356
plows-animal	314,552	251,220	358,356	453,064	372,630
plows-tractor	15,222	18,858	17,824	18,506	19,545
-mould board	5,251	4,089	3,521	3,290	3,855
-w/discs	11,011	14,980	14,213	15,216	15,690
cover crops	24,699	24,530	25,882	26,533	27,176
stuble plow	1,180	1,354	994	880	779
scarifiers	1,469	1,486	1,413	918	1,455
harrows animal	92,895	93,463	75,643	73,629	80,111
light mechanical	13,622	13,988	14,901	4,996	4,988
heavy mechan.	747	533	610	627	603
chisels	621	493	657	839	863
rollers-light	255	266	355	320	161
-heavy	166	149	172	133	397
hoes sarcl-animal	13,955	14,081	14,326	5,614	5,003
tractor	2,155	1,188	755	7,421	551
fertilizer-animal	260	538	294	162	483
tractor	1,299	1,231	1,145	1,394	1,045
seeders-animal	899	380	462	250	399
-tractor	1,477	1,243	1,651	1,391	2,059
-combine	116	177	290	91	133
furrow	4,801	4,611	6,029	5,430	5,839
mower	1,363	1,760	2,017	3,176	3,307

source : Statistical Office - Ministry of Agriculture(MARA)

Supply.

The country is a net importer of modern mechanized equipment, this includes all tractors, which are not being built in the country; as far as, conventional tractor drawn implements, and animal drawn, as well as hand tools, is concerned, the country possesses quite a comprehensive industry capable of producing almost all the needs for implements of the agricultural sector.

The importers of agricultural equipment and implements are usually well established and are providing an efficient service to the market, with sufficient support for spare parts and maintenance, the most popular and best known manufacturers of agricultural equipment in the world are all represented, and many other manufacturers, that were not so active in that country, are now making efforts to penetrate into that market.

As mentioned above, there are several manufacturers producing agricultural implements, amongst the which, the following are worth mentioning, in alphabetical order:

ATMAR - (Les Ateliers Marocaines).

Established in 1974 for the purpose of producing agricultural implements, their installations cover an area of 1,800 sq.m. with 800 sq.m. of covered area, provides occupation to some 125 people, the facilities include equipment for cutting, bending, rolling and forging, cold

and hot forming, machining and heat treatment, manual and semiautomatic welding equipment.

Their production is mainly oriented to satisfy the needs of tractor drawn implements and claim that their production covers the national requirements in the following percentages:

disc ploughs	80 %
cover crops	60 %
chisels	70 - 80 %
subsoilers	90 - 100 %
" for CAT D8	100 %
trailers	80 %

their regular production includes above items and also stuble ploughs, cultivators and an animal drawn mould board reversible plough, besides, concrete mixers, trailers and tanks for non agricultural applications . They recently produced a stuble plough of their own design, with 40 discs for a width of 7 m, to work in a newly developed farm pivot irrigated, the tractor is a 360 HP, two engines, 8 tyres, 4WD.

Auto-hall

Established in Casablanca, it is perhaps the oldest establishment in the country, supplying agricultural tractors and implements, and it is still the largest importer on these lines, their activity covers also the industrial side, are currently manufacturers of disc plows, cover crops and pumps for irrigation applications.

The line of plows and cover crops are imported from Ransome from the UK and also produced under license from Ransome. at their industrial plant, near Casablanca, the cover crops are produced to their own design and also the pumps; the castings are obtained from outside foundries, some items that could otherwise be machined, are also cast for cost saving.

They reckon that between Comicom, Atmar and themselves are covering 95 % of the local needs of plows; for the cover crops, that are simpler to manufacture, there are many other manufacturers in the country.

Comicom - (Compagnie Marocaine Industrielle et Commerciale)

It was established in 1974 for the purpose of importing agriculture equipment, as well as for civil engineering and construction materials, is now concentrating in supplying the agricultural sector.

Operates a main commercial office in Casablanca with an annexed maintenance shop and spares parts depot. In a new site near Casablanca of about 2,000 sq.m. with 50 % of the area under cover, a factory has been built and all the production equipment transferred, which consists of shears, benders for plates and profiles, burners for cutting thick plates in a simple hand pantograph type machine of their own design, and welding equipment.

In that industrial plant they are producing reversible disc plows, chisels, subsoilers, small trailers and some small transporting equipment to be attached to tractors.

Simef - (Societe des Industries Mecaniques et Electriques de Fes)

A 100 % state owned enterprise, under OCI (l'Office pour l'Developpement Industriel), located some 10 km from Fes, it was established some 40 years ago for the purpose of producing military equipment, guns and ammunition, at the beginnig of last decade it was converted into an industrial complex to produce diesel engines, a license contract was signed with Lister from England, in 1976, to produce Lister and Peters diesel engines, and the technological transfer process took place, foundries with continuous moulding and castings were installed, along with most comprehensive machine shops, tool room, model making shops and laboratories were established.

Their production covers a line of Simef diesel engines (old Lister and Peters designs), from 6 to 22 HP, a line of diesel engines built under license from Deutz of the Federal Republic of Germany, since 1987, from 27 to 60/70 HP both for stationary applications in agriculture, as prime movers for pumps, generating sets and other equipment.

At the same plant other lines are being produced, 50 cc gasoline engines for small motorbikes (4,000 per month),

under license from Peugeot and Motobecane, electric motors under license from Leroy Somer of France, up to 450 kw.

Simef is manufacturing within their own facilities all the locally produced items with the exceptions of some forgings that are obtained from the F.I.M. (Forges Industriels du Maroc) a nearby private forging at Meknes. The imported parts of diesel engines include crankshafts, camshafts, at the moment from Portugal and the complete fuel injection systems, from England.

The sands for castings are being imported from Spain and the pig iron from Brazil, the other main suppliers are europeans.

The actual capacity is of 4,000 engines per year, and their annual production is about 2,000 - 3,000 engines per year, the casting capacity is 4,000 tons per year and their production approximately 2,000 tons per year and in pumps the capacity is 500 pumps per year with an actual production rate of about 300 per year. All above mantioned volumes in one shift.

Smadia (Societe Marocaine de Developpements Industriels et Agricoles)

Company founded in 1931, is now located in Casablanca in an area of 10,000 sq.m. all covered with an installed power of 300 KVA, employs some 120 persons, their activity is concentrated on assembling diesel engines up to 147 bhp

under license from Lister - Peters from England since 1987, and other gasoline engines, they are producing electricity generating sets and pump sets, their manufacturing lines cover pumps, 3", 4" and 5 " vertical pumps for deep wells and 2", 3" and 4" horizontal pumps 100 % locally produced in their own foundries.

The Lister - Peters engines produced are including a local content of the order of 25 - 40 % depending on the type of engine.

The company is involved privately in some research projects, which includes windmills for which they look for the cooperation of the "Centre de Developpement des Energies Renouvelables" sited in Marrakech, entity which is acting in coordination the USAID (United States Agency for International Development), with funds provided for small projects.

Another worth mentioning project has been the production of a prototype tractor, called the Lister Pico Tractor, powered by a three cilynder Lister 23.15 Kw at 2,600 rpm., 4 stroke, direct injection, air cooled engine, which was evaluated in 1987 by the National Institute of Agronomic Research with USAID assistance, using a number of tillage tools in wheat stubble on tirs (clay) soils, with good overall results. A copy of the report and a general arrangement drawing may be found attached to this report.

Soframar.

Created in 1946 operates in Casablanca, the factory is in a site outside the city 40,000 sq.m. with 2,100 sq.m. under cover, with 6 million dirhams capital, 50 % french and 50 % moroccan, employs 70 - 80 people, the annual turn over is around 30 million dirhams.

Their lines of production are exclusively dedicated to pumps, with 60 % of their production on vertical pumps 3.5", 4.5" and 5.5" sizes with capacities up to 300 m3 per hour; the gross of the market needs are within that range but the most popular are in the range of 3" to 4.5 " diam.; 40 % of the production at this plant is of horizontal pumps from 3/4" to 6" diam.

The factory does all the machining, while the castings are obtained from outside suppliers, 80 % from Simef and the remainig 20 % from other local foundries and from France; they are licensees from Pompe Guinard from France, who also own 50 % of the capital, all those sizes required by the market and not produced by them are supplied imported from the french partner.

This company estimates that about 65 % of the local needs which include 100 % of the deep well pumps, are being satisfied by the local manufacturers while the remaining 35 % is being imported, with 20 to 25 % of the horizontal pumps also locally produced, the imports occur due to commercial reasons, although all the technology required exists in the country.

Green houses.

This is a technology that has been applied in Morocco for the last 15 years, through the firm "Delta Serres Maroc" the designers, that are also the suppliers, claim that the idea of introducing the economic green houses belongs to them, since nobody had thought of installing green houses in hot countries before they did it.

Since their introduction, about 2,000 ha of green houses have been installed in different locations in the country, mainly for the production of tomatos and other vegetables for export.

With the aid of this technology, Morocco has been able to produce bananas under cover, obtaining average yields of 40 tons per ha, that constitute world records of productivity, the maximum obtained has been 80 tons per ha; the actual covered area for the production of bananas in Morocco is about 1,000 ha.

With this technology, greenhouses have already been exported to Spain and Congo and there are proposals for exports to Greece.

These types of green houses differ from the conventional designs used before, in that they do not include any air preheating, they are built with galvanized steel pipe arches up to 9 m free span, depending on the design and heigth desired that will vary according to type of farming

to be implemented inside and/or the equipment to be used, the cover is made of PVC sheets 1.8 mm thick, that allows for openings to control the air flow in different ways at will, either longitudinal, zenithal or on the sides or by length spans through windowlike openings.

Research and Development.

Research and development can no be identified with particular entities in the country, however, it can be observed that in the field of agricultural equipment and implements the manufacturers are assuming at their own initiative this task; within this report two cases have already been mentioned, the large stubble plow that was produced by ATMAR to satisfy a particular need of a farmer in a newly developed area and the tractor that has been built as a prototype by SMADIA.

It can not be overlooked the fact that thanks to the studies prepared with the assistance of a US satellite, a new map showing the underground water resources of the country was drawn, helping farmers to develop new farms, like the case of Fkih Ben Salah in the Beni Bellal province where one farmers bored a well 500 m deep, to find water and is now irrigating 1,000 ha with the aid of pivots 500 m long, to produce maize, a new similar project is under preparation in the same area, relying on the water table for artificial irrigation.

Or the studies that at the moment are being carried out, with the aid of PNUD, to evaluate all the water resources in the country, at ground level, to prepare irrigation projects and dams building and for underground sources to maintain or refill the water tables.

All these agricultural oriented, many other cases, perhaps, can be found, but one thing is certain, and it is that Morocco can benefit from many aid or assistance programs to help the agricultural development.

Maintenance,

The maintenance will always be a general complain from the users point of view, however, to an independent opinion it does not seem to be one the major problems, for those using the services of the larger importers, who usually maintain reasonable levels of stock of spare parts, nevertheless, the great variety of brands that are now flooding the country will cause minor drawbacks to some users.

The government is trying to help the maintenance, by supplying, in long lease terms tools and equipment to technicians, to help developing local maintenance establishments, in different locations in the country.

The technical level of maintenance obtained at the dealerships is reasonably good, although, some how at a high cost, but, it has been found that many farmers are capable of providing maintenance and performing some minor

repairs without great difficulties, the formation of new maintenance facilities in small localities, with the assistance mentioned above, should help to provide more service stations within the country at lower costs for the farmers.

Production Technology.

The country has already a fairly well developed industry in the fields of metal working, casting, forging, machining and welding, capable of producing much of the equipment in actual use by the agricultural sector, however, they are not yet producing tractors, a major import for agricultural development.

In every country where the production of tractors has been intented, the normal process has been to start with assembly plants, to create the conditions required to start manufacturing parts, leaving for the very last stage, the production of engines. Morocco is producing engines with a very important local content and has the technology to produce good quality castings and the machining processes, to produce the gear boxes and transmissions required for a particular design, so it can not be understood the reasons why there does not exist any project for restarting the production of tractors, within the range of power of the engines in the production programme of SIMEF.

Energy.

The country is now involved in building large, medium and small size dams, some of them with the double intention of helping the irrigation projects and for electricity generation, that will certainly help to reduce the imports of petrol.

However, having important coal deposits that helps to generate more electricity in the thermal power stations, it will still be required important long term investments, to make that energy reach areas distant from the main cities.

The country needs urgently to look into new sources of energy, renewable, such as the wind could be, that at the momen is only used in very limited areas, with the aid of small windmills to extract water from wells not more than a few meters deep for only little more than domestic applications.

Other sources of energy, such as the solar energy that is extremely expensive and the biogas, are not believed to be solutions for Morocco to solve the agricultural energy problem.

Irrigation.

There are sufficient proves at hand that show that much more land could be made available for agricultural purposes if irrigated with subsoil water, however, as this type of

activity has to take place away from the urban areas, at the moment this can only be made viable if imported petrol in the form of diesel fuel is spent in electricity generating sets, however, as mentioned above, the wind energy offers a viable short term and low cost solution, the statistics obtained from the offices of the "Division de Climatologie Generale et Apliquee" at Casablanca, although, not taken in the most appropriate areas for the applications foreseen, show that in many places of the country, there is sufficient wind activity for the installation of windmills capable of producing 250 KW and more, all the year round, enough to feed an small village and to provide the required energy for pumping sufficient water for a medium size irrigation scheme.

Imports.

The country is a net importer of tractors, a major input for agricultural development, and other equipment not produced in the country, most implements can be imported without difficulties, however, there exists a short list of implements with discs and certain categories of pumps, especially centrifugal and vertical that require import licenses, this with the purpose of protecting the local industry.

Statistics.

A government agency called the National Statistical Office publishes the "Annuaire Statistic du Maroc" which contains quite a variety of tables with data not only historical but also about projects which are part of the National Action Plan, as well as, comments regarding the potentials of the country and prospects.

Other government and private entities also publish reliable information, which contain basic and elaborate useful data, required for analysis of different natures.

iii. ZIMBABWE

- Generalities or general enviroment of Agriculture.

The land is Zimbabwe is divided for agricultural purposes in 5 Natural Regions depending on the rain falls, there exist 5 regions as follows:

Region 1	Specialized and diversified farming
rain	more than 1000 mm per annum
area	7,000 sq.km.
farming	74 % large commercial, 24 % communal and 2 % small commercial
Region 2	Intensive farming
rain	750 - 1000 mm per annum
area	58,600 sq.km.
farming	74 % large commercial, 22 % comunal and 4 % small commercial
Region 3	Semi intensive farming
rain	650 - 800 mm per annum.
area	72,900 sq.km.
farming	49 % large commercial, 43 % comunal and 8 % small comercial
Region 4	Semi extensive farming
rain	450 - 650 mm per annum.
area	147,800 sq.km.
farming	62 % comunal, 34 % large commercial and 4 % small comercial
Region 5	Extensive farming
rain	too low and erratic
area	104,400 sq.km.
farming	45 % comunal, 35 % large commercial and less than 20 % national parks

source: Central Statistical Office

Through the last 25 years the variations in the land usage has been as follows:

Farming Area Distribution

	Large Farming				Small
year	total area (1000) Ha	area under crops Ha	area under fruit Ha	area under irrigat. Ha	total area (1000) Ha
1973	14,958	597,647	6,189	113,833	1,069
1974	15,112	606,363	5,983	113,332	1,072
1975	15,193	585,236	5,359	127,194	1,068
1976	15,148	561,207	5,228	130,558	1,062
1977	15,303	570,028	4,752	146,783	1,061
1978	15,317	559,225	4,275	149,377	1,064
1979	15,064	538,105	4,064	151,698	.....
1980	14,798	571,169	3,663	154,806	.....
1981	14,482	595,870	4,005	158,328	1,064
1982	13,516	581,331	3,679	165,405	1,066
1983	12,825	544,882	3,543	143,845	1,074
1984	12,473	527,860	4,062	135,597	.....
1985	11,299	537,635	3,415	149,835	.....

Distribution of land in regions 1 - 3

Comunal land	30 %
Large Scale Commercial land	58 %
Small Scale Commercial land	6 %
National Parks and others	6 %
Total	100 %

Source : Central Statistical Office
Statistical Year Book 1987

Requirements.

The country is a net exporter of agricultural products, especially grains and tobacco, which along with minig represent the main sources of income of foreign exchange for the country.

The large scale commercial farming, covers the larger portion of the agricultural land and mostly in regions 1, 2 and 3, where the rainfalls are more permanent, as it can be seen from the statistical figures included and is farmed with modern technology tractors, implements and equipment.

The farmers in the country have associated themselves in accordance with their interests, that are in all cases related with the size and type of operation they have, and consequently with the level of technology or type of agricultural equipment they can use.

The Commercial Farmers Union of Zimbabwe represent the interests of the large farmers, The National Farmers Association of Zimbabwe represent the medium size farmers working at the comunal lands and The Zimbabwe National Farmers Union group the small farmers who are working in different areas of the country, in small scale. On these same lines, however, a fourth group could be included to mention the Agricultural and Rural Development Authority, a government entity that is capable of producing some 10 % of

the national agricultural output, working large size farms as well as medium sized and small in all 5 regions, from large extensions in the better rainfall areas to those small in remote low productive areas.

The animal drawn equipment plays also a very important role in this country where some 80 % of the rural farmers population are still depending on the animals as their main force to work the land

There also exist an important sector of the population that are dependant on the hand tools, especially in the remote areas in region 5, where standards are still at a relatively low level of development.

Tractors.

The country counts with modern and old tractors to satisfy their needs for traction in farming, however, the maintenance of that fleet is beginning to have difficulties due to the fact that the tractors replacement programmes are not being satisfied in later years nor the spare parts inflow, what in turn is causing premature breakdowns due to improper repair jobs.

The statistics of tractors for farm use in later years has moved as indicated below:

year	90 kw or more	37 kw to 89 kw	less than 39 kw	total
1978	806	10,059	6,547	17,412
1979	833	10,217	5,802	16,852
1980	862	10,325	5,530	16,717
1981	980	10,239	5,160	16,373
1982	914	10,322	5,004	16,240
1983	858	10,093	4,812	15,763
1984	897	10,349	4,630	15,876
1985	n.a.	n.a.	n.a.	16.063

source: Ministry of Agriculture
Economics and Markets Branch

During the period from 1985 to 1989 the local assembly plant Willowvale Motor Industries (PVT) Limited has assembled 2,954 tractors from 40 to 160 HP, in both versions 4 x 4 and 4 x 2.

An approximate breakdown of this park by ages can be obtained from the 1988 survey provided by the Commercial Farmers Union, where with a 67 % response shows that 5,121 farmers own 12,434 tractors, with the following results:

under 3 years	1,520	12.2 %
from 3 to 6 years	1,715	13.8 %
from 6 to 9 years	1,878	15.1 %
from 9 to 12 years	1,923	15.5.%
over 12 years	5,398	43.4 %

However, having been taken these data within the scope of the larger farmers association, the percentages for the older tractor should tend to increase, since a large portion of the tractors in the hands of the medium and small size farmers have been obtained as second hand from the large farmers, which in most cases would not be reflected in this survey.

The figures given above, are reflecting the variations of the fleet and the breakdown, and it can be observed that there exists a tendency for the fleet to be reduced and get older at the same time, what could in turn jeopardize the future of zimbabwean agriculture.

Combines.

These harvesting machines, that can be split in self propelled and tractor drawn, are widely used by the large farmers and according to the latest survey run by the Comercial Farmers Union mentioned above, the situation by the end of 1988, at 67 % response shows that 318 farmers own said combines, in working or workable conditions (excluding scrapped), was as follows:

under 3 years	29	7.3 %
from 3 to 6 years	70	17.7 %
from 6 to 9 years	50	12.6 %
from 9 to 12 years	78	19.7 %
over 12 years	169	42.7 %

Implements.

The country with a very ample agricultural scope, maintains a park of a wide variety of implements, from the most modern and sofisticated, electronically controlled equipment to the very primitive systems of working the land.

The tractor and animal drawn implements most commonly used are the following:

- Tractor drawn: used by all large farmers and to some extent by medium size.
  - disc ploughs: it is the most widely used implement
  - disc harrows: the 4.6 m - 40 discs - 710 mm diam.
  - tyne cultivators: used for weeding or for secondary tillage, just before planting or for minimum tillage.
  - spike harrows: for final seed bed cultivation
  - trailers: for transport
  - planters: non pneumatic - four rows
  - trailed harvester: used for corn, maize, forrage, etc.
  - chisels, ploughs and subsoilers: used mainly for soil improvement, however not as common as others.
  - paraploughs: this is an implement used for minimum tillage, normally under dry conditions, before it rains - it is recommended for soil conservation

- Animal drawn:	80 % of all farmers use animal drawn equipment mainly in the comunal lands.
ploughs	the single mould board plough is the most common, the reversibles have not been very successfull in the market.
spike harrows	the zig zag type is most popular.
cultivators	several variations are present in the market, depending mainly in the width adjustment, it can be either vertical or horizontal.
dam scoops	it is used for land maintenance, levelling of land, contour ridges for controlling down slides.
ridgers	the mould board type is used for making ridges.
single row planters	
scotch carts	small two wheel carts for transport

Mnual use.

The manual type of tools are used by all sectors in agriculture, whether big or small farming is involved, since they find application in many operations that can only be performed with the aid of them; the most common tools are :

- hoes, shovels, picks, mattocks and axes presented in different forms, sizes and combinations
- and also some hand operated crops processing equipment such as maize and ground nut shellers.

Supply

The local industry, well established for quite a number of years in the country, is fairly well developed and is capable of satisfying all the needs of the agricultural sector in the field of hand tools and animal drawn equipment, as well as an important portion of the tractor drawn implements, steel bars and small profiles are also produced in the country from imported steel, since the country is a net importer of steel, the plates required for manufacturing the implements is 100 % imported.

Tractors.

Reports were received that there are three tractor assembly plants in the country, Willowvale, Leyland and Diarma who receive them either in CKD or SKD forms, however, the local content is not considerable.

Nowadays, there does not seem to be any important input of assembled tractors into the country, which seems to be depending solely in the local assembly.

The Willowvale Motor Industries (Private) Limited that assembles approximately 80 % of the local supplies, reported latest years production as follows:

year	1984	1985	1986	1987	1988	1989(a)
qty.	16	80	662	672	586	938

(a) : tractors assembled to end of april

The breakdown of that production of different makes Deutz, Ford, Fiat, John Deere, Landini, Massey Ferguson and Farmwell (with a Massey Ferguson power train from UK), was 2,191 units in 4 x 2 and the remainig 455 units in 4 x 4 versions, a large proportion of the packages for assembly were received in SKD form; Willowvale assembles tractors of their own, but, very often does it as a service for other importers who obtain the tractors either by direct purchase orders or more recently through barter deals, in this way an important number of units have been recently received from Rumania, the UTB 500 a 4 x 2, 46 HP unit and the UTB 640 a 4 x 4, 64 HP.

The local content in locally assembled tractors is quite limited to tyres, batteries, seat and trims, fenders, radiators, weights and other minor elements.

It must be highlighted, that the minimum or no control on the specifications of the tractors being introduced into the market, either built up units or for local assembly is creating a problem of diversity of models and it is the case that to take advantage of a barter deals or other commercial operations advantegeous from a different outlook, many a time tractors go into the market with rutinary changeable elements like tyres, that are not obtainable in the local market.

To prevent this situation to continue, it is strongly reccommended that a comprehensive market research is prepared, with the participation of the end users, which

sometimes gives the impression of being ignored, while the decisions are taken at the negotiations tables by government authorities and the external suppliers.

The supply of tractors, to the opinion of all entities concerned, farmers, intermediaries and government authorities is insufficient, the national figures indicate that some 2,000 tractors should be entering the market every year, to cover the 10 % replacement rate required by the park plus 1 % for increasing same, however, the statistics on hand show that only one third of those needs have been satisfied during recent years.

Combines.

Most of the combine harvesters are of imported origin, however, there also exists a local production of smaller corn and other grain shellers, stationary or tractor drawn that are being manufactured by Tinto Industries.

Implements.

In the fields of implements is where the largest offer can be obtained in the country from the local manufacturers. as mentioned above, there is an important number of industrial enterprises capable of satisfying the national needs and even export to neighbouring countries, hereunder, some selected factories will be described in alphabetical order, along with their lines of products and approximate production capacities:

Bain Manufacturing Co. (Pvt) Ltd.

Belongs to a group of companies which also include Bain Tractor and Equipment, and Zimbabwe Farm Equipment all under William Bain Holding Company. Created in 1923 is oriented to the sale of tractors and agricultural equipment, maintains in the payroll 240 people and in 1969 started manufacturing some implements, with different degrees of in plant manufacture and assembly with bought out items, at the moment is handling, besides an extended line of tractors, Ploughs, cultivators, harrows, slashers, 16 foot trailers, potato diggers, as well as some ox-drawn equipment among others, but, only in limited amount, since their main market is in the mechanized or tractor drawn implements.

For their operations, besides the main offices in Harare, they operate branches in Chegutu, Chinoyi, Mutare and Mvurwi through which they sell 15 to 20 % of the tractor mounted equipment in the country.

Bulawayo Steel Products.

This is a company established in Bulawayo some 400 km south of Harare, where 90 % belongs to Amalgamated Steel Products (Pvt) Ltd., they hire 200 people and operate in a very comprehensive industrial complex, it counts with enough furnaces, presses, drop hammers and benders of different sizes and capacities to enable them to perform a large variety of forging operations required for the production

of a very complete line of agricultural implements as well as for minig. The maximum individual weight for a piece is 5 kg and the maximum press capacity 680 tonnes.

They claim to be the largest manufacturers of ox-drawn ploughs and forged hand tools in Central Africa with 40 % of their total production exported to other african countries like South Africa, Lesotho, Swaziland, Botswana, Zambia, Malawi, Mozambique, Tanzania, Kenya, Uganda and Angola.

Some 60 to 70 % of their capacity is dedicated to the production of animal drawn implements, based mainly in designs obtained from Ransom Plough of Lincolnshire in England from the end of last century. Some development is also being done by themselves and some products have already been offered to the market through the Institute of Agricultural Engineering in Harare, but, without much success, due to the mentality of the farmers that are not prepared to accept new products.

Their production programme for 1989 includes:

	home	export
ploughs-standard	18,000	3,000
silver medal	2,500	
cultivators-two types	6,300	
harrows-triangular	1,550	
Ridgers	100	400
planters	800	
spares		

The total expected output for 1989 is 1,500 tons of steel.

Their line of products for the farming industry is quite large and under the trade mark "Master Farmers" it includes harrows, planters, ridgers, cultivators and others and under the "Anvil Forgings" brand name they offer forged hand tools like picks, axes, hammers and mattocks.

Tinto Industries Limited.

One of the largest industrial enterprises in the country was formed in 1971 as a wholly owned subsidiary of Rio Tinto Zimbabwe Limited, which is also involved in mining, metal refineries and chemicals industries.

They are responsible for about 80 % of the Zimbabwe's offer of tractor mounted equipment and their production is exported to neighbouring countries, such as, Malawi and Zambia that is reckoned to have similar standards than Zimbabwe in agriculture, they also maintain regular markets and sales in Mozambique, South Africa and Tanzania.

Their complexes include 45 acres of industrial property and employ some 700 people through their five major departments that are : Implements and Disc Manufacture, Tractor Distribution, Trailer Manufacture, Irrigation Systems and Foundry Production. Counting for those purposes with shops properly equipped in modelling, foundry and machining, as well as, in general metal facilities for cutting, forming, forging and welding, to satisfy their own needs of production, with minimum dependance from outsiders. except for the supply of structural steels and standard items like bearing and other mass produced technological items.

The total discs requirements of the country are being satisfied by this company in a wide variety of sizes up to 660 mm, supplying to other implements manufacturers, it produces ploughs, chisels and rippers, disc harrows and planters, ridgers, cultivators, tillers, graders, mowers, fertilizers distributors, shellers and tool carriers, and on the animal drawn line they produce the scotch carts; in the past they used to produce also other animal drawn implements but the production was dropped and the tooling sold to Zimplow Limited.

Trailers are also produced in different sizes for the general transport industries and for the agricultural needs in particular, there is also a department of the company that concentrates in irrigation equipment, where irrigation accessories, as sprinklers, valves, couplings and others are being designed and manufactured for conventional or more advanced systems, as for automatic centre pivot.

Zimplow Limited.

This company was formed and established in Bulawayo in 1939, originally with the name of the "Rhodesian Plough Machinery Company Limited", which in 1948 was changed to "Rhoplow Limited" and in 1981 took its present name.

The company employs approximately 200 workers and had a turn over in 1988 of 5.4 M Z$, employing total assets of 5.7 m Z$, they claim to be the largest manufacturers of agricultural equipment in Africa, for hand and animal drawn

use, with 30 to 40 % of their production exported to the neighbouring countries, having as the only competitor The Ubungo Farm Implements in Tanzania.

Their design were originally obtained from Europe, are still being used for the current production and has the characteristic of not having any part welded, they are completely forged and bolted, some designs and drawing of hand tools were also obtained from Tinto Industries and a research and development activity is also carried out within the company. However, they inform that only minor changes have been introduced to the original drawings through the years, to suit local conditions.

Their line of products cover in hand tools : Hoes (a full line, including european Hoes) and axes, the animal drawn implements cover a wide range of Mouldboard ploughs (single, double and three furrow), cultivators, ridgers, harrows (triangular, diamond and zig-zag), groundnut shellers, rippers and planters, other hardware and chains are also produced. They are marketing these products under their trade marks "Mealie Brand" and "Victoria".

Their production program for 1989 calls for some 55,000 implements at 80 % capacity, which means about 2,000 tons of steel processed. Most of their steel requirements are obtained locally (95 to 98 %) from ZISCO (Zimbabwe Iron and Steel Corporation) and the remainig, mainly steel plates, from South Africa.

Research and Development.

The Ministry of Agriculture maintains an organization called The Institute of Agricultural Engineering, in a location situated some 30 km from Harare, where all agricultural equipment and implements, including tractors, are regularly evaluated, they are responsible for channelling all technical information from programme sponsors to WADCO (Ward Development Committe) and VIDCO (Village Development Committe) and viceversa. One WADCO is composed of many VIDCOs, for whom they normally do tractor and implements tests.

A representative of this Institute is also a member of the Agricultural Implements Priorities Committe, government entity responsible for assigning pricrities and authorizations to all expenditures of foreign exchange for imports of agricultural implements and equipment.

Some important research is permanently carried out at this Institute which includes development of implements for hand use, as well as for animal and tractor drawn, along with tests of tractors and equipment in actual use by farmers.

At the moment, a study of machinery and a catalogue on agricultural implements is almost finished and awaiting sponsorship for editing and publishing, csot which is estimated in approximately Z$ 40,000.

Maintenance.

This is, perhaps, the major problem that the agricultural sector of Zimbabwe is facing nowadadys, that if not solved, may put the agricultural production and productivity in serious difficulties within short.

The scarcity of foreign exchange in the country, which forces the government to exert a most strict control on all imports, is producing that the actual imports of spare parts, required to maintain the machinery and equipment park has been drastically reduced placing the market in a situation, where in some cases a piece of equipment has to sit a long time before it can be properly repaired, or else, it has to continue working in a deffective conditions, thus affecting other mechanical components, which in turn, will either leave the equipment idle for a longer time causing a more costly repair by the end.

The labour required to maintain the equipment, has the sufficient level of technology, at least in the major cities and it counts with the appropriate equipment and instruments to produce proper repair and maintenance to the equipment concerned.

Production Technology.

As mentioned above, the country has the appropriate and sufficient production technology to produce all hand tools and animal drawn, as well as tractor drawn implements.

however, there is not enough capacity to produce the designs required for the large farming and will still have to rely for a long time in foreign designs to satisfy the needs of that sector.

However, some efforts are being made by the large farmers and the industry to copy the experiences from other countries, but still at a slow pace. A general complain from the farmers, the smallers in particular, is that the locally produced implements have the tendency to be just a bit too heavy in most cases, for which the manufacturers answer that this is due to the lower quality of the steel available as compared with the imported implements and the harder soil conditions that demand heavier structures with heavier profiles.

One of the main limitations noticed, is that the national universities do not have a faculty of agricultural engineering, the large farms maintain in their payrolls enough proffesionals to cover their needs in farming, however, the smaller farmers, have to rely only on their own experience, without the advantage of receiving the more professional advise that could be available if there were more agricultural engineers produced by the universities.

Energy.

To satisfy its energy requirements the country relies in two main sources, the hydroelectricity generated at Kariba South Bank which represents the 33 % of the national

generation and on the thermal power stations in the interconnected system which burn coal from Wanky, which accounts for the remainining 66 % in the system, the non interconnected mainly in private hands accounts to about 1.5 percent of the generation produced in the country.

The petrol products are 100 % imported and there does not exist other sources of energy worth mentioning in the country. Most of the rural areas do not count with other energy sources than the fuelwood and charcoal, which according to some records collected by ECA means about 6 million metric tons of forestry products burnt in 1986, the largest consumption of wood in the country contributing to the large deforestation that the country is suffering in many areas.

The wind, solar, biogas or other sources of energy that could be made available to those areas, outside the cities and distant from the urban areas, is not being used except for some small applications for domestic uses, but not for farming. It is believed, that the wind energy could be used in a large scale to generate electricity, enough to supply electricity for small communities and for pumping water from deep wells for agricultural applications.

Imports.

As mentioned above, one of the major problems that the agricultural sector is facing is that of imported items, all tractors are imported, although assembled locally, but with almost no local content.

All imports are very strictly controlled by the government, through the Agricultural Implements Priorities Committe; this multilateral entity is formed by:

- one representative from the Economics and Markets Branch of the Ministry of Agriculture - who presides the committe.
- three representatives from the 3 farmers unions (1 ea)
- one representative from The Institute of Agricultural Engineering.
- two representatives from the Agricultural and Dealers Manufacturers Association (commercial companies).
- one representative from the Zimbabwe Tobacco Association.
- one representative from the Ministry of Trade and Commerce and
- one representative from the Ministry of Industry and Technology.

Their main task is to estimate the foreign currency requirements for all agricultural machinery, being the policy to maintain the fleet to approximately 22,000 tractors for all agricultural aplications, with a 10 percent per annum replacement rate, however, it is recognized by some of their members consulted, that said targets are not being met and that the spare parts situation has become more than critical.

The priorities ratings, under which this committe works are the following:

pr.1 Fuels, Tyres, lubricants, oils, greases, spares and bearings.

pr.2 a- tractors (38 to 89 kw) and 92 kw and over
b- kits for local manufacture of mowers, spreaders and sprayers.

pr.3 a- combine harvesters, groundnut harvesters
b- tractors up to 37 kw

pr.4 other specialized machinery, forrage harvesters, hay balers, etc.

Statistics.

The country maintains an organized entity named the Central Statistical Office, which produces several quite comprehensive publications with useful statistical data, that can reliably be used for different types of analysis.

The latest Statistical Year Book available corresponds to 1987, however, with data to the year 1985 or before.

The latest (to May 1989) Quarterly Digest of Statistics available is dated December 1988, which includes in most cases data to december 1987 and in few cases until december 1988.

Other government and non governmental entities also publish on quite regular basis, statistical useful and reliable data, some of which are even recommended by the Central Statistical Office for consultation.