- PN DBI-151 PN 9229

Western Agri-Management Company

FINANCIAL ANALYSIS SUPPLEMENT

TO

A FEASIBILITY STUDY OF
[illegible] TROPICAL
PRODUCTS
[illegible]

PN-ABT-131
isn 91249

1.0 INTRODUCTION AND SUMMARY

1.1 EXECUTIVE SUMMARY

Western Agri-Management, in cooperation with New Ag Zambia, Ltd., has prepared this feasibility study of a 10,000 hectare (25,000 acre) agricultural production complex to be located 170 kilometers Southeast of Lusaka, Zambia. The concept is to create a modern, irrigated farm, using the most current technology, that will produce high yields and good returns for the investors.

As proposed, the project will be developed in two phases. Phase I will irrigate 3,000 hectares (8,000 acres) with center pivot sprinklers and will include the necessary housing, infrastructure and processing facilities to enable the complex to operate at maximum efficiency. Phase II will double the production hectares with little additional infrastructure, thus reducing the overall unit cost.

The conditions necessary for the development of such a complex are a favorable combination of natural resources, political factors, certain infrastructure requirements and marketing considerations; all are potentially present and will provide a very suitable environment for the project as outlined in this study.

As proposed, the project will be funded from a variety of sources, mostly external to Zambia. This will require that a large percentage of the farm's output be exported to generate the hard currency needed to meet the debt service and to provide for returns to the investors. However, a large amount of wheat will be grown for sale on the domestic market. This will help to ease Zambia's growing dependency on agricultural imports, and will reduce the drain on hard currency.

The project, when developed, will deliver a variety of benefits to the local community. These include employment and training opportunities in agricultural production and processing, technical services to the local farmers, central marketing and processing facilities available to local farmers, improvements to the local infrastructure, and by supplying excess water to the farmers, the project will have a significant effect on the production levels of farms adjacent to the project.

Additionally, the project will have a beneficial impact on the entire nation. The project will introduce new agricultural production technology into the country, which will provide a model for further development. The farm's program of seed testing and production will make available new, high yielding crop

varieties to the entire country.

1.2 INTRODUCTION

With partial funding from the United States Agency for International Development, New Ag Zambia Ltd. entered into an agreement with Western Agri-Management of the United States to develop a feasibility study for an irrigated agricultural production complex in the Zambezi River Valley in Zambia.

The main objective of the study is the preparation of a development plan for a project that will best utilize the existing natural resources and infrastructure in accordance with the following objectives:

-- development of an economically viable and profitable production and processing complex;

-- creation of productive training and employment opportunities for the local residents;

-- establishment of technical services and marketing systems that will benefit both the area farmers and the project as a whole;

-- provide a model for future development of similar projects in Zambia.

The project, as proposed in this study, was designed with the above objectives in mind. In view of the country's policy to become self-sufficient in food production in the shortest possible time, emphasis should also be placed on rapid development and high production after an early starting date.

1.3 RESULTS, CONCLUSIONS & RECOMMENDATIONS

Based on the data collected and the analyses of these data as presented in the body of the study, the following conclusions and recommendations have emerged:

NATURAL RESOURCES:

The natural resources (i.e., soil, water, and climate) are excellent in almost every respect for the type of irrigated (and possibly non-irrigated) farming contemplated by the study, and for the production of a wide variety of crops in addition to the specific crops used in the model.

The combination of uniform, gently sloping land, excellent sandy

loam soils, and immediate proximity to an immense supply of high quality water from the Zambezi River make this particular site an almost ideal resource situation for the proposed agro-business complex.

INFRASTRUCTURE:

The local infrastructure (i.e., transportation, housing, labor supply, energy, etc.) is satisfactory for the project in most respects, however, substantial addition and improvements with respect to roads, buildings, processing facilities, river crossing facilities, and electric power supply will be required and will necessarily have to be built as a part of the project. Because of this infrastructure requirement, it is essential that the project be of substantial size even in its first phase in order to spread the cost of this infrastructure reasonably over large crop production areas.

With respect to pumping energy (the principal energy requirement), a major power line will be built from Chirundu to the site, a distance of approximately 15 kilometers, at an estimated cost of $1 million. This will bring power to the site at a lower cost than diesel power. The standard rates quoted are nevertheless higher than desirable for this quantity of power consumption. It will therefore be necessary to negotiate a more favorable rate to bring energy costs into line. (The construction of the line can also provide electricity to nearby users off the project area).

POLITICAL CLIMATE:

The government attitude appears to be good for this type of project, as they place high priority on agriculture - both for internal food supply and for export to produce foreign exchange. The government has been stable for 20 years (see Section 2.0). The President, Dr. Kenneth D. Kaunda, is a strong, stabilizing influence and enjoys great popularity and respect with the citizens and from other African countries.

Based on the government's reputation, it is anticipated that the necessary permits and special concessions needed for a beneficial project such as this will be obtainable. For reference, the following special conditions will be required for the project:

(a) Freedom to export all of the crops (except for the large quantity of wheat produced for internal consumption) and to retain the hard currency earned in order to provide for the large debt service payments plus a good return to outside equity investors, as an incentive for them to

invest.

(b) Exemption from duty on all essential imports and exemption from income tax until the debt is repaid.

(c) The unrestricted right to operate processing facilities such as the cotton gin, oil mill, and possible alcohol conversion plants, and to export the production thereof as needed to produce foreign currency for the project.

(d) Right to ship directly to Zimbabwe and thence to southern ports by barge or ferry across the Zambezi River (depending on the difficulty encountered in the Kafue River crossing facilities required).

(e) Assignment of a government official to assist the project manager in all government related matters such as imports, exports, permits, exchange, etc. and to expedite these processes on behalf of the project.

SCOPE OF THE PROJECT:

Because of the extensive resources available and the requirement for substantial infrastructure, the project has been planned in two phases as follows:

I. Development of 3,000 hectares (8,000 acres) primarily under center pivot irrigation (but with some other types of irrigation for comparison and demonstration) and including a variety of peripheral and vertical integration facilities (i.e., cotton gin, oil mill, seed processing and test facilities) plus housing, shops, bulk grain and bean storage and handling equipment. In the model used, the crops to be grown are cotton, groundnuts, wheat and castorbeans (see cropping plan), but a wide variety of other crops will certainly be grown as markets and the country's requirements indicate.

The water distribution system will consist of 18 pumps in the first phase, with water distribution lines. A pressure stabilizing reservoir and a highly developed pumping and valving system will provide reliable water supply without limiting the flexibility of the individual irrigation systems and their watering patterns required by specific crops.

II. Phase II will approximately double the amount of irrigated land, but at much lower unit cost because of the existing infrastructure which will not have to be duplicated.

It is strongly recommended that Phase II be added immediately following completion of Phase I, as it will reduce the cost of the infrastructure per hectare of farming and therefore greatly enhance the return on investment.

COST:

In addition to the land cost, the requirements for development of the project and provision of operating capital until the point of positive cash flow will be approximately $27 to $28 million U.S. Dollars.

MANAGEMENT:

Western Agri-Management Company will manage both the project development and the ongoing farming, which will follow the pattern of Western's successful operations of similar farms in the U.S. and other countries. The management and financial controls are discussed further in Section 6.0.

FINANCIAL FEASIBILITY:

Based on the assumption that the government concessions (as described above) will be made to this project, the project will produce profits beginning at completion of the project on the order of $6.5 million U.S.D. per year and a cash flow of $7.6 million U.S.D., using what the analysis shows to be the most conservative assumptions. The hard currency available under the conditions described will safely meet the debt service and provide a good return on investment as incentive for the equity investors.

TRAINING PROGRAM:

It is recommended that an effective training program be instituted at the very outset of the project and continue through the development and production stages. This will make it possible, within a few years, to replace most of the expatriate personnel with local professionals, technical people and skilled workers. A few management level trainees should be sent to Western's irrigated farm complex in Texas, U.S.A. for intensive training on that site.

It is also recommended that the training program should provide facilities for the training of neighboring farmers and technical people in order that a satellite farming concept can be instituted. This will ultimately result in the improvement of local production levels which will, in turn, supply raw goods for the project's central processing and marketing facilities.

2.0 BACKGROUND

2.1 GEOGRAPHICAL LOCATION

The Republic of Zambia is located in east central Africa, approximately between latitudes 8 degrees and 18 degrees South and between longitudes 22 degrees and 34 degrees East. The country has a total land area of 752,614 square kilometers (290,586 square miles) bordered on the north by Zaire, the east by Tanzania and Malawi, the south by Zimbabwe and Botswana and on the west by Angola, thus making it completely landlocked.

Physiographically, Zambia is part of the southern Africa uplands. It is mostly a flat or undulating plateau, averaging 900 to 1500 meters (2950 to 5000 feet) above sea level, except to the south where the Zambezi River has cut a deep valley that averages only 600 meters (2000 feet) in elevation, and which dips to almost 300 meters (1000 feet) on the border with Zimbabwe and Malawi.

Influenced by the relatively high altitude, Zambia's climate is considered sub-tropical even though the country is located in the tropical zone. Lusaka, the capital city, and the Copper Belt, where some of the worlds richest copper deposits are located, are both situated on this plateau and enjoy comfortable climates the year around. It is also in these areas where the majority of the country's people live.

Zambia's landlocked condition has been a major deterrent to international trade in the past, but recent developments such as the railway linking Zambia to the ocean port at Dar-es-Salaam, and the re-opening of the southern shipment route through Zimbabwe to the South African ports has alleviated much of the problem. Most of these improvements were made to benefit the copper industry in northern Zambia, but with the decline of the world copper markets, emphasis is now being placed on developing the agricultural sector of the economy to take advantage of the existing infrastructure and excellent natural resources.

2.2 BUSINESS ENVIRONMENT

2.2.1 POLITICAL SYSTEM

The Republic of Zambia has a governmental system termed a "one-party participatory democracy." A British Colony from 1924 to 1964, it gained independence at that time after considerable unrest among the native population, and served as a model for several other African nations striving for independence from colonial rule.

The current constitution, promulgated on August 25, 1973, abrogated the original 1964 constitution and provides for a strong president and a unicameral National Assembly. National policy is formulated by the 25-member Central Committee of the United National Independence Party (UNIP), the sole legal party in Zambia. The Cabinet executes the central committee's policy.

The candidate for the Office of President is selected by UNIP at the party's general conference, in accordance with the intention of formalizing UNIP supremacy. The president is elected by popular mandate to a five-year term, and enjoys substantial veto powers over any piece of legislation passed by the National Assembly. If the National Assembly overrides any veto by a two-thirds vote, the president may either assent to the legislation or dissolve the Assembly.

The National Assembly is composed of a maximum of 136 members, 125 of whom are elected to five-year terms. The president may appoint as many as ten additional members to enhance the tribal and geographical representation of the assembly. A speaker is selected by the members from outside their own ranks.

Members of the Zambian Cabinet are selected from the National Assembly by the president.

Zambia is divided into nine provinces, each administered by a Central Committee member. A House of Chiefs represents the interests of the country's traditional tribal authorities, and is advisory in capacity. The highest court and the court of appeal is the Supreme Court; below it are the High Court, Magisterial Court, and the local courts.

President Kenneth Kaunda, and also UNIP, have enjoyed widespread popular support since independence in 1964. President Kaunda has been able to bridge the rivalries between the country's various regions and tribal affiliations. He advocates a philosophy of "humanism," which stresses cooperation among people and condemns human exploitation. In addition, President Kaunda is widely known and respected by neighboring countries and throughout Africa.

Even though Zambia is a one-party state, political discussion within the country is vigorous, with strongly contested parliamentary elections and a press that enjoys a reasonable amount of freedom to criticize and comment on governmental policies and personalities.

2.2.2 LOCAL POLITICAL FACTORS

The Zambian economy has traditionally been dependent upon the sale and export of the copper resources of the northern provinces. Recently, however, the world copper market has faltered quite dramatically, leaving Zambia in a precarious economic condition. The entire economy has slowed due to the lack of foreign trade, and the foreign currency necessary to purchase raw goods and manufactured items from abroad is very scarce.

The Zambian government has increasingly put emphasis on stimulating agricultural production not only to reduce the amount of imports, but also to provide an environment in which the agricultural sector can develop major export capabilities to replace the copper industry in terms of foreign trade. Price supports for crops, improved tax legislation, repatriation of funds and a growing agricultural extension service have all played a part in increasing production. However, increasing demand and poor weather in recent years have forced the importation of several agricultural products, placing a severe strain on the already troubled balance of trade.

The 1984 Annual Plan continues to place special emphasis on the development of the agricultural and rural sectors as part of a broader strategy to restructure the national economy. Current and previous years' production strategy, supportive policy measures, and the allocation of investment resources in various programs in the agricultural sector, aim at the achievement of the following Third National Development Plan policy objectives:

(i) to promote self-reliance and self-sufficiency in staple foods, both nationally and regionally where feasible and to provide raw materials for agro-industries;

(ii) to stimulate and increase farm production for exports;

(iii) to increase the contribution of the rural sector to the Gross National Product and to promote the diversification of the rural economy;

(iv) to improve rural standards of living and nutritional status and to create a self-reliant and progressive rural economy;

(v) to create new employment and income opportunities in rural areas in order to counteract rural-urban migration, and to improve infrastructural services related to increased productivity in the sector.

2.2.3 MONETARY SYSTEM

2.2.3.1 CURRENCY

The Zambian unit of currency is the Kwacha, which is subdivided into one hundred ngwees. The letter K is used to denote the Kwacha. Like the currencies of most countries, the Kwachas recently depreciated against the U.S. Dollar. The current exchange rate was 1.78 to 1, as of August, 1984.

2.2.3.2 MONETARY POLICIES

In an effort to control foreign currency problems that have existed since the 1970's, the government has placed strict controls on all currencies entering or leaving the country. In order to finance the foreign exchange deficit, the government has also delayed allocations of foreign exchange on a substantial portion of foreign suppliers' credits and other remittances.

Temporary assistance to Zambia has been provided by the International Monetary Fund (IMF) to alleviate this problem and to assist the government in making structural changes in the economy that will reduce the dependency on foreign goods. These structural changes include diversification away from the copper industry and towards the manufacturing and agricultural sectors.

In order to encourage more rapid development in the agriculture sector, the government has instituted several programs that benefit commercial farmers and foreign investors. Among these are: reduced income tax rates, accelerated depreciation on farm equipment, a five year tax holiday on dividends derived from farm income and a repatriation of 50 percent of the income derived from exported agricultural products.

Individuals may not bring Zambian currency into the country and may bring only 10 Kwacha out. All foreign currency must be declared when entering the country and cannot be exported in amounts greater than those imported. Foreign exchange transactions may only be carried out with authorized exchange bureaus and banks, and foreigners may be required to pay for some services (i.e. hotels) with foreign currency.

2.2.4 DUTIES, TARIFFS AND TAXES

2.2.4.1 IMPORT DUTIES AND TAXES

Virtually all goods imported by commercial firms in the private sector are subject to licensing. There are several steps involved in the licensing procedure, including approval by the Ministry of

Commerce. The major problem encountered by most firms is the long time period to await Bank of Zambia allocation of foreign exchange, if the firm does not have access to foreign exchange in another manner such as product exports.

The proposed farm would be able to qualify for several programs that give relief from most of the restrictions placed on enterprises that either import or export goods. Under the Industrial Development Act, the farm as an enterprise that exports a substantial amount of its products, would be eligible for relief from customs duties on machinery, relief from income tax, favorable adjustment of export tariff rates, relief from import tariffs on raw materials, and preferential treatment with respect to the granting and processing of import licenses. Certain special concessions will be needed by the farm to streamline the export of large quantities of products and to make possible the timely import of essential elements of high yield production.

Recent legislation (July, 1984) reduced dramatically the import tariffs levied on many items considered to be important for the development of the Zambian economy. Tariffs on most agricultural machinery were reduced to zero in an effort to encourage the more rapid build-up of the agricultural sector.

2.2.4.2 TAXATION OF AGRICULTURAL ENTITIES

Most businesses resident in Zambia are subject to income tax at a uniform rate of 45 percent of business profits. However, concessionary rates are given to businesses in rural areas (30 percent) and to farming concerns (15 percent). As a "priority enterprise," the farm will also receive relief from sales tax on imported goods, and from import tariffs, as mentioned earlier.

Individual income tax rates are progressive from 5 percent to 80 percent on incomes in excess of K25,000. Zambia and the United States are signatories to a treaty for the avoidance of double taxation and fiscal evasion of income taxes.

2.2.5 GOVERNMENTAL INCENTIVES AND REGULATION

As stated in previous sections concerning taxation, there are several laws to provide incentives for "priority enterprises," as determined by the Ministry of Commerce. These incentives reflect the official policy of the government to give high priority to rural development, operate a crash program in agriculture to regain food self-sufficiency, promote the use of local materials, expand exports, and create additional employment opportunities for Zambians.

The only screening process for investments in agricultural enterprises is the application process for registration of foreign companies, if the majority of equity capital is foreign owned, pursuant to the Companies Act. The Ministry of Commerce does not investigate claims of foreign ownership. (In the case of this project, this step has already been accomplished with the establishment of New Ag Zambia, LTD.).

Dividends and profits earned by foreign controlled companies in Zambia have for several years been subject to being placed in a queue of companies awaiting foreign exchange cover. The length of the pipeline is determined by foreign currency reserves, but the current queue is in excess of 38 months and getting longer. Recent legislation to improve this situation somewhat for "priority enterprises" allows the foreign company to retain 50 percent of its earnings from export sales in the form of foreign exchange, thus by-passing the long wait usually necessary.

As previously stated in Section 1.0 of this report, the feasibility of this project is dependent on gaining preferential treatment by the government regarding import and export regulations and the ability to retain foreign exchange earnings to service the foreign debt and provide for returns to the investors. Due to the nature of the financing involved, it will not be possible for the farm to operate with a long delay in receiving foreign exchange from its export sales and, therefore, special concessions will be needed to make the project feasible.

2.3 MARKETS

2.3.1 STRUCTURE

The market structure for most agricultural products in Zambia is controlled by the government through various cooperative marketing unions and parastatal organizations that provide centralized purchasing and marketing services which the farmers are required to use. These organizations purchase the agricultural products from the producers at the government specified producer prices, and then transfer the products to centralized receiving stations for storage, processing and distribution.

The goal of the government in establishing this centralized market structure was to provide an efficient marketing system that could be used to control the production of various crops by adjusting the producer prices to favor the crops most needed by the country, to provide marketing services to the producers in undeveloped areas that otherwise would not receive them, and to encourage agricultural production by making the returns from an agricultural investment attractive to businessmen.

The role of the large parastatal organizations such as the National Agriculture Marketing Board and the Cold Storage Board has been decreased recently in favor of the smaller cooperative marketing unions. These organizations have shown better performance by reducing the inefficiencies and duplication of operations that were present in the larger parastatals.

2.3.2 EXPORT MARKETS

Currently, very few agricultural products are exported from Zambia due primarily to the shortages present in the major food crops domestically. Tobacco and maize are exported in limited amounts when excess supply over domestic consumption exists, but these rarely account for more than one percent of the country's exports.

Zambia's domestic cotton production in recent years has been in excess of the country's ability to process the raw material into textiles. The excess has been exported through agents in South Africa and Kenya, with the assistance of the Lint Company of Zambia, Ltd., a parastatal organization.

Restrictions on exporting several agricultural commodities currently exist in Zambia for products that are considered essential commodities. These include most edible oil seeds, maize, and wheat. However, in accordance with the government's

desire to see increased exports and the resultant foreign exchange, it is anticipated that these restrictions will be removed to allow the export of all of the farm's output necessary to cover the foreign debt and provide for investors' returns.

Generally, the prevailing prices for export goods in Zambia are reflective of the international markets, minus shipping to the point of use. For the crops being considered for production on this project, the best markets exist in Europe. Figure 2.3.2 A shows a representative list of prices for agricultural commodities in Europe, including the cost of freight.

2.3.3 LOCAL MARKETS

Local markets for all agricultural products except fresh vegetables are through the parastatal companies and the local cooperative marketing unions. Producer prices are established each year by the government at prices that will encourage the production of goods most needed by the country. In the past, determination of these prices has often failed to take all of the important factors into consideration, resulting in imbalanced production.

The major constraint facing the parastatal and cooperative organizations is the lack of sufficient infrastructure to properly collect and process the nation's output. A considerable portion of the agricultural production occurs in areas with poor roads and communications, making it difficult to reach all of the growers. The government has addressed this problem in recent years by allocating more funds to improve the road system and to build more product collection points, but still many areas are unserviced.

Recently there have been several recommendations made by various governmental and private groups to allow a more free market approach in the agricultural sector. These groups argue that a free market can best use the resources available. Although steps toward a free market have been taken by the government, the local markets most probably will continue to be controlled by the parastatal organizations for some time.

7.0 BENEFITS TO THE COUNTRY

There is an aspect to the development of a large, modern farming complex in a relatively undeveloped area which is not easily defined in precise numerical terms, but which nevertheless is significant both to the agricultural project itself and the community and country in which it is located.

Western has learned from experience in many countries that when such a project is built in an undeveloped area, it has a significant beneficial impact on the socio-economic status of the region in which it is located. These benefits include services to the farmers, training, making available new technology, improvement of the existing infrastructure, and several other less tangible aspects that will generally improve the life of the people in the community.

As these benefits flow to the locality around the project, some of these factors will in turn contribute to the ultimate success of the project. For example, providing extension services and a central marketing facility for the farmers in the area will help provide the raw materials necessary to fully utilize the processing facilities to be built on the farm.

7.1 SERVICES

There are a number of services that the project can provide to the people that will benefit both parties. Perhaps the most important will be extension services to help the local farmers improve their yields and increase their crop base. The agronomists on the project will not only be able to instruct the farmers in a classroom situation, but will be able to show them the results of improved technology with the crops being grown on the project.

It is important to note here that extension services alone have little effect without first demonstrating the results. It has been Western's experience that the teacher must first produce outstanding crops on a substantial scale to establish credibility. The neighbors will then ask how it is done; then, and only then, can effective teaching be done to a receptive farmer.

Along with the extension services, the project will be able to help the local farmers by providing them with the excess water it generates to irrigate their own fields during the dry season. It is estimated that this factor alone could double the production of the farmers immediately adjacent to the farm.

Historically, the market structure in Zambia has often failed to adequately serve the relatively isolated areas such as Chiawa, which negates any advances in yields which would result from the improvements mentioned above. However, the project will also act as a central marketing facility, buying specified products from the local farmers, and reselling them along with the products grown on the farm. This will not only beneficially serve the farmers, but will also relieve some of the pressure on the over burdened infrastructure of the parastatal companies responsible for marketing all of the farmers' products at the present time.

Seed will be both imported and produced on the farm, with a constant program of testing and improvement. This program will not only provide the project with high yielding seed, but will also make available the selected varieties to the general public. Quality seed can have a great effect on the yield potential of all of the farmers who use it, and the effect takes place within one year, with rapid multiplication of the results.

This same program of seed development and distribution is being used successfully in Western's project in Paraguay with soybean and wheat seed. In Paraguay, Western imported and tested varieties to obtain superior seed stock and then expanded it by growing out the best varieties. This year Western is selling about 800 tons of superior seed to its neighbors, which will have a significant effect on the bean and wheat yield of the area. The program is expanding rapidly.

7.2 TRAINING

As detailed in Section 6.5, the training program will have a substantial effect on the neighboring community by providing instruction in modern agricultural practices, as well as teaching mechanics, tractor and implement operators, truck drivers, and electrical repairmen among others.

The development of a sound, educated base of workers will attract further development, which in turn will provide more training opportunities, thus repeating the cycle.

It is anticipated that key local professionals will be sent to Western's farms in the United States to receive intensive training in advanced production methods. As some of these people leave the project to go to other jobs, they will take with them the knowledge they gained, benefiting not only themselves but the whole country.

7.3 TECHNOLOGY

The advanced technology necessary to successfully operate a large production complex is not currently available in Zambia. Initially, all of the equipment and machinery will be imported from outside sources, but the presence of only a few of these farms will stimulate an industry within the country to provide support in the form of spare parts, trained service people, and eventually the manufacturing plants to produce many of the items of equipment.

7.4 INFRASTRUCTURE

The project will bring substantial improvement to the local infrastructure. Perhaps the most important will be the electrical line from Chirundu to the project site. This will bring electricity to within five kilometers of the village of Chiawa, and for the first time, the local people will have access to electrical power.

The project will also require the improvement and maintenance of the road system in the area to facilitate the shipment of products to and from the farm. Enlargement of the ferry on the Kafue River will mean better access for everyone in the Chiawa area.

7.5 OTHER BENEFITS

With all of the above mentioned improvements, it is expected that the local farmers will be able to produce and market more and better products than ever before. The sale of export crops for hard currency by the locals, through the project's marketing facilities, will enable them for the first time to obtain their own small scale irrigation and farming equipment, further improving their earnings.

The improvement of the area's standard of living will bring other changes as well. Better diets and the project's medical facilities will improve the general health of all of the people in the area, and the increased earnings should bring about improved educational opportunities.

With the country's severe balance of trade problems, the farm's export sales will bring much needed foreign currency into the country on a very significant scale.

8.0 FINANCIAL ANALYSIS

The following section outlines the projected financial status of the proposed project for a 15-year period. These projections are based on two scenarios: 1) a minimum expected yields and markets condition; and 2) an average expected yields and markets condition, where the minimum and average conditions are used to analyze the financial position of the farm over the 15-year period.

Section 8.1 outlines the project development costs, as determined by the analysis completed in the main feasibility study.

Sections 8.2 and 8.3 show the expected costs of operations and sales from operations at the minimum expected yields and markets condition. These numbers are derived from the attached spread sheet at the end of this section, which computes the costs and revenues based on farming costs and market prices of the crops considered.

Projected cash flows and pro forma income statements and balance sheets for each of the two conditions are shown in Section 8.4, along with the projected internal rates of return.

8.0 FINANCIAL ANALYSIS

8.1 DEVELOPMENT COSTS

Mobilization	$ 200,000
Electric Power Distribution System	1,043,750
Irrigation Equipment	3,240,000
Management and Technical Supervision, Travel, U.S.A. Office Service, Overhead and Profit to Management Company	2,850,000
Development Equipment	1,228,000
Farm Machinery	5,268,150
Water Distribution System	4,615,000
Personnel - On-Site	146,250
Farm Compound Buildings	816,000
Cotton Gin	497,000
Oil Press	596,000
Ferry Boat	200,000
Grain Storage	628,700
Roads and Clearing	900,000
Fencing	387,000
Total Development Costs	$ 22,615,850

ELECTRIC POWER DISTRIBUTION SYSTEM

15 Km	66 KV line	$ 210,000
34 Km	380 V line - overhead	476,000
24 Km	380 V line - underground	192,000
1	11 to 66 KV Transformer	76,500
1	66 KV to 380 V Transformer	89,250
	Total	$ 1,043,750

IRRIGATION EQUIPMENT

60 Center Pivot Sprinklers:

400 meter Lateral,

Nozzle Package,

Pressure Relief Valve, Fertilizer

Injector, Fertilizer Tank, Underground

Piping, Flow Meter, Freight and Installation

$ 3,240,000 Total

DEVELOPMENT EQUIPMENT

Construction Equipment		
2	D-6 Bulldozers with Rippers	$ 220,000
1	Road Grader	82,000
1	Wheel Loader	60,000
1	4 WD Forklift	45,000
1	Concrete Batch Truck	90,000
1	Excavator, Rubber-tired	135,000
1	15 Ton Dump Truck	61,000
1	5 Ton Water Truck	50,000
1	Boom Truck with 3 Ton Hoist	65,000
3	Backhoes with Loader and Fork Attachments	180,000
1	2 Ton Repair Truck with Tools	35,000
4	Tandem Axle Trailers	25,000
1	35 HP Skid Steer Loader	20,000
Vehicles		
1	Toyota Land Cruiser	15,000
6	4 WD Mini Pickups	60,000
2	12 Passenger Buses	40,000
Tools and Miscellaneous		
1	Portable Diesel Welder	3,000
2	AC-DC Electric Shop Welders	4,000
3	Cutting Torch Assemblies	2,000
1	Electric Air Compressor	3,000
1	Portable Diesel Air Compressor	3,000
1	Metal Lathe	5,000
1	100 KW Diesel Generator Set	25,000
	Total	$ 1,228,000

FARM MACHINERY

18	150 HP Tractors (or equivalent HP)	$ 810,000
4	6 Meter Grain Drills	48,000
6	Combines	480,000
12	Grain Carts	180,000
10	5 Meter Offset Discs	150,000
10	5 Meter Tandem Discs	120,000
6	8 Row Unit Planters	100,000
10	Row Crop Cultivators	80,000
4	Groundnut Diggers / Windrowers	25,000
15	Groundnut Harvesters	390,000
68	Groundnut Drying Wagons w/ Dryers	359,000
13	4-Row Cotton Pickers	1,430,000
4	Cotton Module Makers	250,000
6	8-Ton Dry Fertilizer Spreaders	72,000
1	16-Ton Dry Fertilizer Tender	12,000
2	8 Meter Fertilizer Conveyors	25,000
10	Field Sprayers w/ 12 Meter Booms	50,000
		$ 4,581,000
	15% Spare Parts	687,150
	Total	$ 5,268,150

WATER DISTRIBUTION SYSTEM

Materials	Amount Required	Cost
1.83 meter Steel Pipe	8,400 meters	$ 2,000,000
1.524 meter Steel Pipe	1,700 meters	340,000
.930 meter Steel Pipe	5,200 meters	468,000
.762 meter Steel Pipe	6,400 meters	384,000
.610 meter Steel Pipe	7,300 meters	365,000
.410 meter PVC Pipe	1,600 meters	64,000
.356 meter PVC Pipe	800 meters	28,000
.305 meter PVC Pipe	1,900 meters	50,000
.254 meter PVC Pipe	9,600 meters	192,000
.203 meter PVC Pipe	16,100 meters	209,000
Pumps & Motors & Controls		350,000
60 1/4 Turn Valves - Electric for 8" Pipe		12,000
10 4" Vacuum Reliefs - $85.00		1,000
36 14" Dressler Couplers		7,000
18 14" Pressure & Vacuum Relief Valves		9,000
18 14" Gate Valves		18,000
18 14" Foot Valves		18,000
Reservoir		100,000
	Total	$ 4,615,000

FARM COMPOUND BUILDINGS

4	3 Bedroom Staff Houses	$ 200,000
1	Staff Kitchen and Dining Area	51,000
1	24 Room Dormitory with Kitchen, Dining and Laundry Facilities	224,400
1	Warehouse 20 M x 30 M	105,000
1	Workshop 28 M x 16 M	89,600
1	Water Tank	50,000
1	Covered Equipment Storage 15 M x 60 M	45,000
1	Office Building 15 M x 8.5 M	51,000
	Total	$ 816,000

COTTON GIN

1	Reconditioned Saw Gin FOB Houston	$ 280,000
	Freight	50,000
	Building 12 M x 30 M	72,000
	Concrete	35,000
	Erection	60,000
	Total	$ 497,000

OIL PRESS

1	Reconditioned Screw Press FOB Houston	$ 222,000
	Freight	42,000
	Buildings	
	Process Room 10 M x 30 M	60,000
	Cleaning and Refining 12 M x 20 M	48,000
	Storage Silo	75,000
	Oil Storage Tanks	75,000
	Erection	60,000
	Concrete	14,000
	Total	$ 596,000

GRAIN STORAGE

12,250 Metric Ton Capacity Storage
for Grain Crops

4,100 Metric Ton Capacity Storage
for Groundnuts

Scale, Dump pit, Conveyor System and
Drying Capability

Cost	$ 440,400
Freight	90,000
Erection	60,000
Concrete	38,300
Total	$ 628,700

8.2 ANNUAL COST OF OPERATIONS

FULL YEAR OF PRODUCTION 3,000 HECTARES

Direct Variable Farming Costs	$ 4,553,840
Personnel	148,150
Minimum Management Fee (Est.)	1,200,000
Training Program	51,000
Operation and Maintenance	153,000
Depreciation	1,194,300
Total	$ 7,300,290

DIRECT VARIABLE FARMING COSTS

	Per Hectare	Total
Cotton	869.16	$ 1,738,320
Groundnuts	1,175.70	1,175,700
Wheat	426.21	852,420
Castorbeans	787.40	787,400
	Total	$ 4,553,840

OPERATION AND MAINTENANCE

Fuel - Vehicles	$ 48,000
Engine Oil	5,000
Equipment - Repairs and Parts	50,000
Office Supplies	10,000
In-Country Travel	10,000
Miscellaneous Expenses	30,000
	$ 153,000

DEPRECIATION SCHEDULE

	Total	Estimated Life-Years	Annual Depreciation
Irrigation Equipment	3,240,000	30	108,000
Water Distribution System	4,615,000	30	153,830
Farm Compound Buildings	816,000	30	27,200
Cotton Gin	500,000	15	33,330
Oil Press	600,000	15	40,000
Grain Storage	1,198,250	20	60,000
Farm Machinery	5,268,150	7	752,590
Fencing	387,000	20	19,350
			$ 1,194,300

COST OF OPERATIONS

1ST SEASON - 500 HECTARES

Direct Variable Farming Costs		$ 587,849
Personnel		25,200
Training Program		25,500
Operation and Maintenance		26,000
Depreciation		69,200
	Total	$ 733,749

OPERATION AND MAINTENANCE

Fuel Vehicles		$ 8,000
Engine Oil		1,000
Equipment - Repairs and Parts		8,000
Office Supplies		2,000
In-Country Travel		2,000
Miscellaneous Expenses		5,000
	Total	$ 26,000

DEPRECIATION SCHEDULE

	Total	Estimated Life-Years	1st Season Depreciation
Irrigation Equipment	540,000	30	$ 9,000
Water Distribution System	770,000	30	12,800
Farm Compound Buildings	816,000	30	13,600
Farm Machinery	338,000	7	24,100
Fencing	387,000	20	9,700
			$ 69,200

8.3 ANNUAL SALES FROM OPERATIONS - GROSS

1ST SEASON
(Based on "minimum expected" yields and markets)

500 Hectares Groundnuts

Expected Yield	=	3.0 Metric Tons/Hectare
Expected Price	=	$ 1,100/Metric Ton - CIF Europe
Total Expected Sales	=	$ 1,650,000

- -

1ST FULL YEAR OF PRODUCTION - GROSS
(Based on "minimum expected" yields and markets)

2,000 Hectares Wheat

Expected Yield	=	4.5 Metric Tons/Hectare
Expected Price	=	$ 400/Metric Ton - Domestic
Total Expected Sales	=	$ 3,600,000

1,000 Hectares Castorbeans

Expected Yield	=	1.375 Metric Tons/Hectare Oil
Expected Price	=	$ 1,200/Metric Ton - CIF Europe
Total Expected Sales	=	$ 1,650,000

2,000 Hectares Cotton

Expected Yield	=	1.305 Metric Tons/Hectare Lint
Expected Price	=	$ 1,760/Metric Ton - CIF Europe
Expected Yield	=	1.45 Metric Tons/Hectare Seed
Expected Price	=	$ 200/Metric Ton - Domestic
Total Expected Sales	=	$ 5,173,600

1,000 Hectares Groundnuts

Expected Yield	=	3.0 Metric Tons/Hectare
Expected Price	=	$ 1,100/Metric Ton - CIF Europe
Total Expected Sales	=	$ 3,300,000

TOTAL EXPECTED SALES FOR YEAR = $ 13,723,600

8.4 ANALYSIS OF RETURNS (PROFIT AND CASH FLOW)

1ST SEASON
(Based on "minimum expected" yields and markets)

Revenue from Operations - Gross		
500 Hectares	$	1,650,000
Costs of Operations		
500 Hectares		733,749
NET INCOME	$	916,251
		=========
Net Income	$	916,251
Add Back Depreciation		69,200
Total Cash Flow	$	985,451

- -

FIRST FULL YEAR OF PRODUCTION (PROFIT AND CASH FLOW)
(Based on "minimum expected" yields and markets)

Revenue from Operations - Gross		
3000 Hectares	$	13,723,600
Costs of Operations		
3000 Hectares		7,300,290
NET INCOME	$	6,423,310
		=========
Net Income	$	6,423,310
Add Back Depreciation		1,194,300
Total Cash Flow	$	7,617,610

Notes:

1. Above shows costs based on minimum management fee only. Actual management fee may be higher depending on incentive payment of management contract.

2. The above summary is considered to reflect minimum expected cash flows and profits for the following reasons:

   a. The most conservative estimates of costs of production and prices recieved have been used,
   b. Yields will be expected to increase after one year of operating experience,
   c. Purchase of inputs are in all cases based on the least favorable Dollar/Kwacha exchange rate,
   d. Additional higher income specialty crops will be produced after the initial two year startup period.

PROJECT CASH REQUIREMENTS

Land: 10,000 Hectares (by New Ag Zambia, Ltd.)	
Development Costs	$ 22,615,850
Operating Capital	3,561,122
Contingency and Inflation	1,400,000
TOTAL PROJECT CASH REQUIREMENT EXCLUDING LAND	$ 27,576,972

ZAMBIA- CASH FLOW PROJECTION
by Quarter, First five fiscal years
Average expected yields and markets condition

	QUARTERS I	II	III	IV	FISCAL YEAR 1	QUARTERS I	II	III	IV	FISCAL YEAR 2	QUARTERS I	II	III	IV	FISCAL YEAR 3	QUARTERS I	II	III	IV	FISCAL YEAR 4	QUARTERS I	II	III	IV	FISCAL YEAR 5
PRODUCTION INCOME	0	0	0	2,145,060	2,145,060	0	6,310,060	0	0	10,177,200	16,487,260	0	6,310,060	0	10,177,200	16,487,260	0	6,310,060	0	10,177,200	16,487,260	0	6,310,060	0	10,177,200	16,487,260
INTEREST INCOME	0	105,675	89,562	61,908	257,147	87,777	75,000	149,181	87,898	399,857	275,419	119,550	221,262	155,817	772,028	280,124	172,017	226,147	111,082	789,380	287,904	124,420	230,915	113,496	756,745
TOTAL INCOME	0	105,675	89,562	2,206,968	2,402,207	87,777	6,385,060	149,181	10,265,098	10,577,057	275,419	6,429,550	221,262	10,332,017	11,022,228	280,124	6,482,017	226,147	10,288,082	11,026,580	287,904	6,434,420	230,915	10,290,696	17,244,005
DIRECT VARIABLE COSTS																									
MATERIAL	0	0	328,800	3,660	332,460	808,500	0	1,395,100	170,000	2,373,600	808,500	0	1,795,100	170,000	2,373,600	808,500	0	1,795,100	170,000	2,373,600	808,500	0	1,795,100	170,000	2,373,600
TILLAGE	0	0	19,721	10,593	30,313	70,992	48,192	81,218	107,598	308,100	70,992	48,192	81,218	107,598	308,100	70,992	48,192	81,218	107,598	308,100	70,992	48,192	81,218	107,598	308,100
IRRIGATION	0	0	99	9,620	9,719	180,785	134,874	10,116	122,789	450,564	180,785	134,874	10,116	122,789	450,564	180,785	134,874	10,116	122,789	450,564	180,785	134,874	10,116	122,789	450,564
PROCESSING	0	0	0	0	0	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000
TRANSPORTATION	0	0	0	292,500	292,500	0	387,500	0	1,076,700	1,464,200	0	387,500	0	1,076,700	1,464,200	0	387,500	0	1,076,700	1,464,200	0	387,500	0	1,076,700	1,464,200
MARKETING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADMINISTRATIVE COS'S																									
PERSONNEL	0	0	12,6[illegible]	12,600	25,200	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152
MANAGEMENT FEE	0	0	100,000	100,000	200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000
TRAINING PROGRAM	0	0	12,750	12,750	25,5[illegible]	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000
OPER. AND MAINT.	0	0	13,000	13,000	26,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000
DEPRECIATION	0	0	34,600	34,6[illegible]	69,2[illegible]	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300
INTEREST	734,176	734,176	734,176	734,176	2,936,706	734,176	734,176	734,176	734,176	2,936,706	734,176	711,195	688,252	665,311	2,798,934	642,369	619,428	596,486	573,544	2,431,827	550,602	527,661	504,719	481,777	2,064,759
TOTAL EXPENSES	734,176	734,176	1,246,726	1,222,662	3,937,740	2,481,526	2,045,374	2,051,400	2,944,111	10,519,412	2,481,526	2,045,374	2,051,400	2,944,111	10,518,411	2,444,209	1,953,667	2,767,613	2,902,144	10,068,742	2,297,492	1,861,840	2,477,846	2,810,477	9,447,675
NET OPERATING PROFIT	-734,176	-628,462	-1,156,753	984,306	-1,535,533	-2,393,749	4,339,685	-1,757,967	7,320,987	57,645	-2,205,107	4,384,176	-1,830,138	7,387,906	7,504,817	-2,163,085	4,528,350	-2,541,456	7,386,938	7,957,838	-2,009,588	4,572,581	-2,246,931	7,480,219	7,796,585
B LOANS	16,176,972				16,176,972	0	0	0	0	0										0					0
PRINCIPLES CAPITAL	12,000,000				12,000,000					0										0					0
EQUITY (OWN FUND)	3,400,000				3,400,000															0					0
ADD BACK DEPRECIATION	0	0	34,600	34,600	69,200	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300
DEVELOPMENT COSTS	27,615,950				-27,615,950															0					0
PRINCIPLE PAYMENTS	0	0	0	0	0	0	0	0	0	0	-611,780	-611,780	-611,780	-611,780	-2,447,122	-611,780	-611,780	-611,780	-611,780	-2,447,122	-611,780	-611,780	-611,780	-611,780	-2,447,122
DIVIDENDS	0	0	0	0	0	0	0	0	0	0	-3,716,769	0	-1,222,078	0	-4,938,847	1,168,577	-4,222,264	0	-1,795,874	0	-1,771,222	-4,216,142	0	-1,924,591	0
SUB TOTAL: Cash Flow	4,226,966	-628,462	-1,122,153	1,018,906	3,495,274	-2,095,975	4,575,260	-2,050,327	7,320,857	7,523,895	-6,275,582	4,070,951	-4,565,440	6,978,601	1,208,529	6,348,587	6,165,225	-4,402,265	7,491,833	190,793	-4,528,934	4,259,285	-4,696,767	7,167,014	190,715
CUM. CASH FLOW	4,226,966	3,598,504	2,476,379	3,495,274	3,495,274	1,400,063	5,975,259	3,925,932	11,246,789	11,246,789	4,971,187	8,852,138	4,286,698	11,225,249	11,225,249	17,573,836	9,845,874	5,443,209	12,934,042	12,934,042	8,477,296	12,736,581	8,039,814	19,206,857	19,206,857

TOTAL PROJECT COST = 32,576,972
TOTAL LOAN BOW T = 19,576,972
ASSUMPTIONS

YIELDS:
COTTON = 2.0 METRIC TONS PER HECTARE SEED COTTON PRICES:
GROUNDNUTS = 2.0 METRIC TONS PER HECTARE
WHEAT = 5.0 METRIC TONS PER HECTARE
SUNFLOWERS = 3.0 METRIC TONS PER HECTARE

COTTON = $1760 PER METRIC TON LINT CIF EUROPE
GROUNDNUTS = $1200 PER METRIC TON CIF EUROPE
WHEAT = $400 PER METRIC TON DOMESTIC MARKET
SUNFLOWERS = $1200 PER METRIC TON CRUDE OIL CIF EUROPE

BEST AVAILABLE COPY

...ASH- CASH FLOW PROJECTION
by quarter, year 6 through 10
average expected yields and markets condition

	QUARTERS I	II	III	IV	FISCAL YEAR 6	QUARTERS I	II	III	IV	FISCAL YEAR 7	QUARTERS I	II	III	IV	FISCAL YEAR 8	QUARTERS I	II	III	IV	FISCAL YEAR 9	QUARTERS I	II	III	IV	FISCAL YEAR 10
PRODUCTION INCOME	0	6,310,000	0	10,177,250	16,487,250	0	6,310,000	0	10,177,250	16,487,250	0	6,310,000	0	10,177,250	16,487,250	0	6,310,000	0	10,177,250	16,487,250	0	6,310,000	0	10,177,250	16,487,250
INTEREST INCOME	292,671	127,121	276,244	126,201	822,237	299,015	129,548	241,027	118,616	787,206	322,783	121,962	245,798	122,578	813,121	757,221	124,375	250,562	122,441	815,599	312,219	126,789	255,359	125,853	820,220
TOTAL INCOME	292,671	6,437,121	276,244	10,303,451	17,309,487	299,015	6,439,548	241,027	10,295,866	17,274,456	322,783	6,441,962	245,798	10,299,828	17,300,371	757,221	6,444,375	250,562	10,299,691	17,302,849	312,219	6,446,789	255,359	10,302,853	17,307,470
DIRECT VARIANCE COSTS																									
MATERIAL	848,500	0	1,395,100	170,000	2,373,600	848,500	0	1,395,100	170,000	2,373,600	848,500	0	1,395,100	170,000	2,373,600	848,500	0	1,395,100	170,000	2,373,600	848,500	0	1,395,100	170,000	2,373,600
TOLLAGE	70,992	48,192	81,318	167,598	368,100	70,992	48,192	81,318	167,598	368,100	70,992	48,192	81,318	167,598	368,100	70,992	48,192	81,318	167,598	368,100	70,992	48,192	81,318	167,598	368,100
IRRIGATION	18,745	136,874	19,116	122,789	450,544	180,785	136,874	19,116	122,789	450,544	180,785	136,874	19,116	122,789	450,544	18,745	136,874	19,116	122,789	450,544	180,785	136,874	19,116	122,789	450,544
PROCESSING	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000
TRANSPORTATION	0	387,510	0	1,076,750	1,464,260	0	387,510	0	1,076,750	1,464,260	0	387,510	0	1,076,750	1,464,260	0	387,510	0	1,076,750	1,464,260	0	387,510	0	1,076,750	1,464,260
MARKETING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADMINISTRATIVE COSTS																									
PERSONNEL	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152
MANAGEMENT FEE	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000
TRAINING PROGRAM	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000
OPER. AND MAINT.	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000
DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300
INTEREST	447,789	424,837	411,865	378,934	1,663,345	355,982	333,043	310,098	287,157	1,286,277	214,215	241,273	218,331	195,390	869,209	172,448	149,506	126,564	103,622	552,140	80,681	57,739	34,797	11,855	185,072
TOTAL EXPENSES	2,154,679	1,758,986	2,575,012	2,707,624	9,226,261	2,102,872	1,667,219	2,483,245	2,615,807	8,869,143	2,011,105	1,575,452	2,391,078	2,524,943	8,503,577	1,919,128	1,483,685	2,279,711	2,422,222	8,105,046	1,827,571	1,391,918	2,207,944	2,340,525	7,767,958
NET OPERATING PROFIT	-1,861,987	4,678,135	-2,298,768	7,595,777	8,083,226	-1,804,857	4,772,329	-2,242,219	7,679,958	8,405,313	-1,688,322	4,866,510	-2,145,484	7,774,885	8,796,793	-1,161,907	4,960,690	-2,029,149	7,876,919	9,168,373	-1,515,352	5,054,871	-1,907,614	7,962,499	9,594,404
B LOANS					0	0	0	0	0	0					0					0					0
PRINCIPLES CAPITAL					0					0					0					0					0
RATIONAL LOAN ICR BI					0					0					0					0					0
ADD BACK DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300
DEVELOPMENT COSTS					0					0					0					0					0
PRINCIPLE PAYMENTS	-611,780	-611,780	-611,780	-611,780	-2,447,122	-611,780	-611,78	-611,780	-611,780	-2,447,122	-611,780	-611,780	-611,780	-611,780	-2,447,122	-611,780	-611,780	-611,780	-611,780	-2,447,122	-611,780	-611,780	-611,780	-611,780	-2,447,122
DIVIDENDS	-4,616,857	0	2,149,756	0	-6,526,613	-4,620,598	0	-2,341,642	0	-6,962,239	-4,611,333	0	-2,533,777	0	-7,145,110	-4,602,046	0	-2,727,347	0	-7,329,393	-5,192,759	0	-2,922,260	0	-8,115,019
SUB TOTAL - CASH Flow	-6,022,050	4,364,929	-4,801,720	7,277,572	213,741	-6,728,660	4,459,124	-4,896,486	7,366,753	190,731	-6,032,855	4,553,304	-4,990,467	7,464,533	190,715	-5,973,626	4,647,485	-5,084,847	7,552,113	190,715	-7,021,216	4,741,665	-5,179,028	7,649,254	190,715
CONT. CASH FLOW	5,149,827	9,449,754	4,648,034	11,925,598	11,925,598	5,181,938	9,641,062	4,744,576	12,111,329	12,111,329	5,278,473	9,831,777	4,841,111	12,302,044	12,302,044	5,275,044	10,022,493	4,957,646	12,492,759	12,492,759	5,471,543	10,213,208	5,074,181	12,683,474	12,683,474

BEST AVAILABLE COPY

	QUARTERS				FISCAL	QUARTERS			FISCAL	QUARTERS			FISCAL	PLAN	TOTS	QUARTERS			FISCAL	QUARTERS			FISCAL
	I	II	III	IV	YEAR 19	I	II	III	IV	YEAR 19	I	II	III	IV	YEAR 19	II	III	IV	YEAR 19	I	II	III	IV	YEAR 19
PRODUCTION INCOME	0	6,310,000	0	6,310,000	12,620,000	0	6,310,000	0	6,310,000	12,620,000	0	6,310,000	0	6,310,000	12,620,000	0	6,310,000	0	12,620,000	0	6,310,000	0	6,310,000	12,620,000
OTHER OPERATING INCOME	171,187	114,219	289,575	142,844	718,825	256,033	122,145	289,781	142,844	810,803	256,033	122,146	289,781	142,844	810,804	122,146	289,781	142,844	810,804	256,033	122,146	289,781	142,844	810,804
TOTAL INCOME	171,187	6,424,219	289,575	6,452,844	13,338,825	256,033	6,432,145	289,781	6,452,844	13,430,803	256,033	6,432,146	289,781	6,452,844	13,430,804	6,432,146	289,781	6,452,844	13,430,804	256,033	6,432,146	289,781	6,452,844	13,430,804
DIRECT EXPENSE COSTS																								
MATERIALS	448,000	0	1,795,184	170,000	2,373,184	448,000	0	1,795,184	170,000	2,373,184	448,000	0	1,795,184	170,000	2,373,184	0	1,795,184	170,000	2,373,184	448,000	0	1,795,184	170,000	2,373,184
TOOLAGE	75,992	48,192	81,318	157,598	363,100	75,992	48,192	81,318	157,598	363,100	75,992	48,192	81,318	157,598	363,100	48,192	81,318	157,598	363,100	75,992	48,192	81,318	157,598	363,100
TRANSPORTATION	187,785	134,874	17,116	122,789	462,564	187,785	134,874	17,116	122,789	462,564	187,785	134,874	17,116	122,789	462,564	134,874	17,116	122,789	462,564	187,785	134,874	17,116	122,789	462,564
PACKAGING	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000	75,000	0	165,000	240,000	0	75,000	0	165,000	240,000
TRANSPORTATION	0	28,125	0	1,767,125	1,844,250	0	28,125	0	1,767,125	1,844,250	0	28,125	0	1,767,125	1,844,250	28,125	0	1,767,125	1,844,250	0	28,125	0	1,767,125	1,844,250
MAINTENANCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONTRACTUAL COSTS																								
RENT	37,128	37,128	37,128	37,128	148,512	37,128	37,128	37,128	37,128	148,512	37,128	37,128	37,128	37,128	148,512	37,128	37,128	37,128	148,512	37,128	37,128	37,128	37,128	148,512
MANAGEMENT FEE	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000
TRADING PARTNER	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000
OPER. AND MAINT	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000
DEPRECIATION	249,575	249,575	249,575	249,575	1,198,700	249,575	249,575	249,575	249,575	1,198,700	249,575	249,575	249,575	249,575	1,198,700	249,575	249,575	249,575	1,198,700	249,575	249,575	249,575	249,575	1,198,700
INTEREST																								0
TOTAL EXPENSES	1,746,899	1,334,179	2,177,147	2,318,716	7,582,941	1,746,899	1,334,179	2,177,147	2,318,716	7,582,941	1,746,899	1,334,179	2,177,147	2,318,716	7,582,941	1,334,179	2,177,147	2,318,716	7,582,941	1,746,899	1,334,179	2,177,147	2,318,716	7,582,941
NET INCOME (LOSS)	-1,575,712	5,090,040	-1,887,572	4,134,128	5,760,884	-1,490,866	5,097,966	-1,887,366	4,134,128	5,847,863	-1,490,866	5,097,967	-1,887,366	4,134,128	5,847,863	5,097,967	-1,887,366	4,134,128	5,847,863	-1,490,866	5,097,967	-1,887,366	4,134,128	5,847,863
B DEBT						0	0	0	0	0														0
PRINCIPAL REPAYMENT						0				0														0
ACC NON DEPRECIATION	249,575	249,575	249,575	249,575	1,198,700	249,575	249,575	249,575	249,575	1,198,700	249,575	249,575	249,575	249,575	1,198,700	249,575	249,575	249,575	1,198,700	249,575	249,575	249,575	249,575	1,198,700
DEVELOPMENT COSTS						0																		0
PRINCIPAL PAYMENTS																								0
DIVIDENDS	5,797,474	0	-4,297,97	0	-9,095,502	-6,705,222	0	-4,721,259	0	-11,426,481	-6,705,222	0	-4,721,259	0	-11,426,481	0	-4,721,259	0	-11,426,481	-6,705,222	0	-4,721,259	0	-11,426,481
SUB TOTAL CASH FLOW	-6,014,702	5,428,615	5,935,124	8,287,955	1,335,848	-7,852,514	5,429,441	-5,915,050	8,299,784	968	-7,854,350	5,429,442	-5,915,072	8,299,930	0	5,429,442	-5,915,072	8,299,930	0	-7,854,351	5,429,442	-5,915,072	8,299,930	0
CUM. CASH FLOW	8,144,292	13,572,907	9,635,783	17,923,738	17,923,738	8,291,843	13,721,283	7,806,233	16,106,017	16,106,017	8,291,843	13,721,283	7,806,210	16,106,140	16,106,140	13,721,283	7,806,210	16,106,140	16,106,140	8,291,843	13,721,283	7,806,210	16,106,140	16,106,140

BEST AVAILABLE COPY

ZAMBIA- PRO FORMA BALANCE SHEET
Minimum expected yields and markets condition

	JUNE 30,1985	JUNE 30,1986	JUNE 30, 1987	JUNE 30, 1988	JUNE 30, 1989	JUNE 30, 1990	JUNE 30, 1991	JUNE 30, 1992	JUNE 30, 1993	JUNE 30,1994	JUNE 30, 1995	JUNE 30, 1996	JUNE 30, 1997	JUNE 30, 1998	JUNE 30, 1999	JUNE 30, 2000
ASSETS																
CASH	$4,981,122	$3,067,574	$8,013,406	$9,808,951	$10,000,720	$10,191,436	$10,405,176	$10,595,907	$10,786,622	$10,977,330	$11,168,053	$12,490,895	$12,490,769	$12,490,769	$12,490,769	$12,490,769
LAND	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
DEVELOPMENT COSTS																
MOBILIZATION	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
ELECTRICAL DISTRIBUTION SYSTEM	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750
IRRIGATION EQUIPMENT	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000
MANAGEMENT	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000
DEVELOPMENT EQUIPMENT	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000
FARM MACHINERY	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150
WATER DISTRIBUTION SYSTEM	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000
PERSONNEL- ON-SITE	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250
FARM COMPOUND BUILDINGS	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000
COTTON GIN	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000
OIL PRESS	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000
FERRY BOAT	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
GRAIN STORAGE	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700
ROADS AND CLEARING	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000
FENCING	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000
ACCUMULATED DEPRECIATION	0	-69,200	-1,263,500	-2,457,800	-3,652,100	-4,846,400	-6,040,700	-7,235,000	-8,429,300	-9,623,600	-10,817,900	-12,012,200	-13,206,500	-14,400,800	-15,595,100	-16,789,400
TOTAL ASSETS	32,576,972	30,614,224	34,365,756	34,967,001	33,964,470	32,960,886	31,980,326	30,976,757	29,973,172	28,969,588	27,966,003	28,094,545	26,900,119	25,705,819	24,511,519	23,317,219
LIABILITIES AND STOCKHOLDERS' EQUITY																
DOLLAR LOANS	16,176,972	16,176,972	16,176,972	14,154,851	12,132,730	10,110,609	8,088,487	6,066,366	4,044,243	2,022,123	1	1	2	2	2	2
KWACHA LOANS	3,400,000	3,400,000	3,400,000	2,975,000	2,550,000	2,125,000	1,700,000	1,275,000	850,002	425,000	0	0	0	0	0	0
TOTAL LIABILITIES	19,576,972	19,576,972	19,576,972	17,129,851	14,682,730	12,235,609	9,788,487	7,341,366	4,894,245	2,447,123	1	1	2	2	2	2
CAPITAL STOCK	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000
RETAINED EARNINGS	0	-1,962,748	1,788,784	4,837,150	6,281,740	7,725,277	9,191,839	10,635,391	12,078,927	13,522,465	14,966,002	15,094,544	13,900,117	12,705,817	11,511,517	10,317,217
TOTAL STOCKHOLDERS EQUITY	13,000,000	11,037,252	14,788,784	17,837,150	19,281,740	20,725,277	22,191,839	23,635,391	25,078,927	26,522,465	27,966,002	28,094,544	26,900,117	25,705,817	24,511,517	23,317,217
TOTAL LIABILITIES AND STOCKHOLDERS' EQUITY	$32,576,972	$30,614,224	$34,365,756	$34,967,001	$33,964,470	$32,960,886	$31,980,326	$30,976,757	$29,973,172	$28,969,588	$27,966,003	$28,094,545	$26,900,119	$25,705,819	$24,511,519	$23,317,219

ZAMBIA- PRO FORMA INCOME STATEMENT
Average expected yields and markets condition

	JUNE 30, 1985	JUNE 30, 1986	JUNE 30, 1987	JUNE 30, 1988	JUNE 30, 1989	JUNE 30, 1990	JUNE 30, 1991	JUNE 30, 1992	JUNE 30, 1993	JUNE 30, 1994	JUNE 30, 1995	JUNE 30, 1996	JUNE 30, 1997	JUNE 30, 1998	JUNE 30, 1999	JUNE 30, 2000
CROP INCOME																
COTTON	0	0	5,867,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200	5,887,200
GROUNDNUTS	0	2,145,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000	4,290,000
WHEAT	0	0	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000
CASTOREBEANS	0	0	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000	2,310,000
INTEREST INCOME	0	257,547	359,657	724,920	742,360	756,745	772,237	787,204	801,567	815,970	830,292	844,125	858,285	873,888	873,888	873,888
TOTAL INCOME	$0	$2,402,547	$16,846,857	$17,212,120	$17,229,580	$17,243,945	$17,259,437	$17,274,404	$17,288,767	$17,303,130	$17,317,492	$17,331,325	$17,426,085	$17,422,088	$17,426,388	$17,426,888
DIRECT VARIABLE COSTS																
MATERIAL	0	331,800	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600
TILLAGE	0	21,330	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100
IRRIGATION	0	9,719	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564
PROCESSING	0	0	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
TRANSPORTATION	0	292,500	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200	1,464,200
MARKETING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADMINISTRATIVE COSTS																
PERSONNEL	0	25,200	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152
MANAGEMENT FEE	0	200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
TRAINING PROGRAM	0	25,500	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000
OPER. AND MAINT.	0	26,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000
DEPRECIATION	0	69,200	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300
INTEREST	0	2,936,546	2,936,546	2,798,895	2,431,827	2,064,759	1,653,345	1,286,277	919,209	552,140	185,072	0	0	0	0	0
Total Expenses	0	3,937,795	10,519,462	10,381,811	10,014,743	9,647,675	9,236,261	8,869,193	8,502,125	8,135,056	7,767,988	7,582,916	7,582,916	7,582,916	7,582,916	7,582,916
NET INCOME	0	-1,535,248	6,327,395	6,830,309	7,214,837	7,596,270	8,023,176	8,405,211	8,786,642	9,168,074	9,549,504	9,748,409	9,843,169	9,843,172	9,843,172	9,843,172
RETAINED EARNINGS - Beginning	0	0	-1,535,248	4,792,147	6,353,549	7,797,163	9,240,700	10,707,263	12,150,815	13,594,351	15,037,889	16,481,426	16,608,974	15,415,542	14,221,243	13,028,943
Dividends	0	0	0	5,268,907	5,771,221	6,152,733	6,556,613	6,961,659	7,343,106	7,724,536	8,105,967	9,680,861	11,036,531	11,037,472	11,037,472	11,037,472
RETAINED EARNINGS - Ending	$0	$-1,535,248	$4,792,147	$6,353,549	$7,797,163	$9,240,700	$10,707,263	$12,150,815	$13,594,351	$15,037,889	$16,481,426	$16,608,974	$15,415,542	$14,221,243	$13,028,943	$11,835,643

BEST AVAILABLE COPY

ZAMBIA- CASH FLOW PROJECTIONS

By quarter, first five fiscal years

Revised & dated visits and market consultant

	QUARTERS I	II	III	IV	FISCAL YEAR 1	QUARTERS I	II	III	IV	FISCAL YEAR 2	QUARTERS I	II	III	IV	FISCAL YEAR 3	QUARTERS I	II	III	IV	FISCAL YEAR 4	QUARTERS I	II	III	IV	FISCAL YEAR 5
PRODUCTION INCOME	0	0	0	1,850,000	1,850,000	0	5,250,000	0	8,473,000	13,723,000	0	5,250,000	0	8,473,000	13,723,000	0	5,250,000	0	8,473,000	13,723,000	0	5,250,000	0	8,473,000	13,723,000
INTEREST INCOME	0	165,575	89,963	61,959	257,547	76,889	28,042	113,347	50,963	269,044	240,335	137,653	194,573	167,954	670,515	245,224	271,949	290,269	110,458	677,100	254,018	123,483	205,128	112,053	694,682
TOTAL INCOME	0	165,575	89,963	1,911,959	2,107,547	76,889	5,278,042	113,347	8,524,963	13,992,044	240,335	5,387,653	194,573	8,581,954	14,393,515	245,224	5,521,949	290,269	8,583,458	14,400,100	254,018	5,373,483	205,128	8,585,053	14,417,682
DIRECT VARIABLE COSTS																									
MATERIAL	0	0	228,800	3,300	232,100	808,500	0	1,395,100	170,000	2,373,600	808,500	0	1,395,100	170,000	2,373,600	808,500	0	1,395,100	170,000	2,373,600	808,500	0	1,395,100	170,000	2,373,600
TILLAGE	0	0	16,721	10,599	27,320	76,992	48,192	81,318	107,598	318,100	76,992	48,192	81,318	107,598	318,100	76,992	48,192	81,318	107,598	318,100	76,992	48,192	81,318	107,598	318,100
IRRIGATION	0	0	49	9,620	9,719	189,785	134,874	19,116	122,789	466,564	189,785	134,874	19,116	122,789	466,564	189,785	134,874	19,116	122,789	466,564	189,785	134,874	19,116	122,789	466,564
PROCESSING	0	0	0	0	0	0	47,500	0	145,000	192,500	0	47,500	0	145,000	192,500	0	47,500	0	145,000	192,500	0	47,500	0	145,000	192,500
TRANSPORTATION	0	0	0	225,000	225,000	0	222,250	0	882,500	1,104,750	0	222,250	0	882,500	1,104,750	0	222,250	0	882,500	1,104,750	0	222,250	0	882,500	1,104,750
MARKETING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADMINISTRATIVE COSTS																									
PERSONNEL	0	0	32,000	32,000	32,000	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152	37,038	37,038	37,038	37,038	148,152
MANAGEMENT FEE	0	0	140,000	140,000	280,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000	300,000	300,000	300,000	300,000	1,200,000
OVER. AND PAYE	0	0	17,000	17,000	34,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000	12,750	12,750	12,750	12,750	51,000
DEPRECIATION	0	0	34,500	34,500	69,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000	38,250	38,250	38,250	38,250	153,000
INTEREST	774,176	774,176	774,176	774,176	3,096,704	774,176	774,176	774,176	774,176	3,096,704	774,176	711,195	483,257	242,213	2,710,841	242,269	119,428	596,486	572,544	2,531,027	550,602	527,661	504,719	481,777	2,064,759
TOTAL EXPENSES	774,176	774,176	1,146,716	1,355,195	3,870,263	2,481,026	2,040,505	2,957,282	2,848,254	10,227,167	2,481,026	1,977,624	2,841,490	2,379,411	10,219,551	2,384,259	1,885,857	2,769,623	2,687,644	9,722,783	2,797,492	1,794,090	2,677,846	2,595,877	9,265,325
NET OPERATING INCOME	-774,176	165,575	-1,056,752	556,763	-1,762,716	-2,404,137	3,237,537	-2,843,935	5,676,709	3,764,877	-2,240,691	3,409,029	-2,646,917	5,847,318	4,173,964	-2,139,035	3,636,092	-2,479,354	5,895,814	4,677,317	-2,542,474	3,579,393	-2,472,728	5,990,175	5,049,366
B. LOANS	16,576,972				16,576,972																				
PRINCIPALES EQUITY	[illegible]				[illegible]	0	0	0	0	0															0
PARTICIPATION LOAN	[illegible]				[illegible]					0					0					0					0
ADD BACK DEPRECIATION	0		34,500	34,500	69,000					0					0					0					0
DEVELOPMENT COSTS	-17,015,154				17,015,154	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300	298,575	298,575	298,575	298,575	1,194,300
FRANCHISE PAYMENTS	0	0	0	0		0	0	0	0	0	-833,780	-833,780	-833,780	-833,780	-2,447,122	-833,780	-833,780	-833,780	-833,780	-2,447,122	-833,780	-833,780	-833,780	-833,780	-2,447,122
STATE %	0					0	0	0	0	0	-702,476		4,423,917		3,721,442	-1,194,722	-125,347	0	-722,375	-2,042,444	-1,722,315	2,700,72	0	-4,251,218	0
E.B. TOTAL CASH FLOW	8,226,182	-608,601	1,122,255	594,214	7,633,050	2,115,762	3,536,055	-2,415,262	5,974,911	9,545,372	-3,237,155	2,474,824	-2,452,924	5,429,482	2,234,227	-4,361,132	3,172,867	3,097,225	5,587,189	191,749	5,012,199	3,266,188	2,891,442	5,677,249	195,716
CM. CASH FLOW	8,226,182	2,246,526	3,368,774	3,962,988	3,962,988	5,962,550	9,498,605	7,083,343	13,058,254	13,058,254	9,821,095	12,295,919	9,843,000	15,272,482	15,272,482	10,911,350	14,084,217	17,181,442	22,768,631	22,960,380	27,972,579	31,238,767	34,130,209	39,807,458	40,003,174

TOTAL PROJECT COST = 33,576,972

TOTAL LOAN PART = 19,576,972

NOTES:

COTTON = 2.9 METRIC TONS PER HECTARE SEED COTTON

GROUNDNUTS = 2.9 METRIC TONS PER HECTARE

WHEAT = 5.0 METRIC TONS PER HECTARE

CASTOR BEANS = 2.0 METRIC TONS PER HECTARE BEANS

PRICES:

COTTON = 1770 PER METRIC TON LINT CIF ELEVTE

GROUNDNUTS = 1100 PER METRIC TON CIF EUROPE

WHEAT = 1400 PER METRIC TON DOMESTIC MARKET

CASTORBEANS = 1100 PER METRIC TON CASTOR OIL CIF EUROPE

BEST AVAILABLE COPY

ZAMBIA CASH FLOW PROJECTIONS
by Quarters years 11 through 15
Minimum expected sales and markets condition

	QUARTERS I	II	III	IV	FISCAL YEAR 11
PRODUCTION INCOME	0	5,250,000	0	8,873,600	13,723,600
INTEREST INCOME	237,287	154,249	265,025	142,261	871,834
TOTAL INCOME	237,287	5,404,249	265,025	9,015,861	14,597,274
DIRECT VARIABLE COSTS					
MATERIAL	808,500	0	1,395,100	170,000	2,373,600
TILLAGE	70,992	48,192	81,318	107,298	308,100
IRRIGATION	183,785	136,874	10,116	122,789	453,564
PROCESSING	0	62,500	0	145,000	207,500
TRANSPORTATION	0	372,250	0	842,000	1,214,250
MARKETING	0	0	0	0	0
ADMINISTRATIVE COSTS					
PERSONNEL	37,038	37,038	37,038	37,038	148,152
MANAGEMENT FEE	300,000	300,000	300,000	300,000	1,200,000
TRAINING PROGRAM	12,750	12,750	12,750	12,750	51,000
OPER. AND MAINT.	38,250	38,250	38,250	38,250	153,000
DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
INTEREST					
TOTAL EXPENSES	1,746,890	1,266,429	2,173,147	2,114,150	7,300,566
NET OPERATING PROFIT	-1,509,603	4,137,820	-1,908,122	6,901,711	7,296,708
BORROWS					
PRINCIPLES CAPITAL	0	0	0	0	0
PAYMENTS LOAN (In $)					
ADD BACK DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
DEVELOPMENT COSTS					
PRINCIPLE PAYMENTS					
DIVIDENDS	-1,810,178	0	-3,206,697	0	-5,016,875
SUB TOTAL - Cash Flow	-4,019,281	4,436,245	-4,916,281	6,600,136	3,322,842
CUM. CASH FLOW	6,168,772	10,605,017	5,690,736	12,490,872	12,490,872

	QUARTERS I	II	III	IV	FISCAL YEAR 12
PRODUCTION INCOME	0	5,250,000	0	8,873,600	13,723,600
INTEREST INCOME	237,287	154,249	265,025	142,261	871,834
TOTAL INCOME	237,287	5,404,249	265,025	9,015,861	14,597,274
DIRECT VARIABLE COSTS					
MATERIAL	808,500	0	1,395,100	170,000	2,373,600
TILLAGE	70,992	48,192	81,318	107,298	308,100
IRRIGATION	183,785	136,874	10,116	122,789	453,564
PROCESSING	0	62,500	0	145,000	207,500
TRANSPORTATION	0	372,250	0	842,000	1,214,250
MARKETING	0	0	0	0	0
ADMINISTRATIVE COSTS					
PERSONNEL	37,038	37,038	37,038	37,038	148,152
MANAGEMENT FEE	300,000	300,000	300,000	300,000	1,200,000
TRAINING PROGRAM	12,750	12,750	12,750	12,750	51,000
OPER. AND MAINT.	38,250	38,250	38,250	38,250	153,000
DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
INTEREST					
TOTAL EXPENSES	1,746,890	1,266,429	2,173,147	2,114,150	7,300,566
NET OPERATING PROFIT	-1,509,603	4,137,820	-1,908,122	6,901,711	7,296,708
BORROWS					
PRINCIPLES CAPITAL	0				0
PAYMENTS LOAN (In $)	0				0
ADD BACK DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
DEVELOPMENT COSTS					
PRINCIPLE PAYMENTS					
DIVIDENDS	-5,193,769		-7,226,199		-8,419,968
SUB TOTAL - Cash Flow	-6,404,797	4,436,245	-8,835,746	6,900,136	-3,122,968
CUM. CASH FLOW	6,085,975	10,600,199	1,764,453	12,490,769	12,490,769

	QUARTERS I	II	III	IV	FISCAL YEAR 13
PRODUCTION INCOME	0	5,250,000	0	8,873,600	13,723,600
INTEREST INCOME	237,287	154,249	265,025	142,261	871,834
TOTAL INCOME	237,287	5,404,249	265,025	9,015,861	14,597,274
DIRECT VARIABLE COSTS					
MATERIAL	808,500	0	1,395,100	170,000	2,373,600
TILLAGE	70,992	48,192	81,318	107,298	308,100
IRRIGATION	183,785	136,874	10,116	122,789	453,564
PROCESSING	0	62,500	0	145,000	207,500
TRANSPORTATION	0	372,250	0	842,000	1,214,250
MARKETING	0	0	0	0	0
ADMINISTRATIVE COSTS					
PERSONNEL	37,038	37,038	37,038	37,038	148,152
MANAGEMENT FEE	300,000	300,000	300,000	300,000	1,200,000
TRAINING PROGRAM	12,750	12,750	12,750	12,750	51,000
OPER. AND MAINT.	38,250	38,250	38,250	38,250	153,000
DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
INTEREST					
TOTAL EXPENSES	1,746,890	1,266,429	2,173,147	2,114,150	7,300,566
NET OPERATING PROFIT	-1,509,603	4,137,820	-1,908,122	6,901,711	7,296,708
BORROWS					
PRINCIPLES CAPITAL	0				0
PAYMENTS LOAN (In $)	0				0
ADD BACK DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
DEVELOPMENT COSTS					
PRINCIPLE PAYMENTS					
DIVIDENDS	-5,193,769		-7,226,199		-8,419,968
SUB TOTAL - Cash Flow	-6,404,797	4,436,245	-8,835,746	6,900,136	-3,122,968
CUM. CASH FLOW	6,163,954	10,600,199	1,764,453	12,490,769	12,490,769

	QUARTERS I	II	III	IV	FISCAL YEAR 14
PRODUCTION INCOME	0	5,250,000	0	8,873,600	13,723,600
INTEREST INCOME	237,287	154,249	265,025	142,261	871,834
TOTAL INCOME	237,287	5,404,249	265,025	9,015,861	14,597,274
DIRECT VARIABLE COSTS					
MATERIAL	808,500	0	1,395,100	170,000	2,373,600
TILLAGE	70,992	48,192	81,318	107,298	308,100
IRRIGATION	183,785	136,874	10,116	122,789	453,564
PROCESSING	0	62,500	0	145,000	207,500
TRANSPORTATION	0	372,250	0	842,000	1,214,250
MARKETING	0	0	0	0	0
ADMINISTRATIVE COSTS					
PERSONNEL	37,038	37,038	37,038	37,038	148,152
MANAGEMENT FEE	300,000	300,000	300,000	300,000	1,200,000
TRAINING PROGRAM	12,750	12,750	12,750	12,750	51,000
OPER. AND MAINT.	38,250	38,250	38,250	38,250	153,000
DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
INTEREST					
TOTAL EXPENSES	1,746,890	1,266,429	2,173,147	2,114,150	7,300,566
NET OPERATING PROFIT	-1,509,603	4,137,820	-1,908,122	6,901,711	7,296,708
BORROWS					
PRINCIPLES CAPITAL	0				0
PAYMENTS LOAN (In $)	0				0
ADD BACK DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
DEVELOPMENT COSTS					
PRINCIPLE PAYMENTS					
DIVIDENDS	-5,193,769		-7,226,199		-8,419,968
SUB TOTAL - Cash Flow	-6,404,797	4,436,245	-8,835,746	6,900,136	-3,122,968
CUM. CASH FLOW	6,163,954	10,600,199	1,764,453	12,490,769	12,490,769

	QUARTERS I	II	III	IV	FISCAL YEAR 15
PRODUCTION INCOME	0	5,250,000	0	8,873,600	13,723,600
INTEREST INCOME	237,287	154,249	265,025	142,261	871,834
TOTAL INCOME	237,287	5,404,249	265,025	9,015,861	14,597,274
DIRECT VARIABLE COSTS					
MATERIAL	808,500	0	1,395,100	170,000	2,373,600
TILLAGE	70,992	48,192	81,318	107,298	308,100
IRRIGATION	183,785	136,874	10,116	122,789	453,564
PROCESSING	0	62,500	0	145,000	207,500
TRANSPORTATION	0	372,250	0	842,000	1,214,250
MARKETING	0	0	0	0	0
ADMINISTRATIVE COSTS					
PERSONNEL	37,038	37,038	37,038	37,038	148,152
MANAGEMENT FEE	300,000	300,000	300,000	300,000	1,200,000
TRAINING PROGRAM	12,750	12,750	12,750	12,750	51,000
OPER. AND MAINT.	38,250	38,250	38,250	38,250	153,000
DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
INTEREST					
TOTAL EXPENSES	1,746,890	1,266,429	2,173,147	2,114,150	7,300,566
NET OPERATING PROFIT	-1,509,603	4,137,820	-1,908,122	6,901,711	7,296,708
BORROWS					
PRINCIPLES CAPITAL	0				0
PAYMENTS LOAN (In $)	0				0
ADD BACK DEPRECIATION	298,575	298,575	298,575	298,575	1,194,300
DEVELOPMENT COSTS					
PRINCIPLE PAYMENTS					
DIVIDENDS	-5,193,769		-7,226,199		-8,419,968
SUB TOTAL - Cash Flow	-6,404,797	4,436,245	-8,835,746	6,900,136	-3,122,968
CUM. CASH FLOW	6,163,954	10,600,199	1,764,453	12,490,769	12,490,769

BEST AVAILABLE COPY

ZAMBIA- PRO FORMA BALANCE SHEET
Minimum expected yields and markets condition

	JUNE 30,1985	JUNE 30,1986	JUNE 30, 1987	JUNE 30, 1988	JUNE 30, 1989	JUNE 30, 1990	JUNE 30, 1991	JUNE 30, 1992	JUNE 30, 1993	JUNE 30,1994	JUNE 30, 1995	JUNE 30, 1996	JUNE 30, 1997	JUNE 30, 1998	JUNE 30, 1999	JUNE 30, 2000
ASSETS																
CASH	$4,961,122	$3,067,574	$8,013,406	$9,808,951	$10,000,720	$10,191,436	$10,405,176	$10,595,907	$10,786,622	$10,977,338	$11,168,053	$12,490,895	$12,490,769	$12,490,769	$12,490,769	$12,490,769
LAND	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
DEVELOPMENT COSTS																
MOBILIZATION	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
ELECTRICAL DISTRIBUTION SYSTEM	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750	1,043,750
IRRIGATION EQUIPMENT	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000	3,240,000
MANAGEMENT	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000	2,850,000
DEVELOPMENT EQUIPMENT	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000	1,228,000
FARM MACHINERY	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150	5,268,150
WATER DISTRIBUTION SYSTEM	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000	4,615,000
PERSONNEL- ON-SITE	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250	146,250
FARM COMPOUND BUILDINGS	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000	816,000
COTTON GIN	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000	497,000
OIL PRESS	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000	596,000
FERRY BOAT	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
GRAIN STORAGE	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700	628,700
ROADS AND CLEARING	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000
FENCING	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000	387,000
ACCUMULATED DEPRECIATION	0	-69,200	-1,263,500	-2,457,800	-3,652,100	-4,846,400	-6,040,700	-7,235,000	-8,429,300	-9,623,600	-10,817,900	-12,012,200	-13,206,500	-14,400,800	-15,595,100	-16,789,400
TOTAL ASSETS	32,576,972	30,614,224	34,365,756	34,967,001	33,964,470	32,960,886	31,980,326	30,976,757	29,973,172	28,969,588	27,966,003	28,094,545	26,900,119	25,705,819	24,511,519	23,317,219
LIABILITIES AND STOCKHOLDERS' EQUITY																
DOLLAR LOANS	16,176,972	16,176,972	16,176,972	14,154,851	12,132,730	10,110,609	8,088,487	6,066,366	4,044,243	2,022,123	1	1	2	2	2	2
KWATCHA LOANS	3,400,000	3,400,000	3,400,000	2,975,000	2,550,000	2,125,000	1,700,000	1,275,000	850,002	425,000	0	0	0	0	0	0
TOTAL LIABILITIES	19,576,972	19,576,972	19,576,972	17,129,851	14,682,730	12,235,609	9,788,487	7,341,366	4,894,245	2,447,123	1	1	2	2	2	2
CAPITAL STOCK	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000	13,000,000
RETAINED EARNINGS	0	-1,962,748	1,788,784	4,837,150	6,281,740	7,725,277	9,191,839	10,635,391	12,078,927	13,522,465	14,966,002	15,094,544	13,900,117	12,705,817	11,511,517	10,317,217
TOTAL STOCKHOLDERS EQUITY	13,000,000	11,037,252	14,788,784	17,837,150	19,281,740	20,725,277	22,191,839	23,635,391	25,078,927	26,522,465	27,966,002	28,094,544	26,900,117	25,705,817	24,511,517	23,317,217
TOTAL LIABILITIES AND STOCKHOLDERS' EQUITY	$32,576,972	$30,614,224	$34,365,756	$34,967,001	$33,964,470	$32,960,886	$31,980,326	$30,976,757	$29,973,172	$28,969,588	$27,966,003	$28,094,545	$26,900,119	$25,705,819	$24,511,519	$23,317,219

ZAMBIA- PRO FORMA INCOME STATEMENT
Miniaua expected yields and markets condition

	JUNE 30, 1985	JUNE 30, 1986	JUNE 30, 1987	JUNE 30, 1988	JUNE 30, 1989	JUNE 30, 1990	JUNE 30, 1991	JUNE 30, 1992	JUNE 30, 1993	JUNE 30, 1994	JUNE 30, 1995	JUNE 30, 1996	JUNE 30, 1997	JUNE 30, 1998	JUNE 30, 1999	JUNE 30, 2000
CROP INCOME																
COTTON	0	0	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600	5,173,600
GROUNDNUTS	0	1,650,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000
WHEAT	0	0	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000
CASTORBEANS	0	0	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000	1,650,000
INTEREST INCOME	0	257,547	265,044	620,560	677,100	691,490	706,983	721,950	736,313	750,676	765,038	878,698	873,637	873,634	873,634	873,634
TOTAL INCOME	$0	$1,907,547	$13,988,644	$14,344,160	$14,400,700	$14,415,090	$14,430,583	$14,445,550	$14,459,913	$14,474,276	$14,488,638	$14,602,298	$14,597,237	$14,597,234	$14,597,234	$14,597,234
DIRECT VARIABLE COSTS																
MATERIAL	0	331,800	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600	2,373,600
TILLAGE	0	21,330	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100	308,100
IRRIGATION	0	9,719	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564	450,564
PROCESSING	0	0	207,500	207,500	207,500	207,500	207,500	207,500	207,500	207,500	207,500	207,500	207,500	207,500	207,500	207,500
TRANSPORTATION	0	225,000	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350	1,214,350
MARKETING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADMINISTRATIVE COSTS																
PERSONNEL	0	25,200	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152	148,152
MANAGEMENT FEE	0	200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
TRAINING PROGRAM	0	25,500	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000
OPER. AND MAINT.	0	26,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000	153,000
DEPRECIATION	0	69,200	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300	1,194,300
INTEREST	0	2,936,546	2,936,546	2,798,895	2,431,827	2,064,759	1,653,345	1,286,277	919,209	552,140	185,072	0	0	0	0	0
Total Expenses	0	3,870,295	10,237,112	10,099,461	9,732,393	9,365,325	8,753,911	8,586,843	8,219,775	7,852,706	7,485,638	7,300,566	7,300,566	7,300,566	7,300,566	7,300,566
NET INCOME	0	-1,962,748	3,751,532	4,244,699	4,668,307	5,049,765	5,476,672	5,858,707	6,240,138	6,621,570	7,003,000	7,301,732	7,296,671	7,296,668	7,296,668	7,296,668
RETAINED EARNINGS - Beginning	0	0	-1,962,748	1,788,784	4,837,150	6,281,740	7,725,277	9,191,839	10,635,391	12,078,927	13,522,465	14,966,002	15,094,544	13,900,117	12,705,817	11,511,517
Dividends	0	0	0	1,196,333	3,223,717	3,606,228	4,010,110	4,415,155	4,796,602	5,178,032	5,559,463	7,173,190	8,491,098	8,490,968	8,490,968	8,490,968
RETAINED EARNINGS - Ending	$0	$-1,962,748	$1,788,784	$4,837,150	$6,281,740	$7,725,277	$9,191,839	$10,635,391	$12,078,927	$13,522,465	$14,966,002	$15,094,544	$13,900,117	$12.705,817	$11,511,517	$10,317,217

INTERNAL RATE OF RETURN CALCULATIONS
Minimum expected yields and markets condition

YEAR	CASHFLOW TO EQUITY INVESTORS
1	$-13,000,000
2	0
3	1,196,333
4	3,223,717
5	3,606,228
6	4,010,110
7	4,415,155
8	4,796,602
9	5,178,032
10	5,559,463
11	7,173,190
12	8,491,098
13	8,490,968
14	8,490,968
15	8,490,698

Internal rate of return = 23.41 %

INTERNAL RATE OF RETURN CALCULATIONS
Average expected yields and markets condition

YEAR	CASHFLOW TO EQUITY INVESTORS
1	-$13,000,000
2	0
3	5,268,907
4	5,771,223
5	6,152,733
6	6,556,613
7	6,961,659
8	7,343,106
9	7,724,536
10	8,105,967
11	9,680,861
12	11,036,581
13	11,037,471
14	11,037,472
15	11,037,472

Internal rate of return = 35.84%

PN-ABT-131
isn 91249

A FEASIBILITY STUDY OF AN AGRICULTURAL PRODUCTION COMPLEX IN THE REPUBLIC OF ZAMBIA

PROPOSAL TO DEVELOP A CENTER PIVOT IRRIGATED FARM IN THE ZAMBEZI RIVER VALLEY

Prepared for: New Ag Zambia, Ltd.

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-50'

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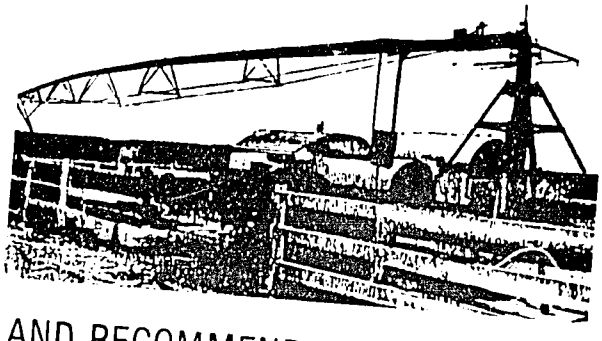
INTRODUCTION

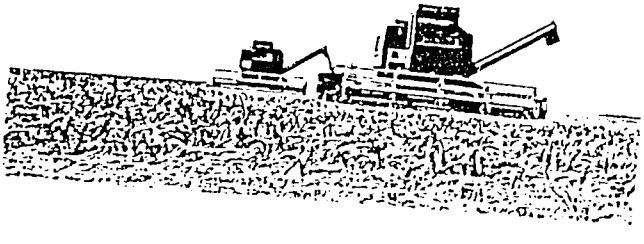
1.0 INTRODUCTION AND SUMMARY

1.1 EXECUTIVE SUMMARY

1.2 INTRODUCTION



1.3 RESULTS, CONCLUSIONS AND RECOMMENDATIONS



1.0 INTRODUCTION AND SUMMARY

1.1 EXECUTIVE SUMMARY

Western Agri-Management, in cooperation with New Ag Zambia, Ltd., has prepared this feasibility study of a 10,000 hectare (25,000 acre) agricultural production complex to be located 170 kilometers Southeast of Lusaka, Zambia. The concept is to create a modern, irrigated farm, using the most current technology, that will produce high yields and good returns for the investors.

As proposed, the project will be developed in two phases. Phase I will irrigate 3,000 hectares (8,000 acres) with center pivot sprinklers and will include the necessary housing, infrastructure and processing facilities to enable the complex to operate at maximum efficiency. Phase II will double the production hectares with little additional infrastructure, thus reducing the overall unit cost.

The conditions necessary for the development of such a complex are a favorable combination of natural resources, political factors, certain infrastructure requirements and marketing considerations; all are potentially present and will provide a very suitable environment for the project as outlined in this study.

As proposed, the project will be funded from a variety of sources, mostly external to Zambia. This will require that a large percentage of the farm's output be exported to generate the hard currency needed to meet the debt service and to provide for returns to the investors. However, a large amount of wheat will be grown for sale on the domestic market. This will help to ease Zambia's growing dependency on agricultural imports, and will reduce the drain on hard currency.

The project, when developed, will deliver a variety of benefits to the local community. These include employment and training opportunities in agricultural production and processing, technical services to the local farmers, central marketing and processing facilities available to local farmers, improvements to the local infrastructure, and by supplying excess water to the farmers, the project will have a significant effect on the production levels of farms adjacent to the project.

Additionally, the project will have a beneficial impact on the entire nation. The project will introduce new agricultural production technology into the country, which will provide a model for further development. The farm's program of seed testing and production will make available new, high yielding crop

varieties to the entire country.

1.2 INTRODUCTION

With partial funding from the United States Agency for International Development, New Ag Zambia Ltd. entered into an agreement with Western Agri-Management of the United States to develop a feasibility study for an irrigated agricultural production complex in the Zambezi River Valley in Zambia.

The main objective of the study is the preparation of a development plan for a project that will best utilize the existing natural resources and infrastructure in accordance with the following objectives:

-- development of an economically viable and profitable production and processing complex;

-- creation of productive training and employment opportunities for the local residents;

-- establishment of technical services and marketing systems that will benefit both the area farmers and the project as a whole;

-- provide a model for future development of similar projects in Zambia.

The project, as proposed in this study, was designed with the above objectives in mind. In view of the country's policy to become self-sufficient in food production in the shortest possible time, emphasis should also be placed on rapid development and high production after an early starting date.

1.3 RESULTS, CONCLUSIONS & RECOMMENDATIONS

Based on the data collected and the analyses of these data as presented in the body of the study, the following conclusions and recommendations have emerged:

NATURAL RESOURCES:

The natural resources (i.e., soil, water, and climate) are excellent in almost every respect for the type of irrigated (and possibly non-irrigated) farming contemplated by the study, and for the production of a wide variety of crops in addition to the specific crops used in the model.

The combination of uniform, gently sloping land, excellent sandy

loam soils, and immediate proximity to an immense supply of high quality water from the Zambezi River make this particular site an almost ideal resource situation for the proposed agro-business complex.

INFRASTRUCTURE:

The local infrastructure (i.e., transportation, housing, labor supply, energy, etc.) is satisfactory for the project in most respects, however, substantial addition and improvements with respect to roads, buildings, processing facilities, river crossing facilities, and electric power supply will be required and will necessarily have to be built as a part of the project. Because of this infrastructure requirement, it is essential that the project be of substantial size even in its first phase in order to spread the cost of this infrastructure reasonably over large crop production areas.

With respect to pumping energy (the principal energy requirement), a major power line will be built from Chirundu to the site, a distance of approximately 15 kilometers, at an estimated cost of $1 million. This will bring power to the site at a lower cost than diesel power. The standard rates quoted are nevertheless higher than desirable for this quantity of power consumption. It will therefore be necessary to negotiate a more favorable rate to bring energy costs into line. (The construction of the line can also provide electricity to nearby users off the project area).

POLITICAL CLIMATE:

The government attitude appears to be good for this type of project, as they place high priority on agriculture - both for internal food supply and for export to produce foreign exchange. The government has been stable for 20 years (see Section 2.0). The President, Dr. Kenneth D. Kaunda, is a strong, stabilizing influence and enjoys great popularity and respect with the citizens and from other African countries.

Based on the government's reputation, it is anticipated that the necessary permits and special concessions needed for a beneficial project such as this will be obtainable. For reference, the following special conditions will be required for the project:

(a) Freedom to export all of the crops (except for the large quantity of wheat produced for internal consumption) and to retain the hard currency earned in order to provide for the large debt service payments plus a good return to outside equity investors, as an incentive for them to

invest.

(b) Exemption from duty on all essential imports and exemption from income tax until the debt is repaid.

(c) The unrestricted right to operate processing facilities such as the cotton gin, oil mill, and possible alcohol conversion plants, and to export the production thereof as needed to produce foreign currency for the project.

(d) Right to ship directly to Zimbabwe and thence to southern ports by barge or ferry across the Zambezi River (depending on the difficulty encountered in the Kafue River crossing facilities required).

(e) Assignment of a government official to assist the project manager in all government related matters such as imports, exports, permits, exchange, etc. and to expedite these processes on behalf of the project.

SCOPE OF THE PROJECT:

Because of the extensive resources available and the requirement for substantial infrastructure, the project has been planned in two phases as follows:

I. Development of 3,000 hectares (8,000 acres) primarily under center pivot irrigation (but with some other types of irrigation for comparison and demonstration) and including a variety of peripheral and vertical integration facilities (i.e., cotton gin, oil mill, seed processing and test facilities) plus housing, shops, bulk grain and bean storage and handling equipment. In the model used, the crops to be grown are cotton, groundnuts, wheat and castorbeans (see cropping plan), but a wide variety of other crops will certainly be grown as markets and the country's requirements indicate.

   The water distribution system will consist of 18 pumps in the first phase, with water distribution lines. A pressure stabilizing reservoir and a highly developed pumping and valving system will provide reliable water supply without limiting the flexibility of the individual irrigation systems and their watering patterns required by specific crops.

II. Phase II will approximately double the amount of irrigated land, but at much lower unit cost because of the existing infrastructure which will not have to be duplicated.

It is strongly recommended that Phase II be added immediately following completion of Phase I, as it will reduce the cost of the infrastructure per hectare of farming and therefore greatly enhance the return on investment.

COST:

In addition to the land cost, the requirements for development of the project and provision of operating capital until the point of positive cash flow will be approximately $27 to $28 million U.S. Dollars.

MANAGEMENT:

Western Agri-Management Company will manage both the project development and the ongoing farming, which will follow the pattern of Western's successful operations of similar farms in the U.S. and other countries. The management and financial controls are discussed further in Section 6.0.

FINANCIAL FEASIBILITY:

Based on the assumption that the government concessions (as described above) will be made to this project, the project will produce profits beginning at completion of the project on the order of $6.5 million U.S.D. per year and a cash flow of $7.6 million U.S.D., using what the analysis shows to be the most conservative assumptions. The hard currency available under the conditions described will safely meet the debt service and provide a good return on investment as incentive for the equity investors.

TRAINING PROGRAM:

It is recommended that an effective training program be instituted at the very outset of the project and continue through the development and production stages. This will make it possible, within a few years, to replace most of the expatriate personnel with local professionals, technical people and skilled workers. A few management level trainees should be sent to Western's irrigated farm complex in Texas, U.S.A. for intensive training on that site.

It is also recommended that the training program should provide facilities for the training of neighboring farmers and technical people in order that a satellite farming concept can be instituted. This will ultimately result in the improvement of local production levels which will, in turn, supply raw goods for the project's central processing and marketing facilities.

2. BACKGROUND

2.0 BACKGROUND

2.1 GEOGRAPHICAL LOCATION

2.2 BUSINESS ENVIRONMENT
- 2.2.1 POLITICAL SYSTEM
- 2.2.2 LOCAL POLITICAL FACTORS
- 2.2.3 MONETARY SYSTEM
  - 2.2.3.1 CURRENCY
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2.3 MARKETS
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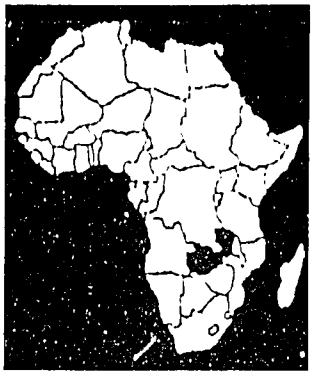


2.0 BACKGROUND

2.1 GEOGRAPHICAL LOCATION

The Republic of Zambia is located in east central Africa, approximately between latitudes 8 degrees and 18 degrees South and between longitudes 22 degrees and 34 degrees East. The country has a total land area of 752,614 square kilometers (290,586 square miles) bordered on the north by Zaire, the east by Tanzania and Malawi, the south by Zimbabwe and Botswana and on the west by Angola, thus making it completely landlocked.

Physiographically, Zambia is part of the southern Africa uplands. It is mostly a flat or undulating plateau, averaging 900 to 1500 meters (2950 to 5000 feet) above sea level, except to the south where the Zambezi River has cut a deep valley that averages only 600 meters (2000 feet) in elevation, and which dips to almost 300 meters (1000 feet) on the border with Zimbabwe and Malawi.

Influenced by the relatively high altitude, Zambia's climate is considered sub-tropical even though the country is located in the tropical zone. Lusaka, the capital city, and the Copper Belt, where some of the worlds richest copper deposits are located, are both situated on this plateau and enjoy comfortable climates the year around. It is also in these areas where the majority of the country's people live.

Zambia's landlocked condition has been a major deterrent to international trade in the past, but recent developments such as the railway linking Zambia to the ocean port at Dar-es-Salaam, and the re-opening of the southern shipment route through Zimbabwe to the South African ports has alleviated much of the problem. Most of these improvements were made to benefit the copper industry in northern Zambia, but with the decline of the world copper markets, emphasis is now being placed on developing the agricultural sector of the economy to take advantage of the existing infrastructure and excellent natural resources.

2.2 BUSINESS ENVIRONMENT

2.2.1 POLITICAL SYSTEM

The Republic of Zambia has a governmental system termed a "one-party participatory democracy." A British Colony from 1924 to 1964, it gained independence at that time after considerable unrest among the native population, and served as a model for several other African nations striving for independence from colonial rule.

The current constitution, promulgated on August 25, 1973, abrogated the original 1964 constitution and provides for a strong president and a unicameral National Assembly. National policy is formulated by the 25-member Central Committee of the United National Independence Party (UNIP), the sole legal party in Zambia. The Cabinet executes the central committee's policy.

The candidate for the Office of President is selected by UNIP at the party's general conference, in accordance with the intention of formalizing UNIP supremacy. The president is elected by popular mandate to a five-year term, and enjoys substantial veto powers over any piece of legislation passed by the National Assembly. If the National Assembly overrides any veto by a two-thirds vote, the president may either assent to the legislation or dissolve the Assembly.

The National Assembly is composed of a maximum of 136 members, 125 of whom are elected to five-year terms. The president may appoint as many as ten additional members to enhance the tribal and geographical representation of the assembly. A speaker is selected by the members from outside their own ranks.

Members of the Zambian Cabinet are selected from the National Assembly by the president.

Zambia is divided into nine provinces, each administered by a Central Committee member. A House of Chiefs represents the interests of the country's traditional tribal authorities, and is advisory in capacity. The highest court and the court of appeal is the Supreme Court; below it are the High Court, Magisterial Court, and the local courts.

President Kenneth Kaunda, and also UNIP, have enjoyed widespread popular support since independence in 1964. President Kaunda has been able to bridge the rivalries between the country's various regions and tribal affiliations. He advocates a philosophy of "humanism," which stresses cooperation among people and condemns human exploitation. In addition, President Kaunda is widely known and respected by neighboring countries and throughout Africa.

Even though Zambia is a one-party state, political discussion within the country is vigorous, with strongly contested parliamentary elections and a press that enjoys a reasonable amount of freedom to criticize and comment on governmental policies and personalities.

2.2.2 LOCAL POLITICAL FACTORS

The Zambian economy has traditionally been dependent upon the sale and export of the copper resources of the northern provinces. Recently, however, the world copper market has faltered quite dramatically, leaving Zambia in a precarious economic condition. The entire economy has slowed due to the lack of foreign trade, and the foreign currency necessary to purchase raw goods and manufactured items from abroad is very scarce.

The Zambian government has increasingly put emphasis on stimulating agricultural production not only to reduce the amount of imports, but also to provide an environment in which the agricultural sector can develop major export capabilities to replace the copper industry in terms of foreign trade. Price supports for crops, improved tax legislation, repatriation of funds and a growing agricultural extension service have all played a part in increasing production. However, increasing demand and poor weather in recent years have forced the importation of several agricultural products, placing a severe strain on the already troubled balance of trade.

The 1984 Annual Plan continues to place special emphasis on the development of the agricultural and rural sectors as part of a broader strategy to restructure the national economy. Current and previous years' production strategy, supportive policy measures, and the allocation of investment resources in various programs in the agricultural sector, aim at the achievement of the following Third National Development Plan policy objectives:

(i) to promote self-reliance and self-sufficiency in staple foods, both nationally and regionally where feasible and to provide raw materials for agro-industries;

(ii) to stimulate and increase farm production for exports;

(iii) to increase the contribution of the rural sector to the Gross National Product and to promote the diversification of the rural economy;

(iv) to improve rural standards of living and nutritional status and to create a self-reliant and progressive rural economy;

(v) to create new employment and income opportunities in rural areas in order to counteract rural-urban migration, and to improve infrastructural services related to increased productivity in the sector.

2.2.3 MONETARY SYSTEM

2.2.3.1 CURRENCY

The Zambian unit of currency is the Kwacha, which is subdivided into one hundred ngwees. The letter K is used to denote the Kwacha. Like the currencies of most countries, the Kwachas recently depreciated against the U.S. Dollar. The current exchange rate was 1.78 to 1, as of August, 1984.

2.2.3.2 MONETARY POLICIES

In an effort to control foreign currency problems that have existed since the 1970's, the government has placed strict controls on all currencies entering or leaving the country. In order to finance the foreign exchange deficit, the government has also delayed allocations of foreign exchange on a substantial portion of foreign suppliers' credits and other remittances.

Temporary assistance to Zambia has been provided by the International Monetary Fund (IMF) to alleviate this problem and to assist the government in making structural changes in the economy that will reduce the dependency on foreign goods. These structural changes include diversification away from the copper industry and towards the manufacturing and agricultural sectors.

In order to encourage more rapid development in the agriculture sector, the government has instituted several programs that benefit commercial farmers and foreign investors. Among these are: reduced income tax rates, accelerated depreciation on farm equipment, a five year tax holiday on dividends derived from farm income and a repatriation of 50 percent of the income derived from exported agricultural products.

Individuals may not bring Zambian currency into the country and may bring only 10 Kwacha out. All foreign currency must be declared when entering the country and cannot be exported in amounts greater than those imported. Foreign exchange transactions may only be carried out with authorized exchange bureaus and banks, and foreigners may be required to pay for some services (i.e. hotels) with foreign currency.

2.2.4 DUTIES, TARIFFS AND TAXES

2.2.4.1 IMPORT DUTIES AND TAXES

Virtually all goods imported by commercial firms in the private sector are subject to licensing. There are several steps involved in the licensing procedure, including approval by the Ministry of

Commerce. The major problem encountered by most firms is the long time period to await Bank of Zambia allocation of foreign exchange, if the firm does not have access to foreign exchange in another manner such as product exports.

The proposed farm would be able to qualify for several programs that give relief from most of the restrictions placed on enterprises that either import or export goods. Under the Industrial Development Act, the farm as an enterprise that exports a substantial amount of its products, would be eligible for relief from customs duties on machinery, relief from income tax, favorable adjustment of export tariff rates, relief from import tariffs on raw materials, and preferential treatment with respect to the granting and processing of import licenses. Certain special concessions will be needed by the farm to streamline the export of large quantities of products and to make possible the timely import of essential elements of high yield production.

Recent legislation (July, 1984) reduced dramatically the import tariffs levied on many items considered to be important for the development of the Zambian economy. Tariffs on most agricultural machinery were reduced to zero in an effort to encourage the more rapid build-up of the agricultural sector.

2.2.4.2 TAXATION OF AGRICULTURAL ENTITIES

Most businesses resident in Zambia are subject to income tax at a uniform rate of 45 percent of business profits. However, concessionary rates are given to businesses in rural areas (30 percent) and to farming concerns (15 percent). As a "priority enterprise," the farm will also receive relief from sales tax on imported goods, and from import tariffs, as mentioned earlier.

Individual income tax rates are progressive from 5 percent to 80 percent on incomes in excess of K25,000. Zambia and the United States are signatories to a treaty for the avoidance of double taxation and fiscal evasion of income taxes.

2.2.5 GOVERNMENTAL INCENTIVES AND REGULATION

As stated in previous sections concerning taxation, there are several laws to provide incentives for "priority enterprises," as determined by the Ministry of Commerce. These incentives reflect the official policy of the government to give high priority to rural development, operate a crash program in agriculture to regain food self-sufficiency, promote the use of local materials, expand exports, and create additional employment opportunities for Zambians.

The only screening process for investments in agricultural enterprises is the application process for registration of foreign companies, if the majority of equity capital is foreign owned, pursuant to the Companies Act. The Ministry of Commerce does not investigate claims of foreign ownership. (In the case of this project, this step has already been accomplished with the establishment of New Ag Zambia, LTD.).

Dividends and profits earned by foreign controlled companies in Zambia have for several years been subject to being placed in a queue of companies awaiting foreign exchange cover. The length of the pipeline is determined by foreign currency reserves, but the current queue is in excess of 38 months and getting longer. Recent legislation to improve this situation somewhat for "priority enterprises" allows the foreign company to retain 50 percent of its earnings from export sales in the form of foreign exchange, thus by-passing the long wait usually necessary.

As previously stated in Section 1.0 of this report, the feasibility of this project is dependent on gaining preferential treatment by the government regarding import and export regulations and the ability to retain foreign exchange earnings to service the foreign debt and provide for returns to the investors. Due to the nature of the financing involved, it will not be possible for the farm to operate with a long delay in receiving foreign exchange from its export sales and, therefore, special concessions will be needed to make the project feasible.

2.3 MARKETS

2.3.1 STRUCTURE

The market structure for most agricultural products in Zambia is controlled by the government through various cooperative marketing unions and parastatal organizations that provide centralized purchasing and marketing services which the farmers are required to use. These organizations purchase the agricultural products from the producers at the government specified producer prices, and then transfer the products to centralized receiving stations for storage, processing and distribution.

The goal of the government in establishing this centralized market structure was to provide an efficient marketing system that could be used to control the production of various crops by adjusting the producer prices to favor the crops most needed by the country, to provide marketing services to the producers in undeveloped areas that otherwise would not receive them, and to encourage agricultural production by making the returns from an agricultural investment attractive to businessmen.

The role of the large parastatal organizations such as the National Agriculture Marketing Board and the Cold Storage Board has been decreased recently in favor of the smaller cooperative marketing unions. These organizations have shown better performance by reducing the inefficiencies and duplication of operations that were present in the larger parastatals.

2.3.2 EXPORT MARKETS

Currently, very few agricultural products are exported from Zambia due primarily to the shortages present in the major food crops domestically. Tobacco and maize are exported in limited amounts when excess supply over domestic consumption exists, but these rarely account for more than one percent of the country's exports.

Zambia's domestic cotton production in recent years has been in excess of the country's ability to process the raw material into textiles. The excess has been exported through agents in South Africa and Kenya, with the assistance of the Lint Company of Zambia, Ltd., a parastatal organization.

Restrictions on exporting several agricultural commodities currently exist in Zambia for products that are considered essential commodities. These include most edible oil seeds, maize, and wheat. However, in accordance with the government's

desire to see increased exports and the resultant foreign exchange, it is anticipated that these restrictions will be removed to allow the export of all of the farm's output necessary to cover the foreign debt and provide for investors' returns.

Generally, the prevailing prices for export goods in Zambia are reflective of the international markets, minus shipping to the point of use. For the crops being considered for production on this project, the best markets exist in Europe. Figure 2.3.2 A shows a representative list of prices for agricultural commodities in Europe, including the cost of freight.

2.3.3 LOCAL MARKETS

Local markets for all agricultural products except fresh vegetables are through the parastatal companies and the local cooperative marketing unions. Producer prices are established each year by the government at prices that will encourage the production of goods most needed by the country. In the past, determination of these prices has often failed to take all of the important factors into consideration, resulting in imbalanced production.

The major constraint facing the parastatal and cooperative organizations is the lack of sufficient infrastructure to properly collect and process the nation's output. A considerable portion of the agricultural production occurs in areas with poor roads and communications, making it difficult to reach all of the growers. The government has addressed this problem in recent years by allocating more funds to improve the road system and to build more product collection points, but still many areas are unserviced.

Recently there have been several recommendations made by various governmental and private groups to allow a more free market approach in the agricultural sector. These groups argue that a free market can best use the resources available. Although steps toward a free market have been taken by the government, the local markets most probably will continue to be controlled by the parastatal organizations for some time.

3.0 RESOURCE EVALUATION

3.1 CLIMATE

3.2 LAND RESOURCES
- 3.2.1 GEOLOGY
- 3.2.2 SOIL TYPES PRESENT
- 3.2.3 TOPOGRAPHY
- 3.2.4 CURRENT USE OF THE LAND

3.3 WATER RESOURCES

3.4 ENERGY RESOURCES

3.5 MACHINERY, EQUIPMENT AND PRODUCTION INPUTS
- 3.5.1 MACHINERY AND EQUIPMENT
- 3.5.2 PRODUCTION INPUTS

3.6 INFRASTRUCTURE
- 3.6.1 TRANSPORTATION
- 3.6.2 AGRICULTURAL INFRASTRUCTURE

3.7 PEOPLE
- 3.7.1 DEMOGRAPHICS
- 3.7.2 AVAILABILITY OF LABOR

3.0 RESOURCE EVALUATION

3.1 CLIMATE

Climate is one of the most important factors in determining the suitability of an area for producing a particular crop, therefore, as much information as possible concerning the climate has been accumulated and analyzed for this feasibility study. Unfortunately, there are no detailed climatic records for the area of the proposed project, and it will be necessary to use data from stations some distance away.

Generally, Zambia is situated in the tropical zone, although in most of the country the climate is moderated by altitude, which ranges from about 900 meters to over 1600 meters (2950 to 5000 feet). The project site being at 300 to 400 meters (1000 to 1300 feet) is one of the lowest areas of Zambia and can be expected to exhibit a more tropical climate than most of the country.

The nearest official meteorological station is at Lake Kariba, some 100 kilometers (60 miles) south of the project site. Although this station is approximately the same latitude and longitude as Chiawa, it is over 500 meters (1600 feet) higher in elevation and will record somewhat different readings than those that can be expected at the lower elevations of the Zambezi River Valley. Figure 3.1 shows the detailed observations for 1980 and 1981 at the Kariba site and a summarized graph depicting mean monthly temperatures and rainfall.

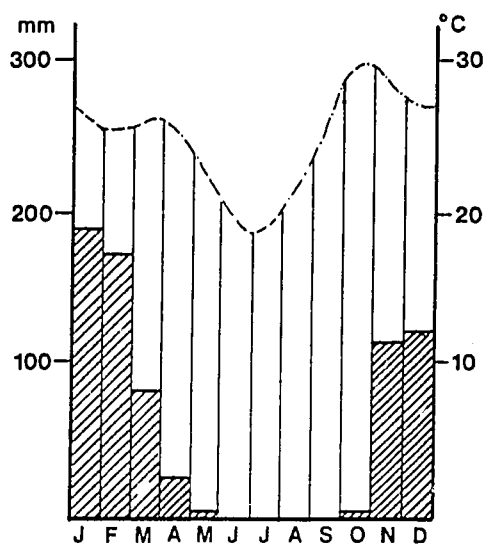
Another set of climate data available can be taken from a series of maps published by the Department of Meteorology. These maps contain generalized information in graphic form, which can be summarized as follows:

RELATIVE HUMIDITY: ANNUAL MEAN PERCENT = 55-60%
JULY MEAN TEMPERATURE: 19-20 DEGREES CENTIGRADE (68 DEGREES F)
AVERAGE MEAN TEMPERATURE: 25 DEGREES CENTIGRADE (77 DEGREES F)
SUNSHINE, ANNUAL TOTAL HOURS: 2950 HOURS
SUNSHINE, DAILY AVERAGE: 8.1 HOURS
MEAN ANNUAL RAIN DAYS: 60
MEAN ANNUAL RAINFALL: 710 MM (28 INCHES)
RAINFALL, ANNUAL RAINFALL LIKELY TO BE REACHED OR EXCEEDED FOUR YEARS OUT OF FIVE: 610 MM (24 INCHES)

All of this information can be used to describe the climate at the project site as tropical, with seasonal dry and wet periods that are reasonably consistent from year to year. Measurable rainfall begins in November and continues through March, with January being the wettest month of the rainy season. Average

Figure 3.1 CLIMATE DATA FROM KARIBA AIRPORT, ZIMBABWE

	Dry Bulb Temp	R.H. %	Evap.	Rain	Daily Sunshine Hrs	Daily Radiation mj/m^2	Mean Cloud Amt Octas
1980							
Jan	26.7	73	201	168.0	9.0	28.0	4.9
Feb	26.2	77	143	149.0	6.6	21.5	6.1
March	24.9	81	146	272.0	7.4	22.1	4.8
April	24.0	77	143	61.3	8.3	22.1	4.3
May	20.8	66	148	---	10.2	21.1	1.0
June	17.4	65	131	---	9.2	19.0	1.5
July	13.0	62	124	---	9.1	20.9	1.5
Aug	22.2	45	190	---	10.0	22.5	1.1
Sept	27.0	45	244	7.7	10.4	25.3	1.3
Oct	28.7	43	264	44.7	9.4	26.1	3.2
Nov	28.4	59	225	75.0	8.1	25.1	5.0
Dec	26.4	73	192	182.0	6.4	22.8	6.0
1981							
Jan	25.9	79	150	265.0	7.1	23.7	6.0
Feb	24.9	85	100	205.0	3.3	18.2	7.1
March	25.1	79	136	69.0	6.9	22.5	5.6
April	23.4	73	134	19.0	8.5	22.1	3.5
May	20.0	73	114	---	8.7	18.9	2.9
June	18.0	64	133	---	10.0	20.2	0.9
July	18.7	60	128	---	9.2	19.0	2.1
Aug	22.0	49	198	---	10.3	23.3	1.2
Sept	25.4	42	219	2.0	9.7	23.9	2.2
Oct	27.9	43	182	63.0	8.5	23.8	3.7
Nov	29.0	55	269	166.0	8.9	28.0	4.3
Dec	27.7	64	218	160.0	9.3	28.1	5.2



annual rainfall is approximately 710 millimeters (28 inches), with 90 percent or more coming during the rainy season

Mean monthly temperatures vary during the year from a high in October of approximately 30 degrees Centigrade (80 degrees F) to a low in July of about 19 degrees Centigrade (68 degrees F).

This information would seem to identify two distinct crop seasons: one from December through May for crops requiring warm temperatures and large amounts of water; and another from June through November for crops that can withstand cooler nighttime temperatures and with lower water requirements. Of course, with irrigation, natural rainfall is not required but it is always welcome to reduce the operating time of the irrigation equipment, and, hence, the operational costs.

A small weather station will be installed at the farm and monitored daily to compile a complete set of yearly meteorological records. This station will record daily temperatures, relative humidity, solar radiation, rainfall, and wind speed and direction to allow the calculation of potential crop evapotranspiration, which will be discussed more fully in a later section. These records will be available to all interested persons and will greatly increase the amount of knowledge about weather patterns in the Zambezi River Valley.

3.2 LAND RESOURCES

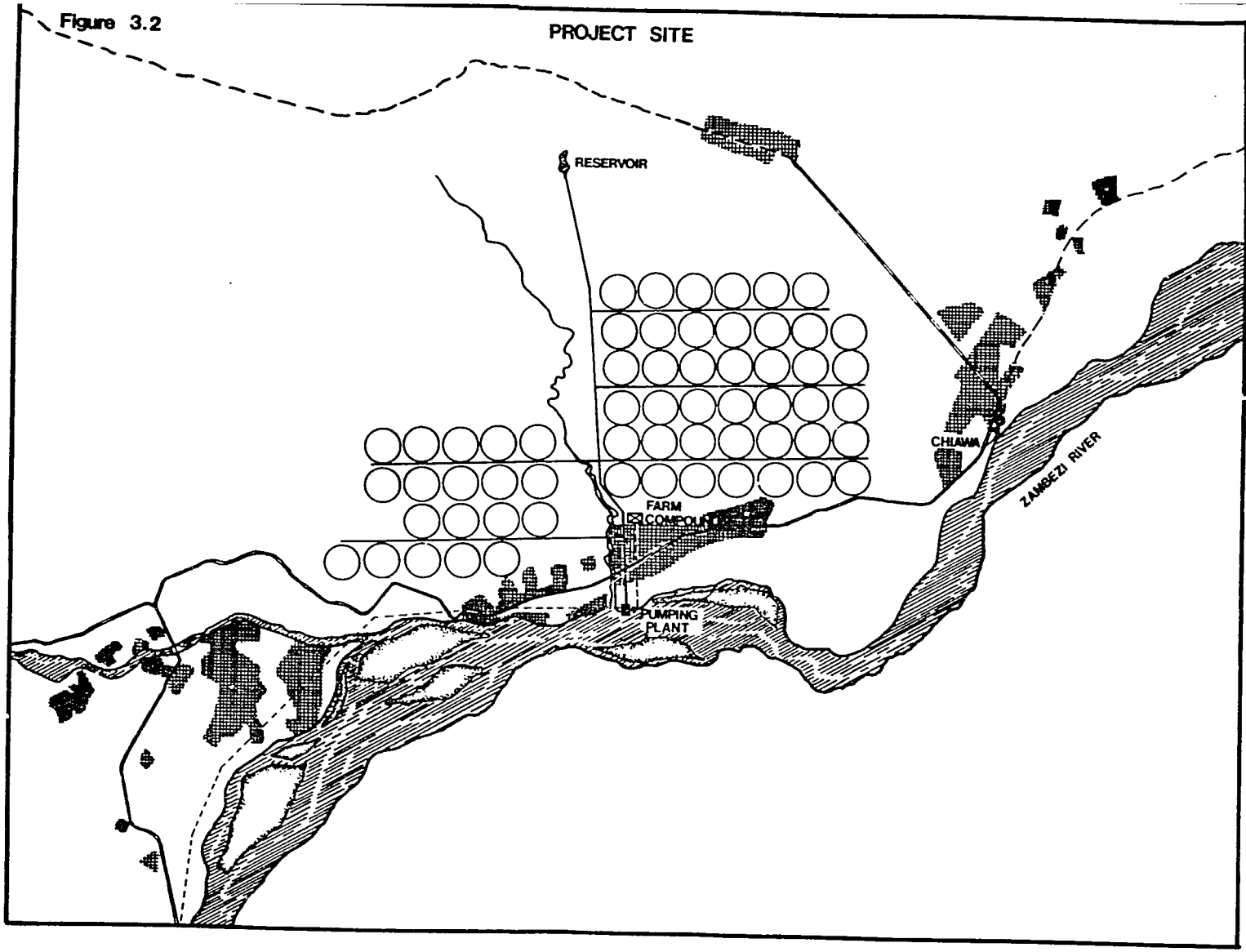
The potential arable land area in the Chiawa section of the Zambezi River Valley is in excess of 1,000 square kilometers (386 square miles), between the river and the escarpment to the north. As delineated in Figure 3.2, the farm site encompasses approximately 10,000 hectares (25,000 acres).

3.2.1 GEOLOGY

Figure 3.2.1 is a map showing the general geological features present in the Chiawa area, with the boundaries of the farm site overlaid for reference. The map shows that the primary features are recent alluvium and colluvium soils, Upper Karoo sandstone, and occasional basaltic outcroppings.

The rocks of the Karoo system are the dominant feature of the middle Zambezi River Valley. Being younger than the underlying Precambrian rocks, they show no evidence of metamorphism and are dated by the reptilian fossils from the Jurassic and Carboniferous periods. The rocks formed during the Karoo deposition are sedimentary in origin, except for the top layers, which are volcanic, and are now the basaltic outcroppings

Figure 3.2


PROJECT SITE
RESERVOIR
FARM COMPOUND
PUMPING PLANT
CHIAWA
ZAMBEZI RIVER

mentioned above.

3.2.2 SOIL TYPES PRESENT

As proposed, the agricultural production would be situated predominantly on the alluvial/colluvial soils and the Upper Karoo sandstone, skirting the areas with major basaltic outcroppings.

The soils which have developed from these geological formations are generally well drained sandy loams, slightly acidic by nature, that have an inherently low fertility status. These soils generally support acacia savanna vegetation groups, which are the major groups at the farm site.

Soil samples were taken at the project site to obtain a general cross section of the soils and to determine if any major limitations to irrigated crop production are present. More thorough sampling will be done to accurately determine fertilizer requirements for each of the fields before actual production starts, but these analyses will enable a basic fertilizer program to be developed and the financial requirements estimated.

Nineteen factors, including pH, nitrogen, phosphorus, potassium, sulfur, and zinc concentrations, cation exchange capacity, and particle size analysis were determined for each of the samples, and are shown in Figure 3.2.2.

The soils have generally low inherent fertilities, which is quite common in the highly weathered soils of the tropics. Of the major nutrients necessary for crop production, only potassium is present in sufficient amounts, but fertilizers will be used to supply the crops with the other nutrients in order to achieve the high production rates expected and used later in this study.

The laboratory analyses show that there are no limiting factors present in the soils tested. The soil pH is slightly acidic at 5.6 to 6.3, but applications of lime will not be necessary in the initial stages.

The other potentially limiting factors of sodium and soluble salts are within acceptable ranges, so no corrective measures will be necessary. The boron content of .3 to .4 parts per million is in the high range of what is considered acceptable, but will not affect the yields of any of the crops planned; however, analysis of the soil should be done after each season to determine if the content of this nutrient increases.

Particle size analysis, which determines the texture of the soil, indicates the soils are either sandy loams or loamy sands.

SOIL FERTILITY REPORT

OLSEN'S AGRICULTURAL LABORATORY, INC.

P.O. BOX 370 McCOOK, NE 69001 (308) 345-3670

SUBMITTED BY: WESTERN AGRI. MGT.
BOX 449-400 N. LINK
FORT COLLINS, CO 80522

NAME:

DATE RECEIVED: 8/13/84 DATE REPORTED: 8/20/84

SOIL TEST RESULTS

LAB NUMBER	SAMPLE IDENTIFICATION	pH SOIL	pH BUFFER	EXCESS LIME	SOLUBLE SALTS mmhos/cm	ORGANIC MATTER %	NITRATE-NITROGEN (N) 0-8 IN. ppm	0-8 IN. lbs/A	IN. ppm	IN. lbs/A	IN. ppm	IN. lbs/A	TOTAL lbs/A	PHOSPHORUS BRAY P1 ppm	BICARB ppm	EXCH POTASSIUM ppm	SULFATE-SULFUR(S) ppm	DTPA ZINC ppm
48771	ZAMBIA - A	6.3	6.8	N	VL .36	.8	5	13					13	VH 35		VH 283	4	M .6
48772	ZAMBIA - B	5.6	6.7	N	VL .42	.6	4	10					10	L 6		VH 266	12	L .3
48773	ZAMBIA - C	5.5	6.6	N	VL .30	1.0	1	2					2	VL 2		M 112	4	L .3

LAB NUMBER	EXCHANGEABLE CALCIUM ppm	EXCHANGEABLE MAGNESIUM ppm	EXCHANGEABLE SODIUM ppm	DTPA IRON ppm	DTPA MANGANESE ppm	DTPA COPPER ppm	BORON ppm	CEC me/100g	% SATURATION BASE	H	Ca	Mg	K	Na	SODIUM ADSORPTION RATIO (SAR)	EST. SODIUM PERCENT (ESP)	PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
48771	M 1010	H 214	L 7	VH30.1	VH26.8	H .9	L .2	* 9.6	79	21	52	19	8	0			72	20	8	SANDY LOAM
48772	L 570	M 147	L 4	VH18.1	VH58.5	H .7	H .3	* 7.8	61	39	36	16	9	0			81	11	8	LOAMY SAND
48773	M 950	H 238	L 2	VH23.8	VH43.1	VH 1.1	L .1	* 11.0	64	36	43	18	3	0			81	6	13	SANDY LOAM

SUGGESTED FERTILIZER RECOMMENDATIONS

LAB NUMBER	SAMPLE IDENTIFICATION	CROP TO BE GROWN	YIELD GOAL	N lbs/A	P_2O_5 lbs/A	K_2O lbs/A	S lbs/A	Zn lbs/A	MgO lbs/A	Fe lbs/A	Mn lbs/A	Cu lbs/A	B lbs/A	LIME T/A	GYPSUM T/A
48771	ZAMBIA - A	PEANUTS		20	0	0	20	5	0	0	0	0	0	0.0	
48771	ZAMBIA - A	COTTON	3 BALE/	260	0	0	20	3	0	0	0	0	0	0.0	
48772	ZAMBIA - B	PEANUTS		20	75	0	0	10	0	0	0	0	0	0.0	
48772	ZAMBIA - B	COTTON	3 BALE/	260	50	0	0	5	0	0	0	0	0	0.0	
48773	ZAMBIA - C	PEANUTS		20	100	100	20	10	0	0	0	0	0	0.0	
48773	ZAMBIA - C	COTTON	3 BALE/	270	100	25	20	5	0	0	0	0	0	0.0	

H = VERY HIGH, H = HIGH, M = MEDIUM, L = LOW, VL = VERY LOW, N = NONE

COMMENTS: * CALCULATED-CEC CANNOT BE ESTIMATED BY THE SUMMATION METHOD WHEN SOILS CONTAIN EXCESS LIME.

PLEASE READ SPECIAL COMMENTS ON BACK

BY

SOIL FERTILITY REPORT

OLSEN'S AGRICULTURAL LABORATORY, INC.

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LAB NUMBER	SAMPLE IDENTIFICATION	pH SOIL	pH BUFFER	EXCESS LIME	SOLUBLE SALTS mmhos/cm	ORGANIC MATTER %	NITRATE-NITROGEN (N) 0–8 IN. ppm	0–8 IN. lbs/A	IN ppm	IN lbs/A	IN ppm	IN lbs/A	TOTAL lbs/A	PHOSPHORUS BRAY P1 ppm	BICARB ppm	EXCH POTASSIUM ppm	SULFATE-SULFUR(S) ppm	DTPA ZINC ppm
48774	ZAMBIA - D	6.0	6.7	N	VL .30	2.0	1	2					2	L 10		H 145		L .5
48775	ZAMBIA - D1	5.6	6.6	N	VL .30	.9	1	2					2	L 9		H 135	1	L .3
48776	ZAMBIA - E	6.2	6.8	N	VL .30	1.0	1	2					2	L 9		VH 217	2	L .3

LAB NUMBER	EXCHANGEABLE CALCIUM ppm	EXCHANGEABLE MAGNESIUM ppm	EXCHANGEABLE SODIUM ppm	DTPA IRON ppm	DTPA MANGANESE ppm	DTPA COPPER ppm	BORON ppm	CEC me/100g	% SATURATION BASE	H	Ca	Mg	K	Na	SODIUM ADSORPTION RATIO (SAR)	EST. SODIUM PERCENT (ESP)	PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
48774	H 1920	VH 326	L 1	VH34.8	VH42.5	H .8	H .3	* 15.7	81	19	62	17	2	0			68	18	14	SANDY LOAM
48775	M 940	VH 319	L 3	VH24.7	VH13.2	H .9	L .2	* 11.7	66	34	40	23	3	0			78	11	11	SANDY LOAM
48776	M 950	VH 308	L 1	VH12.2	VH14.5	H .6	H .3	* 9.9	80	20	48	26	6	0			77	13	10	SANDY LOAM

SUGGESTED FERTILIZER RECOMMENDATIONS

LAB NUMBER	SAMPLE IDENTIFICATION	CROP TO BE GROWN	YIELD GOAL	N lbs/A	P_2O_5 lbs/A	K_2O lbs/A	S lbs/A	Zn lbs/A	MgO lbs/A	Fe lbs/A	Mn lbs/A	Cu lbs/A	B lbs/A	LIME T/A	GYPSUM T/A
48774	ZAMBIA - D	PEANUTS		20	75	50		10	0	0	0	0	0	0.0	
48774	ZAMBIA - D	COTTON	3 BALES	270	50	0		5	0	0	0	0	0	0.0	
48775	ZAMBIA - D1	PEANUTS		20	75	50	20	10	0	0	0	0	0	0.0	
48775	ZAMBIA - D1	COTTON	3 BALES	270	50	0	20	5	0	0	0	0	0	0.0	
48776	ZAMBIA - E	PEANUTS		20	75	0	20	10	0	0	0	0	0	0.0	
48776	ZAMBIA - E	COTTON	3 BALES	270	50	0	20	5	0	0	0	0	0	0.0	

VH = VERY HIGH, H = HIGH, M = MEDIUM, L = LOW, VL = VERY LOW, N = NONE

COMMENTS: * CALCULATED-CEC CANNOT BE ESTIMATED BY THE SUMMATION METHOD WHEN SOILS CONTAIN EXCESS LIME.

PLEASE READ SPECIAL COMMENTS ON BACK

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LAB NUMBER	SAMPLE IDENTIFICATION	pH SOIL	pH BUFFER	EXCESS LIME	SOLUBLE SALTS mmhos/cm	ORGANIC MATTER %	NITRATE-NITROGEN (N) 0-6 IN ppm	0-6 IN lbs/A	IN ppm	IN lbs/A	IN ppm	IN lbs/A	TOTAL lbs/A	PHOSPHORUS BRAY P1 ppm	RICARB ppm	EXCH POTASSIUM ppm	SULFATE-SULFUR(S) ppm	DTPA ZINC ppm
8777	ZAMBIA - E	5.6	6.7	N	VL .30	.6	1	2					2	L 6		VH 225	3	L .3

LAB NUMBER	EXCHANGEABLE CALCIUM ppm	EXCHANGEABLE MAGNESIUM ppm	EXCHANGEABLE SODIUM ppm	DTPA IRON ppm	DTPA MANGANESE ppm	DTPA COPPER ppm	BORON ppm	CEC me/100g	% SATURATION BASE	H	Ca	Mg	K	Na	SODIUM ADSORPTION RATIO (SAR)	EST SODIUM PERCENT (ESP)	PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
8777	L 600	H 172	L 1	VH16.0	VH25.2	H .9	H .4	* 8.0	63	37	38	18	7	0			76	13	11	SANDY LOAM

SUGGESTED FERTILIZER RECOMMENDATIONS

LAB NUMBER	SAMPLE IDENTIFICATION	CROP TO BE GROWN	YIELD GOAL	N lbs/A	P_2O_5 lbs/A	K_2O lbs/A	S lbs/A	Zn lbs/A	MgO lbs/A	Fe lbs/A	Mn lbs/A	Cu lbs/A	B lbs/A	LIME T/A	GYPSUM T/A
8777	ZAMBIA - E	PEANUTS		20	75	0	20	10	0	0	0	0	0	0.0	
8777	ZAMBIA - E	COTTON	3 BALES	270	50	0	20	5	0	0	0	0	0	0.0	

H = VERY HIGH, H = HIGH, M = MEDIUM, L = LOW, VL = VERY LOW, N = NONE

COMMENTS: * CALCULATED-CEC CANNOT BE ESTIMATED BY THE SUMMATION METHOD WHEN SOILS CONTAIN EXCESS LIME.

76.

PLEASE READ SPECIAL COMMENTS ON BACK

Consideration of all of the above leads to the conclusion that there are no soil factors that will substantially limit the production of irrigated crops at the project site. However, regular analysis will be required to determine the nature and scope of any changes in the future.

3.2.3 TOPOGRAPHY

The Chiawa area is part of a gently sloping alluvial plain that extends on the north side of the Zambezi River from below the Kariba Dam, to the entrance of the Luangwa River. Approximately ten kilometers wide at Chiawa, the plain narrows considerably both upstream and downstream, but then widens again in several areas. Numerous small, seasonal streams flow off of the escarpment to the north and across the plain, but most are not prominent.

The average slope is about one percent in the area where the agricultural production is anticipated, but rises to much steeper slopes near the base of the escarpment.

The elevation of Chiawa is 371 meters (1215 feet), which is approximately the elevation of the river. The farm site rises from there to an elevation of 450 meters in the northwest corner; however, the majority of the farm will be between the 380 and 410 meter levels.

3.2.4 CURRENT USE OF THE LAND

Agriculture in the project area at the present time is of the subsistence type by local villagers. The main crops grown are maize and cotton, but small family gardens produce several types of vegetables for home use. Average farm output is low due to rainfall conditions, low standard of cultural practices, insufficient agricultural technology, insufficient agricultural inputs and credit facilities, and damage by wild animals.

Almost the entire existing agricultural production area is located near the river, along the road from Chirundu to Chiawa. Small plots are also located on the river's edge, so that they may be irrigated by hand from the river.

A 10 hectare (25 acre) banana production scheme operated by the government is also located near the river. It is irrigated by a small pump from the river and appears to be an efficient operation, producing good yields of bananas.

Aside from these small areas of production, the land at or near the project site is largely unused for any productive purposes.

The project boundaries have been purposely designed to avoid cultivated areas in order to cause no negative impact on the local people.

3.3 WATER RESOURCES

The Zambezi River, which forms the southern boundary of the proposed farm site and the international boundary with Zimbabwe, is certainly one of the most important rivers in Africa. With a total catchment area of 666,000 square kilometers (257,000 square miles) at Chirundu, it drains an area almost as large as Zambia itself. Average flows at the project site are in excess of 1500 cubic meters per second (23,760,000 gallons per minute) and are fairly consistent owing to large upstream reservoirs at Kariba and on the Kafue River, a major tributary, at the Kafue Gorge.

The Zambezi River originates in extreme northwestern Zambia, exits the country and enters Angola where it flows southward before entering Zambia again. It continues to flow southward before turning easterly just upstream of Livingstone and the famous and beautiful Victoria Falls. The river has literally hundreds of tributaries, the largest being the Kafue River which joins the Zambezi just a few kilometers upstream from the farm site.

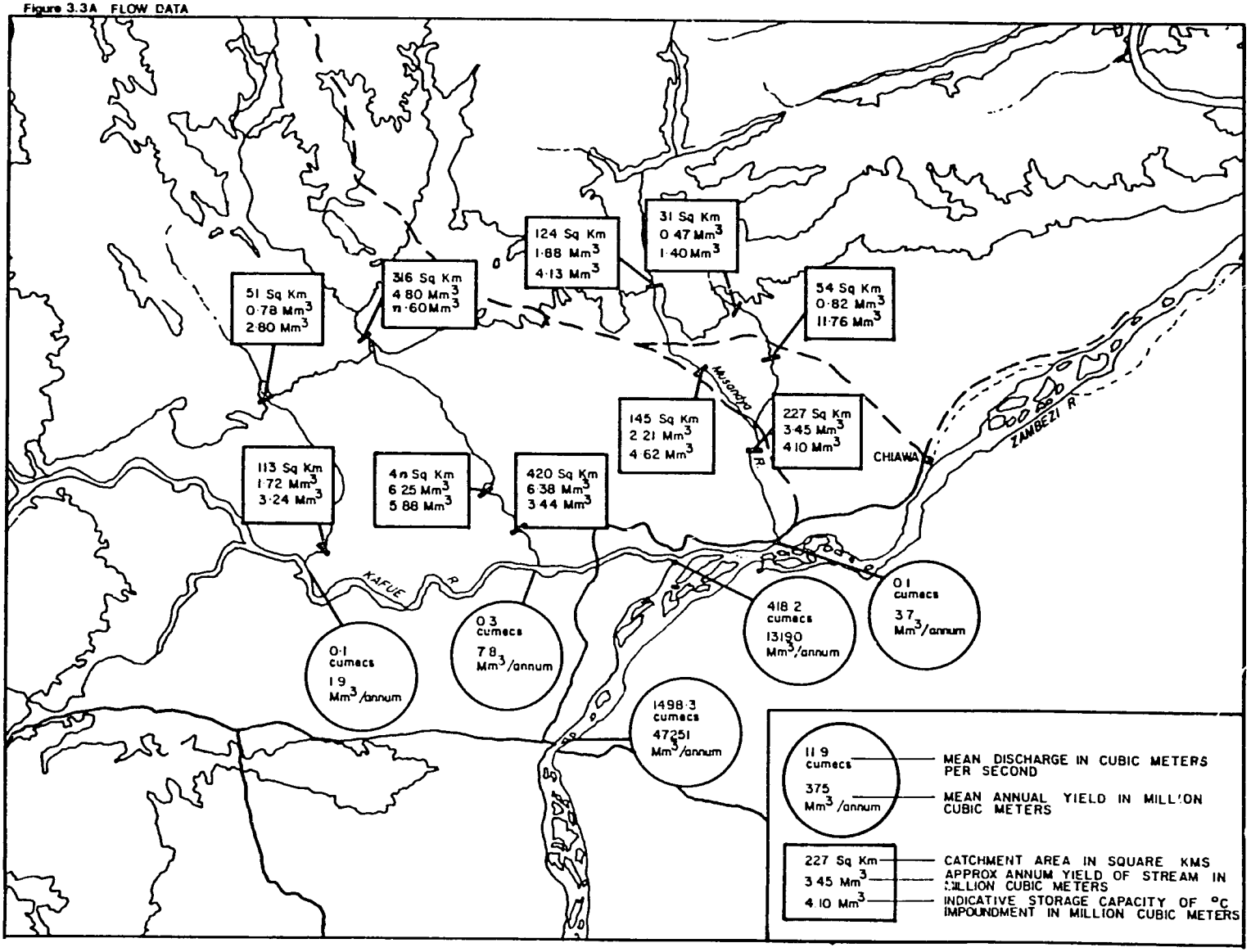
Figure 3.3 A shows the flow data for the Zambezi, Kafue, and the larger tributaries in the area of the project. The combined average flow of the Kafue and the Zambezi is in excess of 1900 cubic meters per second, or 60,000 million cubic meters per annum. The Musandya River, also shown, is the only major stream to cross the farm site. It has an approximate annual yield of 3.45 million cubic meters and an impoundment capacity of 4.1 million cubic meters.

Figure 3.3 B shows the results of a water quality analysis completed on a sample of the Zambezi River taken on July 29, 1984. All of the water quality indices are in the "good to excellent" range for irrigation purposes and will not place any restrictions on the type or quantity of crops grown.

3.4 ENERGY RESOURCES

There are two main types of energy available for use by the project: diesel fuel and electricity. Diesel fuel, due to its expense and the storage and transport problems associated with it, is not a realistic source of energy for the irrigation pumping plant, which will be the main energy consumer on the farm. Diesel fuel will, however, be used to power the farm machinery and as many of the farm vehicles as possible.

Figure 3.3A FLOW DATA



Availability of diesel fuel is generally good, even though it is almost exclusively imported from other countries. The price of diesel is approximately $2.00 per gallon (0.95 Kwacha per liter).

Electrical power is available from an 88 kilovolt line which runs through Chirundu, approximately 15 kilometers (9.3 miles) southwest of the farm. The power originates at the hydroelectric plant at the Kafue Gorge about 50 kilometers (31 miles) west of the project. From Chirundu, a new three phase line can be constructed to connect the farm, at a cost of approximately $1,000,000. It will supply 380 volt power for the pumping plant, the processing facilities and the farm compound.

The Zambia Electrical Supply Company (ZESCO) will erect and install the new line, the accompanying transformers and control equipment. Most of the equipment for the new line, except for the power poles, will be imported from the United States or other countries, because it is not currently available in Zambia.

Electrical energy charges are not unreasonable for small consumers; they are based on the total amount used during a month and the peak demand experienced during the month. When the power consumed during any month exceeds 2000 KVA, there is a fixed charge of K4062, plus a demand charge of K0.276 times the peak demand (KVA), plus a charge of K.082 per KVH. These rates would result in a final charge of approximately K0.085 per KVH, or $0.0475 per KVH. However, because of the large quantity of power used, a more reasonable rate will be requested from the power authorities.

3.5 MACHINERY, EQUIPMENT AND PRODUCTION INPUTS

3.5.1 MACHINERY AND EQUIPMENT

Most of the major equipment manufacturers have representatives or dealers in Zambia. These include Massey-Ferguson, John Deere, Caterpillar and British Leyland Trucks. Stocks of new equipment are almost non-existent, however, due to foreign exchange shortages. Used equipment is somewhat more available, but the condition of the equipment is usually poor, and parts are very scarce - also because of the shortage of foreign exchange.

Due to these problems, the majority of the equipment on the farm will be imported from the United States and European countries. Spare parts will be shipped with the equipment to insure their ready availability.

One alternative to importing all of the equipment would be the purchase of some of the used machinery available in Zambia and the import of parts to bring it up to optimum condition. This used machinery generally brings low prices relative to new equipment because of the scarcity of the proper parts. With a small investment in parts, an essentially new piece of equipment could be obtained for a modest percentage of the price of a new one.

Prices of new equipment imported into Zambia are somewhat higher than usual due to the long overland transport from the nearest ocean ports. The most economical method of shipping is by rail from the port at Dar-es-Salaam in Tanzania, but this is also the most unreliable and generally is subject to substantial pilferage and long delays. Shipment by truck from the ports in South Africa is the safest and most reliable, but is also the most expensive at approximately $70.00 per ton.

3.5.2 PRODUCTION INPUTS

Most of the major production inputs such as fertilizer, seed, herbicides and insecticides are available in Zambia on a limited basis. Usually these materials become available for only short periods during the year, and they must be purchased at the times they are available and stored for later use. Storage facilities are planned for this purpose.

Again, the problem of availability stems from the lack of foreign exchange to buy the goods from outside sources. Only occasionally does the government release the foreign exchange necessary to bring in insecticides from England or seed from the United States, for example.

In order to guard against a critical shortage of an important input, it will be necessary policy for the farm management to keep an amount of foreign exchange available to import certain items when they become short of supply in Zambia. It will be important that the management plan ahead at least one crop season and have all of the major production inputs on the site to insure that shortages during the crop season do not occur.

Prices of most of the inputs in Zambia are reflective of international prices, plus shipping, for those items which are imported. Fertilizers, seed, soil amendments and diesel fuel are all priced roughly equivalent to world prices.

Some of the more technical inputs such as herbicides and insecticides are priced significantly higher than international prices when purchased in Kwachas. A savings of 25 to 50 percent

can be achieved if these items are purchased in Dollars (or some other widely held foreign currency) and imported.

3.6 INFRASTRUCTURE

3.6.1 TRANSPORTATION

Transportation resources within Zambia are fairly good, largely due to the development of the rail system to serve the copper producing regions in the north. This rail system was completed in 1975 and connects several areas of Zambia with the ocean port at Dar-es-Salaam, Tanzania. Although most of the system serves the Copper Belt, there is a major railhead at the town of Kafue, some 60 kilometers (36 miles) northwest of the project site, which connects to the remainder of the system at Lusaka.

Since late 1976, however, massive congestion at the port in Dar-es-Salaam has resulted in long delays and high costs in cargo movement to and from Zambia. Therefore, in 1978 the southern route by road through Zimbabwe to the ports in South Africa was reopened and it now constitutes the most reliable shipping route.

Internal highways in Zambia are fairly good, though few in numbers. Again, the major development has occurred in the Copper Belt, but recent efforts have improved several of the other highways in the country. The main route south to Zimbabwe and the ports in South Africa, mentioned earlier, lies approximately 15 kilometers (9 miles) southwest of the farm site at Chirundu.

Scheduled international airline service connects Zambia to most major cities in Europe and Africa through the international airport in Lusaka. Domestic service by Zambia Airways provides connections to the larger provincial towns.

The only weak point currently, relative to transporting the products from the farm to the various markets, is the ferry crossing on the Kafue River, some 10 kilometers (6 miles) west of the farm compound. The ferry's current capacity is only 16 tons, too small to handle the large trucks that will service the farm. A larger ferry boat, or a bridge, will need to be installed that will be capable of supporting approximately 40 tons.

3.6.2 AGRICULTURAL INFRASTRUCTURE

All of the agricultural infrastructure in Zambia is located in areas far removed from the project site. The vast majority of grain storage sites, cotton gins, oil presses, and grain mills are situated near Lusaka, some 170 kilometers northwest of Chirundu. For both economic and logistic reasons, it will not be

practical to depend on those facilities to handle the farm's output.

The government presently, through the Lusaka Province Cooperative Union, purchases sunflower and cotton from the area farmers and distributes fertilizer, maize, cotton and sunflower seeds through a small depot at Chiawa. There have, however, been major delays in the pick-up of harvested products. Due to insufficient facilities on the part of the Cooperative, and to the nature of the farm itself, these services provided by the Cooperative will not lend themselves readily for use by a project of this size.

Therefore, the project will have to include all of the necessary storage and processing facilities. This will enable the farm to act as an independent unit and allow the farm management to make qualified decisions concerning the marketing of the farm's products without the constraints of timing, transport, and dependence on others.

The facilities required at the farm site include storage and drying facilities for the various crops, processing facilities for the cotton and castorbeans, warehouses for the farm inputs and machinery, workshops, and housing.

3.7 PEOPLE

3.7.1 DEMOGRAPHICS

The project site is located in Lusaka Province, which is the fastest growing province in Zambia, and has the second largest population, behind the Copper Belt province. The 1980 census puts the population of Lusaka Province at approximately 694,000 people, or roughly 12 percent of the total national population of 5,680,000.

The vast majority of these people live in the large urban area surrounding the city of Lusaka. Like most other developing African countries, there has been an ever increasing migration of rural people to the cities, migrating with the hope of taking advantage of the more favorable social and economic conditions there. The National Commission for Development Planning, in the Agricultural Base-Line Data for Planning, has estimated that of the total average growth rate for Lusaka Province of 6.4%, roughly half, or 3.64%, is due to migration from rural areas.

Although the project site lies within the boundaries of Lusaka Province, it is geographically separated from the majority of the Province by the Zambezi River Escarpment, which is a narrow band of steep mountains and narrow canyons that provide only small

areas suitable for habitation. This escarpment effectively provides a buffer zone between the relatively low population of the river valley and the highly populated area around the city of Lusaka. The official census figures show that the population density for the province is 5.67 persons per square kilometer of arable land, but it is thought that this more accurately reflects the population of the higher plateau region and is not representative of the Chiawa area, even though there are no figures available to substantiate this belief.

Zambia is also similar to other African countries in that the population is growing at a substantial rate, in excess of 3 percent per year. This means a doubling of the population every 22 years.

It is estimated that approximately 30,000 people live in the Chiawa area. They are mostly peasant and emergent farmers whose agriculture is mainly dependent on dryland farming, and to a small extent on fishing.

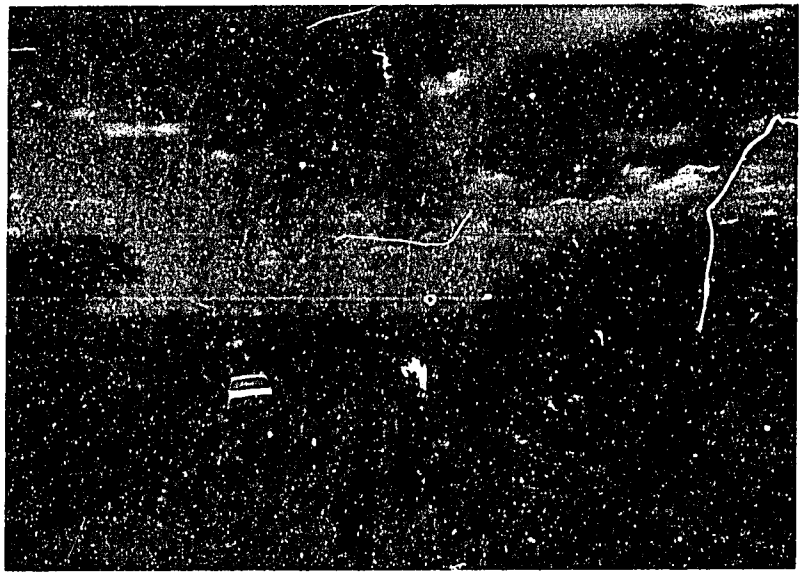
Medical and education facilities are notably lacking in the area, with only a primary school in Chiawa and a small medical clinic. Statistically, there is only one doctor available per 50,000 inhabitants and 1.5 hospital beds per 1,000 inhabitants, which is substantially below the recognized standard of at least one doctor per 20,000 and 3 hospital beds per 1,000 inhabitants.

3.7.2 AVAILABILITY OF LABOR

From the population in the immediate area of the farm, an adequate supply of unskilled labor can be obtained at reasonable costs for both the development and production phases of the project. Although these people will be relatively unfamiliar with any of the tasks to be accomplished, with the training procedures outlined later in the study, it is thought that they can be a positive asset to the project.

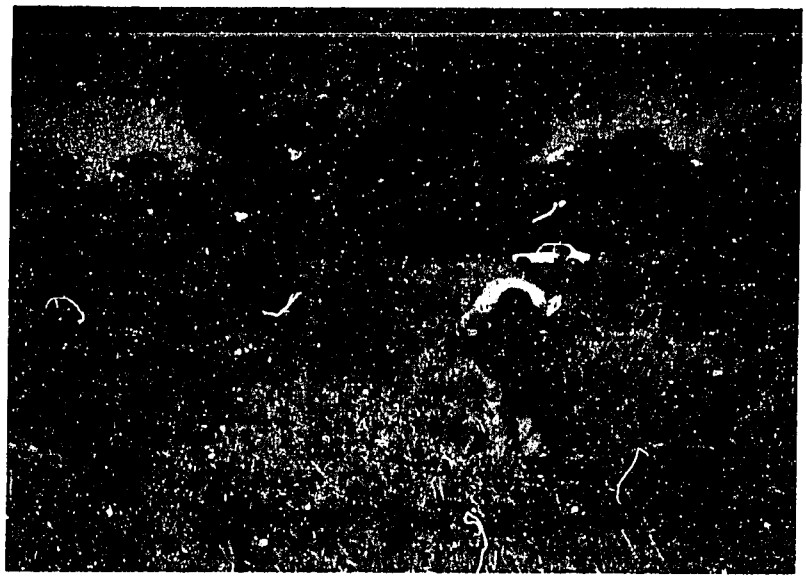
Professional and skilled workers in most disciplines are available in Lusaka. Due to the current slump in the national economy, skilled workers in the building trades are readily available for the development phase. The University of Zambia in Lusaka is now expanding its College of Agriculture, and a ready supply of well trained agronomists and agricultural workers will be available, although they will require some on-the-job training to become acquainted with Western's methods.

Views of the Zambezi River



Road Through Project Site

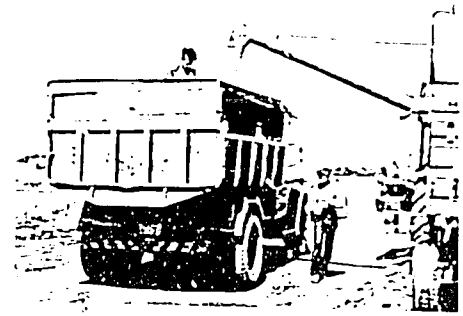
Typical Vegetation



Soil Sampling

Local Village

4. PRODUCTION



4.0 AGRICULTURAL PRODUCTION

4.1 SELECTION OF CROPS

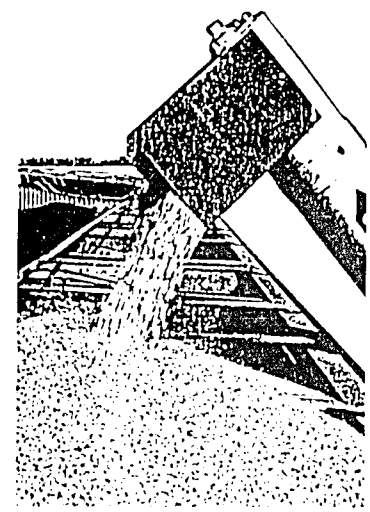
4.2 AGRICULTURAL PRODUCTION
- 4.2.1 COTTON
  - 4.2.1.1 SELECTION OF VARIETIES
  - 4.2.1.2 FARMING PROCEDURES
  - 4.2.1.3 SOIL AND FERTILIZER REQUIREMENTS
  - 4.2.1.4 INSECT PESTS
  - 4.2.1.5 WEED CONTROL
  - 4.2.1.6 DISEASE CONTROL
  - 4.2.1.7 IRRIGATION REQUIREMENTS
  - 4.2.1.8 CROP YIELD ESTIMATES
- 4.2.2 GROUNDNUTS
- 4.2.3 WHEAT
- 4.2.4 CASTORBEANS

4.3 CROPPING PLAN

4.4 PROCESSING FACILITIES
- 4.4.1 COTTON GIN
- 4.4.2 OIL PRESS

4.5 SUMMARY OF AGRICULTURAL PRODUCTION REQUIREMENTS
- 4.5.1 OPERATING CAPITAL
- 4.5.2 IRRIGATION WATER
- 4.5.3 ENERGY
  - 4.5.3.1 ELECTRICAL
  - 4.5.3.2 DIESEL
- 4.5.4 FARM MACHINERY
- 4.5.5 IRRIGATION EQUIPMENT
- 4.5.6 PROCESSING FACILITIES

4.6 CROP PROFIT ANALYSIS



4.0 AGRICULTURAL PRODUCTION

4.1 SELECTION OF CROPS

To achieve the high production necessary to make a technologically advanced farm profitable, careful consideration must be given to all of the environmental, social, and economic factors described in Sections 2.0 and 3.0 of this report. These factors will be used in this section to identify the types of crops and the associated cultural practices that will be optimum under the given conditions.

Some general facts that can be drawn from the previous sections will help set the basic guidelines for the selection of crops. Two seasons are easily identifiable: the summer season with warm temperatures and moderate rainfall, and the winter season with cooler temperatures and almost no rainfall. Although the summer season will not present any limitations to most crops, the cooler temperatures prevalent in the winter will necessitate growing crops that do well under these conditions.

The soils are generally sandy loams that exhibit good drainage, so that few, if any, limitations are imposed by the soils.

Agricultural inputs are generally available in Zambia, or can be secured fairly quickly from other sources. Most of the farming equipment needed is not available in Zambia, but can be brought in from other countries and will not limit the scope of the project.

Water supplies are practically unlimited from the enormous flows of the Zambezi River. Even at the completion of Phase II of the project, water consumption for irrigation will approach only 10 cubic meters per second, in comparison to the average flow of 1900 cubic meters per second.

Markets for most agricultural goods in Zambia are good, with government established producer prices that exceed those on the international markets. However, to meet the demand for foreign currency that is required for debt service, a large percentage of the farm's production will have to be exported. Export markets favor several oil seed crops, cotton and groundnuts, among others to be discussed.

Transportation availability for the export crops is generally good, although it is expensive, due to the distance of the farm from the nearest seaports. This factor will limit the crop choices to high value, non-perishable goods that can easily be shipped long distances. Vegetable crops, such as potatoes and

onions, will be at a distinct disadvantage as export crops for this reason.

With these factors in mind, the most profitable crops for the summer season are groundnuts and cotton. These crops are well suited to the light soils and warm temperatures present. Both are easily transported and will bring high prices in Europe.

The winter season, with its lower temperatures, is ideally suited for the production of wheat for sale in Zambia. Other crops that also are feasible include castor beans, sunflowers (for oil), safflowers, and soybeans. Castor beans and wheat will be used in this study for purposes of analysis, but will be varied as markets and other conditions dictate.

Although these crops appear to be best suited to the conditions and markets currently, other crops may be found to diversify the operations. Continuing research and experimentation to identify these crops will be made by the farm management in an on site experimental area.

4.2 AGRICULTURAL PRODUCTION

4.2.1 COTTON

GOSSYPIUM HIRSUTUM, or upland cotton, is the variety most commonly grown around the world for use in textiles. It is a weak perennial that will continue to grow and flower indefinitely if provided with sufficient amounts of water and nutrients. In practice, however, it is commonly treated as an annual, being replanted each season. The plant will normally reach a height of 60 to 120 centimeters and develop a deep tap root often reaching more than 2 meters in depth.

Cotton is considered a warm season crop, being produced in those areas where the mean annual temperature is higher than 16 degrees Centigrade. The minimum temperature for germination and growth is 16, with an optimum of 34 and a maximum of 39 degrees Centigrade. Temperatures below the minimum will favor the development of non-reproductive (vegetative) branches.

Flowering generally begins about nine weeks after sowing with the squares appearing three to four weeks earlier. Although flowering may continue for a considerable length of time, most of the eventual yield is set during the first four weeks. Another eight to ten weeks is required for the boll splitting to be completed.

Harvesting cotton is accomplished by either hand picking or by mechanized cotton pickers. Due to the slowness of hand picking and the large size of the farm contemplated, mechanical pickers are a necessity for most of this project.

4.2.1.1 SELECTION OF VARIETIES

Properly selected, adapted varieties of cotton will help assure a successful farming operation. Several factors need to be considered when this selection is made, including potential yield, insect and disease resistance, quality of the product for market, and general adaptation to the area where it is grown.

Research and development of high quality cotton varieties have been occurring for many years in Africa with the introduction of American Upland varieties in the early 1900's. These soon became physically mixed with the local varieties and lost their identities through cross pollination and natural selection and adaptation to the new environment. After several selections including BP52 and S47 from Uganda and Tanzania, the Albar varieties were introduced in the 1950's.

The Albar varieties were significant developments because of their resistance to blackarm disease (Xanthomonas malvacearum), and their potentials to produce greater yields and higher quality lint. However, these selections are not well suited for mechanical harvesting.

The Deltapine varieties are introductions from the United States. With further selections made in African countries, there are now several varieties available that have the characteristics sought. From South Africa three are available that combine the high yields necessary with good lint quality and high gin turnouts.

These are Deltapine 61, Deltapine Acala 90, and Acala 1517/70. The Deltapine Acala 90 seems to be the best choice (but it is a new selection and seed availability may be a problem), followed by Deltapine 61, and Acala 1517/70 in terms of desirability.

It is recommended that the farm be planted in several different varieties, rather than restricting the choice to a few. This approach has several advantages. First, it will allow the farm management to appraise the merits of the varieties under the local conditions. Second, the risk of crop failures from disease is reduced because of various genetic differences; the risk that all will be susceptible to a particular disease is greatly diminished.

4.2.1.2 FARMING PROCEDURES

It is important to state that the farming procedures described below are the preferred ones for agricultural practice. They are based on Western Agri-Management's experience and experienced sources in Africa. In reality, there will have to be modifications and adjustments of schedules to accommodate weather related problems and other unforseen complications.

The initial discing is done with a five-meter offset disc pulled behind a tractor. Its primary purpose is to turn over and break up the soil to a depth of approximately 20 centimeters. This procedure will also level and even the soil after the clearing operation.

A tractor-towed fertilizer spreader will be used to broadcast granular fertilizer. Each pass covers about 12 meters. Nitrogen, phosphorus, and potassium will be applied as required by soil analysis.

The secondary discing will mix the fertilizer into the soil, apply and incorporate a herbicide, if required, and prepare a suitable seed bed for planting. This operation will be performed

at a depth of 6 to 8 centimeters. The herbicide is applied immediately ahead of the disc using a tractor-powered sprayer mounted directly on the disc.

Planting will be accomplished using a five-row, row-crop planter, that is also used for planting the bean crops, groundnuts and corn. Plant populations of approximately 50,000 plants per hectare will be targeted, using 5 kilograms of seed and 75 centimeter rows. The seed should be planted at a depth of four to five centimeters to insure an even stand. The planter will also be equipped with hoppers to allow the application of starter fertilizer in a band next to the seed.

Immediately following planting, a light irrigation will be applied to establish the crop and activate the herbicide.

The fields will be checked bi-weekly for moisture depletion, and information such as wind speed, temperature, and relative humidity will be used to calculate the daily water use by the crop. Together, these two sets of information can be used to schedule the irrigation of each crop as effectively as possible, avoiding over - and under - watering. As a part of the irrigation scheduling, additional nitrogen fertilizer will also be applied through the sprinkler during the growing season.

During the early stages of growth while the cotton is still small, the crop will be cultivated at least once. This will eliminate any weeds that escaped control by herbicides applied prior to planting.

Before the crop becomes too big for further cultivation, or at layby, an application of the herbicide Fusilade (fluazifop-butyl) at the rate of two to three liters per hectare will further suppress any weed growth missed by earlier measures.

Harvesting of the cotton crop will be accomplished by using four-row self-propelled cotton pickers. The harvesting procedure begins when approximately 60% of the bolls are open. Harvest aids, such as Arethal, can be applied earlier to stimulate the bolls to open in a more uniform fashion, facilitating a once over harvest.

When the plants are ready for harvest, the crop is sprayed with a defoliant that causes the leaves to fall from the plant, preventing fouling of the picking machinery. Nitrogen in the petiole of the cotton plant must drop below 2,000 PPM or the vegetative growth will be too vigorous for the defoliant to work properly. Irrigation should stop after the bolls are open to prevent boll rot.

Cotton picking is a slow process, even with mechanized harvesting. A four-row picker is capable only of harvesting about one hectare per hour, or approximately one center pivot per week. In order to successfully complete two crop seasons per year, the harvest must be accomplished quickly, necessitating a large number of machines.

If all of the above management practices are followed, a once over harvest will yield 80 - 90% of the cotton lint that would be harvested in two passes, but with significant savings in time and operating costs.

4.2.1.3 SOIL AND FERTILIZER REQUIREMENTS

Generally, it is recommended that cotton not be grown on shallow or extremely heavy soils, but apart from these restrictions cotton is not particularly sensitive to the type of soil in which it is grown. Like most plants it will perform the best on deep, alluvial soils of medium texture with good drainage. However, cotton has yielded well in other soils: for instance, the light soils in the tobacco region of Zimbabwe, and the heavy clays of the Kafue Flats in Zambia. Mostly it is important that the soil not be waterlogged for long periods during the growth stage of the plant.

Cotton also tolerates a wide variation in soil reaction. A soil with a pH of less than 5.0 will produce higher yields when limed to a pH of approximately 6.0, and the cotton plant will generally do well in soils of pH 8.0 and higher.

Figure 3.2.2 shows the results of the preliminary soil analyses. The soils, being predominantly sandy loams with reasonable soil reaction, are ideally suited for cotton production. Nitrogen, phosphorus, potassium, sulfur, and zinc will be needed in varying amounts to maximize production. The table below outlines a fertilizer program based on these results, to achieve a yield of 1500 kilograms lint per hectare.

		NUTRIENTS APPLIED KG/HA				
FERTILIZER	KG/HA	N	P2O5	K2O	S	ZN
20-20-0-10S	275	55	55	0	25	0
46- 0-0	532	255	0	0	0	0
ZNSO4 36%	14	0	0	0	0	5
TOTAL RECOMMENDED KG/HA		300	55	0	25	5

In this program, the first fertilizer listed, 20-20-0-10S, will be applied partly by the broadcast method, and partly as a starter band next to the seed. The remainder of the nitrogen and the ZNSO4 will be applied during the growing season through the irrigation system. This method of application greatly reduces leaching losses and increases the efficiency of recovery.

4.2.1.4 INSECT PESTS

By far the most important pests of cotton are the insects. Until very recently, insects have severely curtailed the production of cotton in many parts of Africa by reducing yields so drastically that most commercial growers could not profitably produce it. Since the early 1950's, however, giant strides have been made in the development of insecticides that effectively control the major insect pests of cotton.

The best method of identifying insect problems is through the use of weekly scouting trips in each field. The agronomist can then determine the kind and numbers of the insects present and make qualified judgements concerning the control measures necessary.

There are four main groups of insects that attack cotton and cause reductions in yields serious enough to justify the use of insecticides in economic terms. The first group to infest young cotton plants are members of the genus Aphis, usually A. gossypii, or the aphids. These are leaf sucking insects that cause a general yellowing of the leaves, and which deposit a sticky substance called "honeydew" on the topside of the lower leaves. One or two applications of the aphicide Pirimor early in the growth cycle of the cotton plant, when aphid damage first becomes apparent, will provide successful control.

The remaining three groups of economically important insects can be controlled with the insecticide Cymbush, a synthetic pyrethroid, which is active against a very broad spectrum of insects. These groups are the jassids, Empoasca spp.; the bollworms, Heliothus armigera, Diparopsis castanea, and Earias spp.; and the stainers, Dysdercus spp. An application of Cymbush at approximately ten day intervals from the time the insects become established, until the crop is nearly ready for harvest is needed to effectively control them. Generally five or six applications, totalling about one liter per hectare, are required.

Other insects that should be watched for (although they are usually not economically important) are the red spider mite, Tetranychus; Lygus spp.; Helopeltis; and the more common

agricultural pests such as cutworms, termites, and grasshoppers.

4.2.1.5 WEED CONTROL

Weed control, although not as critical as insect control, can still have a major impact on the eventual yield of cotton. As a young plant, cotton is a slow grower relative to many of the weed species with which it will be competing. At this time of its life, weed control is especially important. At the later stages of growth, weeds will not compete so much for nutrients and light, but will seriously hamper harvesting efforts if allowed to grow and clog the interrow areas.

The types of weeds that will most likely be encountered are annual and perennial grasses. For these weeds, an application of the herbicide Fusilade, or fluazifop-butyl, at a rate of two to three liters per hectare will be required at layby to effect control for the remainder of the season.

Although not expected to present problems initially, broadleaf weeds may become established, requiring control efforts. The trifluralin herbicides applied before planting and incorporated into the soil will control these weeds very effectively.

The actual application of the herbicides can be accomplished by a tractor-towed spray rig in the case of post-emergence herbicides, and by spraying equipment attached to the planter or disc in the case of pre-emergence herbicides. It is important that the manufacturer's recommendations concerning volumes of water and solution concentrations be followed for best results.

4.2.1.6 DISEASE CONTROL

A few disease organisms need to be discussed here also, even though diseases are not a major concern throughout the cotton growing regions of Africa. Internal boll disease can be very serious, but it is considered simply a part of the problem of its vector, the stainer insects. With proper insect control, this disease will not become prevalent.

Bacterial blight, or Xanthomonas malvacearum, has been a serious disease in other parts of Africa. In Sudan it has threatened to completely cripple the cotton industry by reducing yields by one third or more in some years. Primary infection of the field occurs through the use of infected seed. Secondary infections start from crop residue of previous crops and quickly spread throughout the field by rain splatter and wind. A simple treatment with one of several available fungicides will eliminate the primary infection, and deep tillage and periodic

crop rotations will eliminate the secondary source.

Generally, the keys to avoiding disease are the use of resistant varieties (when available), good cultural practices, and proper seed treatment.

4.2.1.7 IRRIGATION REQUIREMENTS

Figure 4.2.1.7 shows in graphic form the approximate water usage by cotton during its development from seedling to mature plant. Water use peaks about 90 days after planting, when the plant will use up to 10 millimeters per day.

More accurate water use rates can be calculated using one of several equations developed for this purpose. The Blaney-Criddle and Penman equations were developed in the United States to act as general guidelines for establishing evapotranspiration rates for several crops. These equations use meteorological data such as wind speed, relative humidity, temperature and sunlight along with a crop coefficient to determine daily or monthly water usage.

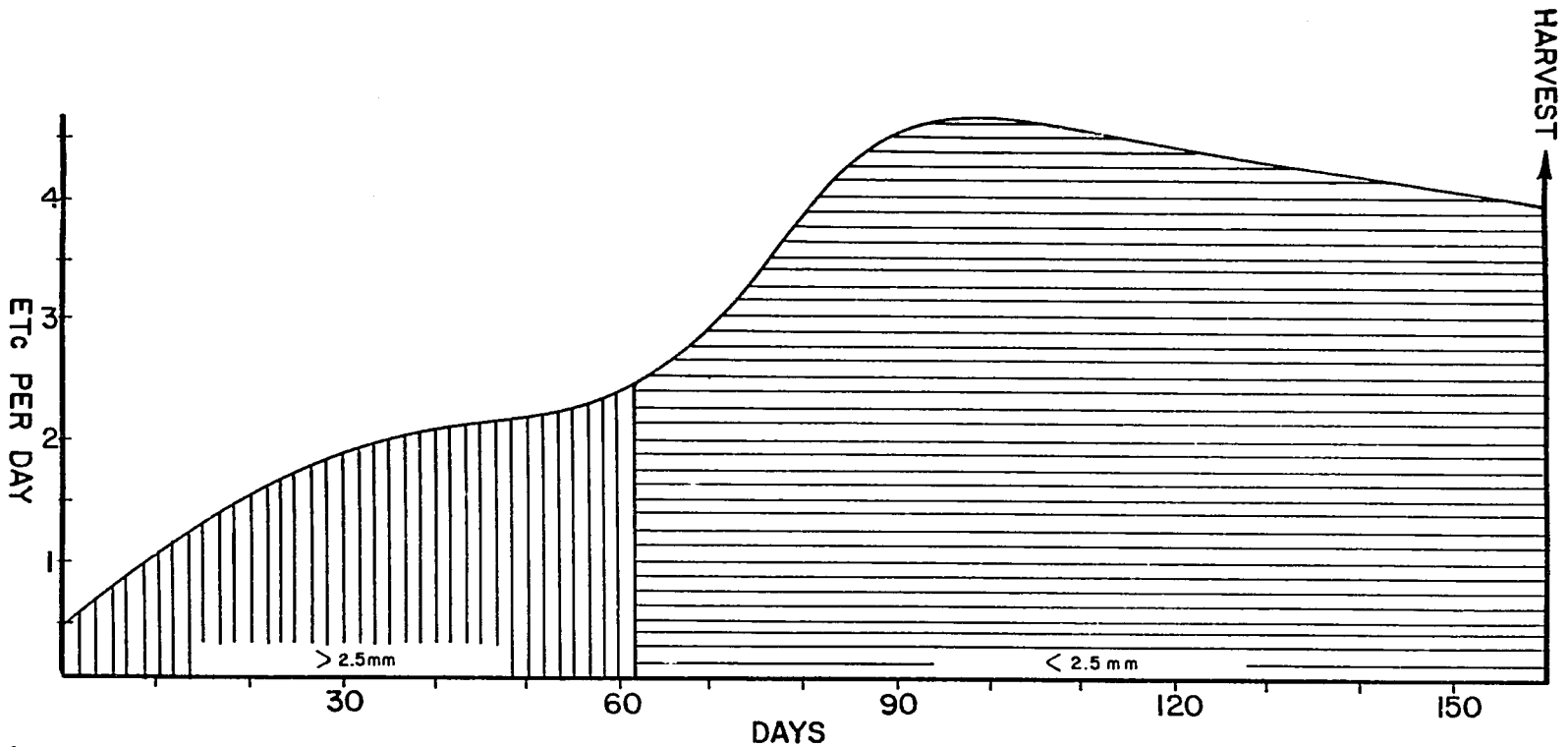
There are several problems inherent in using any of the published methods of determining water use, not the least being the lack of accurate climate data at the project site. To accurately predict evapotranspiration for any specific area and crop, these equations need several years of calibration to adapt them to local conditions. However, to estimate the water use for determining pump capacities and production costs, they serve very adequately.

A recent revision of the Blaney-Criddle method was published by the FAO (Doorenbos and Pruitt, 1977) using air temperature measurements for the site in question, and by classifying the climate at a site based on wind speed, humidity and sunshine. The calculations will then produce a monthly reference crop evapotranspiration that can be adjusted using a crop coefficient.

The monthly reference crop evapotranspiration (ETo) calculations are shown in Appendix A. The table below gives the monthly ETo, the crop coefficient factor (Kc) and the actual crop evapotranspiration (ETc) for the months December through May when cotton will be grown. The monthly and total cumulative water usages are also given.

Figure 4.2.1.7

COTTON WATER USAGE



	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
ETo	4.50	5.25	4.10	4.25	3.90	3.90
Kc	0.44	0.45	1.05	1.05	1.05	0.65
ETc/DAY	1.98	2.36	4.30	4.46	4.10	2.54
MONTHLY TOTAL MM	59	70	129	134	123	76
CUMULATIVE TOTAL	59	129	258	392	515	591

From Section 3.1, Climate, it can be seen that during the months of December through May an average of approximately 550 millimeters of rain can be expected. This amount of rain, if evenly distributed, would almost supply the crops' needs. However, rainfall is almost never properly distributed to meet the crops exact needs, and without irrigation the crop would be subjected to prolonged dry spells that would seriously affect the eventual yields. It is impossible to predict the exact amount of natural precipitation, but there are several methods for estimating the monthly effective rainfall. From the information contained in Appendix A and from the above table showing monthly water usage, the following table can be constructed.

	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
MONTHLY USAGE	59	70	101	134	123	76
MEAN RAINFALL	120	190	160	80	20	10
EFFECTIVE RAIN	50	122	100	60	13	7
CORRECTION FACTOR	.905	.905	.905	.905	.905	.905
TOTAL EFFECTIVE RAINFALL MM	45	110	90	54	12	6
IRRIGATION REQUIRED MM	14	0	11	80	111	70

4.2.1.8 CROP YIELD ESTIMATES

Cotton yields given in the Agricultural Base-Line Data For Planning, published by the National Commission for Development Planning and the University of Zambia, show the average for commercial growers to be only 0.566 metric tons per hectare during the 1981/82 season. These yields are for rain-fed cotton grown during the wet season from approximately November through June.

However, several publications have listed considerably higher yields that have been obtained by commercial growers both in Zambia and surrounding countries. Reports from Zimbabwe show yields as high as 5 metric tons per hectare of seed cotton, which produces 2.0 to 2.5 metric tons of lint (A.N. Prentice, 1972).

Irrigated yields in Arizona commonly reach over 3 metric tons of seed cotton or 1.5 metric tons of lint (personal communication with Harold Payne, Agricultural Consultant, Tempe, Arizona).

It is estimated that the yields of lint cotton for the project will range from approximately 1.3 metric tons to 2.0 metric tons per hectare. In addition, after ginning, approximately 1.5 to 2.5 metric tons of cotton seed will be obtained that can be processed for use either as seed for the following year or for cottonseed oil for sale on the local or export markets.

4.2.2 GROUNDNUTS

ARACHIS HYPOGAEA, otherwise known as groundnuts or peanuts, appears to have originated in central South America, where closely related ancestors have been found. Carried by early travelers from South America to Africa and the East, they have become a major crop far from their ancestral home. Groundnuts are a valuable source of high-quality protein and vegetable oil, and are being viewed with renewed interest because of their potential as a source of protein for emerging nations. Also, a large market exists for high-quality peanuts for the confectionery trade.

The groundnut is a low growing, annual legume that can be broken into three main groups: Spanish or runner types, that are the varieties mostly grown for oil production; Valencia types, that are medium size and are grown for the confectionery trade; and the Virginia types, that are the largest and also are grown for the confectionery trade. The Spanish and Valencia groups are bunch types, with branches that are upright, while the Virginia groups have a spreading habit with horizontal branches.

Generally, the environmental requirements for groundnuts are similar to those for cotton and tobacco - that is, a warm climate with mean temperatures during the growing season of at least 24 degrees Centigrade. Relatively large amounts of water are needed to produce a high-quality crop; however, during harvest, dry conditions are needed to prevent soil from clinging to the nuts.

Being a leguminous crop, groundnuts, if properly inoculated, will form nodules on their roots that will fix atmospheric nitrogen for their use, thus requiring little, if any, nitrogen based fertilizers.

Flowering generally occurs between one and two months after planting. Once pollinated, the flower forms a peg and grows downward entering the soil, which places the ovary in a horizontal position just below the surface. There the fruit, an elongated pod with one to six seeds, develops until maturity.

When mature, the plants are lifted from the soil and shaken to remove the soil and then left in windrows to dry for two or three days. The pods are then removed by combining.

4.2.2.1 SELECTION OF VARIETIES

Properly selected, adapted varieties of groundnuts will help assure a successful farming operation. Several factors need to be considered when this selection is made, including potential

yield, insect and disease resistance, quality of the product, and general adaptation to the area where it is to be grown.

At present, there are three main groundnut varieties available in Zambia from the Zambia Seed Company Ltd. Chalimbana is a large seeded confectionery type that shows good yield potentials under irrigation. It forms the basis for the export trade from several countries in central Africa.

Makulu Red and Natal Common are both smaller seeded varieties that are used mainly in the production of groundnut oil. Both show very good yield potentials under irrigation, especially Makulu Red which currently holds the world record of 9.2 metric tons per hectare in Zimbabwe.

It is recommended that besides Chalimbana for the export trade, other varieties from neighboring countries be tried on a trial basis to determine their yield potential under local conditions. Also, varieties from South and North America should be tested.

4.2.2.2 FARMING PROCEDURES

It is important to note that the farming procedures described below are the preferred ones for agricultural practice. They are based on Western Agri-Management's experience and experienced sources in Africa. In reality, there will have to be modifications and adjustments of schedules to accommodate weather related problems and other unforseen complications.

The initial discing is done with a five-meter tandem disc pulled behind a tractor. Its primary purpose is to turn over and break up the soil to a depth of approximately 20 centimeters. This procedure will also level and even the soil after the clearing operation.

A tractor-towed fertilizer spreader will be used to broadcast granular fertilizer. Each pass covers about 12 meters. Nitrogen, phosphorus, and potassium will be applied as required by soil analysis and crop needs.

The secondary discing will mix the fertilizer into the soil, apply and incorporate a herbicide, if required, and prepare a suitable seed bed for planting. This operation will be performed at a depth of 6 to 8 centimeters. The herbicide is applied immediately ahead of the disc using a tractor-powered sprayer mounted directly on the disc.

Planting will be accomplished using a six-row, row-crop planter, that is also used for planting the bean crops, cotton and maize.

Plant populations of approximately 100,000 plants per hectare will be targeted, using 35 to 45 kilograms of seed and 75 centimeter rows. The seed should be planted five to seven centimeters deep to insure an even stand. The planter will also be equipped with hoppers to allow the application of starter fertilizer in a band next to the seed.

It is important to note here a few factors concerning groundnut seed. Many of the varieties that will be used on the farm exhibit seed dormancy that inhibits germination for some time after the nut is harvested. Especially in the Virginia group, the seed should be tested for germination before it is planted. In addition, all of the seed should be treated with fungicides to control the various fungal diseases that can affect groundnuts.

Immediately following planting, a light irrigation will be applied to establish the crop and activate the herbicide.

Biweekly the fields will be checked for moisture depletion, and information such as wind speed, temperature, and relative humidity will be used to calculate the daily water use by the crop. Together, these two sets of information can be used to schedule the irrigation of each crop as effectively as possible, avoiding both over - and under - watering. As a part of the irrigation scheduling, additional nitrogen fertilizer and/or trace elements, when required, will also be applied through the sprinkler during the growing season.

Once or twice during the early stages of growth, before the peanuts are big enough to fill the rows, the crop will be cultivated. This will eliminate any weeds that escaped control by the herbicides applied prior to planting, and will also provide a suitable bed for peg penetration. During the final cultivation, if necessary, an application of an herbicide such as Fusilade can be done to further suppress weed growth.

Groundnuts are harvested when the kernels are fully grown, the skins displaying a distinct texture and the natural color of the variety, and the inside of the shell is beginning to color and show darkened veins. The nuts will shrink when harvested too early, and some varieties will sprout if left in the ground too long. The plants are removed from the soil with special diggers equipped with blades or half sweeps that cut off the roots below the nut zone and lift the plants from the ground. The vines are then windrowed with a shaker-windrower attachment.

After being allowed to field dry for two or three days, the groundnuts are combined. The moisture content is usually about 15 to 20 percent. The combining operation is very slow, averaging

about eight hectares per day, thus requiring one combine per center pivot.

Once harvested, the nuts must be immediately dried to a moisture content of 8.5 per cent, using forced air at a temperature below 38 degrees Centigrade.

4.2.2.3 SOIL AND FERTILIZER REQUIREMENTS

Groundnuts are best adapted to light, well drained sandy loam soils. Heavy soils will interfere and inhibit proper peg penetration. They tolerate acidic soils better than cotton and are not adversely affected by aluminum toxicity, which is frequently associated with acidic soils in the tropics. Root growth and development are not seriously restricted by acidic conditions. The optimum pH range is from 6.0 to 6.5.

Figure 3.2.2 shows the results of the preliminary soil analyses. The soils, being predominantly sandy loams with reasonable soil reaction, are ideally suited for groundnut production. Nitrogen, phosphorus, potassium, sulfur, and zinc will be needed in varying amounts to maximize production. The table below outlines a fertilizer program based on these results, to achieve a yield of 3.0 metric tons per hectare.

			NUTRIENTS APPLIED KG/HA				
FERTILIZER		KG/HA	N	P2O5	K2O	S	ZN
6-18-12-10S		472	28	85	56	47	0
ZNSO4	36%	30	0	0	0	0	11
	TOTAL RECOMMENDED KG/HA		28	85	56	47	11

In this program, the first fertilizer listed, 6-18-12-10S, will be applied partly by the broadcast method, and partly as a starter band next to the seed. The ZNSO4 will be applied during the growing season through the irrigation system.

As mentioned previously, groundnuts are a legume, and are able to supply themselves with the majority of the nitrogen they require. However, they are heavy users of phosphates and potassium, and proper fertilization with these elements will result in far higher yields.

4.2.2.4.INSECT PESTS

Insects have historically not been considered major pests of groundnuts in Africa. Not that insects have not been reported in groundnuts, but the damage has not been documented thoroughly

enough to determine the extent. Recent evidence, however, seems to show that insects might cause more important yield reductions than previously thought.

The most important insect pest reported to date seems to be the the aphid, Aphis craccivora, which is the vector responsible for transmitting the groundnut rosette virus. The virus itself will be more fully discussed in a following section, but control of the vector will effectively control the disease. Spraying with an insecticide such as Pirimor at ten-day intervals (starting at ten days after emergence) will give significant yield responses. Usually four applications are necessary. It is important to note that spraying must start before the initiation of the disease symptoms, even though the crop may appear to be perfectly healthy. This measure will control only the vector, not the disease.

Other insects that occasionally are problems in groundnuts are millipedes, termites, thrips and jassids. All of these are more or less easily controlled by insecticides utilized at the correct time. During the biweekly field check, the agronomist will note the types and amounts of insects present in the field, and will at that time make the decision regarding the correct insecticide and the appropriate timing.

4.2.2.5 WEED CONTROL

Weed control can have a major impact on the eventual yield of groundnuts, and is an important consideration in seed bed preparation. Early control of weeds by pre-plant or pre-emergence herbicides is important because later cultivations often damage the plants, reducing yields.

The types of weeds that will most likely be encountered are annual and perennial grasses, considering the type of vegetation present at the site currently. For these weeds, an application of the herbicide Fusilade, or fluazifop-butyl, at a rate of two to three liters per hectare will affect excellent control.

Although not expected to present problems initially, broadleaf weeds may become established, requiring control efforts. The trifluralin herbicides applied before planting and incorporated into the soil will control these weeds very effectively.

The actual application of the herbicides will be accomplished by a tractor-towed spray rig in the case of post-emergence herbicides, and by spraying equipment attached to the planter disc in the case of pre-emergence herbicides. It is important that the manufacturer's recommendations concerning volumes of

water and solution concentrations be followed for best results.

4.2.2.6 DISEASE CONTROL

Disease organisms are by far the most important pests of groundnuts in Africa. There are two main types of disease organisms: the fungal agents and the viral agents.

The fungal agents cause seed rots, leaf spots, wilts and blights. Primary infection, in the case of seed rots, generally occurs through wounds or damage to the seed coat, and can be controlled with the use of an acceptable seed treatment, the use of sound large seed, and the proper preparation of the seed bed.

Leaf spot diseases are caused by members of the CERCOSPORA genus, which cause black spots on the upper and lower surfaces of the leaves. They are spread by airborne spores, infected trash in the soil, and to a lesser extent, by infected seed. Control measures include seed dressing, crop rotation, incorporation of infected debris, the use of resistant cultivars, and the use of a mancozeb/benomyl mixture or chlorothalonil applied at regular intervals, starting before the disease becomes evident.

Groundnut blight is caused by the fungus Sclerotium rolfsii, which causes wilting in patches throughout the field, and a white mycelium can be found on the roots. The disease is most likely to appear as the crop nears maturity. When established, the infection may either be limited to a few branches or it may spread to the central stem, in which case the entire plant dies. The use of resistant cultivars and crop rotations are the best means of control.

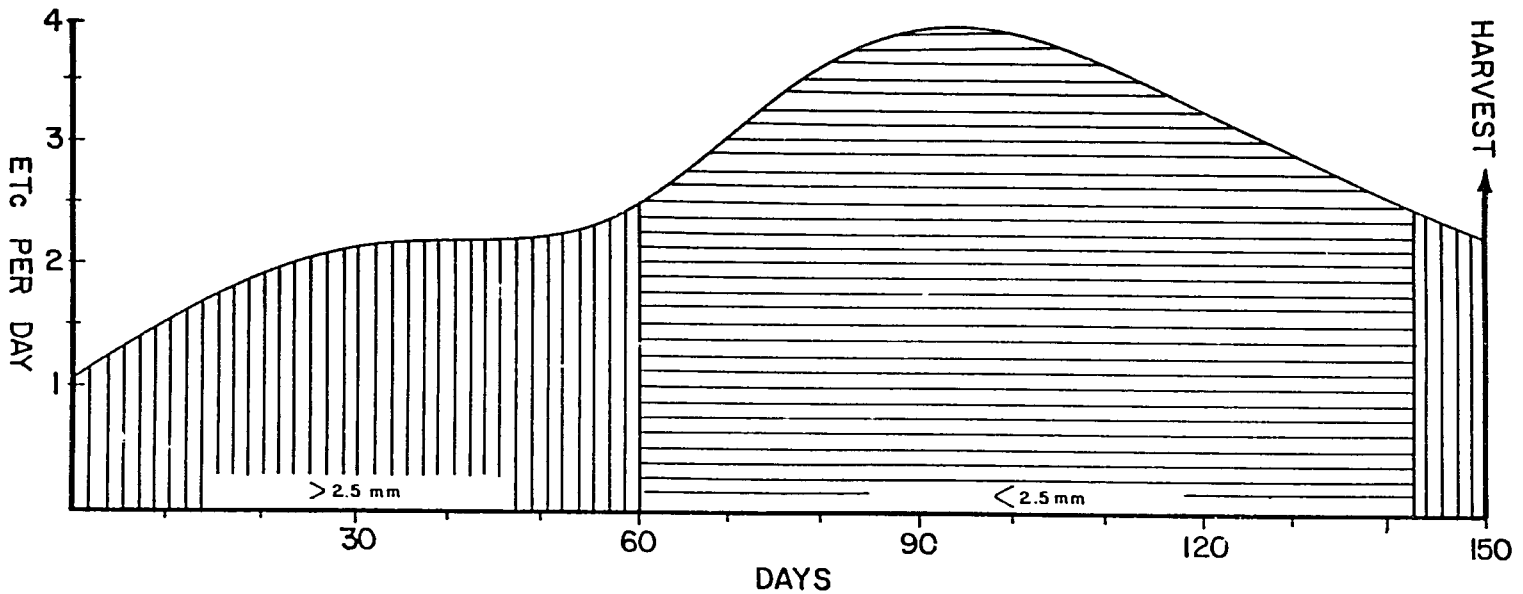
The viral agents cause a disease commonly known as rosette. This disease is a complex made up of at least five different viruses found throughout East Africa. The symptoms include yellowing, mottling and mosaic symptoms, and the stunting and distortion of the shoots. The viruses are transmitted by aphids as previously discussed. By controlling the vector, the risk of this disease is eliminated.

4.2.2.7 IRRIGATION REQUIREMENTS

Figure 4.2.2.7 shows in graphic form the approximate water usage by groundnuts during its development from seedling to mature plant. The plant requires adequate moisture throughout its life, but available moisture is especially critical at pegging and fruiting periods in order to achieve maximum yields.

Figure 4.2.2.7

GROUNDNUTS WATER USAGE



More accurate water use rates can be calculated using one of several equations developed for this purpose. The Blaney-Criddle and Penman equations were developed in the United States to act as general guidelines for establishing evapotranspiration rates for several crops. These equations use meteorological data such as wind speed, relative humidity, temperature and sunlight along with a crop coefficient to determine daily or monthly water usage.

There are several problems inherent in using any of the published methods of determining water use, not the least being the lack of accurate climate data at the project site. To accurately predict evapotranspiration for any specific area and crop, these equations need several years of calibration to adapt them to local conditions. However, to estimate the water use for determining pump capacities and production costs, they serve very adequately.

A recent revision of the Blaney-Criddle method was published by the FAO (Doorenbos and Pruitt, 1977) using air temperature measurements for the site in question, and by classifying the climate at a site based on wind speed, humidity and sunshine. The calculations will then produce a monthly reference crop evapotranspiration that can be adjusted using a crop coefficient.

The monthly reference crop evapotranspiration (ETo) calculations are shown in Appendix A. The table below gives the monthly ETo, the crop coefficient factor, Kc and the actual crop evapotranspiration, ETc, for the months December through May when the groundnuts will be grown. The monthly and total cumulative water usages are also given.

	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
ETo	4.50	5.25	4.10	4.25	3.90	3.90
Kc	0.48	0.45	0.95	0.75	0.55	0.00
ETc/DAY	2.16	2.36	3.90	3.19	2.25	0.00
MONTHLY TOTAL MM	67	73	101	99	68	00
CUMULATIVE TOTAL	67	140	241	340	408	408

From Section 3.1., Climate, it can be seen that during the months of December through May an average of approximately 550 millimeters of rain can be expected. This amount of rain, if evenly distributed, would supply the crop's entire needs. However, rainfall is almost never properly distributed to meet the crop's exact needs, and without irrigation the crop would be subjected to prolonged dry spells that would seriously affect the eventual yields. It is impossible to predict the exact natural

precipitation, but there several methods for estimating the monthly effective rainfall. From the information contained in Appendix A and from the above table showing monthly water usage, the following table can be constructed.

	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
MONTHLY USAGE	67	73	101	99	68	00
MEAN RAINFALL	120	190	160	80	20	00
EFFECTIVE RAIN	70	122	100	55	15	00
CORRECTION FACTOR	.905	.905	.905	.905	.905	00
TOTAL EFFECTIVE RAINFALL MM	63	110	90	50	13	00
IRRIGATION REQUIRED MM	4	0	11	49	55	00

4.2.2.8 CROP YIELD ESTIMATES

Accurate yield estimates for groundnut production in Zambia are unavailable, especially since there are so few commercial, large scale growers of groundnuts. Indications from the Zambia Seed Company are that yields of approximately 1.5 to 2.5 metric tons can be expected using the three cultivars mentioned previously under rain-fed conditions.

However, during the International Workshop on Groundnuts held in Patancheru, India in 1980, significantly higher yields were reported using the same cultivars under irrigated conditions. Chalimbana, the confectionery nut, was reported to have yielded in excess of 4 metric tons per hectare (almost 3 metric tons shelled) in Malawi. Of course, as mentioned earlier, Makulu Red holds the world record at 9.2 metric tons per hectare.

It is estimated that the yields of shelled peanuts for the project will range from approximately 3.0 to 4.0 metric tons per hectare.

4.2.3 WHEAT

TRITICUM VULGARE, or wheat, is the world's most important crop, being grown on over 214 million hectares (530 million acres) on every continent but Antarctica. It is considered to be a cool season annual and is a member of the grass family. The plant normally reaches a height of about one meter, but this is dependent on the variety and the climatic conditions under which it is grown.

There are many different types of wheat, classified by their growth habits and the type of grain they produce. Generally, in the tropical and sub-tropical areas of the world, hard and soft spring wheats are grown, owing to the warmer temperatures. These wheats, when grown in the tropics, are usually planted during the cooler and drier seasons to avoid many of the severe disease problems that can occur during warm, humid weather.

Wheat is a moderately drought-tolerant crop, but the best yields are obtained under irrigated conditions where a well distributed supply of soil moisture is available to the plant. Maturity is dependent on the variety and the altitude; generally, the lower the altitude, the faster the plant will mature. Maturity ranges from four months at lower altitudes to over seven months at altitudes above 2100 meters.

Harvesting is usually accomplished with mechanized combines when the grain moisture content is below 14 per cent. Wheat harvested and stored at higher moisture contents is susceptible to rotting, sprouting and insect damage.

4.2.3.1 SELECTION OF VARIETIES

Properly selected, adapted varieties of wheat will help assure a successful farming operation. Several factors need to be considered when this selection is made, including potential yield, insect and disease resistance, quality of the product, and general adaptation to the area where it is to be grown.

Varietal resistance is the only practical way of countering stem rust diseases that are the major constraint to wheat production in East Africa. The rapid appearance of new races of stem rust have forced plant breeders to continually test and release new varieties that are resistant to the latest race. Varietal recommendations, therefore, change almost yearly with the release of new and better varieties.

Many of the better new varieties have been developed at the CIMMYT research center in Mexico. In a recent test of varieties

at the University of Zambia, five out of the top ten came from CIMMYT. These included the following: Huacamayo "S", Verry "S", Jupateco, Pavon "S" and Sapsucker "S." All of these yielded in excess of 2.0 metric tons per hectare under rain-fed conditions. No statistics are available for these varieties under irrigation.

It is recommended that several different varieties be planted on the farm to minimize the risk of losing an entire crop to disease, and that the latest recommendations from the University of Zambia and other knowledgeable sources be used to determine the varieties to be planted in a particular year.

4.2.3.2 FARMING PROCEDURES

It is important to state that the farming procedures described below are the preferred ones for agricultural practice. They are based on Western Agri-Management's experience and experienced sources in Africa. In reality, there will have to be modifications and adjustments to schedules to accommodate weather related problems and other unforseen complications.

The initial discing is done with a five-meter offset disc pulled behind a tractor. Its primary purpose is to turn over and break up the soil to a depth of approximately 20 centimeters. This procedure will also level and even the soil after the clearing operation.

A tractor-towed fertilizer spreader will be used to broadcast granular fertilizer. Each pass covers about 12 meters. Nitrogen, phosphorus, and potassium will be applied as required by soil analysis.

The secondary discing will mix the fertilizer into the soil, apply and incorporate a herbicide, if required, and prepare a seed bed suitable for planting. This operation will be performed at a depth of 6 to 8 centimeters. The herbicide is applied immediately ahead of the disc using a tractor-powered sprayer mounted directly on the disc.

Planting will be accomplished using seven-meter wide grain drills with 25 centimeter rows. Approximately 90 kilograms of seed per hectare will be planted at a depth of 5.5 centimeters to insure an even stand. The grain drill will also be equipped with hoppers to allow the application of starter fertilizer in a band next to the seed.

Immediately following planting, a light irrigation will be applied to establish the crop and activate the herbicide.

The fields will be checked bi-weekly for moisture depletion, and information such as wind speed, temperature and relative humidity will be used to calculate the daily water use by the crop. Together, these two sets of information can be used to schedule the irrigation of each crop as effectively as possible, avoiding over - and under - watering. As a part of the irrigation scheduling, additional nitrogen fertilizer will also be applied through the sprinkler during the growing season.

If weeds become a problem, post-emergence herbicides can be applied to the crop after the wheat plants are 10 to 15 centimeters tall, but before they reach the boot stage. The herbicides can be applied by aerial means or with a tractor-towed sprayer.

Harvesting of the wheat crop will be accomplished using eight-meter wide, self-propelled combines. The harvesting procedure begins when the wheat has dried to at least the 14 percent moisture level to avoid spoilage in storage. Due to the width of the combine header (8 meters), wheat harvesting is a relatively quick operation, each combine being able to harvest in excess of 40 hectares per day.

4.2.3.3 SOIL AND FERTILIZER REQUIREMENTS

Like most crops, wheat grows best on loamy soils of medium texture, fairly high in organic matter, and with adequate fertility. However, wheat is very tolerant of less than optimum soil conditions - producing good yields on all but the very heaviest and lightest of soils.

The two conditions that will limit yields the most are waterlogging and acidic soils. Soil reaction is optimum at pH 7.0, but wheat will tolerate a pH as low as 5.3 without major yield reductions.

Figure 3.2.2 shows the results of the preliminary soil analyses. The soils, being predominantly sandy loams with reasonable soil reaction, are well suited for wheat production. The soil pH is approaching the lower limit for high yield potentials, and although no soil amendments are recommended at this time, if the pH drops in future years, lime may be required to adjust the soil to more acceptable levels. Nitrogen, phosphorus, potassium, sulfur and zinc will be needed in varying amounts to maximize production. The table below outlines a fertilizer program to achieve a yield of five metric tons per hectare.

FERTILIZER	KG/HA	NUTRIENTS APPLIED KG/HA N	P2O5	K2O	S	ZN
20-20-0-10S	250	50	50	0	25	0
46- 0-0	200	92	0	0	0	0
ZNSO4 36%	14	0	0	0	0	5
TOTAL RECOMMENDED KG/HA		142	50	0	25	5

In this program, the first fertilizer listed, 20-20-0-10S, will be applied partly by the broadcast method and partly as a starter band next to the seed. The remainder of the nitrogen and the ZNSO4 will be applied during the growing season through the irrigation system. This method of application greatly reduces leaching losses and increases the efficiency of recovery.

4.2.3.4 INSECT PESTS

Insects are not considered to be major problems to the production of wheat in Africa. Although there are several species that do attack wheat and cause damage that reduces the yield, all of them are easily controlled by the use of appropriate pesticides.

Probably the most prevalent of insects that attack wheat are the aphids. They usually become established during the early stages of the wheat plant and will cause a general yellowing and debilitation of the young plant. One or more applications of the insecticide Pirimor during the early stages of growth will usually control the aphids for the remainder of the season.

Several species of beetles, Gonocephalum and Heteronychus among them, are occasionally found on wheat plants and can cause damage to both the tops of the plants (by the adults) and to the roots and stems (by the larvae). Seed treatments and applications of Cymbush during the season will adequately control these insects.

4.2.3.5 WEED CONTROL

Weeds in the wheat crop will be controlled to a considerable extent by the rotations with intertilled crops such as cotton and groundnuts where mechanical and chemical weed control is possible throughout much of the crop cycle. In wheat cropping, mechanical cultivation is impossible due to the close spacing of the rows, and therefore chemical control measures are the only ones possible after the crop has been sown.

Since wheat is a monocotyledon, control of grass weeds in the wheat crop is very difficult because herbicides designed to kill them would also injure the wheat plants. Control of the grassy weeds, therefore, is relegated to the season when row crops of

dicotyledonous plants are grown; such control will then carry over to the following wheat crop.

Broadleaf weeds are most commonly controlled by the use of the phenoxyacetic acid derivatives, 2,4-D and MCPA. These chemicals will work very well, but must be applied after the four leaf stage and before the six leaf stage of the wheat plant to avoid damaging the young plants. Aerial application of these herbicides is usually preferable due to the damage caused by the wheels when a tractor-towed sprayer is used.

4.2.3.6 DISEASE CONTROL

Disease organisms are by far the most important pests of wheat in Africa. There are several that cause only minor damage in isolated instances, but stem rust, caused by Puccinia graminis, is a major problem in East Africa. This disease, which attacks the stem of the wheat plant, restricts the flow of nutrients to the heads, resulting in shriveled grain, or no grain at all in the case of severe attacks.

The only practical way of guarding against stem rust is by the use of resistant varieties. The disease is spread by airborne spores, making rotations or seed dressings useless as means of preventing its establishment. Chemical control with zineb or maneb is effective but is too expensive to be used on a large scale.

Other diseases that are sometimes found in wheat are also members of the Puccinia genus that cause brown leaf rust and yellow rust: Septoria nodorum which causes glume blotch, and S. tritici which causes leaf blotch. These organisms seldom become serious problems, except in very wet years, and can be controlled for the most part by using resistant varieties, when available.

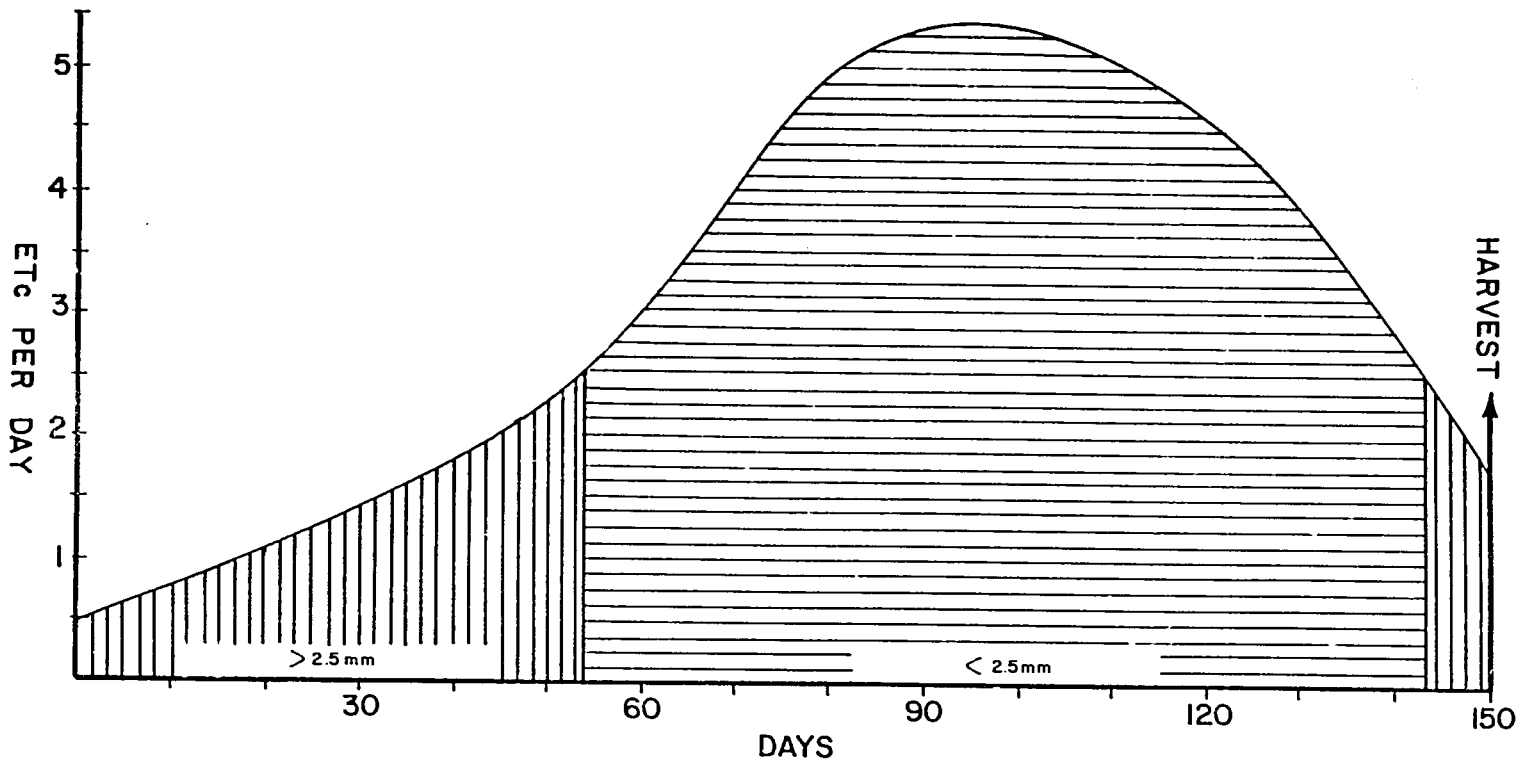
4.2.3.7 IRRIGATION REQUIREMENTS

Figure 4.2.3.7 shows in graphic form the approximate water usage by wheat during its development from seedling to mature plant. The plant requires adequate moisture throughout its life, but available moisture is especially critical from the onset of tillering to when the grain has finished filling. Water shortages during these times will result in diminished yields.

More accurate water use rates can be calculated using one of several equations developed for this purpose. The Blaney-Criddle and Penman equations were developed in the United states to act as general guidelines for establishing evapotranspiration rates for several crops. These equations use meteorological data such

Figure 4.2.3.7

WHEAT WATER USAGE



as wind speed, relative humidity, temperature, and sunlight along with a crop coefficient to determine daily or monthly water usage.

There are several problems inherent in using any of the published methods of determining water use, not the least being the lack of accurate climate data at the project site. To accurately predict evapotranspiration for any specific area and crop, these equations need several years of calibration to adapt them to the local conditions. However, to estimate the water use for determining pump capacities and production costs, they serve very adequately.

A recent revision of the Blaney-Criddle method was published by the FAO (Doorenbos and Pruitt, 1977) using air temperature measurements for the site in question and by classifying the climate at a site based on wind speed, humidity, and sunshine. The calculations will then produce a monthly reference crop evapotranspiration that can be adjusted using a crop coefficient.

The monthly reference crop evapotranspiration ET(o) calculations are shown in Appendix A. The table below gives the monthly ET(o), the crop coefficient factor, Kc, and the actual crop evapotranspiration, ET(c), for the months June through November when the wheat will be grown. The monthly and total cumulative water usages are also given.

	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
ETo	4.25	4.40	5.10	6.0	7.15	6.0
Kc	0.35	0.70	1.05	0.78	0.25	0.0
ETc/DAY	1.49	3.08	5.36	4.68	1.79	0.0
MONTHLY TOTAL MM	45	95	166	140	55	0.0
CUMULATIVE TOTAL	45	140	306	446	501	501

From Section 3.1.1, Climate, it can be seen that during the months June through October, there is essentially no rainfall that would benefit the crop or supplement the irrigation. All of the water usage by the crop will have to be supplied by the irrigation system.

4.2.3.8 CROP YIELD ESTIMATES

Yields as high as 7.0 and 8.0 metric tons per hectare have been reported in several East African countries, including Zimbabwe to the south and Kenya to the north. Generally, the highest yields are obtained at higher elevations where the crop takes longer to mature, and the risks of rust infections are somewhat smaller.

Reports from the Zimbabwe lowveld at altitudes similar to this project indicate that with irrigation, yields of 4.0 to 4.5 metric tons per hectare can be expected. By using improved varieties and higher fertilization rates, it is expected that these levels can eventually be surpassed.

4.2.4 CASTORBEANS

RACINUS COMMUNIS, or castorbean, is a member of the Euphorbiaceae family that includes many plants noted for their oils content. It is believed to have originated in Africa near the present day area of Ethiopia, but is now grown commercially in many parts of the world. In the tropical areas of the world, castorbean is a perennial plant if left undisturbed, but for commercial purposes it is most commonly treated as an annual.

The plant is grown for its seed, which contains approximately 50 percent oil. This oil has several unique properties that make it valuable in uses as diverse as jet engine lubricants and as an additive for flexible, protective coatings.

As castorbeans are of tropical origin, they tend to do best in areas where the temperature remains fairly high throughout the growing season, especially during the flowering period. Generally, a minimum growing season of 130 days is required for the newer varieties to obtain a satisfactory yield.

Harvesting has traditionally been accomplished by hand labor, but this is very time consuming and unreliable, especially with the newer high yielding varieties. Several types of mechanized harvesters have been developed, but the process is still slow and a considerable number of these machines will be required to adequately harvest the number of acres contemplated.

4.2.4.1 SELECTION OF VARIETIES

Properly selected, adapted varieties of castorbeans will help assure a successful farming operation. Several factors need to be considered when this selection is made, including potential yield, insect and disease resistance, quality of the product and general adaptation to the area where it is grown.

Research and development of castorbean varieties was greatest during the 1950's by the United States Department of Agriculture, when several new selections and, eventually, two hybrids were released in the early 1960's. The aim of the research was to develop high yielding varieties that were conducive to mechanical harvesting. To be conducive to mechanical harvesting, the plant breeders needed plants that were small in size and in which the seeds matured at approximately the same time to reduce losses from dehiscence, or shattering.

The two hybrids that were released, Hale in 1960, and Lynn in 1962, both have the abovementioned characteristics. They mature in 120 to 130 days from planting and have dwarf internodes that

keep the plant short and bushy, making mechanical harvesting possible.

As these are both hybrids, seed will either have to be produced on the farm (an extensive undertaking) or imported from the United States each year.

4.2.4.2 FARMING PROCEDURES

It is important to state that the farming procedures described below are the preferred ones for agricultural practice. They are based on the experience of Western Agri-Management and professional castorbean producers. In reality, there will have to be modifications and adjustments of schedules to accommodate weather related problems and other unforseen complications.

The initial discing is done with a five-meter offset disc pulled behind a tractor. Its primary purpose is to turn over and break up the soil to a depth of approximately 20 centimeters. This procedure will also level and even the soil after the clearing operation.

A tractor-towed fertilizer spreader will be used to broadcast granular fertilizer. Each pass covers about 12 meters. Nitrogen, phosphorus, and potassium will be applied as required by soil analysis.

The secondary discing will mix the fertilizer into the soil, apply and incorporate a herbicide, if required, and prepare a seed bed suitable for planting. This operation will be performed at a depth of 6 to 8 centimeters. The herbicide is applied immediately ahead of the disc using a tractor-powered sprayer mounted directly on the disc.

Planting will be accomplished using a six-row, row-crop planter that is specially modified with extra thick plates to prevent crushing the soft seeds, and widened to 100 centimeter rows. Plant populations of 32,000 plants per hectare will be targeted, using 15 kilograms of seed per hectare planted at a depth of 5 to 7 centimeters. The planter will also be equipped with hoppers to allow the application of starter fertilizer in a band next to the seed.

Immediately following planting, a light irrigation will be applied to establish the crop and activate the herbicide.

The fields will be checked bi-weekly for moisture depletion, and information such as wind speed, temperature, and relative humidity will be used to calculate the daily water use by the

crop. Together, these two sets of information can be used to schedule the irrigation of each crop as effectively as possible. As a part of the irrigation scheduling, additional nitrogen fertilizer will also be applied through the sprinkler during the growing season.

During the early stages of growth while the castorbean plant is still small, the crop will be cultivated at least once. This will eliminate any weeds that escaped control by herbicides applied prior to planting. If necessary, an additional application of a herbicide such as Fusilade (fluazifop-butyl) can be made at this time that will further suppress any weed growth for the remainder of the season.

Harvesting of the crop will be accomplished using mechanical harvesters that remove the seed capsules from the spike when the capsules have become brown. Because castorbeans are no longer grown in the United States on a large scale, these harvesters are not available except as older, reconditioned models. There are several types, but the ones most likely to be used are the so-called beater type that remove the capsules with two opposed revolving beaters. This is a fairly slow process in which one machine is capable of harvesting about 10 hectares per day.

The harvest date of castorbeans can be controlled somewhat by using a defoliant to kill the plants and bring on seed maturity. If done too early, this procedure may reduce yields somewhat, but that may be acceptable if the next crop season is approaching and it is necessary to begin harvest immediately.

4.2.4.3 SOIL AND FERTILIZER REQUIREMENTS

Although castorbeans will give fair response on a wide variety of soils, the best yields are obtained on soils that are well drained with no impervious layers and that have good moisture storage capacities. Castorbeans are not particularly sensitive to soil reaction, doing well on both acidic and alkaline soils.

Figure 3.2.2 shows the results of the preliminary soil analyses. The soils, being predominantly sandy loams with reasonable soil reaction, are ideally suited for castorbean production. Nitrogen, phosphorus, potassium, sulfur, and zinc will be needed in varying amounts to maximize production. The table below outlines a fertilizer program based on these results, to achieve a yield of 3.0 metric tons per hectare.

FERTILIZER	KG/HA	NUTRIENTS APPLIED KG/HA N	P2O5	K2O	S	ZN
20-20- 0-10S	250	50	50	0	25	0
46- 0- 0	100	46	0	0	0	0
ZNSO4 36%	14	0	0	0	0	5
TOTAL RECOMMENDED KG/HA		96	50	0	25	5

In this program, the first fertilizer listed, 20-20-0-10S, will be applied partly by the broadcast method, and partly as a starter band next to the seed. The remainder of the nitrogen and the ZNSO4 will be applied during the growing season through the irrigation system. This method of application greatly reduces leaching losses and increases the efficiency of recovery.

If the castor bean crop is following the peanut crop, the amount of nitrogen applied may be reduced by 40 kilograms per hectare to approximately 60 kilograms.

4.2.4.4.INSECT PESTS

Generally, insects do not cause serious damage to castorbean plants. However, the longer castorbeans are grown in a particular area, the more insect damage will occur, thus requiring control efforts. Because castorbeans have not been grown in the project, it is difficult to predict exactly which insects might cause significant damage, but those most likely to become problems are the bollworms, Heliothus spp.; the jassids, Empoasca spp.; and various types of cutworms and aphids.

Periodic applications of Pirimor to control the aphids, and Cymbush to control the others, will adequately protect the crop from serious damage. These sprayings will be scheduled from insect pest numbers determined during the bi-weekly field check.

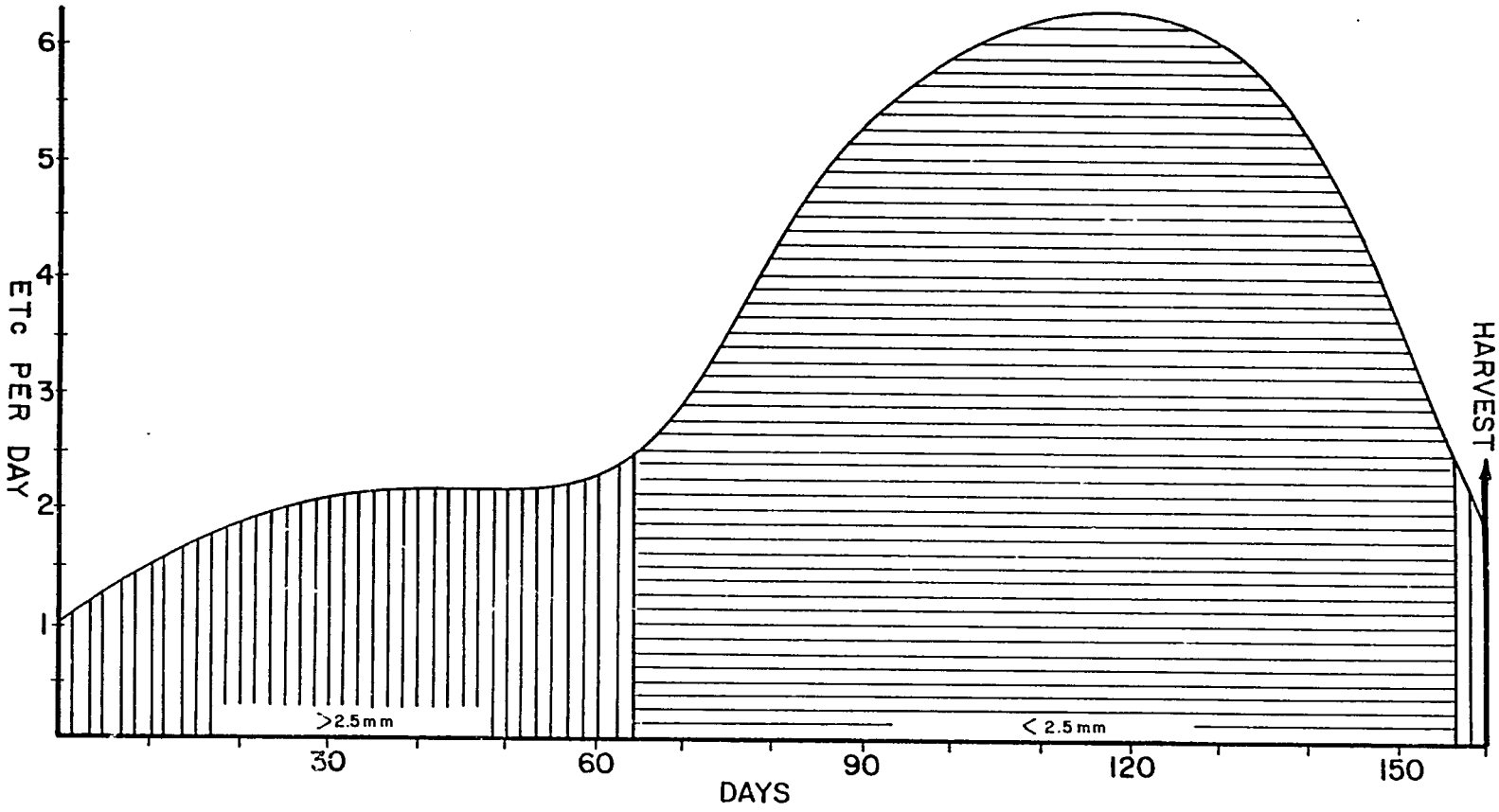
4.2.4.5 WEED CONTROL

Weed control, or the lack of it, can have a major impact on the eventual yield of castorbeans and is an important consideration in seed bed preparation. Early control of weeds by pre-plant or pre-emergence herbicides is important because later cultivations often damage the plants, reducing yields.

The types of weeds most likely to be encountered are annual and perennial grasses. For these weeds, an application of the herbicide Fusilade (fluazifop-butyl) at a rate of two to three liters per hectare will effect excellent control.

Figure 4.2.4.7

CASTORBEAN WATER USAGE



Although not expected to present problems initially, broadleaf weeds may become established, requiring control efforts. The trifluralin herbicides applied before planting and incorporated into the soil will control these weeds very effectively.

The actual application of the herbicides will be accomplished by a tractor-towed spray rig in the case of post-emergence herbicides, and by spraying equipment attached to the planter or disc in the case of pre-emergence herbicides. It is important that the manufacturer's recommendations concerning volumes of water and solution concentrations be followed for best results.

4.2.4.6 DISEASE CONTROL

Disease organisms can be serious problems to castorbean crops grown in areas of very high relative humidity. Several diseases, such as Alternaria blight and gray mold (Botrytis) become prevalent under these conditions. The relatively low humidity (less than 60% on average, and even lower during the months of August, September and October) should prevent these diseases from becoming serious.

Various soil and seed borne fungi cause damping-off of the young seedlings, but seed treatments with Thiram or the equivalent, will control these fungi.

4.2.4.7 IRRIGATION REQUIREMENTS

Figure 4.2.4.7 shows in graphic form the approximate water usage by the castorbean during its development from seedling to mature plant. The plant requires generally the same amount of water as cotton, but with castorbeans the water requirements will be higher in the early part of the season than with cotton, as castorbeans grow more rapidly and have a greater leaf area exposed earlier in the season. Adequate moisture is especially critical during the flowering period to achieve high yields.

More accurate water use rates can be calculated using one of several equations developed for this purpose. The Blaney-Criddle and Penman equations were developed in the United States to act as general guidelines for establishing evapotranspiration rates for several crops. These equations use meteorological data such as wind speed, relative humidity, temperature, and sunlight along with a crop coefficient to determine daily or monthly water usage.

There are several problems inherent in using any of the published methods of determining water use, not the least being the lack of accurate climate data at the project site. To accurately predict

evapotranspiration for any specific area and crop, these equations need several years of calibration to adapt them to the local conditions. However, to estimate the water use for determining pump capacities and production costs, they serve very adequately.

A recent revision of the Blaney-Criddle method was published by the FAO (Doorenbos and Pruitt,1977) using air temperature measurements for the site in question and by classifying the climate at a site based on wind speed, humidity and sunshine. The calculations will then produce a monthly reference crop evapotranspiration that can be adjusted using a crop coefficient.

The monthly reference crop evapotranspiration ET(o) calculations are shown in Appendix A. The table below gives the monthly ET(o), the crop coefficient factor (Kc) and the actual crop evapotranspiration ET(c) for the months June through November when castorbeans will be grown. The monthly and total cumulative water usages are also given.

	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
ETo	4.25	4.40	5.10	6.00	7.15	6.0
Kc	0.50	0.50	1.05	1.05	0.50	0.0
ETc/DAY	2.13	2.20	5.36	6.30	3.58	0.0
MONTHLY TOTAL MM	64	68	166	189	111	0
CUMULATIVE TOTAL	64	132	298	487	598	0

From Section 3.1.1, Climate, it can be seen that during the months June through October, there is essentially no rainfall that would benefit the crop or supplement the irrigation. All of the water usage by the crop will have to be supplied by the irrigation system.

4.2.4.8 CROP YIELD ESTIMATES

Although the worldwide average yield for castorbeans is on the order of a few hundred kilograms per hectare, the use of hybrid seed, irrigation and fertilization can dramatically increase that figure. During the 1950's when castorbeans were grown on a large scale in the United States, yields of 3.3 metric tons per hectare were average, with top yields approaching 4.0 metric tons. It is thought that with the excellent growing conditions present at the farm site, a conservative estimate of the yields expected is 3.0 metric tons per hectare.

4.3 CROPPING PLAN

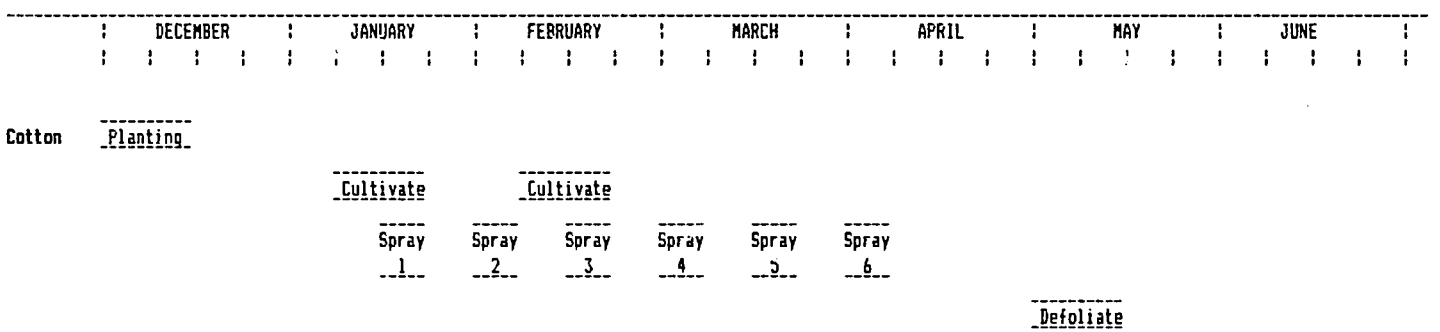
Figure 4.3 A shows the cropping plan for one full year - November through November. The two crop seasons essentially split the year into two equal parts - December through May, and June through November.

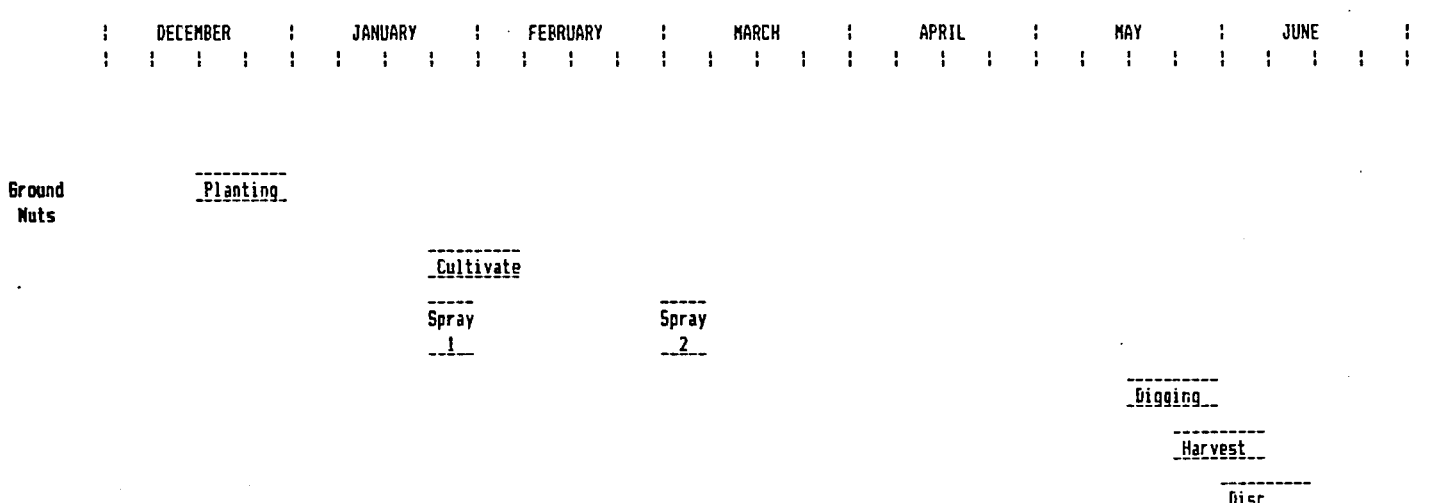
Although this timetable and the accompanying farming procedures for each crop are the preferred ones for agricultural practice, in reality there will have to be modifications and adjustments of the schedules to accommodate weather related problems and other unforseen complications. Because of the diverse nature of the farm production, attention to scheduling planting and cultivation of the different crops to minimize conflicts over the farm machinery is very important.

The farm can be arbitrarily broken into six blocks of ten center pivots each, for better administration and organization. Within each block, the pivots will be planted to the same crop in a particular season. In this manner the rotational pattern can be easily seen and organized to assure that the rotations necessary for high production are accomplished. Figure 4.3 B shows a two year cropping plan based on this concept.

Figure 4.3 A Cropping Plan

Summer Season





Cropping Plan

Winter Season

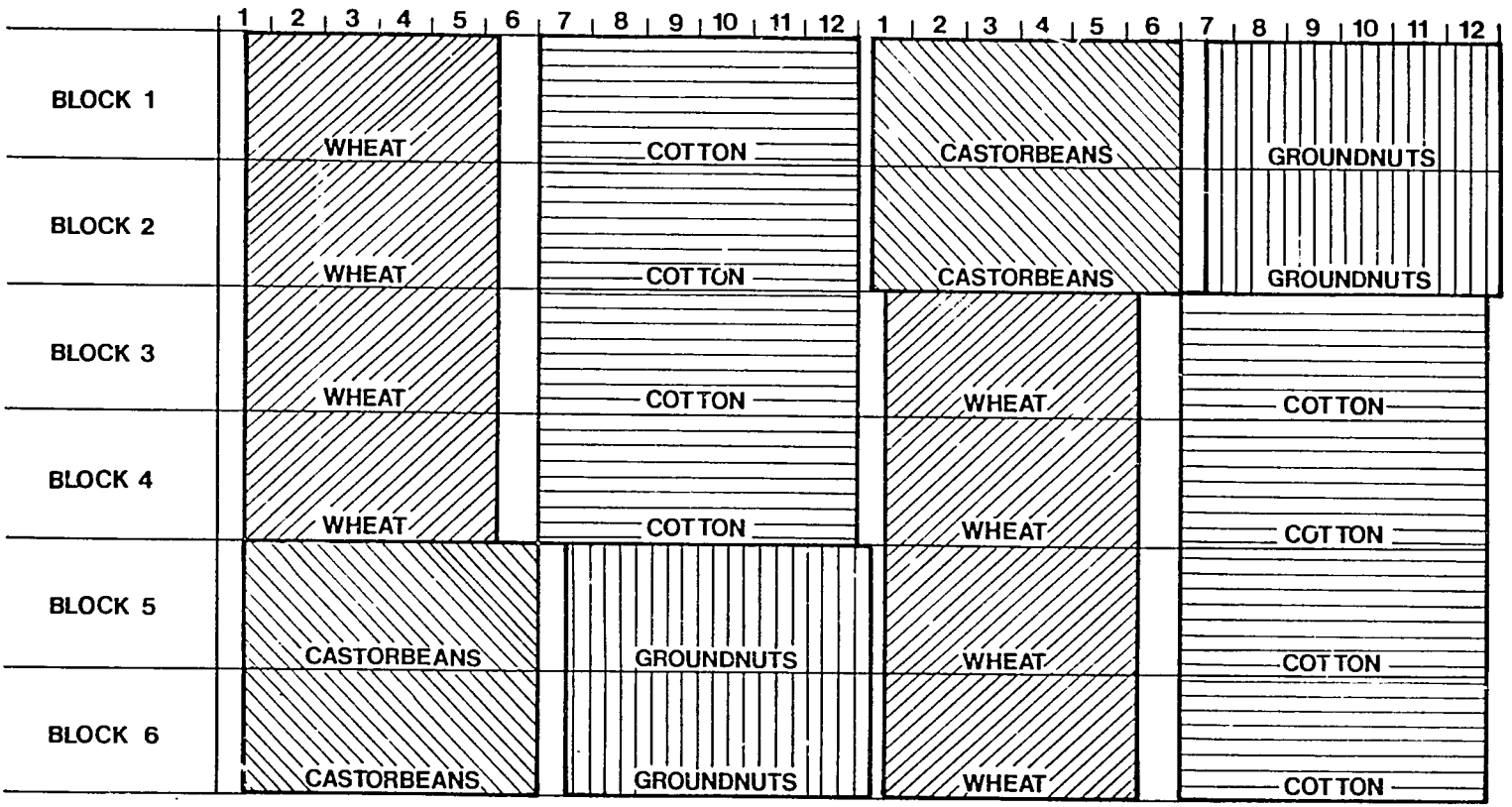
	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Wheat	Plant		Spray 1	Spray 2		Harvest	Disc

	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Castor Bean	Plant	Cultivate	Spray 1	Spray 2		Harvest	Disc

Figure 4.3B

CROPPING PATTERN

EACH BLOCK CONTAINS 10 CENTER PIVOTS



4.4 PROCESSING FACILITIES

4.4.1 COTTON GIN

Seed cotton, or cotton as comes out of the field, is roughly 35 to 45 per cent lint, which is the portion used in textile manufacturing. The remainder consists of seeds and trash. Due to the long transportation link to the world markets, and the associated high costs involved, it will be necessary to include a cotton gin on the project to avoid shipping this excess weight.

After it has been picked, the seed cotton will be hauled in bulk to the cotton gin where it will be unloaded with a pneumatic pipe, and then transferred to the first of several cleaning processes. These initial cleaning stages will remove the larger sticks, bolls and other foreign materials from the seed cotton.

Basically, cotton ginning involves separation of the fibers from the seed. This is accomplished with a set of circular saws that revolve rapidly with a portion projecting through a narrow slit between parallel ribs of metal. The teeth of the saws catch the lint, draw it between the ribs, and thus pull it from the seeds. The seeds, being too large to pass through, drop into a conveyor and are transported to a storage bin. The lint is removed from the saws by brushes and then conveyed to the bale press.

The lint cotton will then be pressed into approximately 225 kilogram bales, wrapped in jute bagging, and securely tied. The cotton seed will delivered to cotton seed delinting and pressing facilities in Lusaka.

Due to the complexity of the ginning machinery and the process in general, experienced ginners from the United States will be used to supervise the processing and to train local Zambians.

4.4.2 OIL PRESS

For similar reasons, an oil press will also be installed. This will allow the farm to process the castorbeans and ship only those products which are saleable on the world markets. Castorbeans, when processed, will yield approximately 55 per cent of their weight in castorbean oil. The remainder, or seed meal, contains toxic chemicals and is not useable as animal feed. Usually it is spread on the fields to return the organic matter and nutrients to the soil.

There are many types of oil presses available, ranging from highly sophisticated solvent extraction processes to the standard expeller machines that have been in use for many years. The

solvent extraction oil mills have the capability of removing a slightly higher percentage of the oil from the seeds, and when the plant has a very large capacity, this added efficiency will more than cover the added expense of operating these mills. However, with the somewhat limited capacity anticipated for this project, the cost of establishing and operating a mill of this type would be prohibitive. Also, the isolated situation of the project would make it difficult to obtain the technical support necessary to properly operate and maintain such a plant.

The expeller machines are basically very simple in concept and actual design. The oil bearing seeds are cleaned to remove the foreign material that accumulates during harvest and then crushed in a hydraulic press to separate the oil from the seed meal. The oil is then filtered and refined to remove the seed meal and purify it for shipment.

Again, due to the complexity of the process and the machinery, experienced personnel will be used to supervise the processing and train the local Zambians.

Figure 4.5.1 OPERATING CAPITAL REQUIREMENTS (IN DOLLARS)

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Cotton	0	0	0	0	0	0	0	0	0	0	0	0	318,418	364,792	124,064	55,739	44,038	254,171
Groundnuts	163,066	123,465	53,099	7,364	5,257	203,099	0	0	0	0	0	0	326,132	246,930	106,198	14,728	10,513	406,198
Wheat	0	0	0	0	0	0	303,717	221,690	99,458	55,543	158,012	0	0	0	0	0	0	0
Castorbean	0	0	0	0	0	0	205,728	182,385	47,029	37,492	22,019	264 000	0	0	0	0	0	0
TOTAL	163,066	123,465	53,099	7,364	5,257	203,099	509,445	404,075	146,487	93,035	180,031	264,000	644,550	611,722	230,262	70,467	54,551	660,369

Figure 4.5.2 SUMMARY OF AGRICULTURAL PRODUCTION INPUTS

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Irrigation Water Cu M	0	0	6,250	275,000	662,500	0	1,925,000	3,225,000	6,225,000	5,862,500	2,762,500	0	350,000	0	287,500	2,550,000	3,437,500	1,750,000
Irrigation Equipment Total Hrs.	0	0	14	650	783	0	2,274	3,811	7,357	6,929	3,265	0	413	0	339	3,014	4,062	2,068
Electricity Consumed - Irrigation KW Hrs.	0	0	1,773	78,132	94,118	0	546,926	916,264	1,269,430	1,655,643	784,874	0	99,439	0	81,679	724,501	976,659	491,199
Cost - $			85	3,766	4,536	0	13,403	16,805	85,248	80,284	37,821	0	4,793	0	3,937	34,921	47,075	23,965
Farm Machinery Hours																		
Tractor	590	120				135	3,540	540					3,540	1,200				270
Combine												500						
Diggers						135												270
Groundnut Combine						225												550
Castorbean Combine												1,000						
Cotton Picker																		2,000
Diesel Fuel Consumed Liters	13,640	1,387	0	0	0	9,478	81,841	12,484	0	0	0	36,366	66,201	27,742	0	0	0	65,195
Cost - $	7,279	740	0	0	0	5,061	43,703	6,666	0	0	0	19,420	36,419	14,814	0	0	0	34,814

4.5 SUMMARY OF AGRICULTURAL PRODUCTION REQUIREMENTS

4.5.1 OPERATING CAPITAL

Figure 4.5.1 outlines the monthly operating capital requirements, which includes only the direct variable costs of production for the first eighteen months of farming. This time frame encompasses the initial three crop seasons; during the first season, assumed to be during the summer months, only ten center pivots will be in production, with the other fifty center pivots coming on line in time for the succeeding winter season.

It is also assumed that during the first season, only groundnuts will be produced. This will allow additional time for the completion of the cotton gin and oil press facilities.

4.5.2 IRRIGATION WATER

The estimated irrigation water requirements in cubic meters per month are shown in Figure 4.5.2. These values were calculated using the crop evapotranspiration rates determined in Section 4.2, and the number of hectares to be planted each season as outlined in Section 4.3. Due to the lack of meteorological records at the project site, the evapotranspiration rates, and therefore the irrigation water requirements listed in Figure 4.5.2, are estimates based on the best available information. The actual requirements may be somewhat higher or lower.

4.5.3 ENERGY

4.5.3.1 ELECTRICAL

The pumping plant will be the largest consumer of energy in the form of electricity on the project. The number of kilowatt-hours that will be consumed by the pumping plant for each of the crops is shown below:

	COTTON	GROUNDNUTS	WHEAT	CASTORBEANS
KW-HR PER HECTARE	1015	348	1779	2123
COST PER HECTARE- $	48.96	16.78	85.76	102.37

The electrical consumption by the pumping plant is shown in more detail in Figure 4.5.2, which outlines monthly consumption and costs for the first eighteen months of production.

4.5.3.2 DIESEL

Diesel fuel will be used to power the farm machinery, and therefore, its use will be more sporadic than the use of electricity. To insure the constant availability of diesel, a 20,000 liter storage tank will be built in the farm compound that will supply the project with a minimum of two weeks usage.

Estimated diesel fuel consumption for the first eighteen months of production, and the associated costs, are shown in Figure 4.5.2.

4.5.4 FARM MACHINERY

Figure 4.5.4 lists the necessary farm machinery that will be needed in addition to the development equipment.

Figure 4.5.4 Farm Machinery

18	150 HP Tractors
4	6 Meter Grain Drills
6	Combines
12	Grain Carts
10	5 Meter Offset Discs
10	5 Meter Tandem Discs
6	8 Row Unit Planters
10	Row Crop Cultivators
4	Groundnut Diggers / Windrowers
15	Groundnut Harvesters
68	Groundnut Drying Wagons w/ Dryers
13	4-Row Cotton Pickers
4	Cotton Module Makers
6	8-Ton Dry Fertilizer Spreaders
1	16-Ton Dry Fertilizer Tender
2	8 Meter Fertilizer Conveyors
10	Field Sprayers w/ 12 Meter Booms

Figure 4.5.2 outlines a monthly approximation of machinery usage by hours for the first eighteen months of production. These figures are for direct farming procedures only, and the actual usage will most likely be somewhat higher, due to indirect uses.

4.5.5 IRRIGATION EQUIPMENT

Figure 4.5.2 also shows an estimated total hourly use of the

irrigation machinery by month for the initial eighteen month production period. These figures were calculated to show only the time required to provide the necessary water requirements, and do not take into consideration any additional time that might be required to apply fertilizers or pesticides through the irrigation system. Normally, these activities are completed during the periods when the systems are applying needed irrigation water; however, there are times when the systems must be operated, to apply the fertilizers or pesticides, when the crops do not actually need the water. This additional water is not injurious to the crop, and in fact, will provide reserves of soil moisture in case of system failures.

4.5.6 PROCESSING FACILITIES

The cotton gin will have the capacity to process approximately 3.0 metric tons per hour of seed cotton, producing about 1.35 tons per hour lint cotton. Assuming a yield of 3.0 tons per hectare, it will take 2000 hours of operation to fully gin the farm's production.

Due to the lengthy start-up procedures required, cotton gins are generally operated 24 hours a day until the years production is completely processed. Repairs and maintenance of the gin normally require four hours per day, leaving twenty hours of actual processing time, or approximately 100 days to process the 6000 metric tons produced.

The gin will consume approximately 700 kilowatts, at a cost of about $33.00 per hour. Total costs, including labor and repairs and maintenance, are estimated to be $55.00 per metric ton of output.

The oil press will have the capacity to process 50 metric tons per day of castor beans, producing about 25 tons of castorbean oil. Approximately 60 days will be required to process the farms output. Total costs, including labor and repairs and maintenance, are estimated to be $25.00 per metric ton of input.

4.6 CROP PROFIT ANALYSIS

Figures 4.6 A, B, C & D outline the expected direct variable costs of production, the gross revenues from sales and the expected profit contribution per hectare of the four crops described previously.

As these figures show, groundnuts will produce the highest profit contribution per hectare, followed by cotton, castorbeans and wheat, respectively.

More detailed information can be found on the computer generated worksheet in the appendix to this study.

Figure 4.6 A Crop Profit Analysis - Cotton

Assuming a yield of 3.3 metric tons per hectare and a price for lint of $ 1.76 per kilogram, CIF Europe; the price of cotton seed is estimated at $ 200 per metric ton in Lusaka.

Revenue per Hectare

Lint	$ 2,613.60	
Seed	330.00	
Total Revenue		$ 2,943.60

Direct Variable Costs of Production per Hectare

Material	$ 450.75	
Tillage Operations	73.13	
Irrigation	56.73	
Processing	82.50	
Transportation	184.45	
Total Direct Variable Costs		849.56
Profit Contribution per Hectare		$ 2,094.04

Figure 4.6 B Crop Profit Analysis - Groundnuts

Assuming a yield of 3.5 metric tons per hectare and a price of $ 1,000 per metric ton, CIF Europe.

Revenue per Hectare		$ 3,500.00
Direct Variable Costs of Production per Hectare		
Material	$ 663.60	
Tillage Operations	42.66	
Irrigation	19.44	
Transportation	385.00	
Total Direct Variable Cost		1,110.70
Profit Contribution per Hectare		$ 2,389.30

Figure 4.6 C Crop Profit Analysis - Wheat

Assuming a yield of 4.0 metric tons per hectare and a price of $ 260 per metric ton, as established by the government of Zambia.

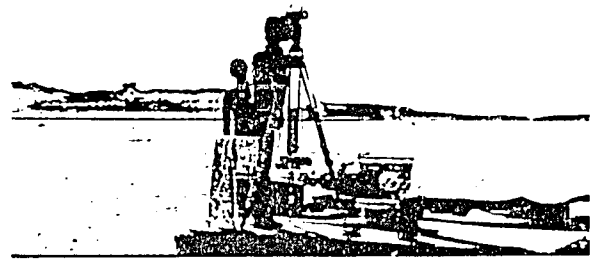
Revenue per Hectare		$ 1,040.00
Direct Variable Costs of Production per Hectare		
Material	$ 231.20	
Tillage Operations	32.63	
Irrigation	99.38	
Transportation	56.00	
Total Direct Variable Costs		419.21
Profit Contribution per Hectare		$ 620.79

Figure 4.6 D Crop Profit Analysis - Castorbeans

Assuming a yield of 3.0 metric tons per hectare and a price of $ 1,400 per metric ton, CIF Europe.

Revenue per Hectare		$ 2,100.00
Direct Variable Costs per Hectare		
Material	346.10	
Tillage Operations	53.93	
Irrigation	118.62	
Processing	75.00	
Transportation	165.00	
Total Direct Variable Costs		758.65
Profit Contribution per Hectare		$ 1,341.35

5. DEVELOPMENT



5.0 PROJECT DEVELOPMENT

5.1 CONCEPT

5.2 SCHEDULE OF DEVELOPMENT ACTIVITIES
- 5.2.1 PRE-DEVELOPMENT ACTIVITIES
  - 5.2.1.1 DEVELOPMENT EQUIPMENT ORDERED
  - 5.2.1.2 SURVEY AND SITE MAP
  - 5.2.1.3 DEVELOPMENT PERSONNEL
- 5.2.2 LAND CLEARING AND PREPARATION
- 5.2.3 OPERATING MACHINERY AND EQUIPMENT ACQUISITION
- 5.2.4 IRRIGATION SYSTEM SELECTION AND DESIGN
  - 5.2.4.1 IRRIGATION SYSTEM SPECIFICATIONS
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- 5.2.5 INFRASTRUCTURE DEVELOPMENT
  - 5.2.5.1 ELECTRICAL SYSTEM LAYOUT AND COSTS
  - 5.2.5.2 SECURITY SYSTEM
  - 5.2.5.3 FARM COMPOUND
  - 5.2.5.4 FARM ROADS

5.3 PHASE II EXPANSION

5.4 PROCESSING FACILITIES
- 5.4.1 COTTON GIN
- 5.4.2 OIL PRESS

5.0 PROJECT DEVELOPMENT

5.1 CONCEPT

The smooth flow of development activities can be achieved only if a well designed schedule is adhered to; however, the schedule must be flexible enough to accommodate delays, shortages, breakdowns, bad weather or unreliable subcontractors without the entire project coming to a halt. The project development will follow a logical and orderly progression of steps to achieve the goal of establishing ten centerpivots that are ready for farming procedures approximately six months after the development crew has arrived at the site. The remaining 50 centerpivots will be completed during the last six months of development, at which time both development and farming activities will be occurring simultaneously on the farm.

The most important development activity, which all other activities will revolve around, will be the construction of the pumping plant in the Zambezi River and the main pipeline and reservoir system. The major components of this system must be completed within the first six months to allow farming to begin on the initial ten center pivots.

In addition to the development of irrigation system, the first six months will be devoted to procurement of equipment and construction of the infrastructure required. Infrastructure here is defined as the electrical main line from Chirundu, roads, housing, water and sewer systems, workshop and storage areas, and a temporary diesel powered generator to power the farm compound until the electrical line is completed. At the same time many of these operations are being accomplished, subcontractors will be engaged in land clearing and fence building activities.

During the last six months of development, the remainder of the irrigation systems will be erected, the farm compound completed and the various processing and grain storage facilities constructed.

5.2 SCHEDULE OF DEVELOPMENT ACTIVITIES

Figure 5.2 shows in graphic form the proposed schedule for the 13 month development period. It can be noted on the schedule that no definitive activities are shown for months 12 and 13 even though the development crew will still be on site. During these months the crew will be available to train the farm manager and farm employees in proper operation of project equipment. Also during this time, any problems, or "bugs", in the irrigation system can be repaired by the crew.

DATE: 10/29/84 REISSUE DATE:

ACTIVITY	YEAR / MONTH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Order Equipment	EST.															
	ACT.															
Development Crew on Site	EST.															
	ACT.															
Establish Temporary Working Camp	EST.															
	ACT.															
Construct and Secure Workshop and Storage	EST.															
	ACT.															
Electrical Line Construction	EST.															
	ACT.															
Survey Boundary and Pivot Points	EST.															
	ACT.															
Land Clearing and Farm Road Construction	EST.															
	ACT.															
Reservoir Construction	EST.															
	ACT.															
Pumping Plant and Water Distribution System	EST.															
	ACT.															
Sprinkler Erection	EST.															
	ACT.															
Permanent Farm Compound	EST.															
	ACT.															
Fencing Construction	EST.															
	ACT.															
Processing Facilities Erection	EST.															
	ACT.															
Grain Storage Erection	EST.															
	ACT.															
Prep for Plant 10 Circles	EST.															
	ACT.															
Plant 10 Circles	EST.															
	ACT.															
Harvest	EST.															
	ACT.															
Prep for Plant 60 Circles	EST.															
	ACT.															

WESTERN AGRI-MANAGEMENT INTERNATIONAL, S.A.

5.2.1 PRE-DEVELOPMENT ACTIVITIES

Prior to commencement of actual construction at the project site, the project manager will devote at least two months time to ordering and procuring the equipment and machinery needed for the development phase. Approximately half of this time will be spent in Zambia arranging for equipment to be purchased there and for the selection of the sub-contractors that will be used for several of the tasks to be performed.

5.2.1.1 DEVELOPMENT EQUIPMENT ORDERED

A. Construction Equipment
- 1 Road grader
- 2 D-6 Bulldozers w/ rippers
- 1 Wheel loader
- 1 4WD Forklift
- 1 Concrete batch truck, 5 cubic meter capacity
- 1 Trencher
- 1 15 ton dump truck
- 1 5 ton water truck
- 1 Boom truck with 3 ton hoist
- 1 Backhoe, with loader and fork attachment
- 1 2 ton repair truck w/ tools
- 4 Tandem axle trailers

B. Vehicles
- 1 Toyota Land Cruiser
- 6 4WD mini-pickups
- 2 12 passenger bus

C. Tools and Miscellaneous
- 1 Portable diesel welder
- 2 AC-DC electric shop welders
- 3 Complete cutting torch assemblies
- 1 Portable diesel air compressor
- 1 Electric air compressor for shop
- 1 Metal lathe
- 1 100 KW diesel generator set

5.2.1.2 SURVEY AND SITE MAP

Local surveyors will be subcontracted to survey the following items in approximately this order:

1) Project boundaries
2) Farm compound
3) Pumping plant and pipeline locations

4) Center pivot points
5) Farm road locations
6) Electrical line locations

The surveying operations are expected to be completed in approximately 45 days. Other subcontractors may be hired to complete this task within the time allowed. The principal subcontractor will be responsible for the development of a farm map outlining all of the pipelines and electrical lines that will be constructed, as well as the farm roads and production areas.

A bulldozer will be assigned to work with the survey crew to assist them in clearing the native vegetation.

5.2.1.3 DEVELOPMENT PERSONNEL- ACQUISITION AND TRAINING

Ex-patriot personnel who have experience in large scale irrigation development, center pivot construction, general construction and construction management will be utilized. These positions include:

1 Development Manager
1 Pivot Erection Crew Foreman
1 Shop Foreman
1 Electrician
1 Training Supervisor

Local Zambians will be used to fill the skilled and semi-skilled positions. Priority in hiring will be given to the people in the local community. Not including subcontractors, the following positions will be filled by Zambians, who will be trained for their duties:

2 Electricians
6 Machinery operators
2 Welders and welders helpers
3 Center pivot erection
2 Mechanics
1 Parts runner
1 Machinist
2 Cooks
Support w rkers (housekeepers, maintenance etc.)
Local laborers (as needed)

5.2.2 LAND CLEARING AND PREPARATION

The vegetation at the project site is dominated by the acacia savanna groups, that consist of shrubs and small trees that often

are very thick. An occasional larger tree will also be found, principally the baobabs. All of the production areas, the pipeline sites, and the farm compound areas will be cleared of this vegetation.

Once the survey crews have identified the project boundaries, the pipeline sites and have started to locate the pivot points, the land clearing operation will be subcontracted to one or more local companies.

One efficient method of clearing this type of vegetation is by the use of a large chain that is attached between two bulldozers. As the bulldozers are driven forward, the chain will uproot all but the larger trees, which must be either pushed over by the bulldozer or, in the case of the really large ones, cut down with the use of chain saws. After all of the brush and trees are down, the bulldozers then push them into large piles or rows for burning.

It is estimated that two bulldozers working together in this fashion will be able to clear a minimum of two hectares per hour, including the piling of the brush and trees. Cost estimates are $200 per hectare.

The farming areas under the center pivots will be subsoiled in the order they will be planted. The irrigable land will be deep-ripped to a depth of 40 to 50 centimeters by a subsoiler behind a bulldozer. This operation will break up any hardpans present, increase aeration and percolation and will also serve to bring to the surface any large roots left from the clearing operation.

5.2.3 OPERATING MACHINERY AND EQUIPMENT ACQUISITION

All equipment procured in Zambia will be specified for delivery to the farm site, as will imports arriving from South Africa via Zimbabwe. Imports being delivered via the railway from the ports at Dar-es-Salaam, Tanzania can be shipped as far as the rail head at Kafue, which is approximately 100 kilometers by highway from the project site. From that point, private transport can be arranged for approximately 15 ngwees per ton per loaded kilometer.

5.2.4 IRRIGATION SYSTEM SELECTION AND DESIGN

The irrigation technology being used in Zambia today ranges from border irrigation (polder irrigation) to fairly modern solid set sprinkler systems. The main drawbacks of these systems are the inefficiency with which they use energy and water resources, especially in the case of border irrigation. Also they require

large amounts of manpower and a high degree of skill to achieve proper water application levels.

Center pivot sprinkler systems were selected for this project for many reasons, but the main advantages are:

* High water application efficiency, typically 75-80%

* Uniform distribution of water throughout the field. Commonly a coefficient of uniformity (C.U.) greater than 93 can be expected on relatively level ground. C.U. here is taken from field test data or canning tests where:

$$C.U. = \frac{\text{Average low-half depth of water received} \times 100}{\text{Mean depth of observations}}$$

* Ability to apply fertilizers, pesticides, and some herbicides through sprinkler nozzles with remarkable uniformity.

* Extremely reliable operation with few breakdowns.

* Low labor cost.

* Capability of leaching salts beyond the root zone.

* Less irrigation skill required to operate the system efficiently.

A center pivot system (see Figure 5.2.4) consists of a row of sprinklers mounted on a pipe that is in turn supported over the crop by mobile towers. Water is pumped into the pipe from a source at the center of the field, and the towers which are mounted on wheels carry the pipe around the fixed pivot point. The rate at which the towers and pipe advance is set by the speed of the outermost tower, with the inner towers consecutively aligning themselves in a straight line. A safety system shuts down the entire pivot when the alignment system fails, preventing damage to the lateral.

Systems currently in use range from 60 to 800 meters in length; however, for optimum coverage and water application, as well as for standardization, all pivot laterals will be 400 meters long. Uniform water application rates along the rotating lateral are achieved by varying the sprinkler arrangement, pressures and individual nozzle sizes and designs.

Figure 5.2.4

CENTER PIVOT SYSTEM

COLLECTOR RING

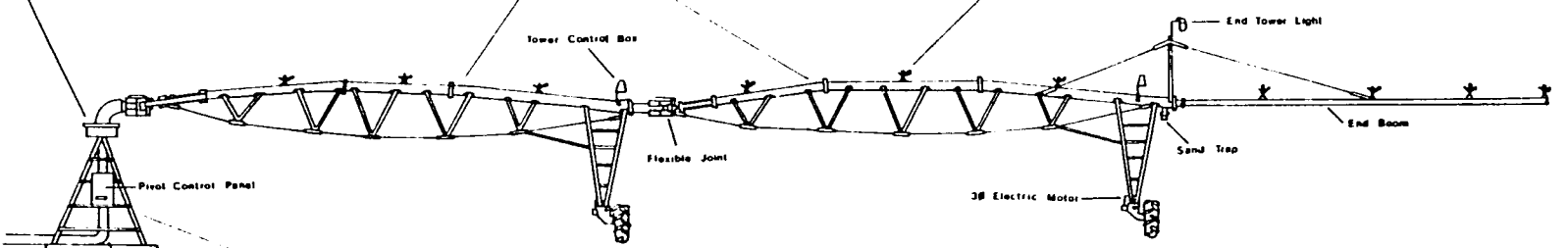
ELECTRICITY IS TRANSMITTED TO THE TOWERS THROUGH ROTATING BRUSHES LOCATED IN THE COLLECTOR RING. BRUSHES ROTATE WITH THE PIVOT LATERAL ELIMINATING THE WINDING OF THE POWER WIRE.

SPANS

SPANS COME IN A VARIETY OF LENGTHS AND PIPE DIAMETERS. THEY CAN BE JOINED TOGETHER IN ALMOST ANY COMBINATION TO MEET SPECIFIC NEEDS.

SPRINKLER & SPRAY OPTIONS

DEPENDING ON CROP AND SOIL CONDITIONS, THERE IS A WIDE CHOICE OF SPRINKLER AND SPRAY NOZZLE SETS AVAILABLE, IN IMPACT OR LOW PRESSURE, VARIABLE OR FIXED SPACING (SEE FIGURE 5).



90-DEGREE ELBOW

THIS STANDARD COMPONENT MAKES BRINGING WATER TO THE PIVOT SYSTEM EASIER. IT CAN ROTATE 360° TO ACCEPT THE WATER SOURCE PIPELINE COMING IN FROM ANY DIRECTION.

PIVOT POINT STRUCTURE

THE 10ft (3m) SQUARE PIVOT BASE IS SECURELY ANCHORED TO A 12ft (4m) SQUARE CEMENT PAD. GALVANIZED BOLTS EMBEDDED IN THE CONCRETE ANCHOR THE STUCTURE TO THE PAD.

5.2.4.1 IRRIGATION SYSTEM SPECIFICATIONS

I. Center Pivot Design Criteria

A. System Capacity or Flow Rate

The design capacity of the water flowing through a pivot lateral is dependent on the crop water requirements, the leaching requirement (if necessary), the area irrigated (lateral length), the probability of effective rainfall, and the contribution of stored soil moisture during peak water use periods.

Four hundred meter long pivots, each irrigating 50 hectares, were chosen for this project partly because the vast majority of center pivots around the world are this length, and most of the available research and experience is concerned with this size. More important, however, is the fact that shorter systems are less economical in initial cost invested per hectare irrigated while longer systems have problems with excess runoff and evaporation at the outer edge of the circle due to the extremely high rates of application necessary.

Table 5.2.4.1 A shows the typical intake rates for various classifications of soil. As a sandy loam, the soil at the project would be expected to accept approximately 25 millimeters of water per hour with out excessive runoff.

Table 5.2.4.1 A

Soil Texture	Intake Rate		Average Intake Rate	
	mm/hr	in./hr	mm/hr	in./hr
Sand	25 - 250	1 - 9.8	50.0	2.0
Sandy loam	15 - 75	0.6- 3.0	25.0	1.0
Loam	8 - 20	0.3- 0.8	12.5	0.5
Clay loam	2.5 - 15	0.1- 0.6	8.0	0.3
Silty Clay	0.3 - 5	0.01- 0.2	2.5	0.1
Clay	1 - 15	0.04- 0.6	5.0	0.2

When the peak consumptive use of each of the crops scheduled to be grown on the project is analyzed, castorbeans are found to have the largest daily water requirement (during the month of September). Therefore, the system design flow plus the moisture

contribution of usable water stored in the soil must be equal to or exceed the crop's peak consumptive use minus effective rainfall as detailed in Section 4.2.4.7. The castorbean crop will be immediately following cotton in the crop rotation set out in Figure 4.3 B, and due to the deep rooted nature of the cotton crop, very little available water will be left in the soil for use by the succeeding crop. Since no effective rainfall can be expected in September, the system design flow will have to provide the total water usage by the crop.

Using the above information, a flow rate of 55 liters per second was arrived at. To check the validity of this flow rate, the following calculations were used:

-First determine values for the following:

1) Gross Application Rate-mm/day

$$= \frac{55 \text{ liters}}{\text{second}} \times \frac{86{,}000}{1 \text{ day}} \times \frac{1 \text{ cu.m.}}{1{,}000 \text{ l}} \times \frac{1}{50\text{ha pivot}}$$

$$= \frac{4{,}725 \text{ cu. m.}}{50\text{ha pivot-day}} \times \frac{1 \text{ ha.}}{10{,}000 \text{ sq.m}} \times \frac{1{,}000 \text{ mm}}{1 \text{ m}}$$

$$= \frac{9.5 \text{ mm}}{\text{day}}$$

2) Net Application Rate-mm/day

= Gross App. Rate x Irrigation Efficiency

= 9.5 mm/day x .80

= 7.1 mm/day

Castorbeans have a peak consumptive use of 6.3 mm/day (from Section 4.2.4.7). The excess net application of 0.8 mm/day is useful in that it will provide an emergency reserve in the event of breakdowns or power shortages.

B. Nozzle Selection

The best sprinkler nozzle package to be installed atop a pivot lateral will distribute the water uniformly, will throw the water the farthest distance possible from the lateral to decrease the application rate, and will have a drop size distribution large enough to resist wind drift and small enough to reduce soil aggregate breakdown which causes surface sealing and inhibits infiltration. All of these characteristics must be obtained at the lowest possible operating pressure to conserve energy. However, as the pressure is lowered, the application rate of the

system will generally rise, increasing the possibility of runoff. Thus an analysis of the potential runoff of applied water will be used in the selection of proper sprinkler nozzle packages for the center pivots. This analysis considers both the application rate of the system and the infiltration rate of the soil.

The greatest potential for runoff and excessive evaporation occurs at the distal end of the center pivot where the application rate is the greatest. As shown in Figure 5.2.4.1 A, the last 54 meters of the 400 meter lateral must apply one-quarter of the total water.

Many types and brands of sprinklers are available on the market today. They can be categorized into six main types as shown in Table 5.2.4.1 B and described.

Table 5.2.4.1 B

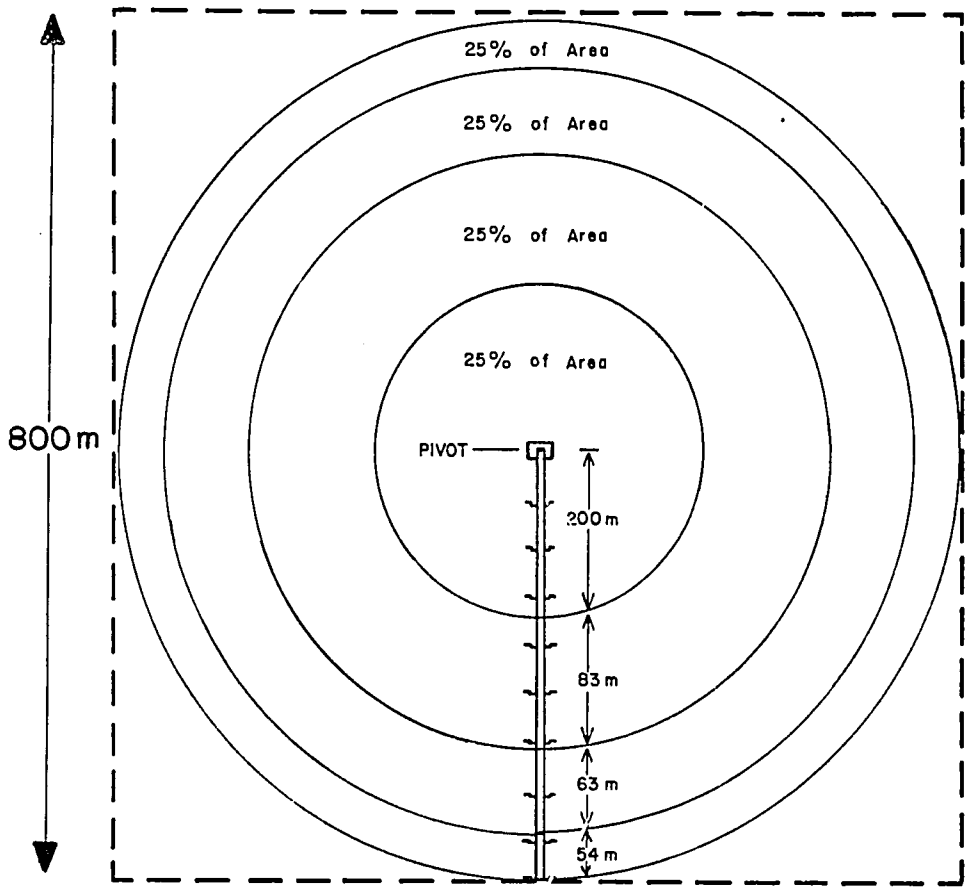
Approximate Pivot Pressure and Sprinkler Radii for Different Sprinkler Packages

Type of Sprinkler	Approximate Pivot Pressure: In kilo-pascals	Approximate Pivot Pressure: In pounds per sq. inch	Approximate Sprinkler Radius*: In meters	Approximate Sprinkler Radius*: In feet
High pressure impact sprinkler	450 - 520	65 - 75	20	66
Medium pressure impact sprinkler	275 - 350	40 - 50	14	46
Low pressure impact sprinkler	205 - 275	30 - 40	10	33
Spray nozzles on drop booms	170 - 240	25 - 35	10	33
Low pressure spray 360 deg.	170 - 240	25 - 35	5	16
Low pressure spray 180 deg.	170 - 240	25 - 35	3**	10**

* Sprinkler radius at distal end of lateral
** One direction only

Figure 5.2.4.1A

WATER APPLICATION ALONG LATERAL



AREA OF SQUARE – 64 HECTARES

PERCENT OF AREA	LATERAL LENGTH	AREA
25	200 m	12.5
50	283 m	25.0
75	346 m	37.5
100	400 m	50.0

To calculate the application rate at the end of the lateral, the following equation is used:

$$hp = \frac{4{,}584\ Q}{Rr}$$

where: hp = peak application rate mm/hr

Q = design flow rate in liters/second
R = lateral length in meters
r = sprinkler radii in meters

The peak application rates for the center pivots on the project for the six different sprinkler options are:

-High pressure impact sprinkler	= 31.5 mm/hr
-Medium pressure impact sprinkler	= 45.0 mm/hr
-Low pressure impact sprinkler	= 63.0 mm/hr
-Spray nozzles on drop booms	= 63.0 mm/hr
-Low pressure spray, 360 degree	=126.0 mm/hr
-Low pressure spray, 180 degree	=210.0 mm/hr

A center pivot always has the same water application rate but the application depth can be varied as the irrigation manager deems appropriate. This is accomplished by increasing or decreasing the speed at which the lateral revolves around the pivot. Short pivot rotation times (1 - 2 days) and shallow application depths do not allow deep percolation of water into the root zone and decrease the overall water application efficiency of the system. Short revolution times are necessary, however, for seed germination, for saturating a shallow root zone and for applying or activating fertilizers and chemicals. Larger application depths are required as the crop matures, the roots deepen and the evapotranspiration, ET(c), increases. To obtain the maximum allowable depth of water applied, the available surface storage of the soil must first be evaluated. Table 5.2.4.1 C presents the allowable surface storage of soils as a function of the slope of the ground. Slopes for the Project area are 0 - 1% which corresponds to an allowable surface storage of 12.7 mm (0.5 in.).

Table 5.2.4.1 C Allowable Surface Storage Values for Various Slopes

Slope as a Percentage	Allowable Surface Storage In millimeters	Allowable Surface Storage In inches
0 - 1	12.7	0.5
1 - 3	7.6	0.3
3 - 5	2.5	0.1
> 5	0.0	0.0

Knowing the intake family of the soil (1.0 Family), the peak application rates for each sprinkler option and the allowable surface storage, the graphs on Figure 5.2.4.1 B can be utilized to obtain the maximum permissable water application depth for each sprinkler option. These results are listed here:

Sprinkler Type		Max. Water App. Depth
- High pressure impact	=	Not Recommended
- Medium pressure impact	=	Not Recommended
- Low pressure impact	=	Not Recommended
- Spray nozzles on drop boom	=	Not Recommended
- Low pressure spray 360 deg.	=	48 mm (1.89 in)
- Low pressure spray 180 deg.	=	30 mm (1.18 in)

All of the sprinkler types except low pressure spray nozzles are not recommended for use because energy is wasted at these high pressures. The sandy nature of the soil will allow infiltration at the low pressure rates, with a significant saving in energy consumed to pump the water. Wherever possible low pressure spray nozzles will be used on this project.

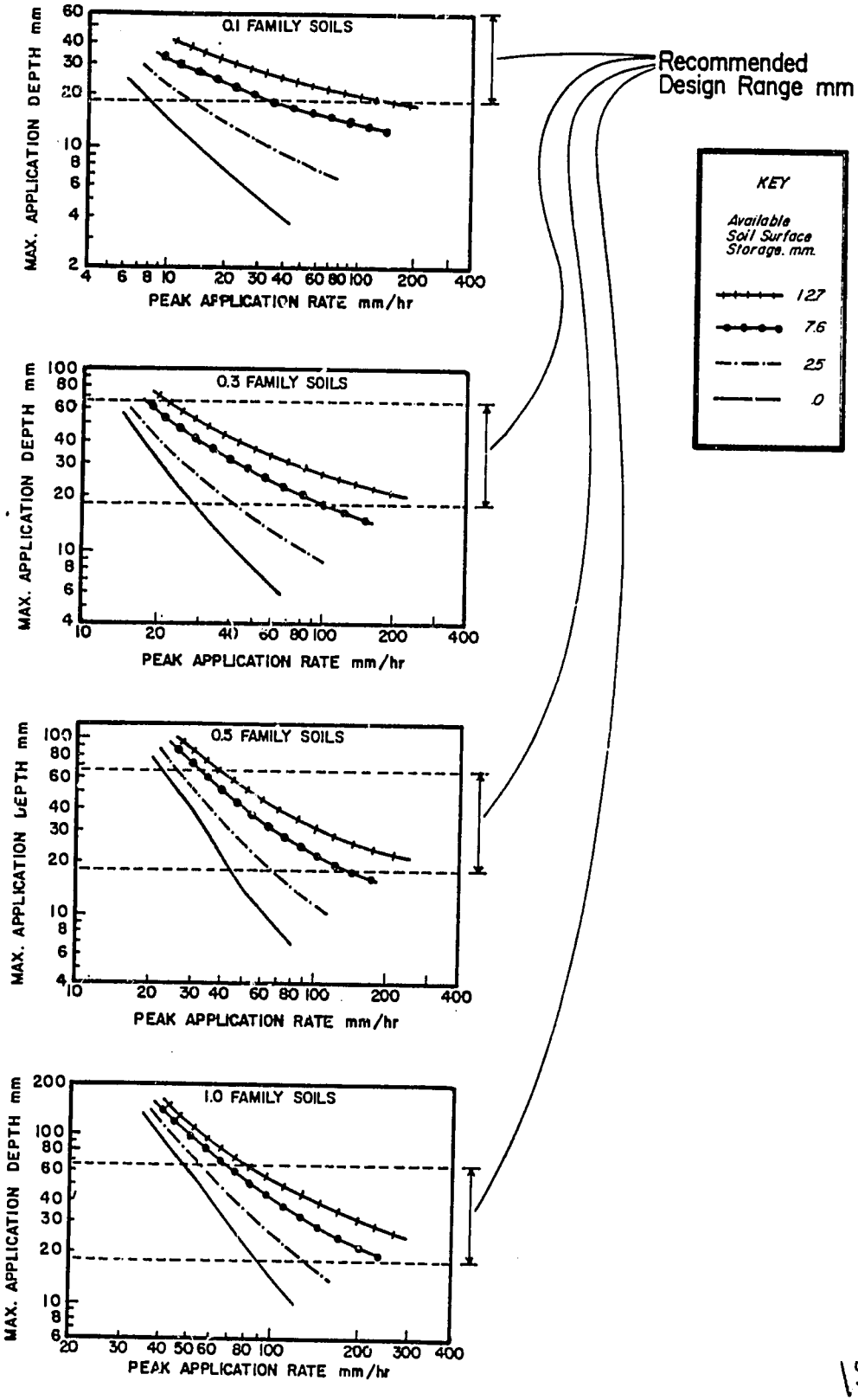
C. Other Design Factors

The center pivot system has many options which make it adaptable to nearly every situation. Some of the options which are recommended for this particular project are mentioned here. In the U.S.A., there are at least six large, reputable center pivot manufacturers capable of supplying these options.

The center pivot systems should have a galvanized lateral, both inside and out. In good quality water such as that found in the project area, lateral life is expected to be a minimum of 20 years.

Both water powered and electric powered systems are available but since electricity is to be used to pump the water, it is most efficient to connect the pivots to the three phase power supply. Electrically driven center pivots generally require less maintenance than water powered ones. Pivots generally require an average of four kilowatts of power.

End guns are commonly used where land is scarce and relatively expensive in an attempt to irrigate more hectares by watering the corners. This is not the case in the project area, and end guns are not recommended for the project. Even though end guns and their accessories are becoming increasingly more reliable,


0.1 FAMILY SOILS
0.3 FAMILY SOILS
0.5 FAMILY SOILS
1.0 FAMILY SOILS
MAX. APPLICATION DEPTH mm
PEAK APPLICATION RATE mm/hr
Recommended Design Range mm
KEY
Available Soil Surface Storage. mm.
12.7
7.6
2.5
0

experience in the U.S.A. on Western's farms indicates that at least one-third of all service calls are for problems with end guns.

II. Irrigation Accessories

Depicted in Figure 5.2.4.1 C is a typical pivot layout with the various accessories required.

The air relief valve, located just ahead of the pivot, allows any accumulated air to escape the pipeline when the system is actuated. This prevents possible damage to the lateral.

The pivot and water supply are connected with 314 mm (8 in.) steel pipe. A quarter turn valve is fitted to the steel pipe and when partially closed will suppress the initial surge when the pump is started. This will increase the life expectancy of the sprinkler nozzles.

A flow meter to measure the water flow rate and total volume through the system is included. Its primary use is as a management tool for scheduling and research purposes.

The heart of the fertilizer program is the chemical injector pump and supply tank. The tank is usually of polyethlene construction and has a capacity of 2000 liters. A filter on the bottom of the tank supplies the injector pump with fertilizers, micro-nutrients, herbicides, pesticides etc. On this application the pump will have a 250 liter/hour capacity and will be powered by a 1/3 Kw, 3 phase electric motor connected to the pivot panel.

5.2.4.2 PUMPING PLANT SPECIFICATIONS

Water for the entire Project will be supplied by a single central pumping plant located approximately 30 meters from the shore of the Zambezi River. The energy utilized to power the plant will be electricity supplied by a power line to be constructed from the substation near Churundu. The pumping plant for Phase I of development must have the capacity to supply sixty center pivots simultaneously with 55 l/s (870 gpm) of water for each pivot and delivered with a minimum pressure of 25 psi (170 Kilo pascals). The plant must also have a variable water delivery rate. This can be accomplished by having a multiple motor plant with each motor being separately controlled by a float control system setup in the proposed storage reservoir. Each motor and pump must have the capability of being started without priming or creating a surge in pressure which may damage the mainline. Other features that must be incorporated into the pumping station are expandability and environmental acceptability and must allow free passage of

Figure 5.2.4.1B

TYPICAL PIVOT LAYOUT

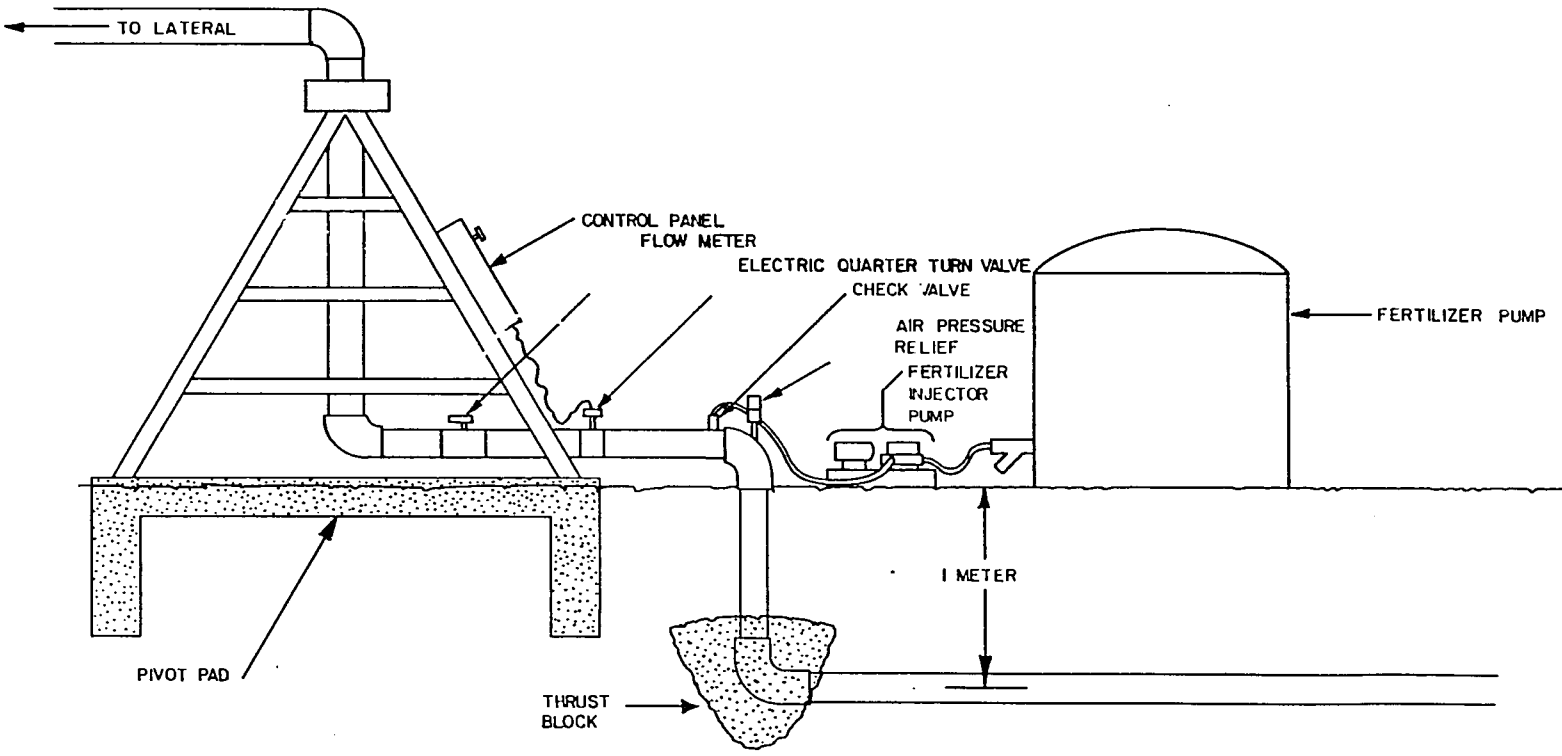


Figure 5.2.4.2.A

ZAMBEZI RIVER PUMPING PLANT SIDE VIEW

Scale 1/50

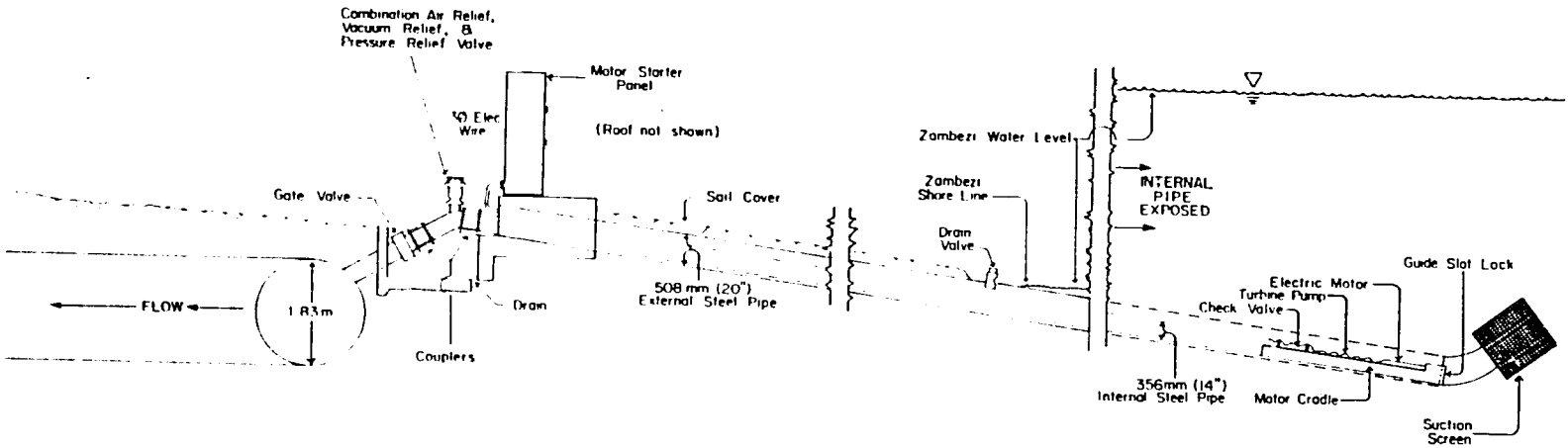
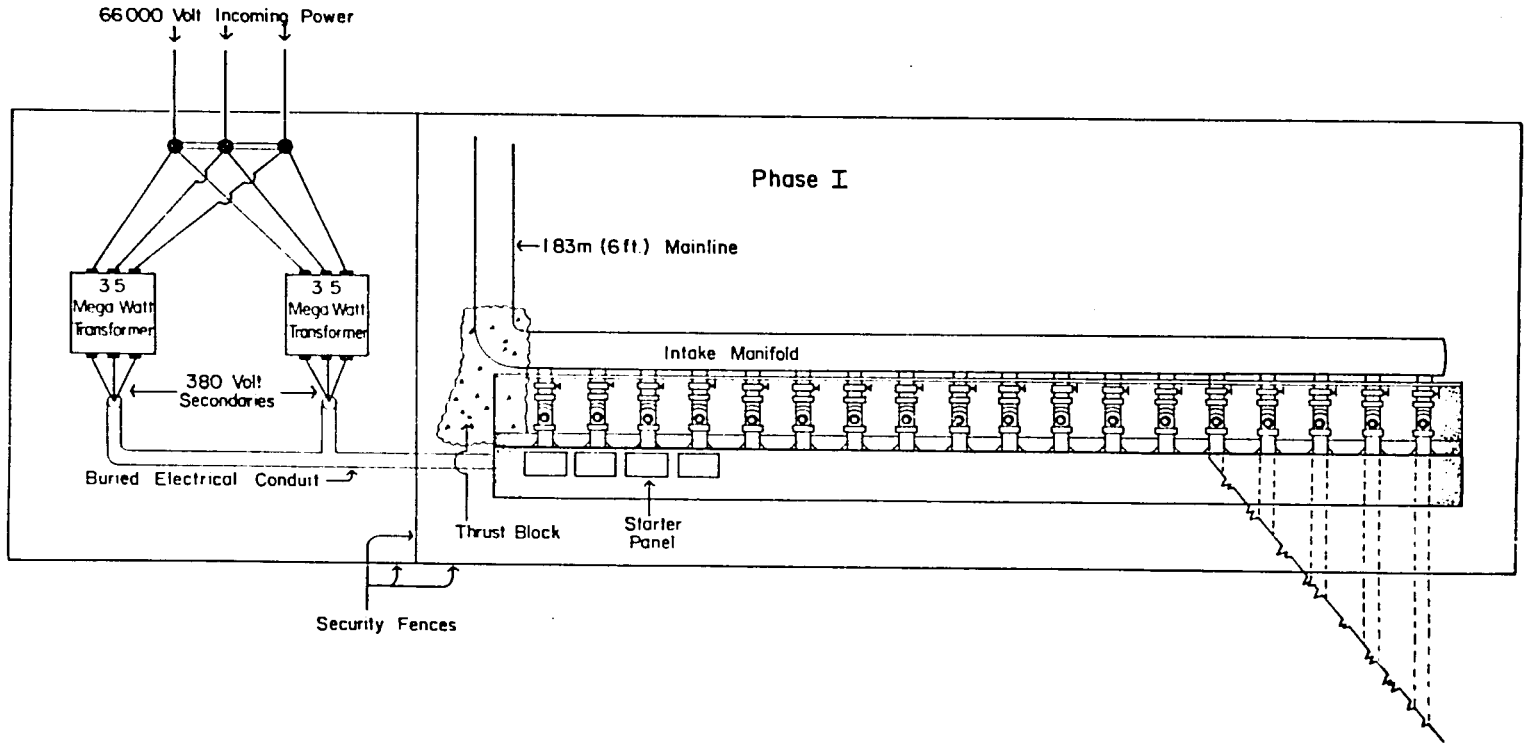


Figure 5.2.4.2. B

ZAMBEZI RIVER PUMPING PLANT TOP VIEW

Scale 1/100



wildlife and people between the plant and the Zambezi without risk. It should also be virtually maintenance free, efficient, economical to operate, have a moderately low initial cost, easily installed, be easily serviced and, perhaps most important, be designed to operate with the changing river levels without incurring adverse effects on the pumps or the plant's electrical components.

Many options, setups and designs have been studied, but a most efficient pumping plant exhibiting all of the above characteristics is shown in Figure 5.2.4.2 A. As can be seen in this layout, most of the pumping apparatus is below ground or submerged below the waters of the Zambezi River. All that is visible are the motor control panels, piping leading to the underground manifold, a small drain valve, and the security fence surrounding the structure. This setup provides very little detrimental environmental impact on the area. After vegetation damaged during construction reappears, the entire pumping plant with the exception of the power line will be barely visible from either the land or water. Since the motors are electric and below the water, no noise will disturb nearby villagers or wildlife.

Electric submersible motors close-coupled to multi-stage turbine pumps will be used exclusively in this setup. The pumps and motors operate below the water surface and always have cool river water flowing next to their outer jackets for cooling. The pump is connected to a foot or check valve which is in turn connected to a 60 x 0.36 meter welded steel tube. The 3 phase wire used to power the motor is run through loops welded atop the entire length of the tube. The wire is also protected by PVC conduit throughout this 60 meter length. The whole unit is then inserted in a steel tube with a diameter of 0.51 meter (20"). Nine of these larger tubes are laid side by side, with one-half of their length in the Zambezi River. The ends of the nine tubes are joined under water by a large suction screen with openings of 6 mm (0.25"). This permits a free flow of water in but keeps aquatic life out. Two groups of nine suction tubes will be utilized for a total of 18 pumps and motors with one pump acting as a reserve.

Servicing a pump or motor is a relatively simple matter. It will only be necessary to disconnect the discharge tube from the mainline, disconnect the motor power wire from the starter panel and pull the tube, pump and motor up the hill until the pump is exposed for service or replacement. The same slope will be maintained above the pumping plant that is on the river side of the plant to facilitate removal. An access plate will be incorporated near the shore to drain the water from the tube

prior to removal for service.

Two hundred twenty five Kilowatt (300 HP) electric motors were chosen to power the pumping plant because these pumps and motors are most common in the industry. Larger horsepower motors are harder to handle, require special orders (and are therefore more expensive), draw too many start-up amps and often are only available at higher voltages requiring separate transformers. If smaller motors were used, there would simply be too many pumps to install, and again the initial cost would increase. Having a larger number of pumps would be impractical.

Submersible motors and pumps with the following specifications were tentatively chosen:

- 225 KW (300 HP) 3-phase, 50Hz, 380 Volt, 2900 RPM electric submersible motors.

- 2900 RPM multi-stage turbine pump delivering 190.5 l/s (3020 GPM) at 76 m (250 ft) of TDH.

- Starter control panel equipped with auto transformer start, phase monitor, thermal protection and an over and under voltage protection relay.

Sizing of the pump to the motor was calculated according to the following equation:

$$\text{Kilowatts} = \frac{Q \quad (TDH)}{102 \ (\text{Eff. of system})}$$

where: Q is in liters/second

TDH is in meters

Eff. of system is (motor eff. x pump efficiency)

$$\text{Kilowatts} = \frac{190.5 \text{ l/s } (76 \text{ m})}{102 \quad (.90 \times .78)}$$

$$\text{Kilowatts} = 202$$

Therefore, if a 225 KW motor is used, a 23 KW safety margin is obtained. Each pivot requires 55 l/s (872 GPM) of water for a total of 33,000 l/s (52,320 GPM) for the Project. This indicates a need for 17.3 pump and motor assemblies if all pivots were on line simultaneously. Eighteen pump and motor assemblies will be installed initially.

A combination air, vacuum and pressure relief valve will be fitted to the steel pipe just before each pipe enters the

mainline. The air relief valve allows air to exit from the pipe system but not water. This is especially useful during initial start-up. Pressure surges occur when a motor is started. Excessive pressures will cause the pressure relief valve to open and dump water or air instantly before damage to the mainline occurs. Because there will be no problem with pipes freezing, non-moving water can remain in the suction tubes year round. Therefore, the one-way foot valve can be located just above the pump so pressure surges during start-up will be greatly reduced.

A gate valve located on each of the 18 discharge tubes will allow slow filling of the mainline during initial start-up and also will allow any one motor to be isolated for repairs without affecting the other pump operations.

Typically, submersible motors with their narrow diameters are more susceptible to failure from erratic voltages. However, special starter panels will be used which are very sensitive to electrical irregularities, and will shut down the motor before it is damaged. These particular control panels are of the auto-transformer type which will eliminate peak start-up amperage. This is an important feature because it prevents any of the pumps from shutting down due to low voltage caused by an excessive power drain from the start-up of another motor on the panel.

The starter panels will be equipped with a roof to shield them from rain and direct sunlight, preventing motor shutdown prematurely due to the hot ambient temperatures incurred when the panel is exposed to direct sunlight.

5.2.4.3 DISTRIBUTION SYSTEM DESIGN

The distribution system must efficiently take the water drawn from the Zambezi River by the pumping plant, and distribute it to each center pivot in the proper quantities and at the right pressure. The distribution system must be designed in a way that facilitates expansion. Also, a means of controlling the pumping rate of the pumping plant must be incorporated into the distribution system. Other important features needed in a distribution system are: lowest initial cost possible, easy installation, maximum longevity, durability, and be designed to facilitate repairs.

A water volume control system was chosen over a pressure control system. The main reason is to decrease the number of motor start-ups. For example, if a motor is started and allowed to run continuously for several days, it will have a much longer natural life than a motor which stops more frequently. A pressure control system is very sensitive and would send erratic control

signals (due to pressure surges and deficits) when there is a minor change in the number of irrigation systems operating.

The volume (water level) of the reservoir will be used as the indicator to govern the number of pumps needed to maintain a specified water level in the reservoir. See Figure 5.2.4.2 B for an illustration of the float control system, reservoir and discharge gate valve.

The reservoir itself will have an approximate water surface area of 10 hectares and will average 2.5 meters (9.8 ft.) in depth. This constitutes a total storage volume of 250,000 cubic meters or nearly a full day's reserve with all 60 pivots running. This will provide insurance in case of a power failure. The desired water level will be at an elevation of 437.5 meters (1435 ft.) above sea level and 71.6 meters (235 ft.) above the river level. To decrease seepage losses from the reservoir bottom, the heaviest soil found in the region will be transported to the site and spread in a 0.3 m (1 ft.) layer over the reservoir floor using the Project's equipment. Clays that swell when wet, and therefore seal the ground from infiltration, are the most desirable. Heavy soils with high clay content, and subsequent low hydraulic conductivity, are known to exist on the northern edge of the Project, near the escarpment.

An open pipeline discharge into the reservoir will be utilized. This system will act as a surge suppressor, or buffer, to reduce the force of potentially damaging water hammers. The mouth of this discharge pipe will be equipped with a 1.83 m (6 ft.) flat backed gate, manually operated to keep the reservoir from draining if mainline repairs are needed.

Incorporated into the dam grade of the reservoir is a concrete spillway. This will allow the reservoir to overfill and the excess water to flow over the dam embankment without causing erosion or jeopardizing the dam itself. After the water flows over the spillway, it follows the natural depression to the river without posing a threat to the farm or humans. The reservoir could overfill for two reasons. The first case is if a rain of high intensity fell on the watershed above reservoir, and the second would occur if the float control system failed to shut off enough motors to maintain a stable water level.

The distribution system for the Project is shown in Figure 5.2.4.3 C. All pipe size diameters and expected pivot pressures at maximum flow rates are given in this figure along with the requirements for expansion. It should be noted that Phase I was designed with the intention of integrating Phase II at a later date. Therefore, some pipes are intentionally oversized to

Figure 5.2.4.2 B

FLOAT CONTROL SYSTEM

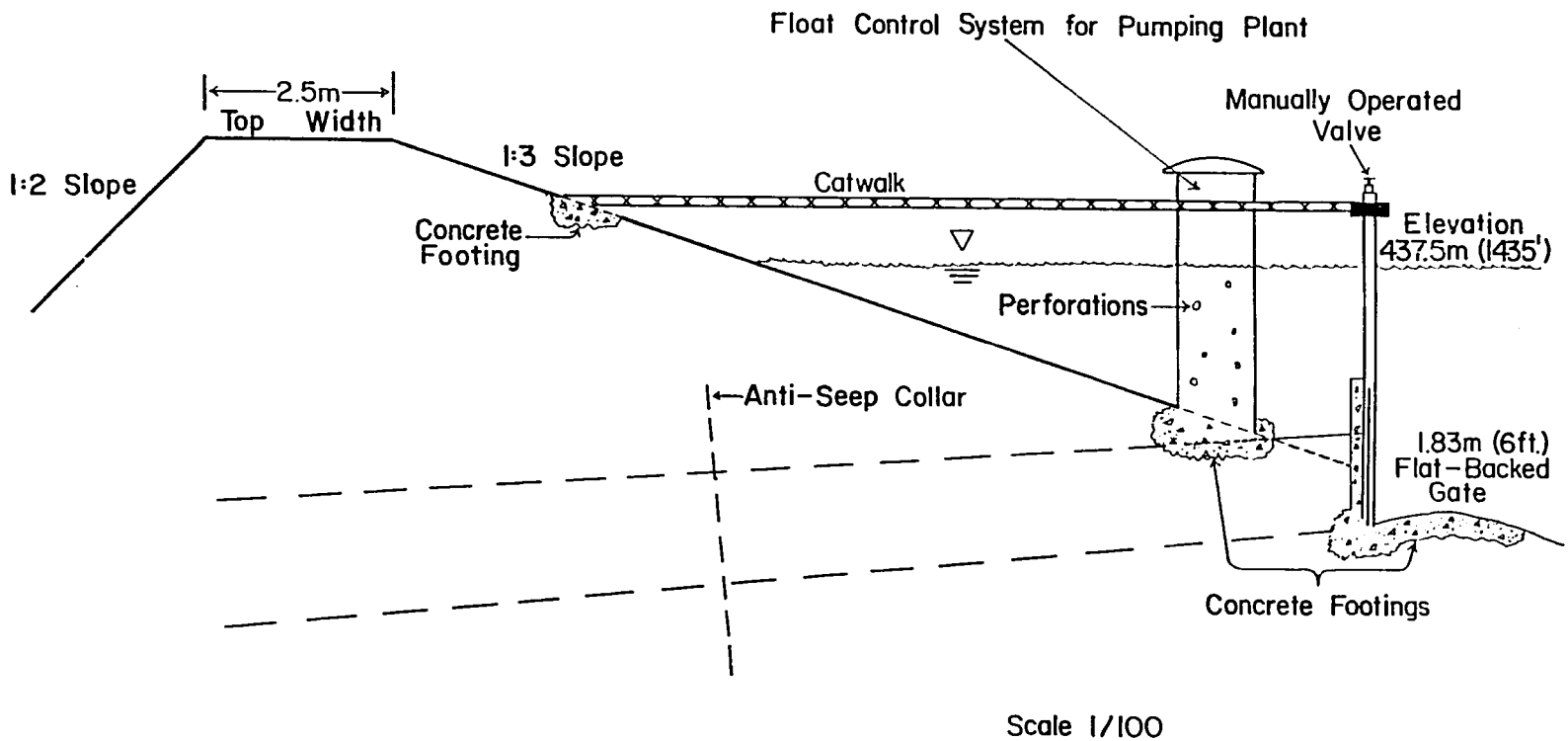


Figure 5.2.4.3C

PIPELINE SIZES AND PIVOT PRESSURES

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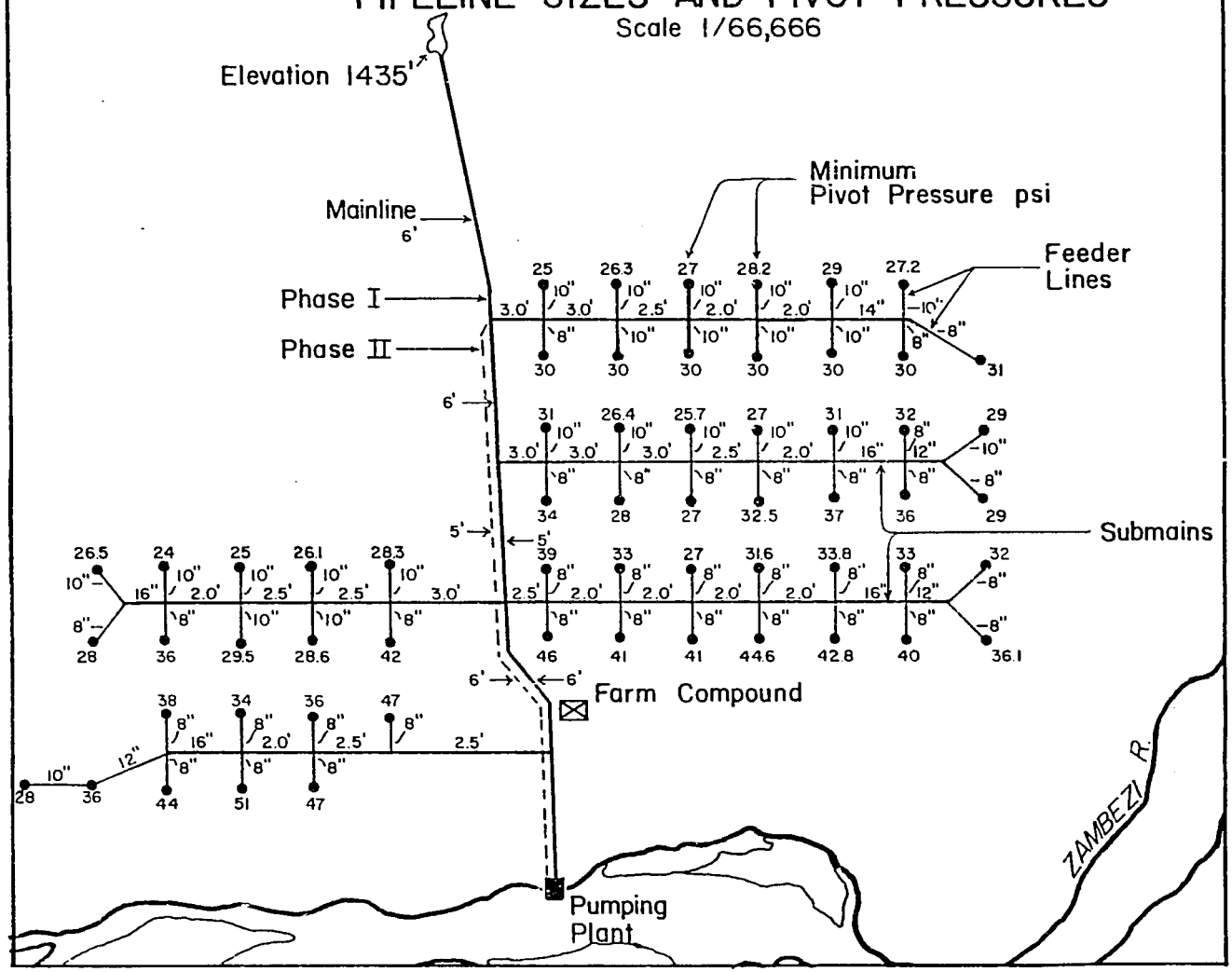


accommodate this future flow requirement at a minimum cost.

All pipe sizes used between 1830 mm (6 ft.) and 610 mm (2 ft.) are of steel construction. Individual pipes are generally 12.2 m (40 ft.) long, are cold tar coated together on the outside, bare on the inside, and are joined together by rubber gasketed, sealed joints. This type of joint allows easy and quick installation. Fittings, sub-mains and feeder lines can be attached anywhere to the steel mainline or to each other quite easily by welding.

All feeder lines (lines connecting the center pivots to the sub-main) will be buried to a depth of 1 meter (3.3 ft.) to enable farm implements to safely pass over them. Main lines and sub-mains can be buried so that the top of the pipe is no closer than 0.5 meters (1.65 ft.) from the ground surface. This extra flexibility will allow the developers to maintain a more constant pipeline grade over rough terrain. All high spots in the pipeline will be equipped with air relief valves. Air trapped in the pipe restricts the flow of water and because air is compressable, increases the force of pressure surges, or water hammers.

Pipelines with a diameter of 405 mm (16 in.) or less will be of Poly Vinyl Chloride construction. PVC pipes have excellent longevity, very low friction losses, are light and easily installed and have a considerable amount of resistance to failure from pressure surges.

The pipes required for the distribution system are listed below:

STEEL PIPE

Pipe Diameter	Length Required	
	Phase I	Phase II (mainline)
1830 mm (6 ft.)	8,400 m (27,450 ft.)	3,550 m (11,600)
1524 mm (5 ft.)	1,700 m (5,500 ft.)	1,700 m (5,500)
930 mm (3 ft.)	5,200 m (17,000 ft.)	--0--
762 mm (30 ")	6,400 m (21,000 ft.)	--0--
610 mm (24 ")	7,300 m (24,000 ft.)	--0--

PLASTIC (PVC) PIPE

Pipe Diameter	Length Required
410 mm (16 ")	1,600 m (5,250 ft.)
356 mm (14 ")	800 m (2,650 ft.)
305 mm (12 ")	1,900 m (6,200 ft.)
254 mm (10 ")	9,600 m (31,500 ft.)
203 mm (8 ")	16,100 m (52,800 ft.)

5.2.5 INFRASTRUCTURE DEVELOPMENT

5.2.5.1 ELECTRICAL SYSTEM LAYOUT AND COSTS

The following section analyzes the various topics concerned with the implementation of the electrical system, i.e. application procedures, installation time, design and cost breakdown.

To receive electricity, the consumer must first make a request to the Zambia Electrical Supply Company (ZESCO) to insure that power is available for that region. Next, the distance to the power source must be determined to estimate the total cost of installation. Both of these questions have been answered for the proposed project.

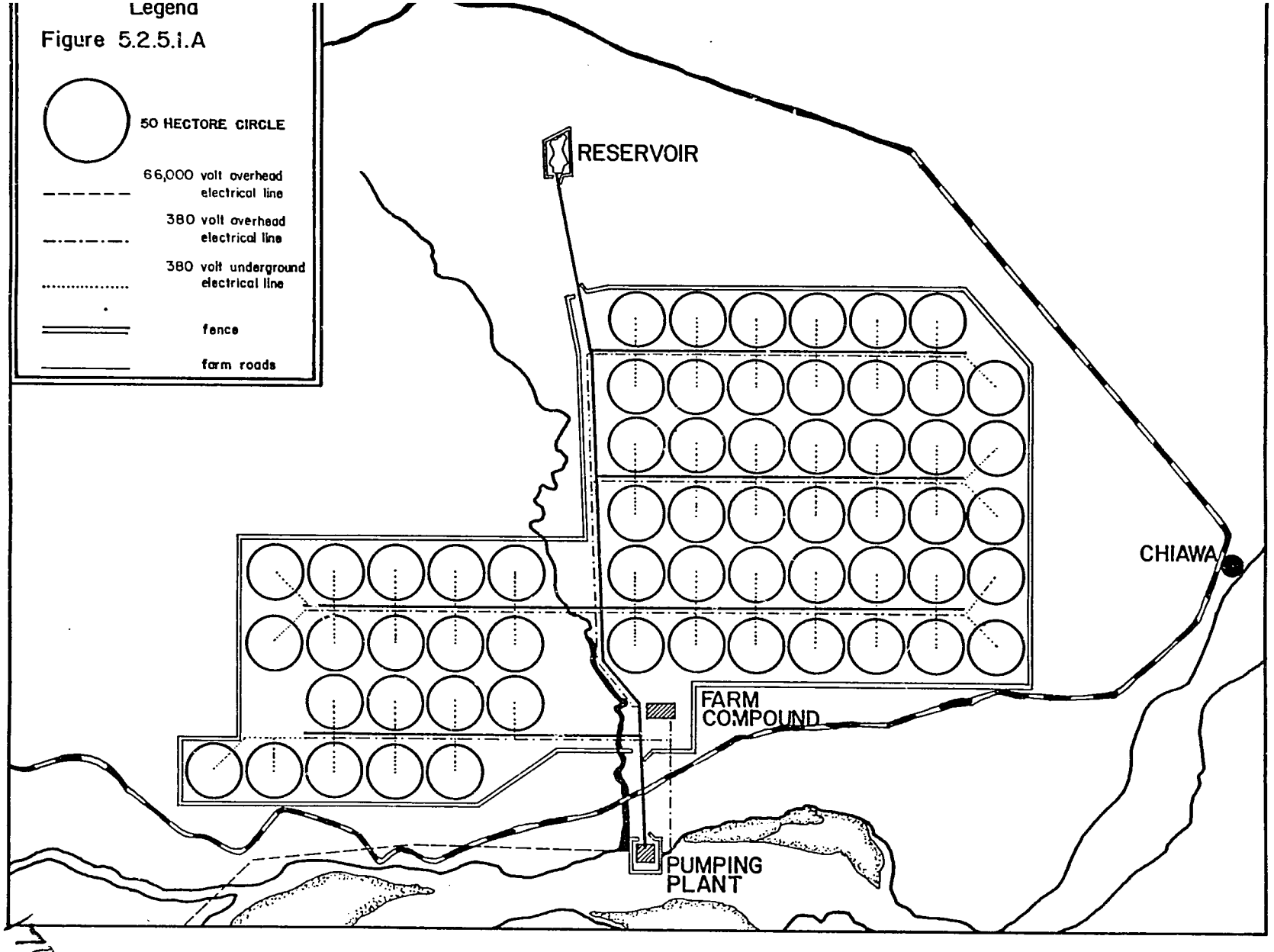
Electricity is distributed to Chirundu by an 88,000 volt line from the Kafue Gorge hydroelectrical plant. Near Chirundu, a substation and stepdown transformer provide 11,000 volt power to the banana scheme just west of the project site.

From this substation, the 11,000 volt power will be transformed back up to 66,000 volts for distribution to the pumping plant on the Zambezi River, a distance of 15 kilometers. This will require the use of an 11,000 to 66,000 volt transformer at Chirundu and a 66,000 to 380 volt transformer at the pumping plant.

ZESCO engineers will provide the exact specifications for the transformers and the wire needed to reach the pumping plant. Due to the lack of manufacturing facilities domestically, these items must be purchased by the project management outside of Zambia to meet ZESCO's specifications. Installation of the main overhead line and the transformers will be carried out by ZESCO crews. They estimate seven working days per kilometer, or approximately 105 working days for completion of this segment.

The overhead electrical supply system on the project site will be installed by subcontractors, as shown in Figure 5.2.5.1 A. The underground portion of the line from the circles' edge to the pivot panel will be installed by the project development crew. This underground line will be protected from rodent damage by PVC piping.

All electricity in Zambia is 50 cycles per second (Hz). All motors on the project will be 3-phase, 380 volt, 50 Hz.


Legend
Figure 5.2.5.1.A
50 HECTORE CIRCLE
66,000 volt overhead electrical line
380 volt overhead electrical line
380 volt underground electrical line
fence
farm roads
RESERVOIR
CHIAWA
FARM COMPOUND
PUMPING PLANT

Cost Estimate for Electrification

QUANTITY	ITEM	UNIT PRICE	COST
15 KM	66 KV LINE	$14,000/KM	$210,000
34 KM	380 V LINE-OVERHEAD	14,000/KM	476,000
24 KM	380 V LINE-UNDERGROUND	8,000/KM	192,000
1	11 TO 66 KV TRANSFORMER	76,500	76,500
1	66KV TO 380V TRANSFORMER	89,250	89,250
			$1,043,750

The plan to supply the project with electricity is shown in Figure 5.2.5.1 A. The main 66,000 volt line will run from Chirundu to the pumping plant where it will be transformed to 380 volt 3-phase to power the irrigation pumps. From that point an overhead line will distribute the power throughout the farm and to the farm compound. Underground lines will then provide power to the pivot points.

The main line from Chirundu is sized large enough to provide limited amounts of power to the village of Chiawa, which currently does not have access to electricity, and to also provide for the future expansion of the project to include 60 additional center pivots.

ZESCO charges a fixed monthly charge of K4062, plus a demand charge, which is based on the peak load or maximum number of KVA drawn during any given month, of K0.278 per KVA. Additionally, the number of KVH consumed during the month is charged at K0.082. Typically, it is expected that the total electrical rate will be approximately K0.085 per KVH. However, due to the large amounts of power to be consumed by the project, a lower rate will be requested from the power authorities.

5.2.5.2 SECURITY SYSTEM

The perimeter of the project's production area will be surveyed, cleared and fenced with two meter high, 6-strand, barbed wire to exclude the native grazing animals, as shown in Figure 5.2.5.1 A. The fence will constructed by a subcontractor using either pipe or angle iron posts to prevent decay from bacteria and insects, which will be set in concrete.

It is not known, at this time, whether elephants will be a problem, as they could probably break through this fence. If it is determined that they are a problem, a trench will be built, using the project's bulldozers, along the outer perimeter of the fence. A 1.5 to 2 meter deep trench with steep walls will

prevent the elephants from gaining access to the fence and minimize any damage they might cause. Because of lack of experience in the problem area, African consultants will be used to assist.

Excluding primates from the production area would be a most difficult task with any kind of fence and a very expensive proposition. The added cost of preventing primate damage to the crops may exceed any benefits gained.

Estimates from subcontractors in Lusaka indicate that this type of fencing will cost K15,000 per kilometer. The project perimeter is approximately 40 kilometers.

The farm headquarters and compound area will have a wall and fence combination surrounding it for security reasons. This fence will be constructed with a one meter concrete block wall topped by a two meter chain link fabric on steel posts. The farm compound will have a perimeter of approximately one kilometer and an estimated cost of K50,000.

5.2.5.3 FARM COMPOUND

The farm compound will be tentatively located approximately one kilometer north of Road D482, just east of the Musandya River, as shown in Figure 5.2.5.1 A. This will locate the headquarters in the approximate center of the project and allow for easy access to the compound from the main road.

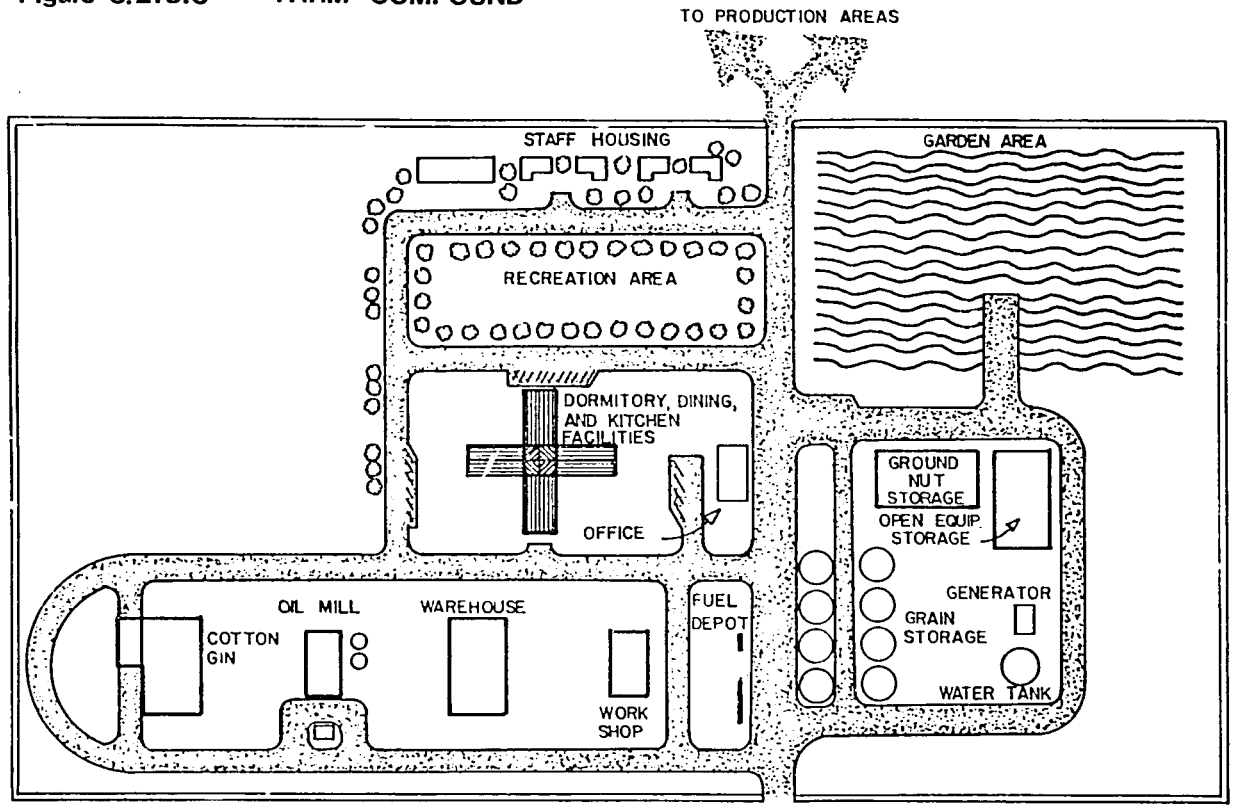
Included within the compound will be the housing facilities for the farm staff, warehousing, workshops, grain storage, processing facilities and fuel storage, all as shown in Figure 5.2.5.3. To facilitate the construction of the farm, a temporary compound will be established first on the same site, which will house the development crew and provide some storage and working areas.

The farm compound will be large enough to incorporate additional facilities when the farm is expanded to 120 pivots or more.

5.2.5.4 FARM ROADS

The farm roads will be laid out as shown in Figure 5.2.5.1 A. All of the roads will built by the development crew using the bulldozers and the road grader included in the project development equipment. They will be 20 meters wide and domed slightly at the center to provide drainage during rains. Approximately 30 kilometers of these roads will be built.

Figure 5.2.5.3 FARM COMPOUND



Roads through the fields to the pivot centers will not be permanent roads to facilitate the farming operations. The sandy nature of the soil will provide a fairly good base for these roads even after a recent irrigation.

As mentioned previously in Section 3.6.1, the ferry boat currently in use on the Kafue River between the project site and Chirundu will be replaced with a larger boat capable of supporting the heavier trucks necessary to properly service the farm. In contrast to the hand operated ferry there presently, it is thought that a motorized ferry will be necessary to provide fast, efficient service that will prevent long delays for the trucks delivering or picking up products from the farm. The ferry boat will be built in sections and transported to the site, where it will be assembled.

5.3 PHASE II EXPANSION

Figure 5.3 details the proposed Phase II expansion plans that call for the development of another 60 center pivots, and the associated infrastructure. The additional hectarage will be developed directly to the east of the original production area, and north of the village of Chiawa. Like the Phase I site selection, this area was chosen to avoid encroaching on any of the local residents' fields or villages.

The proposed electrical line from Chirundu has been designed to carry the increased load necessary to supply power to an enlarged pumping plant capable of delivering the amount of water needed for this number of center pivots. A portion of the mainline water distribution system will be enlarged by the installation of another pipe to adequately supply water to the reservoir. From the reservoir, a large canal will be built to deliver the water to the new center pivots. Due to its large size, this canal will also serve to increase the buffering capacity of the reservoir.

In terms of infrastructure, the electrical, security and farm road systems will be expanded appropriately to meet the new demands. Their design will follow closely that which has been established for Phase I. With the exception of the processing facilities, the farm compound will be essentially doubled in size to adequately house the additional people and machinery.

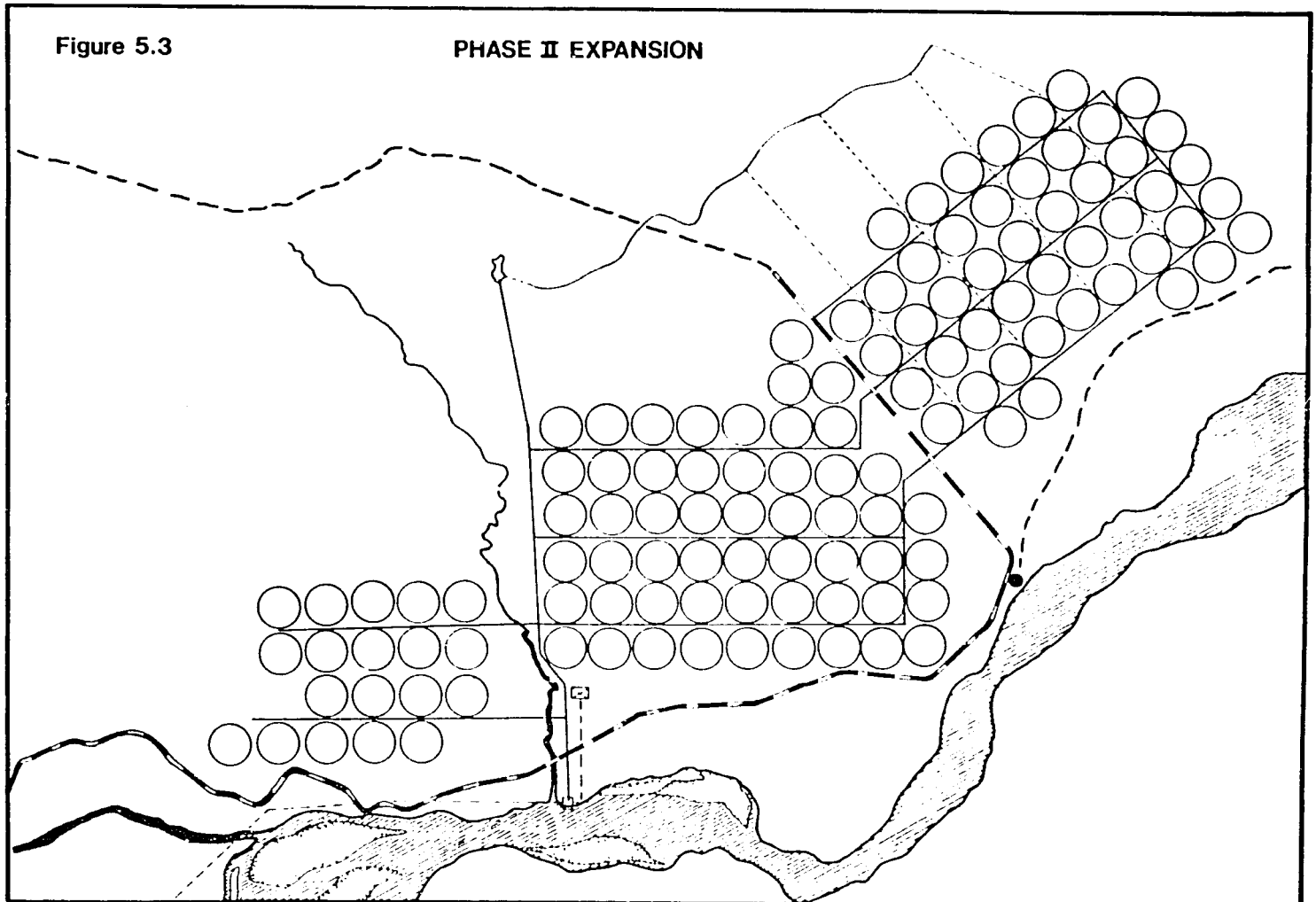
Additional machinery will not be needed for the development of Phase II; the equipment used during the development of Phase I will be used.

An almost identical set of farming machinery, as outlined in Section 4.5.4 for Phase I, will be required, as well as additional vehicles and grain trucks.

The per hectare cost of developing Phase II will be considerably less than Phase I, due to the prior establishment of the required infrastructure. Section 8.1 contains the estimated costs of development for Phase I and II, for comparison.

Figure 5.3

PHASE II EXPANSION



5.4 PROCESSING FACILITIES

5.4.1 COTTON GIN

The cotton gin will be located in the farm compound, as shown in Figure 5.2.5.3, but kept a considerable distance away from the housing area to minimize the noise impact on the residents. Its location in the farm compound will facilitate the storage of the seed cotton coming from the fields, and the shipment of the finished product.

The gin will be purchased in the United States, and shipped in approximately five, twenty foot containers to the port at Durban, South Africa, from where it will be shipped by truck to the project site. Experienced personnel from the United States will be on-site to supervise the construction of the building and the erection of the ginning machinery.

The gin will be housed in a metal building approximately 12 meters wide, by 30 meters long and 8 meters high. Approximately 500 cubic meters of concrete will be required for the floor and to form the needed duct systems.

The complete system, including the burr cleaners, pre-cleaners, saw gins, lint cleaners, drying systems, blowers and balers will consume between 375 and 675 kilowatts of electricity, depending on the type of system purchased, and will process 6 to 8 bales per hour (1350 to 1800 kilograms per hour).

It is estimated that after all of the equipment is delivered on-site, a crew of ten workers and two supervisors can construct the building and install the machinery in approximately three months.

5.4.2 OIL PRESS

The proposed oil press will be located adjacent to the cotton gin, again to minimize the noise impact on the compound residents and to facilitate the delivery and shipment of the products.

As stated in Section 4.4.2, the proposed oil press will be of the expeller type, and will include the associated cleaning, drying, filtering and storage equipment required to properly process castorbeans. Depending on the type, this will normally entail the construction of three or four buildings; one large building to house the actual oil press (approximately 17 X 40 meters), and two or three smaller buildings to house the boiler, scale, laboratory and refining operations.

In a manner similar to the cotton gin, it will most likely be purchased in the United States, and shipped to the ocean port at Durban, South Africa for transport by truck to the project site. Experienced personnel will accompany the equipment to supervise the construction of the buildings and the installation of the machinery.

The mill will have the capability to process approximately 25 metric tons per day, completing the farms output in 120 days from start-up.

6. MANAGEMENT

6.0 MANAGEMENT PRACTICES

6.1 MANAGEMENT PHILOSOPHY

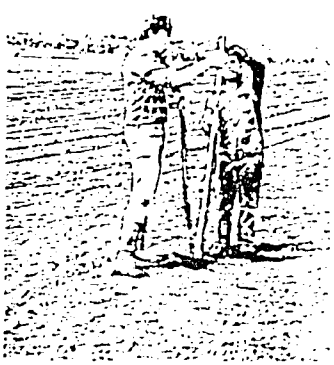
6.2 INTERNATIONAL MANAGEMENT EXPERIENCE

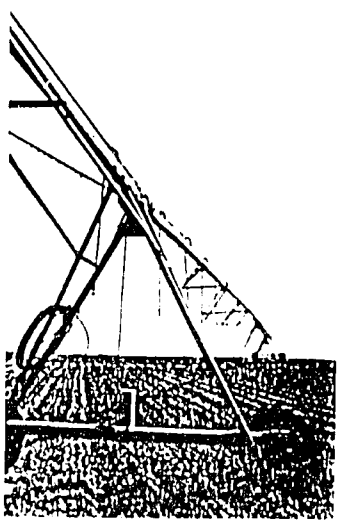
6.3 FINANCIAL AND MANAGEMENT REPORTING

6.4 MANAGEMENT PERSONNEL REQUIREMENTS

6.5 TRAINING PROGRAM

6.6 MANAGEMENT COMPENSATION





6.0 MANAGEMENT PRACTICES

6.1 MANAGEMENT PHILOSOPHY

From experience gained in over 20 years of developing large scale agricultural projects, Western Agri-Management has found that for large scale farming, modern farm machinery in combination with center pivot irrigation will result in the most cost efficient operation and will produce the highest crop yields possible. The development of these machines and cultural practices has occurred primarily in the United States and has dramatically increased the productivity of American farms in the last fifty years. This technology is now readily available for other countries to similarly increase their agricultural productivity.

The existing management and production methods in Zambia are based still on the traditional practices that have been used for centuries. Although the use of fertilizers and other agricultural chemicals has increased recently, other suboptimal production conditions, (e.g., the lack of irrigation) have severely limited any increase in general production.

In order to fully utilize the newer production practices perfected in the United States, it will be necessary, initially, to hire experienced farmers and farm managers in the United States and bring them to the project to develop and establish the technology in Zambia. Part of their job will be to train Zambians in every aspect of the farm, from the management down to the skilled work force necessary to operate such a farm.

As the training progresses and the Zambian staff becomes more and more qualified, the expatriot staff will be replaced, until eventually the farm will be operated entirely by local people.

6.2 INTERNATIONAL MANAGEMENT EXPERIENCE

Western Agri-Management was organized to develop and manage high technology, intensive, irrigated farms in the western United States. Beginning with the purchase of 4,400 acres in western Nebraska, Western developed 13 center pivot sprinkler farm units to irrigate 1,700 acres, and operated the project as a pilot farm. During the next six years, Western continued to develop farms irrigated by center pivot sprinklers for various clients and on behalf of its parent company, Western Land and Investment.

Since 1973, Western has purchased over 35,000 acres of land in the United States and developed approximately 20,000 acres of center pivot irrigation, most of which has been sold to investors

but remains under the management of Western.

The development and operation of these farming operations have provided Western with experience in the latest agricultural technology, including such areas as water management, fertilizer utilization, micronutrient requirements, and insect, weed, and disease control. Western has assembled a team of agronomists, agricultural engineers, hydrologists and other technical personnel, and a management organization which has successfully adapted advanced technology to very large tracts of land.

Using the experience gained in the United States, Western expanded its operation to include the international market in 1979. Since then, Western has undertaken economic and technical feasibility studies plus the development and management of agricultural concerns in several countries including Saudi Arabia, the Republic of Yemen, Pakistan, Egypt, Guinea, Morocco, Venezuela, and Paraguay.

Perhaps the most successful are Western's operations in Paraguay, where the company either owns or manages in excess of 15,000 hectares (approximately 37,000 acres) of cropland. The farms in Paraguay produce soybeans, wheat, maize, cotton, and tobacco, and will soon incorporate several processing facilities, such as a cotton gin and an oil press in an effort to better utilize all of the resources available.

6.3 FINANCIAL AND MANAGEMENT REPORTING

The project manager will be responsible for all of the activities at the project site, and will report to the Board of Directors, in conjunction with other management personnel from Western Agri-Management. Each month the project manager will complete and submit to both the investors and the Board, a project status report, that will inform them of current crop appraisals, operational and administrative problems, employee changes, training program evaluation, and the financial status of the farm.

A project accountant will be on-site to accumulate and prepare the financial records necessary to comply with standard accounting procedures. These records will be kept up to date and will be available for inspection by the investors at all reasonable times. Periodically, this information will be transmitted to Western's office in the United States for final tabulation and analysis on the computers there. This information will then be used in the monthly status report compiled by the project manager.

6.4 TRAINING PROGRAM

A comprehensive training program will be established at the farm that will not only provide trained employees for the project, but at minimal cost the local people can be trained to better operate their own farms. In addition to a training facility that will be built on the farm to house these activities, training seminars in the field will provide hands-on experience in many of the skills to be taught.

Each of the management staff will be responsible for conducting training seminars in their field of expertise, in association with the project manager. For example, the agronomist will be training people in the areas of soil fertility, entomology, irrigation scheduling, weed control, and cultivation techniques. The shop foreman will conduct training seminars on equipment maintenance and repairs, with standard trade school methods using cut-away equipment for demonstration and hands-on learning experiences.

In addition to the project staff, local professionals and extension personnel from the various governmental organizations will be asked to visit the farm and hold training sessions on specific areas in which the farm management is not experienced.

Key local employees will be sent to the United States to participate in training activities at Western's farms in Texas. These farms are very similar in size and scope to this proposed project and will give these people an excellent background in Western's methods.

6.5 MANAGEMENT PERSONNEL REQUIREMENTS

Experienced expatriot personnel will be utilized exclusively in the top level management positions during the initial phases of the project. As the training and experience of the local Zambians progresses, many management positions can be assumed by Zambian personnel. The required management positions and their duties are presented here:

PROJECT MANAGER - Previous business and farm management experience will be required. The project manager will be responsible for the daily operation of the farm. It will be his responsibility to see that all farming and marketing activities are completed in a timely manner, and will report to the Board of Directors and the investors on a monthly basis with the status of the project. Also, the project manager will coordinate the training programs outlined earlier.

AGRONOMIST - Degree in agronomy and previous farm management experience will be required. The project agronomist will establish, in compliance with Western's general specifications, specific agronomic programs for the farm, and, in conjunction with the farmers, will see that they are carried out on a directbasis. He will report daily to the project manager with the status of the crops, and will incorporate into his daily regimen training seminars on the agronomic programs established for the farm.

SHOP FOREMAN - Previous equipment and machinery repair experience will be required. The shop foreman will responsible for the maintenance and repair of all of the project equipment, and for organizing the training programs concerned with his area of expertise.

FARMERS (4) - Four farmers with previous experience in irrigated crop production will be utilized; each will be responsible for accomplishing, in conjunction with four Zambians, all of the farming operations on 15 center pivots, with direction from the project manager and the project agronomist. He will report to the project manager as required to keep him updated with the current status of the farm.

NURSE - Qualified, degreed nurse experienced in general medical care. The project nurse will be responsible for the general health care of the project workers and their families and will periodically hold seminars on nutrition, pregnancy, etc. for the area residents.

In addition to these positions, it will be necessary to also bring qualified personnel from abroad to supervise the operation of the processing facilities during the time of the year when they are in operation. Until the actual facilities are purchased, it will not be possible to accurately predict the number of people required. However, for the financial projections included in this study, an estimated figure for labor and supervision was included, based on information from experienced processors in the United States.

The following personnel will be local Zambian skilled and unskilled workers and trainees:

(1) Project Manager Trainee
(1) Agronomist Trainee
(16) Farming Trainees
(2) Servicemen Trainees
(2) Cooks
(1) Accountant
Support Personnel (Housekeepers, Maintenance, etc.)
(10) Local Laborers

6.6 MANAGEMENT COMPENSATION

The project management agreements between Western Agri-Management and the project's principals are to be executed in two phases: one for the development and another for the long-term production management.

The development agreement will, in general terms, follow those in Western's standard, long form Engineering and Development Contract. Compensation to Western from the corporation will provide for profit and cover Western's expenses for on-site development personnel, travel, communications, purchasing and expediting efforts, agronomic testing, and engineering design work. The amount of compensation will be a percentage of the total development cost, which will be negotiated at commencement of the project. This fee will be paid in monthly installments over the period of development and should include an incentive to encourage cost savings.

Similarly, the long-term production management agreement will be in accordance with Western's International Management Contract. This contract establishes a minimum monthly fee (to be calculated) that will cover the management company's direct expenses. An override, based on a percentage of the direct profit from the farm, before interest, will accrue to Western if specified production goals are met. This will encourage the management company to achieve the highest yields possible with the lowest corresponding production costs.

7.0 BENEFITS TO THE COUNTRY

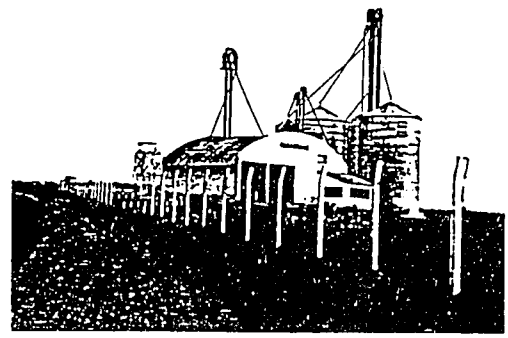
7.1 SERVICES

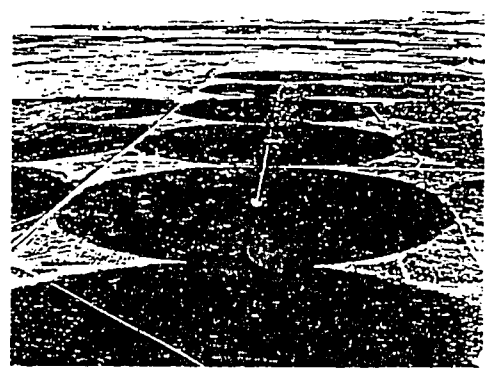
7.2 TRAINING

7.3 TECHNOLOGY

7.4 INFRASTRUCTURE

7.5 OTHER BENEFITS





7.0 BENEFITS TO THE COUNTRY

There is an aspect to the development of a large, modern farming complex in a relatively undeveloped area which is not easily defined in precise numerical terms, but which nevertheless is significant both to the agricultural project itself and the community and country in which it is located.

Western has learned from experience in many countries that when such a project is built in an undeveloped area, it has a significant beneficial impact on the socio-economic status of the region in which it is located. These benefits include services to the farmers, training, making available new technology, improvement of the existing infrastructure, and several other less tangible aspects that will generally improve the life of the people in the community.

As these benefits flow to the locality around the project, some of these factors will in turn contribute to the ultimate success of the project. For example, providing extension services and a central marketing facility for the farmers in the area will help provide the raw materials necessary to fully utilize the processing facilities to be built on the farm.

7.1 SERVICES

There are a number of services that the project can provide to the people that will benefit both parties. Perhaps the most important will be extension services to help the local farmers improve their yields and increase their crop base. The agronomists on the project will not only be able to instruct the farmers in a classroom situation, but will be able to show them the results of improved technology with the crops being grown on the project.

It is important to note here that extension services alone have little effect without first demonstrating the results. It has been Western's experience that the teacher must first produce outstanding crops on a substantial scale to establish credibility. The neighbors will then ask how it is done; then, and only then, can effective teaching be done to a receptive farmer.

Along with the extension services, the project will be able to help the local farmers by providing them with the excess water it generates to irrigate their own fields during the dry season. It is estimated that this factor alone could double the production of the farmers immediately adjacent to the farm.

Historically, the market structure in Zambia has often failed to adequately serve the relatively isolated areas such as Chiawa, which negates any advances in yields which would result from the improvements mentioned above. However, the project will also act as a central marketing facility, buying specified products from the local farmers, and reselling them along with the products grown on the farm. This will not only beneficially serve the farmers, but will also relieve some of the pressure on the over burdened infrastructure of the parastatal companies responsible for marketing all of the farmers' products at the present time.

Seed will be both imported and produced on the farm, with a constant program of testing and improvement. This program will not only provide the project with high yielding seed, but will also make available the selected varieties to the general public. Quality seed can have a great effect on the yield potential of all of the farmers who use it, and the effect takes place within one year, with rapid multiplication of the results.

This same program of seed development and distribution is being used successfully in Western's project in Paraguay with soybean and wheat seed. In Paraguay, Western imported and tested varieties to obtain superior seed stock and then expanded it by growing out the best varieties. This year Western is selling about 800 tons of superior seed to its neighbors, which will have a significant effect on the bean and wheat yield of the area. The program is expanding rapidly.

7.2 TRAINING

As detailed in Section 6.5, the training program will have a substantial effect on the neighboring community by providing instruction in modern agricultural practices, as well as teaching mechanics, tractor and implement operators, truck drivers, and electrical repairmen among others.

The development of a sound, educated base of workers will attract further development, which in turn will provide more training opportunities, thus repeating the cycle.

It is anticipated that key local professionals will be sent to Western's farms in the United States to receive intensive training in advanced production methods. As some of these people leave the project to go to other jobs, they will take with them the knowledge they gained, benefiting not only themselves but the whole country.

7.3 TECHNOLOGY

The advanced technology necessary to successfully operate a large production complex is not currently available in Zambia. Initially, all of the equipment and machinery will be imported from outside sources, but the presence of only a few of these farms will stimulate an industry within the country to provide support in the form of spare parts, trained service people, and eventually the manufacturing plants to produce many of the items of equipment.

7.4 INFRASTRUCTURE

The project will bring substantial improvement to the local infrastructure. Perhaps the most important will be the electrical line from Chirundu to the project site. This will bring electricity to within five kilometers of the village of Chiawa, and for the first time, the local people will have access to electrical power.

The project will also require the improvement and maintenance of the road system in the area to facilitate the shipment of products to and from the farm. Enlargement of the ferry on the Kafue River will mean better access for everyone in the Chiawa area.

7.5 OTHER BENEFITS

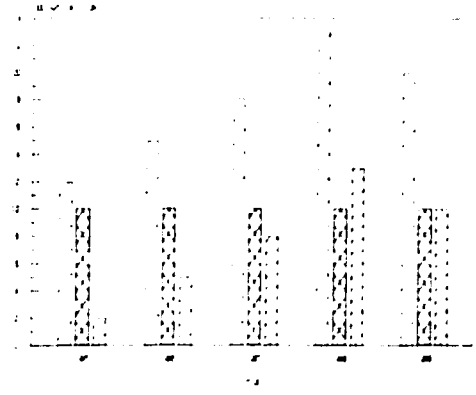
With all of the above mentioned improvements, it is expected that the local farmers will be able to produce and market more and better products than ever before. The sale of export crops for hard currency by the locals, through the project's marketing facilities, will enable them for the first time to obtain their own small scale irrigation and farming equipment, further improving their earnings.

The improvement of the area's standard of living will bring other changes as well. Better diets and the project's medical facilities will improve the general health of all of the people in the area, and the increased earnings should bring about improved educational opportunities.

With the country's severe balance of trade problems, the farm's export sales will bring much needed foreign currency into the country on a very significant scale.

8.0 FINANCIAL ANALYSIS

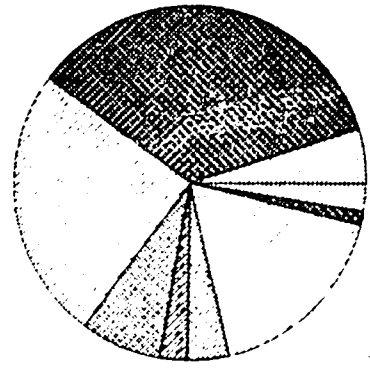
8.1 DEVELOPMENT COSTS



8.2 ANNUAL COSTS OF OPERATIONS

8.3 ANNUAL RETURNS FROM OPERATIONS

8.4 ANALYSIS OF RETURNS



8.0 FINANCIAL ANALYSIS

8.1 DEVELOPMENT COSTS

Mobilization	$ 200,000
Electric Power Distribution System	1,043,750
Irrigation Equipment	3,240,000
Management and Technical Supervision, Travel, U.S.A. Office Service, Overhead and Profit to Management Company	2,850,000
Development Equipment	1,228,000
Farm Machinery	5,268,150
Water Distribution System	4,615,000
Personnel - On-Site	146,250
Farm Compound Buildings	816,000
Cotton Gin	497,000
Oil Press	596,000
Ferry Boat	200,000
Grain Storage	628,700
Roads and Clearing	900,000
Fencing	387,000
Total Development Costs	$ 22,615,850

ELECTRIC POWER DISTRIBUTION SYSTEM

15 Km	66 KV line	$ 210,000
34 Km	380 V line - overhead	476,000
24 Km	380 V line - underground	192,000
1	11 to 66 KV Transformer	76,500
1	66 KV to 380 V Transformer	89,250
	Total	$ 1,043,750

IRRIGATION EQUIPMENT

60 Center Pivot Sprinklers:

400 meter Lateral,

Nozzle Package,

Pressure Relief Valve, Fertilizer

Injector, Fertilizer Tank, Underground

Piping, Flow Meter, Freight and Installation

$ 3,240,000 Total

DEVELOPMENT EQUIPMENT

Construction Equipment		
2	D-6 Bulldozers with Rippers	$ 220,000
1	Road Grader	82,000
1	Wheel Loader	60,000
1	4 WD Forklift	45,000
1	Concrete Batch Truck	90,000
1	Excavator, Rubber-tired	135,000
1	15 Ton Dump Truck	61,000
1	5 Ton Water Truck	50,000
1	Boom Truck with 3 Ton Hoist	65,000
3	Backhoes with Loader and Fork Attachments	180,000
1	2 Ton Repair Truck with Tools	35,000
4	Tandem Axle Trailers	25,000
1	35 HP Skid Steer Loader	20,000
Vehicles		
1	Toyota Land Cruiser	15,000
6	4 WD Mini Pickups	60,000
2	12 Passenger Buses	40,000
Tools and Miscellaneous		
1	Portable Diesel Welder	3,000
2	AC-DC Electric Shop Welders	4,000
3	Cutting Torch Assemblies	2,000
1	Electric Air Compressor	3,000
1	Portable Diesel Air Compressor	3,000
1	Metal Lathe	5,000
1	100 KW Diesel Generator Set	25,000
	Total	$ 1,228,000

FARM MACHINERY

18	150 HP Tractors (or equivalent HP)	$ 810,000
4	6 Meter Grain Drills	48,000
6	Combines	480,000
12	Grain Carts	180,000
10	5 Meter Offset Discs	150,000
10	5 Meter Tandem Discs	120,000
6	8 Row Unit Planters	100,000
10	Row Crop Cultivators	80,000
4	Groundnut Diggers / Windrowers	25,000
15	Groundnut Harvesters	390,000
68	Groundnut Drying Wagons w/ Dryers	359,000
13	4-Row Cotton Pickers	1,430,000
4	Cotton Module Makers	250,000
6	8-Ton Dry Fertilizer Spreaders	72,000
1	16-Ton Dry Fertilizer Tender	12,000
2	8 Meter Fertilizer Conveyors	25,000
10	Field Sprayers w/ 12 Meter Booms	50,000
		$ 4,581,000
	15% Spare Parts	687,150
	Total	$ 5,268,150

WATER DISTRIBUTION SYSTEM

Materials	Amount Required	Cost
1.83 meter Steel Pipe	8,400 meters	$ 2,000,000
1.524 meter Steel Pipe	1,700 meters	340,000
.930 meter Steel Pipe	5,200 meters	468,000
.762 meter Steel Pipe	6,400 meters	384,000
.610 meter Steel Pipe	7,300 meters	365,000
.410 meter PVC Pipe	1,600 meters	64,000
.356 meter PVC Pipe	800 meters	28,000
.305 meter PVC Pipe	1,900 meters	50,000
.254 meter PVC Pipe	9,600 meters	192,000
.203 meter PVC Pipe	16,100 meters	209,000
Pumps & Motors & Controls		350,000
60 1/4 Turn Valves - Electric for 8" Pipe		12,000
10 4" Vacuum Reliefs - $85.00		1,000
36 14" Dressler Couplers		7,000
18 14" Pressure & Vacuum Relief Valves		9,000
18 14" Gate Valves		18,000
18 14" Foot Valves		18,000
Reservoir		100,000
	Total	$ 4,615,000

FARM COMPOUND BUILDINGS

4	3 Bedroom Staff Houses	$ 200,000
1	Staff Kitchen and Dining Area	51,000
1	24 Room Dormitory with Kitchen, Dining and Laundry Facilities	224,400
1	Warehouse 20 M x 30 M	105,000
1	Workshop 28 M x 16 M	89,600
1	Water Tank	50,000
1	Covered Equipment Storage 15 M x 60 M	45,000
1	Office Building 15 M x 8.5 M	51,000
	Total	$ 816,000

COTTON GIN

1	Reconditioned Saw Gin FOB Houston	$ 280,000
	Freight	50,000
	Building 12 M x 30 M	72,000
	Concrete	35,000
	Erection	60,000
	Total	$ 497,000

OIL PRESS

1	Reconditioned Screw Press FOB Houston	$ 222,000
	Freight	42,000
	Buildings	
	Process Room 10 M x 30 M	60,000
	Cleaning and Refining 12 M x 20 M	48,000
	Storage Silo	75,000
	Oil Storage Tanks	75,000
	Erection	60,000
	Concrete	14,000
	Total	$ 596,000

GRAIN STORAGE

12,250 Metric Ton Capacity Storage
for Grain Crops

4,100 Metric Ton Capacity Storage
for Groundnuts

Scale, Dump pit, Conveyor System and
Drying Capability

Cost	$ 440,400
Freight	90,000
Erection	60,000
Concrete	38,300
Total	$ 628,700

8.2 ANNUAL COST OF OPERATIONS

FULL YEAR OF PRODUCTION 3,000 HECTARES

Direct Variable Farming Costs	$ 4,406,890
Personnel	148,150
Minimum Management Fee (Est.)	1,200,000
Training Program	51,000
Operation and Maintenance	153,000
Depreciation	1,194,300
Total	$ 7,153,340

DIRECT VARIABLE FARMING COSTS

	Per Hectare	Total
Cotton	849.56	$ 1,699,120
Groundnuts	1,110.70	1,110,700
Wheat	419.21	838,420
Castorbeans	758.65	758,650
	Total	$ 4,406,890

OPERATION AND MAINTENANCE

Fuel - Vehicles	$ 48,000
Engine Oil	5,000
Equipment - Repairs and Parts	50,000
Office Supplies	10,000
In-Country Travel	10,000
Miscellaneous Expenses	30,000
	$ 153,000

DEPRECIATION SCHEDULE

	Total	Estimated Life-Years	Annual Depreciation
Irrigation Equipment	3,240,000	30	108,000
Water Distribution System	4,615,000	30	153,830
Farm Compound Buildings	816,000	30	27,200
Cotton Gin	500,000	15	33,330
Oil Press	600,000	15	40,000
Grain Storage	1,198,250	20	60,000
Farm Machinery	5,268,150	7	752,590
Fencing	387,000	20	19,350
			$ 1,194,300

COST OF OPERATIONS

1ST SEASON - 500 HECTARES

Direct Variable Farming Costs		$ 555,350
Personnel		25,200
Training Program		25,500
Operation and Maintenance		26,000
Depreciation		69,200
	Total	$ 701,250

OPERATION AND MAINTENANCE

Fuel Vehicles		$ 8,000
Engine Oil		1,000
Equipment - Repairs and Parts		8,000
Office Supplies		2,000
In-Country Travel		2,000
Miscellaneous Expenses		5,000
	Total	$ 26,000

DEPRECIATION SCHEDULE

	Total	Estimated Life-Years	1st Season Depreciation
Irrigation Equipment	540,000	30	$ 9,000
Water Distribution System	770,000	30	12,800
Farm Compound Buildings	816,000	30	13,600
Farm Machinery	338,000	7	24,100
Fencing	387,000	20	9,700
			$ 69,200

8.3 ANNUAL RETURNS FROM OPERATIONS - GROSS

1ST SEASON
(Based on "minimum expected" yields and markets)

500 Hectares Groundnuts

Expected Yield	=	3.5 Metric Tons/Hectare
Expected Price	=	$ 1,000/Metric Ton - CIF Europe
Total Expected Return	=	$ 1,750,000

- -

1ST FULL YEAR OF PRODUCTION - GROSS
(Based on "minimum expected" yields and markets)

2,000 Hectares Wheat

Expected Yield	=	4.0 Metric Tons/Hectare
Expected Price	=	$ 260/Metric Ton - Domestic
Total Expected Return	=	$ 2,080,000

1,000 Hectares Castorbeans

Expected Yield	=	1.5 Metric Tons/Hectare Oil
Expected Price	=	$ 1,400/Metric Ton - CIF Europe
Total Expected Return	=	$ 2,100,000

2,000 Hectares Cotton

Expected Yield	=	1.485 Metric Tons/Hectare Lint
Expected Price	=	$ 1,760/Metric Ton - CIF Europe
Expected Yield	=	1.65 Metric Tons/Hectare Seed
Expected Price	=	$ 200/Metric Ton - Domestic
Total Expected Return	=	$ 5,887,200

1,000 Hectares Groundnuts

Expected Yield	=	3.5 Metric Tons/Hectare
Expected Price	=	$ 1,000/Metric Ton - CIF Europe
Total Expected Return	=	$ 3,500,000

TOTAL EXPECTED RETURN FOR YEAR = $ 13,567,200

8.4 ANALYSIS OF RETURNS (PROFIT AND CASH FLOW)

1ST SEASON
(Based on "minimum expected" yields and markets)

Returns from Operations - Gross	
500 Hectares	$ 1,750,000
Costs of Operations	
500 Hectares	701,250
NET PROFIT	$ 1,048,750
Net Profit	$ 1,048,750
Add Back Depreciation	69,200
Total Cash Flow	$ 1,117,950

- -

FIRST FULL YEAR OF PRODUCTION
(Based on "minimum expected" yields and markets)

Returns from Operations - Gross	
3000 Hectares	$ 13,567,200
Costs of Operations	
3000 Hectares	7,153,340
NET PROFIT	$ 6,413,860
Net Profit	$ 6,413,860
Add Back Depreciation	1,194,300
Total Cash Flow	$ 7,608,160

Notes:

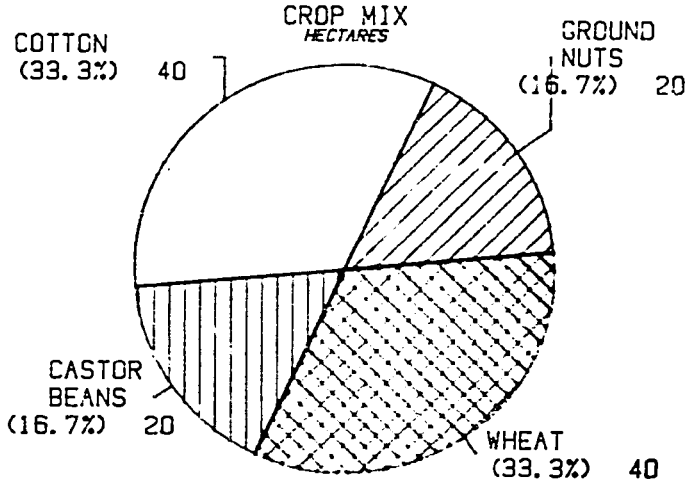
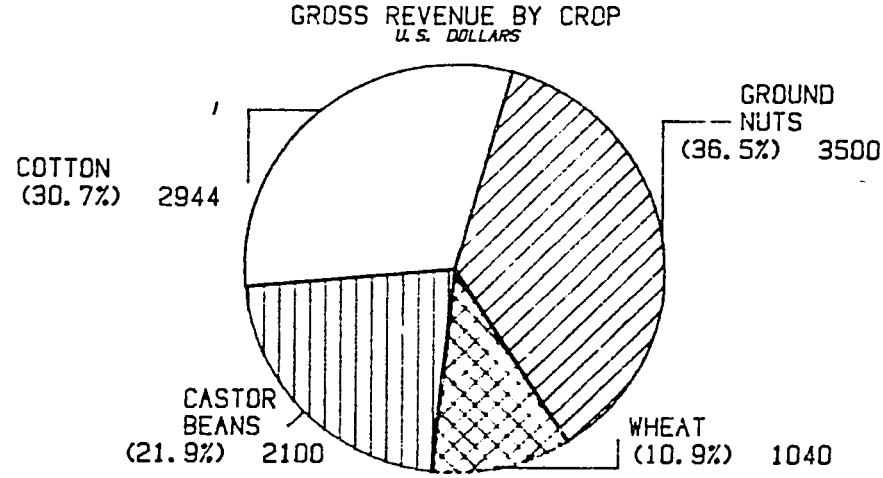
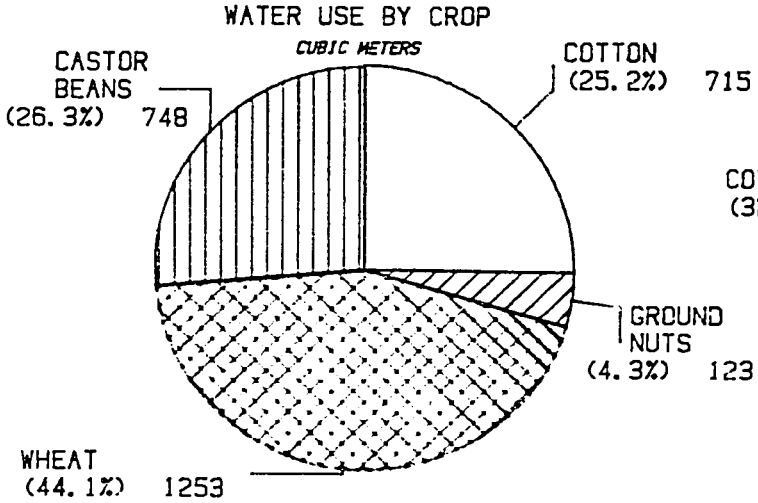
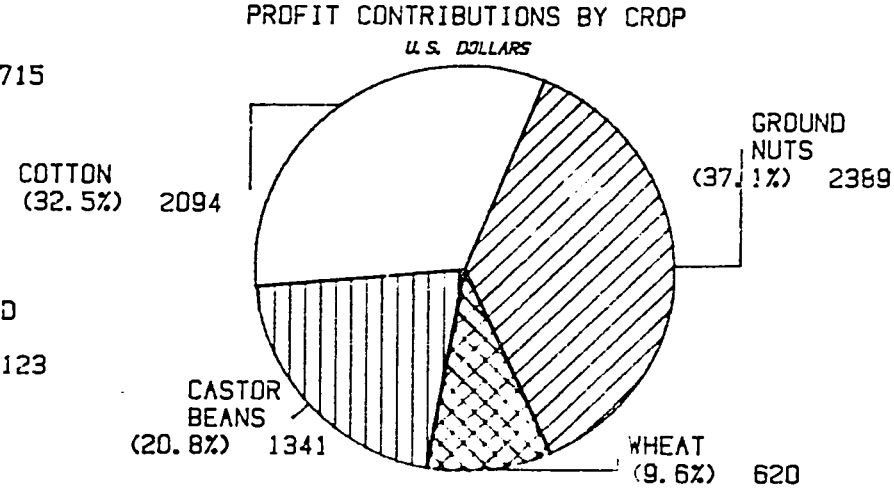
1. Above shows costs based on minimum management fee only. Actual management fee may be higher depending on incentive payment of management contract.

2. The above summary is considered to reflect minimum expected cash flows and profits for the following reasons:

   a. The most conservative estimates of costs of production and prices recieved have been used,
   b. Yields will be expected to increase after one year of operating experience,
   c. Purchase of inputs are in all cases based on the least favorable Dollar/Kwacha exchange rate,
   d. Additional higher income specialty crops will be produced after the initial two year startup period.

PROJECT CASH REQUIREMENTS

Land: 10,000 Hectares (by New Ag Zambia, Ltd.)

Development Costs		$ 22,615,850
Operating Capital		
1st Season	$ 555,350	
2nd Season	1,597,070	
Operation and Maintenance	102,500	
Personnel	124,475	
Training Program	51,000	
		2,430,395
Contingency and Inflation		1,400,000
TOTAL PROJECT CASH REQUIREMENT EXCLUDING LAND		$ 26,446,245

GRAPHICS SUMMARY