OILSEED PRODUCTION AND PROCESSING SECTOR ANALYSIS

COOPERATIVE AGRICULTURE AND AGRIBUSINESS SUPPORT PROJECT
UGANDA

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TABLE OF CONTENTS

		Page Number
I.	THE OILSEED AND EDIBLE OIL INDUSTRY IN UGANDA.....	1
	A. Introduction.....	1
	B. Major Findings.....	3
	C. Recommendations.....	6
	D. Background.....	11
	E. Current Status of the Edible Oil Industry....	15
	F. Edible Oil Processing Equipment and Procedure.....	16
	G. Particular Processing Concerns in Uganda.....	20
II.	DEMAND FOR EDIBLE OIL.....	21
	A. Domestic Demand.....	21
	B. Regional and Export Demand.....	28
III.	THE SUPPLY OF EDIBLE OIL.....	32
	A. The General Cropping Situation.....	32
	B. The Production of Oilseeds and Oil Bearing Crops.....	38
	C. Stimulating Oilseed Production.....	42
	1. Smallholder Oilseed Production.....	42
	2. Semi-Mechanized Small and Medium Sized Farms.....	46
	3. Large Commercial, Fully Mechanized Operations.....	47
	D. Land Clearing.....	48
	E. Capital Investment in Machinery and Equipment	51
	F. Summary of Mechanized Schemes.....	52
IV.	SPECIFIC OILSEED CROPS.....	54
	A. Sunflower.....	54

1. Background and Exports..... 54
2. Production..... 54
3. Yields..... 55
4. Economics of Production..... 55
5. Agronomy..... 56
6. Processing..... 56

B. Soybeans..... 59

1. Introduction and Production..... 59
2. Agronomy..... 60
3. Markets..... 60
4. Economics..... 61
5. Composition..... 61
6. Processing..... 62
7. Trypsin Inhibitor..... 62

C. Groundnuts (Peanuts)..... 66

1. Production..... 66
2. Yields..... 66
3. Markets..... 67

D. Simsim (Sesame)..... 69

1. Production..... 69
2. Agronomy..... 69
3. Yields..... 69
4. Processing..... 70

E. Oil Palm..... 71

V. THE OIL PALM..... 72

A. Introduction..... 72

B. Plant Genesis..... 75

C. Natural Conditions for Production..... 76

D. Propagation..... 77

E. Crop Production..... 79

F. Harvest, Handling and Transport..... 85

G. Extraction of Oil..... 87

H. Refining Palm Oil..... 89

I. Fractionation of Palm Oil..... 91

J. By-Products of the Oil Palm Industry..... 92

VI. COTTON..... 95

A. Introduction..... 95

B. History of Cotton Production in Uganda..... 96

C. Government Intervention in the Industry..... 105

D. The Decline and Re-Stimulation of Cotton Production..... 110

E. The Development of the Edible Oil Industry... 112

INDEX..... 118

ANNEXES

1. FORMER, OPERATING AND PLANNED OIL MILLS..... 125

List #1 - List of Oil Mills (taken over from Asian Owners in 1972..... 127

List #2 - Oil Mills that are Newly Established or will be in the near future..... 146

List #3 - Names, Locations, Date of License and current status of Oil Mills in Uganda..... 153

List #4 - Names, Capacity and Locations of small- and medium-sized expellers..... 155

2. MACRO AND TRADE DATA..... 156

Table A2.1 - Exports and Exports of Cotton and Coffee 1925-1965..... 157

Table A2.2 - Macro Economic Data..... 158

3. Table A3.1 - Crop Production 1957-1987..... 160

4. Table A4.1 - Farm Machinery and Tractor Costs..... 164
Table A4.2 - Sunflower Production Costs..... 165
Table A4.3 - Maize Production Costs..... 166
Table A4.4 - Simsim Production Costs..... 167
Table A4.5 - Soybeans Production Costs..... 168
Table A4.6 - Cotton Production Costs..... 169

LIST OF FIGURES

PAGE	FIGURE NUMBER	TITLE
23	1	Uganda's Trade 1925-1965
25	2	Real Disposable Income 1963-1987
26	3	Receipts from Non-Factor Services 1970-1980
28	4	World Production of Major Vegetables and Maize Oils 1988/89
29	5	Export (of Major Oils-World) as a Percent of Production 1988/89
29	6	Percent Share (of Major Oils-World) of World Exports 1988/89
30	7	Annual Average Vegetable Oil Prices-Rotterdam Markets 1979/80 - 1988/89
31	8	annual Averag Vegetable Oil Prices U.S. Markets 1979/80 - 1988/89
32	9	Uganda Cotton Production (Hectares) 1957-1970 and 1978-1987
33	10	Uganda Cotton Production (Baled Lint) 1957-1987
34	11	Uganda Crop Production (hectares) Millet, Sorghum, Maize
35	12	Uganda Crop Production (Hectares) Bananas
36	13	Uganda Crop Production (Hectares) Sweet Potatoes and Cassava
37	14	Uganda Crop Production (Hectares) Pulses
52	15	Land Clearing Costs
96	16	Uganda's Trade 1925-1965 (Ag/Trade, Cotton %, Coffee %)

LIST OF TABLES AND ANNEXES

PAGE	TABLE NUMBER	NAME
22	1	Per Capita Edible Oils Consumption in Uganda 1960-62 - 1973-75
45	2	Labor Requirements for Seasonal Crops - Uganda
49	3	Owning and Operating Costs per Hour (Catipillar)
50	4	Cost per Acre for Land Clearing
54	5	Sunflower Exports 1958-1979
57	6	Oil Content Analysis of Oil Bearing Seeds Sampled at Various Locations in Uganda During Period--Feb. - april 1979 (Sunflower)
58	7	Sunflower Samples From Uganda From USAID Project (Nov. 20, 1989, Oil Analysis)
64	8	Analysis of Wole Soybeans, Extrudate and Press Cake Obtained From 2YB-78 Oil Expeller (U.S.)
66	9	Mean Yield in Groundnut Troils in the First Rains of 1961-63 (Uganda)
67	10	Exports of Groundnuts from Uganda 1961-1965
83	11	Exports of Nutrients by Mature Palans
93	12	Palm Oil Meal (Chemical Composition)
93	13	Nutrient Analysis of Palm Oil Meal
96	14	Uganda's Cotton Production in Bales of 400 Lb. of Cotton Lint (1910-1965/66)
102	15	Number of Tractors Used in Uganda for Agriculture (1950-1967)
103	16	The Expansion of Group Farms

UGANDA OILSEEDS, JULY 10, 1989

CHAPTER I. THE OIL SEED AND EDIBLE OIL INDUSTRY IN UGANDA.

A. Introduction:

This study of the edible oil industry in Uganda was initiated to help determine ways in which to reinvigorate the industry and find the means by which the edible oil requirements of the country could be met from domestic resources. The industry developed, for the most part, in the period after the Second World War when the need for edible oils was high, and the East African states of Uganda, Kenya and Tanganika were integrated into an economic community. By the 1960s Uganda was producing edible oil for her domestic market and exporting sizable quantities to the other East African states. Uganda was also exporting substantial quantities of oil meal and some oilseeds, mainly groundnuts, to the European markets. The base of the edible oil industry at that time was the crushing of cottonseed in a number of oilmills throughout the country.

The edible oil (as well as soapstock) needs of Uganda are currently being met, for the most part, by imports. There was an assumption that one of the main constraints to an increased supply of domestically produced edible oil was the poor condition of the processing facilities in Uganda. The low utilization of existing edible oil processing facilities was suspected to be mainly due to the mechanical condition of the equipment and machinery resulting from poor maintenance and lack of spare parts. There was also some concern that the machinery was obsolete. Hence, the main thrust of the study was initially to determine the most appropriate method of rehabilitating the existing facilities to ensure a greater and more consistent supply of edible oil.

The original scope of work called for visiting the processing facilities, determining to what extent selected plants needed rehabilitation, specifying which equipment, replacement parts or additional plant and equipment would be required and undertaking economic and financial analyses of the selected facilities and determining their viability after rehabilitation.

The initial visits and investigations of the facilities by the team revealed that the shortage of locally produced edible oil was not due to the inefficiency of the facilities and the state of their mechanical equipment but rather to the non-availability of oil-bearing seeds to process. Although most of the edible oil mills could certainly use refurbishing, even in their current condition they are capable of processing what little oilseeds are available to crush.

This situation was discussed with A.C.D.I (Agricultural Cooperative Development International), U.S.A.I.D. (United States Agency for

Interanitonal Development) and the C.A.A.S. (Cooperative Agriculture and Agribusiness Support) Project staff. It was subsequently decided to undertake a more comprehensive review of the edible oil industry and make recommendations on the most feasible measures to be taken to enhance the edible oil industry as a whole. This would be directed on measures that would progressively expand production of oil seeds, and processed oil and cake to aim at self-sufficiency of edible oil in Uganda.

B. Major Findings:

1. The edible oil industry is currently not facing a constraint of lack of capacity in the processing industry. Although the mechanical and sanitary condition of many of the oil processing mills is not good, there are sufficient mills in reasonable enough condition to process any oilseeds available. In fact, even the better mills stand idle most of the time.

2. The major reason why Uganda is not capable of supplying its domestic needs for edible oil is a lack of oilseed production and therefore product to process.

3. Cottonseed will be able to supply only a small portion of the oilseed requirements in Uganda over the next several years. This will be true even with a large increase in cotton production. Other oil bearing product sources will have to be developed if local requirements of edible oil (as well as oil for soap production) are to be met with domestic production.

4. Sunflower currently appears to be the best oilseed to promote for the supply of edible oil, particularly in the short term. Further work in research and testing are needed, and the crop will have to be promoted among the farmers.

5. There would appear to be good potential for increased production of soybeans. Increasing production substantially, however, will require some mechanization. A further problem is the need to adjust processing to inactivate the trypsin inhibitor[1] present in soybeans.

6. Oil palm is the most logical vegetable oil to develop for the long term as a source of both edible oil and soap stock for the country. Uganda currently has hybrid varieties[2] of oil palm in production at four locations. The production from some of these varieties is good, and efforts should be aimed at multiplying these cultivars. A major advantage of oil palm over other types of oil bearing product is that management and care of oil palm plantations are less limiting than is the

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1 The trypsin inhibitor acts as a growth inhibitor in some animals and humans.

2 The term "hybrid" may not be exactly correct, but was reported as the varieties imported into Uganda. The actual varieties are unknown, and the extent to which hybridization is important to plant reproduction is uncertain. See our section on Oil Palm.

case for annual oilseed crops. The major constraint in oil palm establishment is the five year investment period required before initial production of oil.

7. Other crops that can contribute to edible oil production are sesame and groundnuts. These two will have to be justified economically relative to their use for direct consumption as food. Problems related to the handling and processing of groundnuts to prevent aflatoxin[3] infection will have to be solved.

8. Taking all the oil bearing seeds (the surplus of cottonseed over planting requirements, all the sunflower, simsim and soybean) currently available for processing, gross raw product would not exceed 20,000 tons per annum. At most, this could provide about 2,500 tons of oil. If most of the soybeans are exported under the barter program over the next few years, the real potential would drop to only one-half this amount.

9. The current capacity of the oilseed processing industry is made up mainly of the older, formerly Asian owned, mills with a capacity of about 400 tons per day of cottonseed or 250 tons of other oilseeds. This capacity is now dormant but could be at least 70% operational within a few days with minimal rehabilitation costs. This potential capacity represents a requirement of 100,000 tons per year of cottonseed or 62,500 tons of other seeds.

10. In addition to the old mills, there are private firms and cooperatives whose investment plans include about 260 tons per day of oilseed processing capacity.

11. There are several small, private owned oilseed mills that are processing seeds like sunflower, and some of these have plans for expansion.

12. A major constraint within the industry in Uganda is the lack of training and experience in almost all aspects of oilseed production and processing. This includes factory operations and management, economic and financial management and analysis, factory maintenance and mechanical operations, laboratory analysis and handling of finished product, and the physical and economic elements of oilseed production.

13. There is a fairly keen interest in the production of oilseeds among farmers in some areas of Uganda. One of their main concerns is the relative certainty of a market for their crop.

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[3] Aflatoxin is produced by the fungus Aspergillus flavus.

If some assurance can be given farmers that a market will exist with a reasonable price, production will begin to expand, especially for crops like sunflower.

14. Availability of seeds of sunflower and soybean are not certain, and this problem will have to be addressed in any effort to expand oilseed production. Private sector efforts in this regard will most likely be the most efficient method of providing planting materials.

C. RECOMMENDATIONS:

After reviewing various options that the government of Uganda, USAID Kampala and other donors might take relative to the oilseed and edible oil industry in Uganda we make the following recommendations:

1. Concentrate efforts on the support requirements of the industry. In this case we would explore the costs and requirements for establishing a workshop that would (1) undertake repairs to existing mills and machines (2) manufacture spare parts for existing machinery (3) provide training in mechanics and operations of oilmills and oilseed processing machinery (4) provide management training for cooperative personnel or private individuals, including business and economic analyses and (5) offer technical support to the industry in general. Such a unit should also be capable of supporting other cooperative work such as coffee processing or cotton ginning, maize milling, etc.

   The questions of plant refurbishing, machine rebuilding, parts manufacturing, feasibility studies, economic and financial management, and training in various aspects suggests an option for development support to the industry. We would suggest consideration be given to creating a support center that would offer services to various entities in the industry, both private and cooperative. It would offer the following services:

   a. Undertake feasibility studies for entities that are interested in entering the industry on any level, including production, processing or marketing.

   b. Provide systems design, including factory layout, mechanical and engineering design, product flow design, environment and safety design and energy efficiency analysis.

   c. Provide financial and economic analysis for various clients as part of overall feasibility studies or as pre-feasibility studies. This would include financing and cash flow analysis.

   d. Undertake repair and refurbishing of machines and equipment for the industry.

   e. Undertake equipment modification for clients, or as part of "R" and "D" for equipment in the industry. Adapting equipment for local conditions.

f. Undertake management analysis and training.

g. Undertake general training in plant operations, equipment maintenance and repair, mechanics and machinists training, steam and boiler fitting and repair, and parts manufacturing and fitting.

The Support Center would consist of workshops for repair and manufacturing as well as rehabilitation of machines, engineering and design facilities, management and economic study centers, and an outreach support unit. The advantage to such a center, as opposed to the immediate rehabilitation of existing plant, is that it would have the flexibility to grow and adjust to the industry as it develops. It could support private, cooperative and public sector entities. It could also have the flexibility to offer support services to other industries, such as coffee processing, maize milling, or other food processing sectors.

Some larger firms have already committed to investments in new oilseed processing and others are repossessing old plant, and are planning rehabilitation work. Again, these firms do not always have clear ideas on all of the aspects of the industry, and one large private mill currently stands idle for lack of product to process. The support center recommended could become an important unit to assist these private sector entities. The center should be developed so that cost recovery becomes a central management modus operandi.

2. Leave the rehabilitation of the existing old mills to the private sector or those Cooperative Unions who have the supply of product to process that can justify the investment in a mill.

At the moment the most positive developments in the oilseed and edible oil industry appears to be the positive approaches and actions taken by the private sector. Although this would appear to be mainly the Asians, it is not restricted to them. One Ugandan, for example, operates a former Asian owned mill. Even should this person be required to return the mill to the former owner, she may still be interested and capable of developing another mill or building a new one. Other Ugandan private businessmen in the industry are interested in expanding further. They have enquired as to how we would consider assisting them. We need to study further the possible approaches that might be considered to assist these private sector people. A variant of the support system suggested above might be considered, along with either loan or foreign exchange assistance. The private sector initiatives of AID

under centrally funded programs as well as TA under projects such as PEDS (Private Enterprise Development Support) might be considered.

3. Build one new oilseed mill similar to the one that has been recently built for South Bukedi Cooperative Union. In this case, a mill could be designed for seed other than cotton in order to keep the cost down. The need for a cottonseed processing facility is less needed, as existing mills, particularly like those of Mahdavani, or the LMB mills at Iganga and Mbale have excess capacity and are already set up for cottonseed. For a new mill it would be more advisable to consider processing for the other oilseeds.

   The idea of establishing at least one more Cooperative mill (in addition to the one owned by South Bukedi) is to help to maintain a competitive market. That is, two Cooperative mills will provide an alternative market for farmers' oilseeds, and prevent any collusion in the marketplace on the part of the private sector. At the same time, the Cooperatives will be obligated to operate their mills at a high level of efficiency in order to compete with the private sector mills now being developed. Evidence suggests that in one or two cases in the past, the Asian mill owners did collude to keep the price of cottonseed down. In both of the cases, it appears that the overcapacity of the industry and the economic need for mill owners to increase volumes of seed through their mills caused the agreements on volumes and prices to disintegrate. In other words, like OPEC, they could not keep the agreements together. More than likely, any such future agreements would meet the same fate. However, it would be useful to insure that collusion did not occur by offering an alternative to the private millers facilities and market. Another mill of the size of that at South Bukedi Cooperative Union would allow the Cooperative sector to process as much as 20,000 tons of oilseeds per year, or from 2,000 to 6,000 tons of oil production. That should prevent any price fixing to occur, and offer comfort to those who generally assume that the Asians will work to fix prices.

4. Concentrate on small or medium sized expellers. This option would be to help Unions or their primary Societies to own and operate mills that have a low capital cost. At the same time this would offer a more certain and competitive market to small-holder farmers. In these cases, the idea would be to either (1) set up one of these expellers in a place where oilseeds like sunflower or simsim are now being produced or (2) develop a system whereby these expellers can be portable; able to go from place-to-place to process seed.

The most logical way to begin the promotion with the smallholder in oilseed production is to assure him of a market. Although there are some small private and church-related facilities, these can reach only a small group of farmers. Amongst these are private firms who have an interest in expanding their operations both with increased contract growing and increased investment in plant and equipment. Some Cooperative Unions have indicated an interest in oil processing, but few of these have thoroughly studied the problem, and in no case was a complete feasibility study done. This is also generally true among the smaller private firms.

5. Refurbish some of the old Rosedown or HEB expellers either for new oil mills or configure them as portable units. There are adequate numbers of old expellers in the country to crush all the oilseeds now being grown, or likely to be grown in the near future. Therefore, even in old and somewhat dilapidated factories, the machinery, particularly the expellers, can still be recovered and used. The main question would be the condition of the wear parts, and the cost of replacement of these or their refurbishment. Thus, the possibility of recovering at least a few old expellers from factories is viable. We make this recommendation to the private sector as well as to Cooperative Unions or Primary Societies that are interested in investing in oilseed processing. We believe the investment would be lower and significant amounts of foreign exchange could be gained. If the production of oil bearing crops increases in the country, there will be adequate time for further capital investments.

6. Currently there is a level of production of soybeans that could be significant in oil production as well as high protein cake for animal feed. The problem with soybeans is that they need to be processed slightly differently than some other oilseeds. Either they need to be put through an extruder or roasted, in either case they should be heated to ease the release of oil and to treat both the oil and the meal. The logical oilmill to handle soybean would seem to be the South Bukedi Cooperative Union's mill. To do so, the South Bukedi Cooperative Mill should be equipped to handle soybeans.

7. Another option, and one to be considered seriously, is to do nothing and permit the industry to develop on its own. This option obviously assumes that as oilseeds are available to process, the private sector will develop the facilities to do so. This does not necessarily imply that it will be only the Asians who will enter the industry. We have already met at least two African Ugandans who are active in oilseed processing and there are others reported to us who are or will be in this business. It probably does imply, however, that

little further expansion will occur in the government or cooperative sectors in oilseed processing.

8. USAID may also consider that the most logical intervention in this industry is in the production side. That is concentrating its resources on research and production of crops like palm oil, sunflower, soybeans, or sesame and not on the processing side. Once production begins to increase the processing side can be reevaluated.

9. Finally, a major effort be launched to test the development of oil palm on a large scale in the country. By this we mean acreage adequate to meet national needs for oil. Economic feasibility studies should also look at the regional market for exports of palm oil and palm kernel oil. The main efforts should be concentrated on the following:

   a. Review the work done at the four test fields, and making sure that these sites are refurbished so that good data can be collected and analyzed. This is a resource currently going to waste.

   b. Determine the financial and economic feasibility of developing oil palm on large and small scale plantations. Major consideration will have to be given to the impact of parameters such as interest rates on the feasibility of investment, and methods to overcome these. Low interest loans channeled through local banks for investment in the industry should be considered.

   c. Study the feasibility of establishing a nursery where plants of the best varieties now available in Uganda can be propagated. This study should look closely at the possibility of setting up a tissue culture center to do this. The feasibility study should also address the ownership, management and operational procedures for such a center. Similar centers in the most successful oil palm producing countries such as Malaysia are owned and operated by the commercial sector. A similar system might be the most feasible for Uganda.

D. Background:

The edible oil requirements of Uganda, prior to 1972, were met for the most part by the processing of cottonseed. The processing industry had grown up during the Second World War, and the post-war period. It was based on utilizing cottonseed, previously an unused by-product of the cotton lint industry. The lint industry, one of the oldest of the cash crop industries in Uganda, reached a peak production of about 465,000 bales of lint, of which almost 450,000 were exported. The cottonseed produced as a byproduct from the ginning of cotton was crushed in several oil mills around the country, reaching a peak national output of almost 18,000 tons of edible oil, of which 9,000 tons were exported, along with about 70,000 tons of oilseed cake. Only small amounts of other oilseeds were crushed. Estimates of other seeds crushed would put maximum quantities of groundnuts at 3,000 tons of shelled seed, sesame at 500 tons, and sunflower, before 1980, at 50 tons. Tiny amounts of shea butter and castor oil were also processed, and occasionally palm oil kernels imported from Zaire were processed.[4]

During the decade from the late 1950s to the late 1960s, most of the cotton ginning facilities were taken over from private Asian businessmen by the Cooperative Unions. Cottonseed continued, however, to be processed for oil and cake in private Asian owned oil mills. In 1972, after the Asians were expelled from Uganda, the oil mills were effectively "nationalized", and allocated to private Ugandan "businessmen." The processing of edible oil declined drastically, and in 1974 the remaining oil mills were allocated to the Lint Marketing Board.

Although the LMB made an effort to operate the oil mills, production remained low. This was due to two major factors. First, some of the mills had been systematically looted by the businessmen to whom they had been allocated in 1972. Secondly, and more importantly, the cotton industry as a whole was in a precipitous state of decline. Cotton lint production dropped rapidly from 75 thousand tons in 1972 to 32 thousand tons in 1975. Production has never risen above 25,000 tons since. The level of exports of lint cotton was only 9,000 bales in 1988. This represents only 5,000 tons of seed cotton.

The decline of the cotton industry had several causal factors. Prices of cotton were low relative to other crops, government increasingly taxed the industry, allocations of foreign exchange needed for supplies and spare parts were not forthcoming, trucks, tractors and machinery broke down or were commandeered by the

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[4] Personal discussions with former mill owners.

military, programs in research, extension, seed multiplication and insect and disease control were underfunded and in some cases stopped entirely, and farmers sabotaged government efforts to increase production.

Prior to 1972, cotton was grown primarily on small holder farms. Peasant farmers with 1.5 to 3.0 hectares of land holding would devote 1/4 to 1 hectare of their crop land to cotton production. In some areas, such as Teso district, holdings were sometimes larger, supported by a major effort to promote ox ploughing. Ox ploughing became fairly widespread throughout much of the cotton growing region of the East and North. After 1972, unable to get necessary veterinarian medicines, most farmers lost their oxen. This was exacerbated with the theft and slaughter of remaining animals by armed forces and rebel groups in the 1970s and 1980s.

With the loss of government and private tractor hire services, and the death of most of the oxen, the peasant farmer was left with the hoe as his sole means of cultivation. With limited amounts of labor, made more serious due to the loss of migrant laborers from neighboring countries, who refused to come to Uganda due to security concerns and the declining purchasing power of the Ugandan shilling, the farmer had to set priorities on his efforts. As food prices rose in an uncontrolled market and real cotton prices fell in a government controlled market, the farmers naturally switched away from cotton. Increasingly, in the 1970s and continuing to the present, "food crops" took on the stature of "cash crops" to the Ugandan farmer. Matoke,[5] maize, rice, and beans were competing successfully for the farmers' limited labor. Their prices were relatively higher than cotton, and were more inflation proof, and they offered security in that they could be eaten when the market failed.

Even with these adverse conditions, farmers still continued to produce some cotton. However, these efforts were further frustrated when the entire marketing system failed. Farmers were often left with their cotton crop on their farms or in primary cooperative societies, and could not get paid for the crop. Even when the cotton did reach the gins it often was left unginned or stored at Union's gins after baling. Cotton that was shipped was often not paid for, and when it was, there were occasions of Union officials absconding with the funds. The entire situation since 1972 has left farmers and primary societies discouraged and not favorably disposed to continue with cotton production.

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5 Matoke is the Uganda term for cooked bananas and the large bananas used for the staple in the Lake region.

UGANDA OILSEEDS, JULY 10, 1989

Because of about 15 years of chaos and decay in the cotton industry, little oil has been forthcoming from cottonseed. The chances of cotton regaining its position in terms of gross production are not very good. Even knowledgeable observers have put an optimistic level of production as 150,000 bales of lint per year.[6] Even this will require a 15 fold increase over current levels, which seems optimistic indeed in the short-run. This level of lint turnout would require a production level of 83,250 tons of seed cotton, which in turn would yield about 55,775 tons of cotton seed. After subtracting seed requirements, only about 42,000 tons of seed would be available for processing, and no more than 3,000 tons of oil could be expected as a yield.

Although Uganda has produced other oilseeds, namely groundnuts, sesame, soybeans and sunflower, these have either been in limited quantities or destined for other markets than processing. Groundnuts have been a traditional food source, used commonly in preparing local dishes or for confectionery consumption. Sesame ("simsim") is used in local preparations and occasionally used to extract oil in artisanal manners (i.e., pounding and adding boiling water, for example). Soybeans are difficult to process without solvent methods, and are now processed only by extrusion for soya foods, or exported. In order to process soybeans through the existing expellers, the trypsin inhibitor in the seed has to be destroyed to make the product fractions (oil and cake) edible. This must be done by raising the temperature of the seed to about 140 degrees C. Modifications to existing plants would be necessary to accomplish this. In any case, total production of soybeans has never exceeded 10,000 tons in recent years. Sunflower is the one oilseed currently being processed on a semi-commercial basis, but national production remains low.

Oil palms, imported from the Ivory coast in 1971, have been growing in Uganda since 1972 when they were planted out at four locations in the country. There are 8 hybrid varieties[7] at these locations, of which three are doing very well. These palms have been producing since 1977, and even with little care and the crudest of extraction

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6 We acknowledge that some of the Ugandan technicians assured us that the country would soon be back to 450,000 bales of lint exported. However, these were few, and generally were made by people very closely associated to the cotton industry. Regional cooperatives generally did not agree.

7 The term hybrid was used by Dr. Israel Kibirige-Sebunya. It is unclear if these trees were true hybrids. The tenera is a palm that is a cross of the pisifera and dura varieties, and may have been the type imported.

methods, the three best varieties yield one ton of oil per hectare. This is almost 5 times as much oil as is produced by the other oil bearing crops in the country. The major problem with oil palm is that it requires four to five years before the trees can be expected to bear oil. With current interest rates at 50%, this long gestation period will make it difficult to economically justify the investment. However, for meeting individual household demand, oil palm could be the most reliable product among the oil producers. First, it is self pollinating and therefore a single tree can be planted by a household. Second, it produces oil more or less continuously all year. Third, it requires little care once it has been established. And finally, extracting the oil is fairly simple and requires no sophisticated equipment. The drawback at the moment is that there is no nursery that produces seedlings for farmers.

E. Current Status of the Edible Oil Industry

Clearly the industry is in some disarray. The private sector is developing rapidly but without always having precise ideas of the direction it is taking. The LMB oil mills continue to be overly biased toward cottonseed processing, and are making no efforts to stimulate production of other oilseed crops. Their creation of a parastatal, the Edible Oil and Soap Industries Ltd, seems to have been both ill advised and premature. First, LMB has consistently lost money in oilseed processing, and creating a parastatal on the foundation of 15 years of financial losses will not rectify the situation. Secondly, the hope of interesting the Cooperative Unions in acquiring shares in the new company has not been successful, and no Cooperative Union seems inclined to join. Third, LMB created a company to process cottonseed for the most part, before they could assure their new company an adequate supply of product. Finally, The LMB did not possess the plant and equipment upon which their new venture was to rest. The return of the better plants to their former owners would leave EOSIL with the least efficient and most costly plants to operate. They would not be able to compete with the private sector.

On the other hand, the machinery that currently exists in Uganda is sufficient to process all of the oilseeds that are likely to be produced in the next five years. Although several reports and individuals have asserted that this equipment is "obsolete" or irreparable, neither judgement presents a clear picture. With the exception of solvent extraction, the technology of oil milling has not changed appreciably for many years.

F. Edible Oil Processing Equipment and Procedure.

All of the large scale oil producing mills in Uganda are designed to process cotton seed which was the main source of edible oil prior to 1972. The process stages consisted of:

1. De-linting to remove the short cotton fibers that were still attached to the seed. The value of these "linters" in many cases covered the cost of plant operations in processing the cottonseed. The delinters employed used saw tooth rolls.

2. De-corticating to crack the hull of the cottonseed and crush the kernel. This machine consisted of rotating cast iron discs or hard steel or iron rolls.

3. Screening separated the crushed "meats" of the kernel from the hull and any attached lint. The machine used consisted of a rotary drum screen which allowed the kernels to drop through to be transported to the expeller while the hulls passed through the end of the drum. The separated hulls and lint from the screen are usually used for boiler fuel.

4. Cooking of the kernel meats by adding live steam and indirect steam jacket heat to lease the oil in the oil cells prior to expelling. This is usually a multistage vessel usually mounted above the feed section of the expellers.

5. Expelling is the most important stage of the process because the mechanical condition and efficiency of this machine determines the amount of edible oil extracted from the oil seed. It also determines the quality of the pressed cake which in turn affects its value as an animal feed. The machine consists of a main rotating shaft with an interrupted screw flight configuration, an oil drainage barrel that has spaced hardened steel bars that are mounted parallel to the rotating shaft, a machine frame and a power driven transmission.[8]

The oil from the expelling stage has to be further processed in most instances (particularly with cottonseed oil) to make it acceptable for human consumption and consists of the following:

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[8] The description given here is for the normal commercial expeller found in Uganda. Generally the principles are the same for all expellers, though some small ones have slightly different configurations, and some large ones have pressure feeds or double screws.

6. Refining the oil. The oil is pumped from the expellers to a holding tank which is steam heated. The temperature of the oil is increased to approximately 100° C. and continually agitated to prevent settling of impurities. A caustic soda solution is sprayed over the heated oil at a strength and quantity determined by the free fatty acid analysis of the oil. The oil is then allowed to settle until the impurities separate by gravity. The relatively clean oil is then filtered using an earth clay to remove the dark color and a filter aid for filtration. The filtered oil is then de-odorized by heating to approximately 400° F. while being subject to a vacuum. The solids from the settling tank are removed and the caustic soda produced soap stock is pumped to the soap making stage.

7. Packaging the oil. The oil is now filled into 18 kg tin plate containers for sale to a wholesaler. The cake from the expelling stage is air cooled and bagged in 50 kg hession sacks.

The present and future needs of edible oil in Uganda will be achieved using other types of oil bearing seeds in addition to cottonseeds. These will most likely include sunflower seed, sesame (simsim) seed, groundnuts and possibly soybeans.

Fortunately, all of these oil seeds can be processed in the existing oil mills and in most cases with fewer process stages. Even in the case of palm oil, the processes are similar, and the screw expeller is commonly used to extract oil.[9] The sunflower, simsim and groundnuts are much higher oil yielding seeds than cottonseed, and the oil, after sterilizing and filtering, is an edible oil. Deodorization may need to be done if the flavor and order of the oil is unacceptable.

In the case of soybeans, the most important stage in the process is raising the temperature of the soybean before or during the expelling stage to destroy the trypsin inhibitor in the bean to make it acceptable for consumption.[10]

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[9] The processing and refining of oil palm are briefly discussed in the section on Oil Palm.

[10] This is discussed in the section on soybeans.

The process stages required for these additional seeds are as follows:

1. Cleaning to remove stones, dirt, sand and other foreign matter that can adulterate the oil or cake or cause damage or excess wear to processing equipment. This is done by screening and winnowing, usually with a gravity separation table and aspirated screen.

2. Crushing or rolling. Sunflower seed is usually de-corticated by using a rotating iron disc machine which cracks the brittle hull of the seed and exposes the soft oil-bearing kernel for heating.

   Simsim or sesame is usually flaked in a multi-hardened steel or iron roller machine. This exposes the oil cell structure of the seed and makes it more receptive to heating.

   Groundnuts are granulated by using a hammer mill which also increases the seeds heat absorbing capacity.

   Soybean can be granulated the same as groundnuts.

It should be noted that this stage can be eliminated as is usually the case in small, single-stage expeller operations, or in larger mills where excess capacity for processing exists. This is because these oil mills have the ability to process the seeds more than once through the expeller if oil extraction is not efficient in one pass. If this stage is not done in the processing of these seeds, it does affect the efficiency of the expelling stage. By not exposing the oil bearing portion of the seeds the heating of the oil cells is retarded. Additionally it reduces the pressing efficiency of the expeller because of the voids that exist between the round shape of the seeds when they first enter the expeller's seed zone. Therefore, a percentage of the expeller's capacity has to be used to crush the seed and eliminate the voids before pressure can be applied to the oil cells to extract the oil.

3. Expelling. The same internal screw flight and drainage barrel configuration can be used to expel the oil from all the seeds mentioned.

4. Refining. The oil from the expeller need only be heated to dry and sterilize, then filtered before packaging for sale and consumption. In some areas, flavor and odor may have to be processed out for consumer acceptance.

5. Packaging. The oil is put into containers and the cake packaged as with cottonseed cake. With respect to groundnuts

and soybeans, the cake from these seeds may be used for human consumption, consequently, a further processing stage may be necessary.

6. Grinding. If human food products were to be made from the groundnut or soybean cake, it would be necessary to reduce the cake to a flour. This will require grinding to meet whatever particulate size is required for the cake's designated use.

G. Particular Processing Concerns in Uganda.

The expeller uses a very old principle of engineering physics to extract oil, based on the use of an Archimedes screw flight inside a stationary cylindrical drainage barrel. The rotation of this screw creates a progressively increasing pressure on the material in this barrel section by forcing material through a variable restricted discharge opening called a "choke." This pressure causes the fluid oil to be extracted from the material being processed. Within this part of the machine, along with the gears that drive it, are found most of the "wear" parts of the expeller. There is basically no difference in the design of the "old" expellers in Uganda from the newly manufactured expellers. Only slight increases in efficiency of plant can be obtained from the newer machines. The main question of efficiency comes from the condition of the wear parts in the expeller, and the preparation of the seed prior to entering the expeller.

The oil extracting efficiency and processing capacity are determined by the dimensional quality of the wear parts, the main screw flight shaft's rotational speed and the length of time the material being processed is under maximum pressure. Because of the importance of the condition of the wear parts it is essential that these be rehabilitated or replaced on a regular basis. Most of them are manufactured from carbon steel and cast steel that can be heat treated to provide wear resistant working surfaces. They can be manufactured, even locally, from chilled cast iron that surface-hardens when the iron is poured into iron moulds, or they can be manufactured from untreated steel and hard surfaced steel using special alloyed welding electrodes to create wear resistant surfaces.

The other parts of the old oil mills that are in various states of disrepair are auger conveyors, auger or bucket legs for elevating solid material, delinters and decorticators, necessary for processing cottonseed properly, and boilers and their associated steam pipework, and steam condensate recovery systems. In some cases electric motors are not operating, probably due to the low and variable voltage supplied to the factories, and oil or water pumps need to be replaced or repaired. None of this should present major difficulties to trained technicians.

CHAPTER II - DEMAND FOR EDIBLE OIL

A. Domestic Demand

The demand for edible oil has been estimated by several researchers. The range is from a low of 14,000 metric tons to a high of 40,000 metric tons, not counting requirements for soap manufacture. A thorough review of the literature, including urban budget expenditures in the late 1950s and early 1960s, as well as historical disappearances of edible oil in the period of plentiful supply, suggests a per capita consumption of about 1 kilogram per year. This means the current real demand (that is the amount of oil that would clear the market if supplies were available) would be about 16,000 metric tons per annum, if supplies were available at price ratios consistent with earlier periods. For high quality cooking or salad oil, most of this demand is unmet, except for some imported oils and fats or donated product.

There is little reason to suspect that edible oil consumption today would be any greater on a per capita basis than it was in the early 1960s. First, real incomes have actually fallen since the early 1960s. As we would expect the individual demand for oil to be positively related to income, a fall in income could even tend to reduce per capita demand for oil. Second, we would expect shifts in consumption toward edible oils as urbanization takes place. This is consistent with higher oil consumption in urban areas than rural areas as experienced in most other African countries. However, Uganda has not experienced a significant increase in urban dwellers in the past two decades. This has had to do with living costs, jobs, real incomes and security. Thus the pattern of rapid urbanization seen in other African countries has not occurred in Uganda. If this pattern should shift, then increased consumption of oil could occur.

The demand for oil for the production of soap is quite strong. There are several soap factories in Uganda, none of which receives adequate quantities of oil. However, it is probably safe to estimate that at least 30,000 tons of oil for the soap industry could be absorbed by the factories without any major decline in demand. Currently that demand is being met by small quantities of soap stock coming from the edible oil industry, by imported tallow, and by palm and coconut oils imported mainly from Southeast Asia.

Several estimates of past edible oil consumption have been made using historical data in Uganda. These have been used to project potential demand in the future. Rita Laker-Ojok calculated consumption figures for the period from 1960 to 1975 based on apparent disappearance (production plus imports minus exports) per capita. To smooth out annual data and help account for any

extraordinary stock changes (yearly carryovers or consumption out of previous year's stocks) she used a three year rolling average for annual estimates for the period as can be seen below.

TABLE 1

PER CAPITA EDIBLE OILS CONSUMPTION IN UGANDA
(3 year rolling average in kilograms)

Period	Consumption
1960-62	0.85
1961-63	0.84
1962-64	0.68
1963-65	1.00
1964-66	1.14
1965-67	1.12
1966-68	1.24
1967-69	1.25
1968-70	1.24
1969-71	1.18
1970-72	1.13
1971-73	1.24
1972-74	1.00
1973-75	0.61

Source: Rita Laker-Ojok, 1986.

Laker-Ojok, following the methods used by Coles in 1965, estimated demand from an FAO model using income elasticities of demand for edible oil at 0.5 and 0.95. She found that the population growth parameters overwhelmed the income impacts on demand. In other words, on the national level only population growth is significant in increasing the demand for edible oil. The caution here, of course, is that choosing an elasticity of demand is arbitrary, and Coles had chosen elasticities from studies done in Kenya. Household budget or expenditure studies, or cross-sectional surveys on different income groups are not available, so constructing income elasticities of demand is impossible in Uganda at this time. However, based on these estimates from Kenya, Laker-Ojok arrived at a demand estimate for 1985 of from 14,551 to 14,903 metric tons of oil. The model seems to have been reasonably consistent in prediction of oil consumption in earlier years, when compared to actual disappearance of oil. The predictions for the 1970s and 1980s of course do not relate to actual consumption, as the market supply could not meet demand. That is, there was a physical constraint to demand rather than an economic one.

Some caveats need to be given here on this analysis. First, the elasticities may have been valid in the ranges of income and edible

oil prices with which the researchers were working at the time. They many not be valid at other incomes and prices. For example, with current inflation, edible oil prices have risen in the past month (March-April 1989) in Kampala from about 550 shillings per liter to over 800 (2500 per 3 liter container). If this continues, the price of oil may become such a luxury item that per capita consumption for the average Ugandan will approach zero. In other words, the price elasticity will have gone off the functional part of the scale. By the same token, the general price rise is having the effect of eroding the real income of Ugandans. A continuing decline in real incomes could reduce consumption except for those items that are absolutely essential. The extent to which edible oil is considered an essential commodity is not known, but the low levels of consumption in the past suggests it could be foregone in the diet. Second, the price of oil is currently a function of the imported price. If domestic oil production rises so that it begins to approach current demand levels, the price should soften. It will do that up to the point where producers can still cover production costs. The real elasticities will then come into play. We will only know then if local tastes and preferences for foods remain as they were previously.

Assuming a normal relationship between consumption of edible oil and real income in Uganda, we can expect that current demand has softened from the past due to the unfavorable trends in the national economy. The World Bank[11] calculated the growth in GDP for Uganda from 1963 to 1970 as 4.8% per annum in 1966 prices. This implied a per capita growth rate of 2%. Savings was running at an average rate of 13%, which allowed an ambitious investment program from internal sources. This advantage allowed continued growth without excessive pressure on balance of payments and prices. Exports continued to cover the requirement for imports for

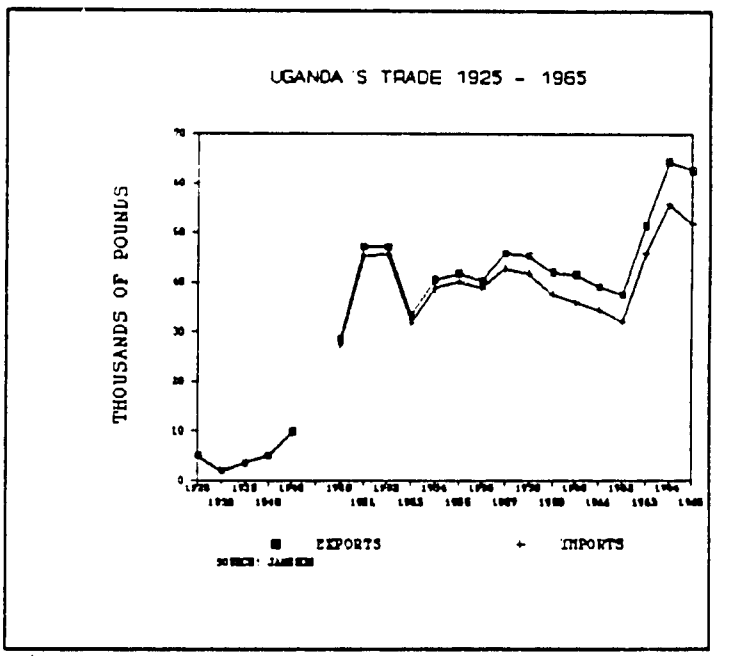

Figure 1

11 Uganda; Country Economic Memorandum, IBRD/The World Bank, 1982.

both investment and consumption. This positive balance of trade had long been the experience of the country. Data from as far back as 1925 show that Uganda had always covered imports with exports. As can be seen in Figure 1 the positive trade picture was increasing after 1953, and by the mid 1960s fairly large trade surplus were the norm. The country was not only self sufficient in food production, but was exporting foodstuffs to neighboring countries. The main export crops, coffee and cotton, were supplemented increasingly by exports of sugar, tobacco and tea. In the mining sector, copper and phosphates had developed as small but significant exports.

At the end of the 1960s, some ominous trends were already taking place. Increasingly the government was looking toward the development of parastatals to take over the marketing functions of private firms. Already the cotton ginning had been shifted to the cooperative sector, eliminating that aspect of the industry from the private sector. But these trends may not have been enough to drag the economy down to the position it reached in the 1980s. The big factor was expelling all the Asians in 1972 and the virtual take over of all private industry by the government. Even parastals that had operated reasonably effectively, like the Lint Marketing Board, were forced to take on enormous new management responsibilities. Not only was LMB forced to take over and operate the oil mills, but they were also charged with the full marketing of lint, including export to the coast, functions that had been performed by the private sector. LMB was not alone. Tea plantations, livestock farms, sugar fields and factories, and scores of commercial real estate and manufacturing firms were absorbed by government firms and agencies.

The impact on the economy can be readily seen in the performance in the gross national product. After 1972 real per capita income takes a precipitous decline which clearly was the result of an incredible mismanagement of the economy. It is true that some exogenous factors, such as the steep oil prices increases in 1972 were contributing factors just as in other African countries. However, in no country on the continent does such a step and large drop in incomes occur. We have calculated real per capita income over the period 1963-1987 based on an average of the Kampala cost of living and population figures from census data and government estimates. These data are shown graphically in Figure 2. What they suggest is that the Ugandan consumer has lost so much purchasing power over the past 15 years that it would be virtually impossible for him to retain the same demand that he had in the pre- 1972 period. With that in mind, we present some further estimates of what demand might evolve to based on prior estimates.

In the development of the Second Five Year Plan, an economic model was utilized to predict expected demand for edible oil. The demand

for oils and fats was expected to rise to between 11,000 and 12,500 tons by 1971, which was on target in terms of apparent disappearance of 12,281 tons for 1971. For 1981, projections were that consumption would rise to between 17,500 and 22,000 tons. Obviously these estimates could not foresee the collapse of the economy and the demise of the oil industry. Actual figures show apparent disappearance at 2,086 tons for 1981.

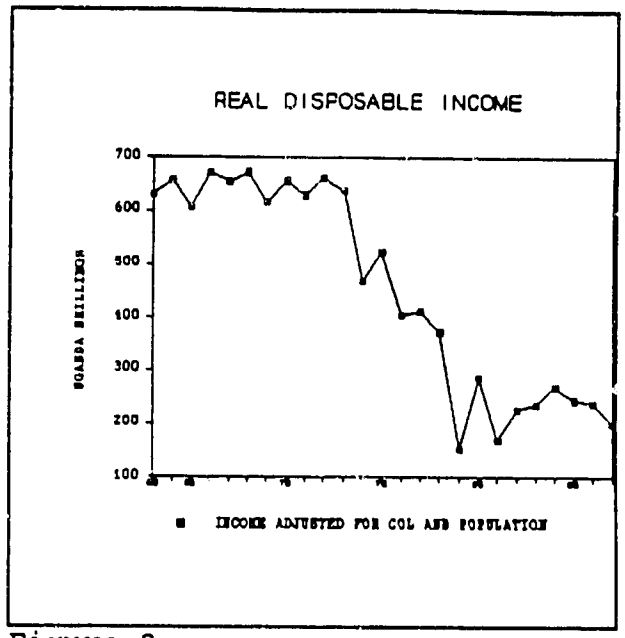

Figure 2

Another study,[12] gave current demand figures based on FAO estimates at 25,000 tons for 1983. The authors note that the EEC Food Strategy study of 1984 considered this an overestimate, because the FAO estimates for Africa did not take into consideration oils and fats consumed in different forms, mainly groundnuts in solid form and animal fats. These figures are based on an apparent demand of two kilograms per capita per year. Such figures show demand at 32,000 in 1988, 34,000 in 1990, 39,000 in 1995 and 43,500 tons in 2000.

Based on historical evidence, we would argue that these demand projections are overstated, and can only be achieved if oil is so abundant that prices fall greatly, or consumption patterns change, mainly by an increase in consumption of edible oils in the rural areas. Although this is a phenomenon that appears to be taking place, the extent and degree to which it continues will have to depend on a greatly increased production of oilseeds in the country (as opposed to cottonseed which needs more sophisticated processing) and the expansion of small oil processing facilities in those areas. Oil consumption has generally been higher in the urban areas, and changes in urban/rural ratios could affect consumption in the future. Currently only 1 city (Kampala) is over 500,000, 1 city (Jinja) over 50,000, and 6 (Kabale, Kabarole, Entebbe, Masaka, Mbara and Mbale) are over 20,000. This is a relatively low rate of urbanization in Africa. However, this rate was mostly the result of slow urbanization growth rates in the

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12 Coppee Courtoy/Agrer, Ministry of Ag/African Development Bank, Feasibility Studies on the Rehabilitation and Development of Seed Farms, Food Crops and Oil Seed Projects, Brussels Belgium, Jan, 1989.

1970s and first half of the 1980s due to a declining economic situation (low employment and high inflation) and insecurity (physical danger). A high rate of economic growth coupled with improved security could result in increased urbanization.

In reviewing the historical data from Laker-Ojok above, it is also important to realize that the pre-1972 data came from a different consuming population. During the 1960s, about 75,000 Asians and about 20,000 Europeans and other nationalities were permanent residents in the country.[13] These groups are much higher consumers of oil than the average Ugandan. With these numbers greatly reduced at present, edible oil consumption is less. Estimates of 10 to 15 kilograms per person per year of edible oil consumption by these groups would alone account for 1,000 to 1,500 tons of oil disappearance in the 1960s.[14] This demand is currently estimated to have been reduced to 200 to 300 tons per annum. Further, the tourist industry was much larger in the 1960s than is currently the case. Although records are not available for the entire time series on numbers of tourists and duration of stay, it is clear that at minimum 25,000 tourists were coming to Uganda annually in the late 1960s. Figure 3 gives some indication of this volume. Non factor income from tourism is given for the 1970-1980 period from IMF studies. It is clear from

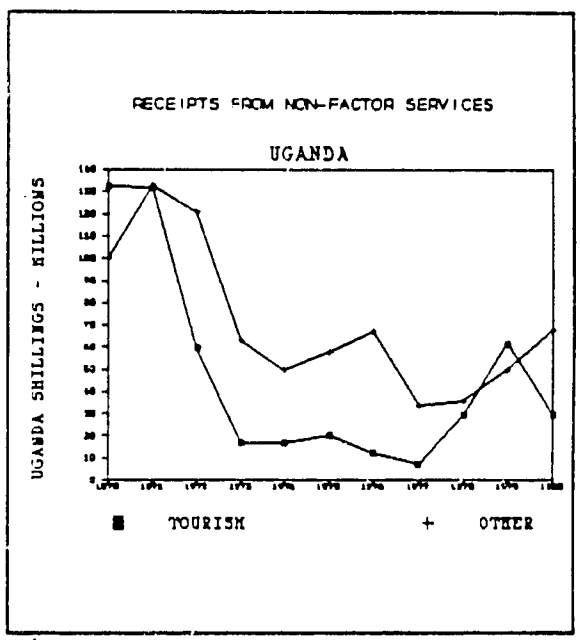

Figure 3

13 The 1969 census listed 74,308 Asians, 3,238 Arabs, 9,533 European and 5,302 "others."

14 Note that this level is not very high. In the U.S. the total consumption (or disappearance) of both visible and invisible fats and oils ranged from 125.4 to 130.8 lbs per person from 1972 to 1981. This, of course, also includes fats and oils that are thrown away, such as those used in deep fat frying, and incudes the "invisible" fats and oils in meats, dairy products other than butter, nuts, fruits and grain products. Visible oil consumption was about 52-55-57 lbs during this period. USDA data cited in Harry W. Lawson, Standards for Fats and Oils, AVI Publishing Co, 1985.

this data that tourism was considerably more important before 1972 than in the period of the 1970s. Today it is doubtful if total tourist visits exceed 5% of the pre 1972 figure. This however, is somewhat offset by the greater numbers of official visits made to Uganda than was the case previously. However, it will still represent a net loss in total visitor days of a high edible oil consuming group.

There have been only a few household expenditure studies done in the country, and most of these date from the late 1950s and early 1960s. Those studies of expenditures by wage laborers in Kampala, Jinja, Gulu, Fort Portal and Mbale suggest that monthly oil purchases ranged from a low of about 0.1 kilograms in Fort Portal (1960) to a high of 0.32 kilograms per month in Jinja. This would give an annual consumption (expenditure) range of 1.2 kilograms to 3.2 kilograms for urban wage earners. If it is accepted that urban populations consume greater amounts of edible oil than rural populations, it is probably fair to posture a physical demand of about 1 kilogram per capita per year. At the current population of about 16 million, this means a requirement of 16,000 tons of edible oil.

Such a level of consumption is consistent with the historical disappearance of oil given above. In terms of a projection of domestic demand it is conservative enough to plan production, after which a review will be necessary to determine if greater production will cause excessive softening of prices. It is safe to say at this point, that production of oil bearing seeds in Uganda will unlikely reach a level to produce this in the next 5 years. Should oil palm production be promoted on both large and small-scale farms, oil production could expand beyond this range. However, oil palm would serve as an excellent source of oil for the soap industry, which can absorb as much as 30,000 tons of oil. This would not be feasible with sunflower oil, where greater production amounts would probably have to be exported and cheaper fats and oils imported for soap production.

B. Regional and Export Demand

Prior to 1972, Uganda was a net exporter of edible oil and oilseed meal. The former was destined primarily for markets in the East African region, most notably Kenya and Tanzania. The latter was shipped mainly to Western Europe which had a high import demand for animal protein feedstuffs. Shipments of edible oil reached 6,000 to 8,000 tons in peak production periods.

The need for analysis of regional and international demand to support the vegetable oil industry in Uganda is presently not of critical importance. The likely production of oilseeds in Uganda, as is noted elsewhere in this paper, will not meet domestic demand for some years. However, if serious investments are made in the production of palm oil and palm kernel oil through establishment of oil palm plantations, then oil exports will have to be considered.

It would appear that current imports of edible oil and soapstock in the East African states bordering on Uganda will average 60,000 tons per year. It is difficult to obtain exact figures of imports due to unofficial shipments that go unrecorded in import data. It is also difficult to ascertain what overall demand would likely be due to restrictions on imports and scarcity of foreign exchange allocations in many of the countries in the region. Currently commercial imports of edible oil and soapstocks are palm oil, palm kernel oil and coconut oil from Southeast Asia.

Production of most of the oil bearing crops has been increasing rapidly over the last ten years. Figure 4 gives world production of the major non animal oils for 1988/89. As is evident the major share of production falls on a few crops, with soybeans leading, and followed closely by palm oil. Recent efforts by the EEC to promote production of vegetable oil has led to an increase in rapeseed oil to the point where it is currently equal to sunflower seed oil in world production. For any exports that might in the future be generated from Uganda, the competion changes from the order of production given in Figure 4. In world trade, the so-called tropical oils tend to show higher exported percentages than the temperate produced oils.

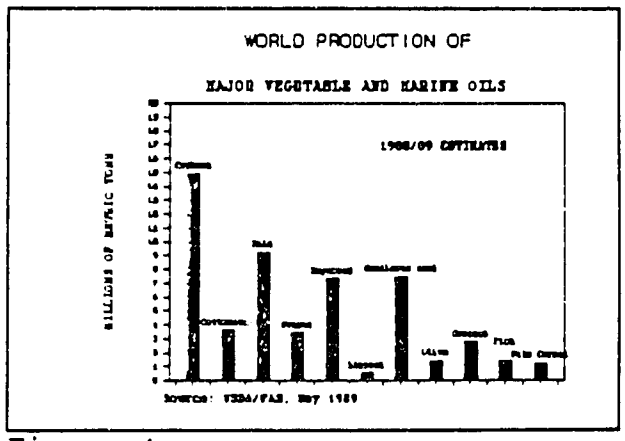

Figure 4

Figure 5 shows the percentage of each type of oil that is exported. As can be seen, with the exception of palm oil, less than 30% of the production of the major oils is exported. The large percentage of oils such as palm, palm kernel, and coconut are indicative of the high concentration of the production of those crops in Southeast Asia. The other oils are generally produced in regions of the world where per capita demand is either high or the per capita production is generally relatively low. India and Pakistan are examples of the latter, both of which produce large quantities of cottonseed, and India also is a high producer of peanuts. However, in both of these cases the countries still remain net importers.

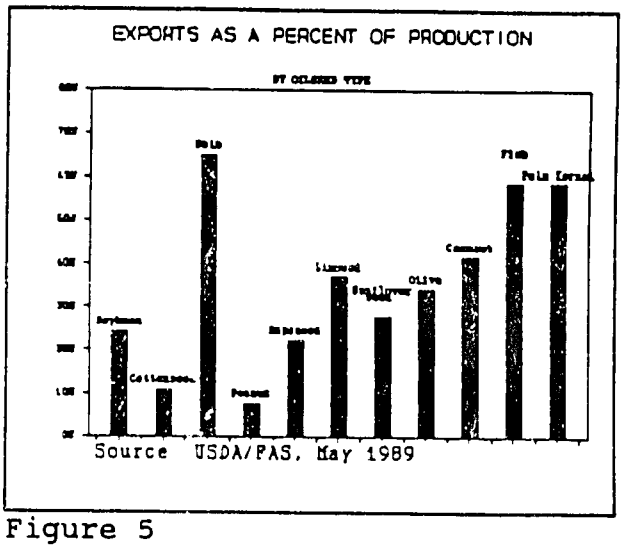

Figure 5

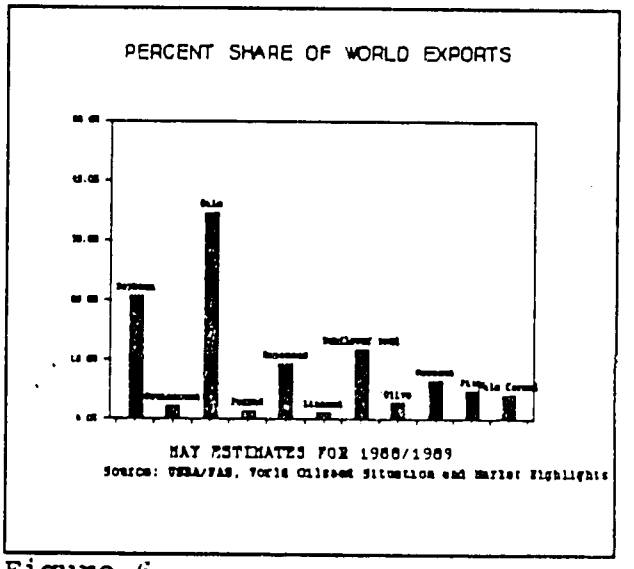

Figure 6

This breakdown of the percent of exports of these oils is more evident in Figure 6 where the percentage of the world's oil exports is broken down by type. Here it is clear how important palm oil becomes in world trade. Together with palm kernel oil, the oil palm contributes almost 40% of the trade oil.

The international oil sector tends to be heavily interdependant with very close correlations in prices between oil types and between regions. The price of most oils in the world market tend to follow each other quite closely due to the high interchangeability of most oils in manufacturing and food uses.

Figure 7 shows oil price movements in Rotterdam, the main price determining market in Europe. Although there is some price variation the movements tend to mirror each other, with perhaps the exception of peanut oil, which has tended to deviate from the

normal trends. This is probably due more to the low volume of production in recent years, and the fact that most producing countries are increasingly consuming their production rather than exporting. Certainly that has been the case in India, the major producer, and West Africa, where overall production has dropped in recent years, and domestic consumption has risen.

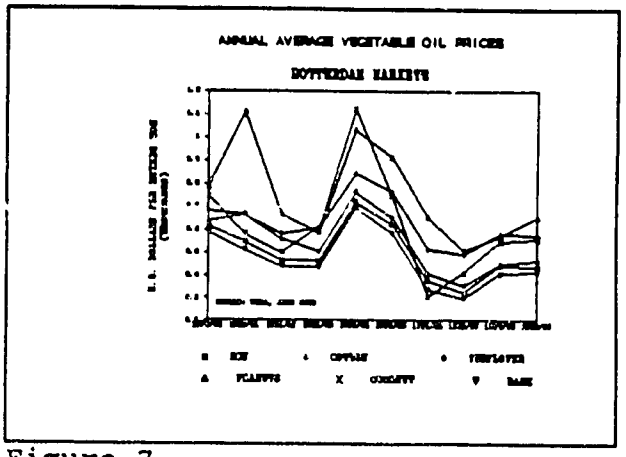

Figure 7

U.S. oil prices show similar patterns as can be seen in Figure 8. Again peanut oil prices tend to deviate from the general pattern. However, in the U.S. peanuts are consumed as confectionary nuts for the most part, and the crush for oil is small. Therefore, peanut oil prices will reflect almost exactly the international prices. Although it is important to understand the relationship of prices to overall production trends in the oil industry, other factors are also important in price determination. For example, the prices in the international markets are closely linked to international ocean freight rates. These may vary 100 to 150% from year to year. Major causes for these large fluctuations are general world economic conditions, international conflicts, disruptions in shipping lanes from such things as closing of canals or straights, etc.

If Uganda becomes an oil exporter, it will likely be looking at markets in the East African region. Given that the countries in the region are currently importing palm oil and coconut oil, these oils will represent the target oils in terms of quality and price for the exporter. Although it was beyond the scope of this study to investigate the regional oil market and the export possiblilities for Uganda, we should be able to make some comments.

First, there are a group of countries in the region that we can refer to as the "A" group in terms of market potential. These are countries bordering directly on Uganda: Kenya, Tanzania, Rwanda, Zaire and Sudan. For the foreseeable future we can eliminate Sudan due to the lack of effective demand, and in any case should stability return to the Sudan, she has a large supply of oil based on her cotton industry. Zaire is reported to have a considerable demand in the area nearest to Uganda, albeit, mainly serviced in unofficial cross-border trade. This market could be further developed due to the lack of supply coming from the west, a result of lack of infrastructure. The most important markets are still Kenya and Tanzania, both importers of oil and soapstock, and having the further attraction of being linked by rail. Rwanda's market is

small but solid, with a stable currency. It can be serviced by road, a route which will improve as road rebuilding proceeds.

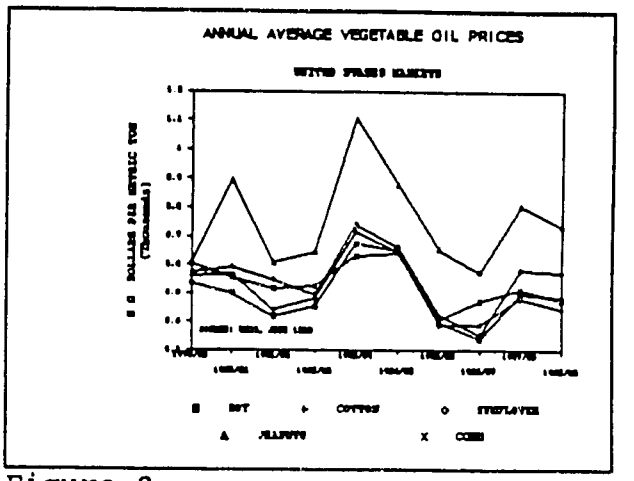

Figure 8

Outside of the "A" countries noted in the paragrapgh above, there are also a group of "B" countries which might offer some market potential. These would be Zambia, linked via Tanzania by rail, as is southeastern Zaire, Zimbabwe and Somalia. Zimbabwe generally has a good supply of oil from her own production. Zambia has some production, but not sufficent. Unfortunately she is financially not currently a good market target, although that could change. Somalia is linked only by road, or rail-sea through Kenya, and therefore Uganda probably would have a difficult time competing with oil delivered by sea.

To be competitive in these markets with supplies from Southeast Asia, Uganda producers will have to undercut Asian prices and offer equal quality. More important will be the need to be reliable as a supplier, and work out trade credits to get around foreign exchange problems. For the countries on the coast, this effectively means competing on a basis of internal East African transport costs versus ocean freigt costs from Asia.

Although the demand appears to exist within the region, at least for a quantity of oil and soapstock greatly exceeding what Uganda exported previously, the competion will be stiff. Malaysian producers vigorously promote their product and work extensively to develop their export markets. It will not be easy to compete with them on an ad hoc basis. A collaborative arrangement for large producers and refiners may be neccessary for Ugandans to penetrate the East African market after a 17 year hiatus. A producers organization that promotes the markets, insures quality standards and insures timely delivery of supplies would be advised. This organization should also undertake to provide research, and seed and nursery stocks to planters as has been suggested elsewhere in this paper.

CHAPTER III - THE SUPPLY OF EDIBLE OIL

A. THE GENERAL CROPPING SITUATION

Area planted in crop and production are given in the annexes for most of the crops grown in Uganda. Although this study is mainly concerned with potential oil producing crops, it is useful to look at the trends of production of the different crops over the last three or so decades.

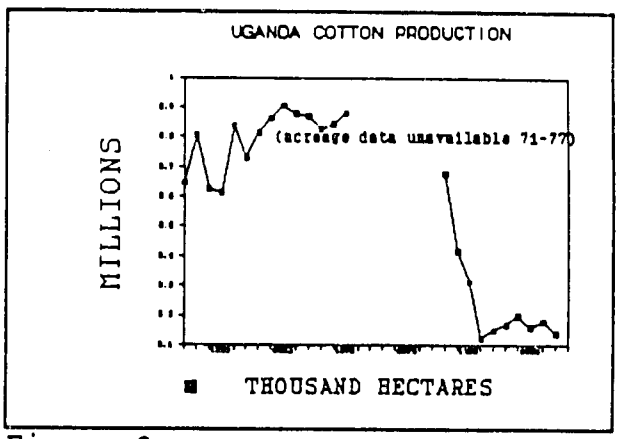

Figure 9

One of the problems in reviewing the historical crop production data is the difficulty in interpreting acreage estimates for all crops, and production data for crops that are not processed in central processing facilities. In other words, all production data except for coffee, cotton, sugar cane, tobacco and tea are suspect. This problem was recognized in the early 1960s when a Government of Uganda, FAO project was initiated, which included a census of agriculture. This was pointed out was Jameson who noted that it was difficult to compare the prior Department of Agriculture data on area in crop with the Census of Agriculture data because the Department's data did not distinguish between pure and mixed stands. In fact, in some areas mixed stands were counted the same as pure stands, and in other areas only pure stands were counted. This led to both over and under-estimation of area in crop. Since most crops tend to be interplanted this led to gross errors in estimation. In general Jameson noted that the Department's estimates on total acreage were much too high. It was calculated that Department over-estimates were by a factor of 1.5 for cotton, 1.2 for finger millet and 3.0 for sweet potatoes. On the other hand, the census report stated that outside Buganda the Department's estimates for banana bore little resemblance to reality, while for beans and cowpeas, Department estimates were below census data. Follow-up surveys to update the census were planned, and some were carried out in the 1960s. However, most of this data collection from field measures was suspended in the 1970s, and accurate data cannot be certain. Thus, the data on area in crop, and even yield data, as it is based on these estimates, cannot be considered very reliable. This makes it difficult to make reasonable estimates of the economic expectations of crop production, and makes it very difficult to predict farmer behavior

vis-a-vis the economic rewards from individual crops.

Over the past 17 years many of the industrial crops grown in Uganda have gone into a precipitous decline in acreage planted. This was particularly true of cotton, which had reached highs of almost 900,000 hectares under production. Figure 9 gives the 1957-1970 and 1978-1987 area in hectares planted in cotton. Although the data of area planted from 1971 to 1977 was not available, it can be presumed that this declined similar to the decline in production. That may be somewhat misleading, as there is evidence that farmers continued to plant cotton even in the face of incredible marketing problems during the period.

Production, given as metric tonnes of lint from LMB figures suggests a rapid decline starting about the mid 1970s as can be seen in Figure 10 Although production is beginning to show declines after 1972, it is not until 1974-1975 that the real downward trend is seen. This was most pronounced during the 1974 to 1980 period, and was consistent with the crops handled though the marketing boards such as cotton.

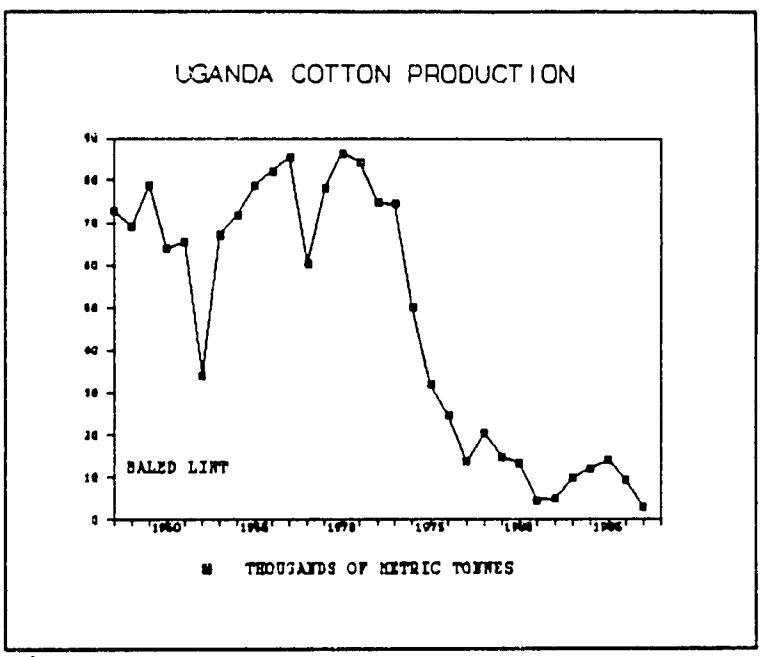

Figure 10

While production of crops like cotton were falling during the 1970s, the production of some other crops, notably the food crops was rising. This has been documented by others. Michael A. Whyte, in observations among the Nyole of Bunyole County in Tororo District, noted that cotton production was abandoned by many Nyole in favor of wet-rice cultivation.[15] This shift, according to Whyte, ended a 60 year period of what was referred to as the cotton-cereals farming system. That system had been centered around cotton as the cash crop of the economy. Although Whyte had found that cotton did not

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15 Michael A. Whyte, "Nyole economic transformation in eastern Uganda." chapter 9 of Uganda Now: Between Decay and Development, Holeger Bernt Hansen and Michael Twaddle, editors, 1988.

provide adequate revenues for the farm family's cash needs, even in the 1960s, and supplemental income had to be gotten from other activities, it had been so generally accepted into the farming culture as to proscribe any other farming innovations from developing. It was the one cash generating activity that was "universal" according to Whyte. The loss of marketing systems, transport, public security and other "support" systems for the production of cotton in the 1970s forced the farmers to find other means of obtaining cash income.[16] This tended to be mainly in food exports to the cities of Jinja and Kampala, and included groudnuts, maize, even millet and bananas..." The cotton-cereals farming system had begun to break down, according to Whyte, and farmers discovered different mixes of crops that could satisfy their needs for food and other goods.

Although this situation that Whyte documented in Bunyole County may not be universal, there are some indications from the macro crop data to suggest it was fairly wide spread. Acreages in crop, particularly for the food crops such as tubers, bananas and some cereals increased during the 1970s.

The area in crop of the cereals was mixed. From Figure 11 we can see that area in maize increased well over 100 percent between mid 1960 and mid 1970, going from an average of 168,000 hectares in the first five years of the 1960s to an average of 371,000 hectares planted in the first five years of the 1970s. As we can see from the graph, that trend did not start down until the war years of the late 1970s. Although data is not currently available, the trends did show continued increase in land devoted to the crop, a trend that many observers feel is continuing today.

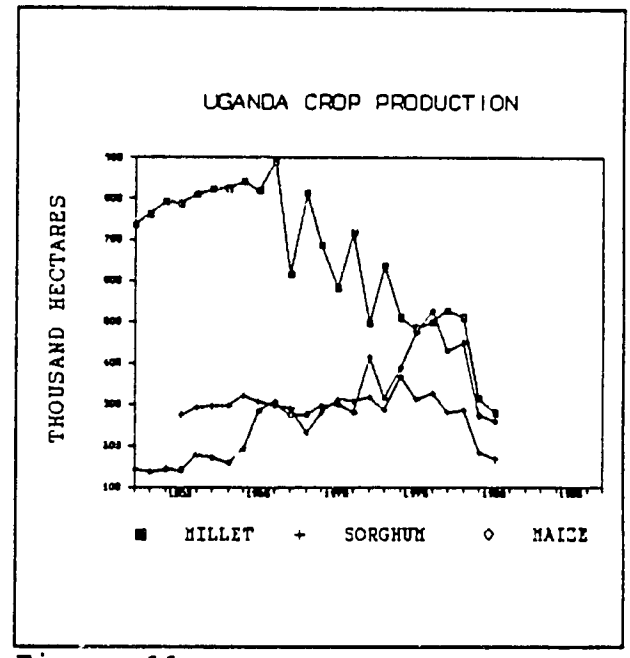

Figure 11

If the data is correct, the impact of the socio-political or economic conditions during the difficult years after 1972, on area devoted to millet is difficult to interpret. By the mid-1960s land in finger millet was estimated at a high of almost 900,000 hectares. However, a downward trend in

16 See our chapter on "Cotton."

estimates of land in millet was already obvious in the data after 1966. What this may suggest is that cereals such as maize were being planted on increased amounts of land in preference to millet. Improved varieties of maize, that could be grown in Uganda could well have been the reason. There is some evidence as well that market conditions in East Africa favored maize over millet, and the farmers were responding to market forces. Sorghum shows little change in trend, although there is a slight increase in acreage through the 1970s.

Banana acreage rose steadily during the period after 1972 as can be seen in Figure 12. Bananas are a major staple of many of the people of Uganda, particularly in the southern half of the country. It is clear that as the marketing system failed, money wages eroded, and Ugandans were forced to retreat to a more subsistance existence in the 1970s, more and more people turned to bananas as the main foodstuff. This was even true in the major urban areas around the lake, and a steady banana market continues now. In the 10 year period 1962 to 1972 area in bananas almost doubled. Production doubled again by 1979, and once again by 1980.

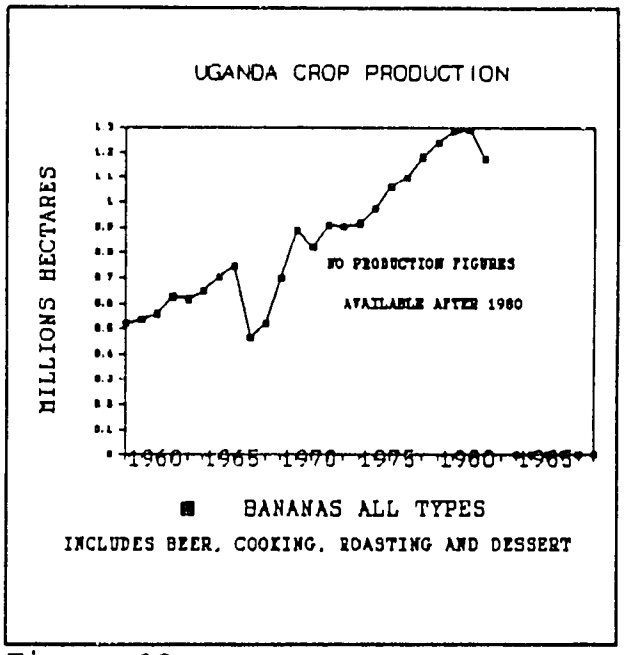

Figure 12

High prices for bananas continue to stimulate production. With increased demand in the urban areas of the country stimulated by improved economic activity and lack of other substitutes in sufficent quantity, linked to a national taste for bananas, production appears to have continued to climb. Fortunately, with adequate land available and favorable climate, banana production can continue to increase without seriously affecting other crop production. This is partially because it does not seem that labor requirements of banana production, harvest and marketing are major impediments to other cropping systems. Without the need for seasonal cultivation, less labor required for care of the plantation and harvesting, banana would have a marginal impact on production of crops such as the oilseeds or cotton.

The Uganda farmer has long used cassava as a security food crop because it takes little care and can be held in the field until needed for consumption. It was a crop that fit well into the

previous cotton-cereal farming system. In the higher rainfall areas of the south, farmers would usually plant cotton on newly cleared land, generally in the short-rain period, followed by millet in the long rain period. This land would often be cultivated in this way for up to five years in good soil, with two and possibly three crops of cotton taken. The millet would often be intercropped with beans, peas groundnuts or seasame. After about five years the land was often planted into cassava and left into a semi fallow state. Cassava does not appear to be favored as a staple in the Ugandan diet, and was grown more as a security crop. Thus the expansion of acreage in the 1960s and 1970s may be no more than a function of population growth and need for food security.

Acreage in sweet potato production steadily increased between the mid 1960s and the late 1970s, more than doubling during this period. These tubers, as can be noticed in Figure 13, only show acreage declines after 1979, when the war broke out and security declined. The decline in acreage devoted to both cassava and sweet potatoes may have continued low through the early 1980s, but appear to have been on the increase in last few years as security improves. The actual decline of acreage in crop may also be in part due to data estimates. Although it is true that a large area of the country that grows these two crops (along with robusta coffee) experienced extreme insecurity in the 1978-1979 period, and again in the mid 1980s, it seems unlikely that these crops, in particular cassava, would have declined in area this much.

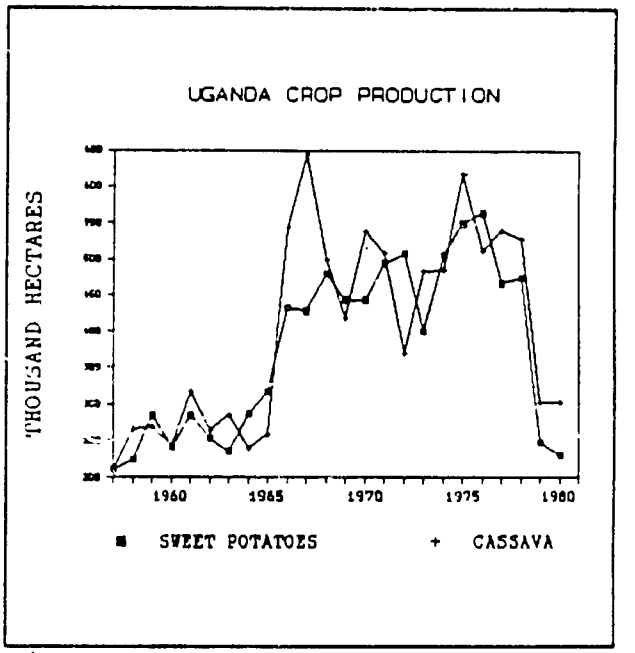

Figure 13

The general class of oilseed crops, with the exception of cotton, has shown little if any trend in production over the 1957 to 1987 period. The crop with the largest acreage, groundnuts, rose to about 250,000 hectares planted in the early 1960s and appears to have maintained that level through the mid 1970s. Acreage planted has subsequently declined as has production, partially due to the war and insecurity, and partially due to disease problems. However, in Uganda groundnuts are mainly consumed as whole nuts or in prepared dishes, and are seldom crushed for oil.

UGANDA OILSEEDS, JULY 10, 1989

Sesame acreage and production has remained almost constant, differences being due mostly to climate. A planting level of 80,000 to 100,000 hectares is normal, and total production seldom exceeds 35,000 metric tons. Soybeans have never been terribly important, and seldom do plantings exceed 10,000 hectares. Because of the concern to this study, the crops with potential for edible oil and soapstock production are discussed more thoroughly in the next section.

The area devoted to the pulses; cowpeas, pigeon peas, field peas and mixed beans, shows only a slight drop after 1972, and a more or less constant trend of land in crop thereafter. Figure 14 needs some care in interpretation, as some of the earlier data series bulked more than one type of the beans and peas together. These crops are often grown in mixed stands with the cereals or other crops, and acreage estimates can be highly subjective. Estimates should be taken in terms of magnitude rather than as having a high order of accuracy. Although this is true of all the crops in Uganda, it is more true of these pulses than other crops. Usually the crops sold through the marketing boards are most accurately estimated (obviously production more than area), followed by the main food crops grown in mostly pure stands.

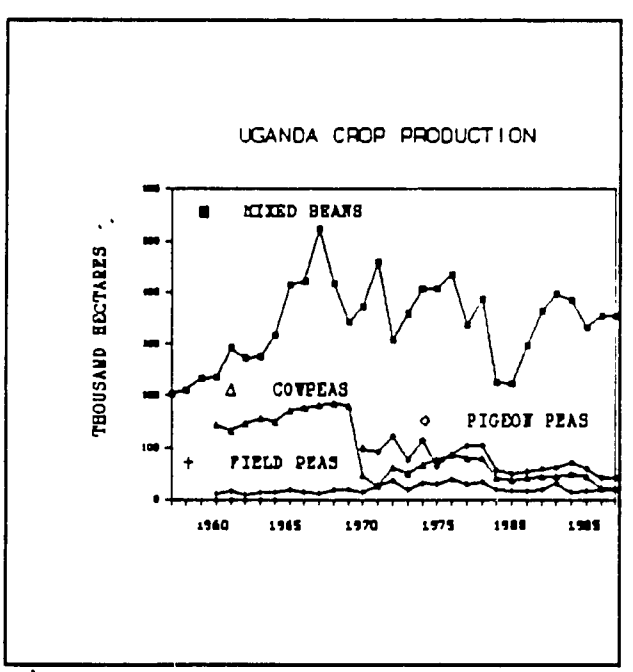

Figure 14

B. THE PRODUCTION OF OILSEEDS AND OIL BEARING CROPS

As noted above, even with a fairly good recovery of the cotton industry in Uganda, a maximum expected yield of oil from this source will be 3,000 tons. In fact, to reach the estimated 16,000 tons of edible oil requirement posited above, we would need about 228,000 tons of cottonseed to process at current rates of extraction, (but only slightly less with historical rates of extraction). Only with solvent extraction methods could these yields be greatly improved. This level would require over 305,000 tons of total cottonseed production, (counting on saving 25% for next planting as seed), or a total of seed cotton of about 455,000 tons; a level of about 810,000 bales of lint. Some drastic changes in the current farming practices would have to occur to obtain such production levels. In addition to this, almost twice as much oil of some type is needed for the soap industry.

The residual edible oil requirements for Uganda, after producing oil with whatever cottonseed is available, will have to be met with other oil bearing products, preferably with those of higher oil bearing production per unit of land than can be obtained by cotton. Currently in Uganda these are generally limited to groundnuts, sesame, soybeans and sunflower.

Soybeans are currently being marketed under a barter arrangement with Yugoslavia. Small quantities are also purchased by African Basic Foods who processes them into soya food products. Although soybeans can be processed locally, they require special handling. An enzyme found in soybeans acts as a trypsin inhibitor and must be destroyed with heat as part of the processing. ABF does this by use of an extruder, which raises the soybean's temperature by friction. For oil production, either a similar process of extruding the beans or use of cookers to raise temperature would be needed. Generally, however, the normal cookers used in the oil processing industry ahead of the expellers are unable to raise the temperature for a sufficient length of time to accomplish this. Therefore, a more sophisticated cooking system will have to be installed on existing equipment. Even if such processes are installed in existing or new oil mills, the total production in Uganda of 9,000 metric tons cannot be expected to contribute more than about 1,000 metric tons of refined oil. Research work now on-going to test improved varieties and agronomic practices for soybeans could stimulate an increase in production of this crop. Modifications to the extruder used by ABF, which are now being attempted might allow a partial defatting of the soybeans which will supply some oil and improve the cake product as well.

The processing of groundnuts for oil is now generally prohibitive due to the high demand, and concomitant high price, for the seed as directly consumed food. Two possibilities exist for making

groundnut a significant contributor to edible oil production. One is to increase production and thereby lower the price of the crop. Given that groundnuts in Uganda have always been overpriced for a processing seed, it does not seem likely that their price will decline sufficiently to make them economical to process. A second possibility exists. That is to process the seed for oil while at the same time retaining the solids as a human food. In this way, the solids part will command a significantly higher price than is the case when groundnuts are crushed for oil and animal feed. It should be noted that it is the oil in groundnuts that give it its specific flavor. When oil is removed the groundnut flavor decreases. Whether appropriate processing techniques and facilities can be developed to make this feasible needs further study. However, simple batch presses have been tested by the Overseas Development Natural Resources Institute (ODNRI) in the U.K. and results have been quite good.

The processing of sesame for oil has been almost totally restricted to a home, artisanal basis. Commercial processing has never been estimated to have exceeded 500 tons per annum. The main reason has been given as lack of seed, but some observers note that this most likely means lack of seed at an economical price. Today the price of sesame, on an oil bearing basis, is more favorable than groundnuts, and some small millers are crushing the seed when it is available to buy. However, production of this crop has been relatively stagnant for several decades, and there are no indications that sesame will be produced in greater quantities in the future. Village level processing of this seed might have some possibility if small processing machines are made available. However, it is unlikely that oil of this seed will reach the market in any significant quantities in the foreseeable future.

Sunflower has come on the scene in recent years as an oilseed crop. Although it has been grown for some years in Uganda, most of the production was for export, and a large share of that seems to have been of the confectionery or birdseed type. Currently there are several small oilmills that are crushing sunflower on a commercial basis, purchasing seed from farmers or arranging a form of contract growing by farmers. In the latter case, the miller often supplies part of the production inputs, such as seed. Larger mills are considering similar arrangements, with at least one planning on including tractor hire services in the package. In the case of some small mills, particularly those operated by church affiliates, crushing sunflower for a part of the oil is practiced, whereby the mill retains a certain part of the oil and the cake for the cost of mill operations, and the farmer takes back most of the oil. This system is also practiced, in part, by at least one private miller.

The level of current production of sunflower is uncertain, but probably does not exceed 2,000 - 3,000 tons. This is expected to

increase due to a more certain market now developing with private oil mills, and the efforts by these millers to promote the production of the crop. Unfortunately, choice of variety, agronomic recommendations, crop protection and handling and marketing are not well determined. Some work on oilseeds is now being done at the research stations under the MFAD project financed by U.S.A.I.D. with the Ministry of Agriculture. Variety testing of sunflower and soybeans are included.

Determining appropriate cropping systems for sunflower production will be crucial to the rate of expansion of the crop. It will be essential that yields of at least 1,000 kilograms per hectare are obtained if sunflower is to be competitive with other crops in terms of returns to farmers' labor. Much higher yields will be necessary for mechanized production. There are clear advantages, from an oil production point of view, to chose certain varieties. This is because some varieties, mainly the blackseeded types, have substantially less hull as a proportion of total seed, and often also have a higher oil content in the "meats" of the seed. Thus, millers will buy "more oil" per kilogram of whole seed, and when whole seed is crushed (undecorticated seed) as is usually the case, less wear on expellers will be experienced. These seeds will also represent a significantly lower transport cost, as less bulk will need to be transported to the mills. Finally, the cake derived from the seeds with less hull will have a higher protein and nutrient content, and therefore will be of more value as animal feed. Once millers learn this, it is likely that they will offer premium prices for those varieties of seed that are the highest yielders of oil. This will be an essential part of variety selection in research.

Production of oil from oil palm would be the most logical in the long run. First, oil palm is already proven to yield one ton of oil per hectare in the country. This means that the requirements for edible oil and soap could be met with about 45,000 hectares of crop, considerably less than with any other oil crop. Second, once the crop is established, it will produce for years without further investment in land preparation, weeding, spraying, etc. The only costs are for harvesting and pruning which are accomplished in one operation.[17] There is also little danger to the land in terms of increased incidence of soil diseases, decline in soil fertility or increased soil erosion, and therefore the problems of soil

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17 Obviously greater care of plantations, and therefore increased production costs, are involved where the drop is grown on modern commercial plantations such as are found in Malaysia. The degree to which this will be necessary in Uganda under different economic conditions is unknown.

management are significantly reduced. As the only major crop production operation after the trees are established is harvest, the cost of machinery is reduced, and management of machinery is less. For the small holder, a few trees can be planted around buildings or field boundaries, and extra income can be obtained without putting extra strain on family labor.

C. STIMULATING OILSEED PRODUCTION:

The current production level of oil bearing products is insufficient to meet the demand for edible oil in Uganda. Further, a large quantity of oil for the manufacture of soap is required. Oil for soap stock is totally imported at the moment. The production of these oils can be produced from oil bearing seeds or from a tree crop like oil palm. Production can be either small holder farmers, in unmechanized production systems, by small and medium holders in a quasi-mechanized production system, or by large commercial, fully mechanized production systems. For the production of oils from the seed crops like soybeans, sunflower, groundnuts or sesame, the method of production will be important as a national policy issue because of its impacts on foreign exchange, labor employment, competition with other crops and land use and development.

1. Smallholder Oilseed Production:

Producing the edible oil portion (as opposed to the soap oil needs) of current demand on small farms will depend mainly on availability of labor to grow the crop. This is because there is sufficient land available. Provision of some inputs will also be needed. This is particularly true for sunflower and soybeans, where there are now not sufficient quantities of seed of acceptable varieties available. Increasing production of these crops will require support in research, seed multiplication and crop promotion. Fertilizer and pesticide requirements are not yet well known, and will have to await further research results. In the case of groundnuts, chemical sprays are needed to control rosette disease, and further work may be needed in variety trials.

In order to meet current demand for edible oil, an additional production of sunflower in the order of 67,500 metric tons per year would be needed. The equivalent production of soybeans would be 112,500 tons. Groundnuts could meet the demand with 38,570 tons. Use of these crops to meet edible oil needs currently would mean that about 67,500 hectares of sunflower would need to be cropped, 117,800 hectares of soybeans, and approximately 75,800 hectares of groundnuts (the latter is larger than straight yields dictate because of the heavy seed requirement), under current cropping practices and yields. It is clear that most smallholder farmers, producing without any mechanization, including ox ploughs, can not cultivate over 1/4 hectare of additional crop. Thus, the number of smallholder farmers required to meet the needs for oilseed for processing for edible oil alone will be between 315,200 and 471,200 individual farms. The level would probably be somewhere in between, as a mixture of the oilseeds is most likely to be produced. The equivalent number of farms required to meet this oil production

level with 1/4 hectare of cotton each will be about 965,000. If oil palm can be encouraged, it is possible that several small plantations of about 1/2 hectare with about 80 trees each could be developed. This would be more logical if they could be established around a larger plantation as outgrower schemes. Only about 90,000 farms of this size would be needed for the oil requirements for all uses in Uganda.

Production costs for smallholder farmers using a non-mechanized production system are not well known in Uganda. The major production costs are for labor, either bought in or supplied by the family. For most crops the labor requirements were unknown and there are widely differing estimates where they are available. The most complete set of estimates were done by the Agricultural Secretariat of the Bank of Uganda, who have calculated labor inputs by type of activity and crop as can be seen in Table 2. Several points should be made regarding Table 2. First, the operation of land clearing is not specified as to what type of vegetative cover was assumed to be on the land prior to clearing. If the bush is fairly heavy or is in more or less of a "virgin bush" stand, the operation could take considerably longer. It may be fair to use these numbers based on averages around the country, but considerable adjustment should be made for specific areas. Second, the land preparation time seems insufficient for many cases in Uganda. Although the figure of 40 man-days on average may be reasonable, it probably cannot cover requirements in the heavier soils. For example, we found that in the Masindi area, farmers and cooperative society leaders gave us an estimate of 50 man-days per acre to prepare land with hand tools. It also depends on the definition of the working day. In the Mubende area, cooperative officials estimated that most farmers would not spend more than 3-4 hours per day on heavy plowing. However, we found man-days calculated from 3 to 8 hours.

Some of the assumptions on operations would have to be examined for the crops given. For example, planting of maize is given as 5 days compared with 10 for cotton, millet and sorghum, row crops with similar plant densities. On the other hand, simisim is listed as requiring 10 days to seed, which could only be the case if seeds are planted in hills, which is not usually the case. Weeding and thinning are estimated to take 20 more days for millet than for cotton, maize and sorghum, which seems questionable. Harvesting of cotton is assumed to take the same amount of time as harvesting of sorghum, beans, simsim, soybeans and cassava, even though harvesting of cotton usually requires 4 to 6 passes through the field. Harvesting times for many crops seem excessive in these estimates. For example, in labor studies done in West Africa, harvesting of millet and sorghum almost never exceeded 10 man-days including transport to the granary.

Even with these notes of caution, the estimates give some magnitude of the labor input for non-mechanized production. They point up the serious problem that small-holder farmers have in meeting labor requirements. In effect, a farm family of four persons, needing about 800 kilograms of cereals per year, would have to devote at least 1/2 of available family labor to grain production.

TABLE 2
Labor Requirement for Seasonal Crops - Uganda
(Man-days per Hectare)

Operation	Cotton	Maize	Millet	Sorghum	Beans
Land Clearance	20	20	20	20	20
Land Prep (Hoe)	40	40	40	40	40
Planting	10	5	10	10	10
Fertilizing	-	-	-	-	-
Spraying	10	-	-	-	-
Weeding/thinning	80	80	100	80	60
Harvesting	40	25	50	40	40
Post harvest	20	20	20	20	10
TOTAL	220	190	240	210	180

Operation	Groundnuts	Simsim	Soybeans	Cassava	Sweet Potato
Land Clearance	20	20	20	20	20
Land Prep (Hoe)	40	40	40	40	60
Planting	10	10	10	20	20
Fertilizing	-	-	-	-	-
Spraying	10	-	-	-	-
Weeding/thinning	100	60	60	120	60
Harvesting	50	40	40	40	50
Post harvest	20	20	15	20	10
TOTAL	250	190	185	260	220

Operation	Tobacco (flue)	Tobacco (fire)
Land Clearance	20	20
Land Prep (Hoe)	20	10 (note that land preparation is by tractor for tobacco)
Planting	80	80
Fertilizing	20	-
Spraying	10	10
Weeding/thinning	80	60
Priming/Topping/ Suckering	40	40
Harvesting	50	40
Post harvest	110	30
TOTAL	430	290

Source: Bank of Uganda

2. Semi-mechanized small and medium sized farms:

The main constraint to expanding the area of crop production for most of Uganda's farmers, is the high labor demand for land preparation. The heavy soils and high plant cover in most areas require deep ploughing. When this is done by hand with a hoe, the labor requirement is enormous. In the past, during the high cotton production years in Uganda, ox ploughing and tractor hire services were promoted to ease land preparation and permit expanded acreage in cotton.

If we assume that mechanization would be advanced in the form of tractor hire services, the number of tractors needed to prepare land for oilseed crops would vary from 1,125 to 1,960, depending on the oilseed crop (not counting cotton). These numbers are based on an average of 2 hectares of land ploughed per tractor per day, and land preparation completed over a 30 day period. The degree to which double cropping can be done in any area could lower these numbers. Rough estimates of equipment costs would be $25,000 per tractor plough unit, or from $28.1 million to $49.0 million for national oilseed production. Additionally, operations and maintenance costs would be required. It would be assumed that all other operations would be by hand.

The estimates given above are based on certain assumptions about the farms to be plowed with tractor services. Principle among these is that the farm fields would tend to be rather small and dispersed around the community. This means that a significant portion of tractor time is lost in turning and finishing a field and moving from farm to farm. If a medium-sized tractor were used, pulling a 3 discs or bottom plow, it would cover a width of about 4 feet. Travelling a 5 miles per hour in a straight line with no obstructions, it could plow 1 acre (4 feet wide by 10,890 feet or about 2 miles in length) in approximately 24 minutes. Considering turning, an estimate of 30 minutes is reasonable. Thus it would require 1 hour 15 minutes to plow 1 hectare. The time requirements go up rapidly when the tractor is not actually plowing, as is the case when turning on the end of the row, stopping or going around termite mounds, roots or other obstructions, finishing the fields where considerable turning may be necessary, or making adjustments or repairs.

The annex contains estimates of costs or production and returns for several crops in Uganda under semi mechanized production systems. These include cotton, simsim, soybeans, groundnuts, sunflower and maize. The estimates were assembled by the study team based on information from the Agricultural Secretariat of the Bank of Uganda, the Ministry of Agriculture, Ministry of Cooperatives, and the teams discussions with Cooperative Union officials. Although we cannot attest to the accuracy of these estimates, particularly

as concerns product price figures[18] they do point up some problems. First, even with tractor plowing, labor requirements seems high for most crops. Second, use of the tractor may not contribute much to yield increases while at the same time requiring high cash outlays. Finally, in most cases there seems to be little understanding of which marginal costs will give the greatest returns. That is, would a small dosage of fertilizer on cotton give a greater return than excessive time spent thinning?

Other things seem clear. Understanding of the proper use and performance of mechanization is low. Much more should be understood about the proper soil preparation functions (for example Ugandans always plow twice, usually with disc plows which seems to be unnecessary and marginally unproductive) in mechanized farming. Further work should be done on other functions to be performed by tractors such as weeding. Finally, much needs to be learned about how to get adequate yield increases to cover mechanized farming costs.

3. Large Commercial, Fully Mechanized Operations:

For crops like soybeans and sunflower, if is often more practical to develop larger scale operations that are fully mechanized throughout, from land preparation to harvest and crop storage. The first major consideration in most of the land areas of Uganda that would be available for large-scale mechanized production is clearing land of trees, termite mounds, rocks and other obstructions that would impede passage of large equipment. Although this is also true for the partially-mechanized systems mentioned above, the degree to which land must be cleared is less. Because land clearing is an investment cost the following section presents the operations and their estimated costs.

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18 Prices for cotton are fixed by government at 80 shillings. Prices for groundnuts were reported from 200 to 300 at farmgate. Other commodity prices in the annex seem exceedingly high, especially simsim at 150 shillings, soybeans at 150 shillings, and sunflower at 120 shillings. Maize at 65 may be slightly low. Farmgate prices for soybeans and sunflower should be adjusted to about 50 shillings per kilogram as of April 1989.

D. LAND CLEARING

The cost of clearing land will vary according to several factors. These include:

1. Slope of terrain; costs will generally be cheaper on level ground, and rise as the degree of slope increases and the variation in slope augments.

2. Firmness of the ground; soft and swampy areas will cost more to clear because (a) the tractor works harder in soft ground (b) there is a risk to have more down time and (c) costs of repairs and lubricants may rise.

3. Type of vegetation to clear; obviously large trees take more time to clear and more power, however, some types of smaller vegetation may be slow to clear, for example the papyrus may have to be entirely handled with bulldozer if it cannot be burned.

4. Rocky terrain; this will depend on the planned use of the cleared land. If tree crops are to be grown it may not be difficult, but if annual crops are to be grown under mechanized cultivation, ripping may be necessary, an added function.

5. Size of field to clear; obviously with large machinery it is preferable to clear large straight pieces of level ground. Small fields require constant turning and therefore unproductive time.

6. Planned use of land; as noted under #4 above, but this applies as well for terrain without rocks. If the land is not expected to be subjected to regular mechanical operations such as plowing or cultivating, then removal of roots and stumps may not be crucial.

Given these conditions, the following is an estimate of land clearing operations and costs in Uganda. The times and areas cleared are based on experience of the agricultural department in the mid-1960s. In 1964 the department imported 3 D8 Caterpillar tractors to use in land clearing. The method used was to attach a 300 foot length of anchor chain between two tractors and to follow with a third tractor to assist the other two when large trees were encountered. This was to limit the need to stop the other operation of the first two tractors and employ their dozer blades to uproot large trees. The rates of work for this operation varied from 2 to 5 acres per tractor hour.

Following the felling operation, windrowing of the felled trees and brush every 50 to 70 yards across the field was carried out using all three tractors with dozer blades. The rate of work was less than 1/2 of the felling operation, and usually averaged about 1 acre per tractor hour. This will vary somewhat on the volume of material to transport with the dozer, and the distance between windrows.

The removal of roots was done with the use of a large Rome TTH 16/36 disc plow. This would probably be sufficent in most of the medium bush area of Uganda. If large trees and rocks needed to be removed, then use of rippers would be essential. After disking, a hand operation was carried out to remove small branches and sticks that were left. This would be necessary only in mechanical cultivation were to follow.

The cost factors used to estimate land clearing costs are taken from Caterpillar Corporation's Perfomance Handbook. 17 edition, 1986. These will be slightly higher for 1989 cost, probably about 15%, considering a moderate U.S. inflation rate.

There are two methods given by Caterpillar for calculating owning and operating costs of heavy equipment. In the first method, each cost center, including depreciation, repairs, hourly operations and labor costs are separately calculated based on type of work being done. In the second method, Caterpillar has estimated three cost levels for each type of equipment to allow a "quick estimate" of owning and operating costs. For track-type tractors, their 1986 estimates are given below.

TABLE 3

Owning and Operating Costs per Hour
(Job Conditions)

Type	Moderate	Average	Severe
D3B	$ 7.00	$10.00	$17.00
D4E	10.00	13.00	20.00
D5B	14.00	17.00	28.00
D6D	17.00	22.00	36.00
D7G	25.00	32.00	49.00
D7H	26.00	32.00	49.00
D8L	39.00	43.00	73.00
D9L	59.00	71.00	100.00
D11N	94.00	111.00	159.00

Source: Caterpillar Performance Handbook, edition 17, 1986.

The tractors' estimated costs given above, are for tractors equipped with straight buldozer with tilt cylinder, hydraulic control, ROPS canopy, crankcase and track roller guards, front pull hook, light system and vandalism protection. The hourly costs exclude interest, insurance, taxes and operator. The machine costs are also depreciated at list prices f.o.b. factory, and repair costs include $U.S. 40.00 per hour for labor. Adjustments for Uganda will need to be made to add shipping, import duties and forwarding and insurance costs to arrive at a c.i.f. Uganda price. Reductions would need to be made for lower labor costs for repairs, and operator salaries would be added to arrive at a cost per hour in Uganda.

To estimate the clearing costs from the experience given by the Department of Agriculture in 1965 noted above, a rough estimate would be to take the average cost of the D7H in the table above. This model compares roughly with the 1965 D8 model noted. That is the earlier model D8H (1958-1974) weighed 48,210 pounds and had 270 hp. The D7H weighs 49,358 and has 215 hp. The current D8L is over 82,000 pounds and 335 hp. Using the average cost, based on the assumptions that maintenance will be less than ideal in Uganda and the work is moderate, and that the delivery and other cost corrections will be mainly offset by lower mechanics costs for repairs, clearing costs per hectare are estimated as follows.

TABLE 4

Cost per Acre for Land Clearing

Operation	Low Output		High output
Felling	$32/2 = $16.00	to	$32/5 = $ 6.40
Windrowing	$32/1 = $32.00	to	$32/1 = $32.00
Plowing	$32/5 = $ 6.40	to	$32/5 = $ 6.40
Total	$54.40	to	$44.80

These estimates would need to be refined from local experience of owners and operators of tractors in Uganda. However, they serve to illustrate the investment cost in establishing either an oil palm plantation or farm for mechanized production of annual crops such as sunflower. Given current commercial interest rates in Uganda, the payback from a tree crop will need to be quite high to justify the investment.

E. CAPITAL INVESTMENT IN MACHINERY AND EQUIPMENT

We have calculated the capital investment requirement for equipping aproximately 250 hectares, (or 640 acres) for the production of these crops. For all the essential operations, the equipment cost would be approximately $446,000 per square mile in crop, (U.S.$677.00 per acre) although some savings could be had from scale of operations, staggering production out as much as possible and direct field to proccesor marketing to avoid high storage costs. Under mechanized production and harvesting, sunflowers would need to be artificially dried before storage. The same may be true for soybeans, depending on the conditions at harvest time and the degree to which the selected varieties shatter near maturity. This would require an investment in drying capacity of about 500 metric tons per square mile, which would add at least $40,000 to the capital cost. Unless the crop can be transferred directly to the mills, a like capacity for storage would be neccessary.

Production of crops like sunflower and soybean cannot be done on a continuous basis. Both crops would require employing rotations in order to prevent disease buildup in the soil or through plant residue, to control weeds, and to limit the nutrient depletion in the soil. Therefore other crops would have to be included in the cropping system such as maize. However, it is likely that on many of the soils in Uganda, grass/legume pasture or hay cropping would be needed to maintain fertility and soil texture (or use of natural grass fallow). This would add to management responsibilities, increase somewhat the machniery requirements (or fencing), and add to both storage and marketing equipment and facilities costs.

Unless large areas could be incorporated into a rotation such that hay crops or pasture could be heavilly utilized to maintain soil fertility, a dosage of fertilizer would be needed, particularly on crops like sunflower, corn and cotton. Evidence in the 1950s and 1960s from the Agricultural Department's research indicated that use of bush fallow or grass leys was essential to maintaining soil fertility under cotton/cereals systems without use of chemical fertilizers or heavy doses of composte or manure.

Obviously, a higher production level would have to be maintained in order to justify mechanized production. Averages of 2 tons for both sunflower and soybeans would be assumed. To meet current demand for oil, this means a total of 135 square miles of sunflower or 225 square miles of soybean would need to be mechanized. At a cost of $388,000 per unit, a total investment cost of from $52,380,000 to $87,300,000 would be needed for initial investment before operations, maintenance and spares inventories are calculated. By comparison, the current parallel retail market value of the oil produced would be approximately $20,000,000 annually.

F. SUMMARY OF MECHANIZED SCHEMES

The major problem with mechanization schemes is that most of the land available in Uganda for medium to large scale mechanization is in quite heavy brush cover. Clearing the brush and preparing the land for mechanized cultivation will require a high initial capital investment. This investment will need to be amortized over several crops. However, with the current interest rate structure it is difficult to undertake this investment on borrowed money. For example Figure 15 shows the cost range estimated to clear an acre of land and the impact on those costs with 50% interest rates and the number of years to generate the payback.[19]

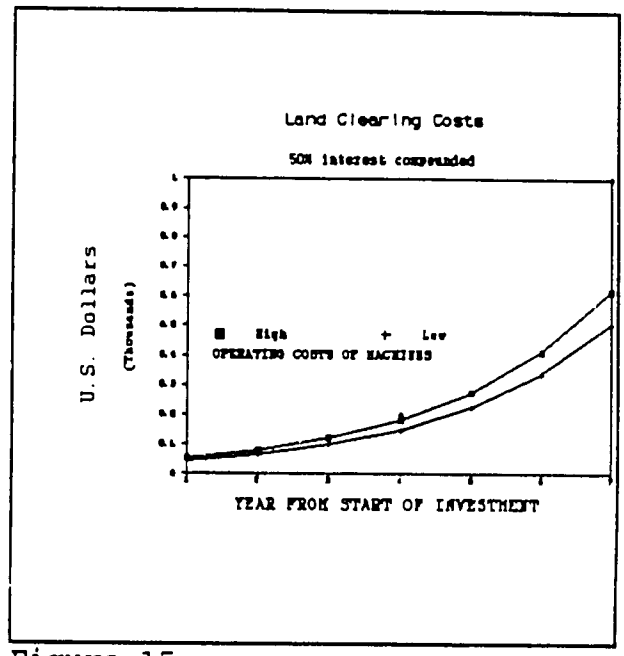

Figure 15

For crops like oil palm, the high cost of clearing is compounded by the fact that production cannot be expected until at least the fourth year after planting out the trees. Given that plants must be started 12 to 18 months before planting out[20], a long capital investment period is involved. As can be seen in , the land clearing cost can quadruple by the time the first harvest comes in.

On the other hand, the advantages with oil palm are that it is easier to establish on a large scale basis, presents fewer soil management and weed control problems, requires considerably less capital equipment to produce a ton of oil as compared with the annual oilseed crops, and generally is easier and cheaper to harvest. Even for large mechanized farms these are major advantages. Its major disadvantage is that it must be processed quite soon after harvest (at least the fruit, the nuts could be stored) and close to the place of production. Therefore it is only

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19 Costs are calculated clearing costs based on figures given in the next section.

20 See section on Oil Palm.

conducive to smallholder production either as an outgrower crop near a factory or as subdivisions of a modified plantation system.

With the cash short position of the Cooperative Unions and Cooperative Societies that have adequate land for mechanized, large-scale production, the financial means to develop the land does not exist. Unless joint ventures or contract growing arrangements can be made by these Cooperative groups, mechanized farming is beyond their means. Mechanized production of annual crops will also require a high level of technical and managerial input. Crop rotations will be required to prevent disease and insect buildup and excessive soil depletion. This means total cropped area will need to be some three to four times that required just for the oilseed output.

CHAPTER IV SPECIFIC OILSEED CROPS

A. SUNFLOWER

1. Background and Exports

The date of introduction of sunflower into Uganda is not known for sure, but Rita Laker-Ojok suggests that it was probably in the 1920s or 1930s. She notes that by 1947 the government had established trials for sunflower in the western region of Ankole and Kigezi Districts. Early efforts to expand production were hampered by a lack of a sure market. Sunflower finally began to have some success mainly as an export crop, and Laker-Ojok gives export figures for sunflowers as follows:

TABLE 5

Sunflower Exports:

Year	Tons	Year	Tons
1958	172	1966	66
1959	262	1967	23
1960	292	1968	251
1961	67	1969	262
1962	20	1970	209
1963	87	1971	58
1964	108	1972	0
1965	105	1973	5
		1974-79	0
		After 1979	none recorded

Source: East Africa Customs and Excise, Annual Trade Reports, 1958-1979, cited by Rita Laker-Ojok. After 1979 by team investigations.

G.E.D. Tiley (In Jameson, ed. 1970) notes that the 1963 export of 87 tons was shipped mainly from West Nile, and was worth 42 per ton.[21]

2. Production

Sunflower is currently grown on a more or less commercial basis in

[21] Presumably this was the export value of the crop, although the author does not indicate the valuation, i.e. free on rail, ex-Mombassa, etc.

the Gulu and Soroti areas, and further to the north and west. It is becoming increasingly known and grown in the areas of Hoima, Fort Portal and Kasese due to the activities of small private and church related oil mills. Because sunflower is being included in the plans of several private and cooperative planned oil mills it will likely receive a great deal of stimulus as another cash crop in some areas. This will necessitate improving the agronomic information on growing sunflowers in these areas.

3. Yields

The common belief in Uganda is that sunflower will yield at least 1,000 kilograms per hectare and produce 30% oil. G.E.D. Tiley gave yields averaging 1000 lbs per acre in 1962, but stated that yields of 2,000 lbs per acre were attainable under the right conditions.[22] Researchers on the oilseeds project believe that 2,500 kgs per hectare should be possible with some varieties. Thompson gave estimates of current production levels in the semi-arid north of 700 to 1,000 kg/ha of a 10 to 20% oil extractable seed. However, he noted that yields should reach at least 1,300 kg/ha in less arid areas and oil content must increase to 40% (30% extractable).[23] The Gulu Diocese experience cannot give a clear picture because varieties are mixed. At the present time, the varieties are generally grouped as black, stripped and white, although some varieties found in the west - Fort Portal and Kasese area - are more of a gray type.

4. Economics of Production.

The economics of sunflower production are a bit uncertain for several reasons. First, the majority of varieties that are grown in Uganda are of the confectionery type and their yield of oil is very low. This is evident from the data in Table 6. Second, the way in which sunflower is grown is often to intermix it with other crops and therefore the yield per acre or per hectare is very questionable. Third, labor requirements have not been documented. Finally, little is known of the fertility requirements for top production, or the pest problems that might arise, especially on a commercial scale. However, if one can obtain a yield of 25 to 30% oil from sunflower, then it would take about 1/6 as much area as cotton on a per hectare basis to yield the same amount of oil that can be produced from cottonseed. Additionally, the oil is generally of a better quality than that of cottonseed, and requires much less refining.

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22 See Jameson, ed., 1970.

23 Thompson, op cite, page 2.

The current price offered for sunflower by crushers is 50 shillings per kilogram or 50/2.2 (22.73 shillings per lb, = 5.68 U.S. cents per lb., at a parallel rate of 400 shillings to the dollar) which equals 166.67 shillings ($0.417/kg) per kilogram of oil on a crude basis (at 30% extraction rate). Cottonseed, on the other hand, yields at best 5% oil on a crude basis, (meaning the yield per kilogram of cottonseed from the ginnery) so to have 1 kilogram of oil from cottonseed will require 20 kilograms of raw seed (5% oil requires 20 kilograms of seed) whereas, sunflower will yield the same amount of oil in 3.33 kilos of seed on average, or 1/6 as much. This means that cottonseed will require 10 to 20 times as much land per unit of oil (yields estimated from 400 to 800 kgs of seed cotton) and 6 times as much machinery in the factory.

5. Agronomy

Sunflower grows well in Uganda, although it is generally felt that it is most suited to the northern and western, drier, parts of the country. One reason for this is because of the potential prevalence of leaf and stem diseases in the more humid areas. Thompson notes that sunflower need not be restricted to these drier areas but research and extension agencies must be alerted to these potential problems and develop sunflower production accordingly. It is also preferable that sunflower mature in drier conditions, and therefore production is usually recommended for the second rains.

Although sunflower is a hardy crop, and fairly drought resistant, the plant generally prefers cropping conditions similar to maize. Seedbed preparation is similar to that for maize or soybeans.

Varietal research is now ongoing, and selection of high oil-yielding varieties suitable to Ugandan conditions will be essential if this crop is to contribute significantly to Uganda's edible oil requirements. Until recently, most of the information on sunflowers was coming from Kenya. At present sunflower is included in the USAID funded crop improvement project (MFAD) which is undertaking agronomic and varietal trials. Thompson recommends a research program dealing with agronomic information (date of planting, fertilizer, and plant population), varietal testing, pests and diseases and the use of bees in pollination.

6. Processing

Local extraction of oil from sunflower is mentioned only briefly before 1977. Coles notes that in 1965 only one oil mill had crushed sunflower. This mill was experimenting with the crop, and crushed 15 tons in that year. Sunflower is not further mentioned as a commercial oilseed in Uganda until 1977 when the churches in the Kitgum District purchased an expeller and encouraged production by local farmers. In the early 1980s, the Gulu Diocese located two

used Italian expellers. One of these was sold to farmers in the Kitgum area, and the church operated the other in Gulu.[24] Reports of about 2,000 hectares of sunflower production in Uganda in 1987 were noted by Thompson[25].

The church also arranged for a shipment of 5 tons of Kenyan hybrid seed, "comet" variety, which was distributed to farmers in 1983. This was produced in the second rains and extraction for oil began in 1984. A second expeller was acquired for the Gulu Diocese in February 1985.

Although there is a clear knowledge that the black varieties have a higher content of oil, no exact records have been kept either on their yields in the field or in terms of oil. Oil content varies greatly among the different varieties of sunflower grown in Uganda. Study team analysis, using solvent extraction, showed large differences as can be seen in Table 6 below:

Table 6

OIL CONTENT ANALYSIS OF OIL BEARING SEEDS SAMPLED AT VARIOUS LOCATIONS IN UGANDA DURING PERIOD FEB TO APRIL 1989.

Sunflower	Oil Content of Kernel	Hull Content of Whole Seed	Oil Content of Whole Seed
Black, small size	53.0%	28.12%	38.09%
Black, Ave size	49.8%	30.0%	34.86%
Mixed, Ave size	50.0%	42.63%	28.68%
Black & White Stripped	47.3%	40.0%	28.38%
Buff stripped	47.7%	41.0%	28.14%
Buff	44.6%	42.1%	25.82%
White	42.7%	40.4%	25.45%
Paradovic	59.0%[26]	25.0%	44.25%

Source: Tests by Derrick Burgess, 1989.

24 See List two of the annexes.

25 Arlo P. Thompson, "An Assessment of Sunflower Production Potential and A Research Plan for Uganda, USAID/MFAD, Kampala, 1988.

26 The oil content was estimated as complete drying was not obtained due to electricity failure.

By comparison, seed imported for the variety testing program were analyzed by Overseas Development Natural Resources Institute (ODNRI) at Abingdon Oxfordshire, U.K. Their report to USAID/Kampala gives the following oil contents of the different varieties:

TABLE 7

SUNFLOWER SAMPLES FROM UGANDA FROM USAID PROJECT (NOV. 28/1989)

Reference (variety or type)	Percent Oil (Moisture Free Basis)	Percent Moisture
Record	46.5	6.0
Kabantolo International		
201	40.7	7.9
202	44.0	7.2
203	45.5	7.0
204	43.6	7.1
211	47.7	6.9
222	45.1	7.2
Mubuku Interstate		
201	48.8	7.1
209	47.7	7.0
210	51.7	6.7
211	42.7	7.9
214	41.3	8.1
Entry IS7000	52.1	6.7
Mubuku International		
203	47.8	6.7
209	49.9	6.9
213	45.9	7.4
214	39.7	8.1
223	44.6	7.3
225	40.7	8.0

Source: Report of Dr. S.W. Head, ODNRI, Jan 5, 1989.

B. SOYBEANS

1. Introduction and Production

The production of soybeans[27] in Uganda has been going on for a number of years but total production remains relatively small, around 9,000 metric tons per year. However, increased interest has been given to the soybean as an oilseed crop for several reasons. First, there is a growing market for soybean products for human food, such as soy flour, full fat flour, soy-maize mixture, etc., primarily due to the work of Africa Basic Foods. Second, a demand exists among the livestock feed processors for soybean meal as a protein supplement in prepared feeds, particularly for hogs, poultry and dairy. Third, soybean appears to grow reasonably well in many parts of the country, and can therefore be offered as an alternative cash crop. Fourth, soybeans can be beneficial in crop rotations due to their nitrogen fixing potential.[28] As a consequence, serious research is now on-going by the Department of Agriculture in varietal selection of soybeans from several sources to select appropriate cultivars for production in Uganda. Some research on agronomic factors relative to the production of soybeans is also being done, but this needs further emphasis.

The introduction of soybeans (or soyabean) into Uganda was given as 1907-1909 by S.K.Mukasa[29] with U.S. seed, but these attempts were apparently unsuccessful. In 1911, Chinese, Japanese and South African varieties were introduced, and by 1920 the East African Departments of Agriculture were conducting trials. Special emphasis to grow soybeans were made during World War II. The largest estimated acreage was in 1944 with about 40,000 acres. In Buganda, 4,020 tons were marketed that year. A peak of 4,314 tons valued at 38,799 pounds sterling were exported in 1950. After this, the area dropped quickly to about 1,000 acres. There has been some renewed

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27 The spelling used in this report is the United States spelling "soybeans" as opposed to the more common spelling outside of the United States "soyabeans."

28 Although this has not been proven in Uganda, mainly because of the lack of appropriate rhizobium in the soil, and lack of innoculants to incorporate it. Nitrogen fixation is accomplished through taking nitrogen from the air and fixing it in nodules on the roots. This is caused by Rhizobium japonicum in soybeans, which may not be present in Uganda.

29 S.K.Mukasa, "Soybeans" in Jameson, ed., 1970.

interest in soybeans since 1965, and production is currently estimated at about 9,000 metric tons on about 12,000 hectares.[30] Much of the current crop is being bought for export by the Produce Marketing Board, for a barter agreement with Yugoslavia.

Hittle[31] notes that experimental yields of the order of 1,100 kg/ha were obtained in 1955 without the use of fertilizer (968 lbs/acre or about 17 bushels). It would appear that current yields on Ugandan farms are at about this level. In addition to the level of crop husbandry and the tendency to inter-crop, yields are probably also affected by the practice of farmers to harvest the crop before maturity to prevent shattering. The resulting seed shrinkage, commonly seen with seed inspection, probably lowers yields.

2. Agronomy

The first serious work in soybean research is now being conducted by the Department of Agriculture. Although many INTSOY trials have been received in Uganda since 1973, the political and security conditions in Uganda prevented these from being reported. Currently, Uganda is doing varietal trials with IITA breeding lines as well as INTSOY lines among others.

Agronomic research, as well as varietal testing is also needed in Uganda if soybeans are to become a serious oilseed crop. These include the usual trials of fertilizers, planting times and plant population, weed control and rhizobium and inoculation. More importantly will be the studies of production under various levels of mechanization, from totally hand hoe operations to full mechanization. These studies are needed to determine if soybeans can compete seriously with other oil seed crops for a place in peasant or commercial farming.

3. Markets

There is some concern in Uganda about assured markets for soybeans. Currently only Africa Basic Foods is a consistent and perennial buyer. They process soybeans into soya flour and high protein food products of soybean and maize flour. The feed mill in Jinja has occasionally purchased some soybeans for processing into livestock feed. In those instances they usually process the beans through the EOSIL's Iganga oil expellers, and mix the partially defatted cake as one ingredient in livestock feed.

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30 See annex tables on crop production.

31 Carl N. Hittle, "Soybean Development in Uganda," USAID/MFAD, October, 1987.

4. Economics

Soybeans, yielding 20 bushels per acre, will give 1272 kilograms per hectare. These yields are considered only mediocre at the present time in most countries where soybean production is important. Yields of 50 to 60 bushels per acre (3,000 to 3,600 lbs or 3,400 to 4,090 kgs/ha) are now common in many areas of the U.S. If we assume a yield of 1,000 kilograms per hectare as an average for Uganda, (880 lbs per acre) or 15.7 bushels per acre, at the current price of 50 shillings per kilogram the gross return will be 50,000 shillings per hectare. ($125.00). This would yield 100 kgs. of oil per hectare[32] and about 850 kilograms of cake. This compares with a yield of 10 kilograms of oil and 90 kilograms of cake (plus 100 kilograms of ginned lint) from cotton under historic yields of 300 kgs of seed cotton per hectare. The value of soybean meal is about 45 shillings per kg. or 38,250 per hectare with 1000 kg/ha yields. The value of oil (5 times 6,000 shillings, the wholesale price of oil in Uganda in the spring of 1989) or 30,000 shillings brings the total gross returns of 68,250 shillings per hectare on an economic basis (that is the economic value of the products in country). For the farmer, cotton will yield 300 kgs selling for 80 shillings/kg, or 24,000 shillings per hectare. On the world market, lint is worth 55 cents per lb. or 22,000 shillings per hectare (at 100 kgs of lint per hectare X 55 cents at 400=$1.00). The combined value of lint and oil is 25,000 shillings and cake is another 2,000 to 2,250 shillings for a total value per hectare of 27,000 shillings. Thus, the value of soybeans is 41,250 shillings per hectare greater. This of course, presupposes that yields can be maintained at slightly above the past national average. For cotton to be competitive with soybeans, yields will have to average over 600 kilograms of seed cotton. Under good crop husbandry these yields are possible, as was experienced under group farm cultivation in the 1960s.

5. Composition

Soybeans will vary in chemical composition among varieties and growing conditions. However, an average composition is 40% protein, 20% lipid (oil), 35% carbohydrate, and 5% ash on a dry weight basis.[33] Removal of the oil, even by the most efficient solvent extraction methods, will still leave about .05% in the cake. Thus,

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32 This implies only a 10% extraction rate of oil which is low. The soybean, on average, will contain 20% oil, and under solvent extraction 18-19% will be extracted.

33 Harry E. Snyder and T. W. Kwon, Soybean Utilization, Van Nostrand Reinhold, New York, 1987.

the crude protein level of the cake will be about 50%.

6. Processing

Processing soybeans for oil can be done by either solvent or mechanical extraction. In either case, the oil extracted is treated much the same as other vegetable oils, and the meal or cake fraction is used for either animal protein or human food. The major nontriglyceride fraction in crude soy oil is the phospholipid. This is usually removed from crude oil by a water washing step known as degumming. Soy oil contains 1-3% phospholipid which is much higher than most other oils. It must be removed before deodorizing the oil, otherwise the high heat treatment will cause the oil to color. Otherwise oil refining is identical to most other oils.

7. Trypsin Inhibitor

Raw soybeans, when fed to some young animals, can inhibit growth. It was discovered that this is primarily due to the inhibition of the production of trypsin, a digestive substance produced in the pancreas. Special processing is necessary for the defatted cake in order to deactivate trypsin inhibitors, or lipoxygenase. The trypsin inhibitors can also be deactivated if the beans are prepared by heating, roasting or extrusion before oil extraction. The usual way to deal with the trypsin inhibitors in soybeans is to treat the beans or the soybean meal with heat. This can be done using live steam at 100° C. for 30 minutes. This will inactivate about 90% of the trypsin inhibitor according to Snyder and Kwon.[34] Heat treatment of soybeans or meal, however, must be done so that the highest level of trypsin inhibitor is inactivated without the loss of the essential amino acid lysine. It is clear that about 80% of the trypsin inhibitor is inactivated in the first 10-12 minutes of heat application, and that there is a negative impact on the protein efficiency ratio.[35] It is also true that heat treatment only impacts on one of the growth inhibitors in soybeans, albeit the most significant one.[36]

A recent development has been the use of extrusion to either prepare soybeans for full fat soya products, or as a preconditioner to mechanical or solvent extraction. In tests done in Illinois, processing soybeans through an extruder inactivated 90% of the

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34 Harry E. Snyder and T.W. Kwon, Soybean Utilization, op cit.

35 Snyder and Kwon, op cit.

36 Ibid.

trypsin inhibitors.[37] In this instance, the time within the extruder was less than 30 seconds, and the temperature was raised to about 135° C. In processing, the machines were manipulated so that the extrudate emerged in a semi-fluid state. It was found also that the material tended to scorch in temperatures over 148° C. Pressing the extrudate direct from the extruder at temperatures of 135° C. recovered the maximum oil. Leaving the material overnight before expelling caused a large reduction in the recovery of oil. Oil recovery rates were as high as 69% using a Carver press. When a Simon-Rosedown Mini-40 screw expeller was used, oil recovery was a maximum of 58.98%. Oil recovery rates from soybean extrudate of over 73% were achieved with the ZYB-78 Chinese expeller, and over 71% with the ZX-10 Chinese expeller. The main factor in these tests seems to have been better extraction rates as the length to diameter ratio of the screw was increased, and an appropriate design to facilitate transport of the material forward in the expeller barrel.[38] In that regard it was apparent to the researchers that a worm shaft with a continuous flight was necessary for satisfactory operation with soybeans, particularly after extrusion.[39] Using the ZYB-78 expeller the following results were given:

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37 A.I. Nelson, W.B.Wijeratne, S.W. Yeh, and L.S. Wei, "Dry Extrusion as an Aid to Mechanical Expelling of Oil From Soybeans," University of Illinois Department of Food Science, Urbana, Ill, in Journal of the American Oil Chemists Society, Vol 64 no. 9, Sept, 1987.

38 Ibid.

39 Ibid.

TABLE 8

Analysis of Whole Soybeans, Extrudate and Press Cake Obtained From the ZYB-78 Oil Expeller.

	Ground whole soybean	Whole soybean extrudate	Whole soybean press cake
Protein, %	41.94	42.62	50.14
Oil, %	20.28	20.95	6.52
Total ash, %	4.81	5.18	5.96
Carbohydrates, %	32.97	31.21	37.38
Total dietary fibre, %	17.26	16.85	19.35
Trypsin inhibitors (mg/g defatted solids)	48.84	4.36	3.02
% destruction of trypsin inhibitors	0	91.0	93.82
Protein dispersibility index, %	88.83	14.99	12.65
Color, visual	cream yellow	light brown	cream yellow
Color, Hunter a/b ratio	0.066	0.205	0.096

Proximate constituents as reported on a dry basis.
Source: Nelson, et al, JAOCS, Sept. 1987.

The researchers also reported that many samples of the oil were held in bottles at room temperature for over a year without becoming rancid. They therefore felt that in many cases it would have potential as an edible oil without further refining.

In another experiment, full fat soy flour was made by roasting whole soybeans in a heated agitated salt bed followed by dehulling and grinding. Protein efficiency ratios (PER)[40] usually begin to decline quite rapidly after ten minutes of heating. During the first ten minutes of heating, the inactivation of the trypsin inhibitor causes the PER to rise. After that it will fall. The presence of some moisture during heating is considered beneficial in that it greatly increases the inactivation of trypsin

[40] The PER is a measure of protein quality in nutrition given by weight increase/weight of protein fed X 100 under carefully prescribed feeding conditions with young rates. See Snyder and Kwon, op cit.

inhibitor.[41] However, in this experiment it was found that the trypsin inhibitor could be inactivated by dry roasting on a bed of heated agitated salt at temperatures of 206-234° C for 15-24 seconds. At the higher temperature and 15 seconds of roasting, 90% of the trypsin inhibitor was inactivated. Although the authors did not experiment with oil extraction after this roasting process, they found that excellent full fat soy flour could be produced with this method with a high protein quality.[42]

In Uganda, Africa Basic Foods has produced full fat soya products using an extruder. They have also just begun experimenting with a novel design which includes a drainage area in the barrel of the extruder. The hope is that the soybeans can be partially defatted during the process of extruding the beans. If this process succeeds in even removing 50% of the oil, then processing of the national crop could contribute up to 900 tons of edible oil. Probably more interesting would be to test such an application with groundnuts.

A logical step in Uganda would be for a plant like that owned by the Cooperative in Tororo to be equipped to either pretreat soybeans with live steam prior to expelling or to equip the plant with an extruder that can process the soybeans just ahead of the expellers. It is not likely that the current steam cookers with which the expellers are equipped will be adequate to inactivate the trypsin inhibitor. However, some test runs could be done and laboratory analysis performed on the cake to determine the effectiveness of the current equipment. Given that experimental work has shown that about 80% of the trypsin inhibitor[43] was deactivated in 6-10 minutes at 100° C, it is possible that current equipment will suffice in the new oil plant.

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41 Snyder and Kwon, op cit.

42 G. Richard Hansen, J.M. Harper and Lousie A O'deen, "A Research Note: Nutritional Evaluation of Full-Fat Soy Flour Produced By Dry Heat Roasting," Journal of Food Science, Vol. 43, 1978. Institute of Food Technologists.

43 Note that in most experimental work, when 55% of the trypsin is inactivated, no adverse growth effects were noted as measured by no enlargement of the pancreas where trypsinogen is produced. Trypsin is necessary to hydrolyze protein in the small intestine.

C. GROUNDNUTS (PEANUTS)

1. Production

Although groundnuts are reported to have been introduced into Uganda before 1862 (G.E.D. Tiley), serious work on groundnuts by agriculturalists did not begin until the 1920s. By the 1963/64 agricultural census, an estimated 380 thousand acres were being grown, generally in pure stands. The major producing area was in the Eastern Region of Busoga, Bukedi and Bugisu, where over 45% of the crop was grown. the majority of the groundnuts grown in the 1960s were the Valencia varieties, preferred for ease of production and higher oil content. Problems with rosette disease had been recognized in 1962, and the variety Mwitunde was considered an available resistent variety.

2. Yields

Yield trials of groundnuts in 1961-63 were conducted in the first rains, chiefly in the Eastern and Northern Regions. Of 73 trials, yields ranged from 763 to 2,240 lbs of dry unshelled pods per acre. (867 to 2,545 kgs/ha). Although the yield performance of these trials should not necessarily be taken as optimum, they suggest some current limits to expect from groundnut production.

TABLE 9

Mean Yields in Groundnut Trials in the First Rains of 1961-63.

Mean yield in lb unshelled pods per acre and number of trials (in brackets).

Variety	Group	Eastern Region	Northern Region	All Trials
B1	Valencia(red)	1211(48)	1501(22)	1329(73)
Acholi White	Valencia(white)	1077(28)	1671(12)	1283(41)
B239	Spanish	1731(10)	1456(3)	1667(13)
Natal Common	Spanish	1025(35)	1624(16)	1244(53)
Bukene	Spanish	1299(3)	1888(3)	1609(7)
Etesot	Spreading (brown)	887(48)	763(7)	851(24)
Amasoga	Spreading (brown)	827(48)	1276(22)	992(73)
Mwintunde	Semi-erect	1213(48)	1376(22)	1268(73)
Mani-Pintar	Spreading (red&white)	1655(3)	2248(3)	2003(8)

Source: G.E.Tiley from Jameson, 1970.

3. Markets

At the moment, groundnuts sell for about 200 to 220 at farmgate (although lower prices were reported in some parts of the country, notably in the southwest). This means that the oil (40% yield) would need to be sold at 482.5 shillings per kilogram if the meal (60% yield) would have a worth 27,000 (equal to soybean meal). Although this is possible, at current market prices for oil of about 500 - 550 shillings per liter, this leaves only a margin of 17.5 to 68.5 shillings per kilogram for processing.

Crushing of groundnuts for oil is currently not considered economical because of the high farmgate and market prices groundnuts command. This high price reflects the demand for groundnuts as a food, both in traditional dishes based on groundnut and for confectionery use. Groundnuts, in the 1960s, were crushed on a small scale in Uganda. Millers in the 1963-65 period reported purchasing on average about 5,000 tons of the seed according to Coles. However, Coles estimated that millers only crushed about 2,000 tons of the seed, the rest was bought, shelled and resold without crushing. Coles calculated that this situation pertained because the prices of groundnuts as a food even then were more attractive than the returns from processing. In addition, the some groundnuts were also exported. In the early 1960s, this had been fairly substantial, but by the middle of the decade, export volumes were already declining.

TABLE 10

EXPORTS OF GROUNDNUTS FROM UGANDA 1961-1965

	Export Price f.o.b. Mombassa Shs/ton (2240)	Export Price less transport cost to coast Shs/long ton	Quantity Exported in long tons
1960	1156	1084	9507
1961	1182	1110	9179
1962	952	880	7247
1963	1052	980	3500
1964	1174	1102	3804
1965	1556	1484	316

Source: East African Customs and Excise, Annual Trade Reports of Tanganyika, Uganda and Kenya, 1960-65, in Coles.

UGANDA OILSEEDS, JULY 10, 1989

According to J.C. Davies[44] groundnuts stored in the shell in Uganda are not attacked by insect and damage is confined to broken or damaged nuts. However, as soon as they are shelled they quickly suffer heavy infestation. They should be stored at about 8% moisture content to prevent the free fatty acids from increasing and to prevent the development of mould and fungi.

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44 J.C. Davies "Insect Infestation and Crop Storage", Chapter 15 of Jameson, ed.

D. SIMSIM (SESAME)

1. Production

This crop is grown mostly in the northern part of the country. The 1963-64 agriculture census gave acreage of 257,000 acres, with 80% grown in the northern region. This corresponds to the Department of Agriculture estimates given in Annex 3, Table A3.1. National production appears to have peaked at 42,000 tons, but usually has been around 32,000. studies cited by D.G.Thomas[45] suggested that acreage had not changed substantially since the 1930s, and were probably experiencing competition from other oil crops.

2. Agronomy

In Uganda, the usual practice in most farming systems is to grow simsim during the second rains following a crop of finger millet, mixed with pigeon peas, although some farmers prefer to grow it in open land.

Normally a dry weather crop, sesame is generally known as a low yielding but also low cost crop. In many cases farmers do little if any land preparation before planting simsim. In some cases, the seed is simply broadcast after the millet has been uprooted. Seed is broadcast at a rate of about 5-10 kg per hectare. Although the crop is quite drought tolerant, it needs good moisture at seeding in order to establish the plant. Thinning and some weeding is usually done after plant emergence, and little other husbandry is performed. Plants are cut when leaves start to dry up, and the plant is stacked and dried for a few weeks before threshing.

Thomas reported in 1962 that many introductions of varieties had been done but none had proved outstanding. Those of the non-shattering type had proved susceptible to leaf diseases.

3. Yields

In some parts of the world, notably Japan and Israel, the yields are over 1,000 kilograms per hectare. However, under less intensive cultivation practices, sesame seldom yields more than 300 kilograms, and in Uganda it probably does not yield more than 100 to 150 kilograms per hectare, although D.G. Thomas (in Jameson, ed.) noted that yields of 300 lbs per acre had been attained. Davies notes that simsim is little damaged if stored for a short time, but can become heavily infested with pests if stored for a year or more.

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[45] D.G. Thomas "Sesame", In Jameson, 1970.

4. Processing

Sesame seed was reported to have been important to the edible oil industry in the past, but no data is available on volumes processed. Given that there were only 3 or 4 oil mills in the country before 1940, and little cottonseed was crushed, it is probable that these mills processed sesame. By 1965 Coles recorded only 400 tons processed by the millers. The reason for the low volume was given as unavailability of seed. Coles estimated that for the 1961 to 1965 period, a maximum of 500 tons was crushed in any one year.

Oil content was given by Thomas as between 44 and 54%, and a protein content of cake between 19 and 25%. In Uganda, simsim is usually processed at home for oil by pounding and adding boiling water, or eaten as whole seeds in prepared dishes. Almost no commercial processing has been done.

E. OIL PALM

Some work in oil palm has apparently been done since the 1960s in Uganda. At the Kituza Coffee Research Station near Kampala[46], trees that had been planted in 1961-2 are still there. These plantations, however, do not seem to have been very serious attempts at growing oil palm trees, and were probably done by research staff for their own interest. Given the interest in oil palm by the private sector in Uganda and the current experience of the Agricultural Researchers, further investigation of the crop, processing the fruit and kernels, use of by-products and propagation of new plants was undertaken. A report of that investigation is given in the next chapter.

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46 12 miles on the Jinja Road at Mukono, 8 miles to the right.

CHAPTER V - THE OIL PALM

A. INTRODUCTION

In March 1970, the Institut de Research pour les Huile et Oleagineux (IRHO), a French research group proposed that Uganda participate in an oil palm field trial.[47] In accordance with a program to develop alternative crops, Uganda agreed and placed the effort under the coffee research unit. Pre-germinated seeds of oil palms were imported from La Me, Ivory Coast. This is reported by the station staff to have been 8 varieties of hybrid trees. The completion of germination of the seeds was done at Kawanda in April - May of 1971. Plants were then placed in small plastic pots until september of 1971 when they were re-potted to larger plastic pots. They were then planted out in the field in October of 1972.

They were planted out in 6 replications on 4.5 hectares at Kituza Coffee Research Station, Mukono district. At the same time, similar plantations were made by the Department of Agriculture. Three other sites, in Jinja District at Nakabango VTC, Masaka District on Ssese island in Lake Victoria, and West of the Rwenzori Mountains at Bubukwanga in Bundibugyo, Kabarole District, in an area that had idigenous palms, each had the same trial plot established at that at Kituza. We visited the Kituza plantation.

The trees are planted in a 9m X 9m triangle, which gives a plant population of about 140 trees per hectare. The Kituza plantation had 640 trees on approximately 4.5 hectares. The trees started producing oil about 4 years after planting. This could be verified by the existence of one young volunteer tree that was about four years old and had 6-7 bunches of fruit.

Of the 8 varieties planted, the researchers reported that 3 of the varieties are significantly better than the others. 2 Varieties were reported to be quite poor. The researchers reported getting about one ton of oil per hectare per annum from the plantation. This could not be verified, as the actual records were not available. However, it seems logical. First, the trees currently are harvested about every two months (that is each individual tree, overall harvesting is more frequent). The fruit bunches range in weight from about 15 kilograms up to 45 kilograms, with most appearing to be in the 20-25 kilogram range. Two to four bunches

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47 Dr. Israel Kibirige-Sebunya, head of the tree crops research program, "Brief Notes on the Oil Palm Crop and Its Potential in Uganda,", mimeo, March 1988. further information was gathered from discussions with station staff at Kituza.

can be harvested at a time.

The gross fruits removed from the bunches were 20% of the bunch weight, giving 3 to 9 kilograms of fruit. The fruit to kernel ratio could not be determined as we had no weighing device with us. However, it would appear to be about 30% kernel. The station now discards the kernel as they had no way of decorticating and extracting the kernel oil. This would not be difficult. The hard kernel should crack easily in a roller crusher or flail apparatus. The kernel meat can then be processed in an expeller. This oil is usually the better oil of the palm. It is used in the manufacture of margarine and culinary oil. The cake is also more valuable for feed than the meal from the pressed fruit.

The station now extracts the oil by a simple process. First the fruit is boiled with water for 45 minutes to 1 hour. It is then pulped with a mortar and pestle to remove the kernel. The pulp is then reboiled and the fat skimmed off of the top. Further boiling will reduce some of the heavy fat, clarify the oil somewhat, and also help to deordarize and neutralize the oil. Because of the crude method of oil extraction, the yield is not high. However, it appears that they are recovering oil at the rate of about 11% of the gross fruit, and about 20% on a pulp basis.[48]

The station reports getting about one ton of oil in the above fashion. This yield could likely be doubled if harvest was more timely, improved steam extraction and an expeller was used for the extraction of oil from the fruit, and the kernels were decorticated and the kernel oil extracted with an expeller.

The oil palm plantation had not received any inputs of any kind since it was established. In fact it was reported that due to lack of funds and negligence, the plantations at Kituza and Nakabango went back to secondary forest which were not cut down until after 1981. The station staff reported that all they have done is harvest the fruit, weigh the bunches, record the number of fruits per bunch and the weight of the gross fruits. No chemicals have been used, nor fertilizers. The plantations at Kalangala and Bubukwanga have not even been visited since 1976.

Given the treatment and care provided it is surprising that any trees survived. The plantation showed no signs of disease or insect problems, or stress to the trees. Most of the trees were fruiting at about 12 to 15 feet from the ground. The staff report that yields are still increasing on the trees, and as the trees mature,

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[48] Dr. Kibirige-Sebunya states that "only about 55% oil yields or less, have been realized." We would question this, see our section on yields of oil below.

they give heavier but somewhat fewer bunches. This is exactly as expected from palms of this age.

One private company, Fourways, has acquired seeds from the better varieties at Kituza. They have produced seedlings which they planted on about 15 acres in 1984. This plantation is now just coming into production, and they report being very encouraged by the condition of the trees. This plantation, near Massaka, was established as a test plantation to determine if commercial plantations would be feasible in the area where the company owns land. They are not planning on production of edible oil, but rather have intended to aim at the soap industry. If it works, they are planning on their own oil factory and soap factory.

The concern of Fourways about oil palm for edible oil stems from the recent worldwide uneasiness about the health aspects of palm oil. However, this problem is not fully researched. Malaysia, for example, has countered U.S. claims of oil palm increasing blood cholesterol with examples of research showing the opposite. It is true that palm oil is not high in cholesterol, generally levels being lower than soybean oil. However, palm oil is generally higher in saturated fats than many other vegetable oils. This can be partially corrected during processing to produce a fraction high in oleic.[49] It certainly should not be a concern at this stage, given the low intake of all types of oil in Uganda. Fourways' concern is that if they invest heavily in establishing plantations and reach a stage in the future where exports are required due to local market saturation, that oil palm will not have a favored market position internationally. Although that may be true, and it is not certain that Uganda would ever be competitive with Malaysia, there is certainly a regional market for palm oil in East Africa. Even if the regional demand is not for edible oil, there still exists a large market for soap stock.

The oil palm is the highest commercial oil producing plant in terms of oil production per given land area grown in the world. There are a number of reasons to believe that oil palm has the potential to supply the oil and fat requirements of the country on a commercial basis. First among the various reasons is that it is now growing fairly successfully in Uganda, albeit on a limited scale. Because of this a general description of its husbandry and the oil extraction process are presented to help government and private investors evaluate what they might do with this crop.

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[49] See Chapter V, Section I, below.

B. PLANT GENESIS

The principle palm commercially exploited for oil is Elaesis guineesis, which belongs to the palm subfamily Cocoideae. The Elaesis genus is generally classified into three varieties: dura, a thick shelled wild variety found in Africa; tenera, a thinner shelled, generally wild, variety having usually more mesocarp than the dura; and pisifera, a thin shelled or shell-less variety. The tenera is now known to be a natural cross between the dura and the pisifera.

The oil palm has been extensively researched in recent years, particularly in Malaysia, which has become the world's largest producer. Originally starting with four dura palms that had supposedly been introduced into the Bogor Botanic Gardens in Java from Africa, most commercial palms in Asia and Africa can be traced to these foundation plants. These were known as the "Deli dura", which are a thick shelled variety. Most modern plantations are of the tenera variety which was developed from a cross of the dura variety with the pisifers variety, primarily from a few palms from Zaire.[50] Development of the tenera variety has reportedly increased yields in Malaysia by 25% over the dura types.[51]

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50 See J.J. Hardon, R.H.Corley and C.H. Lee, Chapter 3 "Breeding and Selecting the Oil Palm", in A.J. Abbott and R.K. Atkin, Improving Vegetatively Propagated Crops, Academic Press, 1987.

51 S. Mielke, "Past and Prospective World Production and Exports of Palm Oil," in Palm Oil, edited by F.D. Gunstone, John Wiley and Sons, 1987. Hardon, et al, give yield increases of "at least 30% higher than the duras in the same D X T progeny." op cit.

C. NATURAL CONDITIONS FOR PRODUCTION

The oil palm generally grows in an area of 10° on either side of the equator. It prefers an evenly distributed rainfall of about 80 to 90 inches per year,[52] but does reasonably well in regions with as little as 60 inches of rainfall and marked dry seasons.[53] In the latter case, the effect of soil moisture can be important, and the greater ability of the soil to retain moisture, or the presence of high water tables can overcome the impact of less rainfall on yields.

Oil palm does best on damp but well drained alluvial soils or marine clays or well textured volcanic soils. The soil should have a depth of three feet with no impediments to rooting. Preferably the soil would not be too sandy and not have large stones or rocks. A strong structured soil with good friability is considered ideal. Land improvements such as drainage to insure that the water table remains below the surface in flat or low-lying areas preferably allowing drainage to about three feet of depth are recommended. Slopes up to 30° - 35° can be planted but terraces or individual basins in hilly country will help yields. Extra acid soils with a ph less than 3.5 to 4.0 should be avoided.

The oil palm likes 6 or more hours of sunshine each day, and yields are often reduced where the daily average is below this. In Malaysia, where this much sunshine is the norm higher yields are obtained than in Nigeria where average sunshine in the oil palm growing areas is 4.5 hours with minimums of 2.5 hours. A mean monthly temperature of 25 to 29 degrees centigrade (77 to 84 degrees fahrenheit) is considered ideal, with a minimum temperature of 18 degrees centigrade (64 degrees fahrenheit).[54]

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52 B.S. Gray, A Study of the Influence of Genetic, Agronomic and Environmental Factors on the Growth, Flowering and Bunch Production of the Oil Palm on the West Coast of West Malaysia, PhD thesis, October, 1969.

53 B.J. Wood, op cit.

54 Although these appear to be ideal temperatures based on yield performances in current producing areas, no research data relative to temperature could be found.

D. PROPAGATION

The oil palm is most often developed from seeds of a cross of the dura and pisifera varieties. In many areas seed preparation is done merely by rotting off or scraping of the mesocarp (the oil bearing fruit), and geminating the seeds in warm sand. In many modern plantations plants are developed from pre-germinated seeds, which have been prepared in dry heat incubators. The pre-germination of seeds is done either in research centers or nurseries operated by an oil palm growers association. The oil palm seed germinates quite slowly under natural conditions, and ideally the commercial grower will want plants that germinate and grow at the same rate. This is because slow germinating or slow growing plants in the early stages reportedly lose sufficient vigor that their later production level is impaired. Dr. Israel Kibirige-Sebunya[55] notes that "In Africa....,it is often necessary to apply artificial heating in the form of fermenting vegetable matter, a wood fire, steam, hot water pipes or preferably an electric incubator (or germinator) with standard controls." He further suggests that a heat application of 39.5^{o} C for 80 days is adequate. This is then followed by cooling to ambient (air) temperature and maintaining optimum humidity, in which germination will be evident in about 15 days. Gray,[56] gives a figure of using dry heat for 60 days for germination in Malaysia, after which plants are planted into bags where they are kept for 12 months before planting into the field. Incubation in plastic bags is usually done at nurseries on the private plantations in Malaysia.

Currently work has been concentrating on the use of tissue culture to increase yields. By 1984 Malaysia had already planted out between 1000 and 2000 hectares of tissue culture developed plants,[57] and it was expected this would lead to yield increases of a further 25%. Wood[58] noted that the recent work of cloning oil palms by in vitro tissue culture was being done in at least three centers. Initially tissue culture was from seedlings which were of unknown performance, but some are now being produced from outstanding mature palms (ortets) selected in the field. It appears that the narrow genetic base of most commercial palms has led to a high

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55 Dr. Israel kibirige-Sebunya, "Brief Notes on the Oil Palm Crop and Its Potential in Uganda," mimeo, March, 1988.

56 B.S. Gray, op cit.

57 S. Mielke, Ibid.

58 B.J. Wood, "Growth and Production of Oil Palm Fruits,", In Gunstone, op cit.

degree of inbreeding and a consequent wide variation in yields of individual palms. Thus, use of vegetative propagation[59] of individual high yielding plants can give large yield increases over plants produced from seed. In addition to a yield increase expectation that comes from tissue culture other advantages are more uniform planting material, more rapid selection progress in breeding and ease of introduction of new genetic material. Disadvantages are mainly that genetic exactness in large plantations risks destruction from an epidemic pest or disease outbreak. This should be reduced by selecting clones of several high yielding trees for a single plantation. L.H. Jones of Unilever Research Laboratory[60] recommends using at least 10 or more good clones in any block. Tissue culture may also be more expensive than producing trees from seeds.

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59 The palm has a single growing point, and no natural means of vegetative reproduction. Thus tissue culture appears to be the only vegetative reproduction that can be used.

60 In Chapter 23, "Clonal Propagation of Plantation Crops", in Abbot and Atkin, Improving Vegetatively Propagated Crops.

E. CROP PRODUCTION

Field planting of young palms is usually done when they are from 12 to 18 months of age, and have attained a height of 80-150 cm. Young palms do not like shade, and therefore it is generally recommended that they be planted out into cleared fields. Planting under other crops, especially tree cover, was not recommended in Malaysia, although some work has been done on planting under existing palm as a replacement for old plantations.[61] The most preferred spacing of oil palm trees in the field seems to be on a 9m X 9m X 9m triangle. Wood notes that the palm cannot adapt to fill an available space as is the case with many plants. Therefore the triangle configuration seems the best for the development of the circular crown. This will result in a plant population of about 150 per hectare. There may be economic reasons to increase the density in order to obtain higher per hectare yields in the early years. However, an adverse impact on yields will result in latter years unless systematic thinning is practiced. Densities as low as 112 plants per hectare are practiced in some areas. It has generally been observed that as density increases, total dry matter production increases, but the ratio of bunches to dry matter, the Bunch Index, declines.

The immature period of the palm is about 27 to 36 months, after which production should start. In this period, almost all floral primordia abort, and they bear no inflorescence. Sometime into the second year in the field, some primordia will began to develop. The abortion rate will remain high, however, and will continue as high as 40% up to 7-10 years after planting. As the plantation matures, this abortion rate will decline to about 10% in mature trees. The time measured from initiation to anthesis (opening of flower) was 33-34 months by Gray.[62] Each inflorescence contains the primordia for both male and female flowers (monoecious) and the sex that develops is determined before anthesis. Gray found that this was not more than 20 months before anthesis, as sex was already determined in 40-45 inflorescence. Sex differentiation and anthesis took, therefore, about 2 years. This concern is important for two reasons. First, there appears to be a relationship between the sex determination of the inflorescence, abortion and fruit setting and plant stress. In other words, rainfall, fertility and management

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61 B.J. Wood, op cit.

62 B.S. Gray, Op cit. Gray's work covers the entire plant development, and was supported by the dissection of a large number of mature oil palms, which is the only way a full study of the flower and fruit development can be done.

of the plantation will not be noticed in production for a period of months. This is based on 25, 11 and 6 months on sex, abortion and fruit set respectively.

In some commercial plantations, managers practiced "castration" whereby the inflorescence were removed when the trees were young. In experimental work reported by Gray, this delayed the first harvest from an average of 36 months (range of 22 - 48 months) to 4.5 years. Although latter yields of the "castrated" trees were greater, and possibly they produced longer, the overall effect was to reduce yields in the early years, and therefore the time of payback of investment.

The palm is a series of leaves that continue to grow from inside the stem. Eventually the tree will have about 50 leaves, although producing trees are usually pruned to about 24-26 leaves when they are younger, and 32 - 40 are retained in older palms. The inflorescence are borne on the leaf axils, normally one per leaf. The pedule will be about 30-35 cm long. The female will have several thousand flowers, the male 700-1200 producing 25-50 g of pollen. The fertilized female flowers become fruit which will develop in about 6 months. The removal of old fronds is usually done in conjunction with harvesting of fruit bunches. Excessive removal of fronds is reported to lead to crop loss. The stem width will be about 22 to 75 centimeters, and the plant will increase in height from between 30 and 60 centimeters per year. The economic life of a planting is normally between 20 and 25 years.

The mature fruit bunch contains from a few hundred to a few thousand individual fruits. Fruit bunches can weigh from 5 kg in poor young palms to 40 kg in healthy mature palms, although some reports of 50 kg bunches have been noted.[63] Individual fruit sizes range from 8 to 10 g. The fruit consists of an exocarp, or the outer skin, the mesocarp which contains palm oil and water in a fibrous matrix, a seed which is contained inside the mesocarp and includes and outer shell, and a kernel or white endosperm. The latter contains oil commonly referred to as palm kernel oil, which is extracted after cracking the shell, or decorticating the seed. The residual de-oiled kernel is used as a livestock feed. Commonly the mesocarp produces about 5 times as much oil as the palm kernel.

Gray estimated in 1969 that 7 to 8 tons per hectare of fresh fruit bunches could be expected after 6 to 8 years, and palms may reach peak yields in 4 to 6 years after planting in the field. However, with increased emphasis on tenera palms, more careful selection and better husbandry, Malaysia planters now expect yields considerably

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63 Kibirige-Sebunya, op cit.

above this.[64] The palm continues to mature up to about 18 years of age, when its yield will plateau. At this time, in Malaysia, yield averages are about 18.5 tones of fresh fruit bunches, yielding a crude oil of about 23%. These oil extraction rates have increased from 15-19% from the older Deli dura[65] to those now given for tenera palm.

In addition to the increased yields from the cross bred variety tenera , other factors are equally important in raising yields. The major ones are pollination, genetic variation, optimal development of the fruit for maximum oil, and general crop husbandry practices.

It was previously thought that pollination of the oil palm in Malaysia was entirely due to wind.[66] However, in the 1970s, it was discovered that insects were the means of pollination of oil palm. It was known that palms were pollinated primarily by 6 species of the weevil Elaeidobius in West Africa. A discovery was made that the palm was pollinated by a tiny insect thrips hawaiiensis in Indonesia and Malaysia.[67] After realizing that pollination was also due to an insect in Asia, experimental work was undertaken that led to the introduction of a pollinating insect Elaeidobius kamerunicus into Malaysia and Papua New Guinea. The result was significantly larger and more compact fresh fruit bunches and yield increases in the order of 25%.

There is a wide disparity among palm oil trees in the same plantation. Wood reports that "nearly all current oil palm plantings are from seeds from crossings. As usual in such cases, there is a wide variation and the overall characteristics of the plantings are dependent on the average from a range of genotypes. Thus, around 60-70 percent of the yield is usually produced by 25-

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64 S. Mielke, op cit.

65 Deli dura is the name given to the dura palms derived from the first imports into Indonesia. Of the four original palms imported in 1848, Gray found two of them still standing in 1969. Gray, op cit.

66 In fact, Gray, in his 1969 thesis, states emphatically that wind was the means of pollination in Malaysia.

67 In fact, Wood notes that it was only luck that this insect took over the role as pollinator in Southeast Asia, otherwise the oil palm probably would never have been introduced there as a commercial crop.

35 percent of the palms."[68] It is, in fact, for this reason that a great deal of emphasis has been concentrated on cloning known high producing trees through tissue culture. Results reported by Wood showed that in one test mean oil yield per palm was equivalent to about 6 tons per hectare, but 5% of the palms produced over 10 tons. In another test, where records were kept on 800 palms for 30 months, beginning when the trees had reached 8 years of age, the mean yield per hectare per year was equivalent to 24.6 tones of fresh fruit bunches containing 27.6% oil, or 6.8 tones of oil per hectare. But of this, the top 5 ranking palms produced the equivalent of 43-48.5 tones of fresh fruit bunches and several palms had oil to bunch ratios of over 30%. Included in this latter category were 2 of the 5 best yielders, which gave oil of 11.3 and 14.3 tons per hectare per year.[69] Because it is impossible to know the potential yield of a given plant when it is selected from seed, to insure that the high yield production from a given tree is obtained, only clones from tissue cultures taken from mature trees are certain to give high yields.

Oil yield per hectare is greatly affected by time of harvest. In Malaysia it was found that it can take up to 2.5 weeks from the time the first fruit ripens on a bunch until the last ripens. However, during the final week of ripening, it was found that the oil content may increase by as much as 80 to 100%. Leaving the fruit on the tree until optimum oil yield is gained has the disadvantage that ripe fruits will began to fall, and will have to be collected as individual fruits from the ground, thereby increasing harvest costs. It is also true that the free fatty acid (FFA) increases rapidly in overripe or damaged fruit.[70] A high FFA content facilitates the pick-up of pro oxidant contaminants that reduce the inherent stability of the oil during storage. Thus, most commercial operations harvest their fruit at a stage of ripeness that the plantation feels is optimum for oil content while reducing the risk of producing poor quality oil.

Although it is not exactly certain what the optimum fertilizer additions are for palm oil trees, and certainly not under the wide variety of soils on which they are grown, some indications can be

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68 B.J. Wood, op cit.

69 Ibid.

70 S.A. Kheiri, "End Uses of Palm Oil," in Palm Oil ed. by F.D. Gunstone, John Wiley and Sons, 1978.

gained from the nutrients exported by the plant.[71] Wood reported that 16 tones per hectare of dry matter are exported each year, and on a fresh fruit bunch yield of 25 tones, this was equivalent to 2-3 kg per palm of ammonium sulphate, 0.5 kg of rock phosphate, 1.2 kg of muriate of potash and 1 kg of kieserite. Gray's analysis of plants in Malaysia showed the following exportation of nutrients:

TABLE 11
Export of Nutrients by Mature Palms
(148 palms/hectare, yielding 25 tons FFB.)

	kgs/ha/annum				
	N	P	K	Mg	Ca
Veg. Growth	40.9	5.1	55.7	11.5	13.8
Pruned Fronds	67.2	8.9	86.2	22.4	61.6
Fruit Bunches	73.2	11.6	93.4	20.8	19.5
Male Inflorescence	11.2	2.4	16.1	6.6	4.4
Total	192.5	26.0	251.4	61.3	89.3

Source: Gray, 1987. p. 51.

Pests and diseases of oil palm have not been too serious, and generally have been quite easy to control. Because the oil palm needs insects to pollinate the flowers, it is usually wise to avoid the use of chemical pest controls unless absolutely essential to save a plantation. In most of the commercial plantations, integrated pest management (IPM) is practiced.

The most serious insect pests have been found to be leaf eating insects which can wipe out the following year's crop and cause lower production from the trees for several years thereafter. These have been found to be leaf eating caterpillars in Asia and South America, leaf-mining beetles in West Africa, and the stick insect in Papua New Guinea.

In Malaysia rats have been known to cause decreases in yields by up to 5% if not controlled.

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71 Nutrient export is the term used for the totality of nutrients removed from the soil by the plant in all forms. Thus, measurements are taken of fruit or seed, stems, stalks and leaves, and the nutrient composition of these is measured. Normally, we would disregard the plant material that remains in the field to decompose, although consideration has to be given to the time of decomposition and the use of otherwise free nutrients required for that decomposition.

The most serious pathogenic diseases mentioned by Wood were ganoderma, a saprophyte, in Asia and Africa which can infect the living palm, and vascular wilt (fusarium oxysporum) which was reported the most serious disease in Africa. Diseases reported by Gray in Malaysia included canoderma spp, or basel stem rot and Marasmius palmivorus, a rotting of the fruit bunches. These were researched and control measures were developed.[72]

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72 Gray, op cit.

F. HARVEST, HANDLING AND TRANSPORT.

Harvesting of oil palm is usually done by cutting the fresh fruit bunches from the trees, usually using a long-handled knife, taking care to prevent excess bruising of the fruits. The fresh fruit bunches are then transported to the factory as quickly as possible. This is essential in producing the maximum amount of high quality oil, and therefore the factory must be located as close to the plantation as is possible.

As noted above, the time in which the fresh fruit bunch is cut from the tree affects the yield of oil per hectare. Different standards have been adopted on different plantations, which obviously attempt to take into account the optimum production of oil while minimizing the labor of harvesting loose fruit and causing excess fruit damage. Of critical importance is the handling of the fruit from harvest to the first process in refining. The level of Free Fatty Acids (FFA) in the crude oil is directly related to the handling of the fruit. When fruit is bruised, rupture of the oil cell walls allows access of the enzymes to the oil in the mesocarp. These are:

(1) lipase, which are responsible for hydrolytic splitting of the triglycerides;
(2) lipoxygenase enzymes which catalyze oxidation of the fatty acid chains; and
(3) phosphorylase which cause an increase in the phosphatide level.

Palm oil is high in palmitic acid, containing about 45% in commercial oil. This is about two times as high as other oils that are high in palmitic acid. Other fatty acids of palm oil are stearic, oleic and linoleic. These, together with palmitic, are responsible for the triglyceride composition and the consequent solid fat content of palm oil. Palm oil contains sufficient levels of solid fat so that at the melting point of 36° C it will require heating to keep it liquid.

The free fatty acids are formed as a result of hydrolysis of the triglycerides. The hydrolysis reaction is effected by enzymatic action in the fruit and by extraction of the oil from the fruit and will continue under adverse conditions in the crude oil. Crude palm oil normally contains 2.5% to 5% of FFA when it reaches the refinery, but can go up to 10% in oils that are badly handled. The makeup of the palm oil can vary greatly as follows:

UGANDA OILSEEDS, JULY 10, 1989

	low	normal	possible
Monoglycerides		< 1%	5.5%
Diglycerides	5.66	5 - 8%	> 9.0%
Triglycerides	6.6		38.1%
Unsaponifiable fraction		0.5%	1.2%

The red color in palm oil is mainly due to carotenoid. These are decomposed with heat during refining. Mishandling during harvest and extraction or other operations can make it difficult to decompose the carotenoid, making them hard to remove by adsorption bleaching and the result will be a brown oil.

G. EXTRACTION of OIL.

The extraction of the oil from the oil palm fruit follows much the same process as other oils, with a few exceptions. Those are mainly related to the volatility of the oil, and the consequent danger of raising the level of FFA. The general steps are summarized below.

1. Processing the fresh fruit bunches as quickly as possible after they have been harvested to prevent buildup of FFA.

2. The fresh fruit bunches are immediately sterilized in order to:

   a. prevent further rise in FFA by inactivation of lipolytic enzymes;

   b. facilitate machine stripping;

   c. precondition the nuts to minimize kernel breakage during both pressing and nut cracking;

   d. prepare the fruit pericarp for further processing; and

   e. coagulate the protein material and hydrolyze the mucilaginous material present in the fruit.

   Sterilization is usually done in cages or baskets of from 1 to 3.5 ton capacity. The filled cages are rolled into a container where steam is applied at 40 lbg/in^2 at 141.5^{o} C. The fresh fruit bunches are "cooked" in this process until the interior of the bunch is at least 100° C. This can be done in a single process for a period of about 60 minutes. Most modern factories in Malaysia now use a multiple peak sterilization process, normally consisting of three peaks. In the first stage, the temperature is raised to 30 lbg/in^2 and then the container is exhausted to atmospheric pressure. It is then raised again to 35 lbg/in^2, exhausted, and finally raised to 40 lbg/in^2 where it is held for 30 to 40 minutes. The entire process will take about 70 minutes.

3. Stripping.

   This process removes the fruits from the fruit bunches. This is normally a continuous process using either a beater arm in a fixed drum where the arms enter through slots in the drum and the fruits fall through the slots, or with a rotating drum equipped with arms or baffles that loosen the fruits which then drop through slots in the drum while the stripped bunches pass out the end.

4. Digestion.

After stripping, the fruit is then reheated to loosen the pericarp from the nuts and prepare it for pressing. This is done in steam-heated vessels provided with stirring arms, called digesters or kettles. This can be in a batch process, but is preferably done in a continuous process where sterilized fruit is added to the top and digested fruit is removed from the bottom. Heat can be direct via live steam injection or by means of a steam jacket. Improper digestion can cause high oil losses.

5. Oil extraction.

The digested material is fed into a screw expeller at about 100° C. where the oil is expelled.

6. Clarification and purification of the crude palm oil.

After extraction the crude oil will normally contain about 66% oil, 24% water and 10% non-oily solids. Most water can be settled or centrifuged. Some water will be dissolved and will have to be removed by evaporation in a dehydrator. Water must be removed down to about .10% to hold it in storage for further processing. Some water is left in the oil to prevent oxidation in order to hold the oil stable and prevent the development of more FFA and to restrict the deposit of "foots." Usually the process used is settling or decanting. In gravity settling, the crude is diluted with hot water to reduce the viscosity of the oil. Then it is screened to remove coarse material. The oil is then heated to 90-95° C and pumped to a continuous settling tank where the oil rises continuously to overflow into a reception tank. The oil is then centrifuged and vacuum dried. Finally it is cooled and pumped to storage.

H. REFINING PALM OIL.[73]

Refining of palm oil can be done either by a physical or a chemical process. In the physical process the FFA are distilled off. In the chemical process, the FFA are neutralized using an alkaline reagent thus forming soaps that are removed by phase separation. The physical process is considered more efficient, but the chemical process can refine poorer quality oil. In either case, the crude oil should be handled and stored properly to:

- prevent contamination between different oil types;
- minimize FFA increase, oxidation and color fixation; and
- prevent unintentional fractionation.

1. Chemical refining

a. Gum conditioning.

This precedes neutralization of FFA by alkali. The purpose is to convert the phosphatide that cannot be hydrated, into a form in which it can be removed. Usually phosphoric acid is used in a concentrated (75-85%) form, and then the oil is treated with caustic soda.

b. Neutralization

Neutralization, washing and drying is done to remove the FFA, dirt and denatured phosphatide together with pigments and other saponifiable impurities. This is usually done with caustic soda. A double neutralization technique is often used for the treatment of poor quality oils, first with strong caustic soda and then with mild lye

After neutralization a centrifuge separation is done to remove soap, and the oil is washed with water to remove the remaining soap. Steam condensate can be used in this process, but it must be soft. The water must be hotter than the oil - over 90° C -and in the amount of 10 to 20% of the oil flow. This should reduce the soap to less than 50ppm. The remaining soap is adsorbed on the bleaching earth. The soapstock and water that is removed are then split usually using sulfuric acid.

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73 F.V.K. Young, "Refining and Fractionation of Palm Oil", in Palm Oil, edited by F.D. Gunstone, op cit.

c. Bleaching

After neutralizing, the oil is bleached using activated bleaching earth under a vacuum or steam process. It appears that the best method is under vacuum with 0.1% moisture at a temperature between 90-120° C for between 4 and 40 minutes. Activated earth is used at between 0.5 and 2.0% by weight of the oil. After this the oil is filtered.

2. Physical refining.

There are two phases in physical refining, pretreatment and distillation.

a. Pretreatment

The pretreatment uses phosphoric acid, in some cases together with citric acid and activated bleaching earth. Some refineries add calcium carbonate after the earth to form insoluble calcium phosphate by reaction to free phosphoric acid.

The oil is de-aerated under vacuum, treated with 0.5 - 0.10% of 80% phosphoric acid. It is heated to 90-100° C for 15 minutes before passing to a bleaching vessel. There 1.0 - 1.5% activated bleaching earth is added, followed by the calcium carbonate. The oil is bleached for 15-20 minutes after which it is filtered, polished and cooled.

b. De-ordorization and distillation.

This process is done to remove the odor and flavor and to increase the shelf life of the oil. The process must remove remaining FFA, which are in the order of 3-6% in palm oil. It also removes aldehydes and ketone and pigments. A steam distillation process is used under vacuum. For this batch plants can be used for palm oil only if they are equipped for high temperature operation or the oil has been de-colorized prior to de-odorization. The oil must be de-aerated before deodorizing. The common temperature employed in this process is 240 - 270° C for 30 to 120 minutes. Heat exchangers are usually used to heat the oil. When the oil is cooled, the hot oil is passed through the heat exchanger and partially cooled with the oil going in. After this a heat exchanger with water is used to bring the temperature down to 60-65° C. It is further cooled to about 35° C.

UGANDA OILSEEDS, JULY 10, 1989

I. FRACTIONATION OF PALM OIL.

Palm oil lends itself to crystallization by controlled cooling followed by separation to yield a liquid (olein) and a solid (stearin) phase. Although detergent and solvent techniques can be used, the most common is a dry process. This can be carried out at any phase of the oil from crude palm oil to highly refined palm oil. The process is to heat the oil to 70-75° C and then send it to a crystallizer, which is a tall cylindrical tank equipped for jacket cooling. The tank has an agitator device designed to scrape solidifying fat from the tank surface. The oil is then cooled to 40° C for 45 minutes. It is then further cooled to 18-20° C for 4 to 8 hours. The crystallin slurry is then pumped to a filter for separation. The yield of olein is about 60-70% unless a membrane chamber is used, which can raise the yield to 75-80% olein.

Normal palm oil is a semisolid. Olein is in a liquid state, and stearin is a solid oil under temperatures of 20° C. For international markets, liquid edible oil will have to be from olein. The stearin is normally used for soap and industrial uses. Crude palm stearin (stearin derived from fractionated crude palm oil) is used in manufacture of household and laundry soaps. Refined-bleached-deodorized palm stearin is used in high-quality laundry and toilet soaps. Crude palm oil is used in tin plating. Other uses for palm oil products are in cosmetics and pharmaceuticals, particularly as creams and oils, to make palm methyl esters and for textile lubricants.

J. BY-PRODUCTS OF THE OIL PALM INDUSTRY.

There are six main byproducts that have some value. These are the palm kernel cake (PKC), palm oil mill effluent (POME), palm press fibre (PPF), palm empty fruit bunches (PEFB) and palm fronds. For animal feed palm oil itself is sometimes fed to pigs and poultry for energy, at up to 3% of the diet.

Palm press fibre, palm fronds and palm empty fruit bunches are usually not worth anything as a feed as they are extremely fibrous. The PEFB can be burned very slowly to produce bunch ash which is a high potassium fertilizer whose alkaline nature is especially useful on acid soils.[74] In some factories, the palm fronds are burned as fuel for the boilers, as can be the palm kernel shells.

One of the major factory wastes from the production of palm oil is the palm oil mill effluent. This volume is large because of the tremendous quantities of water and steam used in the extraction and refining of the oil. For example, Wood gives a figure of 140,000 tones of effluent created by a factory of 60t capacity processing 200,000 fresh fruit bunches per year.[75] In many factories this is simply discharged into anaerobic ponds to evaporate. However, in areas where rainfall is high, the time required can be extremely long. Another possibility is to return this to the plantation in liquid form, which requires slurry wagons.

In one plantation in Malaysia, the effluent was treated in a decanter-drier to reduce the quantity of water and then the sludge was used mainly for fertilizer, although some tests of its use as an animal feed were also tried.[76] The palm oil meal produced had the following properties as fertilizer.

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74 Wood, op cit.

75 B.J. Wood, op cit.

76 H.K. Jorgensen and Gurmit Singh, "Production and Utilization of Palm Oil Meal in United Plantations," U.P. Berhad, Malaysia, in Technology, Utilization and Management of Agricultural Wastes, edited by S.A. Salam Abang Abdullah Abang Ali, Proceedings of a Regional Seminar at Universitii Pertanian Malaysia, Department of Engineering Science, Serdang, Selangor, 15-17 September, 1982.

TABLE 12

Palm Oil Meal

Nutrient	Percent of Dry Matter Range	Average	Fertilizer Equivalent per metric tone fertilizer	kgs
N	1.8 - 2.3	2.0	Urea	44.4
P_2O_5	0.5 - 0.9	0.75	Rock Phosphate	20.8
K_2O	2.3 - 4.0	3.0	Muriate of Potash	50.0
M_gO	0.8 - 1.5	1.1	Kieserite	42.3

Source: Jorgensen and Singh, 1982.

As a livestock feed the analysis showed that the palm oil meal was more limited.

TABLE 13

Nutrient Analysis of Palm Oil Meal

Moisture	5 - 15
Ash	15 - 22
Silica	7 - 10
Ether Extract	11 - 13
Crude Fibre	11 - 14
Crude Protein	11 - 13
Crude Cellulose	20
NFE	28
Gross Energy	4400 kcal/kg
N	1.8 - 2.3
P	0.3 - 0.4
K	2.5 - 3.3
Mg	0.6 - 0.8
Ca	0.55-0.85
B	20 ppm
Cu	20 - 50 ppm
Fe	3000 - 5000 ppm
Mn	50 - 70 ppm
Zn	20 -100 ppm

Source: Jorgensen and Singh, 1982.

To produce the palm oil meal, the mill effluent was processed through a decanter. This consisted of a slow speed, concurrent centrifuge with an extremely high clarification volume that was originally designed for the coal and mining industry. After decanting, the sludge was processed through a dryer. This was a rotating cylinder, 2 meters in diameter and 15 meters long, which had flights and chains inside to stir the material as it rotated. Boiler flue gas was put in one end of the cylinder and exhausted out the other end by means of an exhaust fan. By processing the boiler flue gas through the sludge, a gas scrubbing occurred. Although this was beneficial for controlling air pollution, it increased the amount of ash and silica in the palm oil meal, which reduced its value as a feedstuff. The dried meal was used as a fertilizer, where the plantation found that 50 kgs/palm/year was sufficient to meet the nutrient requirements of trees on some soils.

Wood reported on the use of biogas produced with the use of closed digestors. On the 60t plant noted above, about 200,000 M^3/day of biogas was produced which was enough to generate 1,300 kwh/h of electricity.[77] This translated into 200 X 10^9 kcal of energy, equal to approximately 20 million kg of diesel. In addition, the same factory was estimated to produce nitrogen equivalent to 1,350 tones of ammonium sulfate, phosphate equivalent to 1,400 tones of muriate of potash, and phosphorous equivalent to 285 tons of Christ Island rock phosphate.[78]

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77 B.J. Wood, op cit.

78 B.J. Wood, Op cit.

CHAPTER VI - COTTON

A. INTRODUCTION

Cotton has been one of the major cash crops in Uganda. In its peak, over 900,000 hectares of cotton were planted,[79] and over 450,000 bales of lint were exported. At the time of the peak production of cotton, cottonseed was the major oil seed crushed for edible oil. It was around the crushing of cottonseed that the edible oil processing industry developed in Uganda.

Since the high production days of the 1950s and 1960s, cotton production has declined to only a small fraction of the former output. In 1981, the low point in production, only 4.1 thousand metric tons were exported. Although some recovery has been seen in recent years, with the exception of the war year of 1985/86, current exports probably do not exceed 10,000 bales. Given the previous position of cotton both in the economy of the country and as the basis for the development of the edible oil industry in Uganda, it is useful to review the industry; what caused it to develop and maintain its important position in the farming systems of many Ugandans, what caused its decline and what is its potential for recovery. Although this is important in its own right, for our purposes it is most important to help put the crop into perspective as the potential oilseed to regenerate the edible oil industry.

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79 The acreage figures given are officially reported estimates. The area in crop may be over estimated, as seemed to be confirmed by the 1962 agricultural census. Overestimation of acreage in cotton would tend to under estimate yields, as total production is known from ginnery data.

B. HISTORY OF COTTON PRODUCTION IN UGANDA.

Serious attempts to introduce cotton into Uganda started in 1904, when American Upland varieties were imported by the Uganda Company, Ltd. Cotton was grown by small holders, initially in Buganda, for the most part, which grew 50% of the crop up to 1911. The crop by this time was expanding to other areas, particularly in Busoga, especially in Teso District, which produced almost as much seed cotton as the rest of the Eastern Province by 1913-14 according to D.G. Thomas. The following year, exports reached 32,000 bales of lint. Production of cotton continued to increase up through the 1960s, before a decline set in.

TABLE 14

Uganda's cotton production in bales of 400 lb of cotton lint

From Year	Thousands of bales (5-year average)	Year	Thousands of bales (actual years production)
1910	13	1961-62	181
1920-1	60	1962-63	359
1930-1	204	1963-64	379
1935-6	321	1964-65	438
1940-1	264	1965-66	445
1945-6	218	1966-67	
1950-1	335		
1960-1	334		

Source: D.G.Thomas, in Jameson, ed.1970.

Even by the mid 1960s, Thomas noted that the rate of increase was slowing down and was less than in the pre-war period. This was in spite of major efforts by the Agricultural Department in plant breeding, chemical seed treatment and improved extension of production techniques. The main reason was attributed to the decline in production in Buganda, which had produced 43% of the crop in 1950-51. Although production increased elsewhere in the country, the decline in production in Buganda of over 6,200 bales of lint annually was significant. This decline was attributed almost entirely to the increased interest in coffee in Buganda.

Coffee cultivation had begun in ernest in the 1920s, initially with Arabica coffee, but later replaced with Robusta. The shift to Robusta in Buganda was due to coffee rust, which seriously affects Arabica trees below 5,500 feet elevation. Robusta coffee growing

expanded rapidly in the fertile crescent around Lake Victoria. Robusta coffee plantings rose from 35 thousand acres in 1939, to 129 thousand acres in 1945, reaching one-half million acres by 1960. By 1966 plantings were estimated at about 780,000 acres, with exports of 147.3 thousand tons worth 29.5 million pounds sterling. Thomas gave figures for 1963-64 from the census of agriculture of a total of 715 thousand acres of Robusta coffee, 547 thousand acres were in Buganda.

The importance of cotton and coffee in the national economy also begin to shift places. Increasingly coffee replaced cotton in contribution to the total trade earnings of the country. By 1965 cotton's share of total percentage of exports had declined to under 30%, from a high of 95% of total trade earnings in 1925. Meanwhile, coffee's contribution to total trade was only 5% in 1925 and had risen to 50% in 1965 as can be seen in Figure 16. The difficult years after 1972 would increase this disparity as coffee production and exports managed to hold on to part of their previous magnitude while cotton production and exports declined drastically.

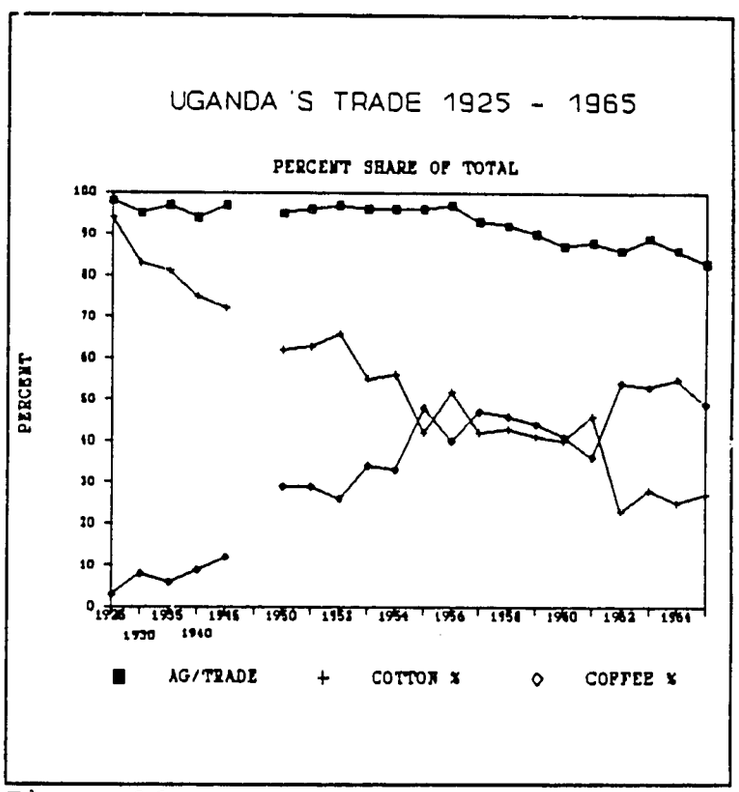

Figure 16

This shift from cotton as a cash crop to coffee in Buganda is significant not only for the impact it had on overall cotton production in the past, and cotton's contribution to the national economy, but also for the positioning of the cotton processing facilities and the structure of the industry. The shift away from cotton and into coffee in Buganda may also help to understand the probable future direction of cotton production in other parts of the country.

In the first place, many of the cotton gins were located in the fertile crescent around the northern end of Lake Victoria, including around Kampala and the region to the West. This

positioning of the ginning facilities led then to the placement of the oilseed processing facilities in the Kampala, Jinja, Tororo axis. Later, as cotton production shifted to the East and North, new ginning facilities were placed in the Mbale - Soroti region, and as the railroad expanded north and west, they would reach all the way to Rhino Camp. However, with the investment in oilseed processing further south, new plant and equipment placement in this subsector of the cotton industry remained in the Lake crescent area.

Cotton has expanded in those areas of the country where there were few other choices among "cash" crops. It is notable, for example, that a major expansion of cotton acreage took place along the upper reaches of the Nile after the "Mbwa" fly (tsetse) had been controlled in the 1950s. At that time, the only other choices among cash crops in the area were oilseeds, notably groundnuts. However, groundnuts were not being promoted as a cash crop, and consequently inputs were not available for this or other crops. Because the population densities in these areas had been low, due to the tsetse fly, at least some mechanization was required to have any large impact on area planted. Cotton, being targeted by government, received credits and subsidies for mechanized cotton production, and cooperatives and groups were leased large tracts of land in these areas. Thomas cites planting of cotton on new soils in a fertile area with favorable climate on either side of the Nile. However, only in Soroti was there investment in an oil processing facility in the region north of Lake Kyoga, and that was apparently quite small.[80]

As the subsidies and other incentives to grow cotton in this area were removed after 1972, cotton production has declined, and even in areas that are now relatively secure from terrorists and bandits, little cotton is being produced. Much of this disinterest in cotton stems from the fact that farmers in the area have found other "cash" crops such as maize or groundnuts that they feel more favorably toward. Factors affecting cotton production by farmers are many, and it is useful to look at those considered most important during the peak growing years of the 1950s and 1960s. Because yields have generally remained constant, with the exception of years such as 1962 which had extremely unfavorable weather, the production of cotton has been directly related to area cultivated. Generally cotton has also been cultivated by smallholders, so their reasons for cultivating any crop and abandoning a crop become paramount. Area cultivated per family was given as between 1/4 and

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80 We did not have a chance to visit this oilmill, but information from Mr. Kanti is that the mill only had four expellers, no where near the capacity of those in Kampala, Jinja, Busembatia, Tororo, Mbale axis.

5 to 10 acres[81], with quality of soil, competition with food crop production and constraints of production means, including shortage of labor being the major determinants of the surface devoted to cotton by a household.[82] In the 1960s it was noted that cotton was generally grown on new land, or land that had just undergone a grass fallow. With new land being opened along the Nile, this would make cotton production favorable, but competition for food production would tend to lead to replacement of cotton with higher cash yielding coffee in areas where land pressure was beginning to be felt. Thomas, for example, already notes in the mid 1960s that in East and West Mengo and Masaka the more fertile lands had already been given over to coffee production, and cotton was being planted on the marginal land. He, therefore, questions why cotton yields did not decline. In reviewing why cotton yields remained stable, even in the face of pressures for land in some of the traditional cotton growing areas, Thomas gives 6 reasons:

i. The introduction of new cultivars.
ii. The innovation of chemical seed treatment and of application of insecticidal sprays.
iii. The general improvement in standard of cultivation.
iv. Greater use of cultural aids, such as ox-drawn ploughs and other mechanical implements, and the expansion of tractor hire services.
v. Expansion of the road and rail network and of rural water supplies, which encouraged people to grow cotton in areas previously considered too far from trading centers and to settle in areas where domestic and stock water was now more readily available.
vi. The greater desire for ready cash.

Of these 6 conditions, one can cite several reasons for the drop in production during the 1970s. First, although both BPA and SATU varieties had been released in the 1960s, almost no work has been done in research since about 1970, and work that had been done has

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81 D.G. Thomas, "Cotton: Local Aspects," in Jameson, ed, 1970.

82 It is interesting to note that in the Buganda area, the first system to estimate acreage in crop used small plots of about 1/4 acre and large plots of 1 acre in size. It was felt that a plot of 34 square yards was thought to be the suitable area for a family to sow in cotton at one time. As cotton was usually the first crop grown on new land, the plots tended to remain of this size throughout any rotation, and it was felt became the standard family plot. See Jameson, ed.

sometimes been lost due to looting and destruction of records.[83] Second, seed treatment is still being done, but for several years it was virtually impossible to obtain chemicals in Uganda. Third, the improvement in cultivation techniques encouraged by the agriculture department was not pursued as staff left and support for extension failed. Forth, oxen, tractors and machinery were lost and still have not been replaced. Fifth, roads and rails, along with rolling stock, deteriorated. Finally, farmers were often not paid for deliveries of seed cotton to gins, destroying the financial incentive of producing cotton. It is significant to note the development of animal traction in Uganda, and particularly in the cotton producing areas, during the expansion of cotton production. Mahadevan and Parsons[84] state that oxen were first introduced for draught purposes in Teso and Bukedi districts in 1909 and 1910. By 1924 there were over 100 ploughs in Kumi County of Teso alone. A figure of 15,388 ploughs in Teso was recorded for 1936-37. In the mid 1960s they estimated that there were over 40,000 ploughs in use in Teso district, and about 7,000 in Karamoja.[85] They also note it was in common use in Lango district and in the Itesot regions of Bukedi district. Sales of plows in the post war period were running at almost 3,000 per year. Rita Laker-Ojok also cites the ox plough as being a large contributing factor in the expansion of cotton in the Acholi area. "By 1961 Kitgum and Gulu Districts combined contained over 5,000 oxplows, compared to

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83 Work done at Namulonge in Uganda became the central cotton research effort in East Africa. Extensive breeding work by specialists such as H. L. Manning after the Second World War and John M. Munro in the 1960s led to the release of varieties still used in Uganda. These included the multi line mixtures of BP52 which formed the BP52 crop from 1954 to 1966, BPA after 1966 as a single plant progeny, and multi line mixtures again after 1969. There is no evidence of anything having been done since that time. See John M Munro, Cotton, second edition, 1987, Tropical Agricultural Series, Longman.

84 P.Mahadevan and D.J.Parsons, "Livestock," in Jameson, ed, 1970.

85 B.W. Rose and E. Williams, in the "Introduction and Organization", chapter of Jameson's book, note that 2 ploughing instructors were appointed in 1912, and by 1924 there were 5 instructors, and over 50,000 ploughs in Teso district.

less than 200 in 1950."[86] Subsidies in the 1960s also apparently encouraged the purchase of animal drawn equipment. For the most part, the expansion of oxen was in the short grass and light brush areas. It was also in the areas were there were abundant cattle. Oxen could not be kept in the areas infested with tsetse fly, for example the areas along the Nile in the west, which were not cleared of tsetse until the late 1950s. In most parts of Uganda, the destruction of livestock during the wars of the late 1970s and through 1985 led to the almost complete elimination of work oxen according to most accounts. It is extremely rare to see oxen working at this time. Certainly the elimination of over 75,000 ox plows from the cotton districts had a massive influence on cotton production.There was also a growing use of tractors in the cotton districts in the 1960s. Laker-Ojok cites an expanding use of tractors, often privately owned, for hire in Acholi. About 40 private owned tractors in Teso, Lango and Acholi districts cultivating about 5,000 acres were noted. Carr[87] also claimed that at its peak in 1966 government tractor hire service in Lango/Acholi accounted for 26,000 acres. This may be exaggerated. J.H. Cleave and E.H.Jones[88] estimated that about 100 tractors were privately owned in 1963[89], and that the Department of Agriculture's Tractor Hire Service operated 200 tractors in 1964. These were estimated to have carried out 1 or more operations on 20,000 acres.

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86 Rita Lker-Ojok, "The Edible Oil Industry and It's Relationship to Economic Development in Northern Uganda," Nov.,1, 1986.

87 Carr, Stephen, "The Impact of Government Intervention on Smallholder Development in North and East Uganda," A.D.U. Occasional Paper No. 5., Wye College, London., 1982.

88 J.H. Cleave and E.H. Jones, "The Economic Background", Chapter 9, in Jameson, ed., 1970.

89 Presumably only those owned by non-estates, although this is not clarified. The date given is the date of the first writing of this section in Jameson's book, although revisions were done in 1968. It is assumed that the data given was for 1963.

TABLE 15

NUMBER OF TRACTORS USED IN UGANDA FOR AGRICULTURE

Year	Government hire service	Non-Government service	Total
1950	17	40	57
1955	11	150	161
1960	34	430	464
1965	394	665	1059
1966	680	655	1355
1967	930	730	1660

Source: W.T.Brown, P. Evans, and D. Innes, in Jameson, ed.

The use of tractors was primarily for ploughing, although some harrowing, planting and spraying was beginning to be done. In 1966, the Government tractor hire service worked a total of 104,362 acres of land, and 60%, or 63,012 acres was ploughing. Over 30 years ago, the department of agriculture recognized that Ugandan farmers had a preoccupation with the production of food crops, and despite major efforts to convince farmers to produce cash crops in the recommended method, which above all included timely planting of cotton, farmers tended to continue in the same fashion. One of the outcomes of this was the recognition of a lack of capital, particularly tools, with which the farmer had to work. A policy was adopted of "giving the farmers the tools to do the job," in the hopes of increasing cash crop production. This led to subsidy and credit schemes by government to stimulate production. Group farms were started in 1963, with the idea of having a group of farmers cultivate with more modern technology and employ mechanization. About 100 farmers would crop about 2,000 acres, using 4 to 6 tractors for major operations.[90] Credit for tractor hire was channelled through the cooperative society, which also handled the marketing. By 1965 thirty-one group farms had been established, cultivating 16,000 acres and a further 100 such farms were targeted for the second five-year plan. Notably, the major crop was cotton. Data indicated that a total of 42 group farms had been established

90 In many cases this was blocks of land carved out of the bush that had recently become available for production because of the control of the Tsetse fly.

by 1967, although only thirty were operating due to loan defaults.[91] Total acreage of cotton on these farms is shown below:

TABLE 16

The expansion of group farms

Year of cotton	Number of group farms	Total Acreage
1963	2	243
1964	19	3350
1965	32	5500
1966	42	9000
1967	42	3400

Source: Rose and Williams.

The average yield of cotton on these group farms was reported to be 900 lb per acre, compared with a yield of about 300 to 400 lbs per acre on peasant farms.Credit for progressive farmers was also started in 1961. This was a medium term credit system, usually 5 years duration. By June, 1964 loans valued at about 300,000 pounds sterling had been approved for 2,800 farmers. Loans were generally distributed in kind, and were linked closely to the subsidy schemes, which included farm machinery. In the early days at least, it appears that this credit was primarily for ox drawn equipment, including newly designed multi-purpose toolbars. A system of short-term credit for small holder farmers was started in 1962, and was linked to crop production. In the first three years, 340,000 pounds in 50,0000 loans had been granted, and a loan recovery rate of 96 per cent was recorded. In both of these schemes, loan approvals appear to be closely linked to the production of cash crops, with animal traction loans heavily dependent on cotton production. The above mentioned schemes were often done with a certain level of mechanization. Potential for mechanization still exists, and it might be argued that in Uganda, any serious attempt at large volume production of cotton, even reaching the previous levels, will require mechanization of production to be reintroduced. Part of the effort of the emergency cotton program is, in fact, a mechanization scheme. However, it should be pointed out that the previous mechanization was almost entirely limited to ploughing, although data suggests that at least some harrowing and spraying were beginning to become accepted. Mechanized harvesting

91 W.V. Rose and E. Williams, Chapter I, Part B, of Jameson, ed., 1970, page 7.

has never been done in Uganda. This may be a crucial factor limiting increased cotton production. Munro gave average harvest figures in Uganda of about 9 kg of seed cotton per day per worker. Even at low rates of 300 kg per hectare production of seed cotton, harvesting would require 33 days per hectare. Higher yields would require 70 or more days. Even at higher productivity, picking by the best workers only averaged 44 kg of seed cotton per day in Aimbabwe on irrigated land, and 33 kg/day on rain fed.[92] Mechanization on a full scale, however, would be quite another matter. This could be particularly true for mechanized harvesting. An example of concerns related to mechanization is suggested by M.A. Arnold[93] in discussing Uganda cotton varieties adaptation to environment. He notes that the insect pests jassid (Empoasca spp.) and the mirid bug, (Taylorilygus vosseleri Popp.), known as lygus, both invade cotton in East Africa. These were not known to be a serious problem in the U.S. where the varieties originated. Although these insects were less of a problem in Southern and Western Uganda, they became a serious problem in the North and East. However, Arnold notes that the fact that these were becoming less of a problem was primarily a function of variety selection. He comments"Jassid resistance is related to leaf hair length and density, and breeding for resistance involves an increase in both of these characteristics (Parnell, King, and Ruston, 1949). A measure of the extent to which this has been achieved can clearly be seen when modern American varieties are grown in Buganda. Most of these are practically glabrous and, in the absence of insecticidal protection, suffer a characteristic and sometimes severe attack. In the Northern Region of Uganda and in the Lake Region of Tanzania the damage is even more spectacular. It may be that jassid damage to some modern American varieties is more severe than would have been the case with the original introductions. Hairy leaf fragments adhere more readily to seed cotton than glabrous ones and many American varieties have been selected for the absence of hair in order to reduce the trash content in mechanically harvested seed cotton." (page 136-7).

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92 John M. Munro, Op cit.

93 M.A. Arnold, Chapter 12, Part A. "Cotton", in Jameson, ed.

C. GOVERNMENT INTERVENTION IN THE INDUSTRY.

Government intervention in the marketing of cotton is almost as old as the cotton industry in Uganda itself. As noted elsewhere, American upland cottons were introduced to Uganda in 1903, and cotton production grew rapidly. The first power gin used in Uganda was in 1906 by the Uganda Company Ltd. in Kampala; prior to that time cotton was either hand ginned or sent to Kenya. After 1907, several new gins were built as transport systems expanded, and by the beginning of WWI, 20 ginneries turned out 30,000 bales of lint. Gins continued to be built, and extremely competitive buying from farmers resulted. Government intervened in 1918, requiring licenses for buying seed cotton at fixed locations. The Cotton Control Board was formed in 1923, which worked to establish a permanent market in Eastern Uganda to safeguard the quality of seed cotton. In 1926 an ordinance was passed to regulate the industry. In this Cotton Ordinance of 1926, ginneries were licensed and markets established for buying of seed cotton and distribution of seed. It also appears to have been a response to a government concern about excessive competition in the ginning industry. But some felt that the Ordinance was inadequate to protect farmers and prevent chaos in the industry. In 1929 the Carter Commission recommended minimum prices to the grower to "restrain ginners from fixing prices at unreasonably low levels."[94] In 1933, the Cotton Zones Ordinance, drawing on the Carter Commission recommendations, established buying zones for ginners. Shipping of cotton between zones was prohibited. It appears that this was promoted as the result of concern about genetic purity of seed in particular zones, and genetic resistance to disease. It also supposedly was to aid the industry by reducing overheads to ginners. This ordinance introduced price fixing, whereby a price formula was established which was to allow ginners a profit based on a sliding scale, and guaranteed an equitable price to the farmer. The ginners supposedly formed buying pools with government assistance to allocate quotas to each ginnery from the available crop. By 1938, another commission was formed, to recommend further measures to "ensure a fairer share of sale proceeds to the farmer."[95] This was based on assumptions of unfair marketing practices by ginners and wasteful competition. All of the regulation up to this point seems to have a built in contradiction from the point of view of economics. If there existed, in these early years, such fierce competition among ginners, then the outcome should have been improved efficiency by

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94 D.G. Thomas, in Chapter 12 of Jameson, ed, 1970, page 170.

95 Thomas. op cit.

ginners and highly competitive prices to farmers.[96] During wartime, and with a guaranteed contract with the Ministry of Supply in London to ship cotton (amongst other products), the Cotton Exporters Group, consisting of exporters of lint, was formed to act as the government's Agent for overseas sales of lint. This allowed the Government to fix prices to growers and processors. It was charged with stabilizing prices to producers over a planting and harvest season, and to the extent possible, to stabilize prices between seasons.[97] This system was never dismantled, and became the forerunner of independent Uganda's marketing system. The Lint Marketing Board grew out of the Exporters Group in 1949, and was finally institutionalized in the Lint Marketing Board Act of 1959. The Board is mandated to fix the minimum producer price at the beginning of the season, and to fix the allowances for buying and processing agents. Further "It determines when the crop season begins and ends; it prescribes conditions of sale, handling, and storage; and it determines the grades of all cotton deliveries. It has power to advance "crop finance" to (some) marketing middlemen as well as power to determine the level of inventory in its storage facilities and the level of the "Price Assistance Fund."[98] With the termination of the guaranteed contract with the British Government, a new cotton ordinance was enacted in 1952.[99] This in part grew out of disturbance in the industry in 1949, when riots broke out initiated by the Uganda African Farmers Union. In part this was to

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96 Aidan Southall is much less charitable when he writes "Fierce competition reigned in cotton buying and processing, raising the price to growers but lowering local capitalist profits. Colonial government sided with the capitalists (the Europeans being most vociferous) and a system of monopoly processing was established, which lowered growers' receipts and raised those of processors, although it was said to be to protect the former from being cheated. Both African and Asian petty bourgeois middlemen were eliminated." "The recent Political Economy of Uganda" Chapter 4, in Uganda Now: Between Decay and Development, ed by Holger Bernt Hansen and Michael Twaddle, 1988.

97 George Alibaruho, "The Impact of Marketing Board Policy on the Level and Variability of Cotton Producer Prices in Uganda: 1945 - 1969.", Eastern Africa Journal of Rural Development, 1976.

98 G. Alibaruho, op cit.

99 The 1952 Acquisition of Ginneries Ordinance.

break the Asian control of the processing industry.[100] In addition to absorbing the price fixing functions, under this Ordinance the structure of the industry was permanently and irrevocably changed. The Ordinance permitted the government to lend money to cooperatives to purchase ginneries. Some "redundant" ginneries were acquired and dismantled, and others were bought by the cooperatives. A prohibition on building new ginneries except by cooperatives was decreed. Additionally the former buying pools were made statutory and membership mandatory, and allocations of the crop were made to ginneries, including to those of the cooperatives. The latter received increases in their quotas in years of increased production, otherwise quotas were fixed. Up to 25% of the seed cotton was allocated to the cooperative ginneries. Rita Laker-Ojok notes that the price structure set by the government to the ginneries was geared to the most inefficient ginneries assuring all ginneries high profits. This created an inflated price for ginning facilities. The result was an inability of the cooperatives to raise the required down payment to purchase gins from the Asians. By 1962 cooperatives had purchased only 14 ginneries.[101] By 1965, however, the cooperatives ginned over 50% of the crop. This was mainly due to the increased efforts by the government after independence to move cotton ginning entirely into the cooperative sector. Quotas to the cooperative ginneries were increased, and cooperative unions were given loans of up to 90% of the purchase price for ginneries. Private owners immediately tried to sell, and ginnery prices fell. Many owners were never able to dispose of these properties. By 1968 the cooperatives ginned over 85% of the cotton crop, and by 1969 they had a total monopoly.[102] Prices to the farmers and ginners are fixed by the government before each crop. Effectively, the producer price is established as a minimum price, and ginners could pay in excess of this price. In fact, during the 1950 to 1960 period, ginners frequently bid up the price for seed cotton, according to Alibaruho,[103] suggesting that lower than optimal producer prices had been established by the Board. It is interesting that competitive

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100 At this time the gins were all owned by Asians. The exact number is unclear, but by the time the Government and the Cooperative Unions bought all the gins there were a total of 52 in the country.

101 Rita Laker-Ojok, op cit, page 17; citing E.A. Brett, Problems of Cooperative Development in Uganda, U.N. Research Institute for Social Development, Geneva, 1970.

102 There are reported to be 34 ginneries owned by the Cooperative Unions.

103 George Alibaruho, op cit.

bidding for seed cotton declined during the 1960s as more controls in the form of quotas were established, and as the private sector was gradually replaced by the cooperatives in the ginning industry. As this competitive bidding declined, the actual producer price in the 1960s, particularly after 1965, began to be identical with the minimum producer price.[104] The mechanism for establishing minimum producer prices, ginners margins and LMB costs charges is treated in detailed by Alibaruho. In effect, the government, previously through the Lint Marketing Board, set minimum producer prices, but the ginneries actually made payment to the farmer. Although some adjustments have been made to that system in the last few years, essentially it is the same. The Cooperative unions, who operate the gins, pay farmers for their seed cotton. Previously, the Lint Marketing Board determined the price the ginneries would receive for cotton lint and cotton seed. Now this is done by the government. This is generally done by calculating a price structure based on the cost of inputs for ginning and baling lint.[105] Included in the inputs is the cost the ginnery pays the farmer for seed cotton. This is based on a lint out turn ratio, generally averaging 1/3 of seed cotton in Uganda. These out turn ratios could be higher or lower than this, and generally LMB adjusts final payment to the gin according to actual end-of-season figures. The Lint Marketing Board (or the government) deducts from the estimated export price the price paid to the ginneries for lint, the transport charges, taxes and grants[106] and the Board's expenses. The income for cotton seed sold to the oil mills is added back to the total. The total is then adjusted for the lint turn out ratio to convert the value

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104 Dr. Southall argues that much of the commercial shifts and conditions developed out of deteriorating political situation in the first Obote presidency. Having lost the support of the peasantry, particularly in Buganda, Obote increasingly relied on the Marketing Boards to concentrate control of rural production. This was an attempt to ally with the elite, who in turn co-operated and partnered the Asian commercial establishments, as well as other non-African business. In Uganda Now, op cit.

105 According to Alibaruho, at least up until 1969 this was done by considering a list of 65 inputs by the Lint Price Fixing Committee, which was established in 1955 under the Lint Marketing Board Ordinance. These were mainly materials, labor, rents and insurances. Supposedly a similar system to determine margins is used today.

106 Previously a bonus was paid to local governments for promoting cotton, later this bonus became a sort of ex officio "tax".

to a seed cotton price. Estimating the season's production, the minimum producer price is set. As Alibaruho determined, this was effectively a residual of the export value.[107] The Lint Marketing Board was given the monopoly to grade and market the cotton crop, including both lint and seed. LMB accepted the lint from the ginneries, sampled and graded it, and auctioned it to buyers in Kampala. Seed for planting was dressed at plants operated either by LMB or the Cooperatives, and given free to the farmer for planting and the residual seed was auctioned by the Lint Marketing Board to the oilmills for crushing. In 1970, a decree by the President established that all exports and imports would be handled by parastals. LMB was supposed to directly market lint overseas. A later amendment of this decree allowed LMB to phase in this process over a 4 year period. After the coup by Amin in 1971, all non-Ugandan lint exporting firms were prohibited from dealing in cotton. Of the 11 firms operating in the country, 8 were non-Ugandan. By the end of the year, the prohibition was extended to the three remaining exporters. LMB was, therefore, immediately thrust back into the arena as international lint marketer, which it was only cautiously accepting since 1970.

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107 Although there is some question as to Alibarohos calculations. It appears that he has not converted the seed cotton price to the grower into a lint equivalent price. This then suggests that the farmer received a considerably smaller percentage of the export price than would have been the case. It also suggests profits to LMB where others have noted deficits.

D. THE DECLINE AND RE-STIMULATION OF COTTON PRODUCTION

In recent years, the picture was distorted by the political and military impacts within the country. It is difficult to get a clear picture of the situation from 1971 to 1979, other that to observe the tremendous decline in the export of cotton from the country. There are several reasons advanced for this situation. First, the allocations of foreign exchange to the industry, particularly the cooperative ginneries, caused the deterioration of plant and equipment and the inability of the cooperatives to turn out lint. Second, trucks were deteriorating and delivering seed cotton to the ginneries and evacuating lint became difficult. This was compounded by a continuing deterioration of the railroad. Third, the real value of the currency was declining and inflation increased. The result was a considerable decline in the real producer price for cotton. With the possibility of growing products like food that were not under price controls, many farmers switched out of cotton. The military response was to order increased production, but Laker-Ojok, citing the Crown Agents study of 1983, notes that many farmers simply sabotaged the system by making sure that the seed would not grow. After 1979, there was some effort to re-stimulate the cotton industry. Although there was a certain amount of euphoria, and some farmers responded by planting cotton, the price structure did not serve. As a result, in 1983-84 the Obote government attempted to inject enthusiasm with new price structures, tripling the price in one year and doubling it for the following year. However, as Laker-Ojok comments, "farmers responded with increased production but the co-operative structure proved increasingly unable to respond accordingly."[108] The Unions' ginneries were unable to cope with even a modest increase in supply (compared with the 1972 - 1982 period), and cotton went unginned. In 1984-85 the situation apparently became even worse, much of the previous year's lint remained in cooperative warehouses, and the new crop was left either at the primary societies or on the farm. Laker-Ojok's report on the Acholi area is indicative of the problems. Payments to farmers were delayed, and then with the coup intervening, many payments were further delayed. In gins that were operating, lint piled up because of lack of means to ship, no instructions from LMB, or lack of hoops to tie bales. The continuation of the war prevented the buying season from starting. Vehicles were looted and stolen, power was out most of the year, and after August 1986 no trains ran. Finally, even if farmers had wanted to and been able to plant, there was not enough seed in the country. A major effort to get the ginneries back in operation was initiated as early as 1973. Three new ginneries were to be constructed and 7 old ones refurbished. Only two of the ginneries

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[108] Rita Laker-Ojok, op cit. p.22.

were completed before 1979. Equipment that had been imported was never installed. A loan from the I.D.A. to rehabilitate 10 ginneries was negotiated in the early 1980s, and several ginneries have been rehabilitated, many with all new equipment.[109] However, the improvement in ginning capacity alone could not bring the production back. During the 1980s, farmers had often delivered cotton to the cooperative ginneries without receiving payment. The cooperatives in turn would ship lint on behalf of the LMB, and wait several months for payment. In some cases, fraud on the part of cooperative unions was reported,[110] and funds to pay farmers disappeared. Given the high rates of inflation, the high interest rates (42% until March of 1989, currently 50%), the cooperatives and the LMB were using the farmers to finance their campaigns, when they got paid at all. As a result improved ginning capacity was not enough. A further program was launched in 1987-88 called the Emergency Cotton Production Program. This effort is supposed to include adequate funds to pre-finance the buying campaign so farmers can receive cash payments (apparently channeled through banks to avoid fraud at the cooperative Union level), provision of tractors for ploughing land for cotton, and importation of chemicals and applicators. Additionally, the price of seed cotton has been raised to 80 shillings per kilogram to induce production. Still, problems persist. Cooperative Unions claim they are losing money on ginning cotton, at a current allocation of 270 shillings per kilogram of lint (which includes about 240 shillings to be paid to the farmer). Some Unions estimate the loss at as much as 25 shillings per kilogram. Farmers also feel the price is too low. Most farmers we talked to felt that cotton prices were not equitable with other crops like maize, and were not overly enthusiastic about growing it. Most felt cotton took more work than other crops, gave only one crop per year, gave little reward for their labor and payment was slow. Non of this bodes well for the industry.

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109 This program has continued until recently. In 1983, Smith felt, after visiting several ginneries that the present plant could handle a significant increase in cotton production without becoming a bottleneck. Laker-Ajok, on the other hand, felt in 1986 that in the Acholi area there was a bottleneck at the gins. However, this seems to have been a problem of power outages, lack of supplies and transport, rather than a problem with the ginning plant.

110 Although James A. Smith reported in 1983 that all accounts payments to farmers were current and there was no longer a problem. This, however, was undoubtedly untrue.

E. THE DEVELOPMENT OF THE EDIBLE OIL INDUSTRY.

In order to complete the picture of the cotton industry, it is necessary to trace the development of the oil seed processing industry as a parallel but linked development. As oil seed processing has been almost totally based on cotton seed since the Second World War, its development has, up to the present time, been dependent on that industry. However, it is fair to speculate that some of its development was a reaction to the intervention by government in the raw seed cotton and lint sides of the industry. Diana Coles found the earliest oil mill in Uganda dated from 1929, and a total of five were registered by 1940, very little cottonseed had been processed for oil.[111] The 1938 (see page 90 and note 95 above) commission found that crushing cotton seed had not been profitable, although at least one oil mill, established in 1938, had been doing some.[112] The use of the seed prior to that time is unknown, but it is presumed to have been burned. With the increased demand for oil during the Second World War, processing was advocated. At the same time the government required oil millers to have licenses, and the construction of new processing facilities was controlled by the Control of Industries Committee. In 1944, apparently there were 5 licensed and 5 unlicensed oil mills in the country. Control of mill construction was decontrolled in 1946, but sale of seeds, oil and cake remained under government control. It appears that 13 mills existed prior to the decontrol of construction, and that 12 were commissioned soon after decontrol. Laker-Ojok says that these last 12 were denied seed supplies by the Vegetable Oil Controller. This decision was supposedly based on the argument that too many mills would limit the quantity of seed each was able to obtain, and make the industry inefficient. In 1948, new regulations limited millers' investment to replacement machinery, but idle mills were still not given seed. In 1953 the industry was freed from all controls, and sale of seed became the responsibility of the Lint Marketing Board. It is fairly clear that the early post war oil mills were established by families and companies already in the cotton business. Most of them probably had cotton gins and entered the industry to take advantage of the profits that could be gained from cottonseed as a byproduct of their gins. In fact it was reported that in 1965, 11 of the 18 functioning oil milling firms were also engaged in cotton ginning. With the change in regulations and the insertion of the cooperatives into the ginning industry in the early 1950s, many of these companies probably

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111 Diana M.S. Coles, "The Vegetable Oil Crushing Industry in East Africa," Occasional Paper 4, Makerere Institute of Social Research, 1968.

112 Personal discussion with Mr. Kanti.

expanded their oil milling business to diversify their investments. This is certainly what occurred in two cases we have observed. In any case, the crushing of cottonseed for oil and cake seems to have been profitable in the early post-War period. In 1947 the price paid to the oil mills was based on an average of 16 gallons of oil from a ton of cottonseed. This was raised to 24 gallons per ton of seed in 1950. Coles says that the millers were averaging about 32 gallons per ton in 1965.[113] The decontrol of the industry in 1953 appeared to cause a rapid expansion of investment in the industry. A total of 25 firms included edible oil processing in their activities before 1950.[114] Eighteen new mills were registered in the 1951-55 period, for a total of 43. More significantly, the number of expellers increased to 90 as 58 new ones were purchased in this

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113 Diana M.S. Coles, op cit. Coles does not specify either her measures or her definition of "cottonseed." If the measure is imperial gallons and the ton is a "short ton" or 2,000 lbs, then 16 gallons represents 66 kgs and the "ton" equals 909 kgs. Likewise 24 gallons equals 99 kgs, and 32 gallons about 112 kgs. There is still a confusion, common throughout the reports, of "seed." If the seed has been delinted and decorticated then the 1947 yield is about 7%, the 1950 yield is based on 10.9% and the 1965 yield was about 14%. This latter is about correct for dehulled seed, which we have found to yield 23.8% of oil using solvent extraction.

114 Note, however, that Coles says that these numbers reflect "the number of firms recorded in the Registry of Companies with oil milling as an activity in their Articles of Association,"(page 9). It is possible that some of these did not actually crush oil seeds. See for example our list of recently licensed mills, many of which are not in operation, and may never be.

five year period.[115] Although 5 new firms entered the industry in the last half of the decade (and 4 retired) and 25 additional expellers were added, the industry was clearly beginning to slow its expansion. This appears to have been the result of fierce competition amongst millers for the limited amount of cotton seed that was available at auction from the LMB. As many as 35 mills had bought cottonseed in 1955, but this dropped rapidly, and with the exception of 1961-62 when 34 purchasers were in the market, mills buying cottonseed never exceeded 24. By 1965 the "final" eighteen were all that remained, and of them, 4 oil mills purchased between 63 and 95 percent of the cottonseed auctioned by LMB between 1957-58 and 1965-66. (Coles p.17) Plant apparently did continue to expand. In 1972 twelve new expellers were installed by one oil mill just prior to the loss of the mills by the Asians. The number of expellers in the country reached 148 by 1972, although apparently 10 were shipped to Kenya after the expulsion orders by Amin.[116] Coles noted that "Thus the impression is one of a declining oil milling industry both in terms of the absolute number of firms registered with oil milling as an activity in the Registry of

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115 Note that Coles gives these numbers as expellers purchased by the eighteen existing operative millers in 1965 for their purchases of expellers over the period 1940-1965. This may or may not be the same as the number of expellers purchased in this period. Her Table 2.3 shows:

Period	Actual No. of Expellers Bought	Cumulative Total of Expellers
1940-45	10	10
1946-50	22	32
1951-55	58	90
1956-60	25	115
1961-65	12	127

Source: Coles, page 11.

It is from this table that most researchers cite the number of expellers in Uganda as 127 in 1965. We have been able to account for 122 expellers in 14 of the oil mills. There are also some other oil mills that existed that are not amongst the 18 cited by Coles or turned over to LMB in 1974. We were quoted a figure of 148 existing when the Asians were expelled in 1972.

116 Personal discussion with Mr. Kanti, who was involved in furnishing machinery and parts for the industry prior to 1972.

Companies and in terms of the activity of those who were registered." (Coles, p.11). The result of this high competition in what was an industry with tremendous overcapacity, was high profits to LMB. Coles notes that in the period from 1954-55 to 1964-65, LMB had covered, or nearly covered, its trading losses on lint with its sales of cottonseed to the millers. In only 4 of 11 years were cottonseed sales inadequate to cover losses from lint. The overall balance for this period was trading profits on cottonseed totalling 14,834,189 Ugandan pounds, and a gross trading loss on lint of 21,143,779 pounds. Yet while LMB was benefiting from this competition, it is likely that only the six firms that had the ability to double refine oil could make a profit on oil and cake. Double refining capacity, however, by these 6 mills was reported to be 30,000 tons of oil, or enough to process the oil of over 200,000 tons of cottonseed. Compare this to the peak year, 1970-71, when 126,572 tons of cottonseed was crushed in Uganda. Another double refining plant was installed in Mbale in 1965, which added to that capacity. As opposed to the ginning of cotton, which was transferred to the cooperatives in the 1960s, processing of edible oil remained in the hands of the Asians until the economic war of 1971-1972. Although there are many reasons advanced for this conflict with the "foreign" business community, the result in the cotton and edible oil industry was effectively a nationalization without compensation. As noted above, the last involvement of the private sector in lint was purchasing lint at regular Kampala auctions and exporting the crop. This function was turned over to the LMB abruptly in 1971. In the oil seed crushing industry, conflict began when the prices of cottonseed rose dramatically in 1970-71, and the government maintained controls on the selling price of oil. These high prices were partly a result of exports of cottonseed to Kenya, which the millers succeeded in having banned.[117] However, high prices were probably mainly the result of fierce competition in an industry with overcapacity. Collusion by the millers forced the prices at the auctions to fall. As prices bid for cottonseed fell, auctions were cancelled and prices were fixed by the government. To recoup, the millers began to ship most of their oil to Kenya where oil prices were higher. The resulting absence of oil in the Uganda market caused government to declare that only LMB would be allowed to export oil. Finally, Amin ordered all Asians out of the country, and the properties entrusted to the Departed Asians Property Custodian Board. In turn, many were allocated to individual Ugandans, most reportedly friends and supporters of Amin, but without experience in the industry or

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117 One argument was that exports of cottonseed rose because ginneries, protesting that LMB was not paying them for their cottonseed took it upon themselves to export their cottonseed directly to Kenyan buyers. There was only one obscure reference to this and no other has been found.

knowledge about business in general. The result was that cottonseed piled up in cooperative warehouses and remained uncrushed in oilmill storerooms, while inventories of oil were systematically liquidated by the "new owners." At the time that the Asians' oil mills were taken over, there were 11,000 tons of seed in the Cooperative Unions' storerooms, and 3,720 was left uncrushed at the mills. The banks had halted all credit to the oilmills (all Asians in fact) after the expulsion order. As a result, Asians had refused to take delivery of cottonseed that they had bid for or refused to pay for seed that had been delivered. LMB was forced to export cottonseed in 1972 in order to empty the warehouses for the new crop. Although some of the mills returned to production, little is known of the results. The government finally, in 1974, took the mills back and turned them over to the LMB. This involved 17 oil mills.[118] Turning the entire oil industry over to the parastatal Lint Marketing Board proved to be a disaster for the Board. It was forced to take many of its top managers out of its Kampala office and put them in charge of oil mills around the country. Although these people may have had good intentions, they had no experience in oilseed processing. Neither did LMB have the funds to buy raw materials and spare parts for the mills, all requiring foreign exchange. Production dropped, mills were closed because of breakdowns or lack of materials, and losses piled up. To add to this, cotton production took a precipitous decline after 1972, and seed to be processed ceased to be plentiful. LMB's losses grew every year. In 1974-75 LMB retained 57.6 million shillings ($8.06 million on official rates) to cover losses in the oil milling sector. In 1977-78 losses reached another 10 million shillings, and in 1978-79 were 3.3 million shillings. The only thing that seems to have reduced losses was the decline in volume of seed crushed. At its low point, in 1980-81, the LMB mills crushed less that 1% of the volume of cottonseed that had been crushed by these mills in 1964-65. For all practical purposes the industry had been killed in one decade, and the mills went silent. The main reason for the demise of the edible oil industry was the decline in cotton production. The reasons for reduced cotton production are touched on above, and are many. However, it is also clear that the oilseed processing industry was incapable of looking beyond cotton, and

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118 This figure is given by Rita Lker-Ojok apparently from LMB records. The Mahdavani mill was already in government hands and the Nakesero Soap Factory was not turned over to LMB until 1985. However, this does not account for all the mills that were supposedly in operating condition at the time the Asians were expelled. At least one had been turned over to the Ministry of Education for a school, and we are aware of three others that never became part of the LMB system, probably because they were no longer producing oil.

appears to have been content to excuse the demise in the industry to the demise in cotton production. This is reasonable, given that the industry, after 1974, was operated by the State's cotton monopoly. In defense of LMB, it is hard to see how they could have done any different. If trucks were not available to haul seed cotton to the ginneries, they certainly were not there to haul other oilseeds to the mills. If electric power cuts prevented running the expellers for cottonseed it would also prevent crushing groundnuts. In other words, the turmoil and confusion over the last 16 years, coupled with questions of ownership of mills, has effectively prevented an evaluation of the capability of LMB to manage the industry. However, given that the industry will now need to start completely anew, an aggressive program that addresses the edible oil industry in total needs to be prepared. The industry can no longer be considered merely as an adjunct to the cotton industry in Uganda.

UGANDA OILSEEDS, JULY 10, 1989

INDEX OF MAIN TEXT

Africa Basic Foods 56
Banana 27
    acreage 27
Bunyole County
    cropping system 26
Cassava
    as security crop 28
    production 28
Castor oil 9
Cooking 13
Cooperative Unions
    takeover of ginneries 9
Cotton
    buying pools 90, 92
    decline of production 94
    distortion of ginneries prices 92
    establishing minimum producer prices 93
      government intervention 90
    group farms 88
    history of cotton production 81
    inefficiencies in price structure 92
    introduction 81
    lint exporting firms 94
    lint out turn ratio 93
    losses in ginning 96
    peak production 81
    percent of trade 83
    price fixing 91
    price structure 93
    production 82
    prohibition on building new ginneries 92
    restimulation of production 94
Cotton Control Board
    formed in 1923 90
Cotton Exporters Group
    formation 91
Cotton ginning
    facilities from Asians 9
Cotton lint
    Peak production 9
    Production 25
Cotton Ordinance of 1926 90
Cotton-cereals farming system 26
Cottonseed
    findings 2
    peak production 9
    supply 2

UGANDA OILSEEDS, JULY 10, 1989

Crown Agents study of 1983 94
De-corticating 13
De-linting 13
Decline of the cotton industry
    causal factors 10
Demand for edible oil 17
    predicting 20
Departed Asians Property Custodian Board
    take over of oilmills 100
Economic war of 1971-1972
    loss of oil mills by Asians 99
Edible oil
    exports 9
    peak national output 9
Edible oil demand
    Asians and Europeans 22
    tourists 22
Edible Oil Industry
    current status 12
    introduction 1
    overview 96
Edible Oil Processing Equipment and Procedure.
    general 13
Elasticity of demand
    for edible oil 18
Emergency Cotton Production Program 96
Endosperm
    of oil palm 68
Exocarp
    of oil palm 68
Expelling 13
Food crops
    trends 25
Fully Mechanized Operations 38
    land clearing 38
Gross national product
    decline after 1972 20
Groundnut
    flavor 31
    contibution to oil 30
    findings 3
    Markets 58
    peak crush 9
    potential 3
    Production 57
    Yields 57
Growth in GDP
    1963-1970 19
Industrial crops
    decline 25

UGANDA OILSEEDS, JULY 10, 1989

Labor Requirement for Seasonal Crops
man-days 36
Land clearing 40
cost per acre 41
Owning and Operating Costs per Hour 40
Lint Marketing Board
allocation of oil mills 9
formation 91
losses in oil milling 101
profitability of cottonseed sales 99
responsibility for sale of cotton seed 97
take over of oil mills 100
Lint Marketing Board Act of 1959 91
Lipase
of oil palm 72
Lipoxygenase
of oil palm 72
Maize
production 26
Major findings
Major 2
mechanized farming
capital investment 42
machinery and equipment 42
Mesocarp
of oil palm 68
Number of tractors used in Uganda 87
Oil bearing seeds
gross raw product 3
Oil palm 2, 60
abortion of floral primordia 67
cloning 69
conditions for production 64
crop production 66
dura 64
extraction of oil 73
factors affecting yields 69
fertilizer requirements 70
findings 2
fractionation 76
free fatty acid and fruit maturity 70
genus and varieties 63
harvest, handling and transport 72
Institut de Research pour les Huile et Oleagineux 61
introduction to 61
maturity and optimum oil yield 70
oil extraction in Uganda 62
oil yield in Uganda 62
oil yield per hectare 70
ortets 66

pests and diseases 71
pisifera 64
plant geneses 63
plant nutrient requirements 71
plantations in Uganda 61, 63
pollination 69
pollination by insects 69
potential 2
private sector interest 63
production 2
production constraint 2
proragation 65
recommendations 8
refining 74
research stations in Uganda 61
spacing 67
tenera 64
tissue culture 66
yield in Uganda 62
yield variations 70
Oil palm industry
by-products 77
Oil palm processing
clarification and purification of the crude palm oil 74
digestion 74
oil extraction 74
sterilization 73
stripping 74
Oil seed processing industry
control of constuction of processing facilities 97
control of product sales 97
decontrol of the industry in 1953 97
development 96
freeing from controls 97
growth of industry capacity 98
licensing of oil millers 96
peak number of expellers 99
profitability of crushing cottonseed 97
Oilseed cake
production from cottonseed 9
Oilseed crop
sunflower 31
Oilseed crops
trend in production 29
Oilseed processing facilities
location 83
Oilseed processing industry
capacity 3
major constraint 3
potential capacity 3

UGANDA OILSEEDS, JULY 10, 1989

Oilseeds
    cottonseed potential 30
    Soybeans 30
Palm empty fruit bunches 77
Palm kernel cake 77
Palm oil
    chemical refining 75
    fractionation 76
    linoleic 72
    oleic acid 72
    palmitic acid content 72
    physical refining 76
    refining 74, 75
    stearic acid 72
Palm oil kernels
    previous processing 9
Palm Oil Meal
    nutrient analysis 79
Palm oil mill effluent 77
    treating 78
Palm press fibre 77
Parastatals
    use by fovernemtn 20
Particular Processing Concerns 16
Per capita edible oil consumption 18
Pests and diseases
    of oil palm 71
Phosphorylase
    of oil palm 72
Processing capacity
    apacity 3
Production costs
    smallholder farmers 34
Production system
    non-mechanized 34
Pulses; cowpeas, pigeon peas, field peas and mixed beans
    acreage 28
Recommendations 4
Refining 14
Rehabilitation
    recommendations 5
Screening 13
Semi-mechanized
    production 37
    tractor hire 37
sesame
    agronomy 59
    contribution to oil 31
    findings 3
    peak crush 9

potential 3
processing 31, 60
Yields 60
Shea butter 9
Small or medium sized expellers
recommendations 7
Smallholder farmers
needed to produce oil 34
South Bukedi Cooperative Union 6
Soybean
findings 3
Soybeans 50
Agronomy 51
Composition 52
contribution to oil 30
Economics 52
Introduction 50
Markets 51
potential 2
Processing 53
production 30, 50
recommendations for processing 7
requirements to meet oil demand 33
total production 11
Trypsin Inhibitor 53
Stimulating oilseed production 33
sunflower
agronomy 47
background 45
economics of production 46
exports 45
findings 2
peak crush 9
potential 2
processing 47
production 31, 45
requirements to meet oil demand 33
Yields 46
Sweet potato
production 28
The 1952 Acquisition of Ginneries Ordinance 91
The Carter Commission
of 1929 90
The Cotton Exporters Group 91
price fixing 91
stabilizing prices to producers 91
The Cotton Zones Ordinance
of 1933 90
price fixing 90
The general cropping situation 24

UGANDA OILSEEDS, JULY 10, 1989

The production of oilseeds and oil bearing crops 30
The supply of edible oil 24
Trade
    export crops 20
    surplus 20
Trypsin inhibitor
    in soybeans 2
    processing for 11, 30
Yields
    of oil palm fruit 68

ANNEX 1

FORMER, OPERATING AND PLANNED OIL MILLS

LIST NUMBER 1

OIL MILLS IN UGANDA TAKEN OVER
FROM ASIAN OWNERS IN 1972

LIST NUMBER 2

OIL MILLS THAT ARE NEWLY ESTABLISHED
OR WILL BE IN THE NEAR FUTURE

LIST NUMBER 3

NAMES, LOCATION, DATE OF LICENSE
AND CURRENT STATUS OF OIL MILLS IN UGANDA

LIST NUMBER 4

NAMES AND LOCATIONS OF SMALL AND MEDIUM
SIZED EXPELLERS

ANNEX 1.

The following is our revision of the preliminary review that we did on March 2 of the oil mills that were taken over from the Asians in 1972, and some of the new oil mills that we are aware of or have visited. The review should be considered to be incomplete, as we have not been able to verify the information in every case. For example, we are not completely confident of the former names or ownership of some of the mills in LIST NUMBER 1, or the intentions of some of the previous owners. We have, however, talked with the Departed Asian Properties Custodian Board, and they have supplied us with a list of the 21 properties given in list number 1. In the cases where we are more certain of the status of these oil mills it is indicated in the review. This is also the case for those new mills or newly purchased expellers we come across, such as those noted in LIST NUMBER 2. There is some confusion and inconsistencies among lists, which makes the information somewhat suspect. For example, an earlier Custodian Board list gave the mill known here as New Budaka (# 15) as having been allocated to the Ministry of Education. This is incorrect. We have verified the address of most of the mills and have found the Ministry of Education property at Km. 30 on the new road between Mbale and Iganga. In other cases, we have not been able to determine the mill site because the address was unknown (i.e. plot number or mile post) and that made it difficult to cross check it with the Asian owner as given on the Custodian Board list. We have attempted to check these locations and the current list has been modified to reflect the most current information as of the date of this report. There are now 21 properties listed from the DAPCB. The original list of 18 oil mills and soap factories turned over to the LMB are included. Additionally there are three propeties, namely, Kwapa Oil Mill, Uma Industries, and the Chemico Industries and Soap Works which have no LMB number on the DAPCB's letter to us. We assume, therefore, that these three properties were either not running at the time LMB took over the edible oil and soap industry in 1974, or they remained with Ugandans to whom they were first allocated.

In the case of the list of mills that have been licensed since 1970, LIST NUMBER 3, we attempted to determine which of these mills had actually been built, were in the process of being built, or at least had equipment on order. This was not possible in most cases, and the status of most of the oil mills on this list is unknown. It should be pointed out that this list, which was prepared for a study on oil seed processing in 1988 by J.K. Ahimbisibwe, L.Msemakeweli, et al of Makerere University, also contains the 18 former Asian owned mills on list NUMBER 1 below. The date of license of those 18 mills may be given due to some legal formality, but does not represent the date of establishment of these mills, as most date from the 1950s and 1960s and some even from pre-war. Finally, there is an additional list, LIST NUMBER 4, also from the Ahimbisibwe report, of small and medium scale expellers for which we have not verified status or condition.

LIST NUMBER 1

LIST OF OIL MILLS IN UGANDA TAKEN OVER FROM ASIAN OWNERS IN 1972.

1. Supersonic Oil Mill. LMB # 1

   a. Location: Plot 25, Bombo Rd., Kawempe - Kampala.
   b. Former Name: Supersonic Oil Mill.
   c. Former Owner: N. Jupiter.
   d. Date established. Unknown.
   e. Allocation: To West Mengo Growers Coop.
   f. Reallocation: to LMB (August 1974) and to Nyangi (or Nyange) Cooperative in Jan 1983 (according to Custodian Board, or Feb or March depending on source. Dr. G.B. Chota Vuru and C.B. Bagira give the date as 23 Feb. 1983 in a letter to the Min Cooperatives, they also state that the mill was allocated to an Ugandan in 1972. James Smith gives the date as March, 1983).
   g. Current situation: Under the Departed Asians Property Custodian Board. The former owner has applied for repossession (VC7/301/9J01). The Nyangi Cooperative has applied to take over or purchase the mill. The decision by the board is pending.
   h. Installed Capacity: 48 TPD according to Dr. Chota Vuru and Rita Laker-Ojok. 12,000 TPA on a 250 day basis. These figures, like those of the other mills noted below, appear to be cottonseed delivered from the gins. A 50 to 60% reduction in weight after decorticating would reduce the amount to 50% of the stated capacity.
   i. Expellers: 3 - 33" H.E.B., 1 - 42" H.E.B., 3 -33" Rose-Down. Currently 1 - 33" H.E.B. and 1 - 42" H.E.B. are operating. The others are down for repairs and are questionable.
   j. General Mill Condition: The boiler is fired with cottonseed husk and is a vertical type. A steam tractor had been installed but is no longer operable. The elevator legs were broken down and seed is manually carried up to the second floor to gravity feed the expellers. The mill buildings are in poor condition. A limited amount of warehouse space is available, and currently the mill had 800 tons of oilseed cake in storage. The mill was very dirty, with oil and dirt deposits thick throughout. Overall the mill is not worth rehabilitation.

2. East African Oil Industry, Ltd. LMB # 2

   a. Location: Plot 118, Bombo Rd., Kawempe - Kampala.
   b. Former name: EAOI.
   c. Former Owner: Patel Ratilal Manibhai.

d. Date Established: unknown.
e. Allocation: Ugandan - unknown.
f. Reallocation: to LMB in August 1974.
g. Current Status: Under the Departed Asians Custodian Property Board. Operated by Edible Oil and Soap Industry Ltd. The former owner has applied for repossession of the mill (VC7/569/9EAO), which also includes a muffler manufacturing facility and a maize mill. The EOSIL Industry wants to retain the mill.
h. Installed Capacity: 40 TPD according to reports, or 10,000 TPA at 250 days.
i. Expellers: 7 Rosedown.
j. General Condition of the Mill: The mill has a decorticator and attached screen. The quality of the decorticating process was not very good, and a great deal of hull and lint was in the processing material. It has an old boiler which has just been re-tubed, but with undersized pipe and not proper flue material. There is no system for recovering the spent steam or condensed water. The plant has an oil refining system originally established for refining, de-coloring and deordarizing oil. There does not seem to have been a hydrogenization process installed. Currently oil is refined twice, and decolored. deordarizing is not done. The plant uses the soap stock to make a laundry soap by setting in pans and cutting manually into bars.

Much of the machinery in the mill such as elevators, legs, augurs, etc. are not working. Seed is unloaded from trucks by hand and carried into the warehouse. Several of the expellers were currently down for repairs, but the mill did have some spares on hand. Equipment for oil refining was only partially functioning, and some did not work at all. One of the most critical aspects was the low level of oil output. This is attributable to three things. One, the high quantity of hulls and lint in the material being processed. Two, the age of the seed, much of it was previous year's production. Three, the general settings and condition of the expellers.

EOSIL in their 1988 development plan give the current capacity of the mill as 1,188 tons of oil, 5,500 tons of seed cake. They have estimated a rehabilitation price of $590,300 which includes a boiler ($544,000) generator workshop machinery and spares. Nothing is listed for building maintenance, expellers, augars or legs.

3. Oil Manufacturing Industry. LMB # 3

a. Location: Plot 156 Block 208, Kyadondo, Kawempe.
b. Former Name: Oil Manufacturing Industries.

c. Former Owner: unknown
d. Date Established: unknown
e. Allocation: unknown
f. Reallocation: unknown
g. Current situation: Under DAPCB. No claim has been registered for this property. The mill was reported destroyed in 1979.
h. Installed capacity: unknown.
i. Expellers: unknown.
j. General Condition of Mill: unknown. It was reported destroyed in 1979 and unuseable.

4. Peter Kirumira Oil Mill LMB # 4 ???

a. Location: Plot 157 Bomba Rd. Kawempe - Kampala. (from DAPCB, but another list of theirs gave Plot 177).
b. Former Name: Jupitor Oil Industries???.
c. Former Owner: Uncertain, it appears that it was Mahandra Ishverbhai Patel.
d. Date established: unknown.
e. Allocation: to Peter Kirumira, 1972, after which it appears it was named Kirumira Oil Industry.
f. Reallocation: To LMB in 1972 who managed it until 1979 (or to 1975 according to DAPCB which shows it closed in 1975).
g. Current situation: Under the Departed Asian Custodian Properties Board. This mill was reported looted in the 1979 war and is only bare lots. DAPCB reports that there is no claim pending against this property.
h. Installed capacity: Unknown.
i. Expellers: Unknown.
j. General Condition: Reported to be nothing left.

5. Anguruma Soap Works. LMB # 5 ???

a. Location: Plot 77, Bombo Rd., Kewempe - Kampala.
b. Former Name: Asaria Soap Factory (later, Angruruma Soap, Oil and Candle Factory).
c. Former Owner: Alibai Asaria.
d. Date established: Unknown.
e. Allocation: M. Ondoga and Mr. Kaakulya from 1972 - 1974.
f. Reallocations: LMB from 1974 - 1985. Allocated by Custodian Board to Mbula Co. in 1985. In May of 1985 the mill was forcibly taken over by Somi Industries. Somi Industries was a company owned by the chief of police, who also looted mill M.3.
g. Current Situation: Under the Departed Asian Property Custodian Board, and operated by the Bunyoro Growers Cooperative Union. The former owner has applied to repossess the mill (VC4/230/9ASA), the claim has not yet

been verified and the decision is pending.

h. Installed Capacity: Unknown, it has four expellers, and originally had a simple factory for chemical soap production.

i. Expellers: Four very old Krupp expellers. Currently two are completely broken down and unlikely to be repaired as there are no spare parts being manufactured for these mills.

j. General Mill Condition: The machinery is very old and not worth rehabilitating. The boiler is a basic vertical boiler fired by cottonseed or wood. The decorticator is functioning and appeared to be doing a good job. The refinery was not open, but appeared to be a simple plant for single refining. The soap works had previously had large vats for mixing chemicals and oil to produce higher quality soap. This part was not working. The soap stock was utilized and a pan process to make laundry soap was done.

6. Iganga Industries. LMB # 6

a. Location: Plot 1/3/5/7, Weatherhead Road, off of Factory Street in Jinja town.

b. Former Name: Iganga Industries Oil Mill. ???

c. Former Owner:

d. Date Established:

e. Allocation: Ugandan?? 1972.

f. Reallocation: To LMB in 1974 who continue to operate the mill under the EOSIL.

g. Current Situation: The EOSIL operates the mill at the moment. They want to keep the mill. There is a claim for repossession (VC7/257/8JIP).

h. Installed Capacity: 60 TPD and 15,000 TPA, according to reports. The capacity was given as 36 TPD and 9,000 TPA in 1983 by Rita-Ojok. These figures are for cottonseed, meaning the original throughput was estimated to be 36 tons of raw cottonseed per day. The mill has 8 expellers working. and does a double pass press using 6 expellers in the first pass and two in the second. There are two disc type decorticators. The factory currently does semi-refined, double filtered oil. It has a soap factory with an automated line. There are 3 delinters out of order. The factory also produces oil tins, but currently most of this is done by hand.

i. Expellers: Ten. Two expellers are completely out of order. Eight are working. All Rosedown 33".

j. General Mill Condition: The EOSIL considers this their best mill, although this is questionable. It does have the most modern soap works of EOSIL's 6 plants (not counting the Kampala soap plant). The rehabilitation cost was put at $346,700 by Rita-Ojok. EOSIL 1988 reports it

having a capacity to produce 2,019 metric tons of oil, 9,350 tons of seed cake and 3,200 tons of soap annually. Again this is based on cottonseed. If this is correct then it crushes about 22,000 to 25,000 tons of raw seed annually. They are requesting $ 736,431 for rehabilitation. This includes a boiler ($544,000), generator, delinter rehabilitation, building rehabilitation, tin plant installation and machinery and spares.

7. O.K. Oil Mill LMB # 7

a. Location: Plot 5/7 Bruton Place and 6/8, Clarke Rd., Jinja. off Factory Rd., near the Uganda Transport Company's workshop.
b. Former Name: Edible Oil and Soap Mills.???
c. Former Owner: Damodan Jinnabhai and Co. Ltd. ???
d. Date Established: Unknown.
e. Allocation: In 1972 it was allocated to Cooperative Central Union.
f. Reallocation: In December 1972 it was allocated to Sir William Wilberforce Nadiope Kajumbula. In 1974 to 1980 it was with LMB. In July 1980 it was occupied by the family of Nadiope. It was retaken by LMB in June of 1982. In August of 1985 it was allocated by Gen. Tito Okello to New O.K. Oil Mill Ltd. (Mrs. Sarah Angoma).
g. Current Situation: Under Departed Asian Properties Custodian Board. The former owner has applied for repossession (VC7/736/8DJC) and the Board has recommended he be allowed to repossess the mill. The claim has been verified but negotiations are not yet completed. The mill has a history of controversy over control. After the Asian owner left, private individuals and government have disputed control. The mill currently is in the possession of Mrs. Angoma. They are reported to have planned renovations and estimate costs at 200,000 pounds sterling. They now lack the foreign exchange. Their plans are to produce their own seed when the security in the north is assured. However, it appears that this mill is to be returned to the former owner.
h. Installed Capacity: Listed as 90 TPD and 22,500 TPA at 250 operating days. Other reports put the capacity as 28,080 mt.
i. Expellers: There are 15 expellers driven by 15 hp electric motors.
j. General Mill Condition: It is reported that 8 expellers are working and 7 are out of order. The 8 working expellers were installed at a later date probably during an expansion phase. The working expellers currently are capable of processing 25 mt per 12 hours or 6,250 mt per year. There are 3 decorticators with capacities of 25 mt,

15 mt, and 15 mt driven by 40 hp, 25 hp and 25 hp electric motors respectively. Only the large decorticator is working, and it requires 2 days to decorticate 25 mt of cottonseed. The refinery consists of a neutralizing tank (1,300 liters), a bleaching tank (650 liters) and a deodorizing tank (650 liters). One filter of 24 parallel plates is used and pumps are reported to be working. There are two boilers, a large and small, which are operational, but only the small boiler is now used because it is felt to be more economical. This is fired by cottonseed husk. Currently the mill crushes 25 mt per week and yields 100-150 tins of refined oil (18 kgs or 20 liters). We were denied permission to inspect the plant and machinery by the person in charge of the factory on the day we visited.

8. Kaliro Oil Mill. LMB # 8 ???

a. Location: Wantwome Village, Kaliro - Kamuli District, Busoga.
b. Former Name: A.M. Kirunda & Company, Ltd., after allocation, previous name under former owner unknown.
c. Former Owner: Unknown.
d. Date Established: Unknown.
e. Allocation: To A.M. Kirunda in 1972.
f. Reallocation: To LMB 1974 to 1979.
g. Current Situation: The mill was listed as closed in 1975 and looted during the 1979 war; it is under the Departed Asians Property Custodian Board. The former owner has not applied for repossession. The Uganda Development Bank had loaned 200,530 shillings to improve the mill. The Bank has applied to the Board to register its claim to repay the loan of 11,116/60 plus compounded interest at 10%, (assume this amount has been converted from old to new shillings). Decision pending.
h. Installed Capacity: Unknown.
i. Expellers: Unknown, but reported to be 3.
j. General Mill Condition: Not running and considered scrap.

9. Busiro Oil Mill. LMB # 9.

a. Location: Busiro Iganga District, Busoga.
b. Former Name: The DAPCB gives it as Alosio Mukimira and Brothers.
c. Former Owner:
d. Date Established: Unknown.
e. Allocation: Uncertain. DAPCB in one list notes it was allocated to Samviri Bamuwamye and Dhirimusangu of Busiro Growers Cooperative Society, Ltd. However, Laker-Ojok gives it as allocated to Alozio Nugumizira and Bros. Ltd.

in 1972, as does Dr. Vuru, this may be a simple confusion with the name of Alosio Mukimira given to us by DAPCB.

f. Reallocation: Uncertain but presumably to LMB in 1974, according to Laker-Ojok the LMB held it until 1985 when it was cannibalized for spares for Kakira, and then it was allocated to Iziru Cooperative Society in 1985. According to the EOSIL development plan of 1988, it was allocated to the Iziru Co-op in 1983, which checks with the DAPCB information.

g. Current Situation: Under the Departed Asian Properties Custodian Board. Presumably still with Iziru Co-op, but it is listed as dormant. The former owner has not applied for repossession, but have applied for compensation. Apparently the allocates have applied for registering an intent to claim the property, but which allocates is not clear. The DAPCB data would indicate that this is the Busiro Growers Cooperative.

h. Installed Capacity: Unknown, but Dr. Vuru's report suggests that it had only 2 expellers and was the smallest mill of the 18, however, this data is from 1965.

i. Expellers: Unknown, evidently only 2.

j. General Mill Condition: Unknown, Dormant. Operated by Iziru Cooperative Society it seems. Apparently only scrap, and condition of buildings and property is not known.

10. Busembatia Oil Mill LMB # 10.

a. Location: Plot No. 41, Busembatia, Komuli District, (Iganga District).

b. Former Name: Hoima Cotton Co./Edible Oil Mill and Ginery.

c. Former Owner: Mrs. S.M. Mehta.

d. Date Established: Unknown, but reported to be 1944.

e. Allocation: According to DAPCB it was allocated to Adagannalya Cooperative Society. Laker-Ojok has it allocated to Uganda Cooperative Central Union in 1972.

f. Reallocation: To LMB from 1974 to 1985. To Busoga Growers Cooperative Union July 9, 1985.

g. Current Situation. The former owner has applied for repossession of the property (VC8/118/8HCC). The claim has been verified, but negotiations have not been done. The Adagannalya Multi-purpose cooperative Society has applied to register a claim. The status is pending. It is now being run by the Busoga Growers Cooperative Union, but they only receive a small quantity of cottonseed to process.

h. Installed capacity: A figure of 18,000 mt of cottonseed crushing capacity was given by the Edible Oil and Soap Industry Committee in 1986. However, this probably means before decorticating, which reduces tonnage by 50 to 60%.

That would mean the mills would have been given a capacity (based on 250 working days per year) of about 36 mt or 3 mt per expeller. This may be high.

i. Expellers: 12 Rosedown 33". These expellers were reported to have been installed new in 1972 just before the owner lost the mill.

j General Mill Condition: The mill is powered by a steam engine in the form of a steam cylinder operating off of a steam boiler, which turns a jack shaft providing torque to 9 of the expellers. At the moment the main engine was undergoing repairs, requiring piston rings and connecting rod bearings. A second steam boiler generated steam for the expeller cookers. Three expellers are powered by electric motors. Two of the expellers are completely out of order and two others are temporarily out of order.

The mill originally had 3 decorticators which handled cottonseed in series. Seed was then moved to the decorticators via an auger and leg. The decorticators and conveyor system was powered by an electric motor. As the seed moved to each decorticator, an air system was used to convey seed. Each decorticator had a cyclone system to vent air. Hulls were moved to the steam boilers via a pipe using fan generated air current. The plant contained a refinery that was in reasonable condition, although most of the pumps were either steam powered or vacuum. It did appear to be serviceable.

Buildings and warehouses were in fairly good condition, and adequate raw material and finished product storage seamed to be available. Two houses and an office go with the property.

11. EMCO. LMB # 11 ???

a. Location: Jinja/Busoga District - The mill is actually located at the farm of the Kakira Sugar Works about 4 miles from Jinja. Head offices are located in Jinja for the corporation, and plant offices are located on the premises.

b. Former Name: Kakira Oil and Soap or the Madhavani Sugar Works Oil Mill.

c. Former Owner: Madhavani Sugar Works, Ltd.

d. Date Established: 1963. (A date of 1941 was also noted on another report for the date that Mahdavani established his mill. It is very doubtful if any part of the current mill was built at that time, and probably refers to an earlier mill).

e. Allocation: Original allocation unknown.

f. Reallocation: LMB from 1974 to 1980.

g. Current Situation: This mill was apparently the first one

taken over by the government. It was repossessed in 1980 by the Mahdavani Group under a joint venture with the government whereby Mahdavani had 49% and the GOU 51%. It was to be rehabilitated at that time. An estimated $964,602 was needed to rehabilitate in 1980, and $11,900,000 to bring it up to 300 TPD. In 1985 it appears that Mahdavani regained 100% control of the farm and plants located there. There are two applications for repossession given in the documents (VC7/326/8MSW and VC7/327/8MSW).

h. Installed Capacity: It was listed by Laker-Ojok in 1986 as having 150 TPD or 37,500 TPA when new. It reported having a crushing capacity of 100 TPD in 1983 and 25,000 TPY. Dr. Chota Vuru gives it as 120 TPD and 30,000 TPA. These figures are all for cottonseed, which would require a capacity per expeller of 6.25 tons per 24 hour period. Actual material throughput would be reduced by 50 to 60%, giving a throughput of just over 3 tons per 24 hours per expeller. This may be high. The plant is a self contained unit, with mechanical feed of seed through delinters, decorticators, expellers, and cake mechanically moved to storage and bagging area while oil is pumped to a refinery. Facilities for handling refining down to double refined oil, hydrogenated oil to produce vegetable ghee, and a margarine plant are there including the hydrogen plant.

i. Expellers: 23 Rosedown 33" and 1 Alfa Engineering Works - Bombay, India 33" machine. Set up in a double line with automatic feed from decorticators through a recently installed triple cooker to the expellers.

j. General Mill Condition: Excellent. This plant is completely self-contained, and includes steam powered turbines to produce electricity. The plant included 4 boilers fired with hulls or wood. They were located with a large shed for storing materials for the fireboxes, and included tracks for a narrow gauge railroad. Although the workers said they did not use bagasse from the sugar mill, it seemed as this could have been possible as the railroad ran to that plant. They did state that they could use bagasse, which was baled at the sugar mill. Two other (fuel fired???) boilers were also installed. The turbine room had 5 steam powered turbines. These were not all operational, but it appeared could easily be repaired.

The factory has a complete refinery for producing oil and ghee. It has not operated since 1982, and is in excellent condition. A laboratory for analysis is also located in this building. A hydrogen plant is located nearby for feeding the ghee operation.

The factory has a tin making complex. This had been completely automated in the past, but currently some machinery has broken down, particularly the automatic soldering machines.

There is a workshop at the plant which has been able to handle most operations of the factory. This included pipe work, lathe work and rewiring of electric motors. More complex work could be handled at a larger workshop attached to the sugar factory.

As noted above, the factory has a narrow gauge railroad. This services every part of the plant, and could be used to move material and machinery. Various lines were connected by cross lines feeding past and into buildings, and serviced by turntables. It currently is used by manually pushing small wagons.

Other units were built, including a dispensary, housing for workers and staff, garages and workshops for vehicles, and a separate office. a large amount of warehouse space is available for raw material and finished product. Additional warehouse space is available that is used in common with the sugar mill which occasional has stored sugar there. The plant is served by a paved road from the main entrance of the plantation, although this road is now somewhat in disrepair. A divided highway connects the plantation to Jinja town. The phone system was currently out of order.

The oil factory has operated only sporadically over the last few years. The mill was not running when we visited, but some repair and maintenance work was going on. They had just received a small quantity of cottonseed which they intended to press. The factory contained a small refinery to handle this oil so the large refinery was not needed. Some material was available for making tins, and a small quantity of cottonseed cake was in the warehouse. We did not find out what the company intends to do in the future.

12. Arapi Oil Industry. LMB # 12.

a. Location: Arapi Teso District. Soroti.
b. Former Name: Arapi Oil Industry.
c. Former Owner: Unknown.
d. Date Established.
e. Allocation: John Wabwire of P.O. 49, Soroti.
f. Reallocation: In 1974 to LMB.
g. Current Situation: Operated by LMB. The former owner has applied for repossession (VC7/649/15ÜCM), but the verification of the application has not been completed.

There is a claim of interest in the mill. The status is pending.

h. Installed Capacity: 30 TPD and 7,500 TPA, Again presumably for undecorticated cottonseed. This capacity may be grossly overstated, given the number of reported expellers.

i. Expellers: Unknown, but it was reported that there were only 4, of which one was installed around 1972.

j. General Mill Condition: The 1983 capacity was listed as 24 TPD and 6,000 TPA. EOSIL gave a capacity in 1988 of 972 tons of oil and 4,500 tons of cake. They estimated a rehabilitation cost of $109,576, most of which was for spares.

13. Tororo Oil and Soap. LMB # 13.

a. Location: Tororo. About 2 miles from town on the road to Mbale. Address, P.O. Box 6, Tororo.

b. Former Name: Tororo Oil and Soap Co.

c: Former Owner: Labdi ??? (check, this was according to an old employee).

d. Date Established: Unknown.

e. Allocation:

f. Reallocation: To LMB in 1974.

g. Current Situation: Under control of the Departed Asian Property Custodian Board. Currently being operated by the LMB (M 13). There is an application for repossession (VC7/741/6DJC), which has not yet been verified.

h. Installed Capacity: 30 TPD and 7,500 TPA.

i. Expellers: 3 Rosedown, 1 HEB, and 1 Krupp.

j. General mill condition: EOSIL gave the capacity in 1988 as 972 tons of oil, 4,500 tons of seed cake and 2,800 tons of soap. They estimated rehabilitation costs at $256,739 of which $133,333 was for completion of a house currently being built (where I don't know, we did not see this).

The mill has 3 warehouses for seed storage, each about 30 x 70 feet. A vacuum system conveys seed from the warehouses to a decorticator which is powered by 2 45 hp electric motors turning discs in opposite direction. The boiler is a Marshall and Sons, Britannia Boiler (Gainsborough, England) in fair condition. The plant appears to be quite old. The expellers are electric motor driven, but only the HEB and Krupp machines were operable. The motors had burned out on the others. The factory also has a basic refinery and a soap factory. The plant was not operating, but they did have a small amount of cottonseed.

In general it would be very questionable if this mill were worth rehabilitating.

14. Magodes. LMB # 14.

a. Location: Tororo District, about 15 kilometers north of Tororo on the Mbale Road, just before the Mbale District line. Address, P.O.Box 101, Tororo.
b. Former Name: Magodes Ginery and Oil Mill (or Magodes Oil Mill and Soap Factory.
c. Former Owner:
d. Date Established:
e. Allocation: To a Ugandan ??? 1972.
f. Reallocation: To LMB 1974 to 1982. On September 29, 1982 it was reallocated to the South Bukedi Cooperative Union.
g. Current Situation: With the Asian Properties Custodian Board. There is an application of repossession (VC7/737/6DJC) which has not been verified. It is unsure who has this mill at the moment, but the guards seemed to be employed by either S.Bukedi or LMB. South Bukedi Cooperative Union did not use the mill and returned it to LMB. However, the DAPCB gives its status as allocated to So. Bukedi in September 1982 and has no change in that status. The LMB reportedly took all the spares to other mills.
h. Installed Capacity: Unknown, but using the capacity calculations used on the other mills it would have been rated at about 30 TPD and 7,500 TPY.
i. Expellers: 2 Bough Engineering (PTT) Ltd. Johannesburg with 9" feed. 6 Rosedown 33", with two completely dismantled.
j. General Mill Situation: Not operating. It was reported to have been shut down by LMB due to "constraints in operations", and is regarded as scrap. The plant has 2 Rosedown decorticators (drum and knife type) that are most likely salvageable. The plant is powered by an old double cylinder steam engine that turns a large jackshaft to run the expellers. Another jackshaft was apparently driven by either a steam or electric motor (no longer there) to power the decorticators. A second steam boiler was apparently used to supply steam to the cookers.

The Plant had also previously operated a steam powered cotton gin, but all that remained were some engine parts and cotton bale storage floors. A large open ended "pole-type" shed was there apparently for storage of raw or finished material or equipment.

The factory had previously had a refinery and soap factory, but not much was left of either of these installations. Only the decorticators and possible some parts appear salvageable. The buildings have some value, but the plant itself would be uneconomical to refurbish.

15. New Budaka. LMB # 15.

a. Location: Plot No. 66/68 Pallisa Rd., Mbale District.
b. Former Name: Mbale Edible Oil Mill and Soap Factory.
c. Former Owner: Budaka Ginneries Ltd., Ibrahim Mitha Kanji.
d. Date Established: Unknown, but the plant appears to have been built in at least two stages. The old part of the plant had 3 expellers and its own decorticating setup. This part of the plant had two HEB expellers stamped with the date of 1951, which could have been when the plant was established unless used mills were installed. A date of 1959 for the mill was also noticed. The Oil refinery was built in 1965, and could have been when the oil mill was expanded. The date of the soap works is unknown.
e. Allocation: Ministry of Education, Bugwere Senior School since 1976 according to DAPCB, This is however in error. Their property is 18 miles from Mbale, and could have been another property of the same owner. The mill at this location was evidently allocated to a Ugandan in 1972.
f. Reallocated: LMB in 1974 who continue to run it (M 15).
g. Current Situation: Under the control of the Departed Asians Property Custodian Board. It is being operated by the EOSIL in conjunction with the New Alliance Mill next to it. uncertain who controls the mill. According to records of the DAPCB, the former owner has applied for repossession (VC7/150/14BUG) and certificate of repossession No. 0132 was issued. There was some confusion with an earlier list where the Min. of Ed. had been listed as having applied to register a claim. Barclays Bank may also have an interest. However, this is the incorrect property for the Ministry of Education. That property is clearly about 20 kms. from Mbale on the Iganga Rd. It does appear that the Min. Of Ed. operated property was owned by Budaka Ginneries as well (as well as a maize mill in Mbale across from the New Budaka Oil Mill, and others). This former owner is listed as applying to reposses both properties.
h. Installed Capacity: 54 TPD and 13,500 TPA. This figure evidently is for undecorticated cottonseed, or 50% of the above for expeller throughput.
i. Expellers: 2 HEB (Harbuger, Eisen und Bronzewerke) (1951), 1 Indian expeller, 6 Rosedown 33". The Rosedown expellers were installed new in 1965.
j. General Mill Condition: The mill was listed as having no capacity in 1983. LMB and EOSIL have run this mill in conjunction with New Alliance. Laker-Ojok gives a rehabilitation figure of $240,000. EOSIL in 1988 gave this a capacity of 3,000 tons of soap annually, which is the only part of the mill they use. They estimated

rehabilitation costs at $873,640 which included a boiler ($544,000) and spares ($260,000). EOSIL has used this plant for spares, taking parts from the Rosedown expellers. The oil mill has not run since 1975.

The condition of the plant is quite good. The Rosedown expellers seemed generally to be in excellent shape, which seemed to support the idea that they were installed in 1965 when a new refinery was built. There were 2 Rosedown decorticators, but one unit was mostly gone. The LMB ran the Alliance mill next door because it was a smaller plant and they felt more economical to run. The 2 decorticators that had been installed for the HEB and Indian expellers was no longer functional and most of the machinery was gone. The HEB expellers, with two stage cookers, seemed serviceable.

The plant has a Marshall and Sons steam boiler fueled with cottonseed hulls or wood. Inside the plant there is also a stove fuel fired boiler, but the EOSIL personnel said it was too expensive to run.

The refinery was built in 1965 and contains all Rosedown equipment which appears to be in very good condition. This looks like a turnkey plant with pumps, vacuums, tanks etc., all Rosedown. The refinery is capable of producing double refined oil, and has neutralizing, deordarizing and decoloring equipment. It apparently has not been used since 1975.

The soap works is being used to produce basic caustic brown laundry soap from soap stock coming from the New Alliance refinery. It has previously been more substantial and appears to have had capacity for bath soap as well, including packaging area. It is currently limited, and needs cleaning and refurbishing for soap production.

The factory is located on the edge of Mbale, and has a large factory yard with office, storage and workshops arranged around it.

16. New Alliance. LMB # 16.

a. Location: Plot No. 70/72 Pallisa Rd., Mbale.
b. Former Name: Alliance Oil Mill and Soap. Also was known as Pallisa Edible Oil and Soap Industry according to the DAPCB lists.
c. Former Owner: Unknown, listed only as Alliance.
d. Date Established:
e. Allocation: Ugandan ??? 1972.

f. Reallocation: To LMB in 1974.
g. Current Situation: Currently run by EOSIL (LMB) as one mill together with New Budaka. The former owner has applied for repossession (VC7/316/14AOM). The claim has not yet been verified and a decision is pending.
h. Installed Capacity: 30 TPD and 7,500 TPA.
i. Expellers: 5 Rosedown 33", all electric motor driven.
j. General Mill Condition: The mill was listed as having a capacity of 24 TPD and 6,000 TPA in 1983 (Laker-Ojok). EOSIL gave the capacity in 1988 as 972 tons of oil and 4,500 tons of seed cake. They estimated rehabilitation costs at $ 90,776, almost all for spares.

All of the expellers were in working condition, except that one lacked a motor. All of the augers and conveyor systems were working. There was 1 decorticator that was working. The steam was supplied by 2 vertical boilers, 1 of which had problems. The fuel used was cottonseed hulls, of which there was an ample supply. These boilers are probably quite inefficient.

The refinery had a single tank for neutralizing oil in a single refined process. It had a large capacity for storage of refined oil, which probably indicates that the refinery previously had more equipment. The soap stock was processed at the Budaka Soap Works.

17. Bulangira. LMB # 17.

a. Location: Bulangira, 32 Km., Mbale-Pallisa.
b. Former Name: North Mbale Oil and Soap Works (Laker-Ojok and Dr. Chota Vuru, or North Mbale Soap Works by DAPCB list).
c. Former Owner:
d. Date Established: This plant is clearly quite old, and probably grew out of an old cotton gin that was on the premises.
e. Allocation: Ugandan in 1972.
f. Reallocation: To LMB 1974 to 1982. In September, 1982 it was allocated to North Mbale Cooperative Union. It clearly had several changes of operators. It may have been allocated first to the Cooperative in the early 1970s, probably in 1972. The Union claims to have had possession twice with LMB in between.
g. Current Situation: It was stopped in 1982 and LMB took the spares to Mbale and Tororo mills. The former owner has applied to DAPCB for repossession (VC7/60/6BCP), but the claim has not yet been verified. It is still in the possession of the N. Bukedi Cooperative Union, who occasionally use the warehouses for storage of inputs and

farm implements.

h. Installed Capacity: 30 TPD by calculations done for other mills, but this seems excessive.

i. Expellers: 4 Rosedown and 1 Laxmi Engineering of Bombay, India.

j. General Mill Condition: In 1982 LMB stopped operating this mill and took spares out. It is generally considered as scrap. The Cooperative Union started some renovation recently, and got as far as the installation of electrical wiring and boxes. These however, were vandalized, with some being stolen, so they have stopped. The building is in fair condition. The boiler is a Pinckey and Sons of London. Most other equipment has been removed. There are 5 warehouses for raw and finished product. There are also an old cotton shed and ginnery building and a small office building. Two houses across the street are also included in the property.

18. Nakesero Soap Works: LMB # 18.

a. Location: Plot No. 86, Kireka Rd, Mbuya, Kampala. (There is also a reference to Plot No 40/46 Old Port Bell Rd Mbuya, Kampala, which is either the corporations headquarters or an earlier works. The DAPCB simply gives the address as Plots 40 and 86 Mbuya).

b. Former Name: Apparently Nakesero Soap Works Ltd. However, this company also owned Nakesero Soap and Edible Oil which is the Kireka Rd address.

c. Former Owner:

d. Date Established:

e. Allocation: Ugandan??? 1972.

f. Reallocated: LMB June, 1975.

g. Current Situation: Now operated by EOSIL as a soap factory. The plant is listed as only a soap factory and not an oil mill, even though there was apparently an oil mill owned by the Soap company in the same area (see a and b above). The former owner is listed as having applied for repossession (VC7/392/14NSW), and the claim has been verified and negotiated but a final decision has been deferred. The Smith report notes that a representative of the former owner had appeared at the plant in 1983, but that he could not produce satisfactory papers and was turned away. The Custodian Board list gave the Custodian Board's recommendation that Nakesero Soap and Edible Oil should be returned to the former owner if he agreed to return to Uganda and manage the factory. For the Nakesero Soap Works, Ltd. (Old Port Bell Rd.) it was noted that the former owner applied for repossession and that the allocatee had registered a claim of interest. It is not clear if the recommendation for repossession covers both properties (if in fact there are separate

properties) but it would seem so.

h. Installed Capacity: 14,000 metric tons of toilet and laundry soap per annum. Smith gave an installed capacity of 40 TPD and 10,000 TPY on a 250 day basis. The factory also has a line for the manufacture of candy, which EOSIL gives as 461 tons per year. What has happened to the oil mill part is unknown.

i. Expellers: This is not applicable unless the two factories are considered. What has happened to the Edible Oil plant is unknown. The soap sections apparently have quite recent model Italian equipment installed in 1961.

j. General Plant Condition: We have not seen this plant. According to Smith, this plant shut down in 1976 because of a lack of raw materials and did not reopen until 1983. He said that it employed 120 people to make soap and 30 people to make candy.

19. Kwapa Oil Mill.

a. Location: Kwapa, Tororo.
b. Former Name:
c. Former Owner:
d. Date Established:
e. Allocation:
f. Reallocation:
g. Current Situation: The former owner has applied for repossession (VC7/398/6KWG) but the claim has not yet been verified.
h. Installed Capacity: unknown.
i. Expellers: unknown.
j. Current condition of the mill: The DAPCB lists this property as having been looted and demolished to the ground. We were not aware of this oil mill and did not visit the property.

20. Uma Industries,

a. Location: Plot 78 Bombo Rd. Kewempe - Kampala.
b. Former Name: Uma Flour and Oil Mills.
c. Former Owner: Kantibhai Nathabhai Patel.
d. Date Established: 1938.
e. Allocation: Ugandan - unknown.
f. Reallocation: LMB August 1974 ???. This is unclear, in our most recent list from DAPCB it has not been given a LMB mill number. This mill was reported burned in 1977. It was looted for machinery which was reportedly taken to Tororo. This was the action of Somi industries in 1985/86. Note that we had this property confused with LMB mill #3, Oil Manufacturing Industry in our earlier report.
g. Current Situation: This mill was returned to the former owner by the Departed Asians Property Custodian Board in

late 1988. He has started clearing the premises and plans to build a flour and oil mill on the property. Although he had first considered building a new large capacity mill and installing new expellers, he has reconsidered this. Currently he is still studying the situation, and has given some consideration to installing old expellers already in Uganda if he can by them. He had expected to be operational in about 12 to 18 months, but because of the shortage of raw material to process, it is likely that this will be delayed.

h. Installed capacity: The former mill had 9 expellers, including one very large south african origin expeller. It operated 10 delinters and had somewhere around 100 TPD capacity. The owner had planed to rebuild the mill to the same or greater capacity. He is now less confident that he can obtain oilseeds from farmers. He plans at this time to look mainly at sunflower and simsim, and groundnuts if the price is right.

i. Expellers: The owner has not determined which expellers to purchase, and is in the process of evaluating information received from several sources in the U.S., India and Europe. Chinese mills may also be a possibility. However, in the short run he may go with used Rosedown expellers.

j. General Mill Situation: The owner will cover the reconstruction costs with shilling reserves as well as the operations and seed purchases. He is now investigating loan possibilities for foreign exchange to purchase expellers, decorticators and delinters if there seems to be an improvement in the cotton situation. The owner was born in Uganda and is a Ugandan citizen of Asian origin. His company previously exported oil and cake, and had properties in Mombasa from which the family had come to Uganda. They disposed of their property, godowns etc. in Mombasa. The company also acted as an agent, supplying parts to most of the other oil mills in the country before 1972.

21. The Chemico Industries and Soap Works.

a. Location: Plot 38 Bombo Rd, Kawempe.
b. Former Name:
c. Former Owner:
d. Date Established:
e. Allocation: unclear, but DAPCB gives it as Amos Mugisa. However, this may not have been the original allocation.
f. Reallocations: unknown. This mill has no LMB mill number on the DAPCB list furnished to us. Presumably it was never turned over to the LMB, but who had it or if it was operating we do not know.
g. Current Situation: An application for repossession (VC7/805/9CISW) was filed but the claim has not yet been

verified. Note that we had this confused with LMB mill #5 previously.

h. Installed Capacity: unknown.

i. Expellers: unknown.

j. General Condition: It was reported to have been looted in 1979.

LIST NUMBER 2

OIL MILLS THAT ARE NEWLY ESTABLISHED OR WILL BE IN THE NEAR FUTURE.

1. Kantibhai Nathabhai Patel.

   a. Location: On the site of the former Mill LMB # 3 at plot 78 Bombo Rd, Kewempe.
   b. Status: As noted under item # 20 above, the mill has been returned to its former Asian owner. This mill had been burned and later looted. Nothing remained except a bare lot full of rubble and the former residence. The owner has started clearing the lot and will rebuild the structures quite soon. His plan is to establish a new oil mill on the premises.
   c. Capacity: The owner originally wanted to install a mill similar to the previous one, but had not chosen the equipment in early February. In our preliminary report we noted he would probably have at least a 50 TPD capacity. After further study, the owner is now reconsidering plant type and size in light of the difficulty in finding material to process. Mill rehabilitation will depend on potential for material in both type and quantity.
   d. Source of Material: The owner was certain that he could get oil seed if he goes to farmers with cash to buy. He was planning on primarily using sunflower from the north and west, but would crush other oilseeds if he could buy them right. The current indications are that the mill will be refurbished in steps as seed or other oil bearing materials can be located.
   e. Dates and times: The owner originally expected to be operating in 12 to 18 months after he had his property returned. Currently the timing will depend on material source. Discussions with other potential processors and cooperative unions have taken place.

2. Mukwano Industries.

   a. Location: At the Mukwano Industries factory in Kampala.
   b. Status: This plant has been ordered and should be shipped. All buildings are erected, boilers, generators, electrical installation, etc are completed. The refinery is already operating, and has been tested.
   c. Capacity: He is buying 3 Anderson 33" AN 3 Super Duo expellers from the United States. The owner says he is planning on 100 TPD.
   d. Source of Material: Mukwano plans on a sort of contract arrangement with farmers. He plans mostly on sunflower, and hopes to eventually buy 50,000 tonnes per year, which

would indicate that he may eventually expand his capacity. The company is also now in the process of buying palm oil kernels.

e. Dates and times: The owner has contracted for the mills already, and thinks he can have everything installed and operating by the end of August. However, he does not plan on approaching farmers until after he is sure everything is ready. He plans to buy 50 tractors so he can offer tractor plowing services to the farmers. He says he is willing to finance seed, fertilizer and other inputs if necessary. He is also in the process of buying palm oil kernels from villagers in the western part of the country, and is now erecting a warehouse to buy and store these seeds.

3. South Bukedi Cooperative Union.

a. Location: About 4 miles west of Tororo on the site of one of the Coop Unions cotton gins.

b. Status: The mill was commissioned in November of 1988. It is currently in the process of crushing cottonseed.

c. Capacity: There are three East German Sket expellers with 35" drain cages. Each machine has 7.5 TPD throughput. The mill also has a seed roller which would be ideal for sunflower or other seeds, and a screening tank which returns fines back to the expellers. The mill has a fuel fired boiler to supply steam to the expellers and refinery. The water is treated for the boiler. The mill has a refinery capable of doing double refined oil, with large capacity storage tanks. There is a warehouse with a capacity of about 800 tons for raw seed, and another of a similar size to hold cake. The mill is equipped with a screw auger leg to feed the raw seed and another screw auger leg to carry cake to the warehouse. The mill has no decorticator and they now are processing whole cottonseed.

d. Source of Material: At the moment they are getting allocations of cottonseed from LMB. However, they are now in the process of buying sunflower, and have offered 50 shillings per kilogram of seed. The Produce Marketing Board in Tororo is also buying soybeans for barter trade to Yugoslavia. They have bought 10,000 bags (about 100 kgs each) this year. Therefore, it is likely that the Cooperative Union could buy soybeans in their area. However, to process soyabeans, the Union will have to modifiy the mill somewhat. They will need to add either an extruder ahead of the expellers or cokkers for the soyabeans.

e. Dates and times: The mill is up and running, and the workers have been partially trained. The East Germans were expected last week (END OF FEB) for a three month training and maintenance program.

4. Private small Mill in Jinja. The Jinja Amalgamated Oil Mill.

   a. Location: Between the OK mill and the Iganga Industries Mill off Factory Road in Jinja.
   b. Status: This mill is owned and operated by a Ugandan and his wife, Mr and Mrs Otire. She is the Managing Director.They have an operator who looks after the expeller.
   c. Capacity: This is an Italian Mozzanica Carrera TIPO MG 750 expeller, which should have a working capacity of about 5 TPD. This is a 33" expeller with an 8" diameter. Right now he is only doing 1 ton in 12 hours, but this must be because of wear in the machine. The Ahimbisibwe report gave its capacity as 200 kilograms per hour
   d. Source of Material: The owner buys sunflower in Lira and transports it to the oil mill in Jinja.

5. Private small mill in Lira: Akonykori Co. Ltd.

   a. Location: Erute County, Adekokwo, Lira District, 7 km. on the Kitgum Rd. Lira.
   b. Status: This is an operating oil mill apparently identical to the mill in Jinja (#4 above). It is owned by Parm Opio who is also a trained mechanic who services other expellers of the Italian Carrera make.
   c. Capacity: Same as above.
   d. Source of material: Sunflower, presumably from around Lira.

6. Three mills owned and operated by churches.

   a. Location:
      1. Gulu Diocese in Gulu.
      2. Gulu Diocese in Kitgum,
      3. West Nile Diocese - Ediofe.
   b. Status: All of these mills are reported to be operating.
   c. Capacity: All of these mills have Italian Carrera Expellers as noted in the Jinja Mill in 4 above. They should each have a capacity of about 5 tons per day.
   d. Source of material: As far as can be ascertained, all of these mills are processing sunflower, either purchased seed, or on a basis of returning a set quantity of oil for each kilogram of seed processed.

7. Najja Cooperative Oil Mill.

   a. Location: Kampala address on the Entebbe Road.
   b Status: This mill is about 2-3 years old, and has been operating crushing sunflower seeds for some time. This plant is cooperatively owned, with about 40 members in the cooperative. It also runs a maize mill.

c. Capacity: 2 Tigerbaby expellers from India, each driven by a 25 hp electric motor and an expected capacity of 1.5 TPD, supposedly in three shifts. The plant also has a simple refinery with a neutralizing tank, a filter and a boiler.
d. Source of Material: Primarily sunflower seed purchased in the north.

8. Kolping Enterprises Ltd.

a. Location: Currently at a bick works outside of Hoima. They are now constructing a new physical plant in Hoima town, where they will move their equipment this year.
b. Status: This mill has been running a short while. The new plant should be operating this year, probably by July.
c. Capacity: The company now has one Carrera expeller as those noted above. They are interested in expanding and are in the market for more machines. They had planned to import one or more new expellers. They have discussed a capacity of up to 30 TPD.
d. Source of material: The company crushes primarily sunflower. They grow a small amount themselves, but mostly buy seed from farmers, under a modified contract arrangement. At the present time, they help farmers obtain seed, but have not developed any plan as to seed varieties, and are using several local varieites. They feel they can arrange for as much as 4,000 acres of sunflower production, which will not be adequate for the expansion of capacity they plan.

9. Kitara Growers Cooperative Union.

a. Location: Hoima town.
b. Status: This Union has apparently done only a very superficial feasibility study. They talked about a plant of 30 TPD, but did not seem to have any clear idea of the volume that indicates.
c. Capacity: unknown, they wanted 30 TPD.
d. Source of Material: The Union feels that they will mostly crush their own cottonseed. However, they did not seem to be aware that the LMB owns the cottonseed, and that they would have to purchase it after allocation to them. In any case, the level of cotton ginning that they do would give them only a small volume of seed, and not an adequate supply for the mill capacity they discussed. They feel that Kolping will do all of the sunflower, so they do not envisage other seed supplies.

10. Kyakatara Rural Development Project.

a. Location: about 10 miles east of Fort Portal.
b. Status: They have operated a small Simon Rosedown

expeller in the past, but it is currently broken down. We could not locate anyone to discuss the status with.

c. Capacity: One Simon Rosedown Mini 40. Capacity of this machine is given as about 15 liters of oil per hour.

d. Source of material: unknown.

11. Nkuruba Mills (Vinka).

a. Location: Catholic Mission in Fort Portal.

b. Status: An operating small expeller which is crushing sunflower, primarilly for local farmers who get oil.

c. Capacity: One Simon Rosedown Mini 40 powered by a 3HP electric motor. This expeller is rated at 15 liters of oil per hour, but they are not getting this much throughput. They cannot process more than about 200 kilograms of seed in a shift.

d. Source of material: The Misssion has some land that they are planting to sunflower. However, it seems that most of this is used to distribute to local farmers for seed. The seed for crushing is mostly sunflower that farmers bring in to have processed in exchange for the oil.

12. Nyakatonzi Growers Cooperative Union.

a. Location: Kasese town, at the Unions cotton gin.

b. Status: The Union has done a very preliminary study on establishing a mill.

c. Capacity: The Union is thinking about a plant similar to the one built by the Tororo Union, the East German Sket equipment. This would be about 30 TPD.

d. Source of material: The Union is expecting to gin about 10,000 bales of cotton per year. They would process their cottonseed, which would be a gross amount of 3,700 tons. After taking seed requirements out, they would probably not have more than 3,000 tons, if they can reach targeted cotton production. This would provide only 100 days of processing. They do feel that they could produce some sunflower in their area.

13. Kagando Rural Development Center.

a. Location: About 30 miles south and west of Kasese at a Mission Hospital.

b. Status: They have a small expeller that has been in operation for about 2-3 months.

c. Capacity: Unknown. This is a Japanese expeller that is quite a bit bigger that the Simon Rosedown Mini 40, and proably of a capacity of 100 to 150 kilograms of sunflower per hour.

d. Source of Material: They pruchase sunflower from local farmers.

14. North kigezi Growers Cooperative Union.

a. Location: In Rukingiri town.
b. Status: This Union is interested in oil processing on a small scale.
c. Capacity: The Union feels that they could get the most benefit from small expellers or hand-operated machines. They definetly have no interest in a central processing plant.
d. Source of material: The Union's area produces a lot of groundnuts and some other oilseeds. They would like to have the ability to help individuals or socities to be able to produce oil locally, particulary from groundnuts.

15. Rukingiri Mulitpurpose and Rural Development Cooperating Society Ltd.

a. Location: Rukingiri town.
b. Status: Unknown. This Society apparently expressed interest to the UCA, but no one was available who had any knowledge of the project.

16. Kigezi Distric Growers Cooperative Union.

a. Location: Rukingiri town.
b. Status: Unknown. Again, we could find no one who had much knowledge of the project.

17. Wamala Growers Cooperative Union:

a. Location: Mityana town.
b. Status: This union has had a feasibility study completed for a central processing facility. They had recieved a bid from a company in the United Kingdom (Protech International Ltd. Engineering Consultants) to supply a plant, including the macinery, engineering, site development and commissioning. At this stage, the Union has not been able to obtain the financing needed.
c. Capacity: The plant was planned for a capacity of 15 metric tons per 24 hour period.
d. Source of material: The Wamala Growers produce some cotton to the north side of their area. However, that is limited and they feel it will not expand sufficiently to supply adequate seed. They are more interested in sunflower, and would both grow their own and purchase from cooperative memebers through their socitties. They have a piece of property that was in cattle ranching covering about 40 square miles.

18. Bunyoro Growers Cooperative Union.

a. Location: Masindi town, at their ginnery on the outskirts of the town.

b. Status: The Union currently operates an oil mill in Kawempe near Kampala (Arguruma Soap Works, # 5 in LIST ONE). This plant will probably be returned to the former owner. The Union would like to establish an oil mill in Masindi because (a) it is too far to transport back and forth from Kawempe and (b) the plant in Kawempe has very old equipment. The Union has a good metal building available at the cotton ginnery that they could use to install a plant. They would be interested in undertaking a feasibility study based on a small unit or a refurbished old unit with posssibility for expansion.

c. Capacity: The Union has not determined capacity size yet. The idea is to establish a mill so that an assured market for product would be known to the famers. Capacity at this point is not as relevant as having a plant that can process seed so they can buy what the farmers grow.

d. Source of material: The Union realizes that cottonseed will not be a very large nor reliable source of seed. They feel that sunflower and simsim is more certain. They are sure that farmers will grow the seed if they know there is a market. In meetings with farmers at the society level this was confirmed. The main thing in this area is to get sunflower production tests going with good oil yielding varieties. The Union has a 60 square mile ranch that now patures a few hundred head of cattle (they lost about 8,000 head during the 1970s and 1980s), and it could be cleared for cropping, at least in part. Some of their societies also have land up to 5 square miles, and some group farms with 2-3,000 hectares are in the area. some individual farmers also have large landholdings and could grow oilseeds on a commercial basis

ANNEX 1. LIST NO. 3

NAMES, LOCATION, DATE OF LICENSE AND CURRENT STATUS OF OIL MILLS IN UGANDA

KAMPALA	LOCATION	YEAR LICENSED	STATUS
ASSARIA SOAP FACTORY	KAWEMPE	1970	OP
BAGAMPADDE OIL MILLS	WAKISO	1987	NI
EAST AFRICAN OIL INDUSTRIES	KAWEMPE	1970	OP
HIGH ENERGY FOODS	KAMPALA	1987	NI
JUPITER OIL INDUSTRIES	KAWEMPE	1970	BR
KABIL Ltd.	KAMPALA	1983	NI
KYAMULA FOOD AND OIL PROCESSORS	SALAMA RD	1985	NI
MUSSECO INDUSTRIES	KYENGERA	1987	NI
NAJJA COOPERATIVES	NAJJANA/ NKUMBI	1984	OP
OIL MANUFACTURING INDUSTRIES	KAWEMPE	1973	BB
PICFARE INDUSTRIES	KAWEMPE	1975	BR
STAR IMPORT ENTERPRISES	KAMPALA	1985	NI
UGANDA SALAD MANUFACTURERS	BUSEGA	1980	OP
UGMA INDUSTRIES	KAWEMPE	1979	NI
NYANGI COOPERATIVES	KAWEMPE	1970	NI
ZULA INVESTMENT COMPANY	NALUKOLOGO	1987	NI
MUKWANO INDUSTRIES	KAMPALA	1984	BB
TUGORORE ENTERPRISES	NTINDA	1988	NI
TRANS INTERTRADE LIMITED	KAMPALA	1988	NI
TEMO GENERAL AGENCIES	KAMPALA	1988	NI
RESEARCH AND OIL DEPARTMENT	KAMPALA	1988	NI
BISANGA UNITED DEALERS	KAMPALA	1988	NI
KATONGA FARM LIMITED	NABUSENKE	1988	NI
PETER KIRUMIRA OIL MILL	KAWEMPE	1970	OB
MBALE			
BUSIRO OIL MILL	MBALE	1970	OP
NEW ALLIANCE OIL MILL	MBALE	1970	OP
NEW BUDAKA GINNERS OIL MILL	MBALE	1970	DORM
MARIDADI INDUSTRIES	BUGEMA	1985	BR
NORTH MBALE COOPERATIVE UNION	BULANGIRA	1973	DORM
UNIVERSAL PRODUCTS	MBALE	1984	NI
TORORO			
EASTERN CHEMICAL INDUSTRIES	TORORO	1982	UNKNOWN
NYAKESI GINNERY (SBCU)	TORORO	1986	OP
SO. BUKEDI COOPERATIVE UNION	TORORO		OP
MAGODES	MAGODISI	1970	OB
TORORO OIL FACTORY	TORORO	1970	OP
JINJA			
EMCO OIL REFINERIES	KAKIRA	1986	OP
IGANGA INDUSTRIES	JINJA	1970	OP
NEW O.K. OIL MILL	JINJA	1982	OP
VICTORIA PRODUCTS	JINJA	1985	NI

GULU			
GULU OIL MILL AND REFINERY	GULU	1981	NI
OMOLO GROUP	GULU	1981	NI
OSOTRACO LIMITED	GULU	1986	NI
UNITED FARMERS COMPANY	GULU	1981	NI
VEGOIL MILLS LIMITED	GULU	1981	NI
LIRA			
LANGO COOPERATIVE UNION	LIRA	1987	NI
KUMI/SOROTI			
HARAMBE BRAIN POWER COOPERATIVE	KUMI	1983	OB
JOHN WARIRE & BROTHERS	SOROTI	1973	BR
TESO TEACHERS SAVINGS COOPERATIVE	SOROTI	1973	BR
UNITED COTTON MERCHANTS	ARAPAI	1970	OP
KASESE/HOIMA/MASINDI			
BUSANGA UNITED DEALERS	KAGADI	1987	NI
HOES (U) Ltd.	KASESE	1983	NI
RWENZORI INVESTMENTS	KASESE	1984	NI
SAAD FOUNDATION	KASESE	1981	NI
TAMARA SEMPEBWA	KASESE	1986	NI
NYANGABYAKI Ltd.	MASINDI	1987	NI
OTHER DISTRICTS			
AGRO FEED INDUSTRIES	MBARARA	1983	NI
KANENA VEGETABLE OIL	BUSHENYI	1984	NI
AKWATA MPOLA INDUSTRIES	ENTEBBE	1987	NI
C.O.ANGOMA	KITGUM	1985	NI
BUDDU FARMERS AND PROCESSORS	MASAKA	1987	NI
BUSEMBATIA OIL MILL	BUSEMBATIA	1970	OP
LUKA AGENCIES	LUWERO	1987	NI
PHELMA FARM	KITGUM	1976	BR
RUGETTE (OVERSEAS) Ltd.	NEBBI	1981	OP
TRANS INTER TRADE Ltd.	KAMULI	1986	NI
JENANA INDUSTRIES	MUKONO	1987	NI
KIRIRIDGE INDUSTRIES	MASAKA	1988	NI
ND COMPANY Ltd.	ARUA	1988	NI
LUWERO SOAP AND OIL MILLS	LUWERO	1988	NI
KALIRO OIL MILL	KALIRO	1970	OB

SOURCE: FROM J.K. AHIMBISIBWE, L. MSEMAKWELI, et.al., 1988.
note: some corrections have been made from original.
NI = not installed; OB = obsolete; BR = broken down;
OP = operational; BB = being built.

ANNEX 1. LIST NUMBER 4

NAMES CAPACITY AND LOCATIONS OF SMALL AND MEDIUM SIZED EXPELLERS

EXPELLER OR MILL	CAPACITY kgs/hour	DISTRICT	TOWN
KAGANDO RURAL DEVELOPMENT CENTER	100	KASESE	KAGANDO
NKURUBA MILLS - VIVIKA CATHOLIC MISS	40	KABAROLE	FORT-PORTAL
KYAKATARA RURAL DEVELOPMENT PROJECT	40	KABAROLE	KYAKATARA
NAJJA COOPERATIVE SOCIETY	125	KAMPALA	NAJJANANKUMBI
BUSOGA DIOCESE RURAL DEVELOPMENT SCH	5	JINJA	JINJA
EDIOFE CATHOLIC MISSION	490	ARURA	ARURA
MALACHA CATHOLIC MISSION	5	ARURA	MALACHA
NEBBI CATHOLIC MISSION	5	NEBBI	NEBBI
EDIOFE CATHOLIC MISSION	5	ARURA	ARURA
KIGO PRISON	40	KAMPLA	KIGO
RESOURCE ESTATES Ltd. OIL MILL	200	LIRA	LIRA
AMINA KETA	70	APACH	ADUKU
NGETTA OIL MILL	100	LIRA	LIRA
LUTHERAN WORLD FEDERATION	40	ARURA	YUMBE
LUTHERAN WORLD FEDERATION	40	MOYO	EAST MOYO
ABI DISTRICT FARM INSTITUTE		ARURA	ARURA

SOURCE: J.K.AHIMBISIBWE, L. MSEMAKWELI, et.al.,1988

ANNEX 2

MACRO AND TRADE DATA

TABLE A2.1

EXPORTS, AS EXPORTS AND EXPORTS OF COTTON AND COFFEE 1925-1965

TABLE A2.2

MACRO ECONOMIC DATA

ANNEX 2. TABLE: A2.1

Year	Total value all exports	Total value agricultural exports	Agricultural exports as percentage of total exports	Cotton (including seed, cake and oil) as percentage of total exports	Coffee (raw) (raw) as percentage of total exports
	000 pounds	000 pounds	%	%	%
1925	5100	5000	98	94	3
1930	2000	1900	95	83	8
1935	3600	3500	97	81	6
1940	5200	4900	94	75	9
1945	9900	9600	97	72	12
1950	28700	27400	95	62	29
1951	47200	45300	96	63	29
1952	47200	45700	97	66	26
1953	33400	31900	96	55	34
1954	40600	38800	96	56	33
1955	41900	40200	96	42	48
1956	40400	39000	97	52	40
1957	45900	42900	93	42	47
1958	45400	41900	92	43	46
1959	42100	37700	90	41	44
1960	41600	36000	87	40	41
1961	39200	34600	88	46	36
1962	37600	32200	86	23	54
1963	51500	45800	89	28	53
1964	64400	55700	86	25	55
1965	62700	51900	83	27	49

Source: East African Customs and Excise Annual Trade Reports.
As reported in Jameson, ed, Chapter 9 "The Economic Background", J.H.Cleave and E.H.Jones.

Note: Percentage figures of total ag exports were calculated from cols. 2 & 3, and differ slightly from those in Jameson.

ANNEX 2.
TABLE A2.2

	IMPORTS MUshs	EXPORTS MUshs	TRADE BALANCE	POPULATON	GDP/factor cost in MUshs current prices	NFI	NET INDIRECT TAXES	CURRENT TRANS-FERS	GNP market prices	INVESTMENT	DISPOSABLE INCOME
1960	652.86	965.64	312.78	6,740,955	3,043		(CURRENT TRANSFERS			372	2,810
1961	679.66	921.02	241.36	6,976,888	3,128		EXCLUDES OFFICIAL			360	2,895
1962	678.92	955.56	276.64	7,221,080	3,133		GRANT RECEIPTS)			354	2,900
1963	817.10	1,359.14	542.04	7,473,817	4,916	-51			4,865	722	4,865
1964	928.18	1,481.54	553.36	7,735,401	5,603	-37			5,566	798	5,556
1965	1,336.70	1,470.60	133.90	8,006,140	6,310	-134			6,176	857	6,176
1966	1,317.30	1,496.20	178.90	8,286,355	6,616	-124			6,492	891	6,492
1967	1,323.70	1,491.40	167.70	8,576,377	6,899	-135			6,764	1,062	6,779
1968	1,421.90	1,577.60	155.70	8,876,550	7,406	-120			7,286	1,111	7,280
1969	1,463.70	1,868.50	404.80	9,535,200	8,342	-126			8,216	1,422	8,216
1970	2,034.00	1,742.30	(291.70)	9,783,115	9,458	-107		-89	9,351	1,261	9,262
1971	1,411.40	1,884.40	473.00	10,037,476	10,765	-161		-94	10,604	1,632	10,513
1972	1,416.10	1,931.50	515.40	10,298,451	11,287	-121		-114	11,166	1,238	11,052
1973	1,940.50	2,100.80	160.30	10,566,210	12,953	-100		-45	12,853	1,062	12,808
1974	1,945.30	1,758.30	(187.00)	10,840,932	16,025	-115		-65	15,910	1,711	15,844
1975	1,989.10	2,707.80	718.70	11,122,796	22,502	-28		-55	22,474	1,712	22,419
1976	3,482.80	4,528.00	1,045.20	11,411,989	26,453	-58		-73	26,395	1,531	26,322
1977	2,708.10	2,484.10	(224.00)	11,708,700	54,406	-90		-61	54,316	3,018	54,255
1978	2,405.60	2,966.60	561.00	12,013,127	69,599	-8		-81	69,591	3,437	69,510
1979	2,708.00	2,368.80	(339.20)	12,325,468	117,478	-50		-142	117,428	3,110	117,286
1980	3,739.00	2,369.00	(1,370.00)	12,636,600	124,001	-62		2	123,939	7,930	234,511
1981	32,347.00	19,149.00	(13,198.00)	13,015,698	201,320				201,320		201,320
1982	47,580.00	34,840.00	(12,740.00)	13,406,169	366,341	-2472	38812		402,681	294	402,681
1983	789.70	106,633.00	105,843.30	13,808,354	541,538	-5956	72260	159.29	607,842	539	607,683
1984	1,618.30	125,306.90	123,688.60	14,222,605	878,187	-22265	127810	346.97	983,732	1,643	983,385
1985	68,096.10	228,000.00	159,903.90	14,649,283	2,321,697	-33600	230191	619.52	2,518,288	2,193	2,517,668
1986	158,230.50	570,080.00	411,849.50	15,088,761	5,865,964	-55720	352474	2172.94	6,162,718	5,044	6,160,545
1987	205,584.50	447,160.00	241,575.50	15,541,424	15,268,696	-228285	1074412	9470.84	16,114,823	19,638	16,105,352
1988			0.00	16,007,667							
1989				16,487,897							
1990				16,982,534							
1991				17,492,010							
1992				18,016,770							
1993				18,557,273							
1994				19,113,991							
1995				19,687,411							
1996				20,278,033							
1997				20,886,374							
1998				21,512,966							
1999				22,158,355							
2000				22,823,105							

POPULATION FIGURES FOR THE PERIOD 1960 TO 1966 WERE GIVEN IN THE 1966 STATISTICAL ABSTRACT AS FOLLOWS:

THESE WERE CALCULATED AT 2.6% GROWTH FROM THE 1959 CENSUS. WITH THE FIGURES FOR THE 1969 CENSUS, THE GROWTH RATE WAS UNDERSTATED. WE HAVE RECALCULATED AT 3.5%.
FOR THE PERIOD 1969-1979, 2.6% GROWTH RATE IS USED, AND 3% THEREAFTER.

6677000
6845000
7016000
7190000
7367000
7551000
7740000

1980-1987 GDP from World Bank, 1988 report adjust to old shillings.
1963-1980 GDP at market prices

D.I. + CURRENT TRANSFERS = GNP AT MARKET
GNP - NFI = GDP
GDP - EXPORTS + IMPORTS = TOT RESOURCES
TOT RESOURCES - G DOM INVESTMENT = CONSUMPTION

1960-1962 IS GDP AT FACTOR COST FROM 1966 STATISTICS TABLES.
THESE DATA ARE CLEARLY UNDERSTATED COMPARED WITH THE WORLD BANK DATA GIVEN AFTER. TO ARRIVE AT GNP, SUBTRACT FLOWS PAID ABROAD FROM GDP AND ADD INCOMES RECEIVED FROM ABROAD.
THE 1960-1962 INVESTMENT IS CALCULATED FROM GROSS CAPITAL FORMATION.
GNP = DISPOSABLE INCOME PLUS CURRENT TRANSFERS.

ANNEX 2.
TABLE A2.2

	SAVINGS	BALANCE OF PAYMENTS	PER CAPITA INCOME	PER CAPIT DISPOSABL INCOME	C.O.L. INDEX 1961=100	REAL GROSS INCOME	REAL DISPOSABL INCOME	REAL GDP PER/CAP LAKER-OJOK	% OURS OF OJOK
1960			451	417	98.0	461	425	718	59.24%
1961			448	415	100.0	448	415	676	61.39%
1962			434	402	96.3	450	417	656	63.56%
1963			658	651	103.3	637	630	693	90.90%
1964			724	718	109.3	662	657	698	94.12%
1965	800	96.39	788	771	127.0	621	607	705	86.16%
1966	783	-49.98	798	783	116.7	684	672	718	93.53%
1967	990	95.68	804	790	120.7	667	655	711	92.13%
1968	1,089	12.14	834	820	122.0	684	672	703	95.63%
1969	1,395	-11.42	875	862	139.7	626	617	749	82.37%
1970	1,356	34.30	967	947	144.3	670	656	735	89.24%
1971	958	-249.20	1072	1047	166.3	645	630	745	84.52%
1972	1,282	-1.20	1096	1073	162.0	677	662	729	90.87%
1973	1,320	-46.00	1226	1212	190.0	645	638	706	90.37%
1974	1,481	-198.50	1478	1461	311.3	475	469	688	68.23%
1975	1,148	8.30	2023	2016	384.7	526	524	656	79.88%
1976	1,835	35.90	2318	2307	570.3	406	404	644	62.80%
1977	3,543	155.70	4647	4634	1,125.0	413	412	637	64.66%
1978	2,374	-330.00	5794	5786	1,552.7	373	373	591	63.06%
1979	3,077	-449.60	9531	9516	6,216.1	153	153	507	30.19%
1980	6,092	-1350.10	9813	18558	6,511.2	151	285	477	59.75%
1981		-14337.00	15467	15467	9,181.7	168	168	482	34.95%
1982	152	-3098.00	27326	30037	13,335.1	205	225	508	44.34%
1983	333	-10527.00	39218	44008	18,733.3	209	235	516	45.53%
1984	1,619	-17971.00	61746	69142	25,704.0	240	269	475	56.63%
1985	1,363	40140.00	158485	171863	70,386.8	225	244	436	56.00%
1986	3,422	162820.00	388764	408287	170,914.1	227	239		
1987	7,809	-4340.00	982452	1036285	519,277.5	189	200		
1988			0		1,090,073.1	0	0		
1989									
1990									
1991									
1992									
1993									
1994									
1995									
1996									
1997									
1998									
1999									
2000									

ANNEX 3

TABLE A3.1

CROP PRODUCTION
1957-1987

ANNEXE 3. TABLE A3.1 CROP PRODUCTION

	COTTON		GROUNDNUTS		SIMSIM (SESAME)		SOY BEANS		MAIZE		FINGER MILLET		SORGHUM		RICE		WHEAT		MIXED BEANS	
	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt
1957	646.8	72.9	164.4						143.2		736.4									
1958	805.6	69.3	178.8						136.0		762.4								204.0	
1959	626.0	78.9	170.8						144.0		792.8								211.6	
1960	614.4	64.0	173.0		99.0				141.0		788.0		275.0		2.0				232.8	
1961	839.1	65.6	225.0		109.0				178.0		810.0		292.0		3.0				236.0	
1962	730.4	34.2	249.0		83.0				171.0		823.0		294.0	(includes	3.0				292.0	
1963	814.9	67.2	238.0		87.0				159.0		825.0		296.0	millet	1.0				274.0	
1964	864.8	72.0	254.0		109.0				193.0		843.0		320.0	and mixed	2.0				276.0	
1965	907.2	79.0	251.0		95.0				284.0		821.0		305.0		4.0				319.0	
1966	880.1	82.2	280.0	103.0	96.0				305.0	264.0	892.0	1136.0	296.0	274.0	3.0				410.0	
1967	870.4	85.4	277.0	137.0	94.0				275.0	337.0	615.0	812.0	290.0	290.0	6.0				423.0	305.0
1968	827.9	60.4	251.0	146.0	96.0		7.0		275.0	307.0	814.0	1041.0	230.0	284.0	5.0		3.0		523.0	340.0
1969	844.3	78.2	245.0	265.0	84.0		4.0		296.0	397.0	686.0	917.0	280.0	435.0	7.0		3.0		417.0	308.0
1970	881.6	86.4	250.0	244.0	86.0	20.0	5.0	5.0	300.0	389.0	582.0	783.0	311.0	462.0	15.0	14.0	4.0	9.0	343.0	266.0
1971		84.4	291.0	251.0	103.0	31.0	4.0	4.0	280.0	421.0	716.0	650.0	307.0	348.0	24.0	22.0	4.0	7.0	373.0	281.0
1972		74.8	291.0	234.0	91.0	28.0	7.0	7.0	415.0	500.0	497.0	594.0	318.0	419.0	18.0	16.0	3.0	7.0	459.0	222.0
1973		74.5	222.0	212.0	96.0	31.0	5.0	5.0	314.0	419.0	636.0	653.0	287.0	389.0	10.0	9.0	3.0	7.0	309.0	237.0
1974		50.0	267.0	200.0	97.0	31.0	6.0	4.0	388.0	430.0	510.0	691.0	367.0	345.0	17.0	15.0	4.0	9.0	359.0	170.0
1975		31.9	243.0	194.0	122.0	39.0	6.0	4.0	475.0	570.0	484.0	682.0	311.0	467.0	18.0	16.0	6.0	14.0	408.0	196.0
1976		24.7	213.0	177.0	113.0	33.0	8.0	8.0	526.0	574.0	498.0	567.0	326.0	390.0	24.0	29.0	5.0	12.0	407.0	325.0
1977		13.8	234.0	193.0	133.0	38.0	6.0	6.0	429.0	566.0	527.0	578.0	280.0	344.0	20.0	20.0	6.0	13.0	435.0	337.0
1978	677.5	20.4	234.0	187.0	137.0	40.0	6.0	6.0	450.0	594.0	510.0	561.0	286.0	350.0	24.0	26.0	7.0	14.0	338.0	253.0
1979	417.0	14.8	122.0	80.0	60.0	16.0	4.0	3.0	272.0	353.0	314.0	381.0	183.0	216.0	12.0	15.0	3.0	5.0	388.0	291.0
1980	312.4	13.3	95.0	70.0	65.0	20.0	4.0	3.0	258.0	286.0	279.0	458.0	167.0	299.0	11.0	17.0	8.0	17.0	227.0	182.0
1981	121.3	4.6	110.0	80.0	70.0	25.0	5.0	5.0		342.0					12.0	15.0	4.0	8.0	224.0	133.0
1982	150.3	5.1	120.0	90.0	80.0	35.0	6.0	6.0		393.0					15.0	19.0	5.0	10.0	299.0	240.0
1983	169.6	9.8	124.0	99.0	95.0	42.0	6.0	7.0		413.0					17.0	22.0	5.0	12.0	364.0	300.0
1984	199.4	12.2	172.0	118.0	86.0	39.0	11.0	9.0		281.0					17.0	20.0	4.0	7.0	398.0	314.0
1985	160.0	14.2	124.0	84.0	76.0	33.0	10.0	8.0		343.0					14.0	19.0	5.0	11.0	385.0	265.0
1986	180.0	9.3	177.0	118.0	80.0	35.0	12.0	10.0		286.0					15.0	19.0	5.0	10.0	334.0	267.0
1987	140.0	3.1	114.0	78.0	74.0	35.0	9.0	7.0		330.0					15.0	19.0	5.0		356.0	285.0
1988																			356.0	

COTTON PRODUCTION IN LINT SOLD BY FARMERS.
THE 1957-59 PERIOD IS SEED COTTON SOLD X .333, FROM JAMESON, 1970.
REVIEW OF THE 1963/64 AG CENSUS DATA BY JAMESON
SUGGESTS AREA FIGURES MAY BE VASTLY OVER-ESTIMATED.

	MIXED BEANS		FIELD PEAS		PIGEON PEAS		COW PEAS	
	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s
1957								
1958								
1959								
1960		12.0		Included		143.0		
1961		17.0		in		131.0		
1962		10.0		cowpeas		147.0		
1963		16.0		to		156.0		
1964		15.0		1970		149.0		
1965		19.0				172.0		
1966	305.0	14.0				176.0		
1967	340.0	13.0				181.0		
1968	308.0	19.0				185.0		
1969	266.0	21.0				179.0		
1970	281.0	14.0	6.0	98.0	39.0	48.0	n/a	
1971	222.0	28.0	11.0	91.0	40.0	28.0	45.0	
1972	237.0	36.0	15.0	121.0	48.0	63.0	62.0	
1973	170.0	20.0	8.0	78.0	31.0	49.0	50.0	
1974	196.0	32.0	13.0	115.0	46.0	68.0	64.0	
1975	325.0	29.0	12.0	64.0	26.0	78.0	57.0	
1976	337.0	39.0	15.0	86.0	37.0	86.0	31.0	
1977	253.0	30.0	12.0	105.0	40.0	80.0	32.0	
1978	291.0	34.0	14.0	105.0	42.0	80.0	31.0	
1979	182.0	19.0	6.0	58.0	19.0	43.0	22.0	
1980	133.0	17.0	7.0	50.0	26.0	38.0	16.0	
1981	240.0	18.0	8.0	55.0	25.0	41.0	18.0	
1982	300.0	20.0	10.0	60.0	28.0	45.0	20.0	
1983	314.0	32.0	17.0	62.0	29.0	46.0	37.0	
1984	265.0	16.0	13.0	72.0	25.0	49.0	39.0	
1985	267.0	17.0	8.0	60.0	28.0	44.0	35.0	
1986	285.0	21.0	10.0	43.0	20.0	22.0	18.0	
1987		21.0		43.0		22.0		
1988								

	SWEET POTATOES		IRISH POTATOES		CASSAVA	
	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt
1957	211.6				211.2	
1958	225.2				267.2	
1959	284.6				270.4	
1960	242.0				245.0	
1961	285.0				317.0	
1962	254.0				264.0	
1963	237.0				286.0	
1964	287.0				240.0	
1965	317.0				259.0	
1966	432.0	893.0			543.0	1710.0
1967	428.0	916.0			644.0	2124.0
1968	480.0	1049.0			499.0	2053.0
1969	444.0	1484.0			418.0	2515.0
1970	444.0	1570.0	9.0	84.0	538.0	2579.0
1971	495.0	1425.0	17.0	128.0	508.0	241[illegible]
1972	508.0	1224.0	17.0	162.0	371.0	2650.0
1973	400.0	1232.0	20.0	177.0	483.0	2132.0
1974	506.0	1786.0	22.0	199.0	485.0	2350.0
1975	550.0	1953.0	35.0	231.0	618.0	2992.0
1976	564.0	2002.0	48.0	345.0	512.0	2838.0
1977	467.0	1658.0	34.0	267.0	540.0	2993.0
1978	475.0	1688.0	37.0	293.0	528.0	2928.0
1979	248.0	576.0	21.0	131.0	303.0	1294.0
1980	231.0	1200.0	24.0	213.0	303.0	2072.0
1981		1300.0				
1982						
1983						
1984						
1985						
1986						
1987						
1988						

	BANANAS (1)		COFFEE ARABICA		COFFEE ROBUSTA		TOBACCO
	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	HAs 000s	PROD 000s mt	PROD 000s mt
1957	519.6		11.6	5.0	161.2	62.0	4.4	1.9
1958	536.0		13.6	5.0	174.4	65.0	5.6	2.1
1959	559.2		14.0	5.0	185.2	93.0	6.4	2.2
1960	626.0		14.4	6.0	199.6	107.0	4.4	1.6
1961	616.0		16.4	5.0	215.2	83.0	3.6	1.7
1962	649.0		16.4	10.0	224.4	104.0	4.0	1.7
1963	705.0		16.8	4.0	235.2	141.0	5.6	1.9
1964	746.0		17.2	10.0	237.6	175.0	4.4	3.3
1965	464.0		16.0	10.0	259.2	208.0	7.6	3.1
1966	521.0	5132.0						2.6
1967	699.0	5602.0						3.9
1968	889.0	7372.0		14.2		119.2		4.6
1969	820.0	7443.0		18.4		232.5		3.4
1970	909.0	7657.0		14.1		107.4		3.2
1971	905.0	7557.0		16.2		159.5		4.4
1972	916.0	7634.0		20.8		162.9		5.0
1973	974.0	8126.0		18.0		195.7		3.9
1974	1063.0	8879.0		18.1		180.5		3.8
1975	1097.0	9106.0		15.0		183.5		3.7
1976	1180.0	8137.0		14.0		123.1		3.1
1977	1239.0	8531.0		4.3		151.6		3.1
1978	1287.0	8855.0	33.0	2.3	190.0	119.0	4.1	2.4
1979	1290.0	5924.0	33.0	5.5	191.0	98.3	3.7	0.8
1980	1173.0	5699.0	33.0	[illegible].8	191.0	130.0	3.3	0.4
1981			33.0	9.0	191.0	93.0	0.6	0.1
1982			33.0	14.3	191.0	152.3	1.1	0.6
1983			33.0	14.6	191.0	142.8	2.8	1.6
1984			33.0	16.1	191.0	126.6	3.1	1.9
1985			33.0	10.6	191.5	144.4	3.0	1.8
1986			33.0	8.6	191.7	134.7	1.5	0.9
1987			33.0	17.7	191.7	155.3	1.5	1.0
1988								

(NOTE THAT BANANAS INCLUDES FOUR TYPES:
a. COOKING BANANAS
b. BEER BANANAS
c. ROASTING BANANA
d. DESSERT BANANAS)

PRODUCTION THROUGH 1965 IN LONG TONS (2240 LBS)

ANNEX 4

TABLE A4.1

FARM MACHINERY AND TRACTOR PRICES

TABLE A4.2

COST OF PRODUCING SUNFLOWER

TABLE A4.3

COST OF PRODUCING MAIZE

TABLE A4.4

COST OF PRODUCING SIMSIM (SESAME)

TABLE A4.5

COST OF PRODUCING SOYBEANS

TABLE A4.6

COST OF PRODUCING COTTON

ANNEX 4. TABLE A4.1 Farm Machinery and Tractor Prices
April 1989

	U.S. $	# required	Required for 640 acres row crops total cost U.S. $	Investment cost per acre U.S. $	Years of life	COST PER ACRE: Depreciation straight line U.S. $	COST PER ACRE: Interest 11.5% U.S. $	COST PER ACRE: Total U.S. $
Combine, self-propelled with grain head								
large capacity	91,600 *							
medium capacity	72,000 *	1	72,000	113	10	11.25	12.94	24.19
Corn head for combine 4 row	11,800 *	1	11,800	18	10	1.84	2.12	3.96
Corn planter, with fertilizer attach.								
4-row	10,100	1	10,100	16	10	1.58	1.81	3.39
8-row	17,800							
Cotton picker, 2 row self propelled	84,800 *							
Cultivator row crop								
4-row	3,010	2	6,020	9	10	0.94	1.08	2.02
Disc harrow, tandem								
15-17 foot	8,850							
18-20 foot	11,600	1	11,600	18	10	1.81	2.08	3.90
Elevator, 6 in. auger, 40 foot	2,220	2	4,440	7	6	1.16	0.80	1.95
Field cultivator								
17-9 foot	5,950	1	5,950	9	10	0.93	1.07	2.00
Mower, drawn, 7 foot bar	3,060	1	3,060	5	10	0.48	0.55	1.03
Plow, moldboard								
5-bottom	7,400	1	7,400	12	10	1.16	1.33	2.49
7-bottom	10,900							
Sprayer, field crop, power, boom type								
tractor mounted	2,760							
trailer type	4,590	1	4,590	7	10	0.72	0.82	1.54
Tractor, 2-wheel drive								
30-39 bhp	12,100							
50-59 bhp	17,400	1	17,400	27	10	2.72	3.13	5.85
110-129 bhp	43,200	1	43,200	68	10	6.75	7.76	14.51
Tractor, 4-wheel drive								
170-240 bhp	79,700							
Wagon, gravity unload, box and running gear								
200-400 bushel capacity, less tires	2,420	4	9,680	15	7	2.16	1.74	3.90
Wagon, running gear only, 8-10 ton	1,180 *							
Truck, 6X4 with grain box, 42,000 gwr	50,000 !	1	50,000	78	7	11.16	8.98	20.15
Truck, 2 tons, cab & chassis	20,600							
Pick-up, 3/4 ton, 4X4	16,500 !	1	16,500	26	5	5.16	2.96	8.12
Total Machinery			273,740	428		49.81	49.19	99.00
Grain Drier, 5000 bu capacity	12,500 !	3	37,500	59	20	2.93	6.83	9.76
Storage, 5000 bu capacity	10,000 !	12	120,000	188	30	6.25	4.80	11.05
Tools	15,000 !	1	15,000	23	10	2.34	4.27	6.61
Total investment cost, corn-sunflower, etc., 640 acres.			446,240	697		61.33	65.08	126.41

Source: USDA, Agricultural Prices, April 28, 1989 Notes: * indicates Oct 1988 price quote.
Items marked estimate are consultants estimat ! indicates study team estimate.

TABLE A4.2

ESTIMATED COSTS AND RETURNS FOR ONE HECTARE OF SUNFLOWER IN UGANDA SHILLINGS

ITEM	PHYSICAL UNITS	UNIT COST USHS	AMOUNT USHS
Land clearing (Thrs)	5	6,250	31,250
First ploughing (Thrs)	2	6,250	12,500
Second ploughing (Thrs)	2	6,250	12,500
Seeds (kgms)	26	120	3,120
Sowing (md)	32	100	3,200
Pesticides			
Spraying (md)			
Fertilizer			
Fertilizer Application			
Weeding (2)	64	100	6,400
Herbicides	-		
Harvesting	32	100	3,200
Post harvesting	32	100	3,200
Equipment			
Hoe	1	700	240
Panga	1	950	320
Marketing costs kgms	1000	0.30	300
Production costs			76,230
Add: Miscellaneous costs 10%			7,623
Total production costs			83,853
Gross Income	1000	120	120,000
Net returns			36,147

Source: J.K. Ahimbisibwe. Compiled from data from The Bank of Uganda, Ministry of Agriculture, Ministry of Cooperatives.

TABLE A4.3

ESTIMATED COSTS AND RETURNS FOR ONE HECTARE OF MAIZE IN UGANDA SHILLINGS

ITEM	PHYSICAL UNITS	UNIT COST USHS	AMOUNT USHS
Land clearing (Thrs)	5	6,250	31,250
First ploughing (Thrs)	2	6,250	12,500
Second ploughing (Thrs)	2	6,250	12,500
Seeds	70	65	4,550
Sowing	32	100	3,200
Pesticides (2 litres)	2	1,200	2,400
Spraying (md)	32		3,200
Sprayer (CP3)	1	15,000	3,000
Fertilizer - SSP	125	70	8,750
Fertilizer - NPK	250	90	22,500
Weeding (md)	32	100	3,200
Harvesting (md)	32	100	3,200
Post harvesting	32	100	3,200
Equipment			
Hoe	1	700	240
Panga	1	350	320
Gunny bags	52	200	10,400
Marketing costs	2500	0.30	750
Production costs			125,160
Add: 10% Contingency			12,516
Total production costs			137,676
Gross Income	2500	65	162,500
Net returns			24,824

Source: J.K. Ahimbisibwe. Compiled from data from The Bank of Uganda, Ministry of Agriculture, Ministry of Cooperatives.

TABLE A4.4

ESTIMATED COSTS AND RETURNS FOR ONE HECTARE OF SIMSIM

ITEM	PHYSICAL UNITS	UNIT COST USHS	AMOUNT USHS
Land clearing (Thrs)	5	6,250	31,250
First ploughing (Thrs)	2	6,250	12,500
Second ploughing (Thrs).	2	6,250	12,500
Seeds	18	150	2,700
Sowing	32	100	3,200
Pesticides			
Spraying (md)			
Fertilizer			
Single Superphosphate (SSP) kgms	125	70	8,750
Sulphate of Amonia SA (kgms)	125	62	7,750
Weeding	32	100	3,200
Harvesting	32	100	3,200
Post harvesting	32	100	3,200
Equipment			
Hoe	1	700	240
Panga	1	950	320
Knives	5	200	1,000
Winnowing baskets	5	500	2,500
Gunny bags	8	200	1,600
Marketing costs (kgms)	600	0.30	180
Production costs			94,090
Add: 10% Contingency			9,409
Total production costs			103,499
Gross Income	500	150	75,000
			(28,499)

Source: J.K. Ahimbisibwe. Compiled from data from The Bank of Uganda, Ministry of Agriculture, Ministry of Cooperatives.

TABLE A4.5

ESTIMATED COSTS AND RETURNS FOR ONE HECTARE OF SOYABEANS IN UGANDA SHILLINGS

ITEM	PHYSICAL UNITS	UNIT COST	AMOUNT USHS
Land clearing (	5	6,250	31,250
First ploughing	2	6,250	12,500
Second ploughing	2	6,250	12,500
Seed (kgms)	40	150	6,000
Sowing (md)	32	100	3,200
Fertilizer	-	-	-
Pesticides	-	-	-
Spraying (md)	-	-	-
Herbicides (kgms)	-	-	-
Weeding (md)	60	100	6,000
Harvesting (md)	40	100	4,000
Post harvesting (md)	15	100	1,500
Equipment:			
hoe	1	700	240
panga	1	950	320
Marketing costs (kgms)	1000	0.30	300
Total costs			77,810
Add: contingency 10%			7,781
Total production costs			85,591
Gross Income	1000	150	150,000
Net returns			64,409

Source: J.K. Ahimbisibwe. Compiled from data from The Bank of Uganda Ministry of Agriculture, Ministry of Cooperatives.

TABLE A4.6

[illegible]

Source: J.K. Ahimbisibwe. Compiled from data from The Bank of Uganda, Ministry of Agriculture, Ministry of Cooperatives.

Best Available Document