PN-ABK-994
ISN 76655

STRATEGY FOR DEVELOPMENT OF UGANDA OILSEED PROCESSING

By

A.R. Bunker
R.R. Perry
R.R. Read
J. Ahimbisibwe

For

UGANDA COOPERATIVE ALLIANCE

UNDER USAID CAAS PROJECT
Contract No. 617-0111-C-00-9100-00

AGRICULTURAL COOPERATIVE DEVELOPMENT INTERNATIONAL
50 F. Street, N.W.. Suite 900
Washington, D.C. 20001

May 1991

ACKNOWLEDGEMENTS

We acknowledge contributions by many people for data and information contained in this report. In particular Leonard was instrumental in coordinating activities of the team with Uganda officials and opening doors and contacts for information. Officials of the various Ministries were kind to offer their time and knowledge to this effort. Many people from companies also were gracious with their assistance. We especially thank those from EOSIL who provided data and supported inspection of their oilmills. Thanks also to farmers who provided valuable perspective at the most fundamental level of agriculture in Uganda. Last the study sponsors, Uganda Cooperative Alliance and CAAS project of ACDI/Ronco were most helpful making their time and expertise available and in coordinating activities of the study team.

ACRONYMS

ACDI	Agricultural Cooperative Development International
CAAS	Cooperative Agriculture and Agribusiness Support project
CoopOIL	Cooperative Oil Industries, Ltd.
DAPCB	Departed Asians' Property Custodian Board
EOSIL	Edible Oil and Soap Industries, Ltd., a parastatal company formed by the LMB.
EPADU	Export Policy Analysis and Development Unit
FOB	Free on board, price quoted includes loading vehicle
FAS	Free along side, price quoted includes delivery to location but not unloading.
GOU	Government of Uganda
ha.	Hectare
HP	Horsepower
IRR	Internal rate of return
kg.	Kilogram
LMB	Lint Marketing Board
MAIF	Ministry of Animal Industries and Fisheries
MPED	Ministry of Planning and Economic Development
mt.	Metric tons
NPV	Net present value
R.O.	Residual oil in cake after processing, expressed as percent by weight of oil in cake.
ROI	Return on investment
UCA	Uganda Cooperative Alliance
USAID	U.S. Agency for International Development

Foreign exchange conversion rates used here are US$1 = 830USh.

TABLE OF CONTENTS

LIST OF TABLES iv
LIST OF FIGURES iv
EXECUTIVE SUMMARY v

CHAPTER 1. UGANDA NEEDS TO INCREASE EDIBLE OIL PRODUCTION . . 1
REPLACE FOREIGN EXCHANGE 1
IMPROVE INCOME 1
IMPROVE DIETS 1

CHAPTER 2. BACKGROUND 2
HISTORY OF OILSEED INDUSTRY IN UGANDA 2
PREVIOUS WORK AND PROBLEMS LEADING TO THIS ANALYSIS . . . 3
HISTORY OF EDIBLE OIL EXTRACTION 5
EXTRACTION TECHNOLOGY 6

CHAPTER 3. THE OILSEED INDUSTRY IN UGANDA NOW 9
CONSUMPTION 9
PRODUCTION 10
TRADE 11
POLICIES 11

CHAPTER 4. DEVELOPMENT POTENTIAL FOR THE OILSEED SECTOR . . 12
COMPARATIVE AGRICULTURAL PRODUCTION 12
PROCESSING 14
REQUIREMENTS OF EXPORT MARKETS 14

CHAPTER 5. DEVELOPMENT STRATEGY FOR THE INDUSTRY 16
PRODUCTION 16
SALES OF VEGETABLE OILS AND OILSEED MEALS 19
INVESTMENT IN PROCESSING PLANTS 20
ROLE OF GOVERNMENT 21

CHAPTER 6. A MARKET ENTRY OPPORTUNITY 23
ACTIVITIES OF EOSIL 23
PROCESSING PLANTS 23
ASSET VALUES 24
HOW TO USE EOSIL ASSETS 25

CHAPTER 7. STRATEGY FOR COOPERATIVES 27
PARTICIPATE IN EDUCATION AND TRAINING OF FARMERS 27
PARTICIPATE IN PROCESSING 29
A MODEL FOR OILSEED PROCESSING IN UGANDA 30
OWNERSHIP AND CONTROL OF CoopOIL 34
FINANCIAL SUMMARY 34
SENTIVITY ANALYSIS 36
DEVELOPMENT TIMETABLE 37
SOME TAX ISSUES 38
LIST OF REFERENCES 40
LIST OF CONTACTS 41
APPENDIX 1. ASSUMPTIONS FOR CoopOIL PROJECTIONS 43
APPENDIX 2. ASSUMPTIONS ON OILSEED COLLECTION FROM FARMERS 53
APPENDIX 3. TECHNICAL COMPONENTS OF OILSEEDS AND PROCESSING 54
APPENDIX 4. TECHNICAL DESCRIPTION OF SELECTED MILLS 60
APPENDIX 5. COMMERCIAL PALM OIL EXTRACTION 63
APPENDIX 6. UGANDA SEEDS 65
APPENDIX 7. POTENTIAL FOR TOXIC PRODUCTS IN UGANDA OILSEEDS 67
APPENDIX 8. TERMS OF REFERENCE 70
APPENDIX 9. TABLES 71
GLOSSARY OF TERMS 73

LIST OF TABLES

Table 1. Cotton seed purchases by Ugandan oil mills 2
Table 2. Cotton seed production, 1971 to 1989 3
Table 3. Consumption of fats and oils in Uganda 9
Table 4. Production of oilseeds in Uganda 10
Table 5. Oil millers in Uganda and estimated production . . . 11
Table 6. Uganda production costs, prices compared to U.S. prices 12
Table 7. Net trade in vegetable oils for selected areas . . 15
Table 8. Net trade in oilseed cake and meal for selected areas. 15
Table 9. Output of EOSIL oil mills and soap factories 23
Table 10. Estimated costs of oilseed extension specialist . 29
Table 11. Financial summary for improved and unimproved mills 35
Table 12. Sensitivity of financial results 37

LIST OF FIGURES

Figure.1. 13
Figure.2. 13
Figure 3. 36

EXECUTIVE SUMMARY

Vegetable oil production and processing has been identified as a development priority for Uganda. The objective here is to suggest a strategy for industry development and the role of cooperatives. In addition, specific steps to implement the strategy now are described.

ACTIVITIES

The oilseed strategy team contacted individuals, companies, government officials, donor representatives, farmers, consumers, cooperatives, transporters and other persons interested in the industry. All were helpful and provided information on production, costs, transport, trade, prices, processing costs, production costs, policies on taxation, investment, imports and exports, and other business regulations. Both old and modern crushing mills were visited. Costs to rehabilitate old mills were estimated. The team consulted previous and related reports on agricultural production, marketing and policy.

FINDINGS AND RECOMMENDATIONS

Following are major findings and suggested activities for Uganda and specifically for cooperatives.

Production

Prices of oilseeds in Uganda are relatively low and farmers can continue to be low cost producers of oilseeds.

There are adequate production resources for Uganda to be self sufficient in edible oil production in 5 years. Increased production support and a market outlet, via improved oilmills, are required to achieve this objective.

Self sufficiency in edible oils will not significantly increase farm price of oilseeds. There will be small, local price increases near processing facilities. Prices of other crops will not change.

Imported farm inputs are not necessary to achieve self sufficiency.

To be self sufficient in oil means Uganda will be surplus in meal, which must be exported until domestic demand develops, such as animal feed.

Uganda can be an exporter of vegetable oils and meal. Oils can be sold in East Africa and nearby regions. Most likely export destination for meal is Europe. Farm inputs such as fertilizer, crop protection chemicals, mechanical equipment, fuel and perhaps planting seeds will need to be imported.

Sunflower will supply most of the increase in domestic vegetable oil in the next 5 years. Cotton production is increasing but will not be a major oil source. Groundnuts and simsim prices will limit quantities crushed. Soybeans will become an important crop if a feed industry develops. Palm oil will not be a factor in the next

5 years and probably never.

Consumption

Consumption of fats and oils is 36,237 mt. per year, 4,305 mt. from domestic production and 31,932 mt. imported. Edible fats and oils consumption totaled 19,738 mt., coming from household consumption of 15,934 mt., hotels and restaurants 618 mt. and institutions 3,186 mt. Industrial use, mainly for soap, was 16,499 mt. Household use of refined cooking oil was 10,136 mt.

Consumption will increase with population and income growth, but such growth will be less than potential production increases.

Processing

Uganda can be a low cost processor of vegetable oil and meal.

To be self sufficient in edible oil Uganda will need 3 oilmills. Two modern mills now exist so 1 more is needed.

The remainder of mills in Uganda have good quality expellers but inadequate supporting equipment. Without investment in supporting equipment they have low efficiency in expellers, low quality meal bringing a low price, and high operating costs, making them uncompetitive with modern mills. They will not be profitable. If one additional mill is refurbished, the remainder will not start, except for exports.

Because old expellers can be used in a refurbished plant and because they are almost as efficient as new expellers, refurbishing costs for Uganda plants are considerably less than importing all new equipment. By world standards Uganda can have good equipment at low cost.

Policy

The sales tax of 30% makes refurbishing an oil mill not feasible. If maintained, the two existing modern plants will operate, but self sufficiency is not attainable.

A sales tax rate of 10% on oil makes refurbishing of an existing plant feasible, but returns near zero the first three years does not make this investment particularly attractive. A sales tax holiday of three years would allow encourage investment and give time for the oilmill to promote farm production of oilseeds. When the mill is operating near capacity the sales tax of 10% is affordable.

Uneven enforcement of tax laws and customs duties discourages development of businesses with large investments in plant and equipment. An established vegetable oil processing plant will likely pay higher taxes than most competitors.

Grades and standards for oilseeds and products should be established and enforced and will improve domestic and export sales.

Restrictions on imports may affect farm income by limiting efficiency of farmers by lack of seeds, fertilizer, machinery, etc.

Transportation services are a constraint to higher farm income.

Strategy

Uganda should set a goal of becoming self sufficient in edible refined oil in 5 years.

Uganda should set a goal of becoming an exporter of meal and oil.

Improved research and extension is necessary for Uganda to remain low a cost producer. Neither are adequate at present.

Low cost meal will spur development of livestock and poultry growing.

IMPLEMENTATION FOR COOPERATIVES

Negotiate purchase of EOSIL assets. If unsuccessful, purchase expellers elsewhere.

Create CoopOIL, a limited company owned by primary societies, to operate an oilseed crushing plant with capacity of 20,000 mt. per year of edible oil. Refurbish the EOSIL mill at Jinja or establish one in other location.

Uganda Cooperative Alliance (UCA) should provide technical and management supervision of CoopOIL for 5 or more years. International technical assistance is required for 4 years. This person should be the plant manager for at least the first two years. Through contacts with donors, UCA can obtain financing, international technical and management assistance, and can help primary societies prepare to manage what will be for them a large, complex company.

CoopOIL achieves positive net earnings in all years with a 10% sales tax. Earnings on sales ranges from a low of 0.0% in years 2 and 3 to a high of 4.7% in year 5 and averages 1.7%. Earnings on investment range from zero to 66.5% in year 5, averaging 18.6%. Internal Rate of Return is -1.6. Net Present Value is 345\- million. Investment costs of 1,050\- million are repaid with interest into a cooperative develoment fund. Over 5 years payments to farmers total 13.1\- billion and tax payments 2.7\- billion.

Sales tax rates above 10% make CoopOIL unprofitable.

An improved mill processing cottonseed earns profits in years 2 and 5. Average return on investment is 6.2%, net present value 73\- million and IRR -235.1. This option is not viable at 10% tax rate.

Unimproved mills had negative earnings at either sales tax rate despite lower initial investment.

The Uganda agricultural research and farm extension system does not adequately serve farmers to assure needed inputs for the mill. CoopOIL will have to provide its own.

Research and production for planting seed in Uganda is not well enough established for the mill to rely on others for this critical input. CoopOIL will have to provide its own.

If CoopOIL is not established, UCA through business services should contract with existing modern mills to provide farmer services to promote production of oilseeds. Payment would be based on quantities received by the mill. Business services could also offer assistance to primary societies to become buying stations for the oilmil. Payment would come from quantity of oilseed marketed through the primary society and from profits at year end.

CoopOIL, with others in the industry should consider developing outlets for surplus meal. Export is possible but high transport costs to European markets makes local prices low. Alternative markets should be developed including animal feed or fertilizer.

CHAPTER 1. UGANDA NEEDS TO INCREASE EDIBLE OIL PRODUCTION

Consumption of edible and inedible fats and oils in Uganda is estimated at 36,237 mt., or 2.1 kg. per capita.[1] Refined edible oil consumption by households was 10,136 mt., 0.6 kg. per capita.

REPLACE FOREIGN EXCHANGE

Domestic production of vegetable oils is estimated at 4,305 mt., suggesting imports of 31,932 mt. and foreign exchange outlay of about 16\- billion. Self sufficiency in vegetable oil production, as Uganda once had, would yield major savings in foreign exchange. Also, exports of vegetable oils and oilseed meals, as Uganda once did, could become a significant earner of foreign exchange.

IMPROVE INCOME

Self supply in edible oil would provide Ugandans income now sent abroad. With an income multiplier effect of 4, total receipts to Ugandans of self sufficiency in refined cooking oil production would reach 20\- billion. Payments to farmers for crushing seed to produce this much oil would exceed 3\- billion.

IMPROVE DIETS

Increased domestic vegetable oil production also has health benefits. Per capita household consumption of refined oils is estimated at .59 kg. for all Ugandans, .43 kg. for rural households and 2.1 for urban households. This is below World Health Organization recommended minimum intake of vegetable oils of 3.3 kg. (Perry) Increased income will improve consumption and having vegetable oil plants located in the country will improve availability in rural areas.

Production of oilseeds is one limiting factor to increase domestic oil supplies. The natural resource base exists to increase production without major distortions in prices of oilseeds or other crops.

But farmers are reluctant to plant oilseeds because of limited outlets. Crushing mills are located around Uganda but process intermittently, producing only 100 tons of oil in 1989/90. Earlier reports identified and described these mills, reporting expellers in good condition (Enger). However, a need for improved pre-expeller preparation of crushing seed and refining of oil means new investment in plant is needed before they can operate efficiently and produce acceptable products. Until farmers are assured mills will operate, expansion of oilseed crops will be limited.

---

[1] See chapter 4 for detail on estimating procedures.

CHAPTER 2. BACKGROUND

American Upland Company introduced cotton to Uganda in 1904 and ginning began in 1906 by British East African Corporation of Kisumu, Kenya. Kampala received its first powered ginnery in 1906 and by 1939 Uganda had 194 ginneries, most owned by Asians and Europeans. Cottonseed had little value and was disposed of by burning. (Coles)

HISTORY OF OILSEED INDUSTRY IN UGANDA

The first Ugandan oil mill using cotton seed is believed installed in 1929. Production of edible oil was limited until stimulated by food shortages for soldiers stationed in Africa during World War II. In 1944 Uganda had 10 oil mill companies, but 43 companies 10 years later. A construction surge began in 1945 when Government of Uganda (GOU) allowed free entry. After 1955 the number of firms in the industry stabilized. Also, tons of seed available for processing remained at about 100,00 to 130,000 tons. (table 1)

Table 1. Cotton seed purchases by Ugandan oil mills.

Year	Seed production1/	Exports	Purchases by mills
	- Metric tons -		
1954-55	87,651	37	n/a
1955-56	110,500	14,606	n/a
1956-57	114,595	1,396	n/a
1957-58	107,381	700	n/a
1958-59	125,410	0	n/a
1959-60	118,512	39	118,473
1960-61	117,992	0	117,992
1961-62	44,301	132	44,169
1962-63	112,659	229	112,430
1963-64	118,265	0	118,265
1964-65	131,830	0	131,830

Source: Coles, 1967.
1/ Includes AR seed only for 1954-55 to 1958-59 and both AR and BR seed thereafter.

Fourn large crushers, all at Jinja, dominated the industry in later years. In 1965 these firms owned 51 percent of crushing capacity but crushed 71 percent of the seed.

The period 1945 to 1972 is characterized by surplus crushing capacity with varying degrees of government control. GOU first controlled entry, allocated cotton seed and controlled prices to millers. Profits were good. Later, entry and price controls were relaxed but crushing seed allocation remained controlled by Lint Marketing Board (LMB). LMB sold by private negotiation but also by open tender to the highest bidder, severely depressing milling profits. In some years millers established purchasing cartels, reducing costs of crushing stocks.

The industry experienced difficulties after 1972 when Asian owners were expelled. Oil mills were allocated to companies not able to operate efficiently. Oilseed production declined, reaching its lowest point in 1987-88. (table 2) Since then a recovery has begun.

Table 2. Cotton seed production, 1971 to 1989.

Year	Cottonseed metric tons	Year	Cottonseed metric tons
1971-72	140,611	1980-81	8,159
1972-73	158,411	1981-82	10,226
1973-74	99,750	1982-83	19,529
1974-75	63,682	1983-84	22,888
1975-76	49,584	1984-85	30,715
1976-77	27,060	1985-86	10,226
1977-78	40,756	1986-87	6,534
1978-79	15,394	1987-88	3,729
1979-80	12,256	1988-89	8,011
		1989-90(est.)	17,000

Source: Export Policy Analysis and Development Unit

Another cause of industry decline is poor condition of equipment in oil mills because of neglect since 1972. This is in part because of lack of foreign exchange for purchase of spares. Some machinery is obsolete and not serviceable. Because of long inactivity, technical staff are not trained to efficiently manage mills.

The decline in cottonseed production has very much affected edible oil production. Estimated annual processing capacity of the industry in 1990 is 150,912 mt. of crushing seed. (appendix table 9.1) Ugandan mills produced 190 mt. of edible oil in 1990, less than 2% of consumption.

A second group of edible oil producers in Uganda are those which use indigenous extraction methods in Northern and North Eastern Uganda. Most of this oil comes from groundnuts, shea butter nuts and simsim. Estimated edible oil produced in 1990 using indigenous methods is 1,840 mt.

The third group of the local edible oil producers are cattle owners who process ghee locally. Ahimbisibwe estimated production in 1990 of 68 mt. This appears extreemly low and for this analysis production is assumed to equal consumption by households of 2,275.[2]

With all sources combined total estimated domestic production of edible oil in 1990 is 4,305 mt.

PREVIOUS WORK AND PROBLEMS LEADING TO THIS ANALYSIS

Enger conducted an extensive review of oilmills and reported mills were in good condition and could be started up with only minor repairs. While true, this study shows capital improvements are

[2]This overstates production as household data includes butter.

needed for mills to be viable. Enger described mills and commented on which oilseeds that could provide self sufficiency in Uganda, suggesting palm oil as best for Uganda.

Ahimbisibwe, et. al. estimated consumption and supply of oilseeds. Some of their data is superseded by the Household Budget Survey, but other data is still the best available and utilized in this report. They concluded Uganda could not be self sufficient in edible oil in 10 years under current levels of investment and support for agricultural production.

Laker-Ojak assessed impacts of the oilseed industry in economic development in Northern Uganda, concluding income improvement from oilseeds was minimal.

A description by Coles of the oilseed industry in the 1960's provides an interesting contrast to the industry today.

Feasibility analysis have been made on restarting selected oilmills. None have yet been started.

Export Policy Analysis and Development Unit reviewed status of the oilseed industry and recommended the edible oil industry be developed for domestic and export markets. No feasibility studies were conducted. From that evaluation, UCA was requested to develop a strategy for the Uganda oilseed industry.

OILSEEDS AND OILSEED PROCESSING

Vegetable oils are generally categorized as drying, non-drying oils and semi-drying oils. The drying capability is determined by a test which assigns an "iodine number." Cottonseed and sunflower are non-drying oils, linseed and tung are drying oils, and soybean and castor are semi-drying oils. Many products are produced from oils besides edible uses.

Many plant specie produce oil, but also products that are not, in fact, oil. Leaves, barks and roots contain fat, oil and wax. Many drugs and toxins are of plant origin. Some oils are highly toxic (castor), some mildly toxic (rapeseed). Duffus and Slaughter report 40 species used to produce vegetable oils, fats and waxes, and hundreds of other species that could be used.(p.142)

Edible oils are an excellent source of energy and vitamins for humans and animals. All oils are a source for essential fatty and amino acids. These compounds the body cannot synthesize and must be supplied from food sources. If not available, body metabolisms are effected. To illustrate, lysine, an essential amino acid, is needed for brain growth.

In most seeds the embryo is surrounded by oil to provide energy for the seedling to grow roots and thrust itself into the sun. Excess oil, if any, quickly decays by natural enzymes present in the seed.

Some examples of the wide variety of plants that produce oils are:

1. The palm family is called "the tree of life" because it can provide nearly everything to sustain life; oils, proteins, fibers, beverages and wood. Some plants in this family are: cocoa palm, palm fruit tree, babassu, oitica and many others. All palm oils

are highly saturated.

2. Most nuts contain valuable oils, many indigenous to Africa.

3. Grains such as wheat, rice, maize and sorghum contain oils.

4. Exotic canopy trees such as shea, pentadecima and many others produce high priced fats called butters.

5. Legumes such as soybean and groundnut are most valuable because of their high protein content. Groundnuts are particularly valuable not only because of their delightful flavor but also because the oil is of unique quality and composition.

6. Flowerseeds are also valuable such as sunflower, safflower, mustard, pepper, rapeseed (canola) and others.

7. Seeds from okra have shown potential as sources of oil.

8. Some seeds that might warrant further consideration in Uganda are: dry process maize germ, castor and safflower.

Presently plants that predominant as sources of vegetable oils are: soybeans, sunflower, safflower, peanuts, cottonseed, rapeseed, canola, coconut, coco palm, palm kernel, bubbasu, linseed, simsim, shea and related specie, cocoa, castor, mustard, pepper, many beans and nuts such as walnuts, cashew, hickory, acorn, pine seeds, and pecan.

HISTORY OF EDIBLE OIL EXTRACTION

Extraction and use of vegetable oils, fats and waxes is as old as man himself. Early Egyptians used fats or oils to illuminate crypts and tombs of pharaohs, to preserve wood and as an agent in mummification. Alladins' lamp probably burned olive oil. Charles Martel used pitch and oils in preparation of the "Greek fire balls." Early shipbuilders preserved ship hulls with oils and Leonardo used paints made from flax (linseed).

How were these valuable oils produced? The Chinese used a water extraction technique still used today in some areas. The stump press was developed in Africa centuries ago. The author has seen many of these in operation in Burma. No doubt oil is still extracted in Uganda using the ancient method which is surprisingly efficient with up to 60% of the oils removed. Various modifications of the wine press were used in the 13th century to press olive oil and other oilseeds. This was the precursor of the hydraulic press used during the early 19th century, particularly to press cottonseed.

In 1896 V.D.Anderson patented the expeller to press whale blubber aboard ships. This machine began processing vegetable oils in 1904, pressing cottonseed, flax and others. Expeller was the dominant method of oil extraction until late 1950's.

Expellers are manufactured in the U.S., Japan, Europe and India. In 1949, the expeller cooking process was patented by Dunning, et. al. of V.D. Anderson Co. This process rapidly dominated extraction. In 1953 French, et. al. modified and improved the Anderson cooker. These processes were soon adopted by most

European manufacturers. By mid-1960's, most oil and protein production was produced by cooking and extraction. In 1953 Dunning patented the prepress extraction system. Solvent extraction was introduced into the United States in 1939 by the Hildebrant, et. al. patent. Prepressing and solvent extraction are the dominant extraction methods today.

EXTRACTION TECHNOLOGY

Expeller Extraction

The expeller extraction process uses a discontinuous screw to confine incoming oilseed in an increasingly reduced volume inside a pressing cage. The screen cage exerts high pressure on the oilseed, forcing oil to escape through a drainage area. The main worm shaft (MWS) is designed so diameter of the hub increases further through the press. The hydraulic forces are sufficient to crush oil cells and overcome capillary forces so oil is discharged. Pressures to 20,000 pounds per square inch have been measured. The longer seeds are held under pressure the lower residual oil (R.O.) in the cake. Thus expeller manufacturers developed a reference of length of the MWS divided by its diameter and multiplied by time (l/d x t). Since proteins in meats become psuedo-plastic due to high pressures and frictional heat, the l/d are held to a maximum of about 10:1, as a practical matter of oil extracted for power input. Ideally, power per ton of seed processed is about 3 - 5 Hp/mt/day. One can readily calculate expeller capacity based on horsepower applied. An expeller with a 20 hp. motor will process 4 - 6 mt. of whole seed per 24 hour day.

There are about 16 separate operations in expeller oilseed processing. The most important are cleaning, dehulling, separation, cooking, expelling, and oil refining.

Most oilseeds may be crushed in any given expeller plant, without significant process modifications. None the less, there are modifications designed to maximize extraction efficiency for specific seeds, such as expeller MWS configurations and speeds. Some minor operating conditions are also effected by seed type. For example, soybeans should be expelled dry so no moisture is added during cooking as is required by sunflower and cottonseed.

Expeller Cooking

The cooking/expeller process is largely responsible for rapid growth of the world feed industry in the mid 1950's. Cooking deactivates legume trypsin inhibitors in soybeans and groundnuts. Cooking also sterilizes meal and prevents spreading aspergillus flavus via the animal-plant-feed cycle. Salmonellae are also destroyed and so are most other harmful bacteria. Unfortunately, spore formers, i.e. anthrax, are not.

The primary economic gain of cooking is from increased oil yields, from a maximum of 75% recovery with cold process to about 96% for cooking. Typical R.O. content should be 3.5% oil in the cake.

Cooked expeller oil quality may be lower than cold pressing due to the "red" color that sometimes comes from high temperatures. This loss is largely offset by larger refining losses for cold

processing, typically 9 to 15 percent. Cooked processing has refining losses of 1 to 3 percent, depending on free fatty acid (FFA) content of the seed.

Cold Expeller

Cold expeller processing was the dominant method of oil extraction in Uganda. In industrialized countries cold processing is primarily used for specialty oils needing superior oil quality. Olive oil is an example.

Typically cold processes remove from 40% up to 75% of available oil. In addition, up to 15% protein losses are common.

Because of low temperatures, meal produced by this method is subject to bacterial and fungal incursions. Uncooked meals are ideal incubation sites for Aspergillus Flavus (producing Alfla Toxins), most salmonellae, many coli, etc. These may be toxic and spread diseases. Soybeans and groundnuts cold processed will contain trypsin inhibitors and cottonseed meals may cause high mortality rates in poultry due to presence of polyphenol gossypol.

Solvent Extraction

Solvent extraction is based on solubility of fats, oils, and waxes in selective solvents. Initially a wide variety of solvents were employed such as trichloroethylene, "dichlor" and many straight chained hydrocarbons, e.g. hexane, heptane, etc. Chlorinated hydrocarbons are no longer used.

While these solvents are selective to some degree, all solvent extracted oil have high refining losses due to presence of non-lipids and pigments. All solvent extraction systems use cooking during preparation of seed prior to extraction.

Extraction efficiency is high, typically 99.5% of available oil, and this method lends itself to large economies of scale with plants up to 3,000 mt. per day. Thus operating expenses are minimized. The major restraints are fire and explosion hazards, environmental concerns (hexane vapors) and health concerns from hexane residues in oil and meal.

Prepress Solvent Extraction

Prepress solvent extraction was invented by Dunning, Perry, et. al. in 1956. It incorporates cooking and expelling prior to solvent extraction. The expellers reduce meal oil content to about 12 to 20 percent, reducing extraction costs and improving oil quality. Economics are improved by processing very large quantities, up to 5,000 mt. per day.

Developing Technologies

There are several new technologies being developed. One is called prepress/solvent/extruder, which uses expeller prepressing in combination with solvent extraction and using extruders to cook and prepare the seed. Another uses other solvents such as liquid

carbon dioxide. Once again water extraction is being considered.

Palm Oil Extraction

Because palm fruit does not lend itself well to above methods of oil extraction, special techniques were developed. These methods are explained by Enger.

Little consideration has been given by previous Ugandan studies to potential environmental impact of current commercial extraction techniques. Ten mt. of water is used in processing and enzymatic sterilization for every 1 mt. of oil produced. Waste water contains large quantities of carbohydrates, some toxic solids, oils, sugar, fats and small amounts of proteins. These effluents, though largely non-toxic, destroy soil fertility and poison swamps and lakes. Investment and operating costs of waste water treatment are large.

Malaysia has realized environmental problems and recently required water treatment in all palm oil facilities. But not before thousands of hectares of land were contaminated.

CHAPTER 3. THE OILSEED INDUSTRY IN UGANDA NOW

Once a flourishing industry, oilseeds in Uganda provided oil and meal for domestic needs plus a surplus for export. Cottonseed was the raw material source. But the last 2 decades are characterized by neglect, both in agricultural production and in seed processing. Attempts are beginning to rebuild the industry.

CONSUMPTION

Total consumption of fats and oils in 1989-90 are estimated at 36,237 mt., including edible consumption of 19,738 mt. and industrial use of 16,499 mt. Refined cooking oil for household use totaled 10,136 mt. for 28% of total consumption. Per capita household consumption in urban areas is usually 3 to 5 times per capita consumption in rural areas.

Table 3. Consumption of fats and oils in Uganda.

	Consumption 1989-90		Percent	Estimated
	Per capita	Total	of total	for 1996 1/
	Kg.	Mt.		Mt.
Household consumption 2/				
Refined cooking oil	0.59	10,136	28	11,890
Butter and ghee	0.13	2,275	6	2,669
Hydrogenated oil	0.14	2,421	7	2,840
Margarine	0.02	393	1	462
Others	0.04	708	2	830
Total household	0.93	15,934	44	18,691
Hotels and restaurants	0.04	618	2	725
Institutions	0.19	3,186	9	3,737
Total edible	1.19	19,738	54	23,153
Industries	0.96	16,499	46	19,353
Total Uganda	2.15	36,237	100	42,506

Source: Appendix table 9.2 for household data, Ahimbisibwe for hotels and restaurants, institutions and industries.
1/ Increased only for population growth of 2.7% annually.
2/ See appendix table 9.2 for estimating procedure.

Consumption of edible oils was also estimated by Ahimbisibwe. Household consumption in 1989 was put at 19,040 mt. Industrial use is mainly inedible oils for soap manufacture.

Consumption in 1996 was projected at 42,506 metric tons, 23,153 for edible use and 19,353 for industrial use.

Cake and Meal

Consumption of oilseed cake and meal in Uganda is low. Coles estimated domestic consumption of 1,375 mt. in 1965, 2% of total production of 70,100 mt. The remaining 68,725 mt. were exported and included cottonseed and groundnut cake and meal. Consumption

is still believed to be low. About 80% of feeds are consumed by poultry, the remainder by dairy and piggery.

PRODUCTION

Oilseed production

Oilseed production in Uganda was led by groundnuts, cottonseed and simsim in the 1960's and 1970's. By the 1980's cottonseed declined to insignificance, leaving groundnuts and simsim, along with milk ghee primary suppliers of oils. The decline in cottonseed production was caused by low prices, acute shortage of inputs, inadequate land and labor, lack of transport and storage, and insufficient crop finance. Ginneries lacked spare parts and employee remuneration was reduced by inflation. Technical staff were not trained to operate mills efficiently.

Recent years have seen increases of sunflower and cottonseed production. (table 4) After price increases in 1990, cottonseed production is increasing rapidly and may reach 26,500 mt. for crushing in 1996 (seed cotton production of 47,000 mt. less 15% for seed times 0.67). This could provide about 5,000 mt. of oil.

Table 4. Production of oilseeds in Uganda.

Crop	Average 1971-75	Average 1981-85	1986	1987	1988	1989(Est)
	- 1,000 Metric tons -					
Cottonseed	42	6	6	2	8	19
Groundnuts	218	94	118	85	98	145
Soybean	5	33	10	8	12	16
Simsim	32	33	37	34	35	45
Sunflower	n/a	n/a	n/a	n/a	3	n/a

Source: EPADU, Enger, MPED, Background for the Budget.

Oilmill production

Oils in Uganda are produced by oil millers, private producers, cooperatives, church expellers, ghee producers and indigenous oil producers. Estimated production by each group is given in table 5. Although rated capacity is high, production is extremely low, estimated at 190 mt. for oilmills, cooperatives and church expellers in 1989-90. Production by indigenous extraction is estimated at 1,840 mt. (Recon) Ghee production is assumed to equal consumption by households and is put at 2,275 mt. Total estimated domestic production is 4,305 mt. in 1989-90.

Table 5. Oil millers in Uganda and estimated production.

Group	Number of mills	Rated capacity Mt. seed/year	Production 1988-89	Production 1989-90
EOSIL	6	48,960	55	36
Private producers	9	71,280	11	17
Cooperatives	4	20,160	192	47
Church expellers	8	10,512	-	90 1/
Indigenous	n/a	n/a		1,840
Ghee and butter	n/a	n/a		2,275 2/
Total		159,912		4,305

Source: Ahimbisibwe, updated by R.R. Read.
1/ Combined production of private and church expellers.
2/ Production from household consumption.

TRADE

From the mid 1950's to the early 1970's Uganda exported edible oil, peaking with exports of 11,637 mt. in 1959 (Coles). Most exports were to Kenya and Tanzania. Exports disappeared in the late 1970's. Imports began in the 1980's but reliable data is not available. Ahimbisibwe accounted for imports of 9,396 tons in 1989-90, but believed this to be less than half total imports. That same report shows recorded imports from 1970 to 1990.

Uganda also exported cake and meal from the 1950's to the early 1970's. Exports were usually in the 50,000 mt. to 70,000 mt. with 1959 at 74,137 mt. As with oil, exports were mainly to East Africa. Unlike oil, Uganda has not imported cake and meal.

POLICIES

A number of policies affect the edible oil industry in Uganda. These are tariffs and duties, sales tax, price fixing, allocation of oilseeds, weak research and extension support for producers or industry, lack of foreign exchange for imports of farm inputs, lack of grades and standards for agricultural produce, and others.

The economic situation also causes problems including high transport costs, unreliable electric power and communications, poor accounting systems, and a shortage of trained and experienced workers. Discussions on specific policies are in Chapter 6.

CHAPTER 4. DEVELOPMENT POTENTIAL FOR THE OILSEED SECTOR

Potential for increasing oilseed production in Uganda is good, both from the perspective of availability of natural resources and from production costs in Uganda compared to farm prices in the U.S.

COMPARATIVE AGRICULTURAL PRODUCTION

Production returns for oilseeds compares favorably to other major crops as shown by returns to labor and land in figures 1 and 2. Simsim and groundnut offer highest returns. Sunflower slightly exceeds or is at par with beans, sorghum and maize. Crops like millet and cassava have value as famine crops and are produced despite low returns. Cotton is a traditional cash crop with decades of marketing experience and is produced in spite of relatively low returns.

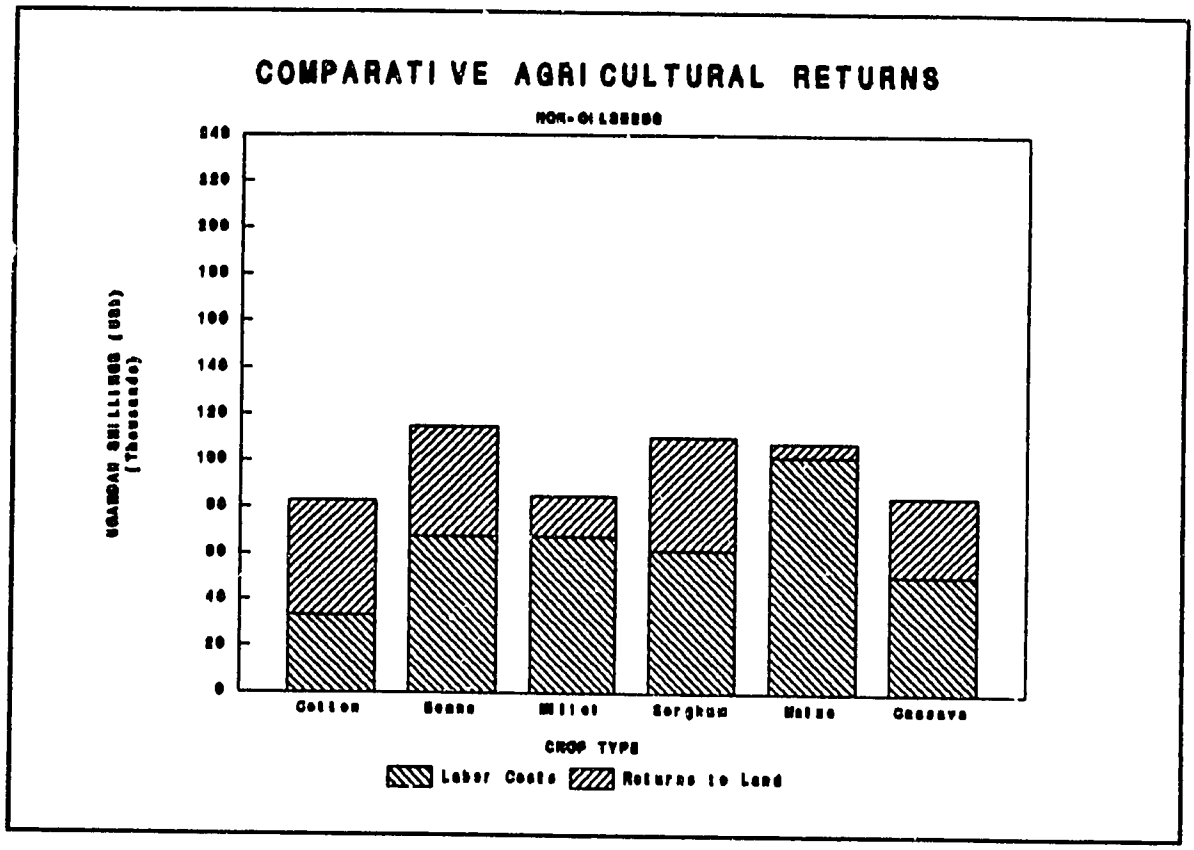
Actual returns to land and labor vary substantially based on season and marketing arrangements. Farm prices for maize have been known to swing between 25 and 100 USh/kg within three months, greatly changing the economics of production. A stable marketing arrangement for oilseeds will encourage production.

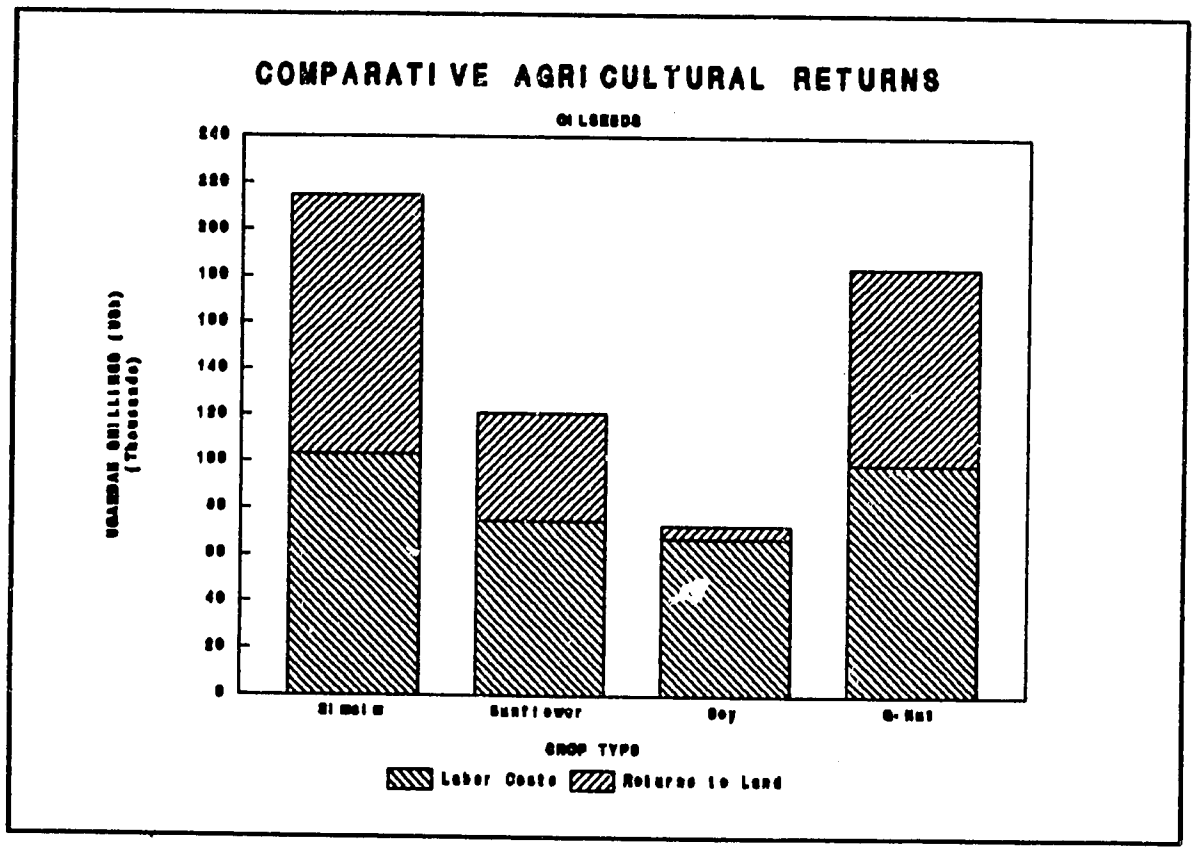
Production costs including cash expenditures and labor but excluding returns to land for Ugandan oilseeds are well below U.S. farm prices, especially sunflower and groundnut (table 6). Uganda farm prices are also below U.S. farm prices.

Table 6. Uganda production costs, prices compared to U.S. prices.

	Sunflower	Groundnut	Soybean	Maize
		- USh per kilogram -		
Uganda cost of production	79	173	153	53
Uganda farm price	100	250	160	55
U.S. farm price	209	518	175	80
		- Percent -		
Uganda cost as % of U.S. price	38	33	87	66
Uganda price as % of U.S. price	48	48	91	69

Source: USDA, World Oilseed Situation. Uganda production cost from Bucyanayandi (1990) updated by R.R. Read. Uganda prices from Bank of Uganda, Sep. 1990 and private interviews for sunflower and soybean prices. Cost of production does not include land cost. Groundnut prices in-shell.


COMPARATIVE AGRICULTURAL RETURNS
NON-OILSEEDS
GAMBIAN SHILLINGS (GSD)
(Thousands)
240
220
200
180
160
140
120
100
80
60
40
20
0
Cotton
Beans
Millet
Sorghum
Maize
Cassava
CROP TYPE
Labor Costs
Returns to Land


COMPARATIVE AGRICULTURAL RETURNS
OILSEEDS
GAMBIAN SHILLINGS (GSD)
(Thousands)
240
220
200
180
160
140
120
100
80
60
40
20
0
Simsim
Sunflower
Soy
G-Nut
CROP TYPE
Labor Costs
Returns to Land

Farm prices will likely decline as farmers practice higher level management, specifically mechanization and fertilization. Bunker estimated production costs excluding land in southwest Uganda with high level inputs at 55\- per kg. for soybean and 45\- per kg. for maize.

The above suggests production costs and farm prices are low enough for Uganda to be an exporter of oilseed products. Over time these relationships will only hold if farmers become more efficient. As area planted to oilseeds expands, especially with exports, competition for scarce land, labor, and other inputs will increase prices. More dense plantings, for example, will require more fertilizer and pest control products. Labor shortages will require mechanization. To offset these increased costs farmers must improve yields. Research and extension services currently available to farmers for oilseed production are inadequate. A successful mill will provide these services.

PROCESSING

The oilseed processing industry in Uganda is idle. Only two mills currently are capable of processing oilseeds efficiently enough to operate consistently. These two mills can output 8,910 mt. of oil. Only 1 more mill is needed to supply domestic edible oil needs to 1996. Increased domestic consumption beyond expections will more likely be met by by existing mills adding capacity than new mills entering. Hence, most currently existing mills will not start up.

Only if exports are contemplated are additional mills needed. Exporting will allow existing mills to enlarge and additional mills to be established. But even with exports, existing mills cannot compete without renovation because their efficiency of oil extraction is less and the meal is low quality and will be low priced.

Location of oilmills is usually near production areas. For supplying the domestic market a location could be anywhere there are good roads for farmers to deliver oilseeds and good roads to markets. However, because Uganda is expected to export, location on a railroad will lower transport costs for exports.

REQUIREMENTS OF EXPORT MARKETS

Both vegetable oils and meals are extensively traded around the world. In general, developed countries are large consumers of meals while developing countries are limited meal consumers and often are surplus in meal and deficit in vegetable oils. Many countries in Africa are this way, including Uganda.

Table 7 indicates a deficit in vegetable oils in adjacent Africa countries of 146,000 metric tons in 1989. Other east African countries were deficit by 164,000 metric tons that year.

Table 7. Net trade in vegetable oils for selected areas.1/

	1985	1986	1987	1988	1989
			1,000 metric tons		
TOTAL	7,191	6,952	6,156	5,656	6,403
Africa Adjacent	95	116	146	158	146
East Africa	232	216	156	148	164
North Africa, Middle East	1,811	1,992	1,376	1,646	1,771
South Coast Asia	2,011	2,819	2,489	2,141	1,832
Europe	2,291	1,401	1,187	1,269	1,466
USSR	751	407	802	293	1,024

Source: FAO Trade Yearbook.
1/ Numbers in parenthesis means exports.

Table 8 shows adjacent Africa countries were surplus in oilseed meals of 23,000 metric tons in 1989, and a larger surplus of 311,000 metric tons in east Africa. The small surplus in north Africa and Middle East is offset by the other Africa surplus and the large South Coast Asia surplus.

The major market for meal from Uganda will be in Europe. USSR and Eastern Europe are also net importers.

Table 8. Net trade in oilseed cake and meal for selected areas.1/

	1985	1986	1987	1988	1989
			1,000 metric tons		
TOTAL	3,771	3,926	8,002	8,404	7,467
Africa Adjacent	(22)	(23)	(23)	(6)	(23)
East Africa	(8)	(30)	(244)	(368)	(311)
North Africa, Middle East	130	110	60	30	88
South Coast Asia	(344)	(403)	(847)	(700)	(1,847)
Europe	3,945	4,231	8,621	9,070	8,998
USSR	70	42	435	380	562

Source: FAO Trade Yearbook.
1/ Numbers in parenthesis means exports.

CHAPTER 5. DEVELOPMENT STRATEGY FOR THE INDUSTRY

Uganda can become self sufficient in edible oils by 1996. To achieve this some policy actions must be taken soon. Proper policies will allow needed investments in oilseed production and processing. Some economic, infrastructure and policy factors supporting these conclusions follow.

PRODUCTION

Production of oilbearing crops must begin soon to achieve self sufficiency by 1996. Encouraging and supporting production is important, but production will not begin until farmers are convinced there is a market for their crop, i.e. until some mills are operating. Development of production must be coordinated with development of processing. First we discuss production issues.

Natural Resources

Uganda can be a relative low cost producer of oilseed crops. There is an abundance of natural resources for crop production including arable land, sunlight, well distributed rainfall throughout the year, favorable temperature, private ownership of factors of production, and available labor. Most areas can produce two crops per year, more in some areas with proper management and investment.

Which Crops to Develop

Uganda can efficiently produce a variety of oil bearing crops. Most often mentioned are groundnuts, sunflower, palm, soybean and simsim. Less frequently mentioned crops include shea, castor, maize germ, coffee for oil, and milk ghee.

The oilseed team has considered all these crops. For the immediate future sunflower will be the important source for edible oil. Brief comments follow on principal crops and their potential as a source for vegetable oils in Uganda. More detailed descriptions are given by Enger.

Sunflower

Sunflower produces a high quality edible oil. Its oil yield compared to meal is high, making it good choice for Uganda where oil prices are high and meal prices expected to be low. Production is adapted to many areas and yields hold up well in dryer areas. Sunflower planting seed can be expended rapidly because of the high ratio of seeds planted to seeds harvested, about 1 to 100. It appears diseases and insects can be controlled by crop rotation and proper cultural practices.

Soybean

Soybean is valuable primarily for high yield of protein meal. In high rainfall areas crop yields generally exceed sunflower. Because of lower oil content, per hectare yield of oil is below sunflower.

Soybeans are also a food crop, but consumption is small. If protein meal prices in Uganda rise to levels comparable to developed countries, soybean may become a preferred crop in many areas. The ratio of seed planted to seed produced is 1 to 30.

Groundnut

Because groundnuts are a popular food and because prices often exceed soybeans or sunflower, most believe they are too expensive to process for oil and meal. But oil content in the seed is higher and refined oil sells at a premium price, making crushing of groundnuts feasible, even when priced higher. Current groundnut prices in Uganda compared to soybean and sunflower prices suggest most will be consumed for food, but second quality product or local surpluses may be crushed. Groundnut oil exported to higher priced European markets may encourage groundnut crushing. Expansion of production is slow with groundnuts because the ratio of seed planted to harvest is 1 to 8.

Simsim

Like groundnuts, simsim is mostly consumed as food. While it can be processed for oil and meal, prices suggest crushing will be limited. Exports of whole seed are expected to yield greater returns than crushing. Less desirable seeds may by processed. Simsim oil, while desired in some markets, is usually priced similar to sunflower oil.

Palm

Palm oil appears attractive for Uganda because of high oil yield per hectare and low cost. But several factors limit desirability of palm oil production.

Assessment of climate, soils, rainfall and other agronomic factors suggests palm trees would perform well in limited areas, namely on islands in Lake Victoria and a narrow band around the north end of the lake and in extreme western valleys of Bundibugyo. Smallholders could cultivate the crop, but because of rapid deterioration of palm after harvesting, fruit must be processed within a few hours. Hence production must be concentrated near the processing plant and may be difficult to coordinate with smallholders.

Palm processing utilizes 10 liters of water per liter of oil processed. Waste water must be treated to prevent environmental degradation, greatly increasing cost. Solid byproducts from processing palm fruit have not yet found a market and are disposed of locally. For Uganda, palm processing plants will be more expensive because machinery must all be imported, whereas for other oilseeds some machines are already in country.

Palm oil requires 5 or more years to come into full production. On

a long term basis the world supply of palm oil is increasing compared to consumption and relative prices are declining. In world markets, soybean, cottonseed, sunflower and groundnut oil are all priced higher than palm oil.

Shea

Shea trees grow wild in northern and north eastern areas of Uganda. Nuts are harvested and used locally. There are some uses for Shea as an extender for chocolate and, if properly prepared, shea oil prices are high. But shea tree maturation is very long, 10 to 15 years to begin production and up to 25 years for full production. Yield of fresh fruit may exceed 3,500 kg. per hectare but most weight is in the pulp and shell, with final yield of shea butter about 300 kg.

Collection of shea nuts could be profitable as a specialty industry. It will not support establishment of a processing plant by itself although it might be processed in existing plants. Shea butter is more valuable as an ingredient in food processing and if commercially processed would likely be exported. It will not significantly change edible oil consumption in Uganda.

Ghee From Milk

Ghee from milk is produced at home or as a cottage industry. The highest value for milk is when sold as fluid. Commercial manufacturing of ghee is impractical because milk must be pasteurized. The smallest pasteurization plant available costs about $2 million for a 10,000 liter per day plant. Also, a market for skim milk in Uganda is uncertain. Any price discount for skim milk compared to full-fat milk would be multiplied by 25 and added to the cost of butterfat for ghee production. Thus, production costs can increase rapidly.

For example: If raw milk were purchased at 100\- per liter and sold pasteurized at 200\- per liter for full fat milk and 10% less (180\- per liter) for skim milk, then raw material cost for ghee production would be 780\- per liter. (((200-(.96*180))*25)+100) Processing costs are additional.

Ghee production is done when no other use for milk is available.

Cottonseed

Cottonseed is preferred as a cooking oil and was the dominant oil in Uganda for many years. However, the seed is valued as a byproduct of lint production and crop production will vary with demand for lint, not for oil or meal. Cotton production will contribute to vegetable oil needs but is not expected to increase enough within 5 years to provide self-sufficiency in edible oil. Ministry of Cooperatives and Marketing projected cottonseed production in 1995-96 at 25,001 mt. (MCM) If 19% is reserved for planting seed then 20,251 will be available for processing, yielding about 4,000 mt. of refined oil.

Unutilized Land, Increased Area Cropped

Some increased production will come from increasing the portion of land in crops. To achieve production of 15,000 metric tons requires an area as large as 60,000 hectares if cotton were the only crop to supply oilseeds, or as little as 45,000 hectares if groundnuts or sunflowers supply the seed. For sunflowers to supply refined edible oil needs in 1996 will require 0.7 percent of land currently in crops.

For a typical farming area in central Uganda with about 75% of land area cropable requires an oilseed crop density (including cotton) of about 3.7 percent of area now in crops within 55 kilometers of a mill processing 20,000 mt. of seed annually. This limited crop share will have no impact on overall prices of competing farm products.

Projections of cropland needed to supply foodcrops to the year 2,000 were made by Bucyanayandi, et.al. With their most likely scenario of medium technology and medium demand increase, area devoted to foodcrops remained constant at 4.3 million hectares. The increase due to oilseed production will not materially change this estimate.

Increase Yields

Most countries find as an agricultural crop develops, cultural practices and yields improve and costs decrease. Even though additional inputs are needed, costs are usually exceeded by increased production and sales.

Uganda Can Increase Production

In summary, introduction of oilseed processing facilities and promotion of oilseed production by farmers in quantities large enough to achieve self sufficiency in vegetable oils will not distort prices for competing crops. Ugandan agriculture can absorb increased production without increases in purchased farm inputs such as fertilizers, pesticides and mechanical equipment. Some local price increases for farm products will occur near processing facilities. Crops displaced from areas near mills will increase production from other areas without significant price increases.

If the industry develops an export market, purchased farm inputs will increase. Higher income will increase area planted. Labor shortages will encourage mechanization. More concentrated plantings will bring increased need for pest, disease and weed control. Successive cropped land will require fertilization.

Some inputs are now only available from foreign sources. By the time imports are needed there should be exports of oilseed meal and perhaps oils to provide foreign exchange.

SALES OF VEGETABLE OILS AND OILSEED MEALS

Oil

For the next few years, vegetable oil output will sell

domestically, replacing imports. Costs will be sufficiently low for Ugandan farmers and processors to displace imported palm oil.

Beyond 5 years, production will exceed domestic edible oil consumption and exports will begin. As shown above, nearby African and Middle Eastern countries are large importers. There is a large potential market in this region. (table 7)

Meal

Like most African countries, Uganda consumes little oilseed meals. Unless major investments are made in livestock or poultry feeding, Uganda will quickly be surplus in meal. Establishment or refurbishing of mills will require development of export markets.

Unlike vegetable oils, most African and Indian Ocean countries are surplus in meal. (table 8) The world's largest market for meal is Europe. Because of ocean shipping availability and rates this is the market most accessible to Ugandan. This market imposes quality standards unimproved Ugandan mills cannot meet. Only one Ugandan mill can now produce acceptable meal. Some cultural practices by farmers may also need improvement.

Developing export markets will be more effective if processors cooperate. Export marketing exhibits economies of scale. In initial years, any one mill will have small quantities to export. Combined or coordinated exports will bring better services and prices for transport, communications, documentation and financing.

INVESTMENT IN PROCESSING PLANTS

Many reasons have been given why Ugandan mills cannot operate efficiently: war, civil strife, untrained people, lack of oilseeds to crush, and others. A more basic reason is lack of profits. In the past few years many mills have tried but none have operated efficiently enough to pay farmers a price adequate to grow oilseeds.

Most Ugandan mills were installed prior to 1955, just prior to a significant change in oilseed processing technology, namely precooking and drying of oilseeds prior to expelling. Precooking improved yield of oil from seeds and improved cake quality. By the late 1960's and early 1970's most mills in developed countries had added cooking and buyers began to restrict purchases of non-cooked meals. About that time Ugandan mills stopped operations and the lack of cookers never became an issue.

In the interval 1960's to 1990's, while Ugandan mills were inactive, vegetable oils declined in value in world markets relative to meals and other agricultural products. When Ugandan millers attempted to restart their mills they were less efficient and could not pay farmers an adequate price to sell oil competitive with prices of imported edible oils. Ugandan millers often process seed and cake several times to obtain a yield much smaller than obtained by mills that cook.

Clearly loss or lack of technology is a major factor in profitability of oilmills. Without newer technology oil yield will remain much the same as it has been historically and profitability

cannot improve. Post 1955 technology increases oil yield and improves value of the meal by producing products in keeping with world market specifications, i.e. bacteria free, high protein and low ash and fiber contents.

Because of investment needed in newer technology for seed pre-processing and in refining oil, existing old expeller plants in Uganda cannot operate economically. This leaves a surplus of expellers in country and a low value for these machines.

Having these expellers available, however, reduces costs of establishing functional processing plants. For the next few years Uganda will be able to establish an industry at significantly less cost than would be the case if all new equipment were imported.

With processing plants established and farm yields improved so farm income is adequate even with low prices, Uganda industry can compete in world markets for meal and oil.

Small scale processing

Most small scale oil processors will not be affected by development of self sufficiency in edible oils in Uganda. They are located in remote areas and process seeds as a service to neighbors. What little refined oil finds its way to their areas will likely be priced higher than services by the small scale processor.

Small processors located near processing plants or in urban areas will be affected. These will probably find it difficult to compete.

There is no reason to discourage small scale processors. At the same time, an equivalent investment in modern plants will yield much greater benefits to a larger number of farmers. Uganda cannot achieve self sufficiency by small scale processing.

ROLE OF GOVERNMENT

Governments encourage or discourage trade for many reasons, sometimes unknowingly, by policies regulating commerce, trade, finance, and other items. Usually governments seek to encourage exports and discourage imports. At times domestic policies inadvertently restrict competitiveness of domestic companies when selling in foreign markets.

Sales tax

One tax facing Ugandan companies is the sales tax of 30%. This is high compared with most countries and severely restricts companies competing in world markets. The combination of a processor in Uganda paying 30% sales tax and importers for the most part avoiding sales tax means domestic processors cannot compete with imported oil. It appears importers mostly avoid import duties.

Import and export duties

Import duties on edible oils are set at 50%. As mentioned above,

most do no pay. The import tax should be imposed first and the 30% sales tax computed on the total. Import duties for inputs to manufacturing are set at 10%. This is refundable for exports. In theory trade policies should help domestic processors, but because of uneven enforcement they discourage domestic production.

Education tax for cooperatives

One tax Ugandan cooperatives pay that non-cooperatives don't is a 1 percent education tax on gross sales. For an oilseed processing plant with low gross margins, this tax is a major expense, about double variable labor costs.

Research and extension for farmers

To resolve production problems that arise and continue improvements in seeds, cultural practices, post harvest handling problems, and quality control will require a continuing program of research and training. Improvements are needed in both.

CHAPTER 6. A MARKET ENTRY OPPORTUNITY

Edible Oil and Soap Factories, Ltd. (EOSIL) operates several oilseed processing mills under control of Departed Asians' Property Custodian Board (DAPCB). GOU has indicated a preference to dispose of these properties.

ACTIVITIES OF EOSIL

Current EOSIL assets in the early 1970's were owned by Asians. When Asians were expelled in 1972 their factories were allocated to Ugandans. Few factories operated and in 1974 GOU placed 18 oil mills and soap factories under control of LMB. These mills operated only occasionally. During the 1980's several mills were reallocated to others, so now LMB controls 7 mills.

The decision to establish EOSIL was made in 1981 and the company informally operated under control of LMB from that time. EOSIL was legally formed in March 1988. Its mission is to operate DAPCB properties assigned to LMB on a commercial basis. LMB is majority shareholder. Cooperative unions owning cotton lint processing facilities were invited to purchase shares. It was expected DAPCD would sell the mills to EOSIL, which has not happened.

Performance of oil mills and soap factories are poor, with less that 10 percent of operational capacity achieved in most years. Production for 1980/81 to 1986/87 are shown in table 9.

Table 9. Output of EOSIL oil mills and soap factories.

Year	Soap	Oil	Cake
	Cartons	Tins	Metric tons
1980/81	37,224	3,935	593
1981/82	7,175	10,348	1,317
1982/83	110,526	7,199	922
1983/84	123,880	6,977	802
1984/85	20,709	8,631	955
1985/86	51,720	13,127	1,364
1986/87	13,543	1,161	125

Source: EOSIL, p. 6.

PROCESSING PLANTS

EOSIL plants are located at Mbale (2), Jinja, and Kawempe (west side of Kampala). All are operational but equipment is inadequate to crush oilseed properly. Most expellers are in good condition but seed preparation equipment and oil refining equipment is in poor condition or obsolete. As is, the mills are not commercially viable. Major investments are needed for seed handling and pre-processing and oil refining. Accessory equipment as water supply, boilers, buildings and godowns need refurbishment or replacement.

ASSET VALUES

Three common methods to value business property are: Income generation, replacement value, and market value. The last is most accurate if data is available. Often all three are used though results are seldom the same.

Income Generation

The income generation method values a business based on future income potential. For example, if a business is believed to have profits of 1\- million per year (inflation removed), then net present value of that income stream over 5 years at a discount rate of 12 percent is 4.6\- million. An investor would pay up to 4.6\- million for the business if his aversion to risk and capital was set at 12 percent and the relevant time limit 5 years.

Income generation method of business valuation is useful when the business has a history of income and future events are projected to be similar to the past. In the case of EOSIL profits are so limited that net present value of the income stream is essentially zero. Because the business cannot operate as is, past history is not relevant.

Replacement value

This method of business valuation estimates cost to replace assets. An evaluation is made of all assets as land, buildings, plant and equipment, and inventories. If the business is expected to continue a value of human capital or good will may be included, especially if there are shortages of skilled workers to operated the business. Sometimes values of copyrights, patents, rights to future income from other activities are included.

This method of valuation implicitly assumes assets have value when continuing on in a productive capacity, usually as currently utilized. Because EOSIL will not likely continue on without major capital investment the replacement method may not give a good indication of the true value.

Market value

This method of business valuation estimates value of a business based on what similar businesses have sold for. The valuator collects data on sales of several other companies similar in nature and then adjusts the sales price of the comparable companies up or down depending on special features of that companies in relation to the target company. This method works when data on sales of similar companies is available, not the case with EOSIL.

Comments on Value of EOSIL

It is beyond the scope of this analysis to determine asset value of EOSIL. However, below are a few comments to guide GOU and UCA in their deliberations and negotiations.

A variation of market value approach is to determine value of

assets of the business will sell for separately compared to similar assets that have recently sold. If we consider groups of assets of EOSIL properties as land, buildings, expellers and parts, seed handling and oil refining equipment then a few comments can be made on value of each.

Land values can probably be valued by the market value method by comparing recent sales of similar parcels of land. No estimate of land value was made in this analysis.

Buildings may be valued on market value and on replacement cost. When using replacement cost be sure to subtract costs of refurbishing or modifying existing buildings to meet needs of a refurbished plant if it were to be restarted.

Expellers are in good condition and potentially useful to a refurbished plant. Cost of new machines would be large so using and repairing old expellers could reduce initial investment costs. Based on replacement cost method expellers have some value.

But according to the market value method, even expellers have little value. In Uganda there are more than 100 expellers, far more than will likely be utilized in the next decade. Because of their age these expellers would be difficult to sell outside the country. Hence there are many more expellers than are likely to be buyers. Even though in good condition, expellers will likely sell for their approximate value as scrap metal.

Equipment for seed handling, dehulling, delinting, oil refining, steam generation and soap making are old and not many pieces are useful. Most of this equipment would be valued as scrap less removal costs.

In summary, the value of EOSIL is mainly in land and buildings and a small value, near scrap values, for equipment. There is no value of income stream and we are not aware of any patents, copyrights, or specialized labor skills that may convey with the business.

In fact, labor agreements and liabilities may transfer to the new owners if the entire business is purchased. We recommend only business assets be purchased: land, buildings, equipment.

Purchasing only assets also allows exclusion of liabilities such as loans, labor agreements, pension liabilities, unpaid taxes, and contracts obligating the company. In particular one should determine if assets are encumbered by liens, especially for loans or taxes.

HOW TO USE EOSIL ASSETS

Because of location and competition from established mills at Tororo and Kampala, it is not feasible to refurbish EOSIL mills at Mbale and Kawempe. The Jinja mill can be rehabilitated and operated efficiently. Moving the best expellers from the four mills to Jinja, combined with refurbished seed pre-processing and oil refining will produce quality edible oil and protein meal. Remaining expellers from Mbale and Kawempe should be stored for spares and future use. Shortly the mill could be fully operational and a model of how other Ugandans could establish oilseed processing using existing equipment.

If the Jinja mill is able to stimulate adequate production of oilseeds in the region and becomes profitable, a long term opportunity would be available to use some of the expellers from Mbale and Kawempe for another mill in western or northern Uganda. Locating a mill near cottonseed growing areas such as Kasese or in the north would more likely bring a supply of seeds to the mill in the early years while other oilseed crops are becoming established. Over time several mills would be expected to be established along the rail line west of Kampala and along the rail line in the North.

Establishment of future mills will depend on establishment of export markets. With the Jinja mill refurbished and the Tororo and Kampala plants operating full time, Uganda's domestic edible oil needs will be met. Future mills would need to export or domestic oil prices will decline and crushing profits limited.

Farm to mill transportation costs dictate most mills will be located close to source of supply for raw materials. Because of future meal exports it is recommended mills be located where railroad service is available.

CHAPTER 7. STRATEGY FOR COOPERATIVES

In the next 5 years it is expected 3 to 7 mills may be operational in Uganda, depending on decisions to supply export markets. One of two modern mills now in Uganda belongs to a cooperative, the Nyakesi Oil Mill and Soap Works, Ltd. in Tororo. One additional mill is needed if only domestic requirements are to be met. With exports, additional mills can be viable. We suggest cooperative leaders set a goal to have cooperative ownership of a minimum one-third of the industry. They could have more of course.

Because of how cooperatives are organized and operate and because of legal requirements, cooperatives are more open to public scrutiny than non-cooperatives. With only a few firms in Ugandan oilseed processing, collusion is easy to establish and more likely to be successful. Having some firms as cooperatives makes collusion more difficult to occur without detection. Even non-cooperative firms often find presence of cooperatives in the industry beneficial to convince wary government officials collusion is not occurring, especially during periods when market conditions produce high profits.

A key factor determining success of a mill is its ability to provide a market and service to farmers. Cooperatives need to be more sensitive to farmer needs than they have in the past. The more removed a cooperative is from direct control by farmers the less it will be perceived as serving farmers.

As a plus, existence of primary societies near farmers represents a valuable asset in extending service to farmers. In developed countries an infrastructure capable of delivery of goods and services to rural areas is a valuable and expensive-to-duplicate structure. Services such as seed source, training, assistance with production problems, supply of farm inputs and collection of oilseeds for processing are all easier if effective primary societies are included. How an oilseed processing cooperative chooses to utilize these resources to enter the industry may strongly contribute to or detract from its success.

PARTICIPATE IN EDUCATION AND TRAINING OF FARMERS

Uganda grows a variety of oilseeds such as cottonseed, sunflower, soybean, simsim, groundnuts and others. While farmers are familiar with these crops there are new cultural techniques and seed varieties to improve production. Because government services for farmer education are limited, a cooperative oilmill will need to include these services.

Accurate and timely market information helps companies function efficiently. This same information helps farmers decide which crops to grow. Accurate information reduces mistakes and increases farm income. A primary society manager who is well informed on supply, demand and prices of farm products becomes an important contact for farmers. When combined with ability to purchase farm products and supply inputs, the society becomes a valuable resource to farmers and usually profitable. The primary society manager

should become the best informed person in the village on prices. Knowing the latest production technology is also a major asset.

Farmer Outgrower Scheme for Existing Mills

To develop primary societies and increase oilseed production, UCA should coordinate with a domestic processor to promote oilseed production and train farmers in cultural practices. This support would be delivered through primary societies if they are willing and capable. Where a primary society is not available or interested it could go direct to farmers. Such a scheme might work as follows.

UCA business services (UCABS) would contract with an oil mill to promote and train farmers to grow oilseeds for the mill. Contact would be both direct with farmers and with primary societies. Functions include providing seed, training farmers in production practices, training primary societies in the business practices, and promoting oilseed industry at whatever level is needed. Payment would be based on quantity of seed delivered to the mill.

At least two specialists are needed to start. One is an agricultural production specialist to solve technical production problems of oilseeds, primarily sunflower. Because little technical information is available in Uganda, this person must be able to access information from other countries and apply it to Uganda. The specialist would help determine best seeds to grow, when to plant and harvest, how much to weed, how to fertilize, how to recognize and control disease and pests, how to handle seeds after harvest, and many other production problems.

This work is directly with farmers. However, if primary societies are buying oilseed to supply the mill, they would be wise to take over this service as part of their normal marketing program for members. The production specialist would also be available to train staff of primary societies.

Depending on the level of support the oil mill is willing to provide, up to 4 production specialists could be effectively used per mill.

If enough primary societies are interested and judged capable of serving as buying stations for the oilmill, UCABS would appoint a agro-business specialist to strengthen business operations of primary societies. For example, this specialist would train how to test and grade seeds, how to store grain properly and how to set prices. He or she would help in bookeeping and accounting, train in management techniques, help boards of directors know their duties, help secure financing and other duties in support of these businesses.

Two groups benefit from this service and each should pay. First, the oilmill benefits and should pay based on quantity of seeds received from the primary society. Second, the primary society benefits and should pay based on total business volume and net earnings. Thus, clients only pay when benefits are received; there is little risk.

UCABS should price services with the intention of recovering costs. It would be wise to pay the specialists in part based on success.

Nevertheless, UCABS is adsorbing most of the risk and it would be appropriate to set aside some grant funds should costs exceed revenue.

Estimated costs per advisor per year are 3.5\- million. (table 10) On a first year volume of 2,500 mt., this is 1.4\- per kg. On a volume of 10,000 mt. per year, expected to be reached in year three it is 0.35\- per kg. It is expected 2 production advisors could adequately service a mill at startup. Cost to the mill operator would be 2.8\- per kg. on volume of 2,500 mt. per year. At year 3 when handling 10,000 or more tons 4 specialists are needed, 3 as production specialists, 1 as a cooperative business specialist. Cost to the mill owner would be as 1.4\- per kg.

Table 10. Estimated costs of oilseed extension specialist.

Item	Number of units	Cost per unit	Cost per year
		USh	USh
Wages and benefits, monthly	12	40,000	480,000
Motorcycle:			
Depreciation, years	3		500,000
Operating fuel, oil, km.	15,000	47.7	715,000
Repairs			200,000
Supplies, monthly	12	40,000	480,000
Office support, monthly 1/	12	20,000	240,000
Direct costs			2,615,000
Overhead at 35%			915,000
Total costs			3,530,000

1/ Office space provided by oilmill.

Unfortunately, if successful this service will become unnecessary in a few years. If 10,000 mt. are achieved in year 3 it is possible the mill owner will decide he will receive sufficient quantity even without UCABS services. But UCA will have strengthened cooperatives and contributed much to the oilseed industry in Uganda.

One drawback. It is almost always possible to obtain more money by buying and selling than just advising. An advisor who is in the field often will have a good idea of prices being offered by various buyers. It will be tempting to trade for their own account. This is why the primary societies should quickly becomed trained to offer this service to farmers.

PARTICIPATE IN PROCESSING

GOU suggests the economy be mixed with cooperative, non-cooperative and parastatal businesses. To represent industry interests an oilseed processors association should be formed, without GOU membership. The presence of cooperatives in this association will benefit both types of owners.

While primary societies can purchase from farmers and sell to any mill, cooperative or non-cooperative, with their own processing plant primary societies can better serve farmers.

Purchase EOSIL Assets

The first step is for cooperatives to negotiate purchase of EOSIL assets, specifically oil mills at Mbale (2), Jinja and Kawempe. If successful, a company would be organized to manage these assets and refurbish and operate at least one mill. This would give the company long-term control of sufficient expellers to assure spares for equipment and future expansion. Land and buildings at Mbale and Kawempe are surplus and would be most beneficial if sold.

Purchase Other Expellers

If negotiations to purchase EOSIL assets are not successful, cooperatives should negotiate purchase of expellers only, either with DAPCB or with other owners. Of the more than 100 expellers in Uganda it should be possible to negotiate reasonable terms for the 10 to 20 needed by cooperatives in the foreseeable future.

Other Options

If negotiations for purchase are not successful, cooperatives could consider a long-term lease of existing expellers or plants. If during that period an acceptable purchase or longer-term lease cannot be negotiated, cooperatives should have adequate funds to purchase other expellers in Uganda or import new equipment. Be sure the lease agreement allows newly installed equipment to be removed when the cooperative leaves, otherwise a competitor is established.

A MODEL FOR OILSEED PROCESSING IN UGANDA

The following discussion assumes cooperatives, led by UCA, are successful in negotiating purchase of assets of EOSIL or 10 to 12 expellers from other mills, and changes are made in tax policy.

It is recommended cooperatives establish an oilseed processing plant, most likely at Jinja. The following paragraphs describe a cooperative owned mill and its operations. The name used in this report is Cooperative Oilseed Industries, Ltd. (CoopOIL).

The refurbished mill can crush 20,000 mt. of seed, producing 6,000 mt. of refined oil and 6,000 tons of meal.[3] Hulls will be burned for heat and power generation, making the mill self sufficient in energy. The plant can crush a variety of oilseeds including cotton, sunflower, soybean, groundnuts, simsim, maize germ and others.

Goals of CoopOIL

This model cooperative business will have as primary goals:

1. Limit new investment, utilizing as much existing equipment as possible.

---

[3] Inputs and outputs vary depending on seed crushed. Estimates in this report assume all sunflower.

2. Maximize extraction yields and minimize operating costs.
3. Provide training and technical and management assistance in plant operations. Develop business and marketing skills for local and eventually for export markets.
4. Provide for oilseed planting stock for farmers, either through existing companies or by CoopOIL, if necessary.
5. Assure that primary societies and farmers receive a fair price.
6. Provide a model for other oil mills.
7. Develop a marketing plan for world market acceptance of Uganda oil mill products.
8. Assist establishment of trading rules for seed purchase and trading of products, as well as development of a national quality control of seed, oil, meal and soap.
9. Assist meeting the national goal of self sufficiency in edible oils.

Specifically for mill operations, objectives will be:

1. Production of 20,000 mt. of sunflower seed annually or equivalent in other oilseed crops in 5 years.
2. Limit new plant investment to $1.1 million, including 374\- million, compared to $3 to $4 million for all new equipment.
3. Commence operation of the rehabilitated oilmill within eight months of order date.
4. Have a positive cash flow after second year of operation.
5. Develop plans for a second oil mill with a MAPP of 30,000 mt.

Technical design and operating parameters of CoopOIL will be:

1. The new oil mill shall be designed to crush 20,000 mt. of sunflower seeds (MAPP) without additional expenditures.
2. The mill shall be self sufficient in electric and steam power.
3. The oil mill shall decorticate all seeds at about 98% effiency.
4. CoopOIL will begin work with the reciept of the seed and provide storage for 30% of anticipated annual crush.
5. CoopOIL shall have adequate storage for finished products. First years meal storage shall handle 30 days of production. First years oil storage shall handle 30 days of production.
6. The oil shall be continuously single refined. Thirty percent of the oil shall be deodorized and bleached.
7. All cake shall be ground to meal.
8. The extraction effiency shall not be less than 94% on a dry basis.
9. Seed shall be cleaned and analyzed for oil, moisture and ash content. Prices shall be adjusted accordingly. New analytical equipment shall be purchased. Training is to be provided for a laboratory technician. All analysis shall be in accordance AOCS standard trading rules.
10. Cleaned seed shall be decorticated. Hulls shall be used as fuel. A new decortication and aspiration system shall be purchased and installed to process 20,000 mt. of sunflower seed.
11. A seed cooker shall be purchased and installed to cook and dry 20,000 mt. of seed annually.
12. Expellers shall be acquired locally.

Planting Seeds for Farmers

The mill cannot be successful unless farmers greatly increase oilseed production. Sunflowers now grown in Uganda have low oil yields. Improved varieties with higher oil yields significantly improve financial returns. But improved varieties are not always easily distinguishable from unimproved varieties. Also, improved varieties can be corrupted if care is not taken in seed production.

A review of planting seed production capability in Uganda suggests CoopOIL be prepared to supply improved variety planting seed to farmers. A seed industry will probably develop, but an input so critical to success cannot be left to uncertain performance.

Included in the financial projections are personnel and equipment for CoopOIL to supply planting seeds to farmers. Initially varieties developed at Namalonga Research Station will be used. Production will be by outgrowers but supervised by CoopOIL. Planting seed stock will be processed and stored at the mill and distributed through primary societies for farmers to plant.

If a domestic seed industry develops to conduct research on seed varieties and to produce and control availability of improved varieties, it is anticipated CoopOIL would not continue planting seed production.

Relationship to Primary Societies and Growers

CoopOIL will purchase and receive seed through primary societies, not directly from farmers. Four CoopOIL technical advisors will offer assistance to primary societies on business operations and on technical problems of farmers.

Assistance with business operations includes accounting and financial control, handling of oilseeds, oilseed testing and quality control, personnel management, and others. Assistance with farm production includes planting seed selection, cultural practices, insect and disease control, fertilizer recommendations, harvesting methods, post harvest handling, and others.

In farm production problems, CoopOIL technical advisors will focus on training primary society staff, who will help farmers directly. In early years CoopOIL advisors may assist farmers directly but also will encourage them to obtain help from primary societies. Eventually primary societies will solve most production problems.

Purchasing Crushing Seed from Primary Societies

Comments on physical handling and title transfer refer to sunflowers, but apply to other seeds except for a few technical factors.

Farmers will deliver seed to a primary society where it will be weighed, tested, a price agreed to, and the farmer issued a receipt. Societies will make a partial payment at that time, say 75 percent of total expected value. Because crushing seed will be priced based on oil content, a final price cannot be determined until delivered to CoopOIL and tested. Seed will be stored pending transfer to CoopOIL.

Seed as delivered may need conditioning, say for insect infestation

or for excess moisture, even if only waiting a few days for transport. Charges for this can be determined upon delivery to the primary and will be deducted from payment to the farmer. Also, credits for inputs received from the farmer can be deducted.

When sufficient quantity has been assembled the primary society will notify CoopOIL to send a lorry to collect seed. The CoopOIL lorry will weigh seed and issue a receipt to the primary society. Upon arrival at the mill seed will be reweighed, sampled and stored for later processing. The sample will be tested for oil quantity, impurities and other quality factors. Price to the primary society will be determined based on test results and a published discount schedule from current prices for lower quality product.

Upon determining quality and price, CoopOIL will issue a draft allowing the primary society to obtain payment from a bank. This would normally be one or two days after delivery. The primary society would in turn then make final payment to farmers.

Primary societies will want to implement quality control procedures to assure farmers deliver proper variety crushing seed and that it is not adulterated. Once seed is loaded on lorry for delivery to CoopOIL it is treated as one lot from each primary society and cannot be identified by farmer. Poor quality seed from one farmer will reduce price to all. If watchful, primary societies can adequately determine quality of crushing stock. If a farmer's delivery is in question the primary society could take a sample and request CoopOIL to test.

Marketing of Finished Product

Refined edible vegetable oil will be packaged in both consumer and commercial size packages. Market testing will determine exact size but anticipated approximate sizes are: 1 liter, 4 liter consumer package in clear plastic bottle packaged in corrugated box. For commercial sales package sizes are expected to be 20 and 200 liter plastic or steel containers. Plastic containers are manufactured now in Uganda.

Product will be sold primarily through wholesalers. Many wholesalers will pickup at the plant but delivery service will be available. Minimum order sizes will apply and transport costs taken into account before deliveries to distant towns begin.

Financing

Financing is required for purchase of EOSIL, initial plant refurbishing, for inventory and working capital. Primary societies may want short term inventory financing and many farmers will want production loans.

Initial grant for purchase of EOSIL assets could be made through local currency funds generated by PL-480 commodity grants. A grant for plant refurbishing could be provided by USAID Commodity Import program (CIP) under Cooperative Agricultural and Agribusiness Support (CAAS) project and/or Export Policy Analysis and Development Unit (EPADU). Grants would form the basis of a cooperatively managed Edible Oil Development Trust Fund.

Loans for inventories, working capital and for primary societies will come from UCA/PL-480 funds. Crop production funds are available through Small Farmer Loan fund through Uganda Commercial Bank or through the Cooperative Credit Scheme of PL-480. Loan rates are expected to be 28% for short and long term loans.

Technical Assistance

A technical advisor (TA) is required for 4 years. For at least the first 2 years the TA should be mill manager. Afterward the board should be given some freedom in manager selection, subject to lender approval. Expenses of technical assistance including payments to the technical advisor/mill manager will be from UCA managed PL-480 funds. U.S. Peace Corps assistance would be welcome.

OWNERSHIP AND CONTROL OF CoopOIL

CoopOIL will be a company, owned by primary societies. But primary societies are unfamiliar with management of a business this large and complex. For early years assistance is needed.

Uganda Cooperative Alliance (UCA) has access through donor-assisted programs to technical and business consultants to assist primary societies in operation of CoopOIL. Second, UCA has credibility with donors to acquire necessary equipment for processing. And third, UCA can support CoopOIL in ministerial and other government offices. To provide these resources UCA should be a partner in enterprise development, control, and management. When primary societies are capable of full operations UCA will withdraw.

Enterprise Structure

CoopOIL will be established as a limited liability company. Initially UCA will be a caretaker with a majority of shares. According to an agreed schedule, UCA would gradually withdraw control in favor of members. By-laws would specify targets for shares transferred each year and how to determine share price, if any. In 5 years UCA would become a minority shareholder and by year 10 would have no shares in the venture. UCA derives a management fee of 1 percent per year of the gross margin during its tenure as caretaker.

After the buy out, CoopOIL will be owned by members; farmers, primary societies, unions, or other companies. Profits, if any, will be partially held in reserve as by-laws may require or the board determines, and the remainder returned to members according to business done with CoopOIL. In the case of primary societies, a portion will be returned to their farmer members according to business done with the primary society.

Control of CoopOIL and management decisions would be through board membership determined by equity positions and would gradually shift from UCA to primary societies.

FINANCIAL SUMMARY

Table 11 summarizes financial performance of improved (CoopOIL) and unimproved oil processing mills using both a 30 and 10 percent sales tax. Results for processing cotton are also included.

Table 11. Financial summary for improved and unimproved mills.

	Improved			Unimproved	
	Sunflower		Cotton		
	(30%)	(10%)	(10%)	(30%)	(10%)
INVESTMENT (MUSh):	1,050	1,050	1,050	150	150
PRE-TAX EARNINGS (MUSh):					
YEAR 0	(1,050)	(1,050)	(1,050)	(150)	(150)
YEAR 1	(87)	6	(19)	(183)	(88)
YEAR 2	(256)	0	8	(438)	(206)
YEAR 3	(687)	1	(143)	(595)	(271)
YEAR 4	(1,062)	270	(17)	(800)	(356)
YEAR 5	(1,566)	699	496	(1,143)	(542)
NPV (MUSh):	(1,533)	345	73	(1,433)	(665)
IRR:	-199.5	-1.6	-18.3	-235.1	-217.2
EARNINGS ON SALES (Percent):					
YEAR 1	-11.7	0.8	-4.4	-28.6	-13.9
YEAR 2	-13.8	0.0	0.7	-30.0	-14.1
YEAR 3	-14.3	0.0	-5.3	-32.6	-14.8
YEAR 4	-11.8	3.0	-0.3	-35.0	-15.6
YEAR 5	-10.5	4.7	6.0	-40.0	-19.0
AVERAGE:	-12.4	1.7	-0.7	-33.2	-15.5
EARNINGS ON INVEST. (Percent):					
YEAR 1	-8.2	0.6	-1.8	-121.7	-58.9
YEAR 2	-24.3	0.0	0.7	-291.8	-137.3
YEAR 3	-65.4	0.1	-13.6	-396.4	-180.6
YEAR 4	-101.2	25.7	-1.6	-533.5	-237.6
YEAR 5	-149.2	66.5	47.3	-761.7	-361.3
AVERAGE:	-69.7	18.6	6.2	-421.0	-195.1

The improved oil mill has investment cost of 1,050\- million and shows a positive rate of return when charged a 10 percent sales tax. Earnings when processing sunflower are nearly zero the first 3 years and rise rapidly in years 4 and 5. Net present value (NPV) is 345\- million and IRR is slightly negative. Earnings to sales ratios are low in years 1 to 3. Ratios in years 4 and 5 are consistent with a high-volume, low margin indutry as is oilseed processing. Average ROI is 18.6%.

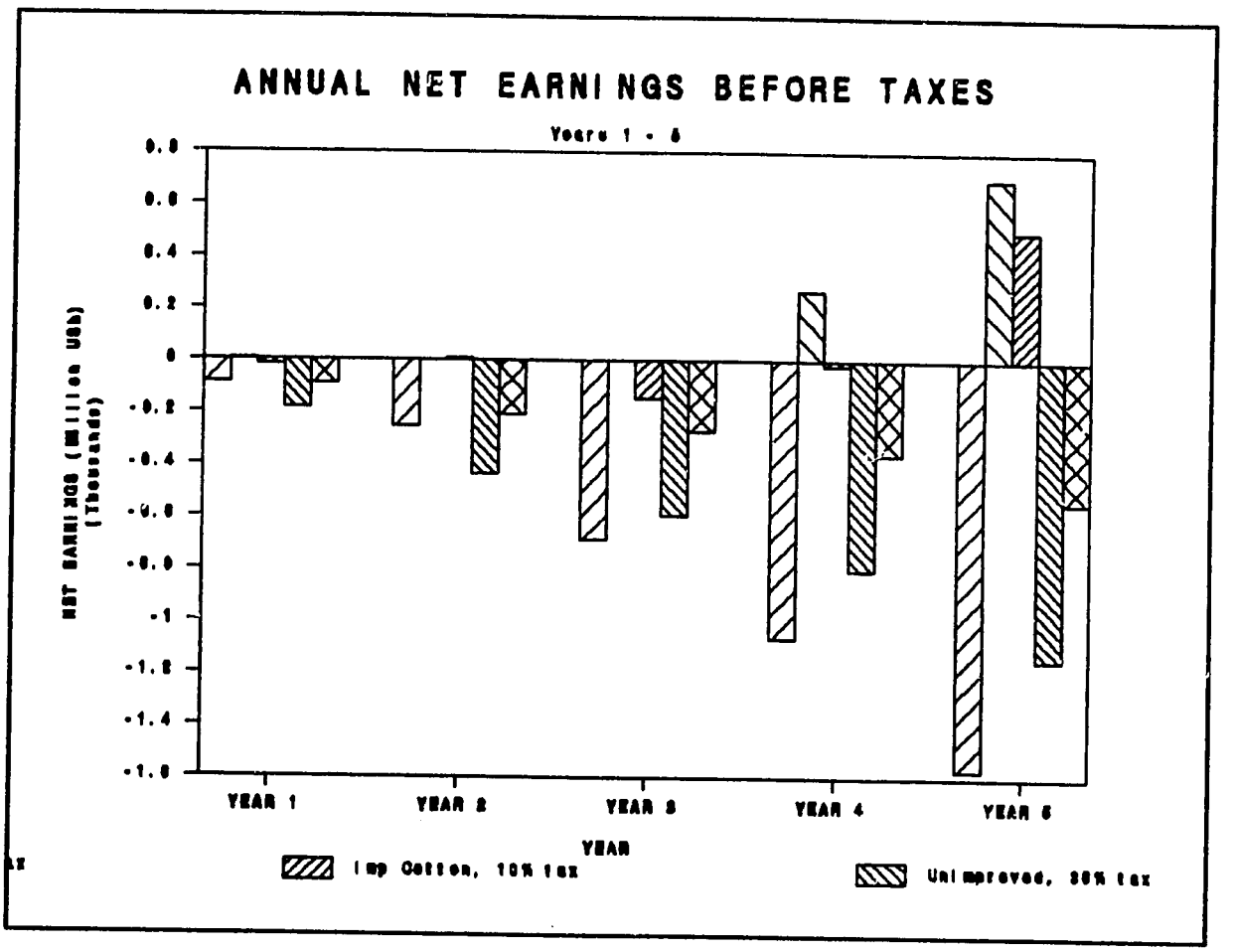
Government receives taxes of 2.7\- billion over 5 years. Farmers receive 13.1\- billion during the same period. Above a 10 percent sales tax, processing is not viable and neither tax returns or farmer purchases accrue (figure 3). More detailed financial results are in appendix 1.

When processing cotton seed with 10% sales tax earnings are positive only in years 2 and 5 with a NPV of 73\- million and a negative IRR. Average ROI is 6.2%. Processing only cottonseed

with a 10 percent sales tax is not viable.

If a 30 percent sales tax is charged even the improved mill is not financially viable, having losses in all years.

The unimproved mill has losses in all years at both tax rates. Losses increase each year.



SENTIVITY ANALYSIS

Unanticipated events may change financial results. Below are described selected events and how financial returns would change if these events were to transpire. (table 12) The changes refer to the improved mill at 10% sales tax.

A sales tax above 10% makes investment not feasible. At zero sales tax average ROI is 65%, NPV is 1,359\- million and IRR is 33%.

If initial investment costs increase by 20% to 1,260\- million, average ROI is reduced from 18.6% to 9.1%, NPV declines from 347\- million to 147\- million, and IRR declines from -1.7 to -13.7. But, if initial investment costs are 20% lower, average ROI rises to 32.6%, NPV to 528\- million and IRR to 11.7.

Financial returns are quite sensitive to changes in sales price. Increased price for oil and meal of 20% results in average ROI of 122.55. NPV and IRR are also large. On the other hand decreased selling price of 20% pushes average ROI down to -68.2%, NPV to negative 1,517, and IRR to negative 193.3.

Increasing prices paid to farmers by 20% makes the mill not viable, with average ROI of -35.2% and negative NPV and IRR.

Increasing oilseed production by farmers is critical to success of CoopOIL. For several reasons, production might not increase as fast as projected. Table 12 shows financial results if sunflower production available to CoopOIL were as follows: Year 1 = 2,000 mt.; year 2 = 4,000 mt.; year 3 = 6,000 mt.; year 4 = 9,000 mt.; year 5 = 12,000 mt. If this occurs, average ROI is -12.0%, NPV -296\- million, and IRR -150.5. It is essential that support for farmers is sufficient to achieve production targets.

Table 12. Sensitivity of financial results.

Event	Average ROI	NPV	IRR
	Percent	MUSh	Percent
Sales Tax:			
Sales tax = 30%:	-69.7%	(1,533)	-199.5%
Sales tax = 20%:	-20.7%	(500)	-170.3%
Sales tax = 10%:	18.6%	345	-1.7%
Sales tax = 0%:	65.7%	1,359	33.0%
Acquisition cost:			
Increase by 20%:	9.1%	147	-13.1%
Decrease by 20%:	32.6%	528	11.5%
Sales price of oil and meal:			
Increase by 20%:	122.5%	2,576	57.9%
Decrease by 20%:	-68.2%	(1,517)	-193.3%
Initial price paid to farmers:			
Increase by 20%:	-35.2%	(806)	-184.8%
Decrease by 20%:	63.4%	1,304	31.6%
Slower production growth:	-12.0%	(296)	-130.5%

Cottonseed Processing

During early years of CoopOIL there is excess milling capacity. Cottonseed should be available for processing. At prices up to 70\- per kg., CoopOIL can cover variable costs and will purchase fresh cottonseed for processing rather than close the plant. If sunflower is available for processing, CoopOIL will process cottonseed only if its price falls below 35\- per kg. At the current LMB price of 55\- per kg. for cottonseed, it is not feasible to invest in a new mill.

DEVELOPMENT TIMETABLE

Physical operations of ordering and installing refurbished equipment and starting up the mill can be done within 8 months. Orders can be placed within a few weeks of decision to proceed and hiring of the technical advisor. Equipment cannot be ordered until grant funds are available.

CoopOIL services to primary societies and farmers can begin shortly after TA is hired. Also, preparations for supplying improved planting seed can begin then. To establish its relationship with primary societies and farmers, CoopOIL should encourage planting and purchase a crop even before the mill is complete. The crop

could be sold to other processors, or held in storage. Increased processing quantities in early years improves financial returns.

SOME TAX ISSUES

Several tax issues must be resolved. First is the 30% sales tax imposed on sales of edible oil. Tax is payable monthly on day 15 of the following month. Other products such as meal, soapstock and trading of oilseeds are intermediate products and not subject to sales tax. If sales taxes are paid on manufacturing inputs they may be subtracted from value of product sold to determine taxable sales.

It is expected cooperatives would pay income tax as a corporation. This is currently 40%. Just how profits are determined is not always clear. No decision is available whether second payments to farmers can be deducted before determining income for taxes. Also not clear is if these payments are taxable to recipients, whether farmers or primary societies.

Some business may be subject to a Commercial Transaction Levy (CTL), usually applied to services. If the service is incidental to the business operations then no tax is due. If the service is a separate profit center and offers service to all, not just the oilmill, it may be liable for the CTL. This might affect CoopOIL if crushing for a fee, called toll crushing. Toll crushing, if paid by fee, would be assessed 10% CTL. Crushing with payment in kind would probably escape the CTL. If paid in oil, sales would be subject to sales tax, which seems to satisfy Finance Ministry. Other services which might be subject to CTL depending on how organized are transportation, soil testing, crop insect or disease consulting or treatment, and others.

There is no property nor inventory tax, but there may be soon.

A pre-business tax is often imposed on businesses. Because companies often do not pay tax at year's end, the Min. of Finance requires advance payment based on estimated earnings. At year's end the business must prove its profits are more or less and pay accordingly or receive a refund. If financial reports are not submitted by due date, advance payment in excess of actual tax due is forfeited. We suggest CoopOil agree to keep proper accounts and make proper tax payments, but negotiate not to be required to make pre-business tax. The practice is not codified.

There is no tax on exports. Import duties and sales taxes paid on products consumed in producing goods for export may be rebated. Claims for rebate not used in one year can be carried over to future years. How many years carryover is allowed is not know.

Import duties on industrial equipment is zero. Import duties on supplies of raw materials for manufacturing is 10 percent. Also a 10 percent sales tax is imposed. These are both rebated on exports.

Import duties on edible oil is 50 percent, assessed first, then a 30 percent sales tax. It appears not many pay this amount.

Several businesses have complained of poor record keeping and arbitrary treatment from tax officials. Sometimes it is difficult

to obtain rebates on tax over payments, or credits from taxes paid on exports. Because of these inequities, actual tax rates may exceed published rates.

Financial statements and taxes due are required 1 month after close of GOU financial year. After that, GOU will not refund operpayments, but retains the right to demand additional taxes be paid.

Tax holidays have been granted for high priority activities. Application is made to the Minister of Finance. Decisions are on a case by case basis and no guidelines are given. If the sales tax is not changed, CoopOIL should request a 5 year sales tax holiday. Five years would allow CoopOIL to repay investment debt and hopefully give GOU time to begin collection of import duties and sales tax on imported edible oils.

If the sales tax is lowered to 10%, CoopOIL should request a sales tax holiday of 3 years. This greatly reduces risk until production base is established, encouraging industry development. At a sales tax rate of 5% or below no tax holiday is needed.

LIST OF REFERENCES

Agricultural Policy Committee. Restructuring of the Produce Marketing Board. Working Group 8, Kampala, Uganda, 1990.

Bank of Uganda, Agricultural Secretariat. Quick Survey on Simsim Production in Northern Uganda, Its Marketing and Potential for Export Diversification. Feb. 1991.

Bucyanayandi, T., L. Tweeten, C. Amorin, S. Zziwa, E. Nsubuga. Uganda Accelerated Foodcrop Production Strategy. Ministry of Agriculture and Manpower for Agricultural Development, USAID, Kampala, 1990.

Bunker, et.al. Feasibility of Cooperative Participation in Milk Produciton, Processing and Marketing. CAAS/ACDI, Kampala, 1991.

Carter, Jack F. Sunflower Science and Technology. American Society of Agronomy. Madison, WI, 1978.

Coles, Diana M. The Vegetable Oil Crushing Industry in East Africa. Makerere University, Kampala, 1967.

Cooperative Societies Bill, 1990.

Duffus, Carol, C. Slaughter. Seeds and Their Uses. John Wiley, 1980.

Edible Oil and Soap Industries, Ltd. Development Plan 1988/89 to 1990/91. Kampala, 1988.

Enger, Warren J., D.R. Burgess, J.K. Ahimbisibwe. Oilseed Production and Processing Sector Analysis. CAAS/Ronco Consulting Corp., Kampala, 1989.

Export Policy Analysis and Development Unit, Min. of Planning and Economic Development. Report of the Task Force committee on Edible Oil Industry in Uganda, Kampala, 1990.

Food and Agriculture Organization, United Nations. Trade Yearbook. Rome, various issues.

Mehta International Limited. Uganda Oilseed Project, Vol. 1, Finance and Marketing. Nairobi, 1981.

Onesmus, Mulondo. Analysis of Retail Prices of Groundnuts in Kampala and Rural Market Prices of Simsim and Soyabeans. Food Crop Analysis Series No. 2, Min. of Agriculture, Apr. 1991.

Ministry of Animal Industries and Fisheries. Poultry Sector Survey Report 1988. Kampala, 1988.

Ministry of Cooperatives and Marketing. Rationalization of Cotton Ginneries. Uganda Agricultural Rehabilitation Project II, Working Group 5, Kampala, 1990.

Ministry of Planning and Economic Development. Background to the Budget, 1990-91. Kampala, July 1990.

Ministry of Planning and Economic Development. Report on the Uganda National Household Budget Survey, 1989-90. Entebbe, Feb. 1991.

Ministry of Planning and Economic Development, Statistics Dept. Key Economic Indicators. 4th issue: Jan. 1991.

Newberg, Richard. RECON Edible Oil Market Survey in Uganda. Memorandum to Thomas Carr, Kampala, March 16, 1991.

Odogola, Wilfred R. and M.A. Kaliisa. Traditional Farm Storage and Food Reserves at Different Levels in Uganda. RECON, Kampala, 1989.

Palm Oil Production in Uganda. Mimeograph report by FAO/WFP, Kampala, 1988.

Perry, Richard. Edible Oil Processing and Distribution, Project Implementation Plan. USAID, Rangoon, Burma, 1987.

Recon International Ltd. Edible Oil Market Survey in Uganda. UCA and ACDI, Kampala, 1990.

Scheithauer, R., K. Dripchak. Economics of Vegetable Oil Processing. by JAYCOR to Oak Ridge National Laboratory for U.S. Dept. of Energy, Washington D.C., 1988.

Sumpter, Alray. Taxation Reforms for Farmer Cooperatives. Uganda Cooperative Alliance, USAID/ACDI/CAAS, Kampala, 1990.

Thompson, Arlo. Assessment of Sunflower Production Potential and A research Plan for Uganda. USAID/MFAD Project, Kampala, 1988.

Uganda, Republic of. Companies Ordinance 1958(Laws of Uganda 1964).

Uganda, Republic of. Investment Code, 1991.

U.S. Dept. of Agriculture. World Oilseed Situation and Market Highlights. FOP 9-90, Washington, Sep. 1990.

LIST OF CONTACTS

Fred Kamugira, Uganda Seeds, Kwanda Research Station

E. A. Katoroogo, Agricultural General Manager, EOSIL

Mr. Kamugisha, Director General, Ministry of Finance

Saul A. Kintu, Mahavani Group, Jinja, Oil and Soap

Neils P. Louwaars, Plant Breeding, Uganda Seed Project

C.J. Mutyaba, Agricultural Engineer, Namalene A.E.D

James Obbo, General Manager, LMB

Philip Oyang, Traffic Manager, Uganda Railways

Sewanyana, Edward, Departed Asians Property Custodian Board

Stephen Were, South Bukezi Cooperative Union, Box 101, Tororo

APPENDIX 1. ASSUMPTIONS FOR CoopOIL PROJECTIONS

Below are assumptions used for profit and loss projections of CoopOIL (improved mill) and for a similar unimproved mill.

TECHNICAL CONSIDERATIONS

Production schedules

Both mills are crushing high-quality sunflower or cottonseed according to the following schedule, in tons per year (TPY):

	Year 1	Year 2	Year 3	Year 4	Year 5
Improved	2500	5000	10000	15000	20000
Improved (cotton)	2500	5000	10000	15000	20000
Unimproved mill	2500	4600	4600	4600	4600

Changes to the improved mill will increase expeller crushing capacity from 4,600 TPY to 20,000 TPY. The unimproved mill will be constrained by main power failures and undecorticated seed volumes.

Extraction efficiencies

Improved and unimproved mills differ in extraction efficiencies and meal quality as shown in appendix tables 1.1 and 1.2.

Appendix table 1.1. Process efficiencies.

Item:	Improved sunflower (kg/mt)	Improved cotton (kg/mt)	Unimproved sunflower (kg/mt)
Husk:	232.5	459.0	0.0
Meal:	389.5	332.0	618.8
Refined oil:	370.0	205.0	319.2
Waste:	8.0	4.0	62.0
	1,000.0	1,000.0	1,000.0

The improved mill will extract almost 95 percent of available oil from decorticated seed, the unimproved mill less than 80 percent. Unimproved processing does not remove liquid proteins from oil nor husk fiber from meal. Total oil extraction for the improved process is 370 kg. per ton of sunflower and 205 kg. per ton of cotton seed, and 319.2 kg. from sunflower for the unimproved mill.

FINANCIAL ELEMENTS

Revenue

Oil sales. Prices of goods sold by mill are as follows:

	Improved mill	Unimproved mill
Edible oil	725 USh/kg.	725 USh/kg
Meal	63 - 97 USh/kg.	30 USh/kg
Soap stock	25 USh/kg.	25 USh/kg

Edible oil price is based on both mills selling sunflower or cotton oil locally in 18 kg. packages at 700 USh/kg and 1 kg. packages at 750 USh/kg for the next five years.

Soap stock. Price is based on current values for cottonseed based materials.

Meal sales. Meal prices for the improved mill are based on international prices FOB Kampala and increase over time as the product becomes more widely known and trusted and transport costs decline with greater quantities. Meal from unimproved mills has higher fiber content and may contain harmful substances. It will be displaced or offered at lower price.

Bag sales. Both mills will sell bags to farmers for an annual revenue of 5\- to 12\- million.

Trading income. Both mills may sell up to 5% of seed purchases to other buyers at an average markup of 20% over purchase price.

Cost of goods sold. Mills will buy crushing material at a nominal (current) price of (USh/kg):

	Year 1	Year 2	Year 3	Year 4	Year 5
Improved mill	110	125	187	234	305
Improved mill (cotton)	45	56	70	88	110
Unimproved mill	110	125	187	234	305

Marketing costs. Both mills spend three percent of gross oil sales revenues for local marketing and sales. Local marketing of meal requires a similar percentage. High costs of international marketing of meal from improved mill increases marketing costs to 10% in year 3 and to 6% in years 4 and 5.

Variable costs

Variable costs for processing seed differ widely between unimproved and improved mills. Appendix table 1.2 shows variable costs of processing sunflower seed.

The unimproved mill will face 24 percent higher costs due to energy and machine downtime. None of the unimproved mills are self-sufficient in fuel and must use firewood or fuel oil to compensate. Dependence on inconsistent mains power increase downtime and miscellaneous costs.

Appendix table 1.2. Variable costs of processing oilseeds.

	Improved mill (Sunfl.)	Improved mill (Cotton)	Unimproved mill (Sunfl.)
	- USh per mt. -		
Oil Packaging	60,947	33,768	52,546
Meal Packaging	3,895	3,320	6,188
Transport	7,537	13,190	7,537
Fuel	0	0	22,703
Electricity	0	0	1,493
Water	0	0	0
Maintenance Materials	3,840	3,840	2,753
Maintenance Labor	1,500	1,500	0
Chemicals	978	978	1,370
Labor	1,387	1,387	1,492
Miscellaneous	7,255	5,798	8,855
Total costs	79,802	63,781	98,893

Fixed Costs

Major fixed costs come from depreciation, administrative costs, and administrative salaries and benefits. Depreciation costs are listed in appendix table 1.3. Administrative costs include supplies and costs of operating a production support program (appendix table 1.4). Salaries and benefits for administrative management are 9\- million in the first year and adjusted for inflation annually.

Appendix table 1.3. Depreciation schedules.

Description	Improved mill Value	Improved mill Years	Unimproved mill Value	Unimproved mill Years
	- Million USh. -			
Building depreciation	40	20	40	20
Store Depreciation	60	20	60	20
Vehicle Depreciation	88	4	88	4
Office Equipment Depr.	10	5	10	5
Capital Equip. Depr	804	10	100	10
Total Depreciation		109		39

Appendix table 1.4. Administrative costs

Description:	Improved mill	Unimproved mill
	- Million USh. -	
Administrative Supplies	5.00	5.00
Production support costs		
Field Agents' S+B	0.96	0.96
Transport Depreciation	3.75	3.75
Transport Maintenance	3.00	3.00
Transport Fuel	2.40	2.40
Total Costs	15.11	15.11

The improved mill incurs management costs and pays contributions to an Edible Oil Development Trust Fund.

Acquisition and improvements of CoopOIL mills cost 1,050\- million. Though this is a grant, CoopOIL repays an annual sum to an Edible Oil Development Trust Fund to promoting cooperative development. Appendix table 1.5 lists foreign exchange and local currency costs of fixed capital equipment, freight and installation for renovation of the improved mill. Total investment is $813,000 plus 222.3\- million.

Interest cost

Crop Finance. Six month loans for purchase of crushing material are made with 28 percent interest. Principal and interest payments are made semi-annually.

Operating Finance. Six month loans for operating expenses above crop finance are made with 28 percent interest. Terms are the same as for crop finance.

Second Payment to Farmers

A cooperatively owned mill returns a portion of earnings to farmers on the basis of business done with the cooperative. If earnings are positive, 60 percent of before tax earnings are returned to farmers.

Income Taxes

Positive earnings before taxes are subject to a 40 percent income tax.

Inflation

Inflation is assumed at 25 percent annually. Inflation increases nominal values of all inputs, revenues including Ugandan shilling denominated exports and operating expenses. Long-term loan principal and depreciation schedules are not affected.

Appendix table 1.5. Estimated equipment, freight, and installation costs.

ITEM DESCRIPTION:	FOREX CAPITAL COSTS (US$)	LOCAL CAPITAL COSTS (USh)
PRE-PROCESSING EQUIP:		
DRYERS(SEED):	$0	0
CLEANERS(SEED):	$0	0
CLEANER:	$12,000	0
DEHULLING:	$32,800	0
SCREENS,CYCLONES:	$28,000	0
HULL BEATER:	$9,000	0
ROLLER MILL:	$78,000	0
COOKERS/DRYERS:	$64,550	0
PRE-PROC SUB-TOTAL:	$224,350	0
EXPELLERS		
EXPELLERS:	$0	0
SUB-TOTAL:	$0	0
POST-PROCESSING EQUIP:		
CENTRIFUGE:	$68,750	0
FILTERS:	$3,000	0
LAB EQUIPMENT:	$6,000	0
SUB-TOTAL:	$77,750	0
INFRASTRUCTURE:		
BOILERS:	$58,000	0
TURBINE:	$115,000	0
AIR COMPRESSOR:	$15,200	0
AUGER LEGS (300'):	$36,000	0
SPARES:	$24,000	0
MECHANICS' TOOLS ETC.:	$10,000	0
BAGS/CONTAINERS:	$3,000	0
OTHER:	$5,000	0
SUB-TOTAL:	$266,200	0
TOTAL MACHINERY COSTS:	$568,300	0
CONTINGENCY (10%):	$56,830	0
SUB-TOTAL:	$625,130	0
OTHER COSTS:		
INSTALLATION COSTS:	$0	179,130,600
FREIGHT, TAX, DUTY:	$187,539	0
BLDG. RENOVATION COST:	$0	20,750,000
SERVICES/ANCILLARIES:	$0	22,391,325
SUB-TOTAL:	$187,539	222,271,925
GRAND TOTAL COST:	$812,669	222,271,925

Appendix table 1.6. Financial projections, improved mill, 30% tax

INCOME:	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Oil Sales:	671	1,677	4,191	7,859	13,098
Meal Sales:	61	154	570	1,069	1,782
Soap Stock:	1	2	4	7	12
Bag Sales:	5	6	8	10	12
Trading Income:	3	8	19	35	61
Gross Revenues:	740	1,845	4,792	8,980	14,965
Cost of Goods Sold:	275	750	1,875	3,516	6,104
Sales Tax (30%):	155	387	967	1,814	3,023
Marketing Costs:	22	55	183	300	500
Gross Margin:	286	648	1,752	3,323	5,290
VARIABLE COST (MUSh):					
Oil Packaging:	152	381	952	1,786	2,976
Meal Packaging:	10	24	61	114	190
Transport:	19	47	118	221	368
Fuel:	0	0	0	0	0
Electricity:	0	0	0	0	0
Water:	0	0	0	0	0
Maintenance Mat'ls:	10	24	60	113	188
Maintenance Labor:	4	9	23	44	73
Chemicals:	2	6	15	29	48
Labor:	3	9	22	41	68
Miscellaneous:	20	50	125	235	391
	220	551	1,376	2,581	4,301
FIXED COSTS (MUSh):					
Building Depr.:	2	2	2	2	2
Storage Depr.:	3	3	3	3	3
Vehicles Depr.:	22	22	22	22	22
Office Equip. Depr.:	2	2	2	2	2
Capital Equip Depr.:	58	58	58	58	58
Dev't Fund Contrib.:	0	100	550	900	1,050
Management Costs:	3	6	18	33	53
Admin supplies:	15	19	24	30	37
Admin S+B:	9	12	14	18	22
	114	224	693	1,068	1,249
INTEREST COST (MUSh):					
Crop Finance:	39	105	263	492	854
Operating Finance:	0	24	108	244	451
	39	129	370	736	1,306
GROSS MARGIN:	286	648	1,752	3,323	5,290
TOTAL OPER. COST:	373	903	2,439	4,385	6,856
PRE-TAX EARNINGS:	(87)	(256)	(687)	(1,062)	(1,566)
2ND FARM PYMT.(60%):	0	0	0	0	0
INCOME TAXES (40%):	0	0	0	0	0
ANNUAL RET. EARNING:	(87)	(256)	(687)	(1,062)	(1,566)
EST. OPER. CAPITAL:	0	168	768	1,743	3,222
OPER. CAP'L REPAY:	0	0	168	768	1743
DEPRECIATION:	87	87	87	87	87
CUM. CASH BALANCE:	1	0	0	0	0
TOTAL TAX PAYMENTS:	0	0	0	0	0

Appendix table 1.7. Financial projections, improved mill, 10% tax

INCOME:	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Oil Sales:	671	1,677	4,191	7,859	13,098
Meal Sales:	61	154	570	1,069	1,782
Soap Stock:	1	2	4	7	12
Bag Sales:	5	6	8	10	12
Trading Income:	3	8	19	35	61
Gross Revenues:	740	1,845	4,792	8,980	14,965
Cost of Goods Sold:	275	750	1,875	3,516	6,104
Sales Tax (10%):	61	152	381	714	1,191
Marketing Costs:	22	55	183	300	500
Gross Margin:	380	882	2,338	4,422	7,122
VARIABLE COST (MUSh):					
Oil Packaging:	152	381	952	1,786	2,976
Meal Packaging:	10	24	61	114	190
Transport:	19	47	118	221	368
Fuel:	0	0	0	0	0
Electricity:	0	0	0	0	0
Water:	0	0	0	0	0
Maintenance Mat'ls:	10	24	60	113	188
Maintenance Labor:	4	9	23	44	73
Chemicals:	2	6	15	29	48
Labor:	3	9	22	41	68
Miscellaneous:	20	50	125	235	391
	220	551	1,376	2,581	4,301
FIXED COSTS (MUSh):					
Building Depr.:	2	2	2	2	2
Storage Depr.:	3	3	3	3	3
Vehicles Depr.:	22	22	22	22	22
Office Equip. Depr.:	2	2	2	2	2
Capital Equip Depr.:	58	58	58	58	58
Dev't Fund Contrib.:	0	100	550	900	1,050
Management Costs:	4	9	23	44	71
Admin supplies:	15	19	24	30	37
Admin S+B:	9	12	14	18	22
	115	226	699	1,079	1,268
INTEREST COST (MUSh):					
Crop Finance:	39	105	263	492	854
Operating Finance:	0	0	0	0	0
	39	105	263	492	854
GROSS MARGIN:	380	882	2,338	4,422	7,122
TOTAL OPER. COST:	374	882	2,337	4,152	6,424
PRE-TAX EARNINGS:	6	0	1	270	699
2ND FARM PYMT.(60%):	4	0	0	162	419
INCOME TAXES (40%):	1	0	0	43	112
ANNUAL RET. EARNING:	2	0	0	65	168
EST. OPER. CAPITAL:	0	0	0	0	0
OPER. CAP'L REPAY:	0	0	0	0	0
DEPRECIATION:	87	87	87	87	87
CUM. CASH BALANCE:	89	176	263	415	670
TOTAL TAX PAYMENTS:	62	152	381	758	1,303

Appendix table 1.8. Financial projections, unimproved, 30% tax.

INCOME:	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Oil Sales:	579	1,331	1,663	2,079	2,599
Meal Sales:	46	107	133	167	208
Soap Stock:	5	11	13	17	21
Bag Sales:	5	6	8	10	12
Trading Income:	3	7	9	11	14
Gross Revenues:	637	1,461	1,827	2,283	2,855
Cost of Goods Sold:	275	690	863	1,078	1,404
Sales Tax (30%):	134	307	384	480	600
Marketing Costs:	19	43	54	67	84
Gross Margin:	208	416	519	649	756
VARIABLE COST (MUSh):					
Oil Packaging:	131	302	378	472	590
Meal Packaging:	15	36	44	56	69
Transport:	19	43	54	68	85
Fuel:	57	131	163	204	255
Electricity:	4	9	11	13	17
Water:	0	0	0	0	0
Maintenance Mat'ls:	7	16	20	25	31
Maintenance Labor:	0	0	0	0	0
Chemicals:	3	8	10	12	15
Labor:	4	9	11	13	17
Miscellaneous:	24	55	69	86	108
	264	608	760	950	1,187
FIXED COSTS (MUSh):					
Building Depr.:	2	2	2	2	2
Storage Depr.:	3	3	3	3	3
Vehicles Depr.:	22	22	22	22	22
Office Equip. Depr.:	2	2	2	2	2
Capital Equip Depr.:	15	15	15	15	15
Dev't Fund Contrib.:	0	0	0	0	0
Management Costs:	0	0	0	0	0
Admin supplies:	15	19	24	30	37
Admin S+B:	9	12	14	18	22
	68	74	82	91	103
INTEREST COST (MUSh):					
Crop Finance:	39	97	121	151	197
Operating Finance:	19	74	152	257	411
	58	171	272	408	608
GROSS MARGIN:	208	416	519	649	756
TOTAL OPER. COST:	390	853	1,114	1,449	1,898
PRE-TAX EARNINGS:	(183)	(438)	(595)	(800)	(1,143)
2ND FARM PYMT.(60%):	0	0	0	0	0
INCOME TAXES (40%):	0	0	0	0	0
ANNUAL RET. EARNING:	(183)	(438)	(595)	(800)	(1,143)
EST. OPER. CAPITAL:	139	532	1,083	1,839	2,938
OPER. CAP'L REPAY:	0	139	532	1083	1839
DEPRECIATION:	44	44	44	44	44
CUM. CASH BALANCE:	0	(0)	0	(0)	0
TOTAL TAX PAYMENTS:	0	0	0	0	0

Appendix table 1.9. Financial projections, unimproved, 10% tax.

INCOME:	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Oil Sales:	579	1,331	1,663	2,079	2,599
Meal Sales:	46	107	133	167	208
Soap Stock:	5	11	13	17	21
Bag Sales:	5	6	8	10	12
Trading Income:	3	7	9	11	14
Gross Revenues:	637	1,461	1,827	2,283	2,855
Cost of Goods Sold:	275	690	863	1,078	1,404
Sales Tax (10%):	53	121	151	189	236
Marketing Costs:	19	43	54	67	84
Gross Margin:	289	602	752	940	1,119
VARIABLE COST (MUSh):					
Oil Packaging:	131	302	378	472	590
Meal Packaging:	15	36	44	56	69
Transport:	19	43	54	68	85
Fuel:	57	131	163	204	255
Electricity:	4	9	11	13	17
Water:	0	0	0	0	0
Maintenance Mat'ls:	7	16	20	25	31
Maintenance Labor:	0	0	0	0	0
Chemicals:	3	8	10	12	15
Labor:	4	9	11	13	17
Miscellaneous:	24	55	69	86	108
	264	608	760	950	1,187
FIXED COSTS (MUSh):					
Building Depr.:	2	2	2	2	2
Storage Depr.:	3	3	3	3	3
Vehicles Depr.:	22	22	22	22	22
Office Equip. Depr.:	2	2	2	2	2
Capital Equip Depr.:	15	15	15	15	15
Dev't Fund Contrib.:	0	0	0	0	0
Management Costs:	0	0	0	0	0
Admin supplies:	15	19	24	30	37
Admin S+B:	9	12	14	18	22
	68	74	82	91	103
INTEREST COST (MUSh):					
Crop Finance:	39	97	121	151	197
Operating Finance:	6	29	61	104	174
	45	125	181	255	371
GROSS MARGIN:	289	602	752	940	1,119
TOTAL OPER. COST:	377	808	1,023	1,296	1,661
PRE-TAX EARNINGS:	(88)	(206)	(271)	(356)	(542)
2ND FARM PYMT.(60%):	0	0	0	0	0
INCOME TAXES (40%):	0	0	0	0	0
ANNUAL RET. EARNING:	(88)	(206)	(271)	(356)	(542)
EST. OPER. CAPITAL:	44	206	433	746	1,244
OPER. CAP'L REPAY:	0	44	206	433	746
DEPRECIATION:	44	44	44	44	44
CUM. CASH BALANCE:	(0)	(0)	(0)	0	0
TOTAL TAX PAYMENTS:	0	0	0	0	0

Appendix table 1.10. Financial projs, improved, cotton, 10% tax.

INCOME:	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Oil Sales:	372	929	2,322	4,354	7,257
Meal Sales:	52	131	327	614	1,023
Soap Stock:	0	1	2	4	6
Bag Sales:	5	6	8	10	12
Trading Income:	1	3	7	13	22
Gross Revenues:	430	1,070	2,666	4,994	8,320
Cost of Goods Sold:	113	281	703	1,318	2,197
Sales Tax (10%):	34	84	211	396	660
Marketing Costs:	13	32	102	167	279
Gross Margin:	270	670	1,644	3,102	5,166
VARIABLE COST (MUSh):					
Oil Packaging:	84	211	528	989	1,649
Meal Packaging:	8	21	52	97	162
Transport:	33	82	206	386	644
Fuel:	0	0	0	0	0
Electricity:	0	0	0	0	0
Water:	0	0	0	0	0
Maintenance Mat'ls:	10	24	60	113	188
Maintenance Labor:	4	9	23	44	73
Chemicals:	2	6	15	29	48
Labor:	3	9	22	41	68
Miscellaneous:	14	36	91	170	283
	159	399	997	1,869	3,114
FIXED COSTS (MUSh):					
Building Depr.:	2	2	2	2	2
Storage Depr.:	3	3	3	3	3
Vehicles Depr.:	22	22	22	22	22
Office Equip. Depr.:	2	2	2	2	2
Capital Equip Depr.:	58	58	58	58	58
Dev't Fund Contrib.:	0	100	550	900	1,050
Management Costs:	3	7	16	31	52
Admin supplies:	15	19	24	30	37
Admin S+B:	9	12	14	18	22
	114	224	692	1,066	1,248
INTEREST COST (MUSh):					
Crop Finance:	16	39	98	185	308
Operating Finance:	0	0	0	0	0
	16	39	98	185	308
GROSS MARGIN:	270	670	1,644	3,102	5,166
TOTAL OPER. COST:	289	662	1,787	3,119	4,670
PRE-TAX EARNINGS:	(19)	8	(143)	(17)	496
2ND FARM PYMT.(60%):	0	0	0	0	0
INCOME TAXES (40%):	0	3	0	0	198
ANNUAL RET. EARNING:	(19)	5	(143)	(17)	298
EST. OPER. CAPITAL:	0	0	0	0	0
OPER. CAP'L REPAY:	0	0	0	0	0
DEPRECIATION:	87	87	87	87	87
CUM. CASH BALANCE:	68	160	105	175	560
TOTAL TAX PAYMENTS:	34	87	211	396	858
TOTAL FARM PAYMENTS:					

APPENDIX 2. ASSUMPTIONS ON OILSEED COLLECTION FROM FARMERS

CoopOIL obtains crushing stock from farmers near the mill. Oilseeds are new crops and will displace other crops plus bring more land into production. Appendix table 2.1 estimates available cropland surrounding Jinja for zones with radius of 20, 35, 45 and 55 kilometers and suggests what share of cropland planted to oilseeds and sales by farmers are necessary to supply CoopOIL. To obtain 2,500 mt. of oilseed requires CoopOIL collect from farmers to 35 kilometers. Collections come from 55 kilometers in year 5.

Appendix table 2.1. Oilseed receipts for CoopOIL at Jinja.

YEAR 1	ZONE 1		ZONE 2		ZONE 3		ZONE 4	
	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount
RADIUS FROM MILL, KM.		20		35		45		55
Area, hectares		125664		259181		376991		573341
Less non-cropland, ha.	15%	18850	15%	38877	30%	113097	30%	172002
Available cropland, ha.		106814		220304		263894		401338
AREA CROPPED	Percent	ha.	Percent	Her.	Percent	Her.	Percent	Her.
Cropped area	15%	16022	15%	33046	15%	39584	15%	60201
Of cropped area:								
In cottonseed	8.0%	1282	8.0%	2644	8.0%	3167	8.0%	4816
In sunflower	2.0%	320	2.0%	661	2.0%	792	2.0%	1204
In groundnuts	1.0%	160	1.0%	330	1.0%	396	1.0%	602
In soybeans	0.5%	80	0.5%	165	0.5%	198	0.5%	301
Total	11.5%	1843	11.5%	3800	11.5%	4552.17	11.5%	6923
YIELD & PRODUCTION	Kilo/her.	Mt.	Kilo/her.	Mt.	Kilo/her.	Mt.	Kilo/her.	Mt.
Cottonseed, 1 crop	250	641	250	1322	250	1583	250	2408
Sunflower, 2 crops	750	481	1000	1322	1000	1583	1000	2408
Groundnuts,2 crops	500	160	500	330	500	396	500	602
Soybeans, 2 crops	1000	160	1500	496	1500	594	1500	903
Total metric tons		1442		3470		4156		6321
SALES TO MILL	Percent	Mt.	Percent	Mt.	Percent	Mt.	Percent	Mt.
Cottonseed	50%	320	50%	661	35%	554	25%	602
Sunflower	50%	240	60%	793	35%	554	30%	722
Groundnuts	15%	24	20%	66	5%	20	5%	30
Soybeans	70%	112	60%	297	35%	208	30%	271
Receipts at mill		697		1818		1336		1625
CUM. RECEIPTS ALL ZONES YEAR 1		697		2514		3850		5476

YEAR 2	ZONE 1		ZONE 2		ZONE 3		ZONE 4	
	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount
RADIUS FROM MILL, KM.		20		35		45		55
Area, hectares		125664		259181		376991		573341
Less non cropland, her.	15%	18850	15%	38877	30%	113097	30%	172002
Available cropland, her.		106814		220304		263894		401338
AREA CROPPED	Percent	Her.	Percent	Her.	Percent	Her.	Percent	Her.
Cropped area	16%	17090	16%	35249	16%	42223	16%	64214
Of cropped area:								
In cottonseed	9.0%	1538	9.0%	3172	9.0%	3800	9.0%	5779
In sunflower	4.0%	684	4.0%	1410	4.0%	1689	4.0%	2569
In groundnuts	1.5%	256	1.5%	529	1.5%	633	1.5%	963
In soybeans	1.0%	171	1.0%	352	1.0%	422	1.0%	642
Total	15.5%	2649	15.5%	5464	15.5%	6545	15.5%	9953
YIELD & PRODUCTION	Kilo/her.	Mt.	Kilo/her.	Mt.	Kilo/her.	Mt.	Kilo/her.	Mt.
Cottonseed, 1 crop	250	769	250	1586	250	1900	250	2890
Sunflower, 2 crops	750	1025	1000	2820	1000	3378	1000	5137
Groundnuts,2 crops	500	256	500	529	500	633	500	963
Soybeans, 2 crops	1000	342	1500	1057	1500	1267	1500	1926
Total metric tons		2393		5992		7178		10916
SALES TO MILL	Percent	Mt.	Percent	Mt.	Percent	Mt.	Percent	Mt.
Cottonseed	50%	385	50%	793	35%	665	25%	722
Sunflower	60%	615	70%	1974	40%	1351	35%	1798
Groundnuts	15%	38	20%	106	5%	[illegible]	5%	48
Soybeans	60%	205	70%	740	40%	507	35%	674
Receipts at mill		1243		3613		2554		3243
CUM. RECEIPTS ALL ZONES YEAR 2		1243		4856		7411		10654

YEARS 3 TO 5	ZONE 1		ZONE 2		ZONE 3		ZONE 4	
	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount
RADIUS FROM MILL, KM.		20		35		45		55
Area, hectares		125664		259181		376991		573341
Less non cropland, her.	15%	18850	15%	38877	30%	113097	30%	172002
Available cropland, her.		106814		220304		263894		401338
AREA CROPPED	Percent	Her.	Percent	Her.	Percent	Her.	Percent	Her.
Cropped area	17%	18158	17%	37452	17%	44862	17%	68228
Of cropped area:								
In cottonseed	10.0%	1816	10.0%	3745	10.0%	4486	10.0%	6823
In sunflower	8.0%	1453	8.0%	2996	8.0%	3589	8.0%	5458
In groundnuts	2.0%	363	2.0%	749	2.0%	897	2.0%	1365
In soybeans	2.0%	363	2.0%	749	2.0%	897	2.0%	1365
Total	22.0%	3995	22.0%	8239	22.0%	9870	22.0%	15010
YIELD & PRODUCTION	Kilo/her.	Mt.	Kilo/her.	Mt.	Kilo/her.	Mt.	Kilo/her.	Mt.
Cottonseed, 1 crop	250	908	250	1873	250	2243	250	3411
Sunflower, 2 crops	750	2179	1000	5992	1000	7178	1000	10916
Groundnuts,2 crops	500	363	500	749	500	897	500	1365
Soybeans, 2 crops	1000	726	1500	2247	1500	2692	1500	4094
Total metric tons		4176		10861		13010		19786
SALES TO MILL	Percent	Mt.	Percent	Mt.	Percent	Mt.	Percent	Mt.
Cottonseed	50%	454	50%	936	35%	785	25%	853
Sunflower	65%	1416	75%	4494	45%	3230	40%	4367
Groundnuts	15%	54	20%	150	5%	45	5%	68
Soybeans	65%	472	75%	1685	45%	1211	40%	1637
Receipts at mill		2397		7264		5271		6925
CUM. RECEIPTS ALL ZONES YEAR 3+		2397		9663		14934		21859

APPENDIX 3. TECHNICAL COMPONENTS OF OILSEEDS AND PROCESSING

The following paragraphs familiarize the reader with definitions, terms and equipment used by the vegetable oil industry.

All vegetable oils fall into the basic category of "fats, oils, and waxes". These products are generally differentiated by traders and millers by melting point of the product. Melting point is related to the number of carbon atoms in the molecule. Oil chemists will take strong exception to these loose definitions as not being technically correct in many instances. "Edible" is used here to mean all vegetable oils, fats, and waxes that can be consumed by humans.

TYPES OF VEGETABLE OILS, FATS AND WAXES

In general all vegetable oils are a mixture of fatty acids of various lengths, typically 11 - 22 carbon atoms. They are a series of chained, complex hydrocarbons, generally called "glycerides" in reference to the carbonyl radical, "(R-COOH)" always present. Thus oils are often referred to as mono-, di-, and tri-glycerides, which relate to the number of glyceride molecules. "Saturated", "unsaturated" and "polyunsaturated" oils refer to the number of carbon atoms attached to the carbonyl radical. Tri-glycerides, for instance, have three carbon atoms attached resulting in saturation.

One characteristic of saturation vs unsaturation is a direct relationship to stability. A saturated oil is not very reactive with other elements, e.g. oxygen, and is called stable. A polyunsaturated oil may be quite reactive (unstable) and join with oxygen readily. This reaction tends to break down oil and form free fatty acids, causing oil to become rancid (spoil). Sunflower is a polyunsaturated oil.

Many oils produced are edible and used in cooking and baking. Non-edible uses are for lubricants, special solvents like turpentine, cosmetics, ointments, paints, explosives, non-fossil fuels, etc.

Most vegetable oils are easily converted to soaps by adding concentrated caustic soda. Conversion is limited by the quantity of the unsaponifiables in the oil. Vegetable oils were the most common ingredient in the early soap making. Today edible oil prices are too high for use in soap.

EXPELLER OIL CAKE AND MEAL

Oilseed cake is the residual solids after oil extraction. After grinding it is called meal and is a valuable byproduct. Because its major use is animal feed, the principal criteria determining value is protein level. Previous Ugandan studies overlooked meal as a source of oil mill revenue. Soybean meal, for example, is a major source of protein in most animal feeds. It is also used for edible purposes in products such as soy milk, meat isolates, etc.

Globally, there is an oversupply of oil in relation to protein. Oil prices have remained constant since WWII while meal prices have increased. In the future oil may become the "by-product".

Vegetable oil meal values vary greatly depending on seed from which derived. But value is based upon protein content and availability, i.e. digestibility, which is affected by the extraction process. It is possible to make proteins totally undigestible during extraction. It is also possible to enhance the value of proteins. For example, cottonseeds contain toxins which must be inactivated during processing. Groundnuts also contain toxins which may cause illness and even death to some animals. Soybeans contain trypsin inhibitors which effect dietary process and may contribute to malnutrition. In fact, most legumes such as beans, peas, and groundnuts, contain these inhibitors. Meals can carry diseases (anthrax, hoof and mouth) which may have catastrophic results. These factors can be controlled by proper processing techniques.

Early in the 1900's, surplus meals were used as fertilizers in the U.S. Lower priced synthetic fertilizers have replaced meals as fertilizers. In Uganda synthetic fertilizer is expensive and usually unavailable because of foreign exchange restraints. Meal prices are expected to be low in the short-term because of high transport costs to export. Meal may be useful here as fertilizer.

Each oil mill should regularly check incoming oilseeds and outgoing products for quality. Tests by the wet method are inexpensive and measure oil content, FFA, moisture content of the oil and meal, hull content, ash content, etc.

THE BAUER DISC HULLER

Hullers and decorticators are of two types, bar and disc. The bar huller is best for dehulling groundnuts and sunflower seeds. It is not effective on cottonseed due to the presence of lint which prevents the Bar from striking the hull.

This device consists of parallel hard metal toothed and serrated discs. Seed enters the unit from a feeder which distributes seed uniformly into the huller. The huller disc is manually adjusted to control the amount of hull shattering and adjust for seed size. Shattered hulls are passed from the disc mill to the hull-meats separation system.

HULL AND MEATS SEPARATION SYSTEM

This system consists of three distinct operations: screening, aspiration and final meat separation in a hull beater. As incoming seeds and hulls enter the system they pass onto a vibrating screen. Air is pulled up through the mixed mass and lifts lighter hulls (and lint in the case of cotton) away from the meat. Hulls then pass through a rotary screen removing fine meat particles. Hull separation is about 98% effective. In Uganda as much as 30% of meats are lost with hulls and many hulls are left in meats. Oil recovery is reduced and meal is of lower quality.

ROLLER MILL

The roller mill is used to flake separated meats to about 0.4 mm in thickness. This procedure ruptures oil cells and increases surface area so efficient and uniform cooking takes place.

THE COOKER

The cooker was developed as a result of the Cottonseed Processor's Association of America request to manufacture a device to deactivate gossypol in cottonseed oil and meal. The gossypol is contained in sacs distributed through the meat. Their presence are known to cause high mortality in poultry and illness in swine. Evidence exists that gossypol enters into the human food chain and can cause illness, particularly in children.

The cooking process has additional benefits such deactivation of lipase (producers of Trypsin toxins), as well as other harmful enzymes. It destroys Salmonellae and most fungi including aspergillus flavus (aflatoxin producers). It does not deactivate existing aflatoxins. The resulting meal is sterile.
Cooking can double oil yields and reduce refining losses by 90 percent.

RECOMMENDED PROCESSING FOR SUNFLOWER, COTTON, SIMSIM, GROUNDNUT, PALM KERNEL

Receiving

Dry, clean, un-decorticated seed is received, weighed and tested for insect infestation and moisture content. High moisture content seed is either rejected or processed immediately. Accepted seed is either moved into storage areas for fumigation or directly into processing.

Decortication

Seed moves to the decorticator where it is impacted with a bar striking the seed (bar huller) or the seed passes between a pair of serrated discs (disc huller). The discs move together manually to adjust for different seed sizes. Broken seed passes over a vibrating table with several screens, two to three tables. Air is pulled through the screen tables (aspiration) separating hulls from seed material by density. Decortication and hull aspiration is about 98% effective in removing hulls from meats when huller beater (secondary separation of meats from the hull) is employed. If a hull beater is not used they may contain up to 3 - 4% oil. Hulls are often used as boiler fuel or discarded.

Pretreatment and Cooking

Decorticated seeds pass through flaking rolls to increase surface area and crush oil cells. Prior to rolling moisture is normally added to about 10%.

Flaked meats are transported to a cooker where moisture is elevated to 12 - 14%. Meats temperature is maintained at about 98 degrees C. and the residence time at 20 - 30 minutes. After cooking meats pass through a series of heated tray's to dry to 2.0 - 3.0% moisture. Temperature is held at 120 - 130 degrees C.

Expelling

Prepared meats pass into the expeller and require little attention by the operator.

Oil flows to a settling tank where oily solids from the expeller are removed from the oil. These solids are returned to the feed stream to the expellers.

The oil is then filtered to remove any fine particles. Filtered oil is called crude oil, it is sterile and of high quality. Many people prefer crude oil because of its characteristic flavor.

The expeller cake emerges in the form of chips about 6 mm thick, 30 mm wide and 60mm long. Cake is cooled and stored. It is usually ground prior to shipment. Bulk density of the cake is about 60% that of meal.

Oil Refining

All filtered crude oil should be degummed. Dilute phosphoric acid is mixed with the oil and filtered again to remove gums (phospholipids or lecithin).

Degummed oil is heated to about 100 degrees C. and dilute caustic soda is added in direct proportion to the FFA content. Excessive caustic soda will reduce oil yields and increase low value soapstocks. The FFA content is normally 1 - 2%.

The above is a single refining. Double refining is not required for processed oil from cooked seed. The neutralized oil is dried to 0.01% moisture.

Bleaching

Neutralized dried oil is bleached by addition of activated carbon and diatomaceous earths. Color bodies are absorbed by the carbon and earth at about 140 degrees C. Oil is filtered to remove carbon and earth.

Deodorizing

Each oil has its own characteristic aroma. This aroma is soluble in certain low boiling point oils. These oils are removed in a special retort under vacuum and high temperatures (200 - 350 degrees C.). The fully refined oil is stored and packaged.

PRE-TREATMENT OF SOYBEANS PRIOR TO EXPELLING

Proper pre-treatment of soybeans is essential for high efficiency expeller operations and production of quality oil and meal. The following describes proper pre-treatment.

Receiving

Dry, clean, un-decorticated seed is received, weighed and tested for insect infestation and moisture content. High moisture content seed is either rejected or processed immediately. Accepted seed is either moved to storage areas for fumigation or directly to processing.

Milling

Soybeans are coarsely milled to reduce particle size, 90 percent on USS screens 20 - 60. Milling breaks down some oil-bearing cells and increases surface area for later heat treatment.

Heat-treatment

Because of anti-nutritive elements (trypsin inhibitors) present in soybeans, the seed and/or meal must be heat-treated to 115 - 135 degrees C. Heat treatment can take place over an extended period naturally in the expeller cage, but this often imparts a scorched flavor to meal.

Alternatively, coarse fresh meal can be extrusion heated to further breakdown oil-bearing cells before expelling. Meal is fed into an extrusion cooker and hot extruded material is then passed directly to a standard expeller.

PROCESS LOSSES AND YIELDS

The amount of oil produced by a given crop depends on the initial oil content of the seed and production losses during processing. Appendix table 3.1 lists initial oil content for a variety of oil seeds and likely production losses during processing.

From a processing standpoint fewer kilograms of sunflower (improved), simsim, and palm kernel have to be processed to make one kilogram of oil than any of the others. Roughly 2.4 kg. of simsim or palm kernels and 3.3 kg. of improved sunflower will make one kg. of oil. Over nine kilograms of cotton, local sunflower, soybean and palm fruit must be processed to make a kilogram of oil.

Appendix table 3.1. Processing losses and Yields

Oilseed	Decortication Losses 1/	Seed Cake Prod. 1/	Expell. Losses 1/	Filter Losses 1/	Neutralization Losses 1/	Lab Oil Content 2/	Extractable Yield 3/
Sunflower(4)	40.0	40.0	6.0	2.0	1.0	20.0%	11.0%
Sunflower(5)	25.0	35.0	6.0	2.0	1.0	40.0%	31.0%
Cotton	40.0	40.0	8.0	1.0	2.0	20.0%	9.0%
Simsim	0.0	50.0	6.0	1.0	1.0	50.0%	42.0%
G-nut	30.0	38.5	6.0	1.0	1.0	31.5%	23.5%
Soybean	0.0	80.0	6.0	1.0	2.0	20.0%	11.0%
Palm Fruit(6)	45.0	40.0	6.0	1.0	2.0	11.0%	6.0%
Palm Fruit(7)	45.0	33.0	4.0	1.0	2.0	22.0%	15.0%
Palm Kernel	30.0	20.0	6.0	1.0	2.0	50.0%	41.0%

1/ Kg. per 100 kg. of seed input.
2/ Solvent extraction, kg. of oil per kg. of seed input.
3/ Expeller extraction, kg. seed per kg. seed input.
4/ Unimproved sunflower varieties.
5/ Improved sunflower varieties.
6/ Dura palm variety.
7/ Tenera palm variety.

APPENDIX 4. TECHNICAL DESCRIPTION OF SELECTED MILLS

Following are brief descriptions of oil mills visited by the team. Additional descriptions are in Enger and Ahimbisibwe.

EOSIL MILLS

Four EOSIL oil mills were carefully examined for possible rehabilitation. A brief description follows:

New Alliance Oil Mill and Soap Works

Two oil mills are located in Mbale on adjacent properties. The wall between the properties is torn down and separation of some assets is difficult. The New Alliance mill has 5 expellers in good condition. The maximum potential production (MPP) of the expellers is about 7,500 mt. per year. LMB rated plant capacity at 6,000 mt. (250 days operation). LMB also reported the oil mill produced 972 mt. of oil and 4,500 mt. of meal from 5,472 mt. of seed. The plant operated late in 1990 and crushed 51 mt of whole cottonseed from October to December producing 5.3 mt. of oil and 2.3 mt. of soapstock from that oil. This suggests a processing rate of 1 mt. of seed input per day.

New Budaka Oil Mill (Adjacent to Mbale Edible Oil and Soap Factory)

This plant has not operated since 1983. Nevertheless, of the 9 expellers in this mill, five are in surprisingly good condition for their age, vintage 1950's. They were well maintained, but missing motors and starters. Remaining equipment is inadequate and in various stages of disrepair.

Perry estimates expellers each have a capacity of 1500 mt. per year or 13,500 mt. for the plant based on cottonseed. The team agrees with Enger that expellers could be rehabilitated in a few weeks. However, overall plant rehabilitation will take several months and a sizeable investment. All pre-processing equipment is useless. Only one of five boilers is usable at present and it requires a major overhaul. The plant cannot effectively dehull any oilseed nor can it cook or dry in a reasonable manner. Therefore, maximum yields will be limited to extracting about 100 kg. of oil in cottonseed that contains 220 kg. per ton or a 45% extraction rate.

Neither Mbale plant has operated continuously for some time.

A batch chemical refinery, installed in 1965, has not been operated since 1975. The critical machinery requires major renovation.

Land value is estimated at 20\- million according to the manager.

There is a spare parts inventory systematically stored. The book value of these spare parts could not be determined.

Surrounding farm land is reported to be capable of growing crops needed to support an oil mill. But if rehabilitated it would compete with the new cooperative mill at Tororo. An adequate quantity of seed may not be available for some time to support two

or three mills in such near proximity. Since the Tororo mill is new with cookers, the EOSIL plants could not be competitive.

Iganga Industries

This mill, located in Jinja, has 8 expellers, 5 in operating condition. The LMB listed MPP is 12,000 mt. of seed per year of cottonseed. This rating is far too aggressive based upon present conditions. This mill was operating on cottonseed and several samples of oilseed cake were examined. The cake appeared to be about 10.5% residual oil, normal for operations of this type without cooking.

All preparation equipment, refining equipment, and soap making equipment are inoperable. The plant does not have adequate spares to maintain expellers even though EOSIL has some in Mbale. The boiler is too small. An old railroad steam engine boiler, in various stages of installation for several years but never completed, is large enough but inoperable.

This plant could be rehabilitated at reasonable cost. It is well located near good seed production areas, product markets, rail and truck transport facilities. One drawback is the EMCO mill nearby.

This mill was crushing soybeans supplied by a nearby feed mill. The toll crushing arrangement let the crusher keep 40% of the oil. This, unfortunately, cannot be a cost effective arrangement for the oil mill because they cannot possible achieve a reasonable extraction yield (i.e.less than 10% residual oil in the cake) even with multiple passes through the expellers.[4] We observed cottonseed decortication and found this equipment inadequate.

East African Oil Mills (Kawempe, KDampala)

The expellers were in good condition although 4 machines were not in operation due to lack of spares. They have two boilers, one operating with maximum steam pressure of 60 psi. We observed decortication of cottonseed and found this equipment inadequate.

OTHER UGANDA OIL MILLS

Nyakesi Oil Mill and Soap Works, a Cooperative in Tororo

This oil mil is new, commissioned in 1988. Equipment was built by SKED East Germany, once a division of H.E.B., Hamburg, Germany. Rated MPP is 30 mt. per day or 10,000 mt. per year whole seed based on sunflower. This plant incorporates the latest in cooking technology and a new batch chemical refinery. Unfortunately no decorticating or hull separation equipment was installed. Even so this mill has produced meals with residual oils of 5.5%. Due to high fiber in the cake they reported difficulty selling sunflower cake at 30\- per kg.

---

[4] It is easy to extract oil from soybeans to 5 - 7% R.O. even with poor maintenance on expellers. It is only necessary to dry beans to 3.0% moisture but the equipment is not capable of even warming the beans to above 80 degrees C.

The mill has a diesel fired boiler. While extraction efficiency is relatively high by local standards, operating costs are higher than other mills using waste hulls for fuel.

Technical assistance should be considered to help this mill install decortication and separation equipment. With decortication equipment this mill could produce 3,562 mt. of sunflower oil, similar quantities of meal and 35 mt. of soapstock.

EMCO Oil Mill, Jinja

The EMCO oil mill has a MPP of 60,000 TPY whole cottonseed. This mill is equipped with large waste heat boilers capable of power cogeneration. Power is currently supplied, free, from the sugar mill. It has cottonseed delinting equipment, decortication, aspiration, and hull beaters. It cannot cook.

The mill has not operated for many years and without major rehabilitation the mill is not economically viable. None the less, the mill could produce 10,000 mt. per year of oil with out cookers and 12,000 if cookers were installed.

The new plant manager told us the owners could not provide rehabilitation funding until 1992. There were reports, however, the owners have applied for funding to purchase a new plant.

Mukwano Oil Mill Kampalla

This is a new Anderson expeller mill capable of processing 100 mt. per day and MAPP of 30,000 mt. Decortication can remove 98% of hulls. The system has full cooking capacity. This plant can produce oilseed cake to about 3.5 - 5.0% residual oil content. Cake is cooled on stream and ground to meet world specifications. Also included is a batch chemical refinery, bottling line and plastic container production. This mill is Uganda's most modern.

APPENDIX 5. COMMERCIAL PALM OIL EXTRACTION

Extraction of oil from palm fruit is different from other oilseed extraction methods and is based on lipase activity and fruit characteristics. The general steps are summarized below.

Step 1. Fresh fruit bunches are immediately sterilized to: 1)prevent further rise in FFA by deactivation of lipolytic enzymes; 2-2)facilitate machine stripping; 3)precondition nuts to minimize kernel breakage during pressing and nut cracking; 4)prepare the fruit pericarp for further processing; and 5)denature proteins and hydrolyze the mucilages.

Sterilization is usually done in cages or baskets of 1 to 3.5 mt. capacity. Filled cages are rolled into a container where steam is applied at 40 psi. The fresh fruit bunches are "cooked" until the interior of the bunch is at least 100 degrees C, usually about 60 minutes. Most oil mills in Malaysia now use a multiple peak sterilization process, consisting of three cycles. In the first stage, the pressure is elevated to 30 psi and the sterilizer is exhausted to atmospheric pressure. This is repeated three times. During each cycle the pressure is elevated 5 psi and held about 40 minutes. The process requires about 1.75 hours.

Step 2. Stripping. A specially designed rotating drum which removes fruits from the bunches in a continuous process.

Step 3. Digestion. After stripping fruit is 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 preferable 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. Incomplete digestion causes high oil losses.

Step 4. Oil extraction. The digested material is fed into a special screw expeller at about 100 degrees centigrade where oil is expelled.

Step 5. Clarification and purification of the crude palm oil. After extraction crude oil will normally contain about 66% oil, 24% water and 10% solids. Three phase centrifuges are used to separate these fractions. This oil is winterized and filtered. The refining procedures are similar to other oils.

The red color in palm oil is mainly due to carotenoid. These color bodies are removed during refining. "Red set" due to mishandling during harvest, extraction or other operations can make it impossible to bleach.

Generally solid wastes are burned in the boiler although many feed trials have been performed. As an animal feed palm oil meal has very limited value. Below is a typical analysis of the solids.

Appendix table 5.1 Proximate analysis of palm oil solids.

Item	Percent	Item	Percent or ppm
Moisture	5 - 15	Nitrogen	1.8 - 2.3
Ash	15 - 22	Phosphate	0.3 - 0.4
Silica	7 - 10	Potassium	2.5 - 3.3
Ether Extract	11 - 13	Magnesium	0.6 - 0.8
Crude Fibre	11 - 14	Calcium	0.55-0.85
Crude Protein	11 - 13	Boron	20. ppm
Crude Cellulose	20	Copper	20. - 50. ppm
NFE	28	Iron	3000. - 5,000. ppm
Gross Energy	4400 kcal/kg.	Manganese	50. - 70. ppm
		Zinc	20. - 100. ppm

Source: Jorgensen and Singh.

Appendix table 5.2 Proximate analysis of crude palm oil.

	Possible	Low	Normal
Monoglycerides		< 1%	5.5%
Diglycerides	5.66%	> 5 - 8%	>9.0%
Triglycerides	6.6%		38.1%
Unsaponifiable fraction	0.5%	1.2%	

Source: Jorgensen and Sing.

APPENDIX 6. UGANDA SEEDS

To streamline production and distribution of improved seed for planting, GOU rehabilitated Uganda Seeds, located at Kawanda Research Station. Recommended varieties are sent to Uganda Seeds farms in Masindi for multiplication and distribution to producers. Uganda Seeds farm is 1 kilometer from Masindi on Masindi-Hoima road next to the head office for Bunyoro Growers Cooperative Union.

Uganda seeds is currently multiplying, dressing and distributing groundnuts, soybeans and sunflower. The varieties multiplied in 1990 are shown in appendix table 6.1.

Appendix table 6.1. Seed varieties produced by Uganda Seeds, 1990.

Seed	Variety	Production
		Metric tons
Groundnuts	Red Beauty	150
Sunflower	Sunfola Namulonge	50
Soybeans	Namulonge 140	50
Maize	Kawanda Composite	400
Sorghum		10
Simsim	Disappeared	0
Cotton	Trials at Isimba	0

Source: Uganda Seeds, Masindi.

Total production in 1990 was 660 mt. Demand for Red Beauty from cooperatives exceeded production by 210 mt. Sudan has pressed for an order of 300 mt. of Kawanda Composite plus Uganda producers have ordered 100 mt. Demand for sunfola and Namulonge 140 fluctuates mainly because of fluctuations in market for farmer produced seed.

The demand for simsim is high especially for Red Cross and ACORD, varieties which disappeared in the east and north during the war.

Cotton seed varieties which shed leaves and are suitable for mechanization have already been tried at Isimba prison in Bwijanga sub-county. Cotton has been harvested with a reported good crop with this variety.

On the whole demand for improved seeds by farmers is low because Uganda Seed prices are higher than other sources. Uganda Seed prices are shown in appendix table 6.2.

Appendix table 6.2. Uganda Seeds prices, 1991.

Seed	Planting seed Wholesale	Planting seed Retail	Ordinary seed	Ratio Retail/Ordinary
	USh.	USh.	USh.	
Groundnuts	660	700	420	1.7
Soybeans	310	350	90	3.9
Sunflower	310	350	110	3.2
Simsim	460	500	350	1.4
Maize	260	300	50	6.0

Source: Uganda Seeds, Masindi.

Retail prices for improved planting seed were between 1.4 and 6 times higher than retail prices for ordinary seed. While farmers often complain seed prices are higher relative to market prices for their output, the price ratios are small compared to seed/ordinary prices in developed countries. In the U.S. for example, hybrid maize prices typically are priced at 30 times ordinary seed price. Also improved seed often has lower planting rates and improved yields. Ratio of planting rate of improved seeds to planting rate ranges from 8.3:1 for groundnuts to 76.9:1 for sunflower.

Appendix table 6.3. Planting rate, yields of improved seeds.

Seed	Planting rate	Expected yield	Ratio yield/planted
	Kg./ha.	Kg./ha.	
Groundnuts	90-150	1,250-1,500	8.3
Sunflower	7-13	1,000	76.9
Simsim	9	500	55.6
Maize	28	2,000	71.4
Soybeans	30	2,000	66.7

Source: Farmers interviews, Hoima, March 1991. Min. of Agriculture, Crop Production Pocket Book, Entebbe, Information and Visual Aids Centre, Dec. 1972.

Uganda Seeds contracts with 200 farmers who grow seed on its behalf. Seed is bought from them at agreed prices, cleaned, dressed, packed and sold. Farmers are organized in associations. Uganda Seeds has extension staff to ensure quality seed is produced.

APPENDIX 7. POTENTIAL FOR TOXIC PRODUCTS IN UGANDA OILSEEDS

There has been allusion to potential dangers of oilseeds as feed supplements for animals and edible food sources in various reports concerning oilseed production and oil extraction in Uganda. None attempt to describe or define these dangers, their source or control.

This section will cover those sources of danger as well control and/or elimination in non-professional terms easily understand.

All cereals and oilseeds are open to attack by bacteria, fungi and insects. Frequently these attacks activate certain enzymes which in turn produce dangerous toxins. Because most bacteria and insects are easily destroyed or inactivated during processing, they are not of much concern although improper processing can have potentially dangerous side effects. By far, the most dangerous attack is from a wide variety of fungi.

One of the most prevalent fungal attacks are those that produce Mycotoxins. These toxins are poisonous. The genera that produce these toxins are: Aspergillus, Fusarium, Penicillium, and Claviceps. The toxins are persistent and remain active long after the fungi have disappeared. There are a wide variety of toxins produced by the Mycotoxins. They may attack the blood and/or nerve systems. Many are also carcinogenic. There are at least 18 compounds in this group that occur in all commonly grown seeds and grains. One of the more common are the toxins produced by Aspergillus Flavus. It is called (Beta) Aflatoxin. These toxins are very carcinogenic. Reports suggest as little as 1 PPB (parts per billion) will cause tumors in fish, for example. Aspergillus fungi often spread in the field as part of the fungi, ground, plant, animal, fungi cycle.

The production level of toxin and propagation of most fungi are low. Because normal oilseed processing (seed cooking) detoxifies aflatoxin it is not a serious threat. The number of fungi present are kept below acceptable levels. But if activity levels are increased through mismanagement of storage, transport and processing, Aspergilli becomes a major concern due to potential spread to other grain and food crops where detoxification does not occur. It is in these steps that incubation and multiplication of fungi occur. Toxin production increases directly with time, temperature and moisture, the increase geometric in rate. Processes for detoxification and fungi deactivation at high levels of contamination do not exist. High moisture, plus 12%, is required for rapid propagation, so rotting seed is the perfect incubator.

Thus good storage management is a major factor in reducing spread of the fungi and resulting Mycotoxins. Field management is also of great value. If Uganda is to be a potential exporter of meals, control of these fungi are vital, in the field, in storage, in transportation and in the oilseed plant.

TRYPSIN INHIBITORS

Trypsin inhibitors are found in most legumes. They effect the digestion process in animals and poultry by blocking production of

trypsin in the small intestine. Trypsin is a primary component for the digestion of specific essential amino acids such as methionine, lysine etc. Thus an animal may actually suffer from malnutrition even though ingesting large volumes of feed.

Inhibitors are deactivated by a combination of time, temperature and moisture. For example a temperature of 100 C. at 12 -14% moisture for 15 - 30 minutes are sufficient. Typically for soybeans, (at 6-8% moisture) require temperatures between 118 to 125 C. Because soybeans need to be dried to about 3% moisture to effectively extract oil and produce 3-5% R.O. in cake, temperatures of 120 -125 C. are reached.

The inhibitors are deactivated. In processing of groundnuts, must be cooked at 12 -14% moisture for 20 -30 minutes, the inhibitors are also deactivated in this manner.

GOSSYPOL

Polyphenol Gossypol is an oil soluble toxin located in "sac's" in cottonseed meats. Gossypol is highly carcinogenic but it effects only monogastric animals apparently. Levels as low as 160 ppm have been known to be fatally toxic to young chickens and other poultry. Toxins of gossypol specially attack the liver.

The cooking process employed during extraction of cottonseed deactivates these toxins. Oil produced by cold processing (crude oil) is known to cause liver cancer in humans, poultry and swine. Fortunately double or triple refining of cottonseed oil produced probably reduce the gossypol activity because temperature of up to 140 C. are often reached. Although there is some evidence that this may not always be the case due to low moisture in the oil during refining. Locally produced cottonseed oil may be dangerous to humans because most oil is produced by the old process method.

CYANAMIDES AND OTHER HCN DERIVATIVES IN OILSEEDS

Many oilseeds contain HCN in proteins and oils. Various enzymes are capable of hydrolyzing the HCN to cyanide salts, ricin in castor beans being an example. Many seed crops such as mustards, rapeseeds, castor, certain peppers and cashew nuts are high in HCN. Fortunately roasting decomposes HCN. Cashew shell oil is, however, highly toxic and it is known to be fatal to humans.

Processing of castor beans produce volatilized ricin vapors. Because of the dilution in air they do not cause any reaction to humans except to those who are allergic or sensitive. In these relatively rare cases it may cause extreme discomfort and sometimes fatal reactions. Castor bean meal may be toxic to all animals.

While many oilseeds do contain HCN and other similar products, the normal cooking process during processing destroy or further hydrolyze these constituents, particularly where the level of HCN is low as in mustard and certain varieties of rapeseed (canola).

SALMONELLAE

By far the most prevalent of bacterial incursion in oilseeds and

grains are from Salmonellae family of bacteria. Generally these bacteria are not fatal but cause reduced weight gain in animals and in some cases may be fatal to brooder poultry, particularly infections from Salmonella Darby. Low grade infections in humans may cause diarrhea, muscle ache, headache and general discomfort. Some reports say most flu cases are in fact caused by Salmonella.

Because bacteria are air borne and may be carried by rodents, birds and insects the presence of this bacteria is a major concern. It may be the largest single cause of reduced weight gain efficiency ratios (amount of feed versus weight gain) especially in poultry.

Recontamination by poor housekeeping and unsanitary operations is by far the most prevalent cause of oilseed meal contamination. Prevention of recontamination is not hard, but it requires a knowledge that it can happen and then enforcement of good manufacturing practices. If good clean housekeeping is maintained, reduction of salmonella is assured. Probably most oilseed products produced in Uganda are infected, but this need not be the case.

Control of salmonella is not easy, but on the other hand salmonella cannot survive with out moisture and are easily destroyed by temperatures in excess of 34 C. Therefore, oilseed processing easily destroys the Salmonella bacteria. Thus all meals as produced are salmonella free but subject to recontamination.

For export of meals from Uganda post sterilization of meal should be considered. This may be a good practice at least initially until quality meal from Uganda is assured.

APPENDIX 8. TERMS OF REFERENCE

A. The consultant will work with Edible Oil Strategy - Cooperatives to accomplish the following tasks:

1. Identify both production and processing constraints in the edible oil industry.

2. Identify oil crops which can be produced and processed economically. Potential oil bearing crops and products to be considered include but are not limited to cottonseed, sunflower, groundnut, simsim, ghee, tallow, shea nut, soybean, palm and palm kernels. The analysis should include both comparative farm level economics based on both existing and likely future farming systems and processing economics based on existing capacities and required adjustments to national capacity.

3. Discuss the most suitable arrangements of producing seeds on a sustainable basis (e.g. large scale contract growing, individual small producers, estates, use of institutions like the NRA and Prisons, etc.) and identify suitable areas for growing the crops.

4. Recommend, if available, suitable technology for:
   a. multi-seed extraction
   b. small-scale producers of palm oil in Bundibugyo district
   c. shea nut production and processing
   d. cow ghee production and processing

5. Assess machinery and building rehabilitation needs of the three EOSIL oil mills and provide comments on other EOSIL assets.

6. Analyze financial and economic feasibility of the three EOSIL mills after rehabilitation.

7. Investigate suitable and viable partnership arrangements (in which UCA and the Unions are principal partners) in the ownership and management of the three mills currently under the LMB.

8. Examine the necessity and feasibility of setting up a centralized workshop and training center to cater to the needs of the entire industry.

B. More specifically the consultant will:

1. Act as team leader and coordinate the activities of the other three team members who will be: Russ Read - Agricultural Engineer/UCA, Josiah Ahimbisibwe - Agricultural Economist/Recon Ltd., Richard Perry - Edible Oil Processing Specialist

2. In consultation with UCA, develop a strategic plan for the rehabilitation and revival of the industry under UCA's guidance. This plan will cover the above mentioned topics as well as issues which the consultant has identified to be essential to the study.

3. Present the strategic plan in the form of a report, no less than 50 pages, no more than 100 pages. The format of the report will be agreed upon by the Team and presented to the Director of UCA Projects Department prior to the presentation of the interim report. A draft report will be submitted by the 24th of April. A final report will be submitted by the end of week five.

APPENDIX 9. TABLES

Appendix table 9.1: Installed annual seed crushing capacity.

Mill Name:	Crushing capacity: (kg/hr)	(TPY)
Private Mills:		
EMCO	4,600	33,120
Mukwano	2,500	18,000
OK Oil Mill	1,600	11,520
Supersonic	500	3,600
Mossewa	200	1,440
Jinja Amal. Co.	200	1,440
Akonykori Co.	200	1,440
Ngetta	100	720
Kigo Prison	40	288
	9,940	71,280
EOSIL Mills:		
New Budaka	1,700	12,240
Iganga Ind.	1,600	11,520
East Af. Oil	1,400	10,080
New Alliance	800	5,760
Arapi	800	5,760
Tororo	500	3,600
	6,800	48,960
Cooperative Mills:		
Nyakesi	1,250	9,000
Busembatia	1,200	8,640
Anguruma	200	1,440
Najja Co-op	150	1,080
	2,800	20,160
Church Mills:		
Ediofe	450	3,240
Kolping Ent.	200	1,440
Gulu Diocese	200	1,440
Kabale Diocese	200	1,440
Gulu Diocese	200	1,440
Kagondo	100	720
Amina Keta	70	504
Nkuruba	40	288
	1,460	10,512
Total:	21,000	150,912

Appendix table 9.2. Uganda consumption of oils and fats.

Item	HH expenditure Monthly	Annual	Avg.Ret. Price/kg	Consum. per HH	Persons per HH	Consum. /capita	Project to 1996	
	USh.	USh.	USh.	Kg.		Kg.	Mt.	Mt.2/
REFINED COOKING OIL								
Urban	560	6,720	723	9.297	4.501	2.066		
Rural	157	1,884	723	2.398	5.589	0.429		
Total	210	2,520	723	3.207	5.447	0.589	10,136	11,890
BUTTER AND GHEE 1/								
Urban	124	1488	2050	0.73	4.501	0.161		
Rural	123	1476	2050	0.72	5.589	0.129		
Total	123	1476	2050	0.72	5.447	0.132	2,275	2,669
HYDROGENATED OIL								
Urban	168	2016	1112	1.81	4.501	0.403		
Rural	57	684	1112	0.62	5.589	0.110		
Total	71	852	1112	0.77	5.447	0.141	2,421	2,840
MARGARINE								
Urban	65	780	1253	0.62	4.501	0.138		
Rural	6	72	1253	0.06	5.589	0.010		
Total	13	156	1253	0.12	5.447	0.023	393	462
OTHERS								
Urban	60	720	1500	0.48	4.501	0.107		
Rural	24	288	1500	0.19	5.589	0.034		
Total	28	336	1500	0.22	5.447	0.041	708	830
ALL PRODUCTS								
Total						0.926	15,934	18,691

Source: MPED, Household Budget Survey: MPED, Key Economic Indicators.
Population: Total 17,214,000, Urban 2,316,000, Rural 14,898,000.
1/ Price of 50% butter at 3,000\- and 50% ghee at 1,100\- per kg.

GLOSSARY OF TERMS

Frequently technicians tend to use "jargon" developed in various trades. This glossary is a list of many of those terms used in the vegetable oilseed industry, recognized throughout the world.

Aspiration	A method of passing air at a controlled rate and velocity to separate meats from hulls.
Cake	Solids as they discharge from an expeller or other types of presses, typically in the form of chips (3 x 4 x 10 mm.).
Conditioner	A vessel used to add additional heat to meats just prior to the expeller.
Cooker	A vessel used to elevate the seed temperature to 210 degrees F. (100 c.) and denature (hydrolyze) the protein fraction of the meats.
Crush, crushing	Extraction of oil.
Decorticating	Synonym of dehulling.
Dehulling	A method of cracking the seed pericarp (hull) employing a dehuller or decorticator.
Dryer	A vessel used to remove moisture from oilseed. Capable of elevating temperature of seed or meats to about 130 C.
Expeller	While the term expeller is frequently used in the generic sense as any machine mechanically that extracts oils by screw pressing, Expeller is a copyrighted name of Anderson International Co. (V.D.Anderson Co.)
Expeller PARTS	
MWS	Main worm shaft, the main pressing shaft of the expeller.
Barrel	The section of the expeller that retains solids and permits oil to be separated, often called a cage.
Barrel bars	Hard steel bars spaced to permit oil separation. A part of the cage.
FFA	Free Fatty Acids. A free radical of glycerides broken away from the parent molecule by enzymatic activity. FFA represent the extent of rancidity.
Gums	Solids residue removed from oils during refining. These gums or lethecins are phospholipids, products of the phospholipase enzyme.
Hull	The exterior coat or shell of seed. The pericarp, usually high in lignins (wood like fibers).
Lipids	Vegetable oils.
Meal	Meal is used generically to include all solid residues from oilseed processing including expeller

	oilseed cake. Value of a meal is determined by protein content. Actually, meal is the expeller cake (or pressed cake) ground so 90% passes through a specific size (mesh) screen.
Meats	The fraction of seed containing oil and protein after hull or shell is removed.
MIU	Moisture, insoluables and unsaponifiables. A measure of oil quality.
MPP	Maximum production potential of an expeller oil mill based on operating 24 hours per day 300 days per year, the definition is used in this paper. This is further defined as the expeller manufacturer's rated capacity per hour or per day.
R.O.	The residual oil in cake or meal after processing.
Soapstock	Technically soapstocks are products of neutralization of free fatty acids in oil. Normally free fatty acid content of fresh oil is 1- 3%. In Uganda soapstock may contain contaminants such as protein and gums. In addition, too much caustic soda added during neutralization reacts with oil to form soapstock, increasing oil losses.
Yield	The ratio of product oil versus available oil in a given oilseed.