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Report of Technical Assistance and Assessment

Village Level Oilseed Processing Module

Catholic Relief Services (CRS) Program

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CRS/AFRICA OILSEED PROJECT

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CRS/Africa Oilseed Project

EXECUTIVE SUMMARY

The goal of having impoverished rural subsistence families grow oilseeds and have the seeds processed into oil and a high protein residue suitable for use as a food ingredient fills a nutritional need and provides a potential source of income. This is true for the four countries visited and presumably for other, if not all, countries in Sub-Sahara Africa. Conceptually, the project appears to be sound. In general, unusual circumstances in each country (as well as the closed nature of the system involving the module's operation) tend to insulate the oilseed module system from conventional economic feasibility considerations. Data and time were insufficient to provide the basis for a rigorous analysis. Unit operating costs seem to be presently inordinately high compared to normal commercial practice and must eventually be improved. The technology is satisfactory for present purposes but work should commence immediately on system improvements as well as exploration of alternate technologies.

In Rwanda and Kenya sunflower production is a priority of the respective governments and the CRS program complements existing efforts to promote edible oil self-sufficiency. Available data indicates that lipid consumption is low and weaning practices poor. Local sunflower production and processing could meet a real and urgent need

In Kenya the Government program for the development of an oilseed processing industry probably limits the CRS project to sites which are remote from the commercial growing and pressing areas. In Rwanda the situation is such that the CRS system could be "the only game in town" for many years and the CRS project in Rwanda has potential for making a major contribution to solving that country's edible oils problem as well as providing direct

benefits to the participants.

In Upper Volta CRS has promoted the use of sesame seed as a source of oil and a high protein residue. Concentrating solely on sesame as a source of oil may be inadvisable. Yield data indicate that participants in the program may not be able to grow enough sesame to justify the program. Since groundnuts and karite nuts are also good sources of edible oil and are readily available, the CRS oilseed program should consider promoting the production and processing of one or more of these crops depending on regional growing conditions. Available data indicates that the program addresses critical nutritional needs. In this case, the presence of existing commercial oilseed cottonseed processing operations probably eliminates the southwestern part of the country as possible CRS sites. Since transport facilities and economic conditions as well as climatic conditions vary from region to region, type of operation (mobile vs stationary) as well as oilseed types should be considered separately for each region.

In The Gambia the abundance of groundnuts would suggest that lipid and protein requirements could be readily met. However groundnuts are a cash crop grown primarily for sale rather than consumption. The government set-aside of peanut oil for home consumption is trivial compared to need. Weaning practices are poor and malnutrition is widespread, particularly during the rainy season. Local sunflower production could serve two purposes: (a) it would assure an adequate supply of edible oil and a low-cost high protein food and (b) increase income by permitting more of the peanut crop to be sold. Two general areas must be watched and any drastic change analyzed for possible effect on the project. These are the groundnut export situation and the effect of the impending Sengalese confederation/cooperation on the vegetable oil situation. Low groundnut prices could change the feasibility of the CRS project dramatically.

The importance of extensive data collection in the near future should be stressed. Appendix III describes the data to be collected and how the data can be used for project control and decision making, future planning of operations and organization, process economics improvements, and evaluation. Details are also available in the country reports. Recommendations have been made regarding cooperation with outside organizations in obtaining data. Suggestions have been made for: (a) programs regarding alternate oilseeds (Upper Volta and The Gambia); (b) study of operating parameters (Kenya); (c) study of cake quality and nutritional value (all countries); and (d) processing dehulled oilseed/grain mixtures (Kenya).

It was concluded that, although of serious concern, the aflatoxin problem did not necessarily preclude utilization of the cake for human food provided proper precautions were taken. Risks should be weighed against potential benefits. Enforcement of screening and testing procedures and adequate drying and storage precautions should permit use of the cake as food.

Suggestions have been made for reinforcing project supervision and assistance, in terms of additional personnel, exposure to alternate technologies, training of personnel, and establishment of cooperative arrangements with other institutions. Appendix IV contains suggestions for minor modifications to the existing system which could improve its efficiency. Investigation of possibilities for alternate technologies available is also recommended. A change in the proposed oilseed procedure has been recommended to provide drying and storage facilities at the centers to facilitate aflatoxin control as well as operations continuity. The effect on cost of improved processing efficiency, increase throughput and an increase in the number of days of operation are discussed in Appendix V. How the oil could be marketed and when marketing of the oil becomes desirable is addressed in Appendix VI.

CRS/Africa Oilseed Project

BACKGROUND

CRS/Africa is encouraging oilseed production (sunflower and sesame) as part of its Food and Nutrition Program. Oilseeds are processed into oil and expeller cake using small-scale oilseed processing units. Project goals are to provide an indigenous calorie and protein source for feeding vulnerable groups and to generate income through the sale of oil (or by substituting the oil for oil normally purchased). Units have been introduced in Kenya, Rwanda, Upper Volta and The Gambia.

CRS requested, and AID/W provided technical assistance related to nutritional need, equipment, cost analysis and future project development.

Since each country represents a different set of needs/problems the team of Hornstein/Wingard visited each of the four countries. Glen Knapp, CRS Regional Agricultural Advisor accompanied this team. He served as mentor, interpreter (in French-speaking countries) and agronomist. He was an invaluable source of information concerning the project's history and development.

Initial discussions with CRS personnel in Nairobi and perusal of existing reports and documents concerning the oilseed project indicated that our initial workscope (appendix I)was appropriate and confirmed that the major issues were concerned with:

1. Efficiency and cost effectiveness of the operation.
2. Problems relating to the expeller cake -
   a. High fiber content
   b. Aflatoxin contamination
3. The nutritional aspects of the program.
4. Future research needs.

It became obvious that the project was in the early stages of real development. However, a solid base has been established for program expansion through the exploratory work done to date. It also became evident, with increased exposure to the different country situations, that normal commercial oilseed and vegetable considerations have little effect on the current value of the project. The entire operation can be considered as a closed system that operates in its own relatively isolated universe. The system elements being: production and transport of the oilseeds by the MCH participants, processing locally by the CRS modules, and transport, storage, and consumption of the crude (without refining) products by the participants and their neighbors.

Because of the above, it is felt that the lack of "solid" operating cost and yield data of sufficient quality for rigorous economic analyses is not a serious matter at this time. Instead, we have concentrated on setting down the types of data that should be collected. We have also tried to indicate factors controlling costs, yields, etc., factors that could materially improve the potential viability of the program in a more competitive environment. We anticipate that more detailed evaluations can be made if good records are kept and the suggested research is carried out during the coming year. Changing world conditions in the overall vegetable oil situation may have some effect on the project environments as well. As new data become available, a serious study of how best to implement future programs in other countries should be initiated.

This report consists of our observations, their implications and our recommendations. Each country is treated as a separate entity. The final section presents an overall assessment of the project and recommendations. Appendix II lists the individuals (and their affiliations) with whom we met and discussed the CRS project. The country reports are basically the draft reports we left at each CRS mission at the end of our country visit.

I. Kenya Country Report

CRS/Africa Oilseed Project

Nutritional Aspects

Information obtained in large part from Report of Child Nutrition Survey 1978/79 - Central Bureau of Statistics, Ministry of Economic Planning and Development.

(1) Survey looked at children 6-60 months of age.

(2) Defined nutritional status in terms of stunting and wasting, that is in terms of height/age and weight/age.

(A child who is small in terms of height/age has been malnourished in the past and is termed "stunted". A child who is low in weight/height is currently malnourished and the condition is termed "wasted".)

(a) "Stunted" children (low ht/age) were greatest in rural part of the coast and Nyanza Province and lowest in urban areas of larger towns.

(b) "Wasted" children (low wt/ht) highest in rural and urban parts of coast and lowest in rural parts of Central and Western Provinces.

(c) Overall 47.2% rural and 33.3% of urban children were below the 5th percentile of reference population. (That is about 50% of rural children were smaller than 95% of children of similar age e.g. in well-to-do Kenyan homes).

(d) In addition 4.3% rural and 6.1% of urban children were fairly severely wasted - (not only small but close to emaciated) and 0.7% rural and 0.8% urban were very severely wasted (probably marasmic).

(e) Mothers in rural areas breastfed their children for an average of 14 months and urban mother breastfed children for about 10 months. The number of children breastfed less than 3 months was 2.6% in rural areas and up to 15.0% in urban areas. Weaning foods are given to children

generally by 6 months of age. However, more than 1/2 the children in rural areas and nearly 3/4 of urban children were given a weaning porridge in which maize flour was the major ingredient (no adequate protein source included). Children fed porridge in which cassava or bananas were one of the main ingredients tended to be more under-nourished than the children in the same areas fed with porridge made from other ingredients. In rural areas children given porridge in which cassava was a main ingredient had the highest prevalence of wasting and combined wasting and stunting.

(f) A visit to the Food and Nutrition center in Iriamorai in Embu District confirmed, at least in this instance, that weaning began at about 4-6 months of age, children were fed until 12-15 months of age, and that the number of stunted children was high. Edible oil was in short supply and Kimbo (a palm oil based fat) was purchased when funds were available.

Implications

The available data appears to indicate that both calorie and protein are generally low in the rural Kenyan diet and that both the oil and the residue cake could play an important role in improving nutritional status. If the CRS oilseed program attains its ultimate goal*, participants would produce about 200 kg of sunflower seed, the yield of oil would be about 70 kg and the yield of press cake about 90 kg. (hulls represent the remainder). Nutrients supplied per capita per day assuming a family of seven are:

(a) Oil - Total calories per annum 630,000 (70,000 x 9 cal/g) or approximately 250 calories/person/day.

(b) Cake - Total calories per annum 360,000 (90,000 x 4 cal/g) or approximately 140 calories/person/day.

- total protein per annum, assuming 45% protein in cake, 40.5 kg, or

* The initial goals appear to be relatively modest about 1/3 the ultimate goal How long it may take to reach the 200 kg. level cannot be predicted.

approximately 16 gm of protein per person, per day. Sunflower protein has a high biological availability and could be equivalent to about 13 gms of fully utilized protein/person/day. If the oil and cake are fully utilized an increase of 390 calories and 13 gms of protein per capita could have considerable impact on improving, nutritional status. Nutritionally the project is well justified.

Problem Areas:

(a) Two of the problems initially cited (i) low efficiency in expelling oil and (ii) the high fiber content of the cake are inter-related. For high oil expulsion, the fiber hull content of the sunflower seed fed into the expeller must be high about 10-15%. However, the residue after oil expulsion has too high a fiber content to be used in child feeding. On the other hand, if the fiber content is low enough so that the residue can be used in child feeding, the oil expelled is much too low to make the process feasible.

The suggestion was made that the sunflower seed be dehulled to the greatest extent possible (thus minimizing fiber content) and that corn kernels be mixed with the sunflower seed and the mixture put through the expeller. The corn would serve the same purpose as the "hulls" creating enough friction (heat) to insure good oil expulsion and would leave a cake with low fiber content. The corn/sunflower cake would be a "CSM" type product. Initial experiments with a mixture of dehulled sunflower seed and corn substantially increased the yield of oil and provided a well-defined cake of improved color. Substituting millet for corn gave a similar result.

Recommendation: Further work should be done to determine the optimum mixtures and conditions. This approach appears to be quite promising and

could solve both yield and fiber problems.

(b) Assessing the Nutritional Value of the Cake.

Before promoting the use of the cake as a food supplement its nutritional value and safety should be confirmed.

Recommendation: Assuming that the sunflower/corn approach is desireable determine the PER (protein efficiency ratio) of (a) the partially dehulled sunflower cake and (b) the sunflower/corn residual cake. If the results are satisfactory, it may be useful to run clinical assays (child feeding trials under clinical conditions) to determine the merits of the products as human food. The Office of Nutrition AID/W supports an existing clinical assay laboratory that can advise on such studies.

(c) Assessing the Composition of the Seed and Cake.

The CRS project would benefit by having a better fix on the composition of the sunflower seed (hull content, oil content, protein content) and the cake.

We visited East African Industries and discussed their sunflower operations in some detail with Mr. Ngugi, chief of their oilseed operations. The results of that visit are discussed elsewhere in this report; our concern here is with their analytical capability. EAI has a small laboratory that carries out the required analysis for water, fat protein and fiber. Mr. Ngugi, when asked if EAI could run these analyses for CRS, (presumably at a fee) was receptive to the suggestion.

Recommendation: It is essential that compositional analysis of seed and the expeller cake be determined. An economic analysis of the project cannot be carried out without this information.

(d) Aflatoxin

Residues after oil expulsion have been assayed for aflatoxin. While

most samples were uncontaminated other samples had more than the allowable 20 ppb. As a result promotion of the press cake has been virtually halted. How to handle this issue requires making a value judgement. A first reaction is to be ultra conservative and not use the cake for child feeding. Whether this action is justified is not clear. In Kenya there appears to be a need for the calories and protein in the cake. Aflatoxin contamination is not limited to sunflower. If improperly dried and stored - corn, peanuts, etc. can all be contaminated and eaten. Perhaps a more useful approach would be to educate the people growing sunflower to improve drying and storage conditions and screen the sunflower to insure that aflatoxin is absent. Subsequent discussions with Ms. Nwanda, aflatoxin expert at the GOK Public Health Service and with Mr. Ogila, head oilseeds development in the Crop Production Section, Ministry of Agriculture revealed that they shared this viewpoint. Ms. Nwanda and Mr. Ogila believe that proper drying and storage should reduce or eliminate aflatoxin contamination. They also agreed that if these conditions are met (proper drying and storage) it should be possible to use the residual cake as a food supplement for children. The rationale again being that aflatoxin in equal or greater amounts is probably being ingested with other foods. Aflatoxin is a universal rather than a sunflower specific problem and the expeller cake would do little to exacerbate the problem. The nutritional benefits would outweigh the risk.

Recommendation: Concern about aflatoxin is justified and efforts to minimize fungus growth should be made but we believe the health danger is not great enough to discard the residue if precautions are taken. Proper drying and storage procedures should be taught to mothers participating in the oilseed project.

(a) It may be worth evaluating the possibility of having the participants in the oilseed project bring the sunflower seeds immediately after harvest to the Food and Nutrition Centers that house the oilseed modules.

Drying, storage and processing could all be carried out at these centers. The Applied Technology Unit at Karen has developed solar dryers that could serve to dry sunflower seed. Mr. Mbogori (CRS) will explore the feasibility of using these dryers.

A "rotating" system could be installed. CRS could make an initial investment in sunflower seed and process the seed into oil and cake. When a participant brings her sunflower seeds to the Center she would receive oil and cake equivalent to the weight of seed minus an amount for processing. This seed could in turn be processed --- and so ad infinitum. Another advantage of this approach is that the expeller could run continuously (and more efficiently) with a supply of seed on hand.

(b) To further insure that sunflower seeds are not contaminated UV Fluorescence can provide a rapid screening method for detecting aflatoxin. Samples that do not fluoresce are not contaminated. Samples that fluoresce may or may not be contaminated and require further checking.

Miscellaneous Observations

(a) At the Iriamorai Food and Nutrition center, 500 of the 700 mothers in the program were growing sunflowers, an indication of their perceived need for oil.

(b) One of the oilseed modules is mounted on a truck and serves several centers. We watched the operation in an isolated area. About 25 women had brought sunflower to the site for processing. The dehulling process had been too efficient, and as a result the yield of oil was low. Despite the low yield the women appeared to be glad to obtain the oil. One woman carried 40 kg of seed a distance of 15 kilometers to obtain the oil! Another had been there the year before and sold one-half the oil recovered. This year she planned to keep all of the oil - she valued the oil more than the money. Obviously, this is not a conclusive argument for the need for oil

but it does appear to be a very precious commodity in poor rural areas.

(c) The cake can be collected and sold for animal feed. East Africa Industries, a large producer of sunflower oil in Kenya sells the cake for approximately $120/ton. The price depends upon the fiber and protein content of the cake. The return could be appropriately distributed to the participants in the project. Six cents/lb. for 45% protein cake would appear to be desireable only if a decision is made not to use the cake for human food.

(d) EAI is concerned about aflatoxin contamination of the "cake" they sell to animal feed producers. Their approach is preventive. On large farms where they have contracted for sunflower seed, EAI plans to harvest, dry and store the seeds themselves. On small farms they will instruct the farmers to harvest the seeds and request them to bring the seeds to EAI for immediate sale

(e) We met with USAID staff and then with Ms. Allisen Herrick, mission director. USAID was unaware of the project but expressed considerable interest in the project. Ms. Herrick expressed an interest in visiting a Center where the expeller was in operation and Dr. Lewis an Ageconomist accompanied us to the Ministry of Agriculture. It could be useful for CRS to explore possibilities for USAID cooperation.

(f) We met with Mr. Adero, head CROP Production Section, Ministry of Agriculture and Mr. Ogila, head oilseeds development in that section. They were unaware of the project. At the end of our discussions, they expressed their belief that the nutritional benefits of the CRS oilseed project was particularly relevant to the needs of the rural poor and that it complemented Kenyan efforts to insure edible oil

self-sufficiency. They asked to be kept informed of progress and offered to help, if requested.

(g) A relatively simple procedure for destroying aflatoxin has been developed. It consists of wetting the contaminated material within ammonia water and storing the material in sealed plastic bags for two to three weeks. There is no loss in palatability etc. Details of the procedure has been left with CRS. It may be useful to collect contaminated material (identified by screening) and treat large batches by this procedure.

I. KENYA COUNTRY REPORT

CRS/Africa Oilseed Project

Technical and Commercial Aspects

A. General Environment -

It appears that the project fits well with needs for oil and additional food and may provide incremental income generation in the rural areas which are remote from the favorable agricultural areas. The GOK Agriculture Ministry personnel reacted favorably to the project and offered field extension help since they felt it would complement their own efforts and benefit "the people" directly. The major processor (East African Industries) felt the project complemented their own efforts in sunflower production and expressed a willingness to help with laboratory work.

There are alternate oil sources and new programs in existence which may offer some restraints and limitations to the locations and circumstances under which the CRS system can operate successfully. These include:

(1) Corn germ oil that might supply at least 4,000 tonnes oil per year if fully exploited. At least one private plant is presently in operation using solvent extraction and others are planned.

(2) Cottonseed oil is currently being produced and could supply as much as 6,000 tonnes per year based on current cottonseed production.

(3) EAI has targeted a 10,000 tonnes per year output of sunflower oil by 1984 (which would presumably be in addition to the 5,000 tonnes that could currently be produced from available sunflower) and other plants are in existence as well.

Best Available Document

All this will not add up to the current imports of some 70,000 tonnes (estimated) so that an overall short supply exists as well as a problem with distribution of that supply.

B. Technology -

Although present data do not permit a rigorous analysis, it appears that the CRS oilseed system can be useful in Kenya. However, it is felt that system and operating refinements are more urgent since economical alternatives exist in the country and will apparently spread. Investigation of possible alternate small scale technology is warranted now in order to cope with future changes in the situation.

It is recommended that the CRS project director's proposed program of obtaining more detailed data on the pressing operation be followed and even expanded. These data would provide a firmer basis for determining current cost parameters and the value of process refinements. They also provide information for control "fine-tuning" improvement of results in terms of yields, costs, capacity, and product quality. These data will also provide a firm basis for making a valid comparison with other systems in terms of relative efficiency.

We suggest that the following information would be very useful to CRS in their current operations as well as in future evaluations of changes in the system and/or program:

1. Seed analysis - (a) oil content and moisture be determined on a number of samples from each crop and from each area at the beginning of the harvest season. Spot checks should be made periodically thereafter. Any unexplained change in operating results might also trigger a seed analysis. Hull content should also be determined by running a conventional fiber analysis. For comparison hulls can be separated by hand and the percentage determined by weighing. This will give an indication of minimum fiber possible as well as check the

analytical method.

2. Cake analysis - oil and moisture content should be determined (a) periodically to check visual evaluation of operating efficiency, (b) in the event of any radical change in cake character, operating conditions, or seed appearance, (c) when operating changes are made, and (d) when feed composition is changed (if corn, e.g. is added to completely dehulled seed).

3. Material balance - quantities of seed fed, oil produced, cake produced, and hulls produced should be measured as accurately as possible over periods of consistent operation such as a day. This will permit cross-checking of analyses and indicate possible sources of losses which might be corrected. Collection of the hulls might facilitate their use as fuel, soil stabilizer, animal litter, etc. Experience will indicate the frequency of analysis that is really required after the initial trial periods.

The importance of adequate operator training should be stressed. The training should lead to an understanding of the basic principles of the system and parameters affecting its efficiency as well as the pure mechanics of the operation.

C. Marketing

Because of existing and contemplated "competition" in the more accessible areas the greater part of the oil will probably be produced and consumed in the remote areas of Kenya since oil prices are controlled and uniform over the country, making it unprofitable to distribute oil to remote areas. The areas of operation should be selected with great care, keeping in mind that the larger oil extraction plants in the country are underutilized at present (generally more cost efficient) and tend to move oil out further from their producing centers as transportation improves and supplies available increase.

There is a possibility that excess cake can be sold (or used) for animal feed.

D. Suggestions - Refer to Rwanda Preliminary Observations.

In addition:

1. Consider making provision to heat the oil when settling or filtration is slow and difficult.

2. See section on testing in part B.

3. Consider relocating Mbitini unit.

E. Addendum - Refer to Rwanda Preliminary Observations.

II. Rwanda Country Report

CRS/Africa Oilseed Project

Nutritional Aspects

Nutritional Data

1. Available data obtained from CRS and USAID indicates that nutritional status of children 0-6 years of age is poor. In terms of weight/age 35% are below 80% of the median for well nourished children and can be considered malnourished. Of these, 6% have Kwashiokor, 6% are marasmic and 3.4% have both kwashiokor and marasmus. The figure of almost 16% so badly malnourished is alarming.

2. The major nutritional problem appears to be a lack of calories. The average Rwandan consumes about 1750 calories/day (about a 20% shortfall). In particular lipid consumption is low. Available data indicate that about 6% of calories is derived from lipid. A desirable diet would contain about 25% of calories in the form of lipid.

3. Protein intake appear on average to be adequate. Legumes are a major food staple. Beans form a surprisingly large part of the diet, the average daily intake is more than 190 gms/day.

4. Mineral and vitamin deficiencies are not considered a problem.

5. Weaning practices are poor. Breast feeding continues until the next child and may continue for more than two years. Solid foods are not introduced in any systematic fashion. To appease hunger bananas or some cereal porridge may be given. This is inadequate both in calories and protein. Poor weaning practices may well account for the high incidence of kwashiokor and marasmus.

6. The Food and Nutrition Centers serve as a dispensory and as a maternity ward as well as a source of supplementary

food and nutrition education.

The nutritionists at the two centers visited - Rwesoro (CRS) and Mukeroye (government operated) provided the following anecdotal information:

a. Women would undoubtedly purchase more edible oil if they could afford to do so.

b. Once the concept of growing sunflower seed (sunflower is promoted in Rwanda) and obtaining sunflower oil is explained and demonstrated, there is little problem in promoting the project.

c. Oil consumed in Rwanda is generally unrefined and usually consists of palm oil or soybean oil. Both of these are strongly flavored. Unrefined sunflower oil presents no acceptability problem

d. It is important to teach proper agronomic practices to insure good sunflower yields.

e. As with other crops produced some of the oil will be sold, some used at home.

f. The expeller cake could be used as an ingredient in foods if the women were instructed in its use. When asked whether it would be possible to promote the use of the cake as a supplement to foods and/or as an ingredient of a weaning food, but e.g. after the safety and nutritive value of the cake was established, rather than initially, we were advised that it would be best to emphasize the value of the cake from the outset.

Implications

Based on the above we can conclude:

1. The oilseed project is admirably suited for Rwanda. The oil is undoubtedly needed and as indicated in the Kenya report could provide an impressive nutritional benefit. If some of the oil is sold it could generate appreciable income since oil sells for about $9/gallon. (The CRS program goal of 200 kg of sunflower is at variance with the Rwanda project paper that estimates a family production of 75 kg of sunflower seed/annum. The value of the project is obvously reduced if oilseed production is low).

2. The expeller cake presents a cloudy picture. As indicated in the Kenya report the sunflower protein is of good quality and could serve as a valuable ingredient if safety was assured. However the need for additional protein may not be as great in Rwanda as in other Sub-Saharan African countries because of the high bean consumption, and beans can be an adequate component of a weaning food. Three possibilities exist for handling the residual expeller cake:

i. In view of the overall availability of legumes the cake can be sold as animal feed and the return appropriately distributed to participating families.

ii. If safety is assured but fiber content is too high for incorporation into a weaning food the residual cake could serve as a general food additive in soups, etc.

iii. If safety is assured and fiber content low the cake can serve as an ingredient in weaning foods and/or a general prupose food supplement. The option also exists in ii. and iii. for selling a portion of the cake.

Recommendations:

1. There is a possiblity that aflatoxin may be a problem. This should be checked. Samples could be sent for analysis to CRS/Nairobi/Regional

Office.

2. The shelf life of the expeller cake may be poor--although not probable, this should be determined. An FAO employee, Dr. Bossyut, a pediatrician at Kigali hospital, appeared to be interested in working with CRS to check the microbiological safety of the cake. This should be done. The cake should have a shelf life of at least six weeks (this figure is based on the CRS assumption that oilseeds would be brought to the expeller at monthly intervals).

3. The nutritionists at the Food and Nutrition Centers are fully aware that weaning practices must be improved. A nutrition education campaign has been initiated to develop the weaning food concept. The expeller cake could be presented as one possible method, not as the sole method, for adding needed protein to the child's diet (beans could serve as an equally useful protein source).

4. To insure that the fiber content of the expeller cake is low and the efficiency of oil expulsion is high, optimum processing conditions and suitable sunflower varieties should be identified. It would be useful to develop a cooperative arrangement with two existing research facilities in Rwanda.

a. There is a pilot project at Nyanza (German Technical Assistance) that is producing soybean oil on a small scale. It would be useful to temporarily locate a CeCoCo expeller at Nyanza and have the German technicians determine the best operating conditions for low fiber and high oil yield.

b. It would also be useful to work with an existing sunflower research station to determine the preferred variety of sunflower for Rwanda in terms of ease of decortication, oil content and yield.

5. Uncertainties concerning the safety of the expeller cake and its fiber content would suggest that prudence be exercised in promoting the use of the cake as an ingredient in a weaning food, until safety and low fiber content are assured. This delay contradicts the opinion that the importance of the cake should be stressed at the initiation of the project. However, in view of the large bean consumption, protein should not be as great a problem in Rwanda as in other African countries and a delay in promoting the cake would not be harmful.

CRS Africa Oilseed Project

Technical/Commercial Aspects

A. General Environment -

The situation appears to be favorable for successful project implementation:

(1) The need for oil is great and current idigenous production is negligible;

(2) There are no existing alternates of any magnitude;

(3) There is an apparent degree of interest on the part of CRS personnel, GOR, and the general development community;

(4) There are facilities for maintenance and testing of possible refinements;

(5) Oil prices are high enough to provide grower incentives.

B. Technology -

The system proposed appears appropriate for local conditions. It should have some cost advantage over existing alternates. GOR projections indicate that adequate raw material for an economically sized conventional system will not be available for some 10 to 20 years. In the interim, the CRS system should contribute greatly to increase the supply of oil. The cost would be amortized long before any more cost effective alternate can develop, if one ever does.

Some refinements in the system may be needed to improve operating costs and accomodate local raw material variations and product preferences.

For example, a problem in dehulling the available sunflower seed developed during the initial test of the mobile unit. Whether this is a serious problem depends on the future reliability of the supply of suitable seed. If the conversion to a suitable variety is not complete, the units may be forced to process a quantity of the seed which may be difficult to dehull. If so, cracking the seed before dehulling should improve results. It is suggested that a test using the German project cracker might be made on this type of seed.

Although the technology applied is not complex, the implications of continuous operation are usually not easily grasped by people in developing countries and adequate training of operating personnel is a must. Since the system is already in operation in Kenya, it would be highly beneficial if the mobile unit driver-operator could be trained in Kenya. It might be helpful if one of the expatriate CRS/Rwanda personnel could also observe the Kenyan operation. This could provide a yardstick to measure the driver/operators subsequent performance.

C. Marketing -

An unusual situation exists regarding oil consumption in that crude vegetable oils are apparently used directly. Since this applies to imported palm oil as well as soybean oil, crude sunflower oil should find ready acceptance since it is far superior (or less objectionable) in taste to the other two. This permits direct consumption at home by the project participants of a significant portion of the oil and simplifies the distribution and retailing task. Early in the project, consideration should be given to selling the "excess" oil so that it can provide optimum income generation (hence maximum incenti e to grow the oilseeds) to project participants. India experience has indicated that best results are obtained where the effort is consolidated so it can be handled by professionals but remains under participant control as in a market-

ing cooperative with the project producers as members. A determination should be made of the market composition and nature (who buys, how much, where are they, etc.) as soon as practical in order to be ready for the first appreciable oil production. Cake marketing will depend on the need and circumstances (this will in turn affect the technology application). For example, the importance of the dehulling step will vary in importance from minor to major if the cake is to be used for: (1) cattle feed, (2) human food, (3) poultry feed, and (4) weaning food component.

D. Suggestions -

The following suggestions are offered for consideration:

1. Cooking/drying prior to expelling - Heating the raw material at elevated moisture content (cooking) and drying will condition the feed and result in (a) greater throughput for a set amount of power input and (b) increased oil extraction. Precooking will also facilitate clarification of the expelled oil whether by settling or filtration. This will become important as refinement of product cost and increased capacity are desired. In the case of soybeans, it is necessary for improving the nutritional value of the cake

2. Cracking the seed - this will facilitate cooking and feeding the expeller uniformly. It could help dehulling of the thick-hulled seed as well.

3. Dehulling difficulties with high moisture seed may be decreased by drying and storing to provide time for the seed to shrink away from the hull (primarily soybean, possibly also sunflower).

4. Consider cull peanuts (broken, small, etc.) as an alternate raw material to increase utilization of press capacity (reducing unit costs). Soybeans also.

5. Check out feasibility of substituting electrical drive for expeller and dehuller in stationary units where available. It appears that power costs would be appreciably less than diesel-based costs in Rwanda.

6. Settlings from oil must be reprocessed by gradual addition to expeller feed or utilized as a product to prevent major oil losses. Consider addition of a simple filter to the system to minimize these if necessary.

7. There are a number of possible system variations that might be required by changes in raw material, product, or operating conditions. To be prepared for these, it would be useful to have the CRS Agricultural Advisor visit the University of Idaho or North Dakota State where an experimental evaluation of the CeCoCo expeller as well as auxiliary equipment are currently under way. (The University of Illinois has a similar program under way on the Rosedowns expeller which has been considered for a future CRS unit). It would also be useful for him to visit a conventional large capacity plant which could well generate ideas for future refinements. These ideas could be adapted to the CRS project scale and needs. It could also be useful for him to visit the Anderson International company in Ohio to discuss a possible collaboration on a machine or machines designed specifically for this application. He might also check out the possibility of batch units in place of continuous expellers. Investigation of the Brady and FFF extruders for possible future blended food production could also be timely.

Addenda -

1. Cost comparisons should be developed for guidance in future system and program refinements. These would compare existing system costs with possible alternates, imported oil costs, and alternate oil sources. Information is not yet available to permit this type of analysis.

2. Additional system modifications to improve costs, ease of operation, ability to handle alternate raw materials or meet new product specifications should be developed.

3. Additional suggestions on possible modifications on the dehulling of sunflower seed, such as the use of intermediate screening to assist in hull separation, should be studied.

III. UPPER VOLTA COUNTRY REPORT

CRS/Africa Oilseed Project

Nutritional Aspects

Nutritional Data

Information on Nutritional Status was obtained in large part from two reports: (a) the Upper Volta Food for Peace/Title II Evaluation (draft report) and (b) CRS data.

(1) Forty to fifty percent of children are under 80% of median weight/age for well fed children i.e. malnourished.

(2) Limited data are available on "stunting" and "wasting". The results are as follows:

Age	Wasted	Stunted
less than 1 year	35%	18%
1 - 2 years	43%	3% 1/
3 - 6 years	10%	40%

1/ The figure on stunting (3%) is misleading since children who were both wasted and stunted were only listed as wasted. The very badly malnourished must be very high in this age group. For example, if we add a category "wasted and stunted", the breakdown might be 30% wasted, 3% stunted and 16% "stunted and wasted", the latter group being very badly malnourished.

(3) CRS data indicates that 37% of new entries into the Food and Nutrition program were less than 80% of standard median wt/age in 1970, and 47% in 1980. This appears to indicate that the nutritional status of children entering the program may actually be declining. There is some seasonal variation and regional variation in the degree of malnutrition but in the more populated areas

40 - 50% of children appear to be malnourished.

(4) Per capita calorie consumption is estimated to be about 1800 cal/day - about 75 - 80% of requirement.

(a) Daily cereal consumption (millet, sorghum, maize, rice) is about 430 gms and supplies about 1500 (out of a total of 1800) calories. This amount of cereal also provides about 40 gms of protein and 12 gms of lipid.

(b) Other sources of lipid include the following:

(i) Legumes are consumed at an average of 40 g/capita/day and provide about 5 gms of lipid.

(ii) Meat consumption averages 40 gm/person/day and provides about 6 gms of lipid.

(iii) Oil and fat per se provide about 31 calories and 3.7 calories respectively -- about 4 gms of lipid.

(c) Total lipid in average diet appears to be about 27 gms/day and supplies about 245 calories. About 13.5% of calories are therefore supplied by lipid -- roughly half of the suggested lipid intake.

(5) Prognosis for future indicates that there will be continuing food deficits. Data extrapolated to 1990 indicates little change in consumption patterns.

(6) Weaning practices are poor. Children are breast-fed until at least 18 months of age. At 6 months of age special childrens' foods are introduced. Children are generally fed "bouille" (a thin millet porridge) or "to" (a thicker millet porridge). "Soumbala", a product made by fermentation of the Niere bean may serve as a source of protein if/when fed to children. (No data on actual consumption of soumbala was available).

Sesame Production/Processing

(a) We visited the Bwassa center where a Chinese made expeller had been installed and operated. The expeller has not been operated recently and existing data is conflicting. In a sense the project on sesame processing is restarting.

(b) Sesame is being grown as part of the program. At Bwassa a communal plot of about 4 hectares is cultivated by 200 women who participate in the Food and Nutrition Program. If we assume a sesame yield of 600 kg/hectare (normal yields are about 1/2 this value) but the higher yields are apparently obtainable) then each woman would receive about 12 kg of sesame seed/year or 1 kg/month. If the oil yield is 50% each woman would receive about 1/2 liter of oil/month and about 300 - 400 gms of the residual high protein cake.

(c) The above might not provide sufficient motivation to maintain interest. However, the near term goal is to produce 60 kg of sesame seed per participant per year. Depending on yield this would require cultivation of 0.1 to 0.2 hectares. Whether this places an undue labor burden on women already overworked should be considered.

(d) For a household of 10 members (the usual household size), 60 kg of sesame seed would yield about 3 kg of oil/person/year or 75 calories/person/day -- an increase from 13-17% in calories supplied by lipid. By comparison the CRS oil ration of 1 kg/month supplies about 300 calories/day. If distributed mong 10 people this would represent an increase from 13-15% in calories derived from li

(e) If the expeller can process 30 kg/hr of sesame seed then 60 kg, a year's production for each participant in the program, can be processed in two hours. If the expeller operates 8 hours/day for 300 days/year the sesame production of 1200 families can be processed in the course of a year. It is doubtful that 1200 families are serviced by one center. Unless other oilseeds are processed the expeller could be poorly utilized.

Potential for Other Oilseeds

On our visits to Bwassa, Manega and Depelago it became evident that peanuts and karite nuts could be utilized as a source of oil.

(a) Peanuts are grown in small plots and are consumed within the family (peanuts are not a commercial crop). If peanut production could be increased peanuts could be processed to yield oil and a residue that could serve as an ingredient in a weaning food.

(b) Karite nuts are collected from trees that grow wild. Nuts are laboriously hand processed to yield "karite butter". The residue is toxic and is used as fuel, not food. Karite butter is the major fat used in food preparation. A commercial export market also exists for the product. Using the expeller to process karite nuts would undoubtedly increase oil yield, provide a labor saving method for processing the nuts, and serve to increase oil availability and income.

Implications

(a) The concept of providing additional oil and a high protein expeller cake that could be used as an ingredient in weaning food is excellent since:

(i) all data indicates that 40-50% of children under 5 are "malnourished".

(ii) Data on stunting and wasting indicates that children 1 to 2 years of age (the weaning period) form the most malnourished group.

(iii) The weaning diet appears to be low in protein.

(b) It is not clear that the CRS program should promote sesame seed as the sole source of oil. Peanuts and karite nuts are also likely candidates.

Recommendation:

(a) For the near term sesame, peanuts and karite nuts should be considered as potential edible oil sources, whichever seems most appropriate for a given

situation should be promoted. There is no reason why more than one oilseed could not be utilized in a given region.

(b) Before full scale demonstration runs are made, satisfactory processing conditions should be established for each of the three oilseeds. This entails knowledge of oil yield, oil content of seed, fiber content of residue, oil content of residue etc.. Prior to leaving Upper Volta we learned that an edible oil research institute is located in Oagadougou. Presumably laboratory facilities exist for carrying out the required analysis. CRS should consider the possibility of establishing a cooperative arrangement with this institution to obtain the necessary data.

(c) Apparently oil from non-decorticated sesame seed is preferred to oil from decorticated seeds. The fiber content of the non-decorticated residue could inhibit protein utilization. The effectiveness of the residue as a protein source should be checked in animal studies.

(d). Decorticated sesame seed and dehulled peanuts may be difficult to process, addition of millet may prove useful.

(e) Since aflatoxin may be a problem participants in the oilseed program should be instructed in proper drying and storage of oilseeds.

III. UPPER VOLTA COUNTRY REPORT

CRS/AFRICA OILSEED PROJECT

Technical/Commercial Aspects

A. General Environment

Although adequate "hard data" was not available because of a three-year gap in implementation of the research program, conditions appear to be favorable for the CRS oilseeds system to have a positive impact on the oils and fats situation, at least in some areas. Oil supplies and apparent prices are such that operating costs, capacity utilization, marketing systems, etc., are relatively unimportant (except for the southwest region) for the immediate future. Anything that results in increased supplies in the rural areas will be of considerable benefit even while the research program is underway. The key element at the moment appears to be the promotional aspect and determining which oilseed or combination of oil sources to promote in any given area. Obviously, good data collection during the research program is essential.

B. Technology

In general, the comments for Rwanda and Kenya apply here. The importance of data collection is particularly applicable to Upper Volta because of the range of possible raw materials.

Tests should be made of processing Karite through the CRS system since this is an important source of fat and the methods now used probably recover only a portion of the available fat. Improvements in recovery should be very significant since any oil remaining in the cake (residue) is lost for human consumption. (The residue is toxic). It could well be that some size reduction prior to processing might facilitate feeding to the expeller at a uniform rate. An investigation of yield, etc., by the present methods should accompany these tests to provide a base for comparison as well as to help promote the concept.

C. Marketing

Information should be gathered on quantities of oil sold, marketing channels, etc. to provide a basis for decisions on both interim and longer-term arrangements to be promoted. This is particularly true in the case of Karite which is widely used and differs greatly from conventional oilseed sources. The peanut (groundnut) oil situation should also be studied carefully since it appears to be a major, but generally underutilized source of oil at least in the central areas. Information on direct consumption as peanuts would also be useful.

D. Suggestions

Most of these listed in the Rwanda and Kenya observations will be applicable in Upper Volta in some areas and at some point in time

It is also suggested that additional information on the existing supply, cost, competitive oil sources be assembled to provide a better picture of the fit of the CRS activity with the overall country situation.

In view of the uncertain supply situation as well as seed options, strong consideration should be given to making the next one or two units mobile. This will not only provide a useful promotional tool but better flexibility for test programs on different oil sources, in particular, Karite.

Information which would be useful for even preliminary studies includes:

1. Prices for groundnuts, sesame, karite nuts, and the oil from these.
2. Overall data such as: oil imports; cottonseed production and amount processed (prices of oil and residue as well as seed); capacity, type, output, products, etc. of the government processing plant (CETEC); any other processors in country; transport costs per km for oil, cake, seed, etc.; groundnut production, exports, etc.; and how various oils are currently distributed and marketed (any government controls?).

IV THE GAMBIA COUNTRY REPORT

CRS/Africa Oilseed Project

Nutritional Aspects

The Gambia

Nutritional Data

Studies concerning dietary intake and nutritional status are to an extent contradictary. The following information is derived from (a) Food Strategy Report Part I. Review of Food and Nutrition in the First National Development Plan (1975-81). (b) Epidemiology of Protein/Energy Malnutrition in children in a West African Village Community, (c) CRS data.

(1) Nutritional Status of Children

A study in Keneba an improverished area indicated the following: (a) at three months of age mean wt/age is normal. (b) by ten months of age children are malnourished. Meanwhile, wt/age has dropped to 80% median wt/age of well fed children and falls to 75% wt/age by the time the child is two years old. (c) nutritional status remains at 75% wt/age from the second to third year. (Although the child is eating the family food the local diet does not support catch-up growth). (d) during the rainy season 75% of children between 13-18 months of age are under 80% wt/age and nearly 40% (an incredible number) are under 60% of wt/age (marasmic). (By contrast with a separate study at Mansakanko, a richer area, the number of children less than 60% wt/age is about 7.5% during the wet season). (e) the rainy season, the period of maximum malnutrition, is also the period of maximum morbidity/mortality.

(2) Data from CRS Food and Nutrition Centers indicates that 30-40% children participating in their programs fall below the 80% of the median wt/age level.

(3) Weaning Practices

(a) Supplementary foods are added to the infants diet at 5-9 months of age. The initial weaning foods are cereal based "Thin" porridges which supply, about 35 calories/100 gms of porridge. By contrast. breast milk supplies about 70 calories/100 gms of milk. The difference in fat content, 0.2 gm/100 gm of porridge, versus 3.5 gms/100 gm of breast milk, accounts for the extra calories. (b) At six months of age, the mean energy deficit is 150 calories/child/day. By one year the deficit doubles. (c) By one year of age children are receiving more energy dense foods (thicker porridges) but not enough to permit catch-up growth.

(4) Consumption Data

(a) Surveys in Sankwia and Bureng in 1979 indicated that year round per capita intake was about 2100 calories/day. Seasonal variations were observed. In both villages rice was the major energy source supplying about 60% of total calories the year round. Cereals provided 70% of all calories. Groundnuts (paste and oil supplied about 14% of calories, animal products about 4% and oil about 5%.

Cereals contributed about 50% of protein intake, groundnutes about 20% and animal products about 22%.

A rough approximation of the amount of lipid and protein as well as calories.

- Cereals contribute about 100 calories
- Animal products about 25 calories
- Groundnutes about 200 calories
- Oil about 100 calories.

This lipids account for about 425 calories or about 20% of the calories intake. In this study, the average dietary intake is reasonably satisfactory in terms of calories, protein and lipid. Significantly, the consumption of groundnut about 45 gms/person/day is a major contributor of lipid and protein as well as calories. (b) In contrast to these data, other studies have measured the dietary intake of pregnant and lactating women and found calorie intake to be low as 1700 calories or about 65% requirement. (f) Existing taboos forbid pregnant women for one reason or another and in one place or another from eating e.g. roast meat, eggs, fresh milk, groundnuts, etc. Taboos also restrict the use of nutritious foods for feeding infants and children. Overcoming these taboos will require intensive/extensive nutrition education compaigns.

(5) Sunflower Production/Processing

(a) There is little indication that intercropping of sunflower and peanut is practiced. The lack of intercropping results from a cultural bias. Men are responsible for the cash crop peanuts. The women are responsible for growing the food crops. Sunflower is a food crop, that is, a woman's crop, and the man wants nothing to interfere with cash crop production. As a result, sunflower either replaces cereals or is grown on unused land and is not intercropped with peanuts, the preferred practice. (b) Although sunflower was virtually unknown in Gambia prior to the CRS program, we saw a number of fields at least an acre in size. Most of these fields were communally grown by women attending the Food and Nutrition Centers and participating in the oilseed program.

(c) One anectodal note. At the Caso Kunda Food and Nutrition Center, a Gambian woman who served as a spokesperson for a group of women expressed their appreciation for the program. A major benefit-the women did not buy oil. Sunflower oil displaced purchased oil. The spokesperson also st that she used the residue cake in a wide variety of dishes and her family found the products wholly acceptable. Apparently, some of the cake was set aside for use as a food supplement for children. (d) Mr. D.S. Nije of the Gambian Peanut Marketing Board told us that 2000 tons of peanut oil was reserved for home consumption. The rest of the oil and cake were exported. The oil is sold at $0.85 US/liter. For a population of 600,000 the per capita per day availability is about 4.5 gms. Since most of the oil is marketed in the Banjul area its impact in rural areas is virtually zero.

Palm oil and peanut oil are purchased in Senegal. Data on the extent of these purchases was not available.

(6) Aflatoxin Contamination

This is currently a major problem. Peanut oil and the solvent extracted residues are the cash crops. However, the aflatoxin content of the residue is so high this year that it is being withheld from the market. Presumably the sunflowers seeds would also be contaminated. Again, if the residue is to be used as an ingredient in weaning foods or for general human consumption proper drying and storage conditions must be established and maintained.

(7) Implications

(a) It is not clear that lipid or protein consumption is inadequate in the average Gambian diet. It does appear that children during the weanin period are at high risk because of poor weaning practices. (2) The concept of providing oil and a high protein residual cake derived from sunflower that can be used as an ingredient in a weaning food appears to be nutritiona valid, primarily because of poor weaning practices and poverty. (3) Althou the data is limited, the overall picture for infants appears to be bleak. Nutrient intake on a average, is inadequate to meet needs after the third month of life. In rural areas the wet season is particularly bad. Adults as well as children lose weight. Breast-milk production declines and infection rates are high. Children do not completely replenish this weight loss during the next dry season and become more vulnerable to disease. If during periods of relative scarcity additional calories and protein in the form of sunflower oil and the residual cake can be made available, the nutrition/health benefit should be appreciable. (4) If the sunflower oil is consumed in the home, money set aside for oil purchases could be used for other purposes, thus, augmenting family income and edible oil consumption.

(8) Recommendations

(a) The safety and nutrition value of the residual expeller cake should be established. (b) Optimum expeller operating conditions should be determined. (c) To avoid or minimize aflatoxin contamination proper drying and storage conditions should be taught. (d) The possibility of working with I.T.A. (Food Technology Institute) in Dakar to analyze for aflatoxin and composition of oilseeds and expeller cake should be explored.

IV. THE GAMBIA COUNTRY REPORT

CRS/Africa Oilseed Project

Technical/Commercial Aspects

Preliminary Observations

A. General Environment

Again, the situation is somewhat different than in the countries previously visited. Crude groundnut oil (as well as some peanuts) is Gambia's major foreign exchange earner. In an average year, the groundnut crop could supply the lipid requirements for the entire population and two times the requirement in a good year. However, only 2,000 tonnes of refined oil (from solvent extraction unit) is retained which is sold at controlled prices by the Gambia Produce Marketing Board. Small amount of crude palm oil from non-cultivated trees is also produced. Oil imported from Senegal is sold at roughly two times the price of the groundnut oil. It was noted that soybean oil (refined) in green plastic jars labeled "gift of the people of Saudi Arabia" was for sale in the market (this was also seen in Upper Volta).

These factors plus the enthusiastic participation of the women in the sunflower program (we saw several sunflower fields), indicates that the supply is far exceeded by the demand at least at prices the rural population could afford. Apparently, sunflower complements rather than competes with the groundnut crop at least until farmers decide it too can be a cash crop.

Both the GOG and USAID showed considerable interest in and support for the project. The expeller cake seems to be well received as a food supplement

in the MCH center areas and is important as a source of cheap vegetable protein.

There is a need in this case, however, to be alert to world groundnut market conditions because any major change in export potentials could affect the project feasibility by changing oil availability and price.

B. Technology

Although the system appears to be adequate for present conditions, the environment suggests improvements in efficiency and cost reductions are more important than in some other cases (Rwanda and Upper Volta). The two "module" installations we visited were well planned and in excellent condition. Work had been done on recovering additional oil by heating the "settlings" indicating thought had been given to improved efficiency. Trials were made of making soap from settlings. It is recommended that the remaining settlings be considered as food (since they are high in protein). Actually, the most common practice is to recycle the settlings to the expeller feed (gradually). The suggestions on technology and data collection reports listed in the Rwanda, Kenya and Upper Volta are generally applicable to The Gambia. In addition, it is suggested that the effectiveness of the expeller be compared to existing informal palm kernel processing methods. The increased yield (if any) could attract additional processing and through this reducing unit costs.

The processing is not complex but the implications of a continuous operation is not always understood in developing countries. The operators should be well trained and understand the principles which affect the operation.

C. Marketing

Indications are that both the oil and cake would be used locally for some time to come. Demand for oil will exceed supply country-wide unless there is a drastic change in the export market. If the project is very successful in attracting participants, there may be some oil produced in excess of the local

area requirements. This should readily compete with imported oil but some marketing arrangements will have to be made. Excess cake could be utilized in local animal husbandry income generating projects. It is suggested that the market for hulls as fuel, soil stabilizer, litter, etc., be determined. Again, the project should keep abreast of both the export situation and the domestic supply situation in order to be able to adjust operations to meet existing needs.

D. Suggestions

As listed above.

E. Addendum

Complete data on operations should be collected for use in evaluating the performance and operation against other systems, other oil sources, and changed situations. At the present situation of supply and price, operating costs and efficiency are not a major issue but could quickly become so if the situation changes.

CONCLUSIONS

A. General

1. The project concept appears to be sound.
2. The technology in use is appropriate and adequate for the immediate goal of producing and processing oilseeds at the local level under existing conditions and environments.
3. Conditions vary widely from country to country and each country program should be treated as a separate project.
4. There is insufficient data to conduct a rigorous cost analysis or a meaningful analysis of economic and technical feasibility. In all cases (although for varied reasons), this does not appear to present an immediate problem. Nevertheless, the required data is essential for long-term planning and for the improvement of operations.
5. Press cake quality problems exist in varying degrees in each country and, while important, do not rule out the use of the cake as food supplement and/or weaning food ingredient, provided proper precautions to ensure safety are taken.
6. "Crude" oil quality generally presents no acceptability problems.
7. The nutritional need for the oil is apparent in all countries. The need for the expeller cake as a weaning food ingredient is most evident in Kenya and Upper Volta.
8. Recipient interest and participation, as well as interest and support for the project by CRS, local governments, USAID's, and other development agencies are widespread.

9. For the near future, normal market considerations will have little impact on the programs. Price, appearance, supply reliability, quality, etc. will become more important only when products are (a) produced in excess of those consumed locally and must therefore be sold, or (b) country-wide commercial production penetrates the local area and becomes competitive with the CRS system.

10. Understandably, little consideration has been given to the long-range planning and future expansion of the project

B. Kenya

1. In some areas (remote from the producing and processing centers), the sunflower program could meet a real and urgent nutritional and lipid/protein need.

2. Interest in the project is evident on the part of CRS/Kenya, USAID and GOK. The GOK and the existing major commercial sunflower promotor/processor view the CRS program as complementing rather than competing with national programs.

3. The aflatoxin problem is serious but does not rule out the use of the cake, provided steps are taken to properly harvest, dry and store the oilseed crop.

4. Cake use for weaning food is complicated by the need for relatively high fiber content for efficient expelling (high fiber content results in poor digestability). A possibility exists for reducing undesirable fiber by substituting maize (or millet, etc.) for the required hulls as a source of friction.

5. The ongoing and planned development of the commercial oilseed industry necessitates that: operating costs must be reduced; pressing efficiency must be improved; market conditions must be watched closely; reliable data of all types must be obtained and analyzed; and local

production promoted in areas remote from commercial production/ processing.

C. Rwanda

1. The project is admirably suited for this country - the oil is badly needed, and the environment extremely favorable since no other significant indigenous oil source exists.
2. Oil prices and supply are such that normal economic and technical feasibility, operating costs, and marketing considerations will be of minor importance for some time to come. However, these items should be addressed now to maintain the utility of the CRS system in the future.
3. The project is really just beginning and considerable advantage should be taken of other indigenous facilities and experience to help optimize operations. Outside training and inputs of technology could be very helpful.
4. Promotion is the current primary need.
5. Government of Rwanda, USAID, and other development agencies are highly supportive.

D. Upper Volt

1. The project has been dormant for the past 2 - 3 years and is essentially a new project. Interest and support on the part of CRS/Upper Volta, USAID, and Government of Upper Volta is evident.
2. The nutritional need for the oil is evident and the potential use of cake in weaning foods important.
3. Conditions vary widely throughout the country requiring that CRS/ Upper Volta identify: the most appropriate oilseed (or oilseed mixtures) for promotion in different parts of the country; which sections are most suited for the project; the best processing conditions

for each oilseed; ideal cake characteristics; and the most appropriate marketing and seed handling approach for each location.

E. <u>The Gambia</u>

1. Groundnuts are the predominant cash crop. This would indicate that the oilseed project has a questionable future. However, the economic situation and the fact that groundnuts are the major foreign exchange earner negate this. The bulk of the groundnuts are sold rather than eaten. Thus, the nutritional need is great and the cake could contribute to solving a major weaning problem. Sunflower promotion would serve the nutritional as well as income generation/conservation needs.
2. Interest by participants, CRS/Gambia, and USAID is apparent. Promotion of the project is well along in some areas. The Government of Gambia is supportive and feels it supplements rather than competes with the groundnut crop.
3. Economic and technical feasibility will have more importance here than in some other countries and could even become critical if the groundnut export situation changes drastically.
4. It appeared that the "oilseed module" installations were well constructed, designed and maintained. Data is probably available at the centers to assess the efficiency and cost of processing. If not, it must be obtained quickly. This information would indicate where cost reductions could be made and could be useful for improvi
in other countries.

RECOMMENDATIONS

A. General

1. Additional data are required for program and operations planning, operations control, increasing processing efficiency, reducing conversion costs, determining future economic and technical feasibility, establishing and improving cake quality and utility, and assisting and evaluating future programs. The types of data required are: seed analysis, cake analysis, processing material balance, operating costs, aflatoxin analysis, microbiological safety of cake, and nutritional value (PER and and possibly clinical assays) of cake. Specific needs for each country and recommendations for sources are included in the various country reports. Details are given in Appendix III to this report.

2. Tests should be run on mixtures of completely dehulled oilseed (primarily sunflower) and maize (or other potential weaning food ingredients) in order to determine the minimum amount of ingredient needed for efficient and economical press operation. Tests should also be run to determine optimum operating conditions for major sunflower varieties and other possible oilseeds which might be used to supplement or replace sunflower

3. It is important to obtain reliable data. Consider establishing a cooperative arrangement with a U.S. university or with an African institution to provide technical backstopping for conducting tests, evaluating modifications, and studying process parameters to establish the most cost-effective conditions.

A possible alternative would be for CRS to set up or designate a particular unit for this work and provide adequate technical staff and auxiliary equipment.

4. Consider the list of suggestions for minor system/operating modifications to increase yields and efficiency of system as listed in Appendix IV to this report.

5. Investigate alternate technology possibilities for increasing efficiency and minimizing cost. Possibilities include: a new expeller specifically designed for the application and a batch process using a hydraulically operated press.

6. Consider assistance for the CRS Agricultural Advisor (who is spread too thin) perhaps in the form of a specific all-Africa project manager or assistant, preferably a processing specialist. An alternate would be to provide a generalist or agriculturist assistant and establish a relationship with an outside processing consultant or organization for part-time consultancy.

7, Arrange a brief study tour of the U.S. by the Agricultural Advisor in order to have him (a) become familiar with conventional processing operations, (b) explore possible cooperative arrangements that could help improve the CRS operations. and (c) become familiar with alternate technology possibilities.

8. In any country where the CRS program provides grain grinding facilities, we recommend using one unit for partial size reduction of the oilseeds prior to expelling. This should improve the oilseed unit performance and might generate additional participation in both projects. Initial grinding of ingredients would be particularly helpful where e.g. the use of a mixture of oilseed and maize is contemplated.

Pregrinding might make up for reduced capacity and further improve cake uniformity and appearance.

9. To minimize aflatoxin contamination and improve operational efficiency, consideration should be given to installing central drying and storage facilities at Food and Nutrition Centers that house oilseed modules. A "rotating" system could be established. CRS would make an initial investment in sunflower seed, and process the seed into oil and cake. Immediately after harvest participants in the program would bring their sunflower to the Center and receive oil and cake equivalent to the weight of seed minus an amount charged for processing. At the Center the seeds would be properly dried and stored. The expeller would be operated only when sufficient seeds were accumulated to insure a continuous and efficient "run".

B. Kenya

In addition to accommodations listed under A.General, country specific recommendations follow:

1. Investigate the possibility of utilizing the solar dryer developed by the Applied Technology Unit at Karen to dry sunflower seed.
2. Coordinate with USAID and explore the possibilities of receiving USAID assistance.
3. To avoid locating a CRS module in an area where there is a competitive market for seed, make a thorough study or existing and contemplated production and processing areas. Make periodic checks on the general state of the vegetable oil industry in Kenya.
4. Consider relocating the Mbitini unit in a more remote location or making it strictly a test unit. The unit is now located in an area where a competitive sunflower market exists, and participants in the CRS program may choose to sell the seeds. This may or may not be advantageous to the seed grower but it means that the expeller is not utilized.

C. Rwanda

1. Promote the cultivation of improved sunflower varieties.
2. Work with Kigali hospital pediatrician on cake microbiological safety and "shelf life".
3. Explore cooperation with German soybean project installation at Nyanza to study the effect of pregrinding and cooking using their existing equipment. It may also be useful to install a CRS module at Nyanza and have the resident technicians determine optimum operating conditions.
4. Explore cooperation with the Sunflower Research Institute to identify best sunflower varieties for Rwanda.
5. Have Kenya check samples for aflatoxin (seed and cake).
6. Integrate the use of cake with weaning practice education.
7. Train operators thoroughly, possibly initially in Kenya. Project supervisor should also observe an existing operation for background.
8. Begin collection of information on existing oil and cake marketing practices. Preliminary plans for marketing and distribution of surplus products should be initiated.

D. Upper Volta

1. Consider supplementing sesame with cull groundnuts in the central area to increase raw material supplies.

   Explore karite nut processing using the expeller. A successful operation would (a) ease the workload on those who now process these nuts by hand, (b) increase oil supplies, and (c) improve expeller utilization.

2. Check on using Oil Research Institute in Ouagadougou for analysis of seed and products.

3. Establish operating parameters for groundnut, sesame, sunflower, and possibly karite as soon as practical - and before any public demonstrations.

4. A study should be made of the oilseed production and processing industry and marketing of oil and cake on a regional basis so as to permit rational module location and oilseed mix selection.

5. Consideration should be given to making the next one or two modules mobile because of the current predominant promotional and research nature of the program.

E. <u>The Gambia</u>

1. The safety and nutritional value of the cake should be carefully checked. Proper drying and storage conditions for seed should be taught and emphasized. Investigate cooperation with the I.T.A. (Food Technology Institute) in Dakar, Senegal to obtain data needed.

2. Utilize or recycle the oil settlings (useful in all country programs).

3. Check out palm kernel processing in the expeller for increased oil availability and press utilization.

4. The project personnel should constantly monitor the groundnut export situation to be alert for possible impact on CRS program.

CRS/Africa Oilseed Project

APPENDIX I-WORKSCOPE

Travel to Kenya, Rwanda, and The Gambia for a period of up to 4 weeks during August - September 1982. (This was later revised to include Upper Volta)

Provide recommendations to CRS on the technical and economic feasibility of the Oilseed Processing Module

Determine if the equipment being used is satisfactory for the intended purpose and if it is being operated and maintained properly. Recommend, if appropriate, changes in equipment and operating and maintenance procedures.

Access the yield and quality of oil and presscake, taking into account the intended uses of the product and the local environment. Recommend, if appropriate, changes in raw materials, product specifications, uses for the product, etc. that would lead to better utilization of the units to achieve their intended purposes.

Access the market for the oil and presscake to determine:

(a) need for the products at the local level and potential for them as saleable commodities elsewhere, (b) prices for the products and marketing costs involved in sale of the products, (c) competitive products available in the market and the effect of these products on potential sales for products from the processing units.

Determine the costs of product (fixed and working capital requirements, and operating costs including labor, utilities, maintenance, depreciations, interest on borrowed capial, etc.)

Determine ancillary costs above and beyond production costs, e.g. storage, transportation, marketing.

Identify future research and development activities with respect to equipment, crops, oil and presscake.

Assess the local attitude of government or community leaders, local businessmen, and other pertinent individuals toward the project.

Prepare a report summarizing the findings and recommendations, suitable for distribution to operators of the oilseed units, CRS and AID.

Report results of visit to CRS Country Directors and USAIDs prior to country departures.

CRS/Africa Oilseed Project

APPENDIX II - CONTAGTS

The following lists individuals with whom we discussed the CRS oilseed program and its potential impact on nutritional status and income, individuals who were sources of information and data, and major visits outside the CRS headquarters towns:

A. Kenya

CRS Personnel

(a) Regional

Michael Wiest	Assistant Regional Director
Andy Dennison	Project Assistant
Rhonda Saroff	Program Development Specialist

(b) Kenya

Ezra Mbogori	Project Manager
Edwin Kariuki	Oilseed Project Manager
Margaret Onyang	Program Animator
A. Karenja	Head Supervisor F & N
S. Mutungi	F & N Supervisor

USAID Personnel

Allison Herrick	Mission Director
Rose Britanik	Pop/Health Officer
Nancy Metcalf	FFP
Dave Lundberg	Ag. Econ.
Gary Lewis	Ag. Ext. Specialist

GOK Personnel

W.E. Adero	Head Crop Produ. Sect. Ministry of Agric. (MOA)
S.Q. Ogila	Head Oilseed Develop in Crop Prod. Sect. (MOA)
Helen Nandv	Public Health Service

Other

Mr. Ngugi	East Africa Industries
Peter Pohland	World Bank
Ken McCloud	World Bank

Major Visits

Iriamarai MCH Center (Embee area)

Mobile unit operation near Gonorole School (Embee)

Mbitini MCH Center-permanent unit

Appropriate technology Center (GOK, formerly UNICEF) Karen

B. Rwanda

(1) CRS Personnel

Joseph Payton (Deceased)	Program Director
Pauline Wilson	Program Assistant
Antoine Ruziga	Project Officer
Francois Kayihura	Oilseed extension agent
Francoise Nambaza	Food & Nutr. Supervisor

(2) USAID Personnel

Gene Chiavarolli	Director
Mary Becci	Project Officer

(3) FAO

Franco Becci	Project Manager

(4) GOR

Julienne Cjatinzi	Ministry of Social Affairs, Office of Nutrition

(5) Other

Dr. Bossyut	Pediatrician Kigali Hospital
Jim Conway	CLUSA Storage Project

Major Visits:

German expeller soybean project-Nyanza

Mukarange MCH Center (?)

Rweserio MCH Center

Kabgayi MCH Center

C. Upper Volta

(1) CRS Personnel

Peter Strazok	Program Director
Peter Sia	Project Officer
Susan Wright	Admin. Asst.
Gregoire Onedreogo	Sr. Supervisor
Barbara Fagley (R.N.)	Nutrition Officer
Patricia Haggerty	Nutrition Officer
Jerry Stanton	Project Asst.

(2) USAID

Emerson Mclaven	Mission Director
John Becker	Agr. Advisor
Helen Campton	Nutritionist
Dale Wright	Agr. Advisor

(3) U.S. Embassy

Julius Waring Walker Jr.	U.S. Ambassador to Upper Volta

Major Visits

Permanent Chinese expeller at Bwassa MCH Center

Depitage MCH Center

Manega Village Area (Karite at production area)

Sesame and Peanut production areas

D. The Gambia

CRS Personnel

James McLaughlin	Director
Penda Camaru	Agric. Home agt. Department of Agriculture-secunded to CRS
Jolly N'Jie	F & N Program Supervisor
Simon Cole	

USAID Personnel

Tom Moser	Mission Director
Keith Simmons	Program Manager
Quincy Benbon	Ag. Dev. Officer

GOG Personnel

D.S. N'jie	GPMB
Victor Bahoun	Agric. Stat. Ministry of Agric
Dr. A.B. H. N'ji	Asst. Director, Medical & Health Dept. Ministry of Health

Other

Tom Winn	CLUSA

E. Ivory Coast at REDSO Conference

Mellen Duffy	Nutrition Health Officer for REDSO W. Africa
Yaa Achiattagan	Asst. to FFP Officer, Ivory Coast
Mike Rugh	USAID/Upper Volta, Proj. Officer

F. Dakar/Senegal

USAID Personnel

Rick Gold	FFP Officer
John Baylis	Chief Ag Produ.

CRS Personnel

Norbert Clement	Director
Raymond Jones	Assistant Director

APPENDIX III - DATA REQUIRED

This section details the data to be obtained at the earliest possible date for both short and long-term project purposes. For convenience, these are listed here although some of the data may have greater importance in one country program than in another. Where possible, this is designated. Data obtained in one country should be shared with the other participating countries.

1. For Processing Operations Control

a. Seed analysis - oil content and moisture is to be run on a number of samples from each crop and from each area at the beginning of the harvest season. Samples should also be analyzed for hull content by running a conventional fiber analysis. At least one of the samples should be checked by physically separating the hulls by hand from a weighed portion of the same sample. This will also give an indication of the amount of fiber which is not in the hull.

Subsequent spot checks should be made (a) periodically and (b) anytime any unexpected results in processing are obtained, such as a sudden decrease in yield.

b. Cake analysis - oil and moisture content should be run (a) periodically to check visual evaluation of operating efficiency and (b) when any radical change in cake character, operating conditions, or seed appearance is noted.

Fiber content should be checked when blending proportions are changed (e.g. corn is added to completely dehulled seed). Note: If weaning food is to be produced, analysis of both seed and cake for protein content could be added as a control method.

c. Material balance - quantities of seed fed, oil produced, cake produced, and hulls produced should be measured as accurately as possible over periods of consistent operation such as a day. This will permit cross-checking of analysis and indicate possible sources of losses which might be corrected. (Note - Collection of the hulls might facilitate their use as fuel, soil stabilizer, animal litter, etc.) Experience will indicate the frequency of analysis that is really required after the initial trial periods. Oil settlings/filter cake should also be measured, unless these are recycled to the expeller and recovered as oil and cake. If the amount or character of these changes radically, processing conditions may need modification.

d. An analysis of the settlings for solids content by a filtering test or something similar will assist in deciding (based on oil loss) whether recycling to the expeller is essential. Note - This is not necessary if the settlings are consumed by the recipients or a market comparable to that for oil is established.

2. For Quality Control

a. Incoming oilseeds should be randomly checked for aflatoxin by means of the quick Ultraviolet Fluorescence Test. This test should be run daily at the beginning of the harvest season and thereafter anytime there has been excessive rain in the area or there is a change in the appearance of the seed. Oilseeds brought from a different area should always be screened. Suspect samples (fluorescence under UV) should be pooled and chemically analyzed for aflatoxin.

b. Cake samples should also be checked and, if necessary, analzed for aflatoxin.

c. If maize or another material is blended with the oilseed, aflatoxin screening of the grain could be a routine control method.

d. Oil quality in terms of taste (rancidity, etc.) and appearance (color, clarity) should be a routine daily test. In addition, random samples should be checked periodically for free fatty acid (FFA) as an indication of seed quality as well as oil quality.

3. For Project Planning and Development

a. Optimum Operating Conditions and Process Improvement

covered in Appendix IV "Operating Guidelines".

b. Cake End Use

(1) Blending Tests - If sunflower hulls are replaced by maize, sorghum, millet - whatever appropriate for the area in order to improve the digestibility of the cake, the least amount of e.g. corn required to give good oil yield should be determined. Data to be obtained include press capacity, oil yield, fuel consumption, cake appearance, oil quality, and cake composition. A comparison point should be obtained by a run on the same lot of seed containing the amount of hulls required for efficient operation.

(2) Nutritional Tests - PER tests should be run on samples of the blended cake and partially dehulled cake from the same seed lot.

c. Alternate Oilseeds

It is recommended that alternate oilseeds be explored as potential oil sources particularly in Upper Volta. These secondary sources could serve (a) as a supplement to sunflower, (b) to increase press utilization, (c) to decrease unit costs and (d) to serve as a buffer against any changes in the oilseed supply situation in any given area.

To determine if there is an economic advantage to using the expeller, similar oilseed samples should be processed by (a) the conventional methods in use in the region and (b) the expeller. Costs and yields should b pared. In general, the data required will be identical to that described in Appendix V "economic parameters".

Karite seed (Upper Volta) and Palm Kernel (The Gambia). The data required will be: oil yield and material balance information by present conventional processing, hopefully on a comparable lot a seed; current prices of nuts, oil (butter), and cake; and the cost of labor and materials to extract the oil conventionally.

d. Overall Market Situation

Data on the country situation will provide a picture of the environment in which the project will operate. This should be updated annually; changes and trends are often more significant than the values themselves. As pointed out in the country reports, the importance of having this information varies from country to country. The following information (by specific oilseed and vegetable oil) is useful in determining the situation:

(1) Oilseed production and farm and market prices;

(2) Oilseeds processed and oil and meal/cake prices ex-factory;

(3) Market prices for oil (crude and processed) and meal/cake;

(4) Processing capacity installed (broken down by solvent extraction, expeller plants, other);

(5) Oil, meal/cake, and oilseed exports;

(6) Oil, meal/cake, and oilseed imports;

(7) Animal fat production, imports, exports, pricing;

(8) Government policies and restrictions on oilseeds and oil and meal/cake.

More important, particularly in Kenya and Upper Volta is the market situation in the immediate area of a CRS module operation. In this case, it is essential that good data be collected on: oilseed prices and availability; vegetable oil prices and availability; local preferences on oil; local oilseed production and disposition, and local oil production (if any).

APPENDIX IV - OPERATING (TECHNICAL) GUIDELINES

The factors influencing operating efficiency and the indicators of efficient operation are summarized below. These are based on sunflower operations and will apply to other oilseeds generally although details may vary slightly for different oilseeds. Although not necessarily critical in the current development/pilot program they will become increasingly important and should be instituted, as soon as practical. The various options require study since the extra cost may not always be justified. Suggestions for improvement in operating efficiency are consolidated at the end of this Appendix.

Factors Influencing Conversion Efficiency

1. Feed Preparation

   a. Size and uniformity facilitate a uniform feed rate and result in improved performance. Size reduction (by rolling or cracking) also assists in any subsequent conditioning/cooking process. Some sort of positive forced feed to the expeller would also improve performance.

   b. Preconditioning/cooking improves performance by: increasing press capacity, increasing oil yield, improving oil clarity, decreasing power consumption, and improving cake formation. Cooking also tends to deactivate enzymes and, improve nutritional quality.

      The usual commercial process is size reduction by rolling, cooking at initial high moisture (12 - 15% - add as steam or spray) with subsequent drying to low moisture (around 3% - 4%)

with cooking and drying time at about 15 to 20 minutes. A simplified village level methodology could be readily devised. This process tends to rupture the oil cells, partially denature the protein (improving cake formation and oil clarification), and eliminates using the expeller as a preheater, which is now the case in the CRS process. Precooking would substantially increase the potential press capacity and decrease power use. The feed should be introduced under some pressure to insure a continuous and uniform suppl

c. Adjusting fiber content to that required to form a coherent cake is essential for reasonable oil yield. Excess fiber will tend to retain oil and reduce yield while insufficient fiber will result in little separation of oil and solids. Fiber content may be adjusted by (a) complete dehulling plus the addition of a nutrition ingredient (maize, sorghum, millet, etc.); (b) partial dehulling; (c) adding back a pre-determined small amount of inert fiber or hulls. Cooking will decrease the amount of fiber required. Low oil content materials (like soybeans) will require little, if any, fiber.

2. Nature of the Equipment

Both expellers in use by CRS are adaptations of old designs and use relatively crude materials of construction. This permits less pressure development (resulting in lower oil yields) than is possible in modern larger expellers. A check with an expeller design expert indicated a good possibility that a similar machine could be designed with improved performance and a possibly lower manufacturing cost.

Elsewhere in this report, it has been suggested that alternate technologies be investigated for specific applications as well as to insure that the expeller route is the best approach. For example, batch processing would give

considerably greater flexibility in operations and is generally feasible for small-scale processing.

Maintenance costs could be substantial with the existing system both in money and utilization of capacity. Materials of construction of certain wearing parts might be a major contributor to this excessive maintenance and should be considered in any redesign or alternative.

3. Procedures and Management

A major economic factor is the maximum utilization of the system capacity. Faithful procurement of the control data listed in Appendix III, its interpretation, and corrective action is critical to efficient continuous operation.

The raw material supply and product distribution systems should be controlled and organized to insure available feed to the system for as much of the time as possible.

The processing of alternate oilseeds to supplement sunflower would contribute to operating efficienty by decreasing the unit fixed costs. Enough supply of a given oilseed or oilseed mixture should be accumulated for a substantial production run so that raw materials are not mixed during processing (system should be cleaned before switching raw materials). The steady operation would help maintain high efficiency.

4. Miscellaneous -

Other factors which can influence costs and yields but over which little control can be exercised include: seed varieties; seasonal variations; seed growing conditions during the year; seed compostion (oil content and moisture content); and consumer product preferences.

Indicators of Efficient Operation

1. Oil yield (% oil remaining in the cake).
2. Throughput (kg per hour of seed vs standard desirable).
3. Capacity Utilization (Hours of operation at standard throughput per

year vs standard desirable).

4. Losses (Seed input to system vs total products obtained).

5. Visual (cake should be uniform, relatively hard, and hot. Oil should discharge uniformly and be cloudy but not muddy - very little fine solids)

Summary

1. Cooking/drying prior to expelling -

Heating (cooking) the raw material at elevated moisture content and drying will condition the feed, and result in greater throughput for a set amount of power input and in increased oil extraction. It will also facilitate clarification of the oil produced, whether by settling or filtration. This will become important as refinement of product cost and increased capacity are required./

2. Cracking the seed -

This will facilitate cooking and feeding the expeller uniformly as per above. It could also help dehull the thick-hulled, off-grade seed.

3. If seeds are not precooked, dehulling difficulties with high moisture seed may be decreased by drying and storing to provide time for the seed to shrink away from the hull (primarily soybean, possibly also safflower)

4. Consider cull peanuts (broken, small, etc. or soybeans) as an alternate raw material to increase utilization of press capacity (reducing unit costs).

5. Check out feasibility of substituting electrical drive for expeller and dehuller in stationary units where it is available and reasonably priced For example, power costs may be appreciably less than diesel-based costs in Rwanda.

6. Settlings from oil must be reprocessed (by gradual addition to ex-

peller feed) or utilized as a food to prevent major oil losses. As an alternate, consider addition of a simple filter to the system.

7. Consider intermediate screening of hulls to recover fine meats.

8. Investigate possibility of having a new machine especially designed for the application which can, at least in part, be fabricated locally. Also check out alternate technology.

9. Determine optimum operating conditions for all oilseeds and the oilseed/grain mixtures discussed.

0. Provide proper training for operators and maintain adequate supervision of their activities.

11. Consider cooperating with the German Soybean Project in Rwanda to get preliminary data on feed preparation to the expeller.

APPENDIX V. ECONOMIC PARAMETERS

This Appendix discusses the important factors which affect economic feasiblity. Available data are insufficient for a rigorous economic feasibility analysis. Cost calculations are therefore based on data which might reasonable be obtained from the normal operation of a stationary oilseed module located in Kenya.

It is assumed that (a) sunflower seed production goals of 200 kg. per participant are attained, (b) the seed quality is good, and (c) the expeller site is removed from present commercial growing and oilseed processing areas.

The economic values of major concern include (a) the cost of producing a liter of oil from a kg. of sunflower seed, and (b) the return, received by the participant in the CRS oilseed program, per kg. of seed brought to the center for processing.

Basic assumptions and calculations are presented. Illustrations and discussions of each of the important factors affecting cost and return follow. Graphs are presented that illustrate the economic effects of modifying operation procedures.

Results should be considered as order of magnitude indicators. Complete operating data secured over a significant period of time are required to ascertain actual costs and to verify/refute assumptions.

Basic Processing Costs and Return on Seed

A. Assumptions:

1. An expeller capacity of 30 kg./hour of feed. In a 10-hour day, assuming 8 hours of actual operation, 240 kg. of feed are processed
2. Sunflower seed composition: 32% oil, 30% hulls and 38% other (protein, carbohydrate, etc.)
3. The expeller residue cake contains 20% non-expressed oil.
4. The hull content of the feed to the expeller is 15%.
5. Sufficient seed is available for 100 days per year operation (24 tonnes, 1 tonne = 1,000 kg.
6. Oil settlings are all recycled to the expeller feed.
7. Petrol cost is 7.02 sh./liter (11 sh. = $1.00 U.S.)
8. Diesel cost is 5.15 sh./liter
9. Based on Kenya data 22 liters of diesel and 8 liters of petrol are used to process 1 tonne of sunflower seed (dehull seeds and expel oil).
10. Cost of oilseed module is 94.000 sh

b. Estimated Oil Yield/Kg. of Sunflower Seed

Assumptions:

Oilseed composition - 70% meats (32% oil + 38% other), 30% hulls.

Feed to expeller contains 15% hulls.

1) Weight of Feed Derived from 1 kg. of Sunflower Seed

x = wt. of hulls; x + .70 = wt. of feed to expeller

$$\frac{x}{x + .70} = .15 \text{ (desired fraction of hulls in feed).}$$

x = 0.124 kg. = wt. of hulls in feed derived from 1 kg. of seed

(x + .70) = 0.824 kg. = wt. of feed/kg. of sunflower seed.

2) Oil Left in Cake (from 1 kg. of seed)

Assumption: 20% oil left in cake.

Weight of an oil-free cake is (0.824 - 2.32) = 0.504 kg.

x = wt. of oil in cake; x + 0.504 - weight of cake and $\frac{x}{x + 0.504} = .20$ (fractic of oil in cake)

x = 0.126 kg. = weight of oil in cake

3) Weight of Cake from 1 kg. of Seed

(x + 0.504) = 0.63 kg. = weight of cake.

4) Recovered Oil from Original 1 kg. of Sunflower Seed (Oil/kg. of Seed)

.32 - 0.126 = 0.194 kg. of oil/kg. of seed

f density of oil = 0.9 = $\frac{0.194}{.9}$ = 0.216 liter of oil/kg. seed

5) One Kg. of Sunflower Seed Yields

0.194 kg. (0.216 liter) of oil

0.63 kg. of expeller cake containing 0.126 kg. of oil

C. Processing Costs for Operating an Oil Seed Module for One Year

1) Variable Costs/Year

	Per Tonne of Sunflower Seed
Fuel (diesel) for expeller	115 sh.
Fuel (petrol) for dehuller	57
Maintenance (parts derived from Kenya data)	203
	375 sh.

Since a year's production is 24 tonnes; variable costs/yr. = 9,000 sh.

2) "Bare" (subsidized) fixed costs/year

Labor (operator)	10,000 sh.
Incidentals	200
	10,200 sh.

3) Normal Fixed Costs/year

"Bare" costs	10,200 sh.
Depreciation @ 10% (equipment)	9,400
Interest @ 5% (concess.)	800
Overhead @ 30% salary (supervisory)	3,300
Lost interest on Operating capital	2,000
	25,700 sh.

D. Cost to Produce 1 Liter of Oil (Crediting Cake Value)

1) Based on "Bare" Costs

Variable costs/yr.	9,000 sh.
"Bare" fixed costs/yr.	10,200
Total cost for processing (24 tonnes of seed)	19,200 sh.

Cost for processing 1 kg. of seed = $\frac{19,200}{24,000}$ = 0.8 sh./kg

Cost for Producing 1 Liter of Oil = $\frac{\text{processing cost for 1 kg. of seed}}{\text{liters of oil obtained from 1 kg. seed}}$ =

$\frac{0.8}{.216}$ = 3.71 sh/liter

Cake value for every liter of oil produced

1 kg. of sunflower seed yields 0.63 kg. of cake and 0.216 liter of oil.

wt. of cake/liter of oil = 0.63/.216 = 2.91 kg.

value of cake/liter of oil = 2.91 kg. x 0.5 sh./kg. = 1.46 sh.

Oil cost (crediting cake value) per liter of oil produced

3.71 - 1.46 = 2.25 sh.

2) Based on Normal Fixed Costs

variable costs/yr.	9,000 sh.
"Normal" fixed costs/yr.	25,700
Total Cost for processing (24 tonnes of seed)	34,700 sh.

Cost for processing 1 kg. of seed:

34,720 sh./24,000 = 1.45 sh./kg.

Cost for producing 1 liter of oil:

Since each kg. of seed yields .216 liter of oil

cost/liter = 1.45/.216 = 6.71 sh.

Cake value for each liter of oil = 1.46 sh.

Oil cost (crediting cake value) per liter of oil produced

6.71 - 1.46 = 5.25 sh./liter

E. Return to Each Participant for Each Kg. of Seed Grown

Assumptions:

Oil purchased costs 15 sh./kg. (Retail Price)

Income from cake (if sold) is 0.5 sh./kg.

1) "Bare" Cost Return/Kg. of Seed Grown

Value of Products /Kg. seed Grown

Value of oil (15 sh./kg. x .194 kg. oil/kg. seed) = 2.91 sh./kg. seed

Value of cake (0.5 sh./kg. x .630 kg. cake/kg. seed) = 0.32 sh./kg. seed

Total value = 3.23 sh./kg. seed grown

Processing Cost/Kg. of Seed Grown (from D.1)

Cost to produce 1 liter of oil = 3.71 sh.

Liters of oil/kg. of seed = .216 liter

Oil processing cost/kg. of seed = 3.71 x .216 = 0.80 sh./kg. seed grown

Net return (3.23 (value of product) - 0.80 (processing cost) = 2.43 sh./kg. seed grown

∴ Net Return to each participant for each kg. of seed grown = 2.43 sh.

2) "Normal" Cost Return/Kg. of Seed

Value of oil and cake (from E.1) 3.23 sh./kg. seed

Processing Cost/Kg. of Seed Grown (from D.2)

Cost to Produce 1 liter of oil = 6.71 sh.

Liters of oil/kg. of seed = .216 liter

Oil Processing cost/kg. of seed=(6.71 x .216) = 1.33 sh./kg. seed grown

Net return = (3.23 (value of product) - 1.33(Processing cost)= 1.90 sh./kg. seed grown

∴ Net return to each participant for each kg. of seed grown = 1.90 sh.

Effect of Oil Yield

The oil content of the presscake is one of the more important variables and is a convenient measure of expeller operating efficiency and can be measured by direct analysis. The theoretical oil yield (oil content of seed minus oil in cake) can be checked against that actually recovered. Any appreciable discrepancy is an indication that there are physical losses in the operation or that the settlings are not being recycled.

Figure 1 at the end of this appendix illustrates the effect of reducing the oil content of the cake (more efficient expeller operation) on (a) the cost to produce one liter of oil, (b) the return per kg. of seed, and (c) the yield of oil. Figure 1 also illustrates the difference in cost and in return which results from using a Normal Cost Basis as opposed to a Bare Cost Basis. (subsidized operation).

Since the amount of oil returned to the participants is of prime importance, note that 30% oil content of cake results in only 115 liters of oil being obtained from one tonne of seed. Reduction to 20% oil in the cake yields an additional 100 liters of oil; to 15% an additional 41 liters; and to 7%, which should be the eventual target, an additional 51 liters. Operating at 7% oil content in the cake yields 313 liters of oil per tonne of oilseed, an increase of almost 100 liters as compared to the yield of 215 liters of oil when the oil content of the cake is 20%.

Although the effect of oil yield is substantial, the costing basis used (bare vs normal) has an even greater effect. The use of the "bare cost" basis also tends to decrease the effect of change in oil yield. Figure 1 also indicates roughly the operating cost range of commercial operations and the German project in Rwanda. (The German project costs have little significance as such since the operation is on soybeans but the figure is given for comparison).

Costs shown are far below the market price of the oil (17 sh/L). This is true only because the cost of the raw material (seed) is not included. For example, at Sh 2.0 per kg. of seed and normal costs, the total cost per liter of oil, with 20% oil content cake, would be about 15 shillings, quite close to the market price of oil.

Effect of Capacity Increase

Figure 2, at the end of this Appendix, illustrates the effect of increasing the amount of seed processed each day on the cost per liter of the oil produced. The magnitude of this effect indicates the value of taking steps to increase expeller throughput/day.

Effect of Module Utilization

Figure 3, at the end of this Appendix, illustrates the effect of operating the module at a given daily throughput for varying number of days during the year. It emphasizes the importance of the promotional aspect in providing a reasonable seed supply. As usual, the effect is considerably greater if the normal costing basis is used rather than the "bare cost" basis. Figure 3 can also be used to evaluate the effect of adding supplemental processing of non-participant seed if the costs collected for doing so are first translated into equivalent "days" of costs. For example, if the processing were done on a cost plus 20% basis, each day would be equivalent of 1.2 days.

Effect of Cake Value

Figure 4, at the end of this Appendix, demonstrates that the value assigned to the cake is a major factor in determining the cost of the oil produced. On the "bare cost" basis, a value of 1.5 shillings per kg. (1500 sh/tonne = U.S. $136 per tonne, which approaches its normal commercial value as animal feed), results in a negative cost per kg. of oil. Extrapolation indicates this would also be true on a normal costing basis if the cake value were 20 shillings per kilogram.

Other

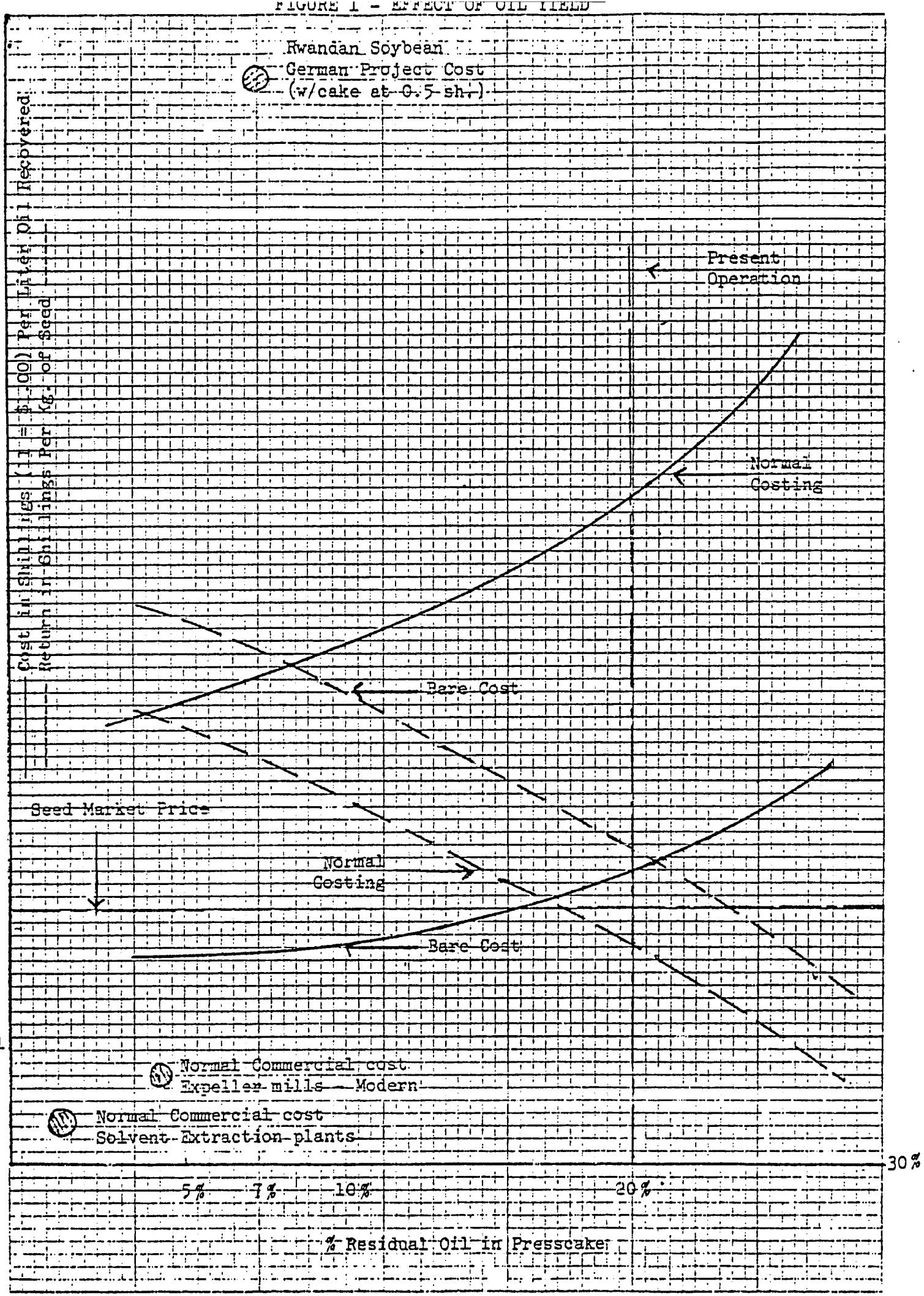
1. Losses - The material balance measurements recommended in Appendix III are important as an indication of losses of product as well as the quality of the operation. Losses may indicate poor quality seed - excessive trash or high moisture (which would be partially lost during the processing through evaporation). Since high seed moisture is also detrimental to cake and oil quality some penalty based on the analyses for moisture and trash would normally be levied on the supplier in a commercial operation

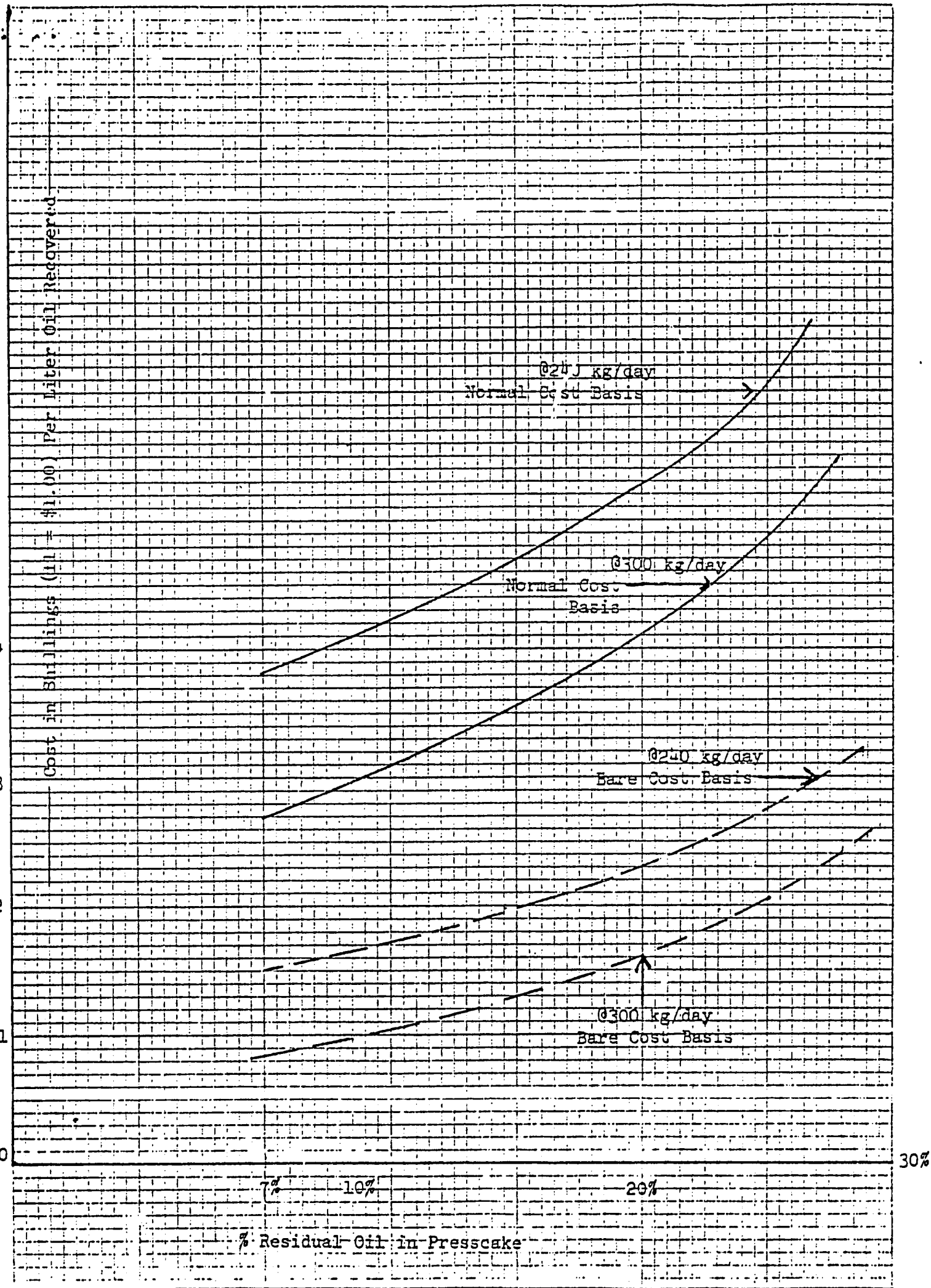
2. Hull Utilization - Realizing some return on the hulls will affect the cost of oil produced and return on seed similar to the effect of the value selected for the cake. The magnitude of the effect will depend on the amount and value of hulls sold.

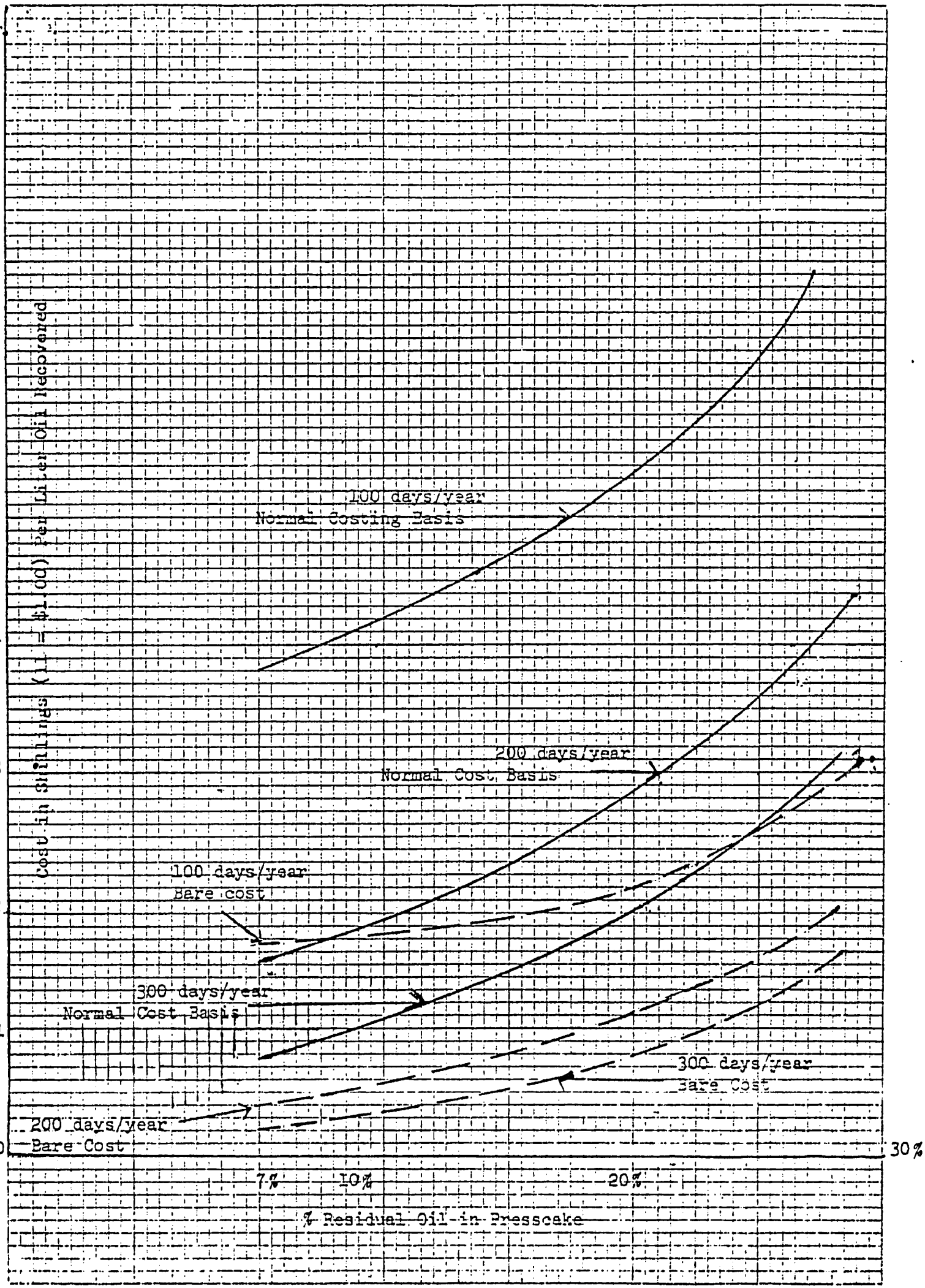
3. Costs of fuel - The importance of this factor depends on whether "bare cost" or normal costing basis is used. If the bare cost basis is used, a 100% increase in the cost of diesel and petrol will result in approximately 35% increase in the cost per liter of oil produced. If the normal costing basis is used, only about 15% increase in oil cost results from a 100% increase in fuel costs. This is applicable at the assumed conditions for the basic calculations. At lower costs for oil (such as obtained by pressing to lower oil content in the cake), the percentage increases would be greater.

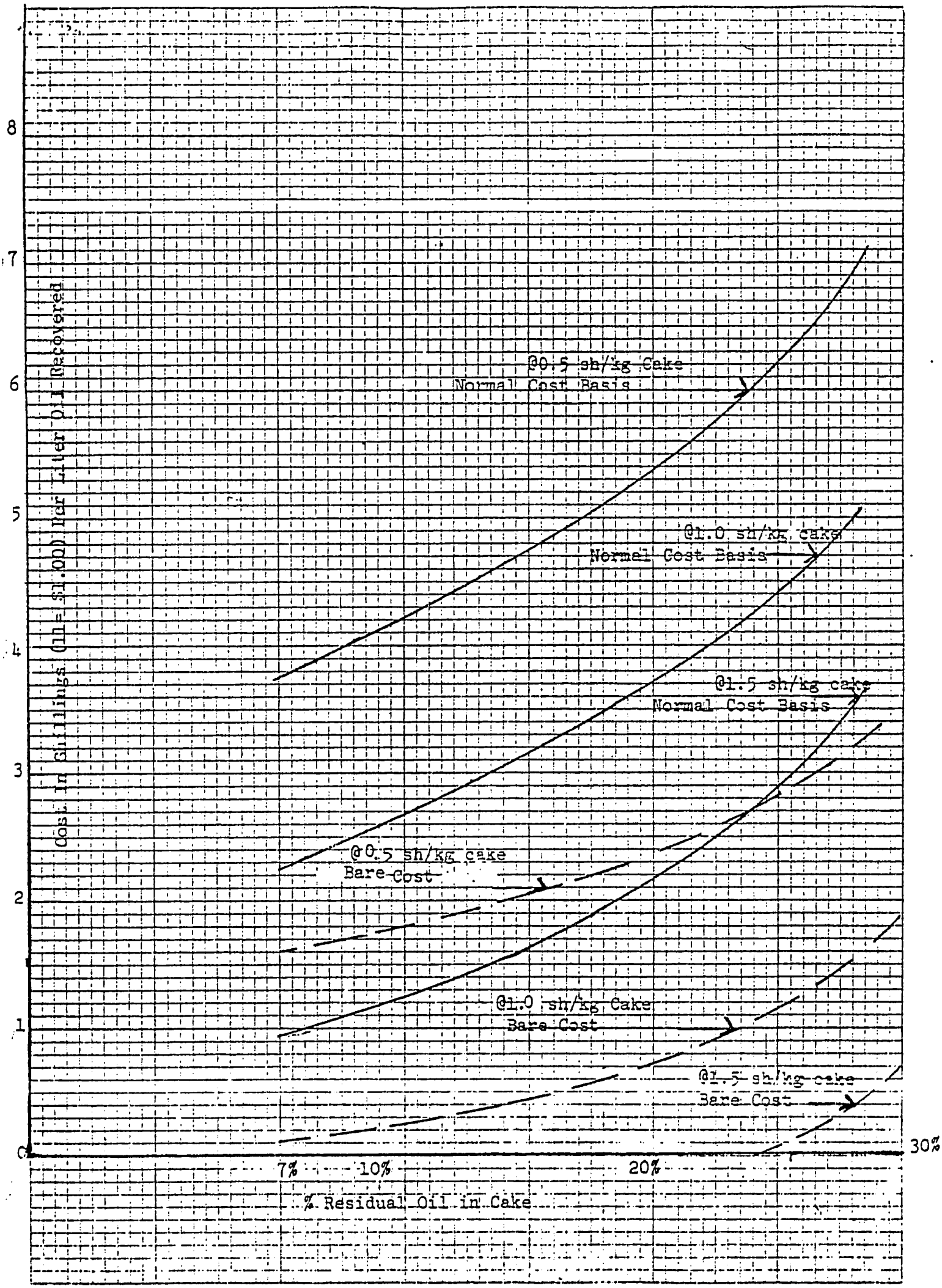
4. Normal Commercial Costs - These would normally include the following (in addition to those already discussed): collection, transport, drying and storage of seed; further processing and packaging of products; product storage and distribution; product marketing; and substantial accounting, financing and overhead costs. These additional costs are not currently part of the CRS project consideration, but do affect the economic environment in which the project operates.

FIGURE 1 - EFFECT OF OIL YIELD




Cost in Billings (11 = $1.00) Per Liter Oil Recovered
8
7
6
5
4
3
2
1
0
@240 kg/day
Normal Cost Basis
@300 kg/day
Normal Cost Basis
@240 kg/day
Bare Cost Basis
@300 kg/day
Bare Cost Basis
7%
10%
20%
30%
% Residual Oil in Presscake


Cost in Shillings (1 = $1.00) Per Liter Oil Recovered
8
7
6
5
4
3
2
1
0
100 days/year
Normal Costing Basis
200 days/year
Normal Cost Basis
100 days/year
Bare cost
300 days/year
Normal Cost Basis
300 days/year
Bare Cost
200 days/year
Bare Cost
7%
10%
20%
30%
% Residual Oil in Presscake


Cost In Shillings (1h = $1.00) Per Liter Oil Recovered
8
7
6
5
4
3
2
1
0
@0.5 sh/kg Cake
Normal Cost Basis
@1.0 sh/kg cake
Normal Cost Basis
@1.5 sh/kg cake
Normal Cost Basis
@0.5 sh/kg cake
Bare Cost
@1.0 sh/kg Cake
Bare Cost
@1.5 sh/kg cake
Bare Cost
7%
10%
20%
30%
% Residual Oil in Cake

APPENDIX VI - Market Guidelines

1. As outlined in the basic project concepts, the main guideline would be to adhere as closely as possible to keeping the operations on a local basis and as a closed economic system. The participants produce the seeds and consume/dispose of the products. They are both the producer and consumer. From the information we obtained, this appears to be most important in Kenya, next in Gambia, next in Upper Volta, and least in Rwanda

2. If a supplementary commercial pressing activity such as karite and palm kernel is entered into to reduce unit conversion costs, it would probably be best handled by pressing for others for a fee. There would be no marketing involved by the project.

3. The amounts of products available from any one unit under the best of circumstances would probably not justify even a minimal organized marketing effort. First priority should be given to the participants selling/bartering surpluses to friends, neighbors, etc. Any required sales above that should be on a bulk, wholesale basis from the units, perhaps through local cooperatives.

4. Normal marketing considerations should be kept in mind and used as guidelines to the extent practical. Their application will help build and maintain participation and increase the project's ability to adopt to changes in the operating environment. Some of these considerations are:

(a) Market Oil Prices - In most developing countries this is a key factor in purchases and Africa is no exception. Prices should be watched closely in the project countries and compared with cost of the production of oil from the CRS system. A market price for oil approaching the CRS cost will probably limit participants to those who do not have the cash to buy oil in the market. Since oil prices fluctuate, this provides one more argument for improving efficiency and minimizing costs.

(b) Market Price of Seed - This has been a problem in Kenya where a unit is located near a commercial growing and processing area. The seed price obtained by the participants from the commercial processors agents is so attractive that many are reportedly selling their seed rather than bringing it to the CRS center for processing. This helps attain the income generation feature of the project but plays hob with the processing module unit costs. In this case, the only solution may be to relocate the unit.

(c) International Markets - International prices will generally tend to influence local prices. If low enough, they have several effects. First, if the cost of imported oil is low enough so that it can be distributed at a cost below that of domestically produced oil (even with the duties imposed on its import) it will tend to be imported thus increasing supplies and lowering prices. A second possibility is that the government may encourage export of internally produced higher valued oils abroad (sunflower, peanuts) to earn foreign exchange and import cheaper oils such as soybean. These imports will become important if they result in depressing domestic market prices for oil to a point approaching the cost of oil production by the CRS module.

(d) Preferences - Although of great importance in the developed countries, cost generally outweighs preferences in the less developed countries except where taboos or customs of use prevail. Of particular relevance in the countries visited, is the wide acceptance, and even preference in many cases, for non-processed (commonly called crude) oil. This is a key to the "closed system" module.

(e) Other - In the event some surplus oil or cake is to be marketed, several other items which normally affect marketability may come into

play, such as convenience (packaging and transport cost), appearance, quality, and reliability of supply. Obviously, more care will be required in the operation, quality control will need to be more strict, and some cost and effort will be required to market the surplus.