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CAPITAL GOODS IN FOOD-PROCESSING INDUSTRY

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Selected machinery and equipment appropriate to developing countries in the grain milling and oil seed processing subsectors

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Summary

Developing countries could benefit from an increased level of production of capital goods. This report deals with capital goods for the food processing industry and particularly with those required for the grain milling sub sector and the oil seeds processing sub sector. The report analyses these two sub sectors according to their unit operations and the medular and peripheral capital goods which they utilize.

The two industrial sectors which are studied here cover processing needs of many and sometimes widely different raw materials. The report analyses the wide range of capital goods required for the processing of these ingredients at different levels of size or sophistication of operation and seeks to establish similarities in equipment requirements that could help in providing a bigger local industrial demand base required for an establishment of a local capital goods manufacturing industry.
The report discusses the capability of different developing countries to manufacture capital goods vis-a-vis the complexity of the capital goods which the milling industry and the vegetable oils and fats industry require and arrives at a list of such capital goods which could evenually be manufactured in the developing countries.

The demand for capital goods in the grain milling and vegetable oil sub sector is discussed in this report vis-a-vis the constraints which dominate the field of demand in developing countries. Questions of know-how availability, manufacturing capability and availability of technical personnel are discussed as well.

Several recommendations are made. These are directed towards the following active areas:

1. Determination of real demand in identified markets for specific capital goods.
2. Determination of local manufacturing of capital goods required per 1 above.
3. Formulate policies and initiate actions directed towards the requirements of 1 and 2 mentioned above.
4. Plan and initiate training and educational programs for the preparation of technicians at all levels which are required by the actions recommended above.

1. Introduction

The purpose of this report is to assist in the definition of indutrial strategies, which will lead to the formulation of policies and of plans of action concerning capital goods in the food industry in developing countries. As part of the general objective of identifying the capital goods requirements in the food processing industry in developing countries and those that have a potential for local production, an immediate objective of this study is to identify the peripheral capital goods that the grain milling and the oilseed processing lines have in common. Of these capital goods those that have a potential for local production in developing countries should be identified.

In the preparation of this study advantage was taken of already available analyses of agro-food capital goods prepared by consultants to Unido as well as other Unido publications. Furthermore, use was made of technical publications and technical literature as well as publications, brochures and bulletins of manufacturers of capital goods for the food industry in general and for the grain milling and oil seed processing in particularly. Additionally, the consultant drew on his personal experience related to the food industry in developing countries and to the capital goods manufacturing industry as well as on personal contacts with experts in these industries. A list of selected references is given in Chaper 6.

Chapter 2 gives a review of the main technologies available world wide for processing vegetable oils and fats and for grain milling. The review deals with the milling industries of the leading cereals world wide - wheat, maize and rice, and with the technologies that are utilized in these industries. It also reviews the technology in the field of oil extraction and processing. Different cereals are different in morphology composition, structure and grain characteristics. This results in the need for different milling technologies, different milling techniques and equipment. Many different oil seeds are utilized world wide for vegetable oil extraction. These include, among others, soybeans, cottonseeds, peanuts, rapeseed, safflower, sunflower and seasame.

Palm fruit, copra and other sources of vegetable oil are of a major importance in various developing countries as well. These sources of vegetable oil represent a very wide range of raw material properties which necessitate the use of different approaches and different equipment design. Such considerations are affected by seed size, shape, composition, structure as well as by seed characteristics. Selection of technologies and the resulting capital goods requirements are sometimes influenced by plant size. Local factors determine optimal plant size.

Availability of raw material(s), infrastructure, funds for investment and marketing opportunities will determine plant size. Technology is available for small or large, batch or continuous, automated or manual plants. Trends in energy conservation in the vegetable oil industry and in the wheat milling industry are discussed as well.

Chapter 2 gives also a breakdown of the most important capital goods utilized in the grain milling industry and in the vegetable oil industry in terms of medular and peripheral capital goods and gives the classification into these two groups for both sub sectors based on the omplexity Index Criteria.

Based on the relative degree of industrialization (table 1), four different levels of degree of industrialization are assigned in decreasing order to Brasil and India, Colombia, Nigeria, Central African Republic and a preliminary identification of capital goods that can be produced in these, and in si ilarly developed developing countries is di cussed.

Chapter 3 reviews the basic problems and issues affecting the development of the manufacturing industry of capital goods for food processing in general and for oilseeds processing and grain milling in particular.

Following a short review of the benefits to the national economy obtainable through the development of a capital goods manufacturing industry, a number of key issues are discussed. The first issue is that of demand and of competition.
Demand depends on different factors. It is related to the availability of the product and to the level in which it is required, but also to the purchasing power of the target customer. The demand for vegetable oil and the demand for ground grain will influence the size of these industries on a national and regional level and could help in establishing the demand for processing equipment. Study and knowledge of these dynamics could help in estimating the demand for medular or peripheral capital goods that will be generated through the demand for more vegetable oil or more milled grains. Availability of capital for investment, both in vegetable oil producing and grain milling plants, as well as in the capital goods manufacturing industry, will determine the level of the development of the capital goods manufacturing industry. Capital goods producing industry requires construction of new factories or enlargement of existing ones. It is noted that both grain milling and oil seed processing installations located in different developing countries are utilized to date at sub capacity. This might to an extent dampen the demand for additional capital goods.

The way in which leading manufacturers of capital goods for the food industry in general, and that of the relatively few companies which dominate the scene with equipment for grain milling or oil seeds processing is discussed.

The way in which leading manufacturers of capital goods for the food industry in general, and that of the relatively few companies with equipment for grain milling or oil seed processing dominate the scene is discussed.

Chapter 3 also di cusses the issues of know-how, engineering and services. These are issues of paramount importance for the success of a capital goods manufacturing industry. It emphasizes the importance of engineering skills on a national and local level, and the role that they can play in helping to minimize importation of capital goods to the level required, and assisting in the development of a local capital goods manufacturing industry. The importance of training of technicians at all levels is discussed as well.

In almost al of the developing countries there is at least some capital goods manufacturing capabilities. These facilities could be utilized and others could be developed if the demand is significant enough.

Chapter 3 discusses the different ways in which a foreign, know-how owning manufacturer of capital goods might approach the need or sometimes the desire to set up local production. It lists such possible linking arrangements to the level of industrial development discussed earlier.

Promotional activities are discussed in Chapter 3 as well. These activities could be considered as both indirect and direct. Formulation of policies and strategies for promotion of agriculture, food, nutrition and both general and technical training and education are among these activities. These though are not enough. Financial schemes for assistance to the national capital goods manufacturing industry as well as establishment of importation policy that will help or favor local manufacturing of capital goods are considered as well.

Chapter 3 proposes a list of peripheral capital goods which could represent a goal and production target for developing countries at levels 3 and 4.

Chapter 4 is devoted to main findings and recommendations. Several recommendations are made. Basically, these recommendations are related to the determination of possibl future or actual demand for capital goods for the food industry sub sectors studied here, and possibly others, to study and determine what should be done in order to bring about improvement in local capabilities in developing countries to manufacture capital goods, and finally to initiate a program that will guide the local government. This guidance may be required in formulating policies that will result in increased involvement and activities in the local capital goods manufacturing sector by foreign and local companies. Final recommendation deals with the need to study and analyse training requirements and assist national governments in planning and execution of training programs.

2. Capital Goods In The Vegtable Oils And Fats and In The Grain Milling Industries

2.1 General

This chapter reviews the basic technological elements employed in the production of vegetable oils and fats and in grain milling at different levels of sophistication. It covers the production of oils and fats from copra, palm, soy, cottonsees, rapeseed, sunflower, safflower, peanuts and the milling of wheat, maize and rice.

2.2 Processing Technologies for Vegetable Oils and Fats

2.2.1 General

The Vegetablo fats and oils industry is very old. Different technologies are employed by this industry to accomodate a large variety of raw materials, processed under different sets of local conditions. This industry has moved from old techniques to modern technologies. Mechanical screw pressing and solvent extraction dominate the scene world wide. A number of equipment manufacturers with vast experiences and precious know-how offer both turn key projects and supply of individual pieces of equipment to potential and existing oil producres.

2.2.2 Preliminary Preparatory Steps: Unloading, Cleaning, Drying and Storage of Vegetabbe oil Bearing Materials

Vegetable oil bearing raw materials (oil seeds) can be delivered to the processing plants in bulk ships, bulk railroad cars, bulk trucks, boxes, field boxes, sacks or bags. Unloading installations are designed to accomodate methods of oil seeds delivery. Plant size and selection of technology depends on local economic conditions and on raw materials availability. This will be emphasized in a different part of this study (1a).

2.2.2.1 Unloading

Bulk trucks are usually emptied by elevating the front end of the truck on a platform and letting the raw material slide out and into the receiving pit. Conventional conveying systems such as chain, drag, screw or belt conveyors, bucket elevators can be used for most oil seeds. Some like copra and palm fruit require special considerations, in design or in care of handling. Pneumatic unloading systems and marine legs are efficient unloading systems. They can reach a throughput of up to 2000 tons of oilseeds per hour. Pnuematic unloading systems of a much smaller capacity can be utilized as well. Requirements depend on the size of the oilseed processing facility and the organization of the raw material flow.

Unloading can be done sometimes with the help of forklift trucks (olives) or by human labor, when oil seeds are delivered in sacks or in bags (1a).

2.2.2.2 Cleaning

Cleaning of oilseeds removes sand, dirt, stems, leaves, weed seeds, stones, metals, field wastes etc. This operation involves a series of shaking or vibrating screens. Removal of dust as well as light weight materials can be done by aspirators. This step in the process yields separately clean oil seeds, stones, metal pieces, sand, dirt etc., and dust free air (1a, 1b).

2.2.2.3 Drying

In order to ensure oil seeds quality and safe storage, moisture in incoming oilseeds needs to be monitored and in most cases reduced to a level (which is characteristic to each oilseed variety) which will promote safe storage. This is achieved in the receiver driyer. Free flowing type oil seeds are dried in conventional grain dryers. Drying is done by subjecting the oil seeds to heated air and the subsequent loss of oilseed moisture to the drying air. Once drying is completed, and prior to the storage of the oil seeds, ambient air is used for cooling. Grain drying and cooloing requires heating of drying air by steam, gas or oil, and flow of heated air trough the moving bed of the oil seeds. Recirculation or partial recirculation of the hot and humid air prior to release to the atmosphere will save drying energy. Use of air for heating and drying of ambient air after its use as air for cooling, will also save energy as ambient air temperature following its use as air for cooling will by higher than ambient air (1a).

Sun drying as well as belt dryers over open fire of non free flow oil seeds like copra, is practiced as well.

2.2.2.4 Storage

Removal of excess moisture through drying and removal of mineral and vegetable waste through cleaning mentioned earlier, are required if safe storage is sought after. Soybeans, flax seed, safflower, shelled peanuts, sunflower, castor beans, rapeseeds, seasome seed, delinted cottonseed can be stored in grain type storage facilities. These storage facilities could be steel tanks or concrete structures. Storage conditions differ and depend on the type of raw material, moisture content, degree of maturity, raw material temperature at the time of entry to the store as well as other factors (1a).

2.2.3 Preparatory Steps: Tempering, Cooking, Cracking, Dehulling, Shelling, Conditioning and Flaking

The conventional system for soybean preparation following storage consists of tempering bins, once more a cleaning with aspiration, scales, cracking mills and a dehulling system. The cracked beans are aspirated in multi-aspirators to remove the hulls. This is done more than once in order to remove maximum hulls from meats and maximum meats from hulls. Peanuts have to be shelled and separation of shells and kernels is achieved by aspiration. Palm fruit in clusters is cooked in sterilizers after delivery to the plant and following weighing (1b).

2.2.3.1 Tempering and Conditioning

Tempering and conditioning methodology varies according to the oil seed and depends also on the method of oil extraction. A conditioner is used in the oil mills before crushing or flaking, so that moisture can be added and proper flaking can be achieved. Conditions can be vertical or horizontal rotary type. Thses are usually circular structures, jacketed, heated with steam and fitted with steam injection and water injection ports. Soybeans are usually tempered before dehulling and conditioned again after dehulling and prior to flaking.
Another method of conditioning is the one employing a fluidized bed system. While the conventional process involves oil seeds drying, cooling and storage in tempering tanks prior to cracking, this new process is a continuous one and the oil seeds are only heated once. They are cracked warm and the hulls are separated. The product is simultaneously conditioned and the cooling and tempering step are eliminated (1b).
Palm kernels are cooked in sterilizers at 140°C for 60-90 minutes. This stops the development of oil acidity and allows separation of the fruit from the stem. It also eases the separation of the kernels from the fruits. The sterilizers are cylindrical and horizontal and are equipped with quick closing doors. Palm fruit is loaded to the sterilizers in carts moving on rail tracke. Once all the air is purged, steam fills the sterilizers until desired temperature is reached. Sterilizers with capacity of 6-20 tons/hr are available (2a).

2.2.3.2 Cracking, Dehulling, Shelling.

Conventionally, soybeans are cracked with corrugated roller mills of 25cm diameter and 107 cm length. Higher capacities have been achieved with longer rolls and rolls with bigger diameters as well as with cracking rolls of higher rotational speeds. Equipment for separation of hulls from seeds includes in addition to cracking corrugated mills, also impact hullers, bar hullers, disc hullers, hammer mills and other machines specifically suited to the raw material. The requirement is to cut the hull so that best sparation of meat and hull will take place.

Soybeans are usually cut unto quarters or eights. Cottonseed, safflower or sunflower are cut coarse and usually into halves only, lengthwise or cross wise, depending on the oil seed.
Tumbling and shaking separate palm fruits from their stems, mashing of palm fruit in vertical, jacketed cylindrical vats equipped with mixing arms, produces a mash which allows for separation of the pulp from the kernel. Use of hammer mills for size reduction prohibits the separation later on of the hulls or husks and will result in a high fiber containing meal. High fiber meal or low protein meals have their market. This market determines what level of protein or fiber content is required and as a result of this, how much effort and how many repetitive separatory steps there will be employed in order to achieve the correct final hulls/meats ratio. As an example, cottonseed can yield a 36,41 or 44% protein meal. Sunflower meal can be produced with 33-46% protein.
Hull removal after oil extraction can compliment dehulling prior to oil extraction, and hull removal operations are designed to meet changing market demands for meals with protein and fiber contents as required from time to time.
Both leading oil seeds, soybeans and cottonseeds can be easily decorticated(1b).

2.2.3.3. Flaking (size reduction)

Flaking of oil seeds is accomplished by flaking rolls. These are smooth rolls, one fixed and one rotating. The distance between the two rolls is adjusted. Flake thickness depend on the distance between the rolls, by the r.p.m. of the rolls and by their weight.
Recent development in flaking rolls technology concerns both larger and longer rolls, moving faster than before. This provides for a larger flaking capacity but cannot be achieved without increase in maintenance and wear costs. Improved distribution of oil seeds along the full length of the rolls and removal of the overflow, together with construction of heavier rolls helps in wear reduction. Still final flake thickness depends on what further processing the oil seed flake will be subject to.

2.2.4 Oil Extraction

Both solvent extraction and mechanical presses are used by the vegetable oils and fats industries for the separation of oil from oil seeds. Both small and large, continuous and batch systems are available.

2.2.4.1 Mechanical Oil Extraction

Screw presses are used world wide for recovery of oil from oilseeds through the application of pressure. Two approaches and techniques are used. The first is the application of high pressures and subsequent production of low fat content residual meals, and the second is a pre-press operation prior to solvent extraction. Seed preparation, seed cooking, screw pressing and recirculation of separated solids from oil/solids mixture, all influence pressing efficiency. High pressure pressing aims to obtain the highest oil extraction from the oil seed and production of a meal with minimum fat content. In pre press operations -

the combination of oil pressing and solvent extraction aims at total efficiency. Mechanical oil extraction through pressing needs to take into account the effect of pressure on meal permeability, both in pre pressing and in high pressure pressing. The screw press has a main wormshaft equipped with worn or screw assembly composed of screw and spacer elements. The barrel is equipped with oil drainage and produces a meal (or cake) and crude oil (with some solids).

Oil presses with main drive motors from 20 H.P. and capacity (cottonseed) of 5 tons per 24 hours to 600 H.P. with capacity of 460 tons/day. Several large European and American companies dominate this field of mechanical oil extraction. An Argentinian and a Brasilian company also manufacture screw presses. Mechanical oil extraction is followed by settling tanks and filter presses for separation of crude oil from solids (2b)

2.2.42 Solvent Extraction

Solvent extraction can be performed in a batch or a continuous way.

2.2.4.2.1. Batch Solvent Extraction

Batch extraction is usually used fro oil recovery from pre-pressed oil seeds and is usually done in series. The extractor is loaded with raw material and is then closed. The extractor is filled with solvent. This is done in cycle with other batch extractors already extracting, so that the meal with lowest oil content will receive fresh solvent and the unextracted meal will receive the rich miscella.

equipment includes miscellaneous filters, distilation (steam) facilities for solvent removal and solvent recovery

.2.2.4.2.2. Continuous Solvent Extraction

The extractor is the heart of modern oil extraction operations. It needs to provide for the following: conveyance of solids, solids retention time as required, solvent flow at required volumes, solid-solvent contact, separation of solid from liquid. In the percolation extractor, liquid solvent or miscellais pumped through a bed of oil seed, flakes or meal. The solvent percolates through the bed and leaves at the bottom through a filter, mesh screen etc. Oil seed or meal and solvent are moved counter-currently with fresh solvent applied to spent flakes and miscella to fresh feed. Continuous percolation extractors are of the rotary type, chain and basket type, perforated belt type, chain conveyor type or the filter type. Immersion type extractors are used for lower capacity a applications, with raw materials that tend to disintegrate and form fines or for pigments extraction (1c,1d).

2.2.5 Distilation and Solvent Recovery

Solvent is primarily recovered from the miscella and from the oil seed meal. The recovery of the solvent from the miscella is achieved through distilation in steam heated distilation.towers. This operation yields crude oil and recovered solvent. Solvent containing flakes coming out of the extractor are desolventized by low pressure steam. Steam condensation requires further drying and cooling of the meal (2c).

Rotary meal dryers and coolers are used for this purpose and the final product is sold as animal feed. Flash desolventizing systems produce meals with higher protein solubility and nutritional quality.

2.2.6 Crude Oil Treatment

This section refers to crude oil handling and storage, bleaching, degumming, refining, deodorization and dewaxing.
Storage tanks for crude oil are required if crude oil deliveries are made to a separate refing plant. They could be required at both ends and could also be required for operational reasons if oil is both extracted and refined on the same premises. Tanks should be equipped with in and out flowing arrangements which allow for oil deliveries.
Storage should be tight and prohibit penetration of foreign material including water or water vapors through contact with air or with metals like copper, brass etc.
Degumming is achieved by adding water to crude oil. The hydrated phosphatides are insoluble in oil and can be separated by centrifuges.
Refining is achieved by use of acid, caustic and heat. Mixer, tanks and centrifuges separate oil from soapstock. Refining can be done in a batch or continuous processes. Bleaching can be achieved by absorption of pigments by clay, carbon stack or by heating the oil in presses or absence of oxigen. Deodorization establishes the final flavor and odor of the oil and is achieved through a series of steps in which oil is subject to heat treatment and stripping at low atmospheric pressure(2e)

2.2.7 Recent Developments

Oil seed handling and processing technology including extraction, solvent recovery, distilation, deodorization - keep developing. New energy saving techniques are developed and employed. Some of these are mentioned in this section.
Extrusion . . as pre treatment of oil seed prior to oil extraction can bring to higher efficiency of use of the solvent extractor and can effect the solvent/oil ratio too. This in turn influences the energy balance of the operation. With less solvent to unit oil produced, energy is saved. Equipment can be smaller, or higher capacities can be achieved with same equipment. Extrusion cooking producing densified soy or other oil seeds and brings about these improvements.

A process which achieves that through increase of bulk density of soybean flakes achieved not through the enhancer, but through a long term low temperature and moisture process, was recently developed. This process which starts with soybean flakes which pass through a process of steam injection and agglomeration, influences not only efficiency of extraction, but can also effect strongly the phosphatide situation in the raw material. It renders the soybean oil phosphatides water soluble enough to permit mechanical refining and makes chemical refining unnecessary. This represents considerable savings. Lecitine recovery can go up by as much as 100 percents(3).

Changes take place in the oil industry in several fields:

Automation: The degree of automation in the oil/fats industry is increasing, both in new and in old plants. Microchips based instrumentation systems and micro processors already control and run fully automated soybean oil extraction and refining plants. Where process control is employed, the operator uses process conditions signalled to him in order to optimize unit operations. By using modern micro electronic based control systems it is possible to move to production control. The data originating from process control will be used by computerized systems in order to make operational decisions. This will lead to improved safety, energy conservation, consistent product quality and less labor costs (1f,2d).

Physical Refining: Mentioned earlier in this section. Increased efficiency of equipment use, higher yield of phosphatides, energy saving have been developed . Simplicity in operation and elimination of the recycling of caustic soda are important benefits (3).

Fluidbed Technology: This technology has now been introduced to oil extraction, and is now employed in the conditioning of cracked beans, dehulling, drying and in cooling. This technology provides for an improved heat and mass transfer and results in energy saving of up to 50%.

2.3 Cereal Grain Milling Processing Technologies

2.3.1. General

Wheat, rice and maize are the most important cereals. Although usually there is more rice and maize produced in the developing countries and these cereals have been a traditional source of nutrition, consumption of wheat and pressures to increase wheat and wheat products availability is constantly growing. Wheat milling today involves usually large, automated and sophisticated plants. Same applies to maize processing when well identified sub streams of maize kernel products are produced. Medular capital goods for these industries are manufactured by a limited number of international companies which own the patent rights or the technological know-how. Peripheral capital goods for these industries can be manufactured by others but in the developing countries such big new grain milling projects are few. Rice processing is different and requires technology which can lend itself to development of local medular and peripheral capital goods industry in the developing countries (4,5).

2.3.2 Wheat Milling

Wheat as delivered from the field contains different types of impurities which need to be removed prior to storage.

2.3.2.1 Wheat dry cleaning

Impurities delivered with the wheat are of different sizes, shapes and bulk density. Machines which have been developed for the removal of these impurities basically employ sieves and air currents or discs, cylibders with special indentations. Scourers with perforated or abrasive cylindrical casings, with beaters installed inside. Soil fungi are removed by the action of these beaters. Air currents are used in aspirators and pneumatic conveying is used to remove impurities from grain. Together with impurities, badly shriveled or weather damaged wheat is removed.

2.3.2.2 Wheat drying

Prior to storage and upon delivery, wheat and/or other grains have to be dried so that an appropriate level of moisture content be established. This level of moisture content needs to be condusive to safe storage. Such removal of moisture is achieved usually by employing grain dryers. Grain dryers are manufactured in many different sizes. Large grain dryers are designed as multi stage dryers of several sections with a cooling section. The moist grain enters from the top of the drying column and advances towards the bottom in a zig-zag fashion. The heating is usually direct with a liquid fuel burner. Temperature and flame controlled. Air circulated through cooler stage can be recovered and used as inlet air to the dryer as an energy saving feature. Small grain dryers are fairly simle installations to construct, maintain or operate.

2.3.2.3. Transport and Storage

The silo consists of several cells, constructed with panels of corrugated galvanized steel sheet, a feature which imparts great rigidity to the walls, the thickness of which varies with the diameter and height. In order to give the necessary vertical rigidity the cell has internal stanchions of steel sheet, which have been galvanized in their last stage of manufacture. The joins between the panels, like those with the stanchions, are made by means of galvanized steel or chromed bolts. The roofs are made up of sheet sections, also galvanized, the shape of which has been designed with the double purpose of ensuring rigidity and watertightness. The silo in itself presents no special problems of technology. Its design is mainly a problem of strengths of materials and structural calculations. Transport elements have been reviewed in section 2.2.2.

2.3.2.4 Wheat conditioning (cold, warm, hot)

Wheat conditioning is the step during which water is added to wheat prior to milling. While addition of moisture helps the separation of bran from endosperm, excess moisture does not facilitate the sifting of milled wheat. A compromise is sought after for the optimum level of moisture addition. The equipment for wheat conditioning is usually rather simple and involves screw conveyors with water addition.

2.3.2.5. Milling

Milling systems include mills, sieves, conveyors, cyclones, filters, feed locks and pneumatic systems.

-Cylinder mills - he supporting frame is of cast iron, usually in one piece. This can be produced by well equipped shops of high quality standards. The cycinders, which are of centrifugally cast iron, need to be of very high quality. They are supported by oscillating ball-bearings. Little maintenance is required.

-Impact and disintegrating machines - This type of equipment may be of simpler construction, still it calls for great precision. The purpose of these machines is to increase the percentage of fine flour and to disintegrate any flakes which may form in the mill, specially with products which contain bran.

The other key pieces of equipment in the production of high quality flour are the sieves, under this heading are grouped a series of machines capable of screening to different size ranges and of separating the by-products of milling. Flat sieves carry out classification according to size of products coming from the crushing rolls and mills. They are capable of carrying out eight separation per compartment, and are therefore very versatile. The sieves, faced with anti-abrasive laminated plastic, facilitate rapid change of output.

Construction of such equipment is limited to companies which own this knowhow and expertise or can obtain it through cooperation.

-Screens are basically two rows of sieves which complete the operations of the horizontal sieves. Flour with much reduced fines can be produced. The technological and construction considerations are the same as those mentioned for horizontal sieves(6).

2.3.3 Rice Milling

Threshed and dry paddy is delivered from the field. It is not suitable for human consumption which can only take place after de husking. Once de husking is accomplished, and also, bran removed, the rest is the rice kernel, high in carbohydrates, low in proteins. Threshed and dried paddy can be converted to dehusked, debranned rice or through a parboiling step to a parboiled, dehusked and debranned rice. At the same time that the removed husks can be used as fuel, the bran, which also can be stored, is usually used as an animal feed or as a source of rice bran oil.

2.3.3.1 Rice Cleaning

Rice cleaning installations, large or small, are simple. They include cylindrical or horizontal rotating or vibrating screens with aspirators, magnets and means for separating stones, sand, metals, field refuse etc. Cleaned rice can further be processed into parboiled rice, or can be dehusked and debranned without parboiling.

2.3.3.2. Parboiling

A considerable portion of the rice produced annually throughout the world is parboiled. Estimates are between 20 and 25%. The process involves submerging the threshed paddy in water and heating.
During parboiling, rice starch gelatinizes, active enzymes deactivated completely or partially, and other important chemical changes occur, which contribute to a higher milling yield and quality of milled parboiled rice, parboiled paddy and parboiled milled rice keep longer. The grain remains firmer during cooking and absorbs more moisture and less fat.*
First the paddy is submerged in water, in metal or concrete tanks. Steeping takes up to 60 hours. After drainage, the rice is heated by steam injection when placed in steaming vats or open pan tempering. Heating can take place in pressurized vessels and some operations utilize automated, pressure valves equipped continuous equipment. Parboiled rice can be sun dryed or dryed by rotary dryers, grain dryers or others. Pans for parboiling are made of hemispherically-shaped steel sheets, welded with a supporting frame of steel profiles. Parboiling can be done also on double-bottom steam heated pans; in this case husks can be used for firing steam generators. A more complex technology employs autoclaves, steam heated and pressurized rotating on an horizontal axis. Small grain dryers are a column, where grain falls in countercurrent with hot air, following a zig-zag path. Air is heated by an exchanger and propelled by a fan. A more complex technology employs vacuum dryers. Manufacturing of pans and small dryers calls for metal sheet forming and welding and for some machining; their grade of complexity is low.
Larger rice mills use integrated parboiling equipment, with same rotating autoclaves for soaking (steam heated) and drying (vacuum effected); this machinery is very complex and fully automatized(7).

2.3.3.3 Milling

Milling of rice, parboiled or non-parboiled includes both husk and bran removal. The rubber roller de-huller consists of two closely spaced rubber rollers, rotating in opposite directions and at different speeds. They are driven by a gear box and supported by ball bearings. A steel profile or cast iron frame supports moving parts. Rubber rollers are subjected to considerable wear and have to be frequently changed. Distance between rollers may be adjusted.

Bran removal is obtained by abrasive cones. This machine is basically a cast iron cone, with an abrasive material external coating. The cone revolves into an aluminium or steel casing where metal mesh or perforated sheet sections remove bran, while rubber bars retain whitened rice. Abrasive action of the cone can be adjusted by vertically displacing the cone. A steel or cast iron frame is the machine body, where the cone is supported by ball bearings and driven by pulleys and shafts.
Cone whiteners can be considered as intermediate technology machines and their manufacturing requires a higher degree of mechanical machining and cast iron forming (8).

2.3.4. Maize (corn) Milling

Wet milling of corn which results in separation of the corn into hull, germ, starch and gluten will not be a subject for discussion here. The dry milling of corn involves the following approaches:

a. reduction in size through dry grinding
b. the tempering degerming system
c. the dry degerming system

Prior to milling, the corn is cleaned and stored. Cleaning of grains have been discussed already in this report.

2.3.4.1 Dry Grinding

This includes hammer mills and stone mills. Hammer mills have a rotating shaft supported by ball bearings. The shaft supports several arms and hammer heads. Alarge variety of shapes and sizes exist. Rotating hammers force-brake the material to be ground against rotors which permit only particles of a certain size or smaller to escape. Stone mills with one stone or both stones rotating driven by an electric motor, diesel engine are also used to grind dry corn. Manufacturing of hammermills calls for casting of the body of the mill and that of the rotating arms, welding of sheets and profiles and machinings of operating and rotating parts. Manufacture of stone grinders requires similar capability (9,10).

2.34.2 Tempering Degerming

Moisture is added to the corn as cold water, hot water or steam in required quantities depending on the properties of the corn. Pre soaking is done in vats, tanks or reservoirs, or in screw conveyors. Soaking time determines size of presoaking installations. Degerming is usually achieved in 2 steps. In the first step, a degermer stock is produced. This is a mixture of endosperm, grits, hulls, germs. The degermer and corn huller is an attrition device built as a cone mill. The cone shaped rotor is mounted on a rotating, horizontal shaft in a conical cage. The cone has protrusions over most of its surface. The Beall degermer is the most utilized degermer in the U.S.A. Degermination of this kind are built in different sizes, with the most popular driven by a 50 H.P. motor and processing up to 2.5-3.0 tons of corn per hour. Depending on moisture content, drying and cooling may be required (down to 15-18% moisture level). This is followed by rolling and grading.

The recovery of various primary products is accomplished on corrugated roller mills. Each pair of rolls is fed a selected mill steam. Sifting is an important operation. Aspirators are used extensively to separate and recover hull fragments. Corrugated rolls are used in the roller mills. Each separation step consists of an aspirator, a roller mill and a sifter. Separation is made on a long, rapidly oscilating sieve clothed by a series of fabrics having progressively larger openings towards the tail end. This (gravity table) separator classifies particles according to differences in density and aerodynamic properties. The different products produced by this separator is later on milled further.

Screw conveyors and bucket elevators are used extensively for material transport in the mill. Pneumatic conveying systems are gaining popularity now. They occupy less space, easier to maintain and are more sanitary (11).

2.3.4.3. Dry Degerming

Degerming and dehulling of untempered corn can be achieved through processes and equipment developed for this purpose by the Miag or Ocrim companies. In both processes, corn with 12-16% moisture is processed in an impact type machine, vertical or horizontal and separation based on size and density takes place with sfters, aspirators and table separators. This specialized technology s supplied through its owners or their subsidiaries (12).

2.4 Consideration of Plant Size

A comparison of the activities in the vegetable oil crushing industry in the U.S.A. in 1982 to that in 1977 shows that the number of factories have decreased from 260 to 233, or a decrease of slightly over 10 percent. At the same time, total oil seeds processed rose from ca. 23 million tons to approximately 42 million tons, an increase of approximately 85 percent. Those figures point to a trend in the United States and one that exists in other developed counries, of fewer larger plants (13).

Large plants both require and justify higher levels of automation and process control. Often, large factories are highly specialized and can handle different raw materials with less flexibility than small ones. Simple equipment for oil crushing and for small scale processing of vegetalbe oil is available (1g). Considerations of availability of raw materials, market demand, availability of funds for investment, infrastructure as well as other considerations will determine the size of the oil extraction plant. An oil seed crushing and refining plant with capacity of 50-250 tons of oil seeds per 24 hours or less is considered a small plant.

Leading manufacturers and suppliers of vegetable oil extraction and processing equipment are capable of supplying complete plants or processing systems for small and large plants, on delivery of equipment or on a turn-key basis. This they can do with or without local suppliers for peripheral or non critical equipment.

In modern grain milling, suppliers may base a large size operation on repetition of smaller lines. This in a sense will make a large plant basically a combination of several samller ones, without changing very much the nature of the problematic of local production of medular or peripheral capital goods.

2.5 Technology for Energy Saving

A continuous effort is being made, usually by equipment manufacturers, to develop systems and processes that will result in saving of energy in the process of extraction and processing of vegetable oils. This is due to the fact that energy has become much more expensive than before, and that following this increase in energy costs, almost all other inputs have gone up in price as well. This situation makes it all the more necessary to cut down on processing costs and there again, the cost of energy becomes a target for reduction.

Steam consumption per metric ton of processed soybeans from beans to desolventized, dried meal and degummed oil was until 1950 approximately 405 kg. In the early 1980's it was approximately 330kg and it is considered that a level of 177 kg. is reachable (14). This can possibly be achieved by redesigning of some equipment systems although better management of equipment and utilities and improved maintenance can still play an important role. Considerable energy savings can be realized by introducing of more heat recovery systems and by developing and utilization of multi fuel systems (2e).

Considerable savings of energy can be achieved if the process includes a cold prepressing step (1c). When compared with the classical process, which requires crushing, milling and cooking prior to prepressing, or with the direct extraction process which requires crushing, flaking and granulation, the cold prepressing requires significantly less energy. This process is optimally suitable for factories with capacity of 300 tons/day of raw materials.
Additional technological innovations, like extraction under pressure (1h), precooking and agglomeration (3) and others result in a continuous reduction in energy consumption.

The wheat milling industry requires very small amounts of energy when compared to other sub sectors of the food industry. Still large mills with extensive pneumatic conveyance systems require ca. 75 KwH per ton of ground wheat while mills with short conveying tracks may require as little as 55 KwH/ton. In small mills energy requirements are high and may reach 80 KwH/ton. While energy requirements for milling did not change much over the last 3-4 decades, phases other than grinding, and primarily cleaning operations show a large decrease in energy consumption. Although the contribution of the wheat milling industry to national energy saving is very small, still to the individual miller it can be significant. It is believed that in wheat milling this can be achieved through better management (14).

Modern, automated or controlled systems for rice parboiling (6) represent considerable energy savings when compared with traditional parboiling techniques.

2.6 Medular or Peripheral Capital Goods

2.6.1. Medular and Peripheral Capital Goods in the Vegetable Oil and Food Industry

2.6.1.1 Peripheral Capital Goods

Pumps
Electrical motors
Electrical motors (explosion
control panels
steam boilers
steam generators
heat exchangers
water coolers
conveyors: belt, screw, chain, drag, bucket
negative and positive air transport systems: cyclones, air compresses, tubing
Hoppers
Sifters
Aspirators
Weighing Systems

tanks
tubes
settling tanks
seed conditioners
magnet cleaners

Storage Installations (oil seeds)
Fork lift trucks
Storage tanks (liquids)

2.6.1.2 Medular Capital Goods

Shakers
Sifters, sieves
Cleaners
Autoclaves
Mixers
Beaters
Batch extractors
Continuous Extractors
Filter presses
Filters
Grinders
Cracking rolls
Flaking rolls
Oil seed (grain) dryers
Screw Presses
Centrifuges
Distilation Columns
Evaporators
Steam ejectors
Meal Dryers
Meal Coolers

2.6.2 Medular and peripheral Capital Goods in the Grain Milling Industry

2.6.2.1. Peripheral Capital Goods

Pumps
Electrical motors
control panels
Steam Boilers
Steam generators
tanks
Conveyors: belts, screw, chain, drag, bucket
Negative and Positive Air transport system: cyclones
air compressers, tubings
hoppers
aspirators
weighing systems
storage installations (grain)
fork lift trucks
tubes
bagging equipment
bins
stalk strippers
hoists
magnet cleaners

2.6.2.2. Medular Capital Goods

grinding equipment: stone grinders, hammer mills
grain dryers
coolers
grinding rolls
sifters
bleachers
Separators
degermers
Fans
Rubber rollers
Sieves
Steel rollers
Abrasive Cones

2.7 Medular and Peripheral Capital Goods according to the Complexity Index Criteria

2.7.1 Medular and Peripheral Capital Goods in the Vegetable Oil Industry according to the Complexity Index Criteria

level of Complexity N4:

Peripheral

Control pannels
Forklift trucks
Weighing systems
Storage installations
Pumps

Medular

Autoclaves
Mixers
Grinders
Continuous extractors
Cracking rolls
Flaking rolls
Screw Presses
Centrifuges
Distilation columns
Evaporators
Meal Dryers
Meal Coolers
Oil Seed (Grain dryers

level of complexity N3:

Peripheral

Pumps
Motors
Steam Boilers
Steam Generators
Heat Exchanges
Water coolers
Conveyors
Air transport systems, cyclones
Air compressors, tubings
Aspirators
Storage installations
storage tanks
tanks
tubes
settling tanks
seed conditioners
magnet cleanors

Medular

Shakers
Sifters, sieves
Cleaners
Beaters
Batch extractors
Filter presses
Filters
Grinders
oil seed (Grain) dryers

levels of complexity N2:

peripheral

Tanks
Hoppers
Containers

medular

2.7.2 Medular and peripheral capital Goods in the Grain Milling Industry according to the Complexity Index Criteria (15)

level of complexity N4:

Peripheral	Medular
Pumps	Grinders
Electrical motors	hammer mills
Control pannels	grain dryers
Steam boilers	Coolers
Steam Generaltors	Grinding rolls
Forklift trucks	Degermors
Weighing systems	rubber rollers
Storage installations	Steel rollers
aspirators	
bagging equipment	

Level of Complexity N3

Peripheral	Medular
conveyors	Sieves
Negative & possitive air transport systems, cyclones	Pans
Storage installations	Bleachers
bins	Separators
hoists	
hoppers	

Level of Complexity N2:

Peripheral	Medular
Tanks	-
Bins	
Hoppers	

2.8 Preliminary Identification of Equipment or Production lines that could be produced in developing countries

The level of development of the local metal-working industry will determine its capability to produce machines or production lines of the types reviewed earlier. For the purpose of a preliminary identification, 4 levels of development of the metalworking industry have been taken arbitrarily and are represented here by the following selected countries; although other selections could have been made equally successfully:

level 1: Brasil, India
leve 2 : Colombia, [illegible]
level 3: Nigeria
level 4: Central African Republic

3. Basic Problems and Issues Affecting the Development of the Capital Goods in the Oil Seed Processing and the Grain Milling Industries in Developing Countries

3.1 General

Medular and peripheral capital goods are required in the developing countries for extension and renovation of existing oil seed processing and grain milling installations. Such capital goods are required as well for setting up of new proce sing facilities. Local production of all or some of these capital goods could contribute to the economy of the developing countries in several important ways:

- 3.1.1 It could reduce the overall size of the investment in machinery involved in the project.
- 3.1.2 It could reduce the foreign exchange component of the investment in the project.
- 3.1.3 It could generate employment and income in the local machine building industry
- 3.1.4 It could start or add force to an on going process of economical development which could bring about an overall improvement in employment, education, income etc.

In order to reap such benefits as mentioned above, it is necessary that certain conditions will be met, so that there will be, or there will be created a sound basis for the establishment or promotion of local machine building industry in the developing countries. As per terms of references for this report, this machine building industry should concern itself with the production of peripheral capital goods for the grain milling industry and the oil seed processing industry. Still, some of the comments made in this report relate to the food processing machinery manufacturing industry as a whole.
Among the factors that could influence directly the development of the manufacturing industry of capital goods for the food indutry the following could be mentioned:

a. Demand and competition.
b. Know-how, engineering services, technical services
c. Manufacturing capabilities
d. Promotional policies

Further on in this chapter, these subjects will be ·ted separately, within the context of the oil seed and grain milling indus and also in a more general way. It should be emphasized that these fac mentioned above are not listed in the order of their absolute importance. These factors may have different relative importance at different times or in different places. They are usually interrelated and will affect one another.

3.2 Demand and Competition

The search for sources of supply when there is need for such supply is the basic process. There were at some points in time, and there will be again in the future demands for both medular and peripheral capital goods for food processing, in each and every country around the globe. This includes capital goods for the grain

Level 1: Brasil, India

Both these countries have a large metal-working industrial base. All machinery, or almost all machinery required for vegetable oil crushing and refining and cereal grain milling, can be produced nationally. Exceptions would be few. POssibly, grooved mill rolls for wheat milling, advanced and semi-advanced automation equipment.

Level 2: Colombia

In countries of this level (2) there might be difficulties in securing electrical motors of local construction, if motors of more than 20 KW are required. Intricate electrocal control pannels may not be secured locally, complete grain dryers will require importation.

Level 3: Nigeria

In countries of this level sheet metal work, welding and simple peripheral equipment can be manufactured locally but not very much more than that. Manufacturing drawings must be supplied and an appreciable level of complexity in production of simple machinery requires imported expertise.

Level 4: Central African Republic

Very minimal technical capability is available locally.

The following table gives the relative degree of industrialization (based on all countries) of the above mentioned countries. This data helped in establishing the four levels of developments and countries belonging to each level. As a matter of fact, other countries could have been selected and there was no special reason but for the level of development behind this selection.

Table 1: Relative Degree of Industrialization by Industrial Branch (16) (1975-1981)

	Food Production	Iron &Seel	Non-electrical machinery	Electrical machinery
Brasil	1.04	1.15	1.32	0.86
India	0.53	2.26	3.20	1.66
Colombia	1.12	1.04	1.22	0.88
Nigeria	0.62	0.11	0.29	0.63
Central African Rep.	0.14	-	-	0.14

milling and the oil seed processing industries in the developing countries as well as other branches of the food and agro industries. This in itself does not determine that all countries could provide an equally encouraging environment to a capital goods manufacturing industry. Although such goods will always be required at different times in every country. As a matter of fact, this industry when permitted to develop and grow over the years, in the developed countries it tended to concentrate and or spread as a result of market pressures, marketing opportunities and the drive of motivated individuals.

Making investments, monetary or otherwise, in setting up a capital goods manufacturing industry (both medular or peripheral) requires the study of marketing potential. This market study could be a two dimentional one, and could relate to the national, sub-regional, regional or international markets. Two dimentional market study for production of capital goods is meant here as involving capital goods required specifically by one type of industry and capital goods required by more than one tupe of industry. As an example, a capital goods manufacturing operation could become specialized in the manufacture of conveyors of different types and for different industries. By comparison, a manufacturer may decide to produce just one type of a dryer which may be used to dry one or more types of product.

In some parts of the world the grain milling industry is milling at a level of production which is determined by the size of local grain crops together with that of imported grain. Together this quantity represents the grain consumption level of the local population, with or without government intervention. Although frequently in developing countries grain consumption per capita is low, primarily because of lack of purchasing power of the weaker parts of the population, the grain milling industry has an over capacity, meaning, part of its capacity is not utilized. Projecting possible future growth in milled grain products in each country, based on population growth, increase of demand for grain products per capita in the future, possible planned government assistance to the purchasing power of the population, thus increasing the level of per capita consumption of grain could assist in the determination of the potential growth of the national grain milling industry and through this, the determination of that country's future needs in capital goods for grain milling industry.

A similar approach could be most valid in the case of the oil processing industry. Many developing countries encounter shortage of vegetable oils. An evaluation of the size of the market for additional supplies of vegetable oils could be the basis for projecting possible growth of this industry. Planning of this sub-sector includes forecast of supplies of oil bearing raw materials from national origin or through importation.

Projecting the growth of the oil seed processing industry based on national demand for the oil and for the oil seed by products and projection of investment in this sector could help in establishing the quantitative need for capital goods for the establishment of this industry. This information, together with similar information concerning the grain milling industry could outline the demand for capital goods in both

Table 2: Projected Growth by sub sectors	World production in 1985 (millions of tonnes)	Annual growth rate World	Annual growth rate Developing countries
Meat Industry 2/	172.3	2.9 1/	2.5 1/
Dairy products	29.8	1.5	0.6
Fruits and vegetables	37.4	1.4	5.5
Fisheries	31.0	3.4	5.6
Cereals	220.4	1.6	4.1
Sugar industry	162.2	2.0 1/	2.1 1/
Chocolate industry	9.8	6.0	21.1
Confectionery	11.0	2.7	8.8
Animal feed industry	267.3	5.2	9.4
Beverages industry	214.8	3.6	4.7
Coffee industry	6.0	2.9	6.4
Oils and fats	42.6	3.2	4.2

SOURCE: International Centre for Industrial Studies (UNIDO)

1/ Average for the activities included in the industry.

2/ Includes slaughtering and processing.

these sub sectors on a national, sub regional, regional and international level. Such studies should be undertaken by reputable manufacturers of machinery and installation for grain milling, oil seed processing and other types of food or feed processing systems, as well as by governmental or international planning agencies (17).
The opportunities in manufacturing of peripheral capital goods for the grain milling or the oil seed processing industries should be considered regardless of the opportunities for the setting up of manufacturing facilities for medular capital goods for the grain milling and for the oil seed processing industries. Peripheral capital goods requiremænts for additional sub sectors of the food and feed industry could strengthen the position of the food industry peripheral capital goods manufacturing industry through a wider range of required products which will provide for a wider manufacturing base.

Investment in medular or peripheral equipment in the grain milling and in the oil seed processing industries, as well as in other sub sectors of the food processing industry involves taking different types of risks. Selection of equipment suppliers is sometimes a subject for a lengthy and delicate process in which many factors are being evaluated. A local national manufacturer of medular or peripheral capital goods will have to establish a name for himself first, so that when the opportunity arises it will be contacted and/or considered. Foreign constructors of capital goods with or without a manufaturing base in the developed country, with an active representative or even without an active representation are usually quite well known by planners and promoters of industrial development. They are usually contacted and brought into the picture, primarily because of the reliability of their products and of their services.

Both medular and peripheral capital goods are required to provide a reliable service. Production problems can occur with both types. Solving production problems of medular capital goods may be more involved and may require higher level of skills than that involved in putting b back to good functioning order of peripheral capital goods. Still, lack of reliability of peripheral capital goods is usually seen by potential customers as a serious danger and a pitfall which should be avoided. For this reason, and unless a reputable local manufacturer or manufacturers of peripheral capital goods exist, and are well thought of, and the expertise of selecting such peripheral capital goods and integrating it into a well functioning system which includes other capital goods both medular and peripheral, a foreign manufacturer can still be preferred.

3.2.1 Future Incsease in Volume of Production of Different Subsectors of the Food Processing

The UNIDO International Center for Industrial Studies (17)has estimated the production up to 1985 in several food-processing subsectors, both for the developed and the developing countries.

Although growth rates are generally much higher in the developing than in the developed countries, the importance of the former in total world production in absolute terms is still low and may continue to be so. The table shows the foreseeable development of production in the food-processing sub-sectors, and the sharp increase in the confectionery and the animal feed sub-sectors.

Although the development of the food-processing industry can be greatly stimulated in the developing countries, closing the wide gap in production when compared to the developed countries, still depends on the various techno-economic limitations and on some other limiting factors like the size of the domestic market and availability of raw materials.

3.2.2. The Production of Equipment for the Food Processing Industry

The Food Processing industries constitute a group of very diverse activities. Some of these have in common some characteristics that make it possible to distinguish them from other industries. These main characteristics have to do with the seasonal nature of the agricultural production and food processing, the need to observe hygienic conditions, the handling of perishable products, the great diversity of products and of required machines.

The case of the grain milling and the oil seed processing industry is different. Both grains like wheat, maize, rice and others, and oil seeds like soy, peanuts, rape, sunflower, safflower etc. are not classified as perishables. At the same time that adverse temperature and humidity conditions can damage eating quality, baking quality of grains, and oil seeds quality both as sources of oil and of meal could be affected. Grains and oil seeds are not quite as susceptible to spoilage as are fruits, vegetables, meat, dairy products, eggs etc. Due to their storage-ability, their processing is not carried out as a seasonal operation. Since processing of grains and oil seeds does not involve so much wet (water) stages, maintenance of hygienic conditions is simpler.

The total estimated sales of capital goods for the food processing industries by the OECD member countries, excluding Denmark, Norway, Switzerland, Portugal, Spain, Turkey and New Zealand are estimated to have been of the order of $U.S.2,800.- million in 1975. The United States accounted in 1975 for about 50 per cent of OECD total ($US1,402 million) - and the Federal Republic of Germany, with about 20 percent. The two countries together sold equipment at a value of some $US2,000million, or nearly 70 per cent of the OECD sales of capital goods for the food processing industry (in 1975).

The above is based on OECD publication "The Engineering and Electrical Industries in the OECD Member Countries", Paris 1977, group 143 (SITC code 718.3 "Food Processing Machines"). Other groups such as 719.1(5), which covers cooling equipment, much used in the foodprocessing industry, or 719.6(2)A, which includes deliveries and sales of packaging machinery and machines for cleaning bottles and other containers, widely used in the food sector exist as well (18).

In the EEC, the Federal Republic of Germany is the leading producer of capital goods for the food processing industry. Out of 50 engineering sectors in six major OECD countries,* machineray for the food processing industry represented only 0.5 per cent of total output. It is more important in France, the Federal Republic of Geramy and the United States (table 3) As a whole, the manufacture of capital goods for the food processing industry is rather small in comparison with other sectors (19).

Three countries, The Federal Republic of Germany, The United States and Japan, account for between 70 and 80 per cent of the total output in OECD countries y value of capital goods for the food industry. This indicates a high level of concentration of capital goods manufacturing industries in a few countries. These could be most highly developed countries with possibly a strong domestic market of its own. Despite this there is an ever growing interest and an ever growing dependency on the large world markets, much of which in grains and oil seeds is located in small or large developing countries(19).

A relatively small number of manufacturers of capital goods for the grain milling and oil seeds processing dominate the international scene. These companies operate usually in one of the way described below:

(a) Enterprise operates predominantly in the country of origin, carrying with exports to foreign customers.
(b) Enterprise is involved in some manufacturing in recipientcountry/ies in order to serve a country or a sub geographic region.
(c) Enterprise seeks and finds local groups with whom to cooperate, usually contract out, with supply of technology.

As a result of this, many suppliers of capital goods for the grain milling and the oil seed processing industry have established a manufacturing base in several developing countries and could widen the production of their machinery there, provided they are encouraged to do so and find that conditions are condusive to such activity.

* Federal Republic of Germany, France, Sweden, Canada, USA, Japan

TABLE 3

STRUCTURE OF ENGINEERING PRODUCTION IN THREE OECD COUNTRIES

(PERCENTAGE FOR EACH SECTOR IN TOTAL PRODUCTION OF ALL SECTORS COVERED)

	Six-country average	FRG	France	USA
Electronic components	3.2	1.4	3.7	4.8
Electric motors and transformers	2.9	3.0	2.8	3.0
Materials handling equipment	2.9	2.3	3.5	1.7
Passenger cars	15.3	16.5	16.3	14.6
Metal structures	5.4	2.2	3.6	5.5
Industrial vehicles	5.8	4.4	5.1	5.8
Telecommunications equipment	2.8	2.6	2.4	1.9
Shipbuilding	4.0	2.3	2.5	1.9
Aircraft construction	4.6	1.2	8.1	10.8
Food-processing machinery	0.5	0.8	0.8	0.6
Metal containers	2.9	2.5	2.3	2.9
Remainder to 50 sectors				
TOTAL	100			

SOURCE: The Engineering Industries in OECD Member Countries. New Basic Statistics, 1963 - 1970 (OECD) (19).

3.3 Know-How, Engineering, Services

Reputable and established manufacturers of capital goods for the food industry usually consider their accumulated knowhow as their most valuable asset and will protect it by all legal means wherever it can apply. This know-how will cover the design, selection of construction materials, manufacture, quality control procedures, pricing and marketing. In some cases, the application of the equipment to processing or simply, what can this equipment do or produce, represents a considerable amount of accumulated know-how which is much deeper than just straightforward operational instructions. Such accumulation of know-how represents in most cases years of continued professional activities in constant efforts of upgrading the quality of the finished products through improved manufacturing processes. A continuous study of the competition, what it produces and how,is an important element in the activities of a manufacturer of capital goods. Although it seems that the complexity of these issues is lower for manufacturers of peripheral capital goods than to manufacturers of medular capital goods, this is not always the case. Although in many cases peripheral capital goods are of a lower complexity index and are thus simpler and less expensive to build, the need for them to function well with different types of systems and different types of raw materials, makes their detailed design and precise construction a demanding task. Because of their relatively lower price when compared to that of medular capital goods, a peripheral capital goods manufacturing industry requires a wide range of development activities and investment programs in order to generate a wide enough economic base for its existance. This could mean that the peripheral capital goods producing industry could develop as a wide based industry involved in many different types of peripheral capital goods with the typical weaknesses inherent in such situation, or as a small and specialized industry, dedicated to the manufacturing of a very small number of items of one or few types, with the economic risks which are involved in such predicament.

Existence of engineering capabilities within a country may influence the development of both the medular and peripheral capital goods manufacturing industry. obviously there is a need for engineering skills to be available to the capital goods manufacturing industry. Availability of such engineers is critical for the design, design of, production, control of manufacturing and assembly operation, sales and service. Without such engineers, setting up of capital goods manufacturing industry will be slow, risky, probably unsatisfactory and probably could not compete with foreign manufacturers. Existence of local engineering capabilities are required, if a process is to be initiated which will eventually lead to competition between local engineering services and such that can be imported from abroad. Importation of engineering services from abroad results many times in importation from abroad of more capital goods than necessary. By this, it is meant here that even though some peripheral capital goods could be available to the project from a national or subregional source or sources, only active local engineering activities could identify those peripheral capital goods which might be available from local suppliers and fit them into the required process. Such activities may not necessarily change the overall package of purchased package of capital goods and could still remain within the definition of the project, the process or the product(s), but can definitely change the nature of the project, from an all out imported turn key project without local engineering or capital goods components into a project which may require some importation of some medular capital goods which will be incorporated in a plant, designed and laid out through local engineering and with maximum of locally produced and properly incorporated capital goods, medular or peripheral as the case may be.

Availability of engineers is critical to continued industrial activities. In this respect several types of activities are to be considered, beyond local manufacture of medular or peripheral capital goods: Professional assistance in installation of and in supervision of installlation of nationally produced capital goods is required and needs to be available. With such services being available from reputable non national equipment manufacturers, difficulties in obtaining such services for nationally produced capital goods will have a negative effect on purchases of locally produced capital goods, both medular and peripheral. With local representatives of foreign manufacturers usually well staffed and organized, such trained personnel may make a difference between the success of a local capital goods manufacturing industry and its failure.

Equally important are questions of warranty, guarantees, availability of service personnel, ware and spare parts and the cost of these goods and services.

It was referred earlier to the importance of availability of engineering services and the training of engineers. Throughout the capital goods manufacturing industry there is a need for staff training at all levels. Activities that formerly may have represented a low level of knowledge (for example, maintenance operations) now require training at intermediate level in order to give reliable technical assistance to customers. This widespread advance in technology increases the importance of training of workers such as technical supervisors and technicians. At the same time, the use of processing machinery of high value and complexity (metering devices, weighers, closing machines, etc.), and the complexity of know-how in fitting together of subassemblies and final assembly, specifications, tolerances durability make it necessary to raise the level of knowledge and experience of direct production workers at all levels.

Staff training needs can be subdivided as follows:
Direct production personnel, production supervisors and technicians, personnel indirectly involved in manufacturing.

Sales personnel, customer technical assistance and repair and maintenance servicemen will play a key role in marketing and their training is of vital importance.

It is necessary to have in the country and in the industry adequate and diversified educational activities directed especially towards helping to provide specialized operators, both for the processing industry and for the capital goods manufacturing industry. Local training in all aspects mentioned earlier are essential for the establishment of an industry producing capital goods, both medular and peripheral.

For the production of machinery incorporating simple technology, the training requirements may be comparable with those required for operators and technicians working in direct production. In countries of a low or intermediate level of development, demand may not justify production in series. Therefore the required level of training is higher.

For the production of machinery involving complex technology diversification of engineering services are required. The qualifications of the technical staff should include production planning and control, standard of maintenance of process machinery, quality control. It may be necessary to have personnel with intermediate and higher education or equivalent in the fields of computer technology, planning methods, statistics and statistical quality control.

3.4 Manufacturing Capabilities

In almost all of the developing countries there is at least some capital goods manufacturing capabilities. This capability can be utilized for the production of capital goods for the food industry in general and that of the grain milling and the oil seeds processing industries. If the local metal industry is limited in capacity, such demand from the different sub sectors of the food industry could help in promoting an increase in the size of the capital goods industry. Different measures may still be required in order for the capital goods manufacturing industry to capitalize on existing and on growing demands for its services, still a gradual increase in size of this industry could be forseen, if there is growth in the size of the food industry and other conditions are met.

For a number of reasons, one of which is the strife for an achievement of a competitive edge over competitors, many first world manufacturers of capital goods seek to locate, participate in or establish a manufacturing base in the developedcountries. In some case this takes the form of an establishment of a wholly or a partially owned subsidiary.

Such subsidiaries have already been established in many developed countries by many of the leading first world manufacturers of capital goods for the grain milling and for the oil seed processing sub sectors. Being profit motivated, these subsidiaries will establish as wide or narrow a manufacturing base in the developing country as is required in order to meet their estimated potential sales goals.

Although such foreign owned subsidiaries are sometimes controlled from abroad and their main profit motivation could be that of attaining maximum profit levels for the parent company and not necessarily a maximum level of profit for the national subsidiary, these subsidiaries could make a most sifnificant contribution to the establishment of a national capital goods manufacturing industry in a developing country. such contribution can be envisaged in several ways. It could create a demand for goods and services, requiring employment of local people and purchasing of locally produced supplies, services and utilities. It could provide for training of personnel at all levels locally or outside the country as may be required, including such in house training of local nationals that might not be available otherwise. It could make available to the national subsidiary of know how including manufacturing drawings required for fabrication which are not available otherwise. It could also open doors for visits of industries in the developed countries where such modular or peripheral capital goods are used and through such visits and other activities it can help promote the establishment of the processing and applications industry in the developing country.

Foreign suppliers of capital goods could also arrange for local supply of some capital goods by contracting out to existing national suppliers rather than arrange for local construction of capital goods through the establishment of a subsidiary in the country where demand exists. Such an approach, although beneficial to the local industry is not quite the same as that of an establishment of a subsidiary. It will involve a lower degree of exchange of information between local suppliers and the foreign manufacturer who will remain aware of the need to guard its technological secrets and will pass on only as much information as is absolutely required for the manufacturing of a limited number of some basic capital goods, and might view the process ofknowledge transfer with reluctance, fearing of the creation through its own doing of yet one more competitor.

Manufacturing operations in countries of different groupings can be envisaged accordingly:

level 1

Brasil, India	Joint ventures, acquisition of licenses.

level 2

Colombia	Joint ventures, licensing, transfer of know-how, training

level 3

Nigeria	transfer of know-how, training supervision

level 4

Central African Republic	only or mostly only import from abroad, together with some local technical limited skills.

A gradual approach can be aopted in the case of levels 3 and 4 countries, for development of a capital goods manufacturing industry.

The objective of the first stage could be that of the development of a local capability for maintenance and repair and for construction of simple components. The technology involved should be simple and should be adaptable to small-to medium-scale installations and companies. There is a need to stimulate local entrepreneurial or artisanal capabilities in sectors such as mechanical and electrical repairs and maintenance, foundry, sheet and plate forming and welding.

Astock taking program needs to be initiated where all capabilities of all local resources should be included and analysed. This should include all existing operations related to local machine or parts building activities and to all food processing operations requiring or projected to require these services, present and future.

The objective of a second stage could be that of a creation of industrial infrastructures which is required for the establishment of a capital goods manufacturing industry. Once local technology has been upgraded and a basis exists for supply of goods and services required for maintenance including simple parts, both wear and spare, a second stage can be considered, that of peripheral non complex capital goods. Training and investment in mechanical and electromechanical equipment will be require. When this is achieved, level 4 and level 3 countries could be elevated to a position similar to that of level 2.

Using the license or the "joint-venture" way will lead to improved construction capacity for specific machines or specialized peripheral capital goods. This stage will result in a potential capability of manufacturing peripheral non complex machines and spares, and having the infrastructure and personnel required for an even more advanced stage.

The objective of the third stage could be the creation of an R & D capability in the field of manufacture of medular and peripheral capital goods at different levels ov complexity as required.

3.5 Promotional Activities

National governments and international organizations can influence the establishment and the development of a capital goods manufacturing industry. This can be done in various ways.

Promotion of agricultural production and policies resulting in increase in food consumption in general and that of milled grained products or vegetable oils in particular, will require additional production capacity of these products. This will create a need to enlarge this processing industry which will create a demand for the supply of capital goods involved directly or indirectly in the processing of cereal grains and seeds.

Planning of educational programs at different levels for the formation of professionals, support of schools of engineering, will result in formation of qualified local engineers. Similarly, establishment of vocational schools where training of technicians, machine operators, etc will take place, will result in the availability of trained workers at all levels without which the capital goods manufacturing industry cannot operate or grow.

Manufacturing of capital goods, both medular and peripheral, require long term planning and endurance. Assistance through investment support policies initiated by the national government will be required if this industry is to be established and to be given the opportunity of becoming a success.

IN various ways, a national government can actively encourage foreign manufacturers of capital goods to become active in the local capital goods market in a way that could lead to development of a local capital goods manufacturing industry. Incentives can be offered. These incentives could be of different kinds and may include: government assistance for training programs, long term loans for investment and working capital,. Legislation and administrative measures can be also used in order to create an incentive to a foreign capital goods manufacturer to enter into some type of venture, joint or otherwise, based on benefits which the foreign supplier may lose or gain if he succeeds or fais in obtaining an exclusive or preferred status. Sometimes, the award of a status of a "national equivalent" to capital goods manufactured locally, make the importation to the country of similar equipment produced abroad restricted or impossible, thus creating a favorable climate for the development and manufacturing of same capital goods locally, with benefits reaped by the local industry and the local economy and with profits to the foreign investor as well, profits which otherwise may not have been possible.

In order to make a preliminary identification of equipment or production lines that could be produced in the developing countries there is a need to take in account many factors. some of these will be discussed in cha--pter 3 . the developing countries are sometimes very different one from another. In Level 1 countries like Brasil , India , all equipment required for the vegetable oil and fats and for the grain milling industry can be produced and much of it is already being produced. Whether one looks at the capital goods required for the oild and fats and grain milling industries together, or separately, or whether one looks at any of the vertically, that is - companies specializing in producing all that is required for a complete or nearly complete production lines, or horizontally, that is, companies specializing in limited types of equipment like pump, or conveyors, or extractors etc. does not really make much difference. In order to contribute to the economy of the country there should be a commercial demand for these products.

Level 2 countries with development level similar to that of Colombia, could manufacture much of the capital goods required for the vegetable oil and for the grain milling industry. There are several exceptions and some medular capital goods may require importation. It may not be the problem of lack of local production or production capability of many peripheral and medular goods in the country but lack of engineering capabilities in the country. Such engineering capabilities that could replace an imported turn-key type expertise, by putting together peri-pheral and possibly also some medular capital goods of national pro-duction. These goods could be produced by a number of local suppliers. Local engineering services would be required, first in order to be familiar with availability of capital goods of national origin and then to be capable of incorporating all the capital goods required, including those requirung importation into an economical and reliable production line. An interesting case worth mentioning is that of the setting up in Colombia of a plant for production of precooked maize flour (20). Rather than proceed on a turn key basis, a local engineering group have studied the availability of medular and peripheral capital goods locally and of national origin. With the exception of a cooking column, centrifugal separator and gravity separation table which were ordered from abroad, (Buhler Brothers) almost all the rest of the capital goods were secured from 3 major and several minor local suppliers. The value of the imported capital goods came to about 30% of the total cost of the equipment and capital goods manufactured locally amounted to close to 70%. In countries of level 2, considerable encouragement to develop-ment of capital goods manufacturing industry could come from knowledge of what is and what could be manufactured locally, are there needs for modification or adaptation and incorporation in a production line.

Level 3 countries require importation of all medular and peripheral capital goods. Availability of local personnel may be limited in capability to that of a supporting role only. In level 4 countries, capabilities are even lower and are almost non existent as far as construction of medular or peripheral capital goods are concerned. The concept of having a national construction of capital goods for the vegetable oil and the grain milling industries may not be an achieveable goal and may in the case of many single countries not even be an optimal one.

A basic list of equipment which could represent a goal and a production target for the developing countries of levels 3 and 4, and which countries of level 1 and level 2 are already producing or are capable of producing is the following:

<u>Peripheral Capital Goods</u>

pumps (some)
electrical motors (some)
electrical motors explosion proof (some)
control panels (some)
tanks, settling tanks
magnet cleaners
air compressors
aspirators
conveyors (some)
cyclones
hoppers
liquid storage tanks
bagging equipment
bins

<u>Medular Capital Goods</u>

grain dryers
batch extractors

4. Main Findings and Recommendations

4.1 General

Capital goods are required at present and are supplied to the growing vegetable oils and fats and to the grain milling industries of the developing countries. This study has an objective which is to identify the peripheral capital goods that the grain milling and oil seeds processing lines have in common and those that have potential for local production in developing countries. This chapter will relate to the findings reviewed in chapters 2 and 3. It will also interpret and discuss the characteristics of the capital goods in the two food industries which are the subject of this study and will relate to the main obstacles to entry into the capital goods manufacturing industry by country, and actions to be undertaken.

4.2 Type of Market

The capital goods manufacturing industry, in the field of both medular and peripheral goods required by the food processing in general and the vegetable oil and grain milling industries in particular, is dominated by a relatively small number of equipment manufacturers. These companies are by and large from the U.S.A., United Kingdom, Germany, Switzerland, Italy, France, The Netherlands and from some other developed countries. Some of these companies operate in some of the developing countries together with local groups through different partnership or ownership arrnagements. Other arrnagements, whether temporary and ad hoc or of a longer duration, and not on a project basis, involve transfer of knowhow in various ways. Some of these companies restrict their activities in the developing countries to that of a foreign supplier with no local manufacturing related activities.
In most cases this situation is determined by the size of the potential market in the country, level of technical capabilities, policies, both of the national government and the Company itself and the activities of the competition. It is important to realize that equipment manufacturers, whther in the developed countries or through their activities in the developing world, or local companies in the developing countries, need to make profit and profits are what motivate all equipmwnt manufacturers. Equipment manufacturers cherish their know-how, manufacturing drawings, patent rights, expertise, knowldge of the market etc. very much and will only share it with others if through this they stand to make more profit, and if they can protect themselves adequately. They need to know that there is a market potential sizeable enough.

The most important single factor affenting the development of the capital goods industry in the developing countries, both medular and peripheral, is that of market size. Knowledge of market development and projections can provide a base for planning of the needs in both medular and peripheral goods in the future. If the national market size is big, especialization in production of vegetable oil production or grain milling lines are possible. If market size is not sufficient for such specialization, then possibly specialization in manufacturing of one or more then one type of equipment, required for more than one type of process is needed. In this report, Chaper 2 gives a list of capital goods required by the oil seed processing and the grain milling industries. It could be that projections for development of these two industries in a particular developing country could provie a base for the establishment of a medular or a peripheral capital goods manufacturing there.

Still, demand may not be big enough to provide such a base. Incorporation in such market evalration of developments in other sectors of the food industry and their requirements may change the picture. Adding demands by other branches of the food industry for conveyors, aspirators, bins, wastes or other peripheral capital goods to the demands of the oil seeds processing and grain milling industries, could provide a base for future activities in manufacturing of capital goods.

If such basis does not seem to exist, then future needs for capital goods, required locally in order to meet demands of growing processing industries will have to be met from abroad. This does not necessarily mean the developed countries. Such demand may be met by deliveries from other developing nations where existing larger demand does provide a base for setting up of a local capital goods industry. Deliveries from capital goods manufacturing industries established in developing countries to customers in other developing countries may require prior consent of the owner of the know-ho, usually marketing rights and privileges are worked out between the foreign partner who owns the know-how and the local subsidiary.

Delivery of capital goods from a anufacturer in a developing country to an end user in another developing country may broaden the base for the manufacturer and increase its profitability. This could certainly be considered as a desirable development. For the customer or end user the imported capital goods are still capital goods required locally and manufactured on the other side of the border.

Recommendation 1: To study the projected dynamics of the development of the vegetable oils and fat manufacturing industry and the grain milling industry on a national basis in each of the developing country in order to estimate future volume of business in manufacturing of peripheral or medular capital goods based on present equipment purchase prices. Such a report will provide a basis for action in the field of the develop nt of the capital goods manufacturing industry in the developing countries. This study should include demand for capital goods in the oil seeds and grains processing sectors, cost of equipment, analysis of cost of manufacturing and marketing of capital goods produceable in the country and should provide information required in order to make a decision whether volume of business which could potentially be produced will indeed provide an economical basis for operation. If such basis does not seem to exist, could inclusion of capital goods requirements for other industrial sectors in the country, and particularly the food industry could potentially provide this extra demand required and thus provide the yet to be established capital goods manufacturing industry with a proper economic base of operation.

4.3 Manufacturing Capabilities

The manufacturing capabilities in a given developing country need to be evaluated vis a vis the results of the study recommended in section 4.2 for the same country.

Recommendation 2: To study on a national level and to establish both quanititively and qualitatively the factors which together detrmine the local capabilities in manufacturing of capital goods for the oil seeds processing, the grain milling and possibly other industries or subsectors of the food industry, based on marketing opportunities established earlier as per section 4.2. Among the factors to be studied are the following:

4.3.1 Physical Plant

This is related to a detailed analysis of the kind and type of machinery and tools required for the manufacture of the required capital goods, as identified in the national study as per section 4.2. Examples of capital goods for production in the developing countries are also given for the oil seed processing and grain milling industries in section 2.8.

The purpose of this analysis is to determine if there is a need, to add to the existing manufacturing systems and or tools, systems or tools that are not yet available in the country and which through their absence or shortage create a bottle neck in the local manufacturing quantitative or qualitative capabilities.

4.3.2 Labor Force

Part and parcel of national manufacturing capabilities is the availability of workers at all levels to the capital goods manufacturing industry. In this respect the capital goods manufacturing industry for the oil seeds and grains subsectors and even that of the whole food sector can be viewed as part of the overall national capital goods manufacturing program.
As part of the study in recommendation 2, the labor force needs to be evaluated. This can be broken down to different groups level according to professional levels and types. The highest echelon consists of engineers (mechanical, electrical, chemical), economists, managers-administrators.

The capability of the national higher educational system to produce such professionals needs to be determined, in view of present and future needs of the capital goods manufacturing industry.
The second echelon consists of senior technicians, capable of filling up positions of production managers, shift managers, supervisors, quality control inspectors, draftsmen etc.

The third echelon consists of graduates of vocational schools. People with sufficient training to operate advanced technology machine tools and highly qualified welders. These need to be trained by a national network of vocational schools preparing technicians for the capital goods manufacturing industry, the food processing industry and other industries as well.

4.3.3. Know-how

Existing or future manufacturers of capital goods could only extend their production program as far as the reach of the know-how which they possess. It is necessary to determine as part of the manufacturing capabilities what is the know-how that will be required at the different stages of development of the capital goods manufacturing industry and to identify possible sources for such know how.

4.4 Policies

Whether setting up of peripheral capital goods manufacturing industry for the oil seed processing industry, or the grain milling industry, or both, or setting up of both medular and peripheral capital goods industry for a wider industrial sector, the major benefits to the national economy through such activities have been summarized earlier:

1. It could reduce the overall size of the investment in machinery involved in the project.
2. It could reduce the foreign exchange component of the investment in the project.
3. It could generate employment and income in the local machine building industry.
4. It could start or add force to an on going process of ec nomical development which could bring about an overall improvement in employment, education, income etc.

The possibility of reaping such benefits could be demonstrated if Recommendation 1 is acted upon. Once this is done, and Recommendation 2 is acted upon, the missing links on the way to a successful setting up of a capital goods manufacturing industry will have been determined.

They can also be given towards expenses in training, organization and working capital which should help in order to see the capital goods manufacturer through the first few lean years.

4.4.2.3. Help and Protection

Having sufficient financial help from the banking system can be of extreme importance to the recently established capital goods industry. Helping this industry secûre its share of the business which growth in the oil seed processing and grain milling industries generate, is an important task. This can be achieved by encouraging the local industry to purchase products produced locally. Such encouragement could be in the form of duties and levies on importation, discouraging rate of exchange, grants and easy loans towards purchase of locally manufactured capital goods and in extreme situations, protection of a national equivalent against importation.

Government can make funds available if necessary to purchase of patent rights and know-how and could encourage foreign companies who own such know-how to go into partnerships with local groups. One form of encouragement is lower taxation. Another is a guarantee to take profits out of the country.

4.5 Main Obstacles to Entry into Capital Goods Manufacturing for the Oil Seeds Processing and Grain Milling Industries

The developing countries could be divided into four categories, as proposed in chapter 3 section 3.4. In countries like Brasil or India all capital goods required for the two sub sectors (oil seeds processing and grain milling) can be produced nationally, much of it in cooperation with foreign companies, who own important know-how and sometimes part of the local company too. At the bottom of the line are companies where hardly any technical capability exists, and the chances for a bug and stimulating demand for capital goods are rather slim, either because of a small local market for the final products which determines the size of the local processing industry, or because existing conditions prevent these sub sectors of the food industry from developing and thus, only little demand for new capital goods is generated. Between these two extremes, one could find countries like Colombia in which the capital goods manufacturing industry is not quite as established and all encompassing as that of Brasil or India, but is certainly in existence and very active, or countries like Nigeria, which is not very active and does not manufacture nor require more things, but where demand still exists

Recommendation 3: Based on recommendations 1 and 2, local governments should be assisted in formulating policies which should be worked out and enacted upon, and which should create the possibility and the incentive for private and public enterprises to become active in capital goods manufacturing in general and in the manufacture of medular or peripheral capital goods for the oil seeds processing and the grain milling sub sectors.

Working out the required policies for the promotion of a local capital goods industry, these policies should relate to a number of different fields:

4.4.1 Promotion of Nutrition, Agriculture, Food Processing

A policy of promotion of adequate nutrition, increased agricultural production and increased food processing is the key to creation of a demand for capital goods in the food processing industry. Discussion of this point is felt to be outside the scope of this study.

4.4.2 Assistance to Local Industry

Based on the knowledge of what is required by way of a capital goods manufacturing industry for the development of the loc oil seed and grain milling industries, and by knowing what is available, (studies as per recommendations 1and 2) the government could formulate policies for assistance to the local capital goods manufacturing industries.

4.4.2.1 Policies in Education and Training

Plans for educational activities should be made and should be followed by actions which should result in formation of professionals at all levels required (see section 4.3.2). These activities may include promotion and support of training of individuals in selected fields abroad, training of teachers and instructors, providing financial means for setting up of workshops for instruction, financial assistance to students and learners of vocations.

4.4.2.2 Guidance and Direction

Although it is envisaged that free market forces should guide the development of the capital goods manufacturing industry, government role in offering guidance and direction could be of vital importance and in several ways:
Government could determine economical preference for small and especialized manufacturing plants or larger, more versatile ones. It can also favor setting them up in selected areas of the country. Government can achieve that by offering investment support schemes that will encourage the industry to follow government planning objectives. These support schemes could be in the form of grants or loans made towards purchase of land, buildings, manufacturing tools and machines.

on a level which is significantly higher tha the lowest. Such countries require an appraach that will take in account all that is already in existence in the local capital goods manufacturing industry.
This is required in Colombia, and it will take years of continued development of the food industry in a country like Nigeria to provide enough demand from a growing local market as a viable customer of local capital goods manufacturing industry. Each and every step and level outlined here is tied in with the others, sometimes providing for a vicious circle.

A systematic approach to removing the obstacles requires dedication but requires also a suitable budget.

4.6. Recommendations

The purpose of this study is to identify the peripheral capital goods that the grain milling and the oilseed processing lines have in common, and those that have a potential for local production in developing countries. Such list was given in section 2.8 :

Peripheral Capital Goods:	Medular Capital Goods
*Pumps (some)	*Grain dryers (some)
*Electrical Motors (some)	batch extractors
*Control Pannels (some)	
*Tanks, Settling Tanks	
*Magnet Cleaners	
*air compressors	
*Aspirators	
*Conveyors	
*Cyclones	
*Hoppers	
Liquid Storage Tanks	
*Bagging equipment	
*Bins	
*Steam boilers	

Developing countries are not equal in level of development. In some, capital goods equal or higher in complexity to those listed above can be already manufactured. In others, capabilities in production of capital goods like those listed above may exist but in order to take

*equipment type common to both sub sectors advantage of what the capital goods manufacturing industry has to offer, a certain level of engineering competence has to be achieved first. In other developingcountries only some of the above mentioned capital goods can be secured locally and in other developing countries none can be produced locally.

In this respect, the term "developing country" does not say very much. This is why in addition to the list given above, I want to make the following recommendations:

Recommendation 1: To study the projected dynamics of the devlopment of the vegetable oils and fat manufacturing industry, and the grain milling industry on a national basis in each of the developing country in order to estimate future volume of business in manufacturing of peripheral or modular capital goods based on present equipment purchase prices. Such a report will provide a basis for action in the field of the development of the capital goods manufacturing industry in the developing countries. This study should include demand for capital goods in the oil seeds and grains processing sectors, cost of equipment, analysis of cost of manufacturing and marketing of capital goods produceable in the country and should provide information required in order to make a decision whether volume of business which could potentially be produced will indeed provide an economical basis for operation. If such basis does not seem to exist, could inclusion of capital goods requirements for other industrial sectors in the country, and particularly the food industry, could potentially provide this extra demand required and thus provide the yet to be established capital goods manufacturing industry with a proper economic base of operation.

Recommendation 2: To study on a national level and to establish both quantitatively and qualitatively the factors which together determine the local capabilities in manufacturing of capital goods for the oil seeds processing, the grain milling and possibly other industries or sub sectors of the food industry, based on marketing oppotunities established earlier as per section 4.2.

Recommendation 3: Based on Recommendations 1 and 2, local government should be assisted in formulating policies which should be worked out and enacted upon, and which should create the possibility and the incentive for private and public enterprises to become active in capital goods manufacturing in general, and in the manufacture of medular or peripheral capital goods for the oil seeds processing and the grain milling sub sectors.

The purpose of these recommendations is to provide a basis for a national plan which could result in an establishment in a developing country of a peripheral capital goods manufacturing industry, producing peripheral capital goods for the oil seeds processing industry and the grain milling industry.

Recommendation 4: In order to meet future demand and in order to facilitate the development of capital goods manufacturing industry there is a need for establishment of national policies and plans of execution in the field of technical education and training. The possible development of local capital goods manufacturing industry and its growth dynamics should determine what types of educational and training programs will be required, when and at what scale.

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