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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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SYNTHESIS PAPER ON THE PROCESSING OF VARIOUS RAW MATERIALS **

Prepared by

Oluniyi Babatunde Omosaiye ***

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** The views expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

*** Chief Executive, Omory Limited
Consultants to Chemical Food and Agro Allied Industries
E 9 Eric Moore, Towers, Surulere, Lagos, Nigeria

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1. BACKGROUND

Developing Countries

1.1. That "Developing Countries as a group, have a relatively large share of the world's raw materials, yet their combined share in the supply of processed or semi-processed products amount to only 10% of the global manufacture value-added" is generally well known, and although the Lima Declaration and Plan of Action stated that the share of developing countries in world industrial output should reach 25% by the year 2,000, progress towards this goal has been slower than anticipated.

The international community fully recognizes the reasons for the slow pace of industrial development, which range from pervasive and structural economic problems of the developing world to political problems, increasing energy costs and world economic recession. Other barriers to industrial development are endemic and these include little or no local development of technology, dwindling export opportunities, falling commodity prices, fluctuating exchange rates and these have combined to make developed country markets less easily accessible.

The processing of raw materials and the value-addition takes place mostly in the industrial developed countries. The third world, as major suppliers of raw materials, can no longer afford the sharp decline in raw material prices and therefore must endeavour to reap and optimise economic benefits from their raw material endowments. It seems logical therefore, that the way forward is by obtaining a higher value-added through domestic processing of raw materials, and so create a base for overall economic development in individual countries and promote a better life for the ever expanding population.

1.2 Against this background, and given the need to strengthen co-operation among developing countries in the field of commodities, in their primary and processed forms, in order to improve the terms of trade and ensure increased earnings from exports, the Inter-governmental follow up and Co-ordination Committee of the Group of 77 (IFCC-VI) decided to initiate an Action Committee on Raw Materials.

In preparation for the first meeting of the Action Committee, the Group of 77 requested UNIDO to assist in the organisation of an Expert Group Meeting on the processing of Raw Materials. The Expert Group Meeting was held in Vienna 22-26 August 1988 and was attended by more than 15 experts in the following sectors:

- Agro based Raw Materials for food production
- Non - metallic minerals and
- Textile Fibres.

A number of eleven papers were specially prepared by UNIDO recruited consultants and examined at the meeting.

1.3. Subsequently, this paper was commissioned to examine the eleven background papers as well as the report adopted at the EGM and prepare a synthesis paper covering such themes as:

- Industrial and Technological Aspects
- Role of Research and Development
- Role of Training and manpower Development
- Marketing
- Co-operation among developing countries,

pursuant to Agreement No. CLT88/1033 between the consultant and UNIDO in accordance with the following terms of reference;

(a) Industrial processing consideratins for the conversion of raw materials into manufactured goods/products in demand of internal and external markets.

(b) The technology of raw materials processing with special emphasis on new trends in user requirements and processing techniques.

(c) Improvement of the function of existing institutions through twinning arrangements and execution of joint research programmes among developing countries.

(d) The role of research centres and similar R & D institutions in developing countries in promoting the processing or exploitation of selected raw materials and possibilities for cooperation among developing countries in technology development and dissemination.

(e) Establishment of networks which enhance research - industry transfers and ensure a dynamic co-operation among researchers, manufacturers, marketing and banking specialists.

(f) The role of training and manpower development for the achievement of effective growth by developing countries in processing of raw materials.

(g) Review of existing mechanisms for marketing and distribution of raw materials; obstacles experienced by developing countries when trying to enter international commodity markets and the scope for cooperation among them in order to create domestic capabilities for strengthening the scope of marketing practices.

(h) Strengthening of the capabilities of resource development research and marketing agencies in management and data processing areas;

(i) Recommendations to developing countries on measures to be taken at national, regional, and international levels with a view to make better use of their raw materials.

2. INDUSTRIAL AND TECHNOLOGICAL ASPECTS

2.1. INDUSTRIAL PROCESSING CONSIDERATIONS:

The business of industry is to secure profitable growth through meeting the needs of consumers both nationally and internationally for products and services of good value and consistent quality. This policy assures repeat purchase, the business grows, and those who have a stake in it are pleased.

To keep the wheels of industry turning, industrialists must make definite plans about processing their raw materials. In general, three key points are essential for meaningful industrial growth:

(i) A knowlege of the quantity, quality, nature and type of raw materials available.

(ii) Possibilities offered by Technological developments about raw material processing.

(iii) The availability of skilled manpower is an indispensable pre-condition for the establishment of viable processing, marketing and distribution activities.

2.1.1. AGRO BASED RAW MATERIALS FOR FOOD PROCESSING

2.1.1.1. FOOD SITUATION IN DEVELOPING COUNTRIES

Food is one of the basic needs of man, the others being shelter and clothing. The lack of it has created major problems such as hunger, malnutrition etc for human beings the world over.

The growth of agriculture is low and still falls behind the population growth rate in most developing countries and because of shortfalls in food production, developing countries have become more and more, heavy importers of food. Internal investments in food production continue to be inadequate and many developing countries still lack the protection of minimum security stocks. Those developing countries which had achieved food self-sufficiency reduced their domestic food subsidies to make structural adjustments to ease the problem of paying off their long term debts. Lack of finance and debt service obligations had already meant little or no local development of technology, poor funding of R & D and lack of skilled technical and management personnel.

2.1.1.2. PLANNING FOR ADEQUACY IN GRAINS, ROOF RAW MATERIALS OILSEED AND OILFRUITS.

Many developing countries do not produce enough agro based raw materials to meet their needs. Low yields per hectare in most cereals and oilseeds production are attributed to poor inputs such as breeding materials, fertilizers, and crop protection chemicals. Extension services are underdeveloped and most farmers relying on farm holdings of 1 - 2 acres in developing countries, use mostly old fashioned tools with little or no mechanization. Insufficient and unsteady supply of raw materials has been the main cause of under-utilisation of installed capacities of existing food processing industries.

2.1.1.3. POST HARVEST LOSSES

Amidst the inadequate food production, post harvest losses remain a major problem in the agriculture of developing countries. Most developing countries do not have adequate storage facilities. Between 15 - 20%, and in some cases 40% of Cereals, 50% of fruits and vegetables and about 30 - 50% of yams are lost post harvest.

2.1.1.4. MARKETING AND PRICE STABILITY

In most developing countries, marketing organisations do not exist, while in others where they exist, they are not effectively organised. Lack of guaranteed price stability remains a disincentive to local farmers. These marketing defficiencies must be removed because in industrial manufacturing, quality, quantity and the right price are essential.

(i) Marketing information is inadequate and this restricts the orderly and timely flow of food from food surplus areas to food deficient areas. Standard pricing policy is also lacking.

(ii) Production of food commodity is highly seasonal. As a result of inadequate storage and processing facilities, seasonal price fluctuations are so large that producers incomes are low at harvest while consumers pay high prices during off season.

2.1.1.5. STANDARDS OF INDENTITY AND QUALITY

Specifications and standards of identity are lacking for many local agro based raw materials and their finished products at the moment. Quality standards for mycotoxin, pesticide residue and heavy metals demand sophisticated analytical equipment and trained personnel. This remains a big challenge to manufacturers who must now set new standards to suit their own processes, and reach back to the farmers on minimum acceptable standards for their farm produce.

2.1.1.6. TECHNOLOGICAL REQUIREMENTS FOR AGRO RAW MATERIALS PROCESSING

There is an overdependence on advanced technology with its attendant cost implications. These may be packaging materials, machinery, expertise or technology. Developed countries sell "turnkey" plants, which are not necessarily adequate for developing countries. In this case, appropriate technologies are needed and therefore, national technological institutes are expected to play key roles in the selection, development, application and transfer of technology.

2.1.1.7. LACK OF INFRASTRUCTURE TO FACILITATE INDUSTRIAL PROCESS

Power and water supplies are unreliable in quality and quantity and cannot yet provide a sure base for meaningful economic activity. Therefore, industries must invest in boreholes and generating plants. This is particularly injurious to the development of small scale businesses which cannot afford the huge investment. Public transport services (rail, road, waterways) are inadequate and this adds to increased marketing costs.

2.1.1.8. NATURE OF THE FINISHED PRODUCT

The key issue is the demand of internal and external markets. In developing countries, food preparation/ consumption is very closely related to cultural, social and religious practices and finished products must be tailored to satisfy the consumption patterns. This is essential as far as grains, roots and oilseeds are concerned. Even when enriched and fortified products are developed, these must be introduced with caution because food habits are difficult to change. Consumers must be educated on the merits of the new products, which, to all intents and purposes, will alleviate the nutritional problems of the people especially in the rural areas.

A key industrial consideration is keeping up with the demands of external markets especially in the areas of processing, packaging, quality and shelf life requirements under prevailing climatic conditions.

2.1.1.9. GOVERNMENT POLICY

Obviously, industries will worry about inconsistent government policies which favour trading rather than manufacturing. In developing countries, management of resources is a problem, and unless manufacturers are satisfied that it is economically, politically and commercially sensible to invest in agro-allied projects, new investments will not come readily. For industries, planning is difficult in an unfavourable, and politically unstable climate.

2.1.1.10. CRISIS IN AGRICULTURAL TRADE

Fluctuating raw material prices and unfavourable demand trends characterise the state of world trade in Agriculture. Thus, the efforts of developing countries to increase production are often poorly rewarded in the current trade environment, resulting in unexportable surpluses. Therefore, to avoid the problem of bumper wastage, developing countries should aim at value added processing, subject to consumer choice. Any stage of processing beyond the natural state of the raw material makes it more tradable, adds even more value to the raw material and raises the self-sufficiency ratio of developing countries.

2.1.2. NON - METALLIC MINERALS - KAOLIN

The optimal utilisation of non-metallic minerals is particularly crucial for the economic well-being of the Developing Countries for two reasons:

(i) They are important for establishing and supplying indigenous basic industries (building materials, ceramics, glass, fertilisers, chemicals, etc)

(ii) All the processing stages and consequent value addition takes place in the country itself, using local labour, and involving in most cases, a simple technology and small capital expenditure.

However, developing countries face three key challenges:

(a) Since all mineral deposits are wasting assets because they have finite economic life span, there is the need to produce clay qualities which maximise the utility and value of their natural resources.

(b) To expand clay-based industries to benefit from the added - value increase between raw materials and finished goods.

(c) To break into export markets, once the home market requirements are met.

2.1.2.1. ECONOMIC VALUE

The economic value and marketability of kaolin would depend upon:

(i) reserves, characterisation and the industrial uses to which it can be put.

(ii) location in relation to ports, transport net-works and consuming centres.

(iii) availability of infrastructural facilities such as energy and water etc.

Production of non-metallic minerals usually does not provide profit margins of the same magnitude as the production of metallic minerals. For example, non-metallic minerals are characterised by low unit cost, and hence are not exportable in the raw form. Transportation constitutes a high proportion of the total costs often more than 50%. Thus, non-minerals have not been regarded as a major potential source of export income for developing countries and colonial powers have taken less interest in developing production of non-metallic minerals. Therefore, due importance should be given to the development of Kaolin-based, small scale industries, as domestic production has an initial competitive advantage over imports of Kaolin-based goods.

To that extent, linkages, both backward and forward, should be established to the rest of the economy, given the relatively less advanced inputs and the capability of local economics to absorb the output.

2.1.2.2. LACK OF INFORMATION

One of the obstacles to a diversified industrial application of non-metallic minerals is lack of information on potential uses and the related technologies. A key consideration before embarking on the development of mineral - based industries is the compilation of a national mineral inventory, providing quantitative data for each mineral deposit and for the derivable products including trends in consumer usage in a form suitable for industrial and commercial assessment. Other aspects include processing technology profiles, standards and specifications, range of suppliers of equipment, materials and services; non-metallic mineral product prices, transport charges, tariff and other governmental measures. In most developing countries only governments have the resources necessary for initiating a comprehensive mineral resources industry through the establishment of a mining development corporation or an appropriate body to initiate mining, processing and manufacturing projects. Unfortunately governments are not known to be good managers in such ventures.

2.1.2.3. PRODUCT QUALITY

Mineral users demand high quality raw materials, and are quite hesitant in trying new suppliers to avoid hazards to their own manufacturing processes. Reliable quality is a key factor for successful entry into mineral markets and this requires know-how, enterprise and capital, as well as adequate supplies of energy and labour. Therefore, great attention needs to be devoted to the development of appropriate skills for good operator performance, thus assuring increased local value added in terms of internal markets and significant benefits for the economics of developing countries.

The achievement of credibility is escpecially important for new operations in developing countries which lack a tradition of skills in clay production. Efforts should be concentrated on small ranges of products and maintaining close contact with domestic customers during the early stages when performance standards are more likely to fluctuate.

2.1.2.4. OPERATIONAL STRATEGY

The main purpose of any clay mining operation remains the extraction and recovery of the highest possible proportion of clay from the deposit in the cleanest possible products and at the lowest possible operating costs. Each operation needs to find a compromise which yields the highest possible profit and hence the best conversion of a natural resource. A planned scale of production in relation to the quality and reserves of the deposit is essential. This strategy enables developing countries to generate more permanent benefits during their exploitation through establishing an infrastructure and secondary industries with the creation of wider reservoirs of manufacturing and service skills.

New operations that have good enough reserves and quality should grow and develop in stages by means of a modular add - on expansion of throughput capacity to allow for inevitable initial difficulties and mistakes, starting with a modest rate of production that would not over-stretch initial financial and technical means. Feasibility studies should provide pertinent data for sequential scenario of production.

2.1.2.5. VARIED GEOLOGICAL AND MINERALOGICAL CHARACTERISTICS

The differences in clay mineral characteristics arising from the varied geological sources can impose widely different requirements on clay production. These affect technical and financial considerations in respect of process and plant design for optimal resource utilisation.

2.1.2.6. SPECIALITY PRODUCTS DEVELOPMENT FOR INTERNATIONAL MARKETS

These are high-tech products and industrial countries have significant advantages because of already existing technological sophistication backed up by sound R & D and skilled labour. This makes it difficult for developing nations to penetrate these markets. Hence, developing countries have only seen around 10% of new mineral investment in recent years, despite the fact that they hold 90% of the earth's remaining untapped mineral resources.

2.1.3. TEXTILE FIBRE

Cotton availability is linked to population trends, availability of suitable land for growing cotton and socio-economic conditions.

2.1.3.1. COTTON PRODUCTION:

Cotton is produced under a wide range of conditions in the developing countries. Although they are endowed with a masive area of cultivable land and weather to grow cotton, lack of resources (machinery, protective chemicals, fertilisers, water, irrigation) makes it difficult or even impossible to make much progress, compared to developed countries where improved agronomical practices have contributed to increasedproduction, high yield and better quality of cotton fibres. In some developing countries, Government policy on land acquisition discourages entrepreneurs from going into cotton production on a large scale. In addition, there is the need for good quality seed being made available for planting, and a growing recognition of the crucial importance of creating a strong organisation which provides farmers annually with seeds with a high standard of genetic purity and of quality to yield fine, mature, strong and long cotton for processing.

2.1.3.2. GINNING

Ginning is a key industrial consideration as it affects the quality of cotton. Delayed and bad ginning is the main weakness of cotton in most developed countries. Cotton fibres deteriorate in quality with delay in ginning. This realisation is having a profound effect on agricultural practices such as selection of varieties, methods of picking, pre-ginning storage pre-drying, pre-cleaning or lint cleaning, contamination etc.

2.1.3.3. FIBRE QUALITY:

The importance of a good quality fibre cannot be over-emphasised because the development of full usefulness of cotton to face the competitiveness of the export market begins with the fibre. The spinners require clean, mature and undamaged fibre and are selective in choosing those growths which give the highest coversion efficiencies and yarn quality in their mills.

2.1.3.4. FABRIC DEVELOPMENT

Fabric development in developing countries is threatened by the presence of man-made synthetic fibres from the developed world. Finishing capacity in the developing countries is not sufficient and the level of technology is not high. This results in poor quality of cloth which cannot face the competitiveness of the export market.

2.1.3.5. DEMAND STIMULATION

Further to the serious threat from man - made fibres, the textile processors, retailers and consumers have no fibre loyalty. Thus, activities which ensure a continuing demand for cotton must be supported, and in order to stimulate demand, international barriers to trade intextiles and clothing should be dismantled.

2.1.3.6. EQUIPMENT AND MACHINERY

User requirements determine the choice of equipment for each unit operation. The textile industries in developing countries are totally dependent on imports for machinery and vital spare parts. Unfortunately, the technology for these is still an exclusive preserve of developed nations. For maximum exploitation of cotton, this trend has to be reversed.

2.2. THE TECHNOLOGY OF RAW MATERIAL PROCESSING WITH SPECIAL EMPHASIS ON NEW TRENDS IN USER REQUIREMENTS AND PROCESSING TECHNOLOGIES

Developing countries have initiated actions aimed at long-term structural transformation of their economies which is vital for breaking the vicious cycle of poverty and underdevelopment and for paving the way for self-reliant economic development.

Stronger measures such as a ban on imports of items designated for self-sufficiency or a ban on items that impeded self sufficiency in other products have been instituted. Private sector participation has led to the development of new products and processes based on available local raw materials. Under the new dispensation, there is the need to understand user specifications which are changing and this calls for a better technical description of standards.

2.2.1. AGRO BASED - RAW MATERIALS FOR FOOD PRODUCTION

2.2.1.1. ROOTS AND TUBERS (YAMS AND CASSAVA) BACKWARD INTEGRATION

The indigenous method of processing roots and tubers has been improved by optimising unit operations with respect to time savings, product quality and cost and better packaging. The new trends in food processing stem from a realisation that there are now tremendous potentials in producing "Convenience" foods, given that the products meet consumer expectation in terms of product quality and presentation. Examples are dehydrated yam flakes which upon reconstitution produces pounded yam, a delicacy for urbanites, and "Gari" derived from cassava, a staple diet of over 100 million Africans. Processing steps in the preparation of pounded yam and various products from cassava are shown in Figs I and II.

One of the obstacles in the maximum utilisation of roots and tubers is STORAGE. Little of t' research that has been done on increasing yields or improving storage characteristics has yet been applied on a large scale. So far rotting and sprouting in yams have been inhibited for up to eight months and cassava chip technology is now in vogue to transform perishable cassava roots into tradeable commodity.

FIGURE I

YAMS

↓

SORTING (Important for variety Indentification).

↓

LYE PEELING (Hand-peeling - labour intensive - 30% losses).
(10% LYE (Mechanized peeling - difficult, irregular
10°C shapes of tubers).

↓

WASHING

↓

COOKING (Atmospheric pressure or steam pressure)
5 - 10 psig

↓

MASHING

↓

DRUM DRYING

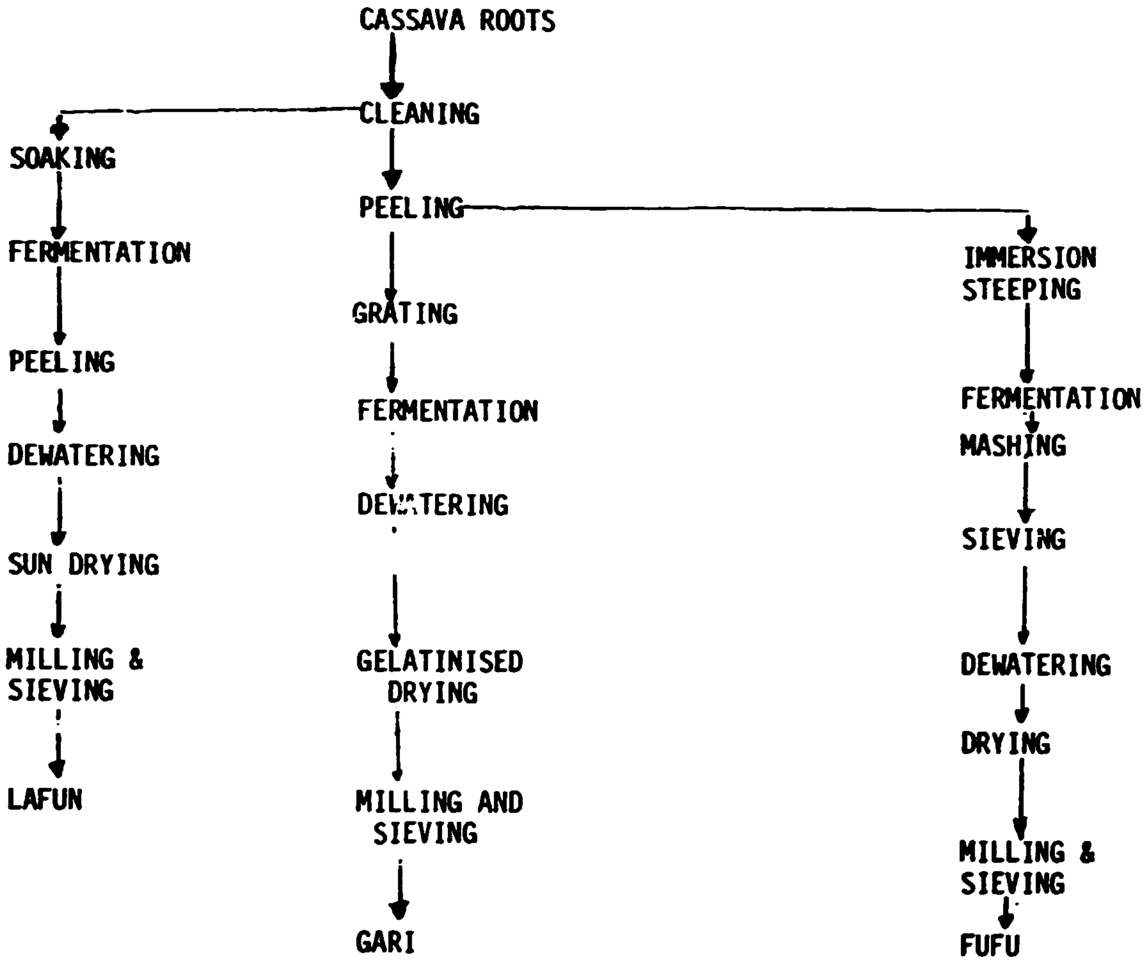
↓

PACKING

PROCESS FLOW CHART FOR THE DEHYDRATION OF YAM FLAKES

Fig II

CASSAVA PROCESSING FLOW CHART



2.2.1.2 GRAINS

Import Substitution

The need for the survival of industries which utlilise a high proportion of imported grains in their processes has also led to increased activities in local grain processing especially in the current economic climate where self sufficiency in food production is the ultimate goal. Breweries and malt based cocoa drinks in developing countries now demand a high proportion of sorghum malt and maize adjuncts instead of barley malt, while flour mills are developing maize and sorghum based flours.

Many challenges are posed:

(i) the task of developing a local raw materials base that provides enough process inputs in making existing products or developing entirely new products.

(ii) consumer needs must be satisfied in an economy where consumers are highly discerning, selective and sensitive.

(iii) appropriate processes must be developed and adequate plant and machinery acquired.

The production of malt from grains especially sorghum for industrial use is a new trend in some developing countries, and is similar to barley malting with some modifications. The process flowchart is shown in Fig. 3.

The final product is malted sorghum which has applications in beer brewing, production of sorghum extract for cocoa beverage and sorghum syrup in confectionery production. The development has led to a much better technical description of specifications because producers and users are operating in the same local environment. Specifications based on processing conditions and specific product requirements have been agreed.

With the ban on wheat, milling industries have turned to maize, and have modified some of their wheat mills to process maize and sorghum. Three key factors are important when modifying machinery:

Size: Variation in size of the grains affect the cleaning method and machineries.

FIGURE 3

SORGHUM

↓

CLEANING

↓

GRADING

↓

WASHING & STEEPING (increases water content to about 45%)
(10° - 18°C, 24 hours).

↓

GERMINATION (16° - 21°C)

↓

KILNING (4% moisture).

↓

ROOTING

↓

MALT

PRODUCTION OF SORGHUM MALT

Hardness:	Hardness of grains affects types of SPOUTS, as flow diagram is different.
Fat content:	Fat limits the keeping quality of flour and so additional machines are required to remove germ from endosperm. The composition and nutritive value of the grains determine what products to aim at.

Maize is a dynamic crop and more products are in fact obtained in a maize mill:

Coarse grits	-	used as breakfast flakes.
Brewers grits	-	used as brewing adjunct.
Household grits	-	for different mills and distilling industries.
Corn germ	-	for oil mills and germ cake.
Flour	-	for starch, non-wheat bread, biscuits and pharmaceutical industries, baby foods.
Bran and offals	-	for animal feed and alcohol extraction.

New products based on local grains are now available to provide the much needed nutritional benefits:

Soyabean - maize combination in breakfast cereals
Soy flours with vitamins and minerals added.
ready to use flour from lime - heat treated corn
baby foods, cereal based cocoa beverage and convenience foods, parboiling by cleaning and soaking rice prior to steaming and drying increases vitamin B retention and reduces susceptibility to beriberi.

2.2.1.3 OIL-SEED AND OIL-FRUITS:

New trends in user requirements demand high quality oils and fats free from rancidity, biological deterioration from moulds and contamination from micro organisms. e.g. Afflatoxin. Some progress has been made in ameliorating the situation even in developing countries.

(i) Raw Materials Storage:

Modern silos in steel, concrete and wood are now equipped with automatic temperature control, microprocessor control, heavy duty and evenly distributed ventilation and cell to cell recirculation systems with refrigerated aid.

(ii) Preparation and Mechanical Oil Extraction.
Fluidized bed technology for soybean processing is an example of sound investment and energy saving; extrusion technique gives a better recovery of oil and higher soya meal quality; milling and heating rice bran and solvent extraction destroys lipase activity. Palm fruits are sterilized before mechanical removal of fruits from the bunch and mechancial breakdown of the fruit structure in a modern plant; sunflower seeds are dehulled before preparation and conditioned before mechanical expression.

(iii) Solvent Extraction
Modern solvent extractor systems, capable of processing up to 4,000 tons daily have been developed, with maximum utilisation of energy at all stages of extraction, distillation and desolventising operations.

(iv) Meal Desolventising;

- An advanced technology (DTDC: desolventiser, toaster, dryer, cooler) has been developed to suit the characteristics of different materials, their heat sensitivity, protein, urease, and other nutritional aspects.

- For high quality soybean protein meals production, two modern systems have been developed - flash desolventising with positive solvent recovery combined with flake stripping and cooking and VDVD (vapour desolventising, vapour deodorizing) which is also applicable to reduce antinutritional and toxic factors in cotton seed, rapeseed meals and groundnut.

(v) Full-fat Soybean Extrusion Method for production of animal feed from Soybean and cotton seed meal has been developed with simultaneous inactivation of antinutritional factors.

(vi) Production of protein foods and concentrates from other oilseeds;
These include protein isolate process for groundnut kernels; acetone extraction for low gossipol products from cotton seed; special preparation of coconuts and industrial production of coconut cream.

(vii) Refining and Deodorising:
Soybean oil reversion flavour has been eliminated by the use of stainless steel equipment, better control of caustic refining, improved bleaching practices, utilisation of activated clay and improved deodorization process. A new bleaching procedure was also developed for obtaining constant, high quality palm oil.

(viii) Hydrogenation:
By means of a careful control of the reaction conditions, pressure, temperatures, agitation, concentration and the right catalyst, oil products with selected higher melting points and specific rheological properties have been produced for the formulation and processing of margarines, shortenings and cooking fats. The hydrogenation process operates through an efficient heat recovery system.

(ix) Rearrangement of Fats:
Confectionery fats are being produced using palm kernel oil as the raw material through a sophisticated technology known as transesterification, interesterification or ester interchange. In the process, fatty acid esters react with other esters or fatty acids to produce new esters by an interchange of fatty acid groups.

(x) Fractionation:
The process has a broad application in edible oil

technology and involves basically the physical separation of oils into two or more fractions. It is used in the production of cocoa butter equialents from palm oil, palm kernel oil, shea fat, hydrogenated soybean and cotton seed oil. Palm oil fractionation produces olein as a liquid oil substitute and stearin for margarine, vegetable fats and cosmetics.

New technologies for some lesser known sources of oils, fats and related products were being investigated: rice bran processing in India, olive oil in the Mediterranean, grape seed oil, safflower oil, jojoba seed new maize hybrids (for high value maize germ oil).

2.2.1.4. BYPRODUCTS UTILIZATION:

Studies of the nutritional requirements of animals have led to the development of nutritionally balanced feeds containing protein, carbohydrates, liquids, minerals and vitamins and accessory factors that improve the rate of growth of animals based on byproducts of agriculture, agricultural raw materials preparation and food processing. For example:

(i) A cost effective nutritional feed can be produced from 50% chopped corn straw, 25% molassess, 13% corn flour, 10% sorghum, 2% urea, phosphorus rock and sodium chloride.

(ii) Chopped bagasse from a sugar mill can be used for animal feed, industrial alcohol and other organic chemicals, paper, textile fibre, cellulose dervatives and fibre boards.

(iii) Molasses derived from sugar crystallisation is rich in fermentable carbohydrates and is being used to produce single - cell protein for animal feed, ethyl alcohol and dextrans.

2.2.2. NON - METALLIC MINERALS - KAOLIN:

New trends in user requirements call for the very highest quality Kaolin clays where both purity of the clay and finest particle sizes are of dominant importance.

For example, well crystallised white Kaolin without mineral impurities fetches the highest price and if the Kaolin is coater grade or filler grade, that Kaolin has excellent export potential, although it has very stringent specifications. Only wet processing routes are capable of yielding these.

2.2.2.1. PROCESS TECHNOLOGY

The process flow chart in a well established sequence is as follows:-

FIGURE 4

Mined Material

↓

Thorough disaggregation and dispersion

↓

Blending to achieve uniform quality.

↓

Removal of Coarse waste

↓

Removal of Progressively finer sized impurities

↓

Size classification of the clay minerals

↓

Cleansing of the clay minerals

↓

Dewatering and conditioning of the clay products.

KAOLIN-CLAY : WET PROCESSING ROUTES.

(i) Disaggregation and Dispersion

These processes are jointly responsible for achieving good liberation of clay from associated waste minerals, obtaining the highest possible extraction of clay per tonne of rock mined. With high shear in crushing and shredding, the valuable finest clay fractions are increased.

(ii) Classification

Good classification is a pre-condition for attaining high quality end products, requiring a high degree of control of process variables such as pump performance, pulp density and flow rate/residence time, with modern electronic instrumentation and computer control as aids. The latest practice uses classification units consisting of a sequence of 10mm hydrocyclones followed by centrifuges, sharper classification cuts of the order of 80% - 0.002mm are achieved.

(iii) Cleaning Processes

These are important for particle size distribution and purity of the clay product. Discolouring contaminants and stains absorbed on clay particles are cleaned to user specifications.

Froth floatation using natural or induced selective surface conditioning is used for separating hydrophobic from hydrophilic minerals and high intensity magnetic separation is used to separate various impurity minerals which are sufficiently paramagnetic for magnetic separation.

(iv) Bleaching:

The process is used for cleaning clay particles which are coated of stained by more or less hydrated ferric iron oxides. At about 30% recommended solids, the clay slurry is first flocculated by adding alum and sulphuric acid, lowering the pH to about 3.5 - 4.0 Ferric oxides are reduced to the ferrous state, become water - soluble and are later removed with the process water, organics if present in addition to iron oxides can be rendered soluble by oxidising them with chlorine gas, and preferably using hydrochloric acid and sodium dithionite to reduce iron oxide to soluble ferrous oxide.

(v) Delamination

The main purpose of delamination is to break up coarse crystals of kaolin minerals into thin cleavage platelets which have a significantly higher value. This raises the total clay extraction and improves the convertible grade of a deposit by increasing the ratio between contained and recoverable values, as well as yielding higher price products. The safest and most dependable method of delamination is wet grinding under conditions of high shear.

(vi) Thickening:

Solids density in the range of 7 - 20% solids by weight, necessistates some preliminary thickening with high speed nozzle centrifuges. No solids are lost with the water and the density is raised to 30 - 35% solids, suitable for filteration. Centrifugal thickening achieves higher solids densities (30-35% solids) and is always more efficient for the finest clay fractions which are very dilute and have very slow settling rates.

(vii) Filtration:

Dewatering is achieved by means of filtration. Relatively fine particle sizes of all kaolin clays create a low cake permeability; necessitating using slurry densities of not less than 25 - 35% solids in order to reduce the volume of liquid to be removed from the filter cake. The most widely - used filtration equipment for kaolin clays are recessed plate and frame filter presses, or large rotary-drum vacuum filters.

(viii) Finishing Treatment:

Apron and rotary driers are used for drying acid clays down to a final moisture content of about 5%, with a roller-type mill used for fine grinding, to 5% and a pulverizer with a flash drying system used next to lower the moisture to less then 1%.

Alternatively, the acid filter cakes may be re-pulped with an addition of a dispersing agent (deflocullant), becoming quite fluid at 65% solids. Spray driers are in use to dry the heat sensitive kaolin to a moisture content of less than 1% in a single stage.

2.2.2.2. TRENDS IN USER REQUIREMENTS

World market for kaolin clays is growing and paper will remain the dominant tonnage production target accounting for 70 - 80% of total kaolin usage. Substantial growth in other users of kaolin is projected both alone and in mixtures with swelling clays to achieve combinations of properties. For example, clay products are used for removing trace metals, for decolorising or for emulsifying in processing industrial and food products. Lower grades of kaolin clays are also gaining an increasing demand for replacing more expensive organic thickeners in paints. Clay fillers improve performance in new plastics and in cosmetics, high quality speciality kaolins is used increasingly to replace magnesium carbonate. Kaolins in a size range of 0.020 - 0.045mm have uses in fibre glass, welding electrodes, animal feeds or insecticides.

2.2.2.3. NEW DEMANDS

There are now demands for more and more highly purified kaolins, which are needed for electronic and other tough new ceramics, (e.g. SIALONS) which have growing demand in engineering, structural and surgical uses. Such kaolins command very high prices but face exceedingly demanding specifications. Tables 1 and 2 give the characterisation of kaolin in relation to its marketability while Table 3 gives an analyses of coater and filler paper kaolins. A careful evaluation of production strategies and targets is necessitated given the wide choice of potential markets facing new kaolin producers. Longer term, success and entry into export markets are attainable only with a combination of product quality, reliability and cost effectiveness.

Table 1

Characterisation of kaolin in relation to its marketability
(Adapted from U. Aswathajarayana) UNIDO Consultant (1988)

Parameter	How to be determined (Phiri et al , 1983)	Relevance in terms of marketability
1. Particle size	Wet sieving of > 63 µm fraction ; sedimentation for < 63 µm fraction ; plotting of spherical diameter(µm) vs. cumulative percent.	Particle size of kaolin for most applications is sub 10 µm . Kaolins are washed, screened, settled in water and filtered . Continuous, high-speed centrifuging , installation of large blungers to make-down and disperse kaolin at the mine, piping of kaolin slurry to the beneficiation plant, etc. are some of the techniques currently employed to produce uniformly sized products for the market.
2. Mineralogy	Petrological and binocular microscopy ; X-ray diffractometry of oriented and un-oriented samples ; Differential thermal analysis and transmission electron microscope examination of < 5 µm fraction.	Well-crystallised, white kaolin without mineral impurities, fetches the highest price . While non-clay minerals can be removed on the basis of their grainsize, the presence of even small quantities (about 5 %) of other clays like montmorillonite, or the presence of colloidal silica which cannot be easily removed,affect the marketability of kaolin as (say) filler and coater. Such clay compositions are,however, perfectly acceptable for refractory ware, stoneware , etc.

Table 1 (contd.)

Parameter	How to be determined	Relevance in terms of marketability
3. Bulk chemical composition	XRF and AAS to determine SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO , Na_2O , and K_2O ; Loss on ignition is determined in three stages : 100°C, 375 °C, & 1000°C; ;pH and soluble ions in some cases.	Chemical standards for finished clay are : Al_2O_3 > 38 % , L.O.I. : about 14 % (assuming absence of carbonates) ; Fe_2O_3 < 0.5 % ; Ti O_2: < 0.2 % ; Na_2O + K_2O < 0.2 % . Chemical composition of kaolin determines its use in pesticides , paints, alum, etc. industries .Iron by far is the most serious impurity for paper & whiteware.
4. Atterberg limits & plasticity index.	Determination of liquid and plastic limits and plasticity index.	Optimum moulding is determined from plastic limit and plasticity index . Highly plastic or "fat" clays could be blended with less plastic or "lean" clays to obtain the desired plasticity .
5. Colour	Measurement of hue, purity and brightness of raw clay discs and the same discs after firing (say, at 1100°C & 1250° C) by relection spectrophotometry	Hunter Brightness factor has to be at least 80 for kaolin to be used as a paper coater and filler, and this is the grade of kaolin which has export potential. Brightness factors of about 90 have been achieved commercially by calcining (to 1050° C), ultra-flotation and high-intensity magnetic separation (to remove traces of Fe & Ti) and by delamination techniques (Murray , 1976; Figs. 3+4)
6. Firing tests	Linear shrinkage of briquettes when fired (at,say, 1100,1180 & 1250 ° C)	If shrinkage during drying and during firing is too high , the clay cannot be used for firing . This test is critical for ceramic & refractory applications .

Table 2

Degree of importance of characterisation parameters for industrial use

Use	Particle size	Mineralogy	Bulk chem.	Plasticity	Colour	Firing tests
1. Paper	A	A	A	B	A	C
2. Ceramics	B	B	B	A	A	A
3. Paints	A	B	A	B	B	C
4. Plastics	A	B	A	B	B	C
5. Adhesives	A	B	A	A	B	C
6. Alum	B	B	A	C	B	C
7. Catalyst	B	B	A	C	C	C
8. Rubber	A	A	A	B	C	C
9. Pesticides	A	B	A	B	B	C
10. Miscellaneous*	A	B	B	A	B	A

A :Critically important ; B : Moderately important ; C : Marginally important/ unimp.

* Miscellaneous uses of low-grade kaolinite for making stoneware , pottery , bricks, refractory ware,etc., with appropriate blending of clays, where necessary .

Table 3

ANALYSES OF PAPER KAOLINS

Source: Documentation from the various producers (courtesy : STAMICO/AUSTROPLAN)

	UTILIZATION	COATING		FILLING			
	Country	Great Britain	England, W-Germany	France	England	Germany	Austria
	Brand Name	Dinkie A	Euroclay	Kaolin 1C	Grade B	L 30	DT 60
Physical Analysis	Whiteness (R 46) %	86,8	86,5	81	82,5	80	79
	Abrasion (AT 1000) mg	7,0	< 2	26	n.d.	20	n.d.
	pH (20 % solids)	5,0	6,5	n.d.	n.d.	7	n.d.
	> 53 microns	0,02	n.d.	n.d.	0,05	n.d.	n.d.
	> 10 -"-	0,5 max.	n.d.	~ 1,5	12,0	n.d.	n.d.
	> 63 -"-	n.d.	n.d.	n.d.	n.d.	< 0,01	0,02
	> 45 -"-	n.d.	< 0,03	n.d.	n.d.	< 0,05	n.d.
	Grain fractions < 2 microns	75,0	92,0	59	45,0	55	69,2
	Mean specific surface (m^2/g)	10,5	n.d.	n.d.	8,0	n.d.	13,65
Chemical Analysis	Loss on ignition %	13,10	13,80	12,70	11,90	12,5	13,00
	SiO_2 %	47,80	44,90	46,90	48,70	48,5	46,60
	Al_2O_3 %	37,00	39,20	37,20	36,00	36,5	37,80
	Fe_2O_3 %	0,58	0,25	0,78	0,82	0,5	0,60
	TiO_2 %	0,03	1,50	0,15	0,05	0,8	0,3
	CaO %	0,04	n.d.	0,12	0,06	n.d.	0,3
	MgO %	0,16	n.d.	0,28	0,25	n.d.	0,2
	K_2O %	1,10	0,05	0,79	2,12	1,1	1,0
	Na_2O %	0,10	0,15	0,15	0,10	0,1	0,2
Mineralogical analysis	Kaolinite and other minerals %	90	> 98	88,40	n.d.	n.d.	98,6
	Quartz %	< 0,5	< 0,5	1,40	n.d.	n.d.	0,7
	Feldspar, mica & residual minerals %	< 10,0	n.d.	8,65	n.d.	n.d.	0,7

2.2.3. TEXTILE FIBRE

2.2.3.1. TRENDS IN COTTON PROCESSING

From spinning to finishing, the end use aimed at determines linear density of the yarn, the weave structure, the dyeing properties and the type of finish to be imparted. For example, weaves of cotton knit shirts are different from those of tarpaulin and crease resistant fabrics are different from fire proof fabrics.

The flow chart for cotton processing is shown in Fig. 5. All operations are interrelated and each depends on receiving quality products from one unit operation to the other.

(i) In cotton production, full advantage should be taken of recent findings in selecting those cotton varieties in which the fibre can be separated easily from the seed. Such varieties gin easily and fibre breakage minimised.

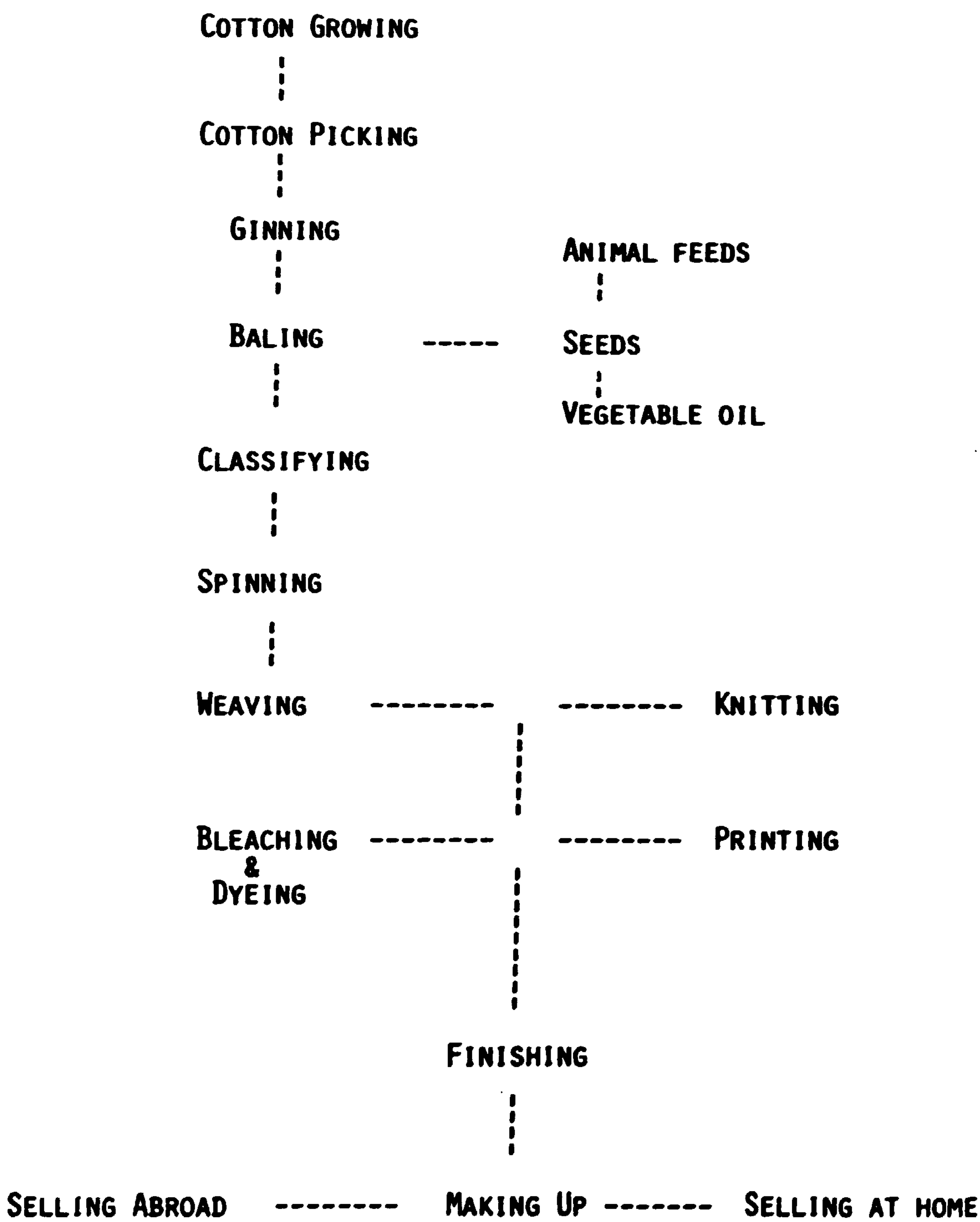
(ii) The Spinner requires good quality bales to produce good quality yarns for the weavers and knitters, to give high processing efficiencies on their faster looms and knitting machines.

(iii) The foregoing requires good quality fibre which must be clean. Automatically controlled modern equipments cannot afford the presence of foreign matter or contaminants in the fibre as remedial action is virtually impossible at this stage. The fibre must be mature, and the bale obtained after ginning and cleaning must contain few broken fibres.

(iv) New systems for yarn production include Rotor Spinning, used for the production of coarser count (heavier) yarns. The particular combinations of fibre properties required for food processing performance and good quality are high fibre strength, fineness and cleanliness. A high level of maturity is advantageous.

Fig. 5

FLOW CHART FOR COTTON PROCESSING



(v) Two new Spinning Systems known as "friction" and "air jet" have been developed and their potential is being evaluated in commercial trials. As in rotor spinning, fibre quality requirements are strength, fineness, maturity and cleanliness.

(vi) <u>High Volume Instruments (H.V.I.)</u>

It is now possible to measure fibre length, length uniformity, strength, elogations, colour, trash and micronaire extremely rapidly on H.V.I. It is capable of measuring these properties on about 2000 bales of cotton a day, enabling a producer or merchant to test very large number of bales. The use of H. V. I. by cotton merchants and spinners overseas to monitor quality will have a negative impact on cotton exports from developing countries where H. V. I. systems are not available.

(vii) <u>Evolutionary Developments</u>:

A high quality of yarn with uniformity from inch to inch and from cone to cone, high strength, uniform dyeing behaviour, freedom from impurities, conformity to specification etc is required for evolutionary developments in all manufacturing and finishing processes other than spinning. For fabrics, quality means very few faults of any type, consistency of width, few short pieces and conformity to specification. New trends in user requirements have led to:

- Improvement of Dimensional stability of cotton. In the recent past, work has been geared towards the improvement of dimensional stability of cotton which inherently undergoes shrinkage. One of the outcomes is the "STARFISH" project executed at the IIC to produce cotton knit wear which is dimensionally stable, with substantial savings in time and costs.

- Computer - aided design (CAD) and Computer - Aided Manufacturing/Management (CAM) have emerged as a result of recent revolution in micro-computer capacity, colour graphics capability and the use of sophisticated scans, plotters and printers. CAD/CAM systems may be planned as a long term objective for improved design greater accuracy, appropriate colour matching, higher productivity and better consumer response.

3. RESEARCH AND DEVELOPMENT

3.1. ROLE OF RESEARCH CENTRES AND SIMILAR R. & D INSTITUTIONS IN DEVELOPING COUNTRIES IN PROMOTING THE PROCESSING OR EXPLOITATION OF SELECTED RAW MATERIALS; AND POSSIBILITIES FOR CO-OPERATION AMONG DEVELOPING COUNTRIES IN TECHNOLOGY DEVELOPMENT AND DISSEMINATION.

Research and Development in this context is the adaptation of processed and equipment for conversion of primary raw materials into intermediate products (Industrial Raw Materials) or conversion of intermediate products into finished goods and services. The main objective should be for industrialisation in developing countries. The process involves scientific investigations, pilot plant demonstrations of processes or production of new products, acceptability tests and feasibility studies. Research centres should be well equipped in terms of technocrats machinery, modern testing equipment and other support facilities.

3.1.1. AGRO - ALLIED RAW MATERIALS: (MAIZE, SORGHUM, YAMS, CASSAVA, OILSEES, AGRIC BY-PRODUCTS).

Key achievements recorded are given below:-

3.1.1.1 CROP PRODUCTION.

Present efforts include yield multiplication through the introduction of high yielding disease resistant varieties, e.g. the improvement of maize to lowland rusts and blight which has consistently outyielded local varieties by 50 - 70 percent; development of early maturing and branched resistant varieties of cowpeas; improved rapid multiplication technique for cassava; high yielding varieties of sorghum, millet and maize; creation of new palm hybrid (tenera hybrid) and improvements in the yield of fresh fruits, after systematic breeding was organised; and development of new high oil yielding hybrids of sunflower seed.

3.1.1.2. Storage and Preservation:

Improved storage systems for grains from family level storage to large indusrial scale have been developed. Sprouting and rotting in yams have been arrested and oil palm protection chemicals have been developed.

3.1.1.3. PROCESSING

Traditional technologies have been upgraded for staple foods from Cassava, yams, development of breakfast cereals from corn and soybeans, sorghum malt production, improvements in palm oil processing technology, development of new technologies adapted to palm oil processing, (fractionation techniques, hydrogenation, inter esterification etc) and development of new products attractive to the international market (olein, stearin, CBS, CBE) and elimination of flavour reversion in soy-oil and development of coconut processing.

3.1.1.4. FABRICATION OF PROTOTYPE EQUIPMENT FOR FOOD PROCESSING:

These are on-going and include:

- Semi-mechanized and fully mechanized integrated processing equipment for all derivable products from cassava.
- continuous grain dryer
- maize shelling machine
- palm oil processing equipment
- setting up of foundr for spare parts manufacture.

3.1.1.5 FOOD PRODUCT DEVELOPMENT:

Notable products are "soy-ogi" a breakfast cereal from corn - soy flours, also corn-soy flours with vitamins and minerals added, lime heat - treated corn flour, poundo yam from yams and parboiled rice with increased vitamin B retention.

Other R & D activities in Agro Allied areas include the development from Agric by-products of nutritionally balanced feeds containing all food components plus growth stimulators.

3.1.2. NON-METALLIC MINERALS

As a result of the dynamic growth in types and ranges of the use of industrial minerals and their products, a permanent capability for applied research and development is necessitated, to cover the following function:

- Initial technical evaluation of the raw materials.
- Products development and evaluation
- Process and plant design, up to and including batch trials on pilot plant scale with modification in process if necessary.
- Technological trouble shooting, including the provision of technological extension services to small enterprises and dissemination of scientific and technological information.

In response to changing user specifications, product qualities should be monitored using equipments located at designated centres of excellence.

However, lack of funds, and modern laboratory equipment are problems of mineral research institutes in developing countries. The foregoing notwithstanding, mineral research institutes can produce some high quality products like calcined Kaolin and coating grade clay (e.g. in China) although on a small scale. Quality is unstable and must be monitored. Cost is high, labour condition is poor and products have no competitive power in the world market.

3.1.3. TEXTILE FIBRE:

In promoting the utilisation of cotton, the role of R & D centres in developing countires are:

- fundamental and applied research on cotton fibre, yarn, cloth and cotton seed, and on processing of cotton fibre with a view to optimising utilisation.
- scientific evaluation of fibre properties and yarn characteristics of the improved varieties of cotton evolved at the various breeding stations and to compare their performance with established varieties
- fibre and spinning tests on trade varieties and dissemination of technological information on standards and quality control to the trade and industry.
- provision of testing house facilities for the benefit of trade, industry and export agencies.
- improvements in clothing and fashion design technology and traditional dyeing technology.

R & D involvement starts with land preparation for mechanized production through seed breeding and cropping, bailing, classification to experimental spinning, in relation to soil type, climate and availability of water, to know which varieties thrive best in the environment and give necessary advice for improvement.

Increased production, yield and quality, to cope with the imminent automation in textile industry which will require fine, mature strong and long cotton for processing is the sole aim of R & D.

POSSIBLILITIES OF COOPERATION AMONG DEVELOPING COUNTRIES IN TECHNOLOGY DEVELOPMENT AND DISSEMINATION:

The development and exploitation of raw materials need action oriented measures such as:

(i) Bringing together people with common interests in processing technology from developing and developed countries, to provide for an exchange of scientific experience, research findings, innovations, inventions and market prospects, which as a result of global development of science and technology and management techniques, undergo frequent changes.

(ii) Information Technology:

There is the need for an impressive rapid information retrieval system, preferably computerised for the developemnt of a huge data base on various aspects of Raw Material Processing Technology, funded jointly by developing countries to facilitate accessibility.

(iii) Exchange of Technical Personnel/Technical Visits

Experts from developing countries should be free to work in laboratories in other developing countries and interract freely. The setting up of Raw Materials Developing Centres in developing countries and exchange of information on these is a step in the right direction.

(iv) Developing countries should collaborate and borrow technology from more advanced developing countries in order to develop indigenous industry; for example.

- collaborate with foreign manufacturers to make a new machine.
- start research on the machine
- modify and improve it
- come out with better product even purchaseable by the original collaborator.

(v) Some countries may be too poor or too backward to have R & D facility of their own, but have experts. Therefore, joint operation of regionally based R & D or testing centres on agreed standards for raw materials (fibre and yarn, non-minerals and agricultural raw materials) is an aspect of collaboration.

3.2. TWINNING ARRANGEMENTS AND EXECUTION OF JOINT RESEARCH PROGRAMMES.

Joint scientific and research work can lead to the establishment of regional research centres or centes of execellence for research into specific raw materials or joint process/equipment development. Collaborative work enables researchers to share experience, avoid duplication of efforts and to bring the wealth of years of experience into solving problems common to developing countries. To ensure the maximum use of the available expertise in the developing countries, a directory of their specialists and institutions should be maintained and made available to member countries.

Since many of the developing countries have common problems in industrial development, these can be indentified and solved through co-operative research, provided that joint funding is available. There is a good scope for this co-operation in a spirit of solidarity. Example are:

(i) Joint projects in nutritional problems common to developing countries and exchange of information on product development to alleviate these.

(ii) Collaboration in all aspects of primary production including breeding, development of disease resistant and high yielding varieties of crops, storage and preservation etc.

3.3. ESTABLISHMENT OF NETWORKS TO ENHANCE RESEARCH - INDUSTRY TRANSFERS.

(i) The results of R & D are commercialised and practical applications in Industry promoted through information exchange (publication and distribution of technical papers, preparation of project scale up proposals, organization of industrial fora for scientists, industrialists, marketers and Bankers and participation in trade fairs, exhibitions and expos) thus facilitation transfer of technology for larger - scale testing and production.

(ii) In the area of agriculture, research - industry transfers can be organized through the identification of raw material producing and marketing co-operatives and small scale producers devoted to supplying and processing agricultural raw materials for industry, as a means to pool resources, promote quality control, achieve equitable pricing and promote efficient use of local raw materials. The fabrication of processing equipments will be supervised by reserachers while the Banks will finance the loans for the purchase.

(iii) Industry and R & D should establish and maintain a functioning interface between them. Industry should fund R & D units to conduct studies in areas which are directly related to its needs. This form of co-operation is mutually beneficial.

4. ROLE OF TRAINING AND MANPOWER DEVELOPEMNT FOR THE ACHIEVEMENT OF EFFECTIVE GROWTH BY DEVELOPING COUNTRIES IN PROCESSING OF RAW MATERIALS.

Science and technology is a dynamic and versatile discipline and practitioners should therefore be abreast of current developments, which exposes practitioners to new frontiers of knowledge in their respective fields. Training may be in the form of participation in short-term conferences, exhibitions or symposia on topical issues; and should be arranged for all categories of staff in industry. Enterpreneurs can best be intimated of new technologies acquired or invented through workshop training to facilitate their decision on commercialisation.

Training will enhance quality performance and increase productivity. At the primary production level e.g. agricultural raw materials including cotton, training is essential in crop protection measures to minimise contamination and maintain good quality yields. The establishment of an "economic threshold" of infestation depends on good management and an enlightened attitude by the farmers.

Courses on these aspects can be organised by research centres, University Extension services or jointly by developing countries,

At the production level, training of operators and supervisors would need to include appreciation of the necessary quality aspects of product specifications and importance of proper process control and operational procedures. For the production of industrial minerals, great attention needs to be devoted to labour training, because the quality of mineral products is highly dependent on operator performance. Training in Labour Utilisation, Materials Management, Cost Consciousness, loss prevention and role appreciation are key elements of training at the management level which can be organised by manpower development departments of industries "in house" or in collaboration with external resource personnel.

Training in all aspects of plant maintenance is essential to instill the essence of a "maintenance culture" into the workforce and this is crucial for developing countries.

Co-operation between members of the Group of 77 is advocated on the widest possible basis to maximise the usefulness and minimise the cost of training. A system of exchange of information on available training facilities in areas of production, research and development, management and marketing should be established. The terms of co-operation should also provide for exchange of experts and trainers, joint courses, on the job training and regular review meetings to assess the changing needs of training.

Manpower development demands that every new project should have a training element through the initial stages of process and plant design to pilot testing so as to allow potential operators acquire familiarity with the raw materials, equipments and with the specific process requirements.

Specialised technical courses may be required in view of technological developments in key areas of unit operations in processing and analytical procedures.

For example, a course in Instrumental Methods for Quality Assurance and Research is useful for Technical personnel including R & D, analytical chemists and quality control. An update of instrumentation for analysing pesticide residues and heavy metal contents in foods is necessary for the review of standards. The International Institute of Cotton (IIC) organises specialised training courses on the "State of the art" in Science and Technology of cotton processing and participataion creates a forum for technology development and dissemination. The courses, which are conduced in Britain include Cotton Fibre Technology - Testing and Evaluation, Sizing and Weaving of cotton yarn, cotton knitting, wet processing of cotton, Textiles and Recent Developments in technology and Quality Control. Cotton producing developing countries can jointly introduce such courses with assistance provided by UNIDO.

5. MARKETING

5.1. REVIEW OF EXISTING MECHANISMS FOR MARKETING AND DISTRIBUTION OF RAW MATERIALS.

5.1.1. AGRICULTURAL RAW MATERIALS (Grains, Roots and Tubers)

Marketing and distribution of Agric raw materials have not kept pace with improvements in other sectors of the economies of deveoping countries. Since food products are perishable, the chain of activities from the producer to the the ultimate consumer must be such that guarantees protection and fair play. There are problems in food product markets:

(i) There is no organised or controlled marketing and distribution system. Farmers sell directly to middlemen or consumers at cheap prices, and the middlemen sell at higher prices to wholesalers or retailers in the local markets. In the process, pricing system is distorted and inflationary.

(ii) Usually, there is a long chain of distribution. Wholesalers cartels allow price and delivery collusion.

(iii) Farmers and others are cheated because of the lack of standardised weights and measures, no quantity and quality control and no protection for producers and consumers.

(iv) Government marketing boards are inefficient and storage facilities inadequate.

(v) Credit restriction limits operations to a few wealthy powerful wholesalers who squeeze distributors.

(vi) High transportation and handling costs discourage movement of food products from rural food producing areas to cities, resulting in wastage and attendant scarcity in the urban areas.

(vii) Shelf-life is affected by poor post-harvest handling and packaging systems. Products exposed are often bruised and contaminated.

(viii) Funds are inadequate to support appropriate agric research and training. Market intelligence and education are poor and there is lack of market information, as a result of which the pattern, character, volume and value of internal trade is unknown.

5.1.2. TEXTILE FIBRE

Spinners rely on the availability of graded fibre, and suppliers who are reliable and have large stocks. Marketing of cotton fibre is regulated.

(i) Marketing of cotton is fairly smooth and the law of supply and demand works satisfactorily for seller and buyer; with producer experiencing little difficulty in selling his produce.

(ii) Prices differ with season and quality. Monthly/daily prices of cotton are published by various newspapers and organisations. For developing countries, no cartels are involved and prices received are fair.

(iii) An adoption of standards through GRADING has become a routine tool for marketing of cotton. The HVI system (quick and accurate) is the latest machine in the market designed to facilitate grading and quick exchange of information.

(iv) Rates of end stock to use, worked out by the ICAC, is a good index of the health of cotton economy of the country. Cotton producing and consuming countries are always happy if their end stock is low.

5.1.3. NON-METALLIC MINERALS

In some developing countries, most users source their own requirements. There are no standards in the supply-demand chain and private individuals supply non purified non-metallic minerals to localised users. Local mining contractors supply the immediate demands of construction programmes.

In more advanced developing countries arrangements are made by producers and consumers and negotiated prices tend to be stable for long periods according to basic costs plus some acceptable return tax. Where sudden price oscillations occur, the consumer cannot promptly move to a new supplier who may need to modify processes and at the same time meet shipment and delivery dates.

5.2. OBSTACLES EXPERIENCED BY DEVELOPING COUNTRIES WHEN TRYING TO ENTER INTERNATIONAL MARKETS.

5.2.1. AGRIC RAW MATERIALS: THE FOLLOWING COULD BE USED TO OBSTRUCT; DELAY OR PREVENT IMPORTS.

(i) Stringent Quality Standards

Keeping up with trends in processing and packaging is a limitation in developing countries.

Higher capital outlay is required in meeting quality standards e.g. mycotoxin, pesticide residues, and heavy metal content regulations, hygiene standards and packaging requirements for product shelf life set by developed countries.

(ii) Tariff and non Tariff measures

There hamper international trade in oilseeds, oils and oil meal protein to a great extent. Both developed and developing countries apply non-tariff measures thus creating additional problems for developing countries by adding to the instability of prices in world markets.

(iii) Product Development and the Competition

Products from developing countries cannot compete favourably with similar products which benefit from heavy advertising campaigns in developed countries. Developing countries cannot afford the funds required for effective communication through product advertising, promotion and choice of right distribution channels to effectively promote the products to a level of acceptability.

(iv) Pricing

To maintain a reasonable profit margin, a product of good quality in all its ramifications faces the threat of being priced out of the international market. Some of the "Third world" products have built-in costs of infrastructure (electricity, water etc), which are relatively cheap in developed countries.

5.2.2. TEXTILE FIBRE

(i) There are implications for a buyer trying to sell into an already saturated market namely the important of good quality, presentation, and price. Where an importer/merchant acts as a pivot between the exporter and the processor, specifications have tended to become more rigorous with cotton yarns and cotton grey fabrics.

(ii) Cotton is facing serious competition from man made synthetic fibres (MMF), whose consumption surpassed cotton for the first time in 1985. Since fashion is on the side of cotton, developing countries should try and keep the price advantage with cotton.

(iii) Developed countries have an edge of production capacities and exports of textiles, as their projected shares of world exports (in textiles) is put at 60% for 1990.

(iv) Developed nations are fully aware of third world's expansion of their share of exports in clothings and are trying hard to turn many labour intensive processes into capital intensive ones and imposing restriction on imports.

5.2.3. NON-METALLIC MINERALS

The market is dominated by USA, UK and USSR and together, account for 70% of world production. Because of lack of expertise in developing countries, kaolin is exported and finished goods imported. Paper grade clays produced are of low quality, and where quality is good, prices are not atrractive thus making it hard to compete with established major producers on open markets.

5.3 THE SCOPE FOR CO-OPERATION AMONG DEVELOPING COUNTRIES IN ORDER TO CREATE DOMESTIC CAPABILITIES FOR STRENGTHENING THE SCOPE OF MARKETING PRACTICES.

5.3.1. AGRICULTURAL RAW MATERIALS:

(i) Developing countries should organise themselves into specialised grain, root or oilseed raw materials producting areas, form co-operatives and through consultations, jointly finance farm inputs, post harvest processing, joint storage and quality monitoring, including quality standards, their appropriateness and their up-grading.

They should also exchange information on existing and proposed measures, laws, regulations and procedures affecting imports.

(ii) Developing countries should set up common markets and establish same tariff, same currency where possible and same regulations on trade flow.

(iii) The formation of Joint Ventures is a real profitable form of co-operation. This can lead to technological development in that product technical problems are solved, quality of final product is improved and market introduction expedited, on a global scale. With transnational companies, the association can take any of the following patterns:

- Contract packing and marketing through an agent.
- Partnership, which is production based, the company abroad pays royalty.
- Joint Venture, where resources of all parties are pooled for greater advantage

5.3.2. NON-METALLIC MINERALS

(i) With generally low prices and relatively high transport costs it may be more sensible to barter mineral commodities across boundaries between neighbouring countries through bilateral trade arrangements.

(ii) Joint techno-economic evaluation of kaolin deposits between regions especially where the deposits exist across boundaries will lead to the preparation of techno-economic and market models for the regions.

5.3.3. TEXTILE FIBRE

(i) In view of the ever tighteningstrangulating grip of the M.F.A, there is room for mutal consultation among third world cotton producing countries.

The establishment of International Cotton Producers Association (ICPA) to intensify joint action in all aspects of cotton production and marketing is an example of co-operation.

(ii) Developing countries should jointly utilise marketing tools. These include the availability of samples, sales promotion, participation at yarn and fabric fairs, trade delegations etc to project the beauty of local designs in textiles and clothing.

6. STRENGTHENING OF THE CAPABILITIES OF RESOURCE DEVELOPMENT, RESEARCH AND MARKETING AGENCIES IN MANAGEMENT AND DATA PROCESSING AREAS

The diversity of uses, technologies, quantities, nature and types of raw materials make it virtually impossible for any single developing country to build up a complete spectrum of knowledge and know-how. A possible solution to this problem is the establishment of an Industrial and Technological Information Bank which would collect and disseminate information from and among participating countries. Linked to UNIDO's Information Systems, The Bank will help developing nations choose technology.

6.1. TECHNICAL INFORMATION:

(i) Provision of technical information is vital in Research and Development, focussing on the use and application of knowledge concerning new products, raw materials, quality standards and specifications, processing technology profiles, suppliers of equipment, materials, services and management techniques.

(ii) The purpose of setting up an industrial information division as an integral part of R & D centre is to collect, process, store and supply locally generated information. The division should operate a computerised Data Base with direct links to national, regional and international focal points e.g. UNIDO, in order to strengthen its capability and enable it to provide industrial and technological information to meet the needs of industry in developing countries.

(iii) Various Research Centres have been set up in developing countries to expedite the development of raw materials and processing machinery. These centres are sources of information and are expected to generate data which will be pooled and retrieved as required from the data bank. For example, to strengthen resource development:

- The Institute of Tropical Agriculture (IITA) Ibadan, has generated a lot of data on breeding and producing disease resistant varieties of grains and roots, including the mini-set technique for yam production. This is expected to revolutionise yam production, and enhance processing.

- The Federal Institute of Industrial Research has developed processes for soy-ogi and non-wheat bread.

- Others are African Regional Centre for Science and Technology, Dakar; and Centre for Design, Engineering and Technology, Ibadan; and COTISTICS, a bi-annual cotton statistical bulletin of Pakistan Central Cotton Committee.

6.2 Marketing and economic research among others, forms a major function of commodity boards/committees. The pre-requisite for researches in these areas are sufficient availability of accurate data and facts much needed for sound and viable development plans. Information on land area, production, yield, exports, imports, stocks, products and prices should form part of the data base, and these have significant impacts on market forecasts.

6.3. SERVICES

Various types of services can be provided from the computerised data base. These includes: Current Awareness Services (CAS), Technical Inquiry Services, Selective Dissemination of Information, Document Reproduction and Supply Services. Without scanning a wide variety of information sources, CAS keeps users aware of latest developments, problems and problem solving information, information needs of subject specialists, news about conferences, seminars and workshops through a regular publication of New letters: Such information system should be able to provide links between entrepreneurs and potential investors, listing current project opportunities representing all branches of manufacturing and industrial services including development finance institutions.

7. RECOMMENDATIONS TO DEVELOPING COUNTRIES ON MEASURES TO BE TAKEN AT NATIONAL, REGIONAL AND INTERNATIONAL LEVELS WITH A VIEW TO MAKE BETTER USE OF THEIR RAW MATERIALS.

7.1. AGRICULTURAL RAW MATERIALS:

7.1.1. AT NATIONAL LEVEL:

Developing countries should map out clear objectives, strategies and detailed programme to:

(i) Identify raw materials and set up a time table for national self-sufficiency, together with the appropriate measures to achieve it. Conduct surveys, collect and evaluate data needed for planning and decision on agricultural raw materials for industry, their derivatives and quantities used by industry and set up a comprehensive data bank.

(ii) Technologies aimed at reducing post harvest losses should be developed and funds provided for the erection of silos in the rural areas.

(iii) Upgrade traditional technologies for products closely reflecting consumer demand and generate consumer awareness through education.

(iv) Teach farmers and small scale processors loss prevention systems; an example is the conversion of perishable roots into shelf-stable intermediates e.g. Cassava chip technology.

(v) Set up farmer co-operatives and small scale producers in different localities, define and agree national standards and gradings for agricultural products, popularise such standards and promote quality control.

(vi) Set up a co-ordinated and extensive agricultural support services for all aspects of farming including the provision of infrastructure. Private sector initiative is important.

(vii) Adequate tax incentives as a basis for the production and supply of suitable quality raw materials for industry should be provided. Protection from unfair competition form imported goods should be guaranteed.

(viii) There is the need for improvements in market organisation,information, education and intelligence.

(ix) Government, Research Institutes and Industry to co-operate; identify areas for process development for industry and jointly fund research and equipment fabrication.

(x) The formation of R & D associations aimed at improving process and product development should be encouraged.

7.1.2. AT REGIONAL AND INTERNATIONAL LEVEL

Co-operation among developing countries, established and supported jointly or separately by the appropriate United Nations agencies should:

(i) Enhance face-to-face exchange of information, including exchange of personnel;

(ii) Develop amd provide access to a data base on food processing technology;

(iii) Establish regional comprehensive data Banks on agricultural raw materials for industry, their derivatives and quantities used by industry;

(iv) Promote co-operation among their research centres and similar R & D institutions. This would cover exchange of scientific experience, research findings, inventions, innovations, the scientists themselves. Joint scientific and research work would lead to establishment of regional centres for specific oil seeds, oil fruits, grains, roots and tubers, and for their processing;

(v) Commercialize the results of R and D and promote practical applications in industry by promoting exchange (publication and distribution of technical papers, preparation of project scale up proposals, organization of industrial fora for scientists and industrialists, participation in trade fairs) and facilitating transfer of the technology for larger-scale testing and production;

(vi) Promote technical co-operation in the area of manpower training by setting up joint training centres and exchange of fellowships;

(viii) Negotiate trade agreements within the General System of Trade References covering tariffs and trade regulations to simplify and promote subregional and international trade in agricultural raw materials for industry; particularly with regard to vegetable oils, developing countries should take advantage of the General System of Trade References to establish parallel markets to satisfy their own requirements;

(ix) Promote joint ventures to optimize transfer of technology and use of national resources, especially human skills and natural resources.

7.1.3. AT INTERNATIONAL LEVEL

Co-operation between developing and developed countries should proceed by means of:

(i) Contract packaging and marketing in developed countries;

(ii) Production-based partnerships with licencing and raw materials supply to the developed country partner;

(iii) Joint ventures to develop, monitor and implement strategies, to provide information, material back-up, training and R and D, and to identify growth opportunities.

7.1.4. WITH INTERNATIONAL ORGANISATIONS

(i) UNIDO should issue a compendium of new technologies developed in, used by or developed for developing countries in the field of food processing as a means of exploiting their local materials; the compendium wculd describe the technology and indicate the scale range in which it can be used, the raw materials and equipment required, any materials the technology can replace, and the technology source (UNIDO);

(ii) UNIDO should continue to organize international fora, consultations, solidarity ministerial meetings, round table minsterial and high-level meetings for co-operation, and to implement advisory services, study tours, training and other joint industrial programmes;

(iii) FAO, ISO, UNIDO, WHO and others should help developing countries to understand international quality standards as a prerequisite to penetrating world markets and to upgrade (revise) them when trading among themselves.

(iv) In conjunction with UNIDO and other international organizations as appropriate, organize a series of "Standards Forums" to enhance understanding of standards and their use in domestic and various types of international trade.

7.2. <u>TEXTILE FIBRE</u>

7.2.1. <u>AT NATIONAL LEVEL:</u>

(i) Liberalisation of Government policy on Land Acquisition to encourage entrepreneurs go into cotton production.

(ii) Where cotton is under threat, demand stimulation programmes for cotton should be maintained. An effective means is by upgrading traditional technology and organising training courses to upgrade technical know-how, and by engaging in import substitutions using available raw materials, for example in textile auxilliaries.

(iii) In co-operation with textile companies, research centres should be established and equipped with adequate fibre testing facilities. Research centres and industry should co-operate in establishing test materials for legislative requirements.

(iv) Given the wide range of technologies and processes presently available, research centres should render technical assistance and consultancy services to local industries, auditing operations, providing advice on textile testing and quality control. The efficient use and proper maintenance of existing cotton processing machinery rather than the development of new machinery should be emphasized.

7.2.2. AT REGIONAL AND INTERNATIONAL LEVEL:

Countries with a large cotton processing industry or a long history of cotton production and/or processing should establish technical reseaach centres and provide a wide range of expert services to new comers. Such services should include exchange of information, access to a data base on textile technology, including recently developed data and know-how on the production of high quality knitted cotton fabrics, exchange of technical personnel, manpower training and development, analysis of market changes and opportunities and joint efforts at international market penetration.

7.2.3. WITH INTERNATIONAL ORGANISATIONS

(i) Co-operation with FAO in the development of high-yield disease - resistant varieties of cotton for a particular soil type and weather (Breeding and Ginning).

(ii) UNIDO to help cotton producing developing countries upgrade ginning, induct HVI and set up lint standards.

(iii) Co-operation with International Textile Manufacturers Federation (ITMF) for participation, at least on Inter-laboratory trial basis, in the International Committee on Cotton Testing Methods - maturity, honey dew, fibre length, foreign matter and dust.

(iv) The practical experience and expertise of ITC and IIC should be extended to developing countries so that these countries can improve their marketing techniques, fashion trends and marketing skills in line with modern trends.

7.3. NON-METALLIC MINERALS : KAOLIN

7.3.1. AT NATIONAL LEVEL:

Emphasis should be on prospecting and exploration, characterisation and techno-economic scenarios.

(i) Assess the potential ranges of kaolin clay products for domestic consumption and for export, and the scope for manufacture of clay-based industrial and consumer goods.

(ii) The necessary initiatives and responsibilities should be assigned to three national organisations:

National Mining Development Corporation: with responsibilities for a national inventory of mineral resources, for feasibility studies and initiating mineral projects.

Industrial Development Corporation: Collaboration in market research and initiating industrial projects based on kaolin raw materials.

Research and Development Institute: Providing processing support services, from preliminary mineral appraisals, process design, pilot plant studies, feasibility studies and plant design to production trouble shooting and product evaluation.

(iii) The national mineral resources inventory should be maintained and updated as a permanent source of reference and information for future development projects.

7.3.2. AT REGIONAL LEVEL

(i) Exchange of information and experience with regards to non-metallic mineral resources, e.g. geologic setting, mode of occurence, reserves, present mode of utilisation, plans for development etc with special reference to clays. Since some deposits may lie across national boundaries, new prospecting strategies may be formulated on the basis of remote sensing and geomorphological approaches.

(ii) To assist efforts in Characterisation; a central regional facility in one of the member countries should be established, since some countries may be too poor or backward to have R & D facility or pay for consultancy.

(iii) Integrated techno-economic and market models may be prepared for a region, so that the most feasible projects are taken up first for implementation.

7.3.3. AT INTERNATIONAL LEVEL:

(i) A network structure, consisting of a central secretariat with connections to national focal points placed in appropriate institutions in each country, to facilitate access to technologies and data by all interested developing countries would accelerate development in the production of non-metallic minerals.

(ii) The setting up of an International Minerals Research Centre equipped with modern laboratory equipments and pilot plant is another means of International co-operation.

(iii) In both cases, UNIDO is expected to play an important catalytic role by drawing on the expertise and financial resources available in both industrialised and developing countries.

LIST OF DOCUMENTS FROM WHICH THIS PAPER WAS SYNTHESISED

	Title	Author
	Food Processing	
1.	INDUSTRIAL PROCESSING CONSIDERATION FOR THE CONVERSION OF GRAIN AND ROOT RAW MATERIALS INTO FOOD PRODUCTS IN DEMAND OF MARKETS	Dr. Oluniyi Babatunde Omosaiye
2.	INDUSTRIAL PROCESSING CONSIDERATIONS FOR THE CONVERSION OF OIL-SEEDS AND OIL FRUITS INTO EDIBLE OIL AND PROTEIN ANIMAL FEED COMPONENTS	Mr. J. Turinski
3.	INDUSTRIAL PROCESSING CONSIDERATIONS FOR THE CONVERSION OF GRAIN AND ROOT MATERIALS INTO FOOD PRODUCTS IN DEMAND OF MARKETS	Dr. Salvador Badui Dergal
	Non-Metallic Minerals	
4.	STRATEGIES FOR THE OPTIMAL UTILISATION OF KAOLIN PRESOURCES BY THE DEVELOPING COUNTRIES: A TECHNO-ECONOMIC APPROACH	Prof. U. Aswathanarayana
5.	UTILIZATION OF KAOLIN CLAYS IN DEVELOPING COUNTRIES	Prof. Henry E. Cohen
6.	THE TECHNOLOGY OF KAOLIN MINING, BENEFICIATION AND INDUSTRIAL APPLICATION	Prof. Henry E. Cohen
7.	THE ROLE OF MINERAL RESEARCH INSTITUTE OF DEVELOPING COUNTRIES IN PROMOTING EXPLOITATION OF KAOLIN AND INTERNATIONAL COOPERATION	Mr. ZHOU Guifang
8.	KAOLIN SITUATION IN BRAZIL AND THE ROLE OF R AND D CENTRES	Dr. Alexandre R. Zandonadi
	Textile Fibres	
9.	THE EXISTING MECHANISM OF MARKETING AND DISTRIBUTION OF RAW COTTON AND COTTON PRODUCTS	Mr. Iftkhar Afzal
10.	TRENDS IN THE PRODUCTION AND PROCESSING OF COTTON	Mr. Frank H. Burkit
11.	PAPER ON TEXTILE FIBRES	Dr. Ibitoye Aladeselu
12.	REPORT - Expert Group Meeting on the Processing of Raw Materials Vienna, Austria, 22-26 Aug., 1988	U N I D O

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SYNTHESIS PAPER ON THE PROCESSING OF VARIOUS RAW MATERIALS *

Prepared by

Oluniyi Babatunde Omosaiye **

* The views expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

** Chief Executive, Omory Limited
Consultants to Chemical Food and Agro Allied Industries
E 9 Eric Moore, Towers, Surulere, Lagos, Nigeria

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CONTENTS

1. INTRODUCTION

1.1. FERROUS ORES

Ferrous ores are utilised almost entirely as the primary raw material for iron and steel production. The ferrous ore production required to serve the industry is huge, exceeding 800 million tons/year, throughout the past decade. The need to generate these enormous volumes of production has given iron ore mining its dominant characteristics of:-

(i) huge size
(ii) huge production equipment and
(iii) huge financial investment.

Many developing countries are endowed with the best, high quality iron ore deposits and the developed countries which produce the major part of world iron and steel output, are almost entirely dependent on iron ore mining in the developing countries.

Thus, if developing countries are to benefit from the exploitation of their resources, they must formulate and pursue a strategy which is both technologically and economically successful.

1.2. NON FERROUS ORES

The most important non-ferrous metals (aluminium, copper, lead, zinc and tin) have an annual production averaging 35 million tons, about 10% of world steel output but the higher value of the non-ferrous metals balances that effect and makes them of major economic significance.

Although widely distributed on a world scale, they are generally not available now in deposits with high metal concentration. Thus unlike ferrous ore exploitation, the trend in non-ferrous mining has been one of developing more low grade and secondary resources.

Since the scale in utilisation of a metal is related more to price/volume rather than price/mass, there has been a higher level of consumption of aluminium, which is the only non-ferrous metal to seriously compete with steel as a structural material and the use of the most expensive non-ferrous metals such as tin, is confined to applications such as thin coatings where the volume required is very small.

The non-ferrous metals have many non-structural applications based on their unique physical and chemical properties. Consumption in these areas is likely to continue to increase with higher and higher added value.

2. INDUSTRIAL AND TECHNOLOGICAL ASPECTS

2.1. INDUSTRIAL PROCESSING CONSIDERATIONS:

2.1.1. FERROUS ORES

2.1.1.1. ECONOMIC CONSIDERATION

Bcause of the relatively low value of its end product "iron" and the abundance of high grade deposits, iron ore is only mined in locations of high metal content and easy extraction. Since high grade iron ore deposits are frequently located in regions remote from centres of population, their exploitation depends on the creation of costly bulk transport facilities and iron ore mining is highly capital intensive.

2.1.1.2. HIGH TECHNOLOGY

Most of the iron ore mined throughout the world is destined for use in blast furnaces located in integrated iron and steel production facilities. Crushing and screening are important for further beneficiation and necessary to prepare the final products for the strict physical and chemical specifications of blast furnace charge. Consequently, the processing of iron ore can involve a high degree of technology and control and the ore is commonly pelletised in modern ore treatment plants.

Pelletising is the first stage of sintering.

2.1.1.3. SIZE AND VOLUME OF PRODUCTION

Iron production in the industrialised countries is dominated by the iron blast furnace process; the characteristics of which are its great size and volume of production, its long period of continuous operation and its very high capital cost Utlising a very large production volume of liquid iron, a blast furnace is always linked to a large capacity steel making facility in an integrated iron and steel plant.

2.1.1.4. RAW MATERIAL QUALITY

The efficient operation of the modern blast furnace is critically dependent on the control and quality of the raw materials charged into it. Of these, the iron ore and coke are the most important. All modern blast furnaces operate on sintered or pelletised ore as these possess the correct ore particle size and distribution required for the permeability of reactive gases through the furnace charge burden.

A key industrial problem is that whereas iron ore resources are relatively abundant, coking coal of the highest quality is rare and, in some areas of the world, virtually absent. As a consequence, competition for supplies of metallurgical quality coking coal is intense and many of the best supplies are pre-empted by long-term total production contracts with the major steel producers of the industrialised countries. For these reasons, iron making processes more suitable for use in developing countries have been developed.

2.1.1.5. STEEL PRODUCTION

Three major steel making processes are widely recognized:

- basic oxygen converter process (BOS), produces steel directly from liquid iron, no scraps.
- electric arc furnance - (100% scrap)

- the open hearth furnace - oldest process; (70% scrap), its use has declined progressively.

The latest development is that of modern integrated plants, with deep water harbour access, which import their raw materials by sea and produce large volumes of steel via the blast furnace, BOS, continuous casting experience.

Although a number of developing countries have built plants of this type, their successful operation presents great difficulties. Thus new forms of technology are needed to produce quite different types of iron and steel.

2.1.2. NON FERROUS ORES

2.1.2.1. MINING AND PROCESSING TECHNOLOGY OF NON-FERROUS ORES

The necessity to mine lower grade ores on a greater scale for the same level of metal production has escalated costs. The mining industry has undergone major changes in its efforts to streamline operation and improve technology to remain competitive. There has also been a general trend towards larger scale mining using much larger equipment and the development of open-pit mines where lower grade ores can be more easily exploited. Substantial progress in the processing and beneficiation of non-ferrous ores has led to the following processes:

2.1.2.2. PYROMETALLURGICAL PROCESSES

This is a fundamentally energy intensive and expensive process, using oxygen injection to speed chemical reactions and increase furnace capacity.

2.1.2.3. HYDROMETALLURGICAL PROCESSES

These are generally less expensive and require simple technology. They are particularly convenient for developing countries in that the plant used requires minimum capital, is cheap and fast to construct and can be amortised very quickly.

2.1.2.4. MINERAL LEACHING:

The technology of mineral leaching has not yet been universally accepted but the situation is changing rapidly. Mineral leaching can be carried out in situ on fractured or fragmented ore material which is not excavated.

2.2 TECHNOLOGY OF RAW MATERIAL PROCESSING WITH SPECIAL EMPHASIS ON NEW TRENDS IN USER REQUIREMENTS AND PROCESSING TECHNOLOGIES.

2.2.1. FERROUS ORES

Of the alternative iron making processes, the simplest is:

(a) Electric Iron Making: Suitable in countries possessing cheap electricity supplies but expensive coke.

Heat is supplied by electricity instead of the burning of coke but chemical reduction of the iron ore to iron is still done by coking.

(b) Sponge Iron Processes: the aim is to reduce the iron ore to iron at a temperature below that at which iron melts. The unmelted product is called "Sponge Iron". Based on a high grade iron ore concentrate, this sponge iron may be refined directly to steel in an electric arc furnace and the process is called "Direct Reduction", having by-passed the blast furnace.

Two main groups of sponge iron processes are well known: those based on solid fuel and those based on gaseous reducing agents.

(i) Solid fuel processes require a high temperature (1,000°C) for the carbon to reduce the iron oxide to iron and the fuel used in these processes may be cheap coal, coke breeze or lignite, with solid carbon as reducing agent.

(ii) Gaseous Reducing Agents:

Suitable reducing agents for iron ore may be derived from either natural gas or oil Gaseous reduction occurs at relatively low temperatures and require little heat input for the reaction itself but produces an excess of reducing gas which must find other uses for full efficiency.

The most widely used process in developing countries is Direct Reduction which can be achieved in shaft furnaces using an iron ore pellet charge and a reducing gas, which must be pre-heated to a temperature of 900°C to generate the reaction and cover heat losses in the process resembling the upper part of the normal blast furnace.

All sponge iron processes suffer from the common problem that the product rapidly rusts during storage and transportation. Therefore, the processes should preferably operate in direct conjunction with a steel plant. The development of direct reduction processes utilising cheaper raw materials is likely to continue, particularly in the area of substituting raw coal for more expensive coke.

c. Charcoal Blast Furnace

The charcoal blast furnace has been developed as an alternative to the production of sponge iron via direct reduction. The process is suitable for developing countries lacking a supply of normal blast furnace coke, but with an abundance of forest or land, and involves the use of a small shaft furnace capable of production rates up to 800 t/day. Although the process is labour intensive in terms of its raw material charcoal, the trees needed to supply the charcoal are a renewable resource. The process has been exploited in Brazil.

d. Steelmaking:

No small - scale steel making processes have been developed which would supersede the electric arc furnace (EAF). The EAF provides a flexible and efficient method of producing steel from sponge iron in an integrated plant. Where sponge iron is not available, semi-integrated steel production may be achieved using steel scrap, requiring other fuel sources besides electricity for furnace heating.

2.2.2 NON FERROUS ORES

The current and alternative technologies for non-ferrous ore exploitation are given below.

a. Aluminium

Bauxite containing at least 50% aluminium oxide or hydroxide, is the main source of the metal. The first stage of refining involves the production of alumina (Al_2O_3) via the Bayer Process in which high-grade bauxite is digested with caustic soda solution and separated from waste residues as a solution of sodium aluminate which is decomposed, precipitating aluminium trihydrate which is subsequently calcined to alumina. Present day trends are to establish integrated plants including aluminium smelters, located on coastal sites because of the availability of low cost sea-borne transport of raw materials through the use of large bulk carriers, and the availability of low cost energy.

b. Copper:

Copper is a very important base metal in the mining production of the developing countries. The strategies involved in exploitation are:-

(i) Bacterial Leaching:

The need to process low grade copper ores, which cannot be used with more expensive standard floation techniques, has led to the increased use of bacterial leaching as a means of treating copper sulphide ores.

The process is simple and cheap and produces solutions which can subsequently be conveniently processed.

(ii) Solvent Extraction - Electro winning (SX/EW). The SX/EW process is a direct and effective process for the recovery of cathode copper from leached solutions. The process has a relatively low investment cost and low operating costs. Combined with leaching and solvent extraction provides the avenue to avoid the expensive floatation process and the most expensive of the conventional operations, smelting. The process produces high purity copper.

(iii) Pyrometallurgy:
Scientific research and technological advance has produced important results in pyrometallurgical copper smelting. The most successful new smelting process is that of Flash Smelting and this success has been enhanced since the 1970s by the introduction of oxygen injection.

c. <u>Lead and Zinc:</u>

Lead and zinc frequently occur in association with copper and the copper and zinc must first be separated since they interfere with one another. Therefore the first stage of processing is normally the floating-off of lead and copper concentrates from zinc. There remains a major difficulty in the separation of lead, zinc and copper into individual concentrates. Metal recovery rates are usually no more than 80% and the metal losses occur mainly in the secondary separation rather than the primary bulk floatation. Since bulk floatation is a relatively efficient process (90% recovery) the processing of primary concentrate is often <u>pyrometallurgical</u> smelting. The dominant smelting process is the Imperial Smelting Process, designed to recover lead and zinc simultaneously from low grade ore concentrates, through the use of the blast furnace principle in which oxide ore is reduced by a carbonaceous combined heating and reducing agent. The process is ideal for dealing with lead-zinc-copper concentrates and produces an overall recovery of 95% of these metals.

Recent pyrometallurgical processes (bath smelting and flash smelting) for the extraction of lead, copper and zinc have not been fully proven and both involve high technology and control and therefore not as yet suitable for developing country application.

d. Tin

Traditional methods of tin extraction rely on the use of high grade concentrates from alluvial deposits, which are purified by roasting or leaching operations and subsequently processed in two or three stage smelting operations. As alluvial deposits have become exhausted, lode tin has been mined and these require a different approach.

Fuming processes have been adopted to produce medium grade concentrates.

To recover more tin from the finer grade ore to liberate cassiterite the tin oxide mineral required, floatation methods using specific reagents have been widely introduced.

In developing countries (Thailand, Malaysia, Indonesia and Central Africa) where 75% of all tin is still found, wet gravity methods are used successfully for concentration. Pyrometallurgical process involving fuming for the extraction of tin is uneconomical in present day situation of very depressed prices of tin.

3. RESEARCH AND DEVELOPMENT

3.1. ROLE OF RESEARCH CENTRES AND SIMILAR R & D INSTITUTIONS IN DEVELOPING COUNTRIES IN PROMOTING THE PROCESSING OR EXPLOITATION OF FERROUS AND NON FERROUS METALS: AND POSSIBILITIES FOR CO-OPERATION AMONG DEVELOPING COUNTRIES IN TECHNOLOGY DEVELOPMENT AND DISSEMINATION:

3.1.1. FERROUS ORES:

The R & D centre may cover broad sectors of the mineral and metallurgical industries or may be confined to a specific subject such as iron and steel or aluminium. The specific technical areas covered would include:

- ore beneficiation
- metal extraction
- refining and processing into finished shapes and forms
- evaluation and testing of raw materials and exploration of a country's mineral resources and reserves
- standardisation of products
- fuel and energy conservation, environmental aspects and consultancy work for local clients.

R & D also have important functions as the focus for activities such as the collection, cataloguing and dissemination of technical information and documentation, well placed to prepare feasibility studies, market surveys and project reports for industry.

3.1.2. NON - FERROUS ORES

(i) the extraction of all useful components from ores and the recovery of valuable by-products at all stages in the processing of base metals.

(ii) improvements in floatation technology to increase metal recovery and improve separation efficiency.

(iii) increased use of hydrometallurgy to achieve higher energy and capital savings by leaching and solvent extraction methods;

(iv) achieving lower energy consumption in all operations;

(v) development of higher value prducts such as aluminium - lithium alloys, aluminium-silicon carbide composites, and aluminium super - pure form.

The exploitation of non-ferrous ores is often of a highly localised nature and requires techniques specific to the particular ore deposit. Consequently, there is a need to develop scientific and technical expertise in all the developing countries with non-ferrous ore resources.

3.1.3. JOINT RESEARCH AND DEVELOPMENT ACTIVITIES FOR FERROUS AND NON - FERROUS METALS.

Non-ferrous research and development can co-exist with that in the ferrous field although they may have different objectives.

(i) Ferrous ore exploitation has a well developed technological base and research is focused mainly on the end product, steel.

(ii) In the non-ferrous case, the primary production stage is still of great technical complexity and the financial rewards of success in this area are very high.

(iii) Both ferrous and non-ferrous research require similar equipment and staff of a similar scientific background. Therefore in a developing country or region, it amounts to duplication of resources to separate these activities.

(iv) There is considerable scope for co-operative research and development on an inter-regional basis on the exploitation of copper since the different types of deposits have common characteristics and can be exploited using similar mining and metallurgical strategies.

3.2. POSSIBILITIES FOR CO-OPERATION AMONG DEVELOPING COUNTRIES IN TECHNOLOGY DEVELOPMENT AND DISSEMINATION.

A viable R & D centre is clearly a major long term investment with valuable spin-off benefits for the country accruing to the specific industries it serves and this requires careful planning in terms of staffing and infrastructure. Since most of the equipment of an R & D centre will have to be imported with overseas training of personnel representing a potential foreign exchange drain, there are greater benefits for small developing countries in co-operating in the creation of a regional R & D centre, with good resources and a wide range of scientific and technical activities, fully backed by maintenance and servicing expertise within the the R & D centre. The creation of scientific and technical awareness and competence within the community as a whole is a necessary element in the industrial development of developing countries.

Regional and Inter-regional co-operation has led to the existense of various International organisations created by the individual metal industries involved in the production of copper, zinc and tin. These R & D associations are active in the collection and dissemination of information of specific interest to their metal producers and users undertaking research and providing a model for such activities in the developing world.

3.3 ENHANCING RESEARCH INDUSTRY TRANSFERS

The location of R & D centres in or near the industries they serve maximises personal contact and technical interchange. With the building of appropriate pilot plant facilities at locations close to industry, research-industry transfers are enhanced which could promote a dynamic co-operation among researchers and manufacturers through joint research projects.

4. ROLE OF TRAINING AND MANPOWER DEVELOPMENT

Technological development will continue to depend on the creation of an educated and trained work force. Developing countries own institutions, e.g. an R & D centre has a key role in technical training. Equipped with the necessary facilities, it is expected to provide technical training for industry and research personnel, with majority of the work force in industry benefitting. Such investment has permanent long term benefits. Regional co-operation in such training is also advantageous.

5. MARKETING

5.1. EXISTING MECHANISMS FOR MARKETING AND DISTRIBUTION OF FERROUS AND NON - FERROUS ORES.

5.1.1. FERROUS ORES EXPLOITATION, IRON AND STEEL DEVELOPMENT:

Developing countries differ in their stage of development, size and type of natural resources, size of population and internal market structure and any discussion of the exploitation of the ferrous ore resources of a developing country and its intimate link with the national and internatioal iron and steel industry is complicated by these differences.

Consumption of steel per capita and steel consumption to Gross National Product are indicators used to judge the stage/level of industrial development of countries. The values for developing African countries are generally much lower than Latin America and the Far East. These are still lower than the fully industrialised developed countries with values in the range of 200/600kg/head.

5.1.2. NON - FERROUS ORES

The non-ferrous metal industries based on aluminium, copper, lead, zinc and tin each have their own market structure.

(i) Aluminium markets are highly concentrated. There is very little open trading of either bauxite or alumina as commodities as the industry is dominated by six vertically integrated transnational companies in which the production of bauxite, alumina and aluminium are closely linked to consumption in all their main markets extending into fabricating, and very little aluminium available to independent fabricators.

Used widely for structural purposes, its good strength/ weight characteristics have always made it attractive in the field of transport, and aluminium has made major inroads into the market of steel.

(ii) Copper: In contrast to the situation in aluminium, developing countries have established national ownership and control over most of their copper industries, having displaced the former transnational corporations as the leading force in world copper production. A relatively expensive base metal on a price/volume basis, electrical applications account for 70% of new copper production. A well developed scrap industry supplies much of the copper used in construction and transport, providing 40% of Western needs.

(iii) Lead and Zinc

The principal market for lead is in acid storage batteries and demand for these stems from the activity of the car industry. Like copper, up to 40% of supply is derived from scrap, with used car batteries the principal source.

Other technological developments in the battery field will lead to increased lead consumption e.g. small batteries for use in permanent memory storage in computers and the lead - acid battery for off-peak electricity storage.

Galvanizing, die castings and brass (copper-zinc alloy) are the principal markets for zinc, which enjoys a stable market. Zinc and lead can be freely traded through the commodity exchanges because of the large number of producers.

(iv) Tin:

Tin is an expensive metal with the highest percentage level of production of any base metal in the developing countries. Due to its high price, it has lost much of its traditional market in the canning industry and solder has now taken over as its principal end-use. Tin is now low-priced and new uses and increased consumption will develop if the situation persists.

In general, tariff barriers and other artificial trade constraints appear to have little influence in the marketing of non-ferrous minerals.

5.2. OBSTACLES EXPERIENCED BY DEVELOPING COUNTRIES WHEN TRYING TO ENTER INTERNATIONAL COMMODITY MARKETS.

5.2.1. FERROUS ORES

The relative abundance of high grade ores, coupled with a declining market for iron and steel products in the industrialised countries of the world, will continue to keep basic mineral prices low.

Therefore mineral processing in the developing country of origin carries some financial benefit in that iron ore fines, the lowest value at $15 per ton, can be converted into pellets worth $24 per ton.

The metal content of iron ore demanded by consumers has risen progressively over the years and can now only be obtained in high grade deposits. Consequently, the exploitation of low grade ore for export has little potential other than as a blending constituent for sinter production.

5.2.2. NON FERROUS ORES

The basic metals are among the highest ranking industrial sectors in terms of the ability to generate economic linkages and promote growth.

Unfortunately, much of the non-ferrous ore production of the developing countries is exported directly and they have a much smaller involvement in mineral processing or metal production.

(1) The greater problems have been financial, in that mineral processing development requires large capital investment and the creation of large scale plants. These costs and the associated indebtedness can easily negate any added value in the products.

(2) The linkage from the mining of ore through smelting and refining to the fabrication of metal products and finally capital goods production is one of the basic patterns of successful industrialisation. Many developing countries lack the experience of the technology involved.

(3) The marketing of higher value added mineral products requires an extensive organisation, the creation of which involves costs.

5.3 THE SCOPE FOR CO-OPERATION AMONG DEVELOPING COUNTRIES IN ORDER TO CREATE DOMESTIC CAPABILITIES FOR STRENGTHENING THE SCOPE OF MARKETING PRACTICES.

5.3.1 FERROUS ORES

Mature economies have a declining steel intensity and projection of steel demand on a world-wide basis indicate that growth in consumption will occur only in developing countries. Since developing countries produce about 20% of total world steel output, they themselves should be the main beneficiary of their own development, through national, regional, and international co-operation among themselves to become self sufficient in iron and steel products.

(i) For example, developing countries in Africa could derive great value from their iron ore resources by converting them into higher grade engineering products which are currently imported. Where a country's domestic market is small, technology on the scale of miniplants already exists.

(ii) Latin American countries are developing important supply arrangements with a number of other developing countries such as China and Libya.

There is scope for co-operation between less developing countries and several Latin American Countries who have diversified iron and steel production and are now active in the production of capital goods. Argentina, Brazil and Mexico are examples of this advanced stage of development and the associated high value added aspect of the iron ore production. India, Korea and China can also assist less developed countries in the creationof iron and steel industries.

There is great hope for regional self-sufficiency in iron and steel products among the developing countries through co-operative development. This is particularly evident in the case of the developing countries of Africa, where raw material resources are good and the market for finished iron and steel products is still at an early stage of its potential growth.

5.3.2. NON-FERROUS ORES

A strategy of greater inward-oriented development can offer advantages, particularly if pursued on REGIONAL basis. Most regions of the developing world have the required combination of raw material resources, cheap energy, space and freedom from environmental constraints and some access to foreign capital. Collectively, they have the means to create self-sufficiency through JOINT VENTURES in order to acquire experience in producing base metals for consumer and industrial application. At the moment, developing countries lack experience in the technology required to produce these products.

6. RECOMMENDATIONS TO DEVELOPING COUNTRIES ON MEASURES TO BE TAKEN AT INTERNATIONAL LEVEL WITH A VIEW TO MAKE BETTER USE OF THEIR RAW MATERIALS.

i. There is the need for an increased flow of information, technology and financing by means of international co-operation. Members of the Group of 77 themselves should be the main contributors to this co-operation, to generate economic linkages and promote growth.

ii. Since raw material resources are good and developing Countries' market (especially those of Africa) are at an early stage of development, there is the need for co-operative development. Higher grade engineering products to replace imports should be developed and the establishment of miniplants should be encouraged. Joint Ventures also have great potential.

iii. UNIDO is expected to play an important catalytic role in this development process by drawing on the expertise and financial resources available in both industrial and developing countries.

LIST OF DOCUMENTS FROM WHICH THIS PAPER WAS SYNTHESISED

Title	Author
The Processing of Raw Materials	
I Ferrous Ores	
II Non Ferrous Ores	
	A. J. BAKER