



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org



D02389



Distr.
GENERAL

ID/CONF.1/16
8 June 1967

United Nations Industrial Development Organization

ORIGINAL: ENGLISH

INTERNATIONAL SYMPOSIUM ON INDUSTRIAL DEVELOPMENT
Athens, 29 November-20 December 1967
Provisional agenda, item 2

FOOD AND FOOD PRODUCTS INDUSTRIES

Prepared for the Symposium

Presented by the Food and Agriculture Organization

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

Contents

Paragraphs

Summary

I.	GENERAL CONSIDERATIONS	1 - 30
	Introduction	1 - 7
	Measures undertaken in developing countries	8 - 14
	Raw Materials	15
	Size of operation and location	16 - 18
	Research and organization	19 - 24
	Co-ordination of research	25
	Technical personnel	26
	By-product utilization	27 - 28
	Food standards	29 - 30
II.	PRESENT PROCESSING TRENDS	31 - 47
	Drying and dehydration	31 - 34
	Canning	35 - 40
	Refrigeration - cold storage and freezing	41 - 47
III.	RICE MILLING INDUSTRY	48 - 60
	Processing techniques	48 - 50
	Present production and trade	51 - 52
	Outlook for rice	53 - 55
	Prospects for the rice milling industry in developing countries	56 - 60
IV.	MILK PROCESSING INDUSTRY	61 - 67
	Shortage of milk	64 - 67
V.	MEAT INDUSTRY	68 - 73
VI.	SUGAR INDUSTRY	74 - 96
	Processing techniques	74
	Production of raw sugar	75 - 77
	Sugar refining	78
	Non-centrifugal sugar	79
	Present production and trade	80 - 83
	General outlook for sugar	84 - 85
	Prospects for sugar manufacturing in developing countries	86 - 96
VII.	OILSEED CRUSHING INDUSTRY	97 - 111
	Background	97 - 99
	Factors affecting development	100 - 111

Summary

(1) In terms of value added to the raw material by processing, the food processing industry is the largest of all industries and, with the exception of the paper industry, expanded most rapidly during the 1950's the less industrialized countries showing a greater rise than the industrialized.

(2) The growth of the food processing industry has been considerably faster than that of population, since consumers tend as their incomes rise to demand an increasing proportion of processed food, while the processing is also gradually shifted from the farm and the household to the factory, reflecting the increasing opportunity costs of time spent in home processing. Urbanization also tends to bring an increase in demand for processed food, since urban dwellers have to purchase most of their food and are consequently the more ready to purchase it in processed form while it increases the need for the preservation of perishable foods that may have to be brought long distances from producing to consuming centres. Between 1953 and 1958, the value added in the world's food, beverage and tobacco industries rose by more than a third.

(3) In the earliest stages, the food processing industries may be expected to consist mainly of the preparation for consumption of the staple foods of which the diets of low-income consumers so largely consist (for example, the milling of wheat and rice). As consumer incomes rise, there is some shift in consumption towards more expensive foods such as meat, milk, eggs, fish, fruit and vegetables, and industries processing these products increase in importance. At the same time, industries develop for the more elaborate processing of the basic foods (for example, bakery and confectionery). Later, the food industries become still further diversified to meet a wide range of tastes and convenience.

(4) There are many advantages for a developing country if it can successfully process and market its own food products. On the other hand, such countries are often at a disadvantage in competing with processed foods from industrialized countries. Thus, before deciding to invest in food processing industry, a careful study is required with regard to the present and future domestic, export, and international situation for the products it intends to manufacture, and the comparative costs of processing them. The present paper intends to provide some background framework for such decisions for a few selected food products industries

(5) Particular attention should be given to the establishment of pilot plants in the field of food and food products processing which now can be made available by the manufacturing industry in greater variety and in various degrees of sophistication.

(6) As investment costs for such pilot plants are relatively low, thus reducing the risk factor, such plants are considered an investment of prime importance serving a variety of purposes, such as:

- (a) to introduce and demonstrate modern techniques and technologies;
- (b) to gain experience in handling, processing, packaging, distribution and marketing based on indigenous raw material;
- (c) to establish the required contacts between primary producer and industry;
- (d) for in-plant training of a variety of technical and managerial personnel;
- (e) to prepare an investment climate through local co-operatives and credit banking organizations.

I. GENERAL CONSIDERATIONS

Introduction

1. In the industrialized countries, there is nowadays available an ever-increasing range of canned frozen, and dehydrated food, TV dinners, and other foods for convenience which are mixed-prepared, pre-processed and packed in the food factory. Similar practices and processes are now in use for fresh farm produce, eggs, poultry, fruit, vegetables, etc., which are graded, cleaned, washed and packed by the industry.

2. All this was possible only because of newly developed equipment and machinery, better understanding through science and technology with respect to the nature of a variety of raw materials, chemical and biochemical processes that were applied, new techniques in temperature control, advanced techniques in dehydration, including freeze drying. Quite a number of processes now in use are not new, and many modern large food industries thus are actually founded on the ancient skills of millers, brewers, bakers, etc. Other processes such as canning, manufacture of margarine, condensed milk, chocolate, etc., were developed by industrialized methods from the start.

3. For some "traditional foods" produced in the home or in cottage industries, changes in the scale of production have taken place and large-scale factories for

/...

soya sauce, fish sauce and soya milk have been established in Japan, Thailand, the Philippines, China (Taiwan) and other countries, whereas in Indonesia a spray dried soya milk plant has been established with FAO/UNICEF assistance.

4. The know-how at present available in industrialized countries needs to be made useful to developing countries, but will have to cross areas of adaptation, application, feasibility, economics of operation, and commercialization, i.e., needs to be adjusted to prevailing conditions. There is a need to recognize inherent inertia, to change traditional approach. One conclusion, however, has to be drawn from developments in the industrialized countries, and that is the necessity for a proper build-up of infra-structure.

5. In practical terms, industrialists and food processors are no longer prepared to accept whatever raw material is offered by the farmer or livestock producer, nor do they base an industry on any surplus production. Thus, developing countries have to establish a proper feed-back system between agriculture and industry, and agriculture will have to make the raw material available to meet specific requirements, as demanded by industry.

6. Over the last two decades, developing countries in general have made a considerable effort to intensify agricultural production of various food crops. Much of the food which has been produced, however, has not been fully utilized due to the absence of proper facilities for preservation and processing. Moreover, in many countries losses occurring at harvesting, during transport and storage are still alarming, whilst marketing and distribution facilities are also lacking.

7. Developing countries, therefore, first of all will have to take measures and devise methods to control and minimize losses at the various levels, i.e. from farmer to consumer. The measures required in all these fields, and the necessity that for maximum effect they should be implemented simultaneously, whenever possible, indicate clearly the need for ultimate development of a vertically integrated system having elements of, and comparable to, in several respects, the supermarket system which has become increasingly popular in the industrialized countries. The development of such a chain requires a considerable volume of investment, in human skill as well as in equipment and machinery for processing, for improved storage, marketing and distribution structures and facilities, for market development and the institutional and organizational structures serving agriculture and fisheries. The potential returns of this investment, however, can

be substantial as, at present, losses and waste are much too high, and occasionally could be rapidly achieved. For many newly developing countries, especially when rapid urbanization cannot be prevented, steps to accelerate the development of food and food products industries are becoming rather urgent. Campaigns to promote acceptability of new products (and by-products) will be required to inform potential consumers of nutritional advances and how to buy them in a selected manner.

Measures undertaken in developing countries

8. Several Governments have taken steps to assist and promote the development of food industries. For example: A Food Industry Advisory Group has been established in Burma, while in Ceylon a three-year plan for the fruit and vegetable industry has been formulated. In India, the Development Council for food industries has been set up to assist in bringing about a co-ordinated development and to recommend to the Government the measures to be undertaken for this purpose. A Food Industries Promotion Law has recently been passed in Peru. In the United Arab Republic an organization for food industries was set up in 1954.
9. Exemption from import duty for raw materials like tinplate has been granted in Mexico, on a temporary basis, conditioned to the export of processed food in which this raw material has been utilized. Exemption from import duty has been established in Venezuela for food processing equipment and spare parts. Exemption from import duty on food machinery for new food industries is also given in the Philippines.
10. In Thailand, Malaysia, Korea and Ceylon, the Government provides loans at reasonable interest for the establishment of new food industries. Industrial banks in Sudan and Tanzania have provided loans for establishing industries such as onion dehydration, date processing, meat canning and instant coffee.
11. Industrial development co-operation or similar organizations have been set up in Gabon, Ghana, Lebanon and Madagascar to plan and assist in starting a proper development of all types of industries including food industries. The Industry Institute in Lebanon conducts feasibility studies and prepares detailed plans, including design of industrial plants.
12. Sugar at cost price is provided to canning plants in Ceylon and Malaysia. New food industries in the Philippines are exempted from tax in the initial period of

operation and there is a ban on the import of food products which are locally manufactured.

13. With a view to introducing new methods and increasing operational efficiency, teams of technical and management personnel from industries and research institutions have been sent by several Governments to visit food industries in developed countries.

14. In a few cases, food industries in developed countries have been invited to invest capital to start a new type of industry either by themselves or with partnership of the local investors. In such cases, facilities are often provided for importation of equipment on a duty-free basis and easy transfer of funds.

Raw material

15. Variation in yield due to poor quality seed, adverse weather conditions, diseases, etc., often restrict the availability of the produce even for the fresh market in developing countries. The absence of regular supplies and failure to conform to standards can lead to high production costs. In order to ensure a dependable supply of raw materials, the processor may contract with farmers or establish his own production units where he can grow the produce specifically designed for processing. Raw product requirements for the production of optimum quality processed products have been established during the last twenty-five years. For each product and for each type of process, such as canning, freezing or dehydration, specific requirements have been formulated and must be met. Shape, size, texture, colour, flavour, odour, acidity, viscosity, maturity, specific gravity, soluble solids, total solids, vitamin content, etc., are all factors for which standards have been established by industry. It requires careful planning in plant breeding and cultural practice to produce a raw fruit or vegetable suitable for either canning, freezing, dehydration or concentration.

Size of operation and location

16. The raw material supply is linked with the scale of operation, and in the early stages of new development it is often rather difficult to organize a regular supply of raw material within a reasonable distance of the industry, thus limiting the scale of operations. In addition, transport is usually not well developed.

17. Many Governments are still encouraging cottage-scale units which are often not very productive, especially when using old-fashioned techniques. Establishment of processing plants in or near producing areas is, however, in many instances necessary from the point of view of spoilage of the raw material, although it is recognized

that difficulties are encountered with regard to purchases of packaging material, such as cans, bottles, etc., and with respect to the supply of power, water, etc. and the marketing of the finished products. Governments should encourage the development of modern pilot plants nowadays available. (See paragraphs 21 and following.)

18. In the developed countries, there is a tendency to increase the scale of operation and thus the number of food industries establishments gradually decreases. This is particularly the case when the final product is designed for export and will face a competitive world market. For example, most fruits and vegetables have to be processed within a few hours after harvesting. In such cases, a food industry has to be established near the production areas; other examples are the sugar and cassava flour industries because of the bulky raw material in relation to its cost and the price of the final products. The palm oil and olive oil mills also have to be established in rural areas as the oil must be extracted soon after harvesting to prevent an undesirable increase in the free fatty acid content.

Research and organization

19. Food industry faces keen competition, particularly in the export market. Therefore, to operate the industry profitably it is necessary for every part of the food processing organization to operate with utmost efficiency. Operational research should be an integral part of the industry. It helps to improve the existing technique, evolve new methods of handling, introduce improved machinery, better quality control, improve quality of finished product and finally utilize finance to the maximum extent possible.

20. Large food industries in the United States of America have operational research teams of their own who continuously keep on studying various aspects of the industry and make their recommendations. Many industries in the developed countries make use of the private consultation services in the field of operational research and productivity and also take advantage of the facilities available for this purpose at the various research organizations and universities.

21. Large-scale industries undertake such research themselves. In many newly developing countries Governments will have to initiate and develop research facilities, and applied research institutes or pilot plants are now being established with UNDP Special Fund/FAO support in Brazil, Chile, China (Taiwan), Ghana, Jordan, Malaysia, Poland, Senegal, Sudan, Syrian Arab Republic, Turkey, and

/...

some other countries. These institutes will pave the way for the development of food industries, especially when introducing modern pilot processing plants.

22. The manufacturing industry nowadays makes available a great variety of equipment and machinery in various degrees of sophistication and suitable for the establishment of small to medium size processing plants. (Investment costs, depending on the type of plant, i.e., raw material, ranging from some \$US30,000 to a few hundred thousand dollars). These pilot units differ from larger units size (thus cost), but the appropriate technique or technology (the process to be applied) is mainly the same.

23. FAO has, in its field operational programmes, used with advantage such pilot plants in many instances. They are considered an investment of prime importance, as they are especially suitable (a) to introduce and demonstrate modern techniques and technologies; (b) to gain experience in the handling of indigenous raw material production (linking farm operations), processing, packaging, distribution and marketing; (c) to establish the required contacts between primary producer and industrialist; (d) for in-plant training of a variety of technical and managerial personnel; (e) prepare an investment climate through local co-operatives and credit organizations.

24. In view of the fact that investment costs are relatively low, i.e., the risk factor is greatly reduced, Governments are recommended to make greater use of such plants which, provided equipment and machinery are carefully selected, can greatly accelerate industrial development (through duplication, enlargement). They can also be used as "test bed" for related industries, such as packaging and by-products utilization and development.

Co-ordination of research

25. In the United States of America and Europe, co-operatives or associations of processors operate research laboratories to assist the members with respect to quality improvement and day-to-day problems. The National Cannery Association in the United States has central and zonal laboratories in the food processing areas. The research project of the Association covers studies on colour and flavour of processed foods, development of new equipment, processing technology, retention of nutrients, sanitation, waste disposal and consumer acceptance. The Meat Research Laboratory in Denmark was started with funds from the entire meat processing industry which has helped to lay down standards for the quality of raw materials for various products. Food technologists of the Laboratory sometimes

work in the processing plants to solve their problems. Co-operative research laboratories have been established in Malaysia by pineapple growers, in China (Taiwan) for the sugar and in Japan for the canning industry.

Technical personnel

26. One of the basic factors effecting growth of food industry is the availability of trained personnel. Training courses in food technology have been established in a number of developing countries and few of them also include advanced post-graduate training facilities. It was noted before that in most of the developing countries the industries are either of medium or small-scale size and these industries, therefore, do not primarily require fully trained food technologists. Hence, it is essential that training facilities should be organized to train technical personnel such as operators, technicians, etc., but such facilities are most often not existent. With a view to assisting the member nations in Asia and Far Eastern regions, FAO, supported by the Canadian Hunger Foundation established a Regional Training Centre at CFTRI, Mysore, to train personnel working in different types of food industries. In addition, provision is made for advanced training in food technology. The Centre is operating for three years and it is hoped that in the near future national training programmes will be organized in different countries to train personnel at a level suitable for the medium and small-scale industries. Negotiations are in progress also to start a similar centre in Latin America.

By-product utilization

27. There are very few agricultural products which can be completely processed and used without leaving some waste or by-products behind. Thus, a characteristic sign of highly developed food processing industries is the optimum utilization of these residues. Although often many by-products can be further processed, the waste from food industries is hardly utilized in many countries. The pineapple industry is able to recover 50 per cent of its sugar requirement from the fruit waste. Pineapple waste, after juice extraction, can be used in the manufacture of animal feed. In many countries, rice bran is being extracted by solvent, yielding an excellent oil suitable for human consumption.

28. Another example is the utilization in the butchery trade. In small-scale conventional slaughtering processes, blood, tail, some intestines and glands, hooves, etc., are thrown away or used in an uneconomic way. When fully utilized,

/...

these parts are of considerable value and allow for lower pricing of these portions of the animal which are of greater use for human consumption. (Glands are very valuable for the pharmaceutical industry.) As the scale of operations, however, is usually small in the developing countries, the utilization of these by-products usually is not commercially feasible.

Food standards

29. The standardization and grading of primary food products is of particular interest to the less industrialized countries wishing to expand their exports to the industrialized countries in order to obtain hard currency for development programmes, some of which are related to the processing of food products. It is in connexion with the latter type of product that many of the difficulties concerning public health measures and food standards arise. Higher standards of living in the industrialized countries have created a growing demand for quality produce on a world-wide basis and therefore in order to ensure the exchange of foodstuffs as easily as possible FAO and WHO, through the mechanism of a Codex Alimentarius Commission, are endeavouring to achieve international agreement in the field of food standards and obtain acceptance and eventual harmonization of national requirements as governments give effect to these standards in their national legislation.

30. The wide acceptance of internationally agreed standards which create a greater degree of certainty among vendors and purchasers will be of benefit to both exporting and importing countries especially in the following respects:

- (a) Food products can be bought and sold more expeditiously, without first having to undergo preliminary inspection on the part of the buyer;
- (b) Litigation, disputes and misunderstandings concerning the composition of food products can be avoided or at least settled in an expeditious manner where an agreed standard method of analysis is available for reference;
- (c) Phytosanitary requirements and food standard requirements can be unified whilst increasing protection of the consumer, for instance by agreed tolerances for pesticide residues and food additives.

II. PRESENT PROCESSING TRENDS

Drying and dehydration

31. The preservation of foods by drying is one of the oldest methods used by man. Some fruits like prunes, peaches, apricots, dates, figs and various raisin grapes are still sun-dried in many areas. Sun-drying requires several days and is followed by "curing" in sweating bins or sheds where the moisture of various pieces equalizes.

32. Artificial drying has expanded rapidly during the last decade. There are numerous methods of dehydration, from very simple to highly sophisticated ones. The choice of a proper method is primarily dictated by the type of the initial product and the desired characteristics of the finished product. The economic analysis of the operation and factors pertaining to the local conditions would further define the requirements more specifically. For developing countries, the social factors have added significance and should be given exhaustive examination in selecting the method of dehydration. Matters such as availability of qualified operating personnel, services from the equipment manufacturers, maintenance requirement, availability of fuel, etc., may become factors more decisive than anything else.

33. Freeze drying has come into commercial use in the last decade or so. The food so dried retains its original shape and has a very porous structure which facilitates rehydration. Flavour and colour are generally excellent. Freeze drying is much more expensive than other more conventional methods, and cost figures reported vary over a rather wide range. Unless the product to be freeze-dried is a high priced one it simply does not pay. For developing countries, the only logical possible application of freeze-drying would be for foods that can find a high price export market. Some foods cannot yet be freeze-dried satisfactorily. One notable example is banana. Freeze-dried banana darkens rapidly upon rehydration because of enzymic action.

34. In designing a drying process, it is not uncommon to find that greater economy and better product quality could be achieved by dividing the process into stages employing different conditions or even different methods. The scope of this paper does not permit to give further details on other drying processes, nor on the development of new or improved packages or packaging techniques which have been introduced for dehydrated food.

Canning

35. Canned foods are those perishable foodstuffs of either vegetable or animal origin the preservation of which is assured by the sealing in a container impervious to liquids, gases and micro-organisms, and sterilized through heat with the purpose of destroying, or completely inhibiting both the enzymes and micro-organisms and their toxins, the presence or proliferation of which could cause a deterioration of the foodstuff concerned or render it unfit for human consumption.

36. To emphasize the importance that canning has reached all over the world, as the most safe and popular method of food preservation, it is stated that the world canning industry uses approximately 8 million tons of tin plate a year to manufacture the cans it needs for packing food (1963). As an example of the magnitude of canned food consumption in the United States, it is interesting to quote the statement of the United States of America National Canning Association that "If all the food cans Americans open in a year were laid end to end, they would stretch a distance equivalent to three round trips to the moon".^{1/} The United States holds the first position in the world canning industry. In 1962, for instance, the production of canned food was 2 million tons, which represents over ten times the output of Australia or Japan, which are the next larger producers.

37. The trend for further expansion of canning in the world is enormous. The rapid growth is more evident in many important canning countries, such as Japan, France, Australia and South Africa. The total production of Japan, which in 1951 was not more than 7 million cases, had risen by 1961 to nearly 58 million cases. In 1963, the French canning industry employed more than 210,000 metric tons of tin plate (as against 100,000 tons in 1952). The output of canned food in Australia has grown from 118,000 tons (1946-47) to 294,000 tons (1962-63). In the Republic of South Africa, the production of canned food has increased from 13,000 tons in 1938 to more than 200,000 tons in recent years.

38. New canning industries have also been established in several developing countries and even in countries where none had previously existed. For instance, Malagasy (Africa) exported in 1962 1,500 tons of canned meat; Morocco exported in 1960, 10,000 tons of canned fruits; Mexico exported in 1961, 17,239 long tons of canned pineapple, and Malaysia produces a yearly average of 40,000 tons of canned pineapple.

^{1/} Consumer and Trade Relationship Committee, 1960.

39. To get a sound development of food canning industries in the developing countries, it is necessary to overcome several difficulties or shortcomings which have hindered its progress, such as regular supply and quality of raw materials; transportation; modernization of machinery and equipment; efficiency of processing and unit operations; industrial sanitation; organization and management of factories; marketing of canned foods; production cost; standard of quality of these products; lack of know-how and so on.

40. The scope of this paper does not permit to discuss details on a number of new processing techniques that have been developed over the last years. It is recognized, however, that expert advice on the choice of technology to be used is extremely necessary.

Refrigeration - cold storage and freezing

41. Like the long used methods of preservation, such as drying, salting, smoking, etc., refrigeration (application of low temperature) reduces losses. In addition, it retains very much better the natural quality characteristics (appearance, colour, flavour, texture) and nutritional value of the food. The increased cost of refrigeration is frequently more than compensated for by the enhanced acceptability and quality of the stored product.

42. Refrigeration considerably slows down microbiological and biochemical action responsible for deleterious changes and spoiling of the produce. Hence, by the use of refrigeration, it is possible to preserve fruits, vegetables, meat, fish and other sea food in a state very similar to the fresh one. The importance of refrigeration in tropical climates is evident because of higher spoilage by micro-organisms and enzymes due to the higher temperatures. Cold storage helps in avoiding the numerous losses which occur when the market is not able to absorb seasonal surpluses of foods and thus enables a better distribution of produce the year round and favours the development of national and international trade of these products. It also may often be used to advantage for raw materials to help keep processing plants at economic size, improve quality, extend operation season and allow for a certain independence from the unskilled seasonal workers employed to cope with glut supplies.

43. Refrigeration requires large investments and cannot be applied successfully to all products and under all conditions. Refrigeration systems from producer to the consumer have been developed in the United States and, to a certain extent, in Western Europe, through the network of cold chains, but such practice is to be

extended to the developing countries. Here, the first phase should be established by multipurpose refrigeration warehouses in the main consuming centres.

44. Four very important points must always be respected whatever treatment by cold or low temperatures (i.e., chilling: temperature decrease without freezing; freezing: temperature below freezing point) is applied: (a) The product to be treated must be in good condition; (b) it must be submitted to the cold as quickly as possible after harvesting, landing or slaughtering; (c) in storerooms, some products are not compatible with others because they emit volatile substances affecting the flavours or the rate of ripening of other stored products; (d) once chilled or frozen the product must remain at a temperature as constant as possible until it is used.

45. It must be understood that the best cold storage can do is to keep products in the same state in which they were placed in it. As cold storage is expensive, it is necessary to select high quality foods for which the consumer is ready to pay a higher price. In chilled storage, or when frozen, certain varieties or kinds of raw produce stand up better than do others. Therefore, only suitable products should be chilled or frozen. Since the cost of refrigeration is high, the industry requires well trained personnel and competent refrigeration specialists to act without delay in an emergency. Training facilities for personnel responsible for the running and maintenance of the machinery must be provided for parallel with the development of this industry.

46. Cold storage is extensively used for a wide variety of products such as fruits, vegetables, dairy products, eggs, meat, and fish which are held under cold storage for periods ranging generally from a few days to a year. Among the tropical fruits, banana is a large export item under controlled temperature. Cold storage is also applied to certain seeds, such as potatoes and cereals, not only for preservation, but also for activating their germinating quality.

47. There are three main direct-contact freezing methods, with many variations: freezing in still air, blast freezing and immersion freezing. There are also several indirect-contact freezing methods among which is the multiple-plate freezer. There are additional freezing methods as for instance by floating the product in a blast of cold air. New techniques are continuously proposed to meet special product requirements and to attain greater production economy.

III. RICE MILLING INDUSTRY

Processing techniques

48. Although rice processing is a relatively simple operation, there is a large variety of processing methods the use of which depends on the intended end use for the processed rice. In addition, there are several preliminary or pre-processing operations, such as harvesting, field curing, threshing to remove the panicle but not the husk and, where necessary, drying of the threshed grain. The proper completion of these operations will improve the processing out-turn.
49. Processing involves the removal of the husk, germ and bran layers from the grain and, in doing so, a primary aim is to keep the grain as nearly whole as possible. The percentage of broken grains determines to a large extent the commercial value of the milled product, and often its end-use. Whole grain rice, for instance, is generally used for human nutrition. Small broken rice, on the other hand, is used for animal feed, and for brewing and wine-making. Milling by-products also have a variety of uses, the most important being rice bran. Japan produces over a million tons of bran per year, from which both edible oil and animal feed are derived.
50. Processing methods vary from hand-pounding, through crude mechanical methods, to large modern rice mills costing about \$120,000. In vast areas of Africa, the Near East and the Far East, the most commonly used device is the mortar and pestle made of wood and worked by hand, foot, or water power. The hand-pounded product is highly nutritive as it still contains some of the outer grain covers, but losses are high, primarily due to the repeated winnowing necessary. But mechanical milling (including small-scale village "hullers") is spreading, and probably processes more than one-half of the world's rice supply. As more technically efficient mills are introduced, the percentage of "brokens" tends to decline, and all grains are milled to a high degree, and in some cases "polished" before packing. Highly polished milled rice meets consumer tastes, especially in developed countries, and has a larger storage life than undermilled rice, but the polishing involves a serious loss of vitamins. To some extent, the vitamin content can be maintained by parboiling (steeping in water, steaming or heating, and subsequently drying). This process also increases the yield of whole rice.

Present production and trade

51. Between 1950 and 1962, world rice production rose at nearly double the rate of population growth, and by the latter date the milled output was about 160 million tons, or a third higher than a decade earlier. The main producing countries are China (Mainland), India, Japan and Pakistan, which together produced about 110,000 tons. Other countries in the Far East accounted for a further 34,000 tons, so that in total that area contributed 90 per cent of the world's output of milled rice. Since 1962, however, output has grown at a much slower rate and has not kept pace with demand.

52. The rate of expansion of trade has also slowed down recently after increasing from 5 million tons in the early 1950's to 7 million tons by 1963, in which year the value of exports was about \$US750 million. In 1961-1963, the main exporting countries were, in order of importance, Burma, Thailand, and the United States of America. The slowing down of the rate of expansion in world rice trade is partly due to a lack of any strong price incentive. Though export prices have risen in recent years, the increase appears to be moderate in view of the strong import demand. This is partly due to the fact that a large part of the world trade is under direct government-to-government contracts or subject to considerable official control. Prior to the Second World War, there was a substantial export of paddy from the Far East to Europe. Today, almost all rice is exported in milled or husked form. The European milling industry is largely confined to the general processing of locally produced rice (just over 1 million tons per annum) and to the final polishing of imported husked rice. Imports of husked rice into Germany (Federal Republic) and the United Kingdom enjoy preferential tariff advantages over fully milled rice, but this trade is small, and most of the husked rice imports come from the United States.

Outlook for rice

53. Because of the strong influence of government policies on the production and consumption of rice, and the possibility of unforeseen changes in such policies, it is difficult to project what the rice situation will be in 1975. The rate of increase in per caput demand for rice in both developed and developing countries is likely to be smaller than in the past, but the growth in total world demand is expected to be between 2.6 and 2.9 per cent per annum on average, due to the substantial increase in population. Demand growth is likely to be particularly high in developing countries (between 2.9 and 3.2 per cent per annum). Many of these

countries may be able to expand their production considerably and there may be large export availabilities in some countries, such as the United Arab Republic and possibly China (Mainland), but in others, particularly in West Africa and Latin America most of the increase is expected to go to local consumption. In the Far East, however, substantial deficits are likely to arise, especially in Indonesia and the Philippines, and perhaps also in India and Pakistan.

54. In the latter two countries, imports of large amounts of wheat in the form of food aid continue to substitute for rice. If wheat imports are cut, rice prices would rise. But it is problematic whether the resultant rise in rice output would be sufficient to bridge the gap between supply and demand.

55. It is projected that on a world scale supplies will match demand by 1975, and an expansion of trade in rice, mainly from developed countries, especially the United States of America, but also from developing countries, such as the United Arab Republic, to the deficit Far East area might be contemplated. This solution may not, however, be feasible due to the chronic lack of foreign exchange in the deficit countries to pay for increased imports of rice. If the projected balance in world supply and demand is to be achieved, therefore, further inter-governmental agreements may be needed, perhaps in the form of a food aid scheme for rice. At the same time, however, adequate incentives to growers in both importing and exporting countries must be ensured.

Prospects for the rice milling industry in developing countries

56. Unlike many of the other food industries, such as oil seeds and wheat, competition in processed rice from developed countries does not present a serious problem for the rice milling industry in developing regions. The milling output for Japan, for instance, has levelled off much earlier than anticipated, and although the United States exports from a large part of its total rice production, the amount involved is still only about 15 per cent of total world trade in rice. As pointed out above the main problem is to mill sufficient rice to satisfy the rapidly growing demand, and mills in developing countries are in some ways in a better position to do this than those in developed countries.

57. The main deficit area now and in the future is the Far East. This region already has a large milling industry: the Republic of Korea, for instance, has about 20,000 mills, and India has more than double this amount. Many of the mills are small, and in some countries, such as the Republic of Viet-Nam, the average capacity is only about 200 kilograms per hour. The yield from such small mills

is low, and the out-turn of broken rice is sometimes as high as 30 per cent.

Nevertheless, smaller mills often have certain economic advantages: a large part of the rice crop is consumed by the farmers themselves, and this is milled mostly in small mills close to the farms, in small batches and at frequent intervals.

58. Medium and large mills enjoy some economies of scale: a simple huller type mill with a capacity of 250 kg/hour will process rice at a cost of about \$US6 per ton, whereas the unit costs in a \$US10,000 standard type rice mill are about \$US2.70 per ton in the Far East. Moreover, large mills can separate the bran from the husk and brokens for further processing into oil and animal feed-stuffs, thus obtaining greater value from the original input. But the general tendency in the Far East is towards decentralization of processing facilities away from shipping ports and into the rice growing districts. This is due to the improvement of inland transport facilities, the saving of transport costs by shipping rice rather than bulky paddy, and the proximity of the livestock market for by-products. There is thus in many cases difficulty in finding locations where large mills can operate economically: the paddy must be sufficiently concentrated in one area to keep them running throughout the year.

59. As has been seen above, most of the mills in developing countries are small or medium-sized. But the position of a very large number of the existing mills is far from satisfactory: many of them use old equipment and are also under-utilized despite their small size. In this situation, milling costs tend to be relatively high. At the same time, under-utilization of existing capacity acts as a deterrent to investment plans to develop a modern and technically efficient rice-milling industry. Thus, the present situation faced by the rice milling industry in many developing countries is somewhat paradoxical: despite a large and growing demand for rice, the existing rice milling capacity is far from fully utilized. To some extent, the demand reflects a diet-deficit rather than an effective demand on the part of individuals who can afford to pay, or on the part of importing countries who have adequate foreign exchange. Nevertheless, the longer-term outlook for demand and trade in rice suggests an upward trend, and several countries, including developing, importing and exporting countries, have programmes to step up rice supplies. Successful implementation of these production programmes will help not only in meeting the growing demand, but also in more intensive utilization of existing rice milling capacity. Maintenance of rice

prices at levels that provide an incentive for higher production is thus an important element in the over-all strategy for promoting higher production and better milling. 60. While increased production and greater supplies for milling will in the longer term help solve the problems of over-capacity and high milling costs in many of the developing countries, government policies should also be directed towards rationalization of the present structure of the rice milling industry so as to obtain economies of scale without increasing the total milling capacity.

MILK PROCESSING INDUSTRY

61. The term "Milk Processing" refers mainly to: (a) the processing of milk for liquid consumption, but also to (b) the manufacture of milk products such as butter, butter oil, cheese, fermented milks, evaporated and condensed milk, milk powder, etc.

62. With regard to liquid milk processing, pasteurization by heat treatment (HTST) is the most widely used, although, particularly in warm countries, milk sterilization may in future be adopted to a greater extent as the basic processing system for liquid milk. In this context, it should be pointed out that appropriate heat treatment and the proper packaging of pasteurized - and, of course, sterilized - liquid milk is extremely important in countries where adulteration frequently occurs between the point of dispatch of the milk from the milk plant and its arrival at the consumer. It should be borne in mind that the extra cost for packaging (approximately 10 per cent of the price of the liquid milk ex-factory) is more than justified when compared with the 15-20 per cent of water which may often be added to bulk milk, such water not usually being in the best hygienic condition.

63. In connexion with the manufacture of milk products, emphasis should be given to the manufacture of cheese, as this has been found to be a suitable product from both the economic and the marketing points of view. Furthermore, cheese-making may prevent the waste of highly valuable protein in those countries where conditions are not favourable for the transport of liquid milk over long distances owing to lack of adequate roads, transport, cooling and processing facilities.

Shortage of milk

64. In those countries where milk processing is being, or has already been established, any shortage of locally produced milk may be overcome by the preparation of toned milk, reconstituted milk or filled milk, provided arrangements can be made for the provision of skim milk powder under favourable conditions.

65. In India, the preparation of "toned milk" (i.e., the mixing of locally produced milk of high fat content with reconstituted skim milk) has enabled consumers to receive liquid milk at reasonable price even where local milk supplies were inadequate. This also applies to the reconstituting of skim milk from skim milk powder. Such "reconstituted milk" should either be prepared by the milk plant or by the consumer provided that he is adequately instructed how to do so and how to use the powder under hygienic conditions, and told to consume it immediately after preparation. Preparation of reconstituted milk by the consumer should however, be restricted as much as possible. In countries where vegetable fats of high nutritive value are available, the manufacture of so-called "filled milk" - a mixture of vegetable fats and milk protein - may be of advantage in order to provide people with milk protein and fat in their diet. Such a product should, however, be correctly labelled so that the consumer is not misled as far as its composition is concerned.

66. The type of milk processing or milk products manufacture should be chosen in accordance with local habits and conditions, due account being taken of the quality of the raw milk available. A technological process suitable for manufacturing milk products, particularly as far as the animal protein and the calcium content is concerned, should be used to provide the population with sufficient quantities of these important constituents.

67. It is difficult to assess the over-all success of the dairy industries already set up in developing countries, but experience has shown that in the majority of cases it has been found that the existence of a milk plant has been of great benefit to both milk producers and consumers.

MEAT INDUSTRY

68. A wide variety of methods exists by which meat can be processed in order to maintain the hygienic standard and nutritional value of the meat during transport and distribution. Methods requiring a minimum of facilities, such as sun-drying, salting, curing and smoking can be applied under primitive conditions and on a small scale that can hardly be classified as industry, even though curing and smoking techniques are also widely used in the modern (bacon meat) industry.

69. In addition to these classical methods of meat preservation, the following systems are applied refrigeration, heat treatment, irradiation and chemical treatment. Ionizing irradiation of meat and bacteriostatic treatment of slaughter animals and/or meat are methods still subjected to research in developed countries

and they are not likely to be applicable on an industrial scale in developing countries in the near future.

70. By refrigeration, low temperatures are applied in order to inhibit or retard bacterial growth in the meat during storage and transport, preventing bacterial spoilage. According to the length storage required, two temperature levels are used: $+2^{\circ}$ to $\pm 5^{\circ}\text{C}$ (chilling) and below -10 , usually -20 to -30°C (freezing). In either case the process consists of two phases: (1) rapid removal of the heat from the carcass to the desired temperature and (2) storage at this temperature. Refrigeration is commonly used in the African Continent for medium (chilling) and long distance (freezing) intracontinental transport of meat whereas it is used only to a very limited extent in the domestic meat trades and for intercontinental export.

71. Freeze-drying is being developed on an industrial scale to serve special purposes, but it is unlikely that the method will be applicable to developing countries in the near future it being too costly.

72. Meat treatment (canning) by which the products packed in air-tight containers are exposed to temperatures sufficient to inactivate all pathogenic and most spoilage bacteria is the safest method of meat preservation. This method is applied to pure meat and meat products as well as dishes containing meat components. Canning is widely used in South America and Africa mainly for export purposes.

73. The determination of capacity for meat canning depends upon the market outlets, as well as the possibility of obtaining supplies. Unfortunately, in certain instances abattoirs have been planned on too large a scale, with the result that the capacity is not fully used and they are burdened with heavy overhead costs. Cost calculations and actual cost records of abattoirs of varying sizes in Europe have shown that slaughter costs per head of cattle decrease considerably up to a capacity of 30,000 to 40,000 head of cattle per year. Beyond this capacity, slaughter costs decrease theoretically only very slightly with the size of the plant. In practice, however, there is a risk that in large abattoirs the advantages gained by the use of mechanized equipment may be jeopardized by inefficient operation. When labour costs are high it may happen that larger abattoirs (more than 100,000 cattle slaughtering a year) cannot withstand competition from medium-sized units which have higher labour productivity and are more easily managed. In addition, the development of small and medium-sized equipment for the processing of by-products, such as fat rendering and the

processing of meat, bone and horn meal, has enabled medium-size abattoirs, provided they are well located and efficiently operated, to compete with larger plants. More information needs to be collected when canning of meat to permit exports is envisaged. (Disease situation).

SUGAR INDUSTRY

Processing techniques

74. The sugar industry is based on two general processing stages: (a) primary processing of the crop to produce "raw sugar"; (b) the further refining of the raw sugar.

Production of raw sugar

75. Sugar is produced from both beet and cane, and also from palms. In the case of cane sugar, three main processes are involved: extraction of the juice from the raw material, concentration of the juice, and separation of the sugar from the molasses which are valuable for cattle feed. The juice is extracted by crushing the cane stalks in multiple-roller mills. Non-sugar solids dissolved in the juice are removed by "clarification", i.e., lime and heat treatment, and the juice is concentrated by the evaporation under vacuum in multiple effects of most of the water in the clarified juice until as much of the sugar as possible is crystallized. Separation of the molasses from the sugar crystals is done in centrifuges. The resulting raw sugar is about 96 per cent sucrose and is usually light brown in colour due to the continued presence of some molasses.

76. Centrifugal sugar from sugar beets is made by methods roughly similar to those for cane sugar, except that the juice is extracted not by crushing but by osmosis in the beets, which are first sliced, soaked in water in diffusion batteries.

77. The basic principles of modern sugar manufacture have remained largely unchanged for many years although the processes described above are being steadily improved, and many of them have been converted from batch to continuous operation.

Sugar refining

78. After primary processing, sugar is further refined to almost 100 per cent sucrose content. This is done by washing with water in a centrifuge, then dissolving or melting the sugar and passing it through various types of filters,

before recrystallizing and packing. Cane sugar is usually refined in separate factories from those that house the primary processing operations, but beet sugar factories usually manufacture refined sugar without first making raw sugar for further refining.

Non-centrifugal sugar

79. The processes described above include the use of centrifuges and the product is known as "centrifugal sugar" to distinguish it from "non-centrifugal sugar" which is produced from cane mainly in Asia and the Far East, but also in Latin America. Non-centrifugal sugar is produced by simpler, less standardized methods, and is known by a variety of local names, such as gur, jaggery, panela, repodura, chancaca, papiton, muscovado, etc. In the juice extraction stage, the processing method is usually similar to that for centrifugal sugar, but concentration of non-centrifugal is often done in open boiling pans, and no centrifugal process is used to separate the molasses from the sugar. The sucrose content of the end product is substantially lower than that of centrifugal sugar, and due to its high moisture content, there are storage problems.

Present production and trade

80. Total annual world production of centrifugal sugar in the period 1964/5-1965/6 was about 65 million tons, raw value, comprising 36 million tons of cane and 29 million tons of beet sugar; in the same period, output of non-centrifugal sugar is estimated at about 11 million tons of products of differing sucrose content, equivalent in total content to, say, 7 million tons of raw centrifugal sugar. Developing countries account for about 45 per cent of centrifugal output, and almost all of non-centrifugal production. About 30 per cent of centrifugal production originates in developed countries and the remaining 25 per cent in the centrally-planned economies. These two groups of countries produce mainly beet sugar, the only important developed cane sugar producers being the United States, Australia and South Africa. Among developing countries, the largest sugar producers (centrifugal and non-centrifugal) are Cuba, India, Mexico, Argentina, Brazil and the Philippines.

81. Total world exports of sugar averaged 18.5 million tons per annum (raw value) over the period 1962-65, compared with net exports of 15.3 million tons per annum. Almost all of this was centrifugal sugar, international trade in non-centrifugal

sugar being negligible. Two-thirds of these exports originated in developing countries, especially in Latin America. Exports from developed and centrally-planned countries accounted respectively for 20 and 14 per cent of the total. Over the same period, nearly two-thirds of world imports of sugar were into developed countries, the remainder being divided equally between developing and centrally-planned countries. The largest inter-regional trade flows are between Latin America, on the one hand, and North America, Western Europe, the USSR and Eastern Europe, on the other, and also between the Far East and North America, but there is extensive trade between other regions and within regions.

82. Sugar constitutes the main, or one of the main, export commodities in several developing countries. For example, more than 90 per cent of the export earnings of Mauritius are derived from sugar, 80-85 per cent of those of Cuba, about 30 per cent of those of China (Taiwan) and Jamaica and more than 20 per cent of the Philippines.

83. Refined sugar accounts for rather more than a quarter of world sugar trade, but the degree of refinement often varies, and sometimes falls considerably short of 100 per cent sucrose content, so that what is exported as "refined" sugar is sometimes refined again in the importing country. The bulk of the exports from developed and centrally-planned countries are in refined form. Of the two-thirds of world trade originating from developing countries, only about 15 per cent is refined sugar, and this proportion is tending to decline. Among developing countries, the most important exporters of refined produce are Cuba, China (Taiwan), India, Hong Kong (from imported raws), Mexico and Argentina.

General outlook for sugar

84. There is a general tendency for the income elasticity of demand for sugar to decline with rising incomes and in high-income countries it tends to sink towards zero, as first direct household per caput consumption, and later industrial consumption (for use especially in soft drinks, jam and confectionery industries) reach saturation. This trend is expected to have a powerful influence on future sugar demand. In developed countries, in some of which the income elasticity is virtually nil, the growth rate is expected to be lower than in developing countries, and the projected growth of total demand is below 2 per cent per annum. On the other hand, the highest growth rate (of 3.9-4.7 per cent per annum) is projected

for developing countries (in many of which per caput consumption is still extremely low and income elasticities relatively high). The projected growth rate for centrally-planned countries lies between those for developed and developing countries. By 1975, world demand for sugar is expected to be about 75-80 million tons, implying a significantly lower rate of growth than that achieved in the past decade.

85. There is likely to be a tendency for production to outrun consumption in the future, as importing countries in all three groups - developing, developed and centrally-planned - continue the past trend towards self-sufficiency. The main burden of adjustment to this situation will fall on the traditional exporting countries. Exports are therefore not likely to increase substantially unless there is a change of policy in the main importing countries.

Prospects for sugar manufacture in developing countries

86. Primary processing: Sugar cane is highly perishable and should be milled within 24-36 hours of cutting. If processing is too long delayed, invert sugar results which does not crystallize and is unsuitable for refining. Moreover, the large weight loss in conversion - the sugar content is only 12 to 15 per cent of sugar cane weight - affects the relative transport costs. Since, therefore, sugar is crushed in producing areas, and since several developing countries have large cane sugar production, raw sugar manufacture is often the largest food industry after staple grain milling in developing countries.

87. The total sugar manufacturing capacity in individual developing countries tends to correspond closely to the size of sugar production, but it also varies according to the length of the sugar harvesting campaign. Short campaigns generally require relatively larger daily capacities to ensure that as much of the cane as possible is processed in a condition in which it will give maximum sugar yields, although within limits processing requirements can be varied to some extent by lengthening the season in years of good crops.

88. In establishing individual processing plants, the capacity should be carefully planned. Average cane factory capacity in developing countries in 1961-62 was 1,450 metric tons of cane per day, but the spread about this mean ranged from 100 tons to 15,000 tons. The average capacity was highest in Central America and in

Africa (over 2,000 tons in both areas): in South America it was about 1,000 tons, and in Asia only 850 tons. In a large number of countries, however, there is much unused capacity. This is partly due to the impossibility of full capacity operation throughout the entire season because of the uneven supply of cane noted above. In other cases, however, it may be due to inadequate planning and particularly to an over-optimistic assessment of the raw material supply situation without taking sufficient cognizance of the state of world markets for raw sugar, the competition from other crops, and the effects of these on producers' incentives.

89. Although non-centrifugal sugar can be economically processed in small, inexpensive plants, there is some incentive to establish large modern centrifugal factories to take advantage of economies of scale, and obtain a higher yield of sucrose. In the post-war period, there has been a trend towards increasing concentration in the sugar industry. In Mauritius, for instance, the number of factories has declined between 1937 and 1961/62 from 49 to 23, but average annual output per factory has increased over the same period from about 8,000 tons to 24,000 tons. But large factories are only economic if they can be operated near full capacity and must be able to offer a price for cane sufficiently high to attract deliveries from growers who would otherwise make non-centrifugal sugar themselves. The maintenance of a large and reliable supply of sugar cane requires considerable areas under cane production within easy access to the factory, as well as good roads and good transport organization to the factory. In addition, as just mentioned, large factories must be able to dispose of their output.

90. Procurement of assured markets is the most important problem facing developing countries wishing to expand or establish new sugar processing facilities. Developing countries as a group are expected to have the highest rate of increase in total sugar demand in the future, and by 1975 total demand may be as large as in developed countries, at present (26-28 million tons). Most of them, however, will be concentrated in Latin America and in Asia. And in many individual countries in these areas even, expected domestic market offtake may be insufficient to justify a large sugar processing industry.

91. In planning the capacity of the industry, account has to be taken of potential markets outside the country itself. More than half of present world trade takes place under preferential arrangements which offer assured markets to some producing countries at relatively favourable and stable prices. Any new production would have to be channelled to the domestic market or traded on the "free" or residual market

where surplus conditions in recent years have been reflected in extremely low prices, far below average costs of production of efficient producers. It may be possible for particular developing countries to obtain an assured market for some of their new or additional output under new or extended preferential arrangements, but in the long run, and for developing countries as a whole, the prospects for exports of raw sugar are only likely to improve if there is a slackening in the trend towards self-sufficiency - and export surpluses - in developed and centrally-planned countries with highly protected industries.

92. Sugar refining: Some of the same considerations as for raw sugar production apply to the setting up of sugar refineries in developed countries. But the economic size of a refinery is normally much larger (perhaps four times) than that for a factory producing raw sugar. There is, therefore, an even greater incentive to obtain adequate capacity utilization and this depends primarily on the size of the domestic market for refined sugar.

93. The volume of refined sugar entering world trade is much smaller than the raw sugar shipments, since most large importing countries own refining industries and impose quantitative restrictions or practise tariff discrimination against refined sugar and in favour of raw sugar. Prospects for an expansion of trade in refined sugar are thus on the whole less favourable than for raw sugar. Moreover, raw sugar lends itself more easily to bulk handling and the consequent lower costs.

94. The large minimum economic size of a sugar refinery, and the difficulty in entering export markets, will largely limit refinery construction to those developing countries with a substantial domestic market for the refined product. Under certain circumstances, however, it may be advantageous to build where domestic demand than the economic output for exporting refined sugar. For instance, prospects might be improved by the development of regional arrangements between developing countries which could not individually support refining industries. Moreover, government subsidy and tariff protection may be given for the construction of a large refinery whose capacity will only be partially utilized at first, where sugar demand is expected to increase rapidly in the future, or where refinery construction will also lead to the establishment of other industries, such as centrifugal cane factories, to supply the raw sugar, by-product industries for alcohol, cattle feed, and pulp and paper (from bagasse), and sugar-using industries manufacturing confectionery, preserves, soft drinks and sugar canning.

95. Indeed, in some cases refining facilities, despite their heavy capital costs, may be constructed before consideration is given to the primary processing of local sugar. It may, for instance, be advantageous for a developing country with a large demand for sugar to set up its own refinery and to import raw sugar. Relatively cheap supplies of raw sugar are likely to continue to be available on the free world market in the future. (In the past, sugar has been cheap in eight years out of every ten on average, and if sufficient stocks can be carried to tide over periods when world sugar prices are high, there may be little need to develop a local sugar producing and manufacturing industry.)

96. In conclusion, neither the manufacture nor the refining of sugar appears to open up any unsuspected avenues for investment in developing countries. The development of the industry has, in most cases, been done in close co-operation with the Governments, which have been motivated by political as well as economic factors. The size of the units involved requires financing on a scale only possible by large organizations and with the assistance of Governments.

OILSEED CRUSHING INDUSTRY

Background

97. Many developing countries are substantial producers and exporters of such vegetable oilseeds as copra, groundnuts, cotton-seed and palm kernels. There are usually no insuperable economic difficulties in the way of their developing seed crushing and related processing industries to meet the demands of their domestic markets for vegetable oils and oilcakes and such other products based on them as margarine, vanaspati, soaps, and animal feeds. However, the domestic markets are often small and the major exporters of tropical oilseeds are inevitably faced with the task of developing processing industries to serve the world market. The first step in this direction is the development of an oilseed crushing industry designed to export oils and oilcakes rather than the unprocessed seeds and it is to this

aspect of the question that FAO has given particular attention.^{2/} (It should be mentioned here that oilseed cakes, in many instances, are badly needed in the country of production to develop the livestock industry. In such cases, restrictions to prevent export are required.)

98. This is a question of considerable topical interest; the background to it is that virtually all the developing countries are anxious to expand their seed-crushing industries, provided they can find profitable outlets for the oil and cake, and some are already doing so. The industrialized countries of Western Europe and Japan which process oilseeds imported from developing countries and from North America are also increasing the size of their "crush". Moreover, the provisional FAO agricultural commodities projections for 1975 envisage a further substantial increase in world requirements of vegetable oils and oilcakes with a corresponding increase in oilseed production which, in turn, would require a further expansion of the world's oilseed crushing industry.

99. Technically, there is now virtual freedom of choice as to the location of new mills whether in the importing or exporting countries. The extraction of oil and cake from vegetable oilseeds is not, in itself, a complex process. Modern mills using either expeller or solvent extraction equipment can be operated satisfactorily from the technical point of view in most developing countries. The process requires little in the way of materials except the seeds themselves and both the seeds and the finished products can nowadays be stored and transported without undue difficulty. Thus the expansion of the seed-crushing industry in developing countries is likely to be determined not so much by technical considerations as by social and economic factors.

^{2/} See particularly the FAO study on "The Economic Aspects of the Location of Oilseed Crushing Industries - CCP/OF/66/12", which examined the position of the industry in a number of developed and developing countries and arrived at the conclusion that there appear to be no overriding reasons in terms of processing, transport and handling costs why oilseed crushing industries in exporting developing countries should not be able to compete effectively on world markets. The FAO Study Group on Oilseeds, Oils and Fats was in general agreement with the conclusions of the Study and recommended that the Director-General of FAO should examine, in co-operation with other international organizations, the possibilities of facilitating the development of such industries on the lines indicated in the Study and set out at paragraph 13.

Factors affecting development

100. Study of a number of developing countries has brought out the complexity of the factors which have influenced the industry and the following is an attempt to summarize only the most important of them. However, one general point should be made at the outset. Government policy has probably a more direct bearing on the development of the industry than any other single factor. Where government is known to look favourably on an expansion of seed crushing, this tends to create a climate of opinion conducive to increased investment, irrespective of the detailed measures, if any, which government may have taken to implement its policy.

101. A substantial home market for factory-produced oil and/or oilcake provides a more suitable foundation for the expansion of factory processing than reliance on export outlets alone, but this has not prevented the growth in a number of oilseed producing countries of industries designed essentially to serve the export market.

102. Expatriate capital and expertise can be important factors in many developing countries, bearing in mind that local capital is often scarce and that expertise both on the technical and commercial sides of the industry has, in the past, been largely concentrated in Europe and the United States of America, where the firms requiring oils and oilcakes for further processing are mainly concentrated.

103. General improvements in transport services and power supplies have removed some of the disadvantages which hampered expansion in developing countries in the past. FAO has no information to indicate that preferential rates for transport or reduced tariffs for power (which is a substantial item of cost in the running of expeller mills) have been available in developing countries, although concessions of this sort could influence the rate of expansion in much the same way that special arrangements for credit and the supply of seeds to a local industry to reduce the costs of stock holding can be useful.

104. If developing countries are to be able to compete effectively on world markets their plants must be large enough to enjoy most of the economies of scale. For practical purposes this probably means that they need to be of an annual capacity of at least 70,000 tons of seed a year and indeed most new plants erected recently in the developed countries are well above this figure.

105. The most successful export industries have been developed where sufficient raw materials are available to keep factories of around optimum size working to capacity. Where this condition cannot be met, as for instance in some of the minor producing countries, it seems unlikely that processing factories will be able to compete effectively on the world market.

106. Some degree of assurance as to outlets for exports of oil and cake can be and have been provided in a number of ways; for instance, as a result of direct links between crushers in producing countries and processors of the oil and cake in the main importing countries, duty-free entry for oil and oilcake from certain exporting countries, and by special price arrangements. It appears that nearly all successful developing exporters of processed oilseed products have, in the past, enjoyed some form of market preference or assurance for part of their exports, although these have usually served only to put them on the same competitive footing as crushers in the importing countries.

107. There are apparently no very significant ocean freight savings to be made from exporting oil and cake rather than seed. On the other hand, there are possible savings to be made in handling oil and cake in bulk both at the point of export and, perhaps more important, at the point of import where dock labour charges are often high. These savings appear to have been particularly important in facilitating an expansion of exports of the processed products from the Philippines.

108. There is some scope for substitution of labour for capital in plants in developing countries, but this is limited in practice largely to the handling of supplies on arrival and on dispatch from the plant and indeed, in many cases, mechanical handling seems to be preferred.

109. It is extremely difficult to make precise comparisons between total processing costs in developed and developing countries. In the past, there has been a tendency to assume that industries in the developing countries must necessarily be at some considerable disadvantage in this respect. Recent study in FAO, however, suggests that this may no longer be the case. This being so, it is worthwhile to consider how the expansion of oilseed crushing industries in developing countries could be encouraged where such expansion is likely to be profitable. There are a

number of possibilities, some of which offer scope for co-operation at the international level and with well-established industries in the developed countries, e.g.:

- (a) Pre-investment surveys. Careful pre-investment surveys would clearly have to be made to identify potentially profitable ventures;
- (b) Provision of capital. Some countries are anxious to obtain either international finance or private capital both for investment surveys and for oilseed crushing where this is shown to be justified;
- (c) Training personnel. Arrangements for training personnel, especially in factory and commercial management, are clearly needed;
- (d) Access to markets. Some crushers (e.g. in Senegal) are already linked with industry in the importing countries. There may be scope for similar bilateral arrangements elsewhere but, for many countries, this would still leave the obstacles presented by differential tariffs in some of their main markets;
- (e) Development of local markets. Development of local outlets for at least part of the oil and cake would help crushers to withstand the inevitable periods of poor trading on the international market.

110. Within the producing countries, there is also scope for improving the efficiency and competitive position of the industry through:

- (f) Tax and other incentives, modelled on those which many developed countries have adopted to attract new industry to particular areas.
- (g) Freedom of access to regular supplies of seed at no more than the world market price, since crushers in developing countries are otherwise at an obvious disadvantage compared with crushers in the importing countries.
- (h) Reasonable arrangements for financing the holding of stocks, bearing in mind that the working capital required to finance six weeks' stocks of raw materials and finished products can be equal to the capital cost of the factory and that if seeds are exported regularly throughout the year, the opportunity cost of earmarking supplies for domestic crushes may be virtually nil to the economy of the country.
- (i) Factories of optimum size able to operate to capacity so that the most is made of the economies of scale.

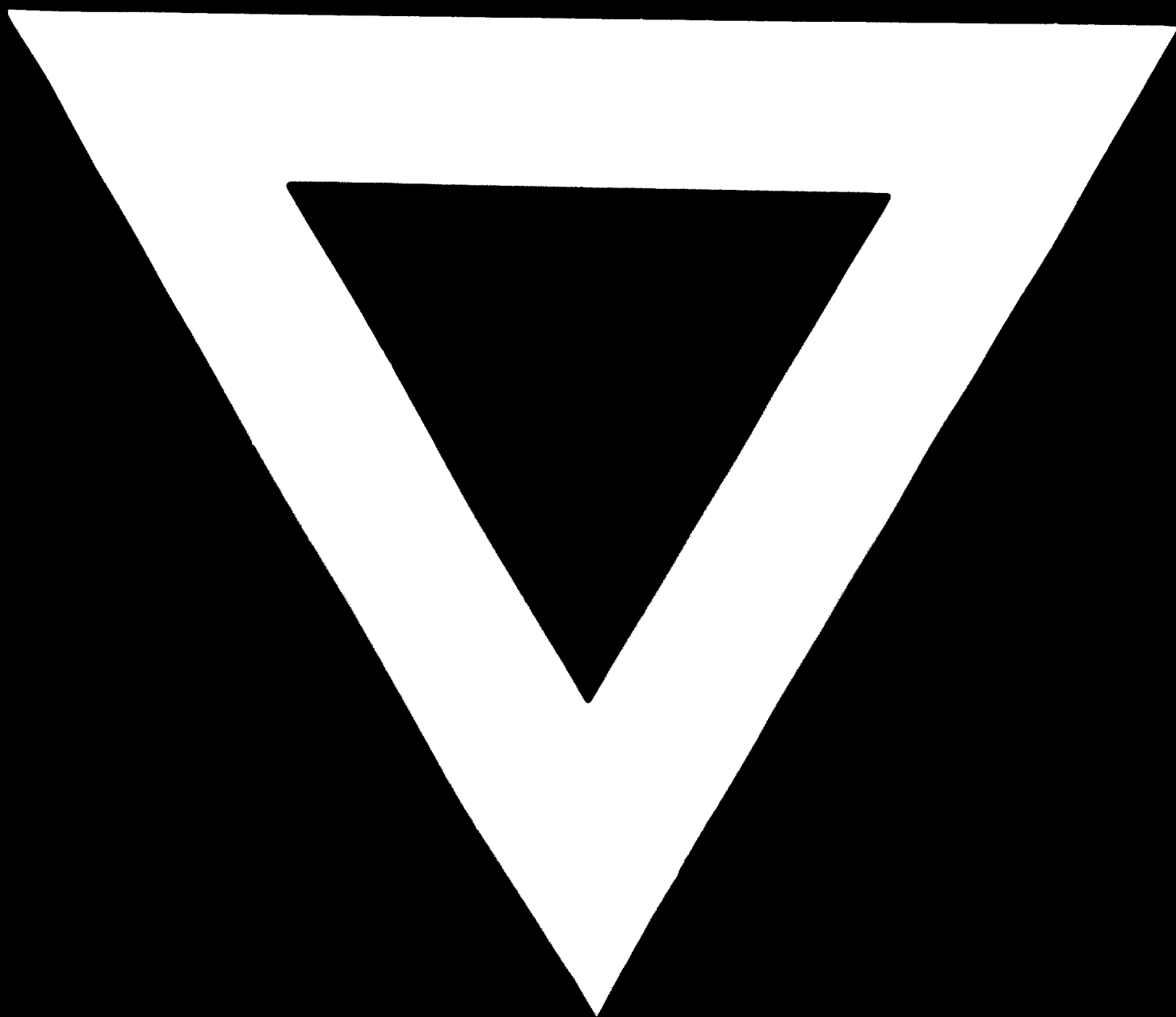
(j) Adequate and reasonably priced sources of power; power is a substantial cost, in most developed countries electricity for industrial purposes is supplied at special rates.

(k) A high standard of management on the marketing side as well as in the factory.

(l) Port and transport facilities which can handle oil and cake efficiently and in bulk, so that any potential savings of this kind are fully realized.

111. The value added in processing oilseeds into oils and cakes is small - seldom more than \$US10 to \$US15 per ton of seed. On the other hand, the capital required is substantial. This underlines the importance of careful feasibility studies to ensure that the particular circumstances of each potential venture are considered on their merits.





27 . 6 . 72