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DO 2399

ID

Distr.
GENERAL

ID/CONF.1/26
21 June 1967

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

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

SECTORAL STUDIES PREPARED FOR THE SYMPOSIUM

THE FOOD PROCESSING INDUSTRIES

Presented by the Executive Director
of the United Nations Industrial Development Organization



United Nations Industrial Development Organization

Distr.
GENERAL

ID/CONF.1/26/Corr.1
26 September 1967

MEMORANDUM ONLY

INTERNATIONAL SYMPOSIUM ON INDUSTRIAL DEVELOPMENT
Athens, 27 November - 29 December 1967
Provisional agenda, Item 2

GENERAL AGENDA PREPARED FOR THE SYMPOSIUM

DEVELOPMENT OF INDUSTRIAL PROCESSES

Dehydration

Paragraph 102. 1st sentence: Change to read as follows:

Like canning, dehydration is applicable to a wide variety of foods, although the quality of the finished product has far less acceptance in world markets with a few exceptions such as tea, coffee, dates, dehydrated coconut, cassia etc.

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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.

1. THE FOOD PROCESSING INDUSTRIES AND INDUSTRIAL DEVELOPMENT

Importance of the food industry to developing countries

1. Food production and food processing are among the most important actions to initiate, implement and realize in developing countries, where many feasible food sources are not utilized because of a lack of a well developed food processing industry and all of the necessary supporting activities.
2. The values to be derived from the development of an efficient, productive food industry are manifold.

Conservation of existing food supply

3. The world population will be doubled by the year 2,000 according to today's best estimates. There is no sure and positive answer at this time to the question "How will we feed these added billions of people who will populate the earth in another thirty years?". Highly sophisticated research is being carried out at the present time to develop completely new and bounteous sources of nutritious food. However, this does not answer today's needs in many parts of the world where sufficient food is not available and supplies must be imported to provide even a minimum level of nutrition.
4. In the general division of the world between regions that have abundant food and those that do not, the former have well developed food-processing technologies and also a high level of specialization in food production. The less developed regions generally have primitive processing facilities at best and are forced, to a large degree, to live where the food is produced. Populations are plentifully supplied with the perishable commodities (such as fruits and vegetables) only during harvest seasons. Neither production nor preservation of food in these regions has achieved the efficiency of modern technology that is necessary to sustain the material wealth of urbanised civilisation. The preservation of foods in small factories yields expensive luxuries

for the wealthy, in contrast to the mass-produced, low cost foods for all classes in the urbanized countries. Processing tends to be minor and simple. The bulk of the food supply is made up of a few basic items.

5. There are steps which can be taken now to reduce food shortages - at least temporarily - by significant amounts simply by conserving supplies of food which are already being grown or harvested but are lost through lack of methods of preservation, retention and utilization. This is a function of the food industry - to process and to convert into storage-stable form the product of agriculture, animal culture and foods harvested from the sea. It is inherent in the definition of the food industry that its products will generally have extended storage life as compared with raw foods in their natural state.

6. Outmoded and unsatisfactory practices connected with the storage, processing, and transport of foods cause immeasurable losses throughout the world, and particularly so in the hot countries. Losses of raw products have been estimated to be as high as 30 per cent in some Latin American countries, with the average running about 20 per cent.^{1/} Reliable agencies in Asia have estimated that as much as 30 per cent of all the food produced may be lost through spoilage; that close to 40 per cent of all vegetables and fruit rot; that 30 per cent of the eggs putrify; that most fish caught in some regions can only be used as fertiliser for the land; that more than 10 per cent of all grains, pulses and oil seeds are destroyed by insects, rodents and fungi.

7. One can only speculate upon the improvement in public health which might result if all the wasted fish, milk, eggs, fruit and pulses were preserved and distributed nutritionally intact among the people of these regions.^{2/}

^{1/} Gaman, J.P., Food Technology in Latin America, Food Tech. 17, No. 12, p. 1500.

^{2/} Hulse, J.H., The Canada-Livestock Project, Food Tech. 18, No. 8. (1964).

8. Thus, conservation of existing food supplies by itself provides a compelling motivation for establishing or expanding the food industry within the developing countries.

Economic incentive to produce more raw materials

9. The Food and Agriculture Organization of the United Nations has reported that in the last year the per capita food production dropped 4 to 5 per cent in the developing regions of Africa, Latin America and the Far East. Evidently, increased food productivity is not keeping pace with the increase in population. It becomes imperative, therefore, that these areas should not only preserve existing produce but should encourage as rapidly as possible greater production of perishable and non-perishable foods.

10. Since most crops mature only at a given time of the year, the fresh produce market becomes saturated with produce during the peak growing season. Unsold produce is wasted through spoilage. This wastage creates a further motivation for the farmer or other producers of perishable foodstuffs to reduce his production level, since he knows that his products will be spoiled or cannot be sold under these circumstances.

11. If processing plants exist in or near the producing areas, the motivation is reversed immediately. The farmer, fisherman or other producer of raw materials now has a regular, dependable outlet for his products. He knows that he can sell, in most cases, all that he can produce if he maintains an adequate quality level and, of course, the more he sells the greater his income. Thus a strong economic incentive is brought to bear to increase production.

12. The producer of raw materials is thus more susceptible to encouragement to use modern methods of fertilization, use of pesticides, modern cultivation techniques etc., since these increase his production and hence his income. Although food processing plants do not normally pay prices equal to those obtainable on the open market, this is often largely offset by reduced transportation costs, loss of time in delivering the product to market and losses of saleable product which occur during storage.

13. Since processed foods are inherently much more stable than raw foods, the market potential is far greater. Processed foods can generally be sold throughout the year instead of only during seasonal periods.

Processed foods can be transported for great distances without significant deterioration and can therefore enter market areas never before available to the raw material producer. This transportability of processed foods, of course, also lends itself to export possibilities for improving the balance of trade of the developing countries.

14. It is interesting to note that, given the proper incentive, there appears to be a great potential for increased production of foods. For example, one source^{3/} states "If India applied the Japanese methods of rice production throughout the country she could not only feed her people but have a surplus for export. Japan, with one hundred million people, produces and uses twice as much artificial fertilizer as India with almost five hundred million people to feed."

15. A well-known example of increased production of raw material resulting from the establishment of a well planned processing operation is the Anand milk plant in India to which the United Nations Children's Fund has given substantial assistance. This plant was started in 1948 with a daily capacity of 300,000 pounds (now increased to 500,000 pounds). Supplies to the plant rose from 6 million pounds in 1949/1950 to 24.5 million pounds in 1955/1956 and to 62 million pounds in 1963/1964, while the sales value of the milk passed through the plant rose from Rs. 7.4 million (\$US1.5 million) in 1955/1956 to over Rs. 60 million (\$US12.6 million) in 1963/1964. Among the beneficial side effects of the plant have been the construction by the Milk Union of neighbouring roads and the building of a new water supply system.

Processed food as a source of export revenues

16. Even without a highly sophisticated food processing industry, foods constitute an important part of export commodities of developing nations.^{4/}

^{3/} Hunt, D.L., The Reapers are Many, Maryknoll, p.7, November 1966.

^{4/} Olson, R.L., and Rasmussen, C.L., Farmer's World, U.S. Dept. of Agriculture, (1964).

A major part of the food in world export has only simple or primary preservation - for example, natural sun-drying of cereals, preliminary separation of sugar, and extraction of vegetable oils without refinement. At destination, these products require further processing. This practice lowers the cost of food in international trade: labour and other resources of the importing nation are used in final processing.

17. Another analysis indicates encouragement for food export possibilities. As the sixties have progressed, commodity prices have begun to strengthen modestly, and this has been some assistance to developing countries. The strengthening in prices has been selective and in some cases began in late 1963 and 1964. The improvement in the prices of tropical commodities, such as cane sugar, cacao, coffee, and jute has been significant when compared with levels before the Second World War but less impressive when compared with exceptional peaks in the post-war period.

18. Since import requirements tend to rise with industrialization, an important element of planning strategy is that the developing countries should do their utmost to increase their foreign exchange earnings. But earnings from the traditional primary agricultural exports, which provide most of the foreign exchange earnings of the developing countries, and are therefore one of the main contributions of agriculture to economic growth, are rising only very gradually. While there is little reason to hope for a sustained reversal of this trend, a more promising feature has been the relative success of the developing countries in increasing earnings through exporting processed or semi-processed agricultural products. Thus, between 1953 and 1955 and 1959-1961, while earnings of the developing countries from unprocessed agricultural commodities rose by only 3 per cent, those from the major processed products^{5/} increased by almost 50 per cent. Although the contribution to the balance of payments of these industries, which process raw materials from farms, forests and the sea (renewable resources), is still small relative to the traditional

^{5/} Including canned meat and fish, fish meal and oil; processed fruit; vegetable oils, oil cake and meal.

exports, they provide a starting point for industrialization and have wide repercussions on the economy as a whole.

19. Libya^{6/} is increasing its production of processed fruit because of the considerable difficulty imposed on the exportation of fresh orange juice. The Philippines anticipate major increases in the value of exports through development of processing to yield more valuable products from coconut than the copra which is now the principal export.

20. As in most industrial sectors, large scale food-processing operations tend to be more efficient and hence more profitable than small. The addition of export markets may make it possible for developing countries to plan and design their food-processing industry on a sounder economic basis than would be feasible if they were dependent on the domestic market only.

21. In general, the greater the degree of processing or manufacture of the primary product, the greater the value added which can be defined as the gross value of the output of a firm or industry, as the case may be, less the cost of purchased materials and other payments for productive services such as transport, insurance etc. The net value added constitutes the amount available for distribution as wages, salaries and profits. Thus, the expansion of processing and manufacturing activities raises a country's national income which is the aggregate sum of value added at all stages of production.

22. When countries that have been exporting an agricultural commodity in an unprocessed form start to sell it abroad in a processed or manufactured form, the difference would constitute an increase not only in value added but also in foreign exchange earnings to an equivalent amount. If a commodity previously imported is produced locally, foreign exchange to the amount of value added is saved. To calculate the net gain (or saving) to the balance of payments as a result of establishing domestic processing

^{6/} Finner, Winn F., Problems in Marketing, Farmer's World, U.S. Dept. of Agriculture, (1965).

industries, it is necessary to deduct from the foreign exchange earned (or saved) the amounts spent on importing the capital equipment and any raw materials needed for its production. Thus, an analysis of canned meat exports showed that in several developing countries the import content of processing is high since cans and even labels and sealing materials must be imported and these items constitute as much as 25-35 per cent of variable production costs. Although the precise determination of such import content presents some quite formidable difficulties, it is frequently possible to estimate, more or less, whether a particular industry is a net earner (or saver) of foreign exchange, and there is little doubt that the export in a processed rather than in an unprocessed form adds to the net foreign exchange earnings of the developing countries.

23. These industries also assist the balance of payments through import-substitution when domestic production increasingly takes the place of imports. A policy of import substitution is the most obvious and the safest one for a newly industrializing country to pursue. Indeed, one of the more striking features of economic development is the continuous increase in the range of domestically produced articles replacing imports.

24. Some countries have found food products to be the major source of their export income. For example, in Costa Rica, the food industry accounts for approximately 20 per cent of manufacturing facilities, employs about 33 per cent of the working force but yields approximately 80 per cent of their export dollars.^{7/} Other countries import up to 50 per cent of their food because of the lack of arable land or because the food industry has not been developed to a significant extent.

25. Foods suitable as sources of export revenue are usually best selected from raw materials which are indigenous to the country and which are already reasonably abundant and are known to be grown in good quality. Example of items which are successfully exported from developing countries include: Lobster tails from certain sections of the African

^{7/} Bolanos, E.S., U.N. Seminar on the Food Canning and Preserving Industry Copenhagen, Denmark, Sept. (1964).

coast, pineapple and naranjilla from Costa Rica, dates from the Sudan, orange products from Israel, dessicated coconut from the Philippines etc. Food exports need not necessarily be finished, ready-to-eat products. In many tropical areas of the world fruits are available where are rich sources of valuable food ingredients such as vitamins and enzymes. Spices, gums, and fats and oils find a ready export market if properly processed to meet the standards of importing countries whose agriculture cannot produce the necessary raw materials but whose industry requires those valuable ingredients.

26. In addition to high volume commodity items such as sugar, coffee, tea, cocoa etc., food or food ingredients suitable for export must usually meet one or another of these following criteria:

- (a) They have a high foreign market value; or
- (b) They have a very low raw product cost in the country of origin.

Stimulation of supply and allied industries

27. The introduction of any new industry has an effect on various supply industries. In food processing, this is especially true in relation to packaging materials.

28. In Japan, where industry is now well developed, the packaging industry was studied. This study showed that since the Second World War the industry has grown in line with the increase in the production of processed foods. The study showed that packaging food currently accounts for 70 per cent of packaged goods. This has helped to raise the production of tinsplate, aluminum, plastics, paper and glass,^{8/} thereby adding to the national income and employment.

29. If tinsplate manufacture cannot be justified, it may be feasible to import rolls of tinsplate to proper specification and to establish a can-forming industry. This has been done with great success in the Philippines where most of the cans for the entire country are formed and processed from imported tinsplate.

^{8/} Petal, M. Wakabayashi, J., Woshirmwa, T., Packaging Role for the Rising Sun. Mod. Packaging, 39, No. 12, p.2 Sec. A, para. 3, (1966).

30. Every phase of the food industry involves the paper industry. Starting with the label on either can, glass or plastic, to individual overwraps to shipping case, it is easy to see where the processed food industry is dependent on the paper industry as paper makes it possible to protect certain dry or dehydrated foods by means of relatively inexpensive cartons, bags, pouches or paper.

31. Glass is still of great importance in the food industry. Besides beverages, more and more fruits and vegetables are being glass-packed, especially since the old problems of top and side browning have been solved. Glass is ideal for a product that requires long life on a shelf in either distribution or use. Glass does not deteriorate; it does not dent; with a proper closure it provides a 100 per cent barrier of protection against practically every element. Colored glass or all-over labeling can give protection against light where required.

32. Aluminium cans have been adopted by certain processors. Some of the advantages are its characteristics of corrosion resistance, its light weight, attractiveness, ease of fabrication and compatibility with foods and beverages.

33. Domestic production of sacking from jute, for the shipping of rice, dessicated coconut etc., is a good example of stimulation of new business by an established food industry.

34. The processing of agricultural products can also induce the spontaneous establishment of a number of supporting or complementary industries. Industries that use by-products or waste products tend to spring up, and those linked to the processing of fish and livestock products can be quite numerous. For instance, animal feed industries can be based on whey from cheese, oilseed presscakes and other agricultural waste and by-products, as well as on animal products such as blood, carcass and bone meal. The less refined elements of the latter can also be used for the manufacture of glues, gelatins and fertilizers. Likewise a fish-meal industry can handle residues from fish processing plants.

35. Much more important, however, is the fact that the establishment of a primary processing industry in a country can lead, through forward linkage, to the setting up of a number of secondary and tertiary industries. Sugar processing and refining give rise to a number of supplementary industries, and some raw materials like vegetable oils and rubber are used in a number of manufacturing industries, many of which are suitable for establishment in the early stages of industrialization. From the hides and skins produced as by-products of animal production, tannery operations can be established and linked with the industries manufacturing footwear, clothing and many other forms of leather goods.

Transportation and utilities

36. A food-processing plant of any type is dependent upon, and at the same time, strengthens many other industrial activities. Important among these are transportation, storage, fuel, power and water supply.

37. Transportation is required both to ensure delivery of raw materials and supplies to the plant in good condition and to deliver the finished product to distribution centres. These two purposes are of equal importance. Many raw materials, including peas, fish, milk, tomatoes and some fruits are so perishable as to require processing within as little as two hours after harvesting. Provision for refrigerated delivery of raw materials may be necessary in some instances. In planning the location and the need for transportation facilities for the processing plant, careful consideration must be given to the materials to be processed.

38. The transportation and storage of processed foods often needs careful planning also. Frozen foods, chilled meat, milk and other dairy products must be handled in refrigerated vans and stored in adequate cold storage centres; the latter are absolutely essential to the successful operation of the plant. In general, canned and dehydrated foods need only protection against weather or humidity.

Equipment and tools

39. In many developing countries most of the equipment required for food processing will have to be imported. However, in most food operations,

there is a considerable need for hand tools, such as knives, and for utensils, conveyor systems, racks, hand trucks etc., which may often be produced locally. The fish-meal industry of Peru is a case in point. Of the 35,000 to 40,000 persons employed in the industry as a whole, two-thirds are fishermen and only one-third are employed in the manufacturing plants. In addition - and this is one of the clearest indications of the potential impact these industries can have on an economy under favourable circumstances - other auxiliary industries have been established. Almost all of the machinery and other equipment required by the fishing fleet (except marine motors, are supplies locally; local boat-building yards are fully employed; a large proportion of the packing equipment required by the fish-meal industry is supplies by Peruvian firms; and new industries have sprung up including those for the manufacture of jute bags and floats for nets.

Agriculture

40. A major repercussion on agriculture is worth noting. Many food processing industries may necessarily have to be located in rural areas or this would be advantageous. The development of processing and manufacturing industries requires the provision of economic infrastructural facilities, e.g. transport and power networks, and the impact of these facilities on agriculture can be economically valuable and stimulating with far more value and impact than when equivalent facilities are provided to urban residential areas. The effect of transport development in opening up new markets and bringing in new tools, equipment and supplies for farming is obvious. The availability of cheap power in rural areas can induce farmers to install items of modern machinery, thus opening the way to an improvement in agricultural production and productivity. This has happened in Pakistan where the availability of power in certain areas has led to the installation of irrigation pumps and equipment.

Improved nutrition

41. One of the obvious benefits of a developed food-processing industry, which succeeds in conserving available food supplies, provides incentive to produce even more food, as noted earlier, and makes these foods available to poorly fed segments of the world population, is the achievement of improved nutrition among those who might otherwise go hungry. Volumes have already been written by many authors and agencies describing in detail the specific types and degrees of malnutrition which exist in various parts of the world. These need hardly be repeated in this report. It may be important, however, to take a brief look at the nature and extent of poor nutrition in the world today and to consider the likely possibility that undernourishment may be responsible in part for a significant part of the difficulties which developing countries experience in trying to improve their own economic status. In other words, improved nutrition is not only a desirable end in itself but, if achieved, may have far reaching effects upon the vigour of developing areas through improved mental and physical health.

42. With too little food for long periods, the body adapts to a lower plane of existence by conserving the expenditure of energy. For adults, this results in a loss of weight, lower physical activity and consequently a lower output of work.

43. "Realization is growing that a prolonged period of malnutrition, especially protein insufficiency in infancy and early childhood, may cause irreversible impairment in physical and mental development. When these conditions become widespread, they are cumulatively detrimental to the over-all vigour and productivity of a country's population."^{9/}

^{9/} Milner, Max, Food Technology and World Food Needs, 846, Food Technology, 17, (1963).

44. It is noted that the more serious conditions of protein malnutrition are concentrated mostly in the developing world, the tropics and sub-tropics. "Much of the cause of social unrest; slow economic development; administrative malfunctioning, and other problems of the developing world may lie in protein malnutrition."^{10/}

45. Thus, through making more and more food available to more people in developing countries, there is the possibility of significantly enhancing their vigour and accomplishments.

II. PREDETERMINING FACTORS AFFECTING THE FEASIBILITY AND LOCATION OF A FOOD PROCESSING PLANT

46. The actual design and construction of a food-processing plant is fairly easy to accomplish. Equipment manufacturers and engineering companies in developed countries - for instance, in Europe and the United States - are well qualified to perform these functions efficiently. They will often undertake full responsibility for the design and installation of a complete plant ready to operate as a "turn-key" contract. All that is needed is the funding to pay for the plant and the provision of appropriate technical and commercial management.

47. However, a successful food-processing enterprise requires much more than building a functioning plant. Other factors to be considered may be as expensive and as important as the actual factory. These factors include the supply of raw materials, transportation, operating personnel, fuel and water, packaging material facilities for waste disposal, and, of utmost importance, a suitable market for the finished product.

48. Food technology and food-processing science today cover vast fields of know-how for the development and operation of food processing and beverage factories on a commercial basis. Those who develop and operate

^{10/} Chapman, W. McL., Resources of the Ocean and the Potentialities for Man, Food Technology, 20 No. 7, (1966).

the factories must have knowledge of product development, nutritional needs, marketing requirements and packaging techniques. Food processing covers the preservation of foods, the extraction of food components, ensuring their purification from other biological and chemical raw materials, and compounding and modifying food materials to obtain new or different food forms.

49. A recent study by the U.S. Department of Agriculture^{11/} forecast what is now realised, that the food balances in developing countries (for 1965/1966) would fall short of the minimum nutritional standards by:

- 1.5 million metric tons of animal protein;
- 150-200 million tons of peas and beans;
- 3 million tons of vegetable oil; and
- 30 million tons of wheat and rice.

These quantities were calculated after taking into consideration very optimistic increases in the production of food, increase imports, grants, and concessional purchases by developing countries.

50. In developing countries, where the population expands rapidly, malnutrition increases even faster and the food crisis becomes a political, social and international problem. In the less developed countries, there is generally a shortage in arable land. In Australia, Canada, Turkey and the United States there are from 2.5 to 6.5 acres of arable land per capita for the production of food. In Pakistan this figure is 0.7; in Egypt 0.3; in Ceylon 0.4; and in India 0.9. Population is growing faster in non-developed countries than in developed countries, and this gap is widening every year. Producing cheap food (such as wheat, rice and others) on limited arable land is expensive, and the cost becomes progressively higher with rising yields per unit of arable land.

^{11/} The World's Food Budget 1962-1966; Rp. No. 4, 1961

51. In the developed countries of the northern hemisphere, the high achievement in food production and processing have been reached because of the existence of excellent modern agricultural practices, highly developed industries, skilled manpower, scientifically based research work to promote the knowledge of food processing, and a highly efficient system of transportation, distribution and marketing. In brief, the developed countries succeed because they have built, over many years, a completely integrated system of food production which begins with the selection of seed and ends with the delivery of an unlimited variety of high quality, nutritious foods to consumers who are educated to use them to maximum advantage.

52. The task of the developing countries must be to emulate in a short time the complex systems of food production which have been evolved by natural economic pressures in the developed countries over a period of many years. This enormous task will not be solved by building a processing plant without regard to quantity and quality of raw material supply, water and utilities, transportation to and from the plant, technical and administrative know-how to operate the plant, adequate distribution facilities suitable for the finished goods, and a market which can afford and is willing to accept the end-products of the industry.

53. Plans for establishing a food processing plant must be developed harmoniously, taking into account all of the factors listed above and discussed below.

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Supply of raw materials

54. A careful study of the availability of suitable raw materials must be made, with respect to fruits, vegetables, seafood, dairy products and meat.

55. The amount of raw material available within a given radius must be determined. This is especially true when dealing with certain fruits and vegetables, which must be processed within a short time after harvesting. This factor involves consideration of the type of agriculture practiced in the particular area, whether it is of the subsistence or the industrial type. The subsistence type of agriculture is the growing of products in a small or "home" garden for family or local consumption. "Industrial agriculture" refers to a larger operation that is planned and carefully controlled to produce products to be sold to a commercial processing operation.

56. Industrially oriented agriculture normally does not exist until a food industry is established to require it. Thus, in planning a food processing plant, it is necessary to plan the steps which must be taken to ensure that the raw materials will be available in adequate quantities and in good quality, and, for economic reasons, that the crop or harvest will extend over a long period of time in order to keep the factory busy. The change-over from subsistence to industrial agriculture is not often easy, frequently involving significant changes in the way of life of the farmers, herders or fishermen.

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57. The average of food production per acre and per worker are at a relatively low figure in most of the less developed countries. The farm value of food produced per farm worker averages less than \$US100 per year in the less developed countries compared with over \$US700 in the developed countries. Average crop yields per acre are only about half as high in the less developed countries and are frequently much lower.^{12/}

58. If modern farming techniques are not being used, a programme must be instituted to get the maximum yields from the acreage available by the use of modern fertilization techniques, proper crop rotation and irrigation programmes. If large arable lands exist, suitable for the industrial type of agriculture, such programmes can be implemented more easily than would be the case with small individually owned plots.

59. When it has been determined that a sufficient supply of the products under consideration can be produced within a practicable radius of the plant site, it must also be determined whether the varieties available are suitable for processing.

60. Not all types of raw materials are suitable for processing. Different processes for the same food may have different requirements. Many varieties of food grown for fresh consumption do not lend themselves to processing for various reasons. Some will not tolerate the heat of processing, which causes browning, texture deterioration or drastic flavour changes. Fragile varieties may not be able to stand the preparation procedures, especially if a mechanized system is employed.

^{12/} Christensen, R.P., Man's Historic Struggle for Food, Protecting Our Food, United States Department of Agriculture, Washington, D.C. (1966).

61. Some varieties of fruits and vegetables are much better adapted for freezing than others. When the variety or varieties to be produced have been selected, a system must be established to ensure that these are actually produced by the growers. The Government or the processor may supply the seeds or seedlings to the growers.

62. Many crops are grown under contract to the processing plant. The processor is then able to control the variety, the planting time and hence the approximate time of maturation, contributing to a uniform supply of food to the plant throughout the longest possible harvesting season. In a developing country, those food surpluses that are rotting because they are not reaching home or export markets should have high priority in the food processing programme. It is easier, faster and more economic to process raw material surpluses than to grow new crops for processing.

Water supply and utilities

63. Water supply is of the utmost importance in any food processing operation. It must be determined that an adequate supply of water is available during the entire anticipated operating time of the plant.

64. The quality of the water must be investigated to assure that it is suitable for human consumption and free of bacterial contamination. Also, the hardness of the water should be determined in order to ensure that certain metallic ions do not exceed the amount that might be harmful to the operation by causing, for example, insoluble substances with pectins in fruits and vegetables or discoloration of certain products.

65. In many countries, water usage is regulated by governmental authorities. Therefore, before a plant location is decided upon, pertinent information must be obtained from the local authorities as to the extent and type of re-use systems permitted and any other regulations pertaining to water usage.

66. Often waste disposal presents a problem. The old method of running waste into a nearby stream or river is not recommended and, in many areas, may not be permitted. Before a particular system is decided upon, local authorities should be consulted to determine that the proposed system meets all local regulations, and, above all, that it will not contaminate the plant's own water supply.

67. Developing new water sources, planning water-treatment schemes and water-saving programmes should be included in every programme of food processing development for developing countries.

68. Fuel and power requirements are not usually a major problem in the food industry. Consumption is usually much lower than in many heavy industries. If public power is not available for electrical requirements, diesel generators can be installed. In some of the developing countries, electrical power is so expensive (sometimes costing 10 per cent more than in the developed countries) that, if the contemplated operation will require a heavy load of power, it may be more economical to install its own source.

69. Fuel oil needed for boiler operation or other types of heating is usually easily obtainable in most parts of the world. If the transportation of the oil might offer some difficulty as to regularity of shipments, storage tanks can be constructed with sufficient capacity to assure an adequate supply over a long period. There is also the possibility of seeking other sources of material to use as fuel such as bagasse from raw sugar production.

Transportation

70. Transportation is the vital link between the source of raw material and the processing plant, and between the plant and its markets. Without adequate transportation facilities a processing plant cannot be successful.

71. Since many foods are perishable, they must reach the plant and processing must begin within a very short time. The mode of transportation must therefore be related to distance from the plant .

72. For example,^{13/} for peaches and peas, which are perishable products, one and one-half to two hours are allowed for picking and collection and one and one-half to two hours from field to canner. If proper roads and trucks are available, the growing perimeter can be much larger if mechanized methods are used.

Operating personnel

73. A large percentage of the labour force required for a food-processing operation is made up of unskilled and semi-skilled workers. However, most important to the successful operation of a processing plant is the availability of properly trained technical, managerial and marketing personnel.

74. The importance of the role of the properly trained food engineer or technologist to a food processing operation cannot be overemphasized. It is not enough to put food in a can. There must be people to oversee the quality of the raw products, have the understanding of the processing techniques involved and assure the quality of the final product. Microbiological control is very important, especially in the tropical and sub-tropical climates.

75. Engineers and trained mechanics are essential for the proper maintenance and repair of equipment.

^{13/} Ishler, N.H., Pre-investment Data for Food Processing Industries. Prepared for the United Nations Centre for Industrial Development. (1964).

76. Managerial and marketing personnel are necessary for the orderly conduct of the business operations, such as finances, overseeing the running of the operation as a whole and the selling of the finished products at a profit.

77. As for plant operations, a survey was made of seventeen "Industry Profiles", prepared for the United States Agency for International Development, covering different types of food industries.

78. The total breakdown of labour requirements is as follows: unskilled - 42.3 per cent; semi-skilled - 27.8 per cent; skilled - 8.1 per cent; indirect - 21.8 per cent. Indirect labour includes all the people in the plant operation not directly involved in production, including supervisory personnel, maintenance people and truck drivers. The figures show that 70 per cent of the total people necessary for operating these plants is made up on the average of unskilled and semi-skilled labour which, in most instances in the developing nations, draw low wages. This factor, to some degree, may be offset by having to bring in highly trained technical and managerial personnel from outside the country at high cost for a period of time to operate the plant, establish procedures and train local personnel.

79. Investment failures in developing countries have often been caused by the lack of indigenous experience in economic and technological scheduling of a food processing programme. For the most part, good results are very closely connected with local economic and processing research work and with success in the education and training of national research and engineering personnel. Every developing programme must include funds for utilising a food-processing research centre to provide food processing knowledge and training to the entire country.

Distribution

80. Distribution of processed foods is more complex than mere transportation. If the product is intended for domestic use, it must fan out in many directions as it leaves the plant of origin until it finally reaches the actual point of sale to the ultimate consumer.

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81. Many processed foods, properly packaged, are stable and require less careful handling than the raw materials from which they were prepared. Some products, however, such as chilled or frozen meats and fish, fruit juices and many products of dairy processing require special handling during distribution. The provision of the correct equipment for such distribution and storage is as important to the successful operation of a food processing plant as is the equipment and technical know-how of the plant. The distribution requirements of each plant must be provided for even in the planning stages, before the plant is built.

Marketing

82. In many cases, the beginning of a proposed project to establish a food processing plant should be a market survey. This survey must comprise a careful evaluation of where the potential markets lie; the receptivity of prospective consumers, dealers and distributors of the new food supply; the availability and cost of suitable transportation and distribution facilities; the quality required to meet market demands; and, of course, the price which the market can be expected to pay.

83. If the products to be marketed are for domestic consumption only, some of the factors to be investigated are the cultural and dietary customs of the people. Frequently, an educational programme in the use of new processed foods is necessary. In many areas, the people are accustomed to cooking fresh foods only, and difficulty may be encountered in introducing these people to processed foods. However, if the area is undergoing industrialization and urbanization, a more rapid acceptance of processed and/or convenience foods can be expected.

84. For the less developed countries, the distribution of processed foods may present many problems that do not exist in the more developed countries with their highly developed marketing and distribution centres. Retail food

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distribution outside of North America, Europe and Australia usually has been done through many little shops with small capital investment, limited stock, high margins and personal selling.

85. The number of supermarkets or self-service stores has been growing in several of the larger cities in Latin America. These countries have been developing their own sources of supply, a packaging industry, and an integrated marketing structure. As the demand for more and better food grows, because of the growth of a middle class with good incomes, refrigeration and transportation, further growth of supermarkets can be expected.

86. Most of the wholesaling in the developing countries is performed by small operators and is characterized by many middlemen. Often the wholesaler's main function is to extend credit. Some of the primary wholesalers offer storage and transportation.

87. Often the spread between producers and consumers is wide. The large number of middlemen and poor transportation are conducive to high cost, often running to five or six times in the city markets what the producer received for the product. ^{14/}

88. It is therefore imperative to study carefully the marketing and distribution facilities of a country along with the per cent of the population which will be able to afford the processed product before deciding to produce for internal consumption only.

89. When studying the export market, it is imperative to check carefully all the existing regulations covering imported food commodities. The study must take into account the existing quality or grade standards; standards of identity; allowable additives, including colours; tolerances allowable

^{14/} Hoecker, R.W., "Supermarkets Around the World" Farmer's World. U.S. Department of Agriculture, Washington, D.C., (1964).

for pesticides, solvents etc.; mandatory labeling requirements; weights and measures systems to be used; and whether special import permits are required.

90. Food health laws differ from country to country. Since the Second World War, interest in "pure food" legislation has increased, especially in the use of additives to food and food and pre-harvest and post-harvest chemical treatments. It is therefore necessary to take into account all regulations pertaining to the products intended for export from each country under consideration.

91. Tastes, habits and prejudices in food differ from country to country. Even a small country may have diverse marketing situations because of several distinct areas with differing traditions and customs. It is therefore, not enough to test only the major market in a country if distribution is planned for a large area.

92. To be competitive in the field of processed food, especially with respect to export, good and consistent quality must be maintained. Quality standards must be established and adhered to at all times. Another company of chainstore for which the product is being packed will usually supply the packer with its own established specifications. If the product under consideration for export is indigeneous, especially in tropical climates, to the area of production, and the population to which the product is to be exported are unfamiliar with it, a study in depth must be made on how to build a market and how the product may be utilized in the production of other processed foods such as mixed fruit salads, beverages and ices. This may prove expensive.

93. An exporter must locate the importers and brokers in the foreign lands who will handle products of the nature intended for export. A list of importers can generally be obtained through the trade association of the different countries. Direct contact with these organizations or individuals will be of vital importance in evaluating market potentials before a plant investment is made.

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94. In summary, the importance of assessing the market potential for the products of food-processing installations cannot be overemphasized. The investment in this type of study is just as important as the investment in the processing plant itself.

III. DEVELOPMENT OF SPECIAL SERVICES FOR THE PROMOTION OF FOOD PROCESSING INDUSTRIES

95. It is apparent from the preceding sections of this report that food production and processing throughout the world are even now inadequate to provide sufficient food for large sections of the world's expanding population, and that the problem is worsening, rather than improving. The development of an extensive modern food processing industry, in conjunction with improved agricultural practices and industrialization is not only a means of solving this crisis, but also offers a remarkable opportunity to improve both the physiological and economic health of the developing countries. Action is needed, and in order that the necessary action be undertaken wisely, it is recommended that certain steps be taken to assist the developing countries to realize their maximum potential for food production.

Planning a programme for food development

96. A plan and organization is needed to stimulate and organize the elaboration of general and special food processing programmes on a national or regional basis. Food-processing development programmes are needed which would comprise a comprehensive integration of the efforts of food processing experts, exhibits, conferences, education centres, patent agreements, mutual technical assistance contracts covering all other activities on behalf of food processing development in developing countries.

97. A special task should be to work out for every developing country a scientifically balanced human diet programme for the future, based on realistic and economically reasonable goals which can be attained with in present national income trends and resources.

98. An economic and a food processing study should be made to show:

- (a) The necessary capital investments and know-how;
- (b) The required processing equipment;
- (c) The necessary changes in agriculture;
- (d) The needs in personnel, energy, water and other facilities.

99. Large quantities of food and food raw material spoil, deteriorate, or are not properly utilised in developing countries because of the lack of: processing and storage facilities; knowledge to utilise these facilities; processing factories or transport; and home or export markets. The wasted products constitute costly surpluses which must in future have a high priority in the food processing programmes of developing countries. Such programmes should include:

- (a) Surveys to determine quantities, qualities and location of these surpluses;
- (b) Economic analysis of the proposed processes;
- (c) Fixed capital investments and other requirements;
- (d) Analysis of the home market or export possibilities;
- (e) Necessary organisation and time schedule.

100. Special surveys, proposals and programmes should be worked out to show the necessary steps to achieve better utilization of food surpluses in developing countries through:

- (a) Further processing and utilization of by-products;
- (b) Co-operation and specialization;
- (c) Co-operative production of packaging material;

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- (d) Standardization of sizes and quality;
- (e) Co-operative exports and home marketing;
- (f) Financing research and food specialists training, etc.

Assistance on an international basis should be provided to: provide expert consultants; evaluate the programmes outlined; sponsor the creation by developing countries of regional export associations; and attract private capital investments to development projects.

101. On a broader scale, each developing country or region should be surveyed imaginatively to discover and evaluate untapped natural resources which can be exploited to provide marketable foods or food ingredients through food processing and technology.

International food engineering and technology services

102. One of the most intricate and very difficult problems of assisting developing countries in developing up-to-date food-processing industries is the lack of high level professional feasibility studies and projects for the realization of a programme of food processing development.

103. The big food-processing industries in the developed countries or the engineering companies of these countries are for the most part unwilling to lend their outstanding experts for such a service because their collected know-how could be utilized far more profitably if they had control of the products of the future factories.

104. One way to avoid old-fashioned techniques, under-sized plants or poorly located food processing industries is to organize an international food-engineering service which would be supervised by an appropriate international association willing to serve the developing countries on a high level of business fairness, supplying project feasibility programmes and feasibility studies, larger investment and investment data, technical and commercial management assistance in the field of food production and food exports, assistance

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in plant organization and management and all other services needed by developing countries in the development of industrial food-processing.

105. Such an international food-engineering organization would be staffed to do the following:

- (a) Collect experiences and research results about innovations and developments, utilizing these to provide the best technical information in the field of food processing on behalf of their clients;
- (b) To organize research in special fields of the food-processing industry pertaining to indigenous raw materials, unit operations or food distribution in developing countries;
- (c) To solve special engineering problems involved in the development of food industry of those countries; to organize scientific meetings, symposia, training courses and similar efforts on behalf of developing countries; and
- (d) To provide feasibility studies and, if needed, "turn key" engineering projects for specific food processing projects.

106. It should also be a function of such an international food-engineering organization to provide standardized food process flowsheets, sources of food processing equipment, raw materials, ingredients and quality standards. Such an organization would train domestic workers and administrators to ensure successful commercial operation of the plant according to good production and sanitation standards.

Collection and analyses of pre-investment data

107. At this time, there is no good source of objective pre-investment data on the food-processing industry available to the developing countries. Each country procures pre-investment and feasibility studies as it needs them to determine such factors as the optimum size of a factory, its location, specifications, equipment and equipment costs, product specifications, packaging etc. These studies also include the prices of raw materials and finished

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products of world markets, the best processing techniques available, the need for electrical energy, the need and the qualifications for manpower, projections of possible production costs, and the requirements for water, buildings, transport facilities etc.

108. All such data should be collected at one centre as a basis for feasibility studies made or on the account of developing countries. Such data should be supplied on request to other developing countries or should be issued as regular information papers for distribution to developing countries.

International standards of product quality, packaging and label declarations

109. A strong need is felt for the establishment of international standards of food quality, packaging and label statements concerning the quality, ingredients and characteristics of processed foods. A great deal of confusion and contradiction exists today between the requirements and standards established by different importing countries. Complexities exist even within the developed countries, where different agencies may promulgate standards to be met by foods of various kind. Within the United States Government, for example, food standards may be established by the Department of Health, Education and Welfare; the Department of Agriculture; the Department of the Interior Bureau of Commercial Fisheries; the Department of Defense; the Department of Commerce; the Treasury Department (Wine, beer and whiskey standards); the Federal Trade Commission; the Veterans' Administration; and the General Service Administration. Such standards cover: contents, ingredients, additives, weights, shapes, sizes, labels, styles, varieties, processes, raw materials and many other items.

110. A similar situation can be found in Australia, Canada, England, the Federal Republic of Germany, France and Switzerland as well as many other food importing countries. In each country, it is difficult to determine what

foods are affected and how these foods are standardized. The large number of different standards is one of the most important obstacles facing developing countries in their efforts to export to hard-currency markets.

111. It is difficult for a small country to put together the essential knowledge, understanding and experience in a well-organized directory for the country's food exporters. Producers in small countries are also unable to produce foods which will comply with all these different standards. It is not possible to produce food profitably in such a diversified assortment.

112. Standardisation can be promoted by co-operating with FAO and other affiliated agencies of the United Nations in establishing the "Codex Alimentarius" and through the formation of an International Commission for the Standardisation of Food for International Trade. This Commission, as a first step, can prepare a handbook of all the most important food standards in the biggest export markets for use by exporters in developing countries. The Commission can, through co-operation with international associations of the food industry, establish and recommend general standards to facilitate the production and export of processed and semi-processed foods in developing countries.

113. The importance to developing countries of meeting quality, packaging and labeling requirements of importing countries is illustrated by the following list which one large country published as reasons for rejection of imports

Reasons for detention

- (a) Beverages and beverage: insect-infested; contaminated with oil; materials (coffee-green and roasted, Kola nuts, tea); rodent filth; contains mold; mandatory labeling omitted; false labeling; short-weight; inaccurate contents statement.
- (b) Bakery, ready-to-eat cereals and macaroni products: contains rodent and insect filth; mandatory labeling omitted; deviates from standard of identity.
- (c) Chocolate, sugars and related products: false labeling; shortweight; insect infested; rodent and bird filth; held under insanitary conditions.
- (d) Dairy products: contain unsafe food additives; a deleterious substance (benzene-hexachloride); a valid import mill permit is required; short-weight; contain animal filth.
- (e) Eggs and egg products: contains unsafe food additives (DDT, DDD, DDE and BHC); contains a poisonous substance (salmonella organisms).
- (f) Fish and shellfish (fresh, frozen, dried, salted and canned): parasitic cysts, filthy -unfit for food, mandatory labeling omitted, insect infested, another product substituted in part, decomposed, bacteriological contamination, false labeling, deviates from standard of fill of container.
- (g) Flavours, spices, condiments: mouldy; contain rodent and insect filth; insect infested; insect damaged; inaccurate contents statement; contain a non-permitted colour inaccurate contents statement and mandatory labeling omitted; contain stones; contain unsafe food additive; Hexane, contain unsafe food additives; Methylene, Chloride and Ethylene Dichloride, decomposed.
- (h) Fruit and fruit products: contain insect filth; insect infested; deviates from standard of identity; mandatory labeling omitted; mouldy; decomposed and contains maggots; omission of artificial sweetener statement; false labeling-identity of product misrepresented.
- (i) Meats and meat products (gelatine): contains liquifying micro-organisms unfit for food, contains E. coli.

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- (j) Vegetables and vegetable products: short contents; deviate from standard of identity; insect infested; inaccurate contents statement; mandatory labeling omitted; false labeling of contents; unsafe colour additives; contains maggots; contains badly dented, swollen and ruptured cans.

Food marketing research

114. The identification and development of markets for processed foods is often a different problem but is fully as important as the stages of raw material supply and the processing itself. A market must be assured and its size determined before a plant is built; otherwise the entire project may better be discarded. Plants have been built and now stand idle because the planners did not assure themselves of a market for the finished product. One such case is a series of plants designed capable to produce chilled meat, but suitable distribution and storage facilities and, above all, a market did not exist. Only recently, long after the plants were ready to operate, have the proper steps been taken to provide the necessary facilities for profitable disposition of the high-quality finished product.

115. These steps should have been taken at the same time the factories were planned and the necessary research, studies and action taken so that the distribution system and market would have been prepared to receive the processed food. However, this is not easy, and may take considerable time, which is also expensive.

116. It happens sometimes that the markets in developing countries are unprepared for new, processed forms of foods, that the food is fully unknown and extraneous to current eating habits, or that there are social, political, religious or other obstacles to developing markets for a new branch of processed food. The distribution of modern processed food, preserved by freezing or pasturization and refrigeration requires a well established technical basis of cold storage, selling facilities, and refrigerated transport.

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This sometimes requires far more investment than is needed for establishment of the raw material production or the processing facilities themselves. The psychological factors involved in educating populations to eat new foods which differ from traditional diets are formidable obstacles to marketing processed foods, even though the new foods may have greater nutritional values than those of traditional foods. Generally, processed foods will be found to be cleaner, purer and more free from contamination because of the stricter controls which can be exercised over large-scale production operations.

117. Modern marketing of foods is accomplished by the use of special packaging materials, labeling, advertising, domestic science courses in schools, adult education courses for women in special institutions or schools, and by traveling lecturers who can explain and demonstrate the advantages of the new food products.

118. Unless a sizable market can be established, production levels in the factory will necessarily be small. Costs of small-scale processing are high compared with larger operations, and consumer prices of local production will not be able to compete with imported foods. Thus, the marketing plans must be laid so as to assure a large enough market to consume the output of an economically large processing plant.

119. Under some circumstances, exports of the processed foods may provide outlets for the processed foods beyond the quantities which can be utilized by the domestic market, making possible a larger and more profitable food industry. As the domestic market grows through a process of education and experience, production may be increased, or a higher proportion of production retained for local use.

120. Another possibility is to use imported foods as a means of developing a domestic market through the educational processes described above. As local acceptance of the new foods grows, plans can be made for developing the country's own food industry. When domestic production is under way, protective tariffs or import duties may be imposed to help the new domestic products to enter the newly created market.

121. Internationally organized assistance should be available to developing countries through the services of marketing specialists, who can guide and advise on planning and implementing of marketing programmes simultaneously with the planning and implementation of technological programmes.

Regional and bilateral technical assistance and co-operation

122. Special attention should be devoted to the establishment of regional and bilateral co-operation in the food processing industries, by mutual technical assistance and in the interchange of results, research workers, experienced trainees, operating personnel, marketing specialists etc.

123. Some of the regions of the developing countries are characterized by growing, catching or harvesting typical food products and processing these by primitive handwork methods to semi-processed products which are not competitive on world markets or are sold at prices below world market prices. For example the largest quantity of fish meal comes today from Chile and Peru. The cocoa beans in West Africa account for 80 per cent of the world crop. Dates come from Iran, Lebanon and the United Arab Republic. Varieties of nuts come from Brazil, East Africa, India, Iran, and Turkey. Dry prunes come from California and Yugoslavia. Tea comes from Ceylon, India, Indonesia and Southern USSR. Coffee comes from Brazil, Latin America and the Near East and East Africa. Citrus fruits come from Argentina, Israel, Spain, Italy and the United States. Beef meat comes from Argentina, Australia, Paraguay and Uruguay. Most fresh grapes and wines come from Algeria, Italy, Morocco and Spain.

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124. Growing, harvesting, and storing these products with better industrial methods will save large quantities of raw materials and produce high quality products which can compete more effectively in the world markets. Before the Second World War, many specialized research institutions in Belgium, England, France, Germany and the Netherlands worked in this direction. Most of these research centres for tropical and semi-tropical food processing research are now working in other branches of the food industry.

125. Some of these institutes have continued their work (e.g. Institute for Cocoa Beans in Ghana, Institute for Grapes and Wine in Algeria), but with reduced staff and budgets. Africa's cocoa bean export has a value of \$US2 billion per year. An additional value of \$US500-700 million could be derived from reduced spoilage, high quality, bulk transport, better drying and industrial fermentation and storage.

126. It would be a most valuable function for an international organization to sponsor or assist in the organization of new regional research institutes or to help the existing institutes to expand their activities to exploit the natural food resources of the less developed regions of the world. Many of the specialists in cocoa beans, coffee, tea, nuts and bananas live in Bremen, London, Wageningen, the Netherlands, Paris and Brussels, and their wide experience can be utilized through a well-planned international organization. The big food equipment producers, such as Blaw-Knox Co., Food Machinery Co., Alfa-Laval AB, Unions Ltd., and Buhler & Co., may be willing to assist in this field.

Education and training of specialists

127. Every area of the world has the potential for producing food materials of one kind or another. This is as true of the countries which are relatively underdeveloped as it is of those which have already achieved a high degree of industrial and economic development. In fact, most of the less developed

countries already produce nearly enough food for the demands of their population, else they would not now be able to exist. It is true that many of them purchase foods which are produced in other parts of the world, but there is no such thing as a country which is supplied with all, or even a major part of its food requirements by outside sources of supply. Why, then, are the developing nations typically unable to produce an excess of food suitable for export which can also provide a source of revenue to improve the over-all economic conditions of these countries?

128. The answer seems to lie in the lack of technological know-how in most developing countries. The skills required include agricultural and food technology, production administration, distribution and transportation and sales and export knowledge.

129. The Food and Agricultural Organization (FAO) of the United Nations and such agencies as the Agency for International Development (AID) of the United States, but particularly the former, provide extensive service to developing countries to help them improve and modernize agricultural practices so that higher yields may be obtained from the various sources of food and raw materials production within those countries. It has been noted earlier in this report that increased yields per hectare or per acre of crops planted is not necessarily enough, in itself, to correct deficiencies in food production in the less well-developed areas of the world. It has been noted that spoilage of food, through lack of processing, is still a major cause of failure to produce adequate dietary regimens for large segments of the world population. Adequate processing of food in order to preserve and conserve available supplies has been shown to be a vital area of development throughout the world.

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130. A lack of understanding of the requirements for the successful development of a food-processing industry now appears to be the outstanding obstacle to improvement of the supply of food in developing countries, both for domestic consumption and for export. The areas in which knowledgeable assistance is most needed include (but are not limited to) the following: principles of sanitation; quality control; seasonal nature of crops production; and steps to minimize difficulties; distribution skills and facilities; market requirements and sales and creation of an integrated plan from raw material production to the consumer.

131. The physical installation of a plant to perform almost any type of food processing is relatively simple to accomplish, and the capital investment for this purpose may not be a prohibitively high figure. There are many competent engineering firms throughout Europe and the United States which are capable of designing and constructing such plants. However, the efficient and profitable operation of such a plant requires an entirely different approach. Most organisations which will install and design a plant are not prepared and are not interested in providing personnel and assistance in operating the plant or in training personnel for management, production, sales, distribution, administrative and marketing for a period of one to two years after the plant is started. Even before a plant is designed, a complete understanding should be arrived at as to the management of raw material supply, staffing and training of operating personnel, and distribution and marketing of the end product. Arrangements should be made to ensure that knowledgeable and competent people will be available to guide the plant through the start-up and breaking-in period.

132. This type of planning is available only through individuals or organization who are thoroughly knowledgeable in the fields and in all aspects of food production, processing, distribution and marketing. The United Nations Industrial Development Organisation can render valuable advice and assistance

either directly or by recommending suitable sources for the needed information. This assistance should be utilized to the fullest extent.

Establishment of technical research and information centres

133. Technological centres, research and development centres or industrial research centres, as they are variously called, have been established by many developing countries to support their growing food industries. Frequently, centres of this type may be integral parts of a larger technological centre serving other industries as well as the food industry. It is desirable in many cases to locate such centres near a university or similar academic institution so that library facilities and specialized equipment need not be duplicated in separate locations. Also the technical staffs of the university and the centre can complement and stimulate each other's activities. Graduate students of the university may also be able to perform some of the laboratory work at the centre.

134. A technological centre may be set up by the Government or in some cases may be supported by industry within the country. In either case its function should be to make its services available to as many aspects of the food industry as possible for the betterment of the whole.

135. Some of the functions which may be performed by such a technological centre are: agricultural research and raw material improvement; product and process development; quality control; sanitary control and assistance; technical advice (consultation); import and export quality standards and certification; microbiology; source of technical information; education and training of industrial personnel; standardization of food processing; and development of new sources of food products.

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136. Broadly, the technological functions needed in developing countries are those which will assist the country to maximize its use of existing technological knowledge and expertise; to adapt this vast reservoir of information to the specific conditions obtaining in the developing country; to apply this knowledge to the development of new products which may be possible because of the special climatic conditions, traditions, customs and dietary requirements of the country and to see that such information is disseminated thoroughly and efficiently to all the phases of food production which can utilize it.

Food processing statistics and trends

137. Throughout the world there is available in diverse and scattered form a wealth of information about food-processing techniques, trends, costs, methods of solving specific problems, management systems, new or special equipment etc. Much of the information which would be especially valuable to developing countries might come from other developing countries, since different countries in similar climates and similar economic situations often encounter similar problems.

138. A valuable service could be rendered by an international organization which might be established to gather methodically and regularly statistical information of the types mentioned above and to disseminate this information where it will be of the greatest benefit. The international organization proposed here might use its collected information to answer specific inquiries from developing countries, or the information might be organized and distributed on a monthly basis. The proposed organization should also maintain a roster of food-processing experts in many fields of food production whose qualifications are known and whose services could be made available to assist developing regions or countries in solving specific problems.

139. If such an organization is to function effectively, it is imperative that the developing countries share their factual information, production rates and capacities, operating costs etc. with other countries for the benefit of all. This is sometimes difficult to accomplish, but the value of such co-operative effort would far exceed the risk of losing some proprietary information.

Development of sectors related to the food processing industry

(a) Industrialization of Raw Material Production

140. The importance of the quality and timing of raw material supply to the processing plant has been pointed out earlier. As with any other production operation, food processing plants cannot be run efficiently and profitably unless there is a steady flow of incoming raw materials of high and uniform quality. Since many food raw materials are perishable, the stockpiling of these materials is precluded. Also, many foodstuffs must be harvested and processed at just the right level of maturity if optimum quality of the processed food is to be achieved. The situation requires careful planning and skilful scheduling.

141. Fortunately, the maturity dates of many crops can be reasonably well controlled by scheduling planting times throughout the growing season, so that the resulting harvest will be uniform and will not overload the plant some days while allowing it to stand idle on other days. Since climatic conditions are rarely completely reproducible from year to year, complete uniformity of harvesting throughout a season cannot be assured. However, the highly industrialized nations have achieved excellent success in such agricultural scheduling, and, in fact, could not accomplish their present high

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and efficient levels of production of processed foods without such scheduling.

142. A vital task for improving the food processing industry in developing countries involves the industrialization of raw material production. Today's modern processing facilities should be planned from the first moment in such a way that they will not be dependent on the will of a hundred or a thousand individual farmers. The necessary investment of the industrial production of raw material should be planned from the beginning. The quality, quantity and careful scheduling of raw material production required by large, efficient processing plants cannot be satisfied by the ancient methods of agriculture practised by small individual farmers, each acting independently and on his own schedule.

143. Two possible solutions exist:

- (a) The food industry on its own initiative may undertake the industrialization of agricultural practices on large homogeneous growing areas within the radius of practical deliveries to the plant;
- (b) If the land is subdivided into small portions owned by small farmers, an appropriate organization should be established to change the farmer's position so that he is willing to work under the direction and leadership of the technical management of the factory.

144. Such "agro-industrialization" is a worthy objective of all developing nations and, indeed, a worthy international goal. Integrated production, processing, and distribution of food is especially adapted to the needs and possibilities of the developing countries because (a) international banking associations are better able to facilitate special investment; (b) such integration is not a long-range project but can be realized from raw materials production to distribution in a period of three to four years; and (c) the quality and low priced final products obtained in this way should enable a developing country to develop exports of their processed foods.

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(b) Packaging techniques and materials

145. The necessity for, and the means of accomplishing, good, protective packaging of processed foods is a matter of grave concern to all developing countries. It would be of great value if an international agency could be established to collect, organize, and disseminate information concerning the packaging problems of developing nations; ways by which these problems have been met in isolated instances; and independent suggestions and information about new, more effective, or less expensive means of packaging processed foods.

146. Fresh foods normally require little or no packaging. In the first place, they are in distribution for so short a time that packaging would not reduce normal rates of spoilage, and would be a waste of time and money.

147. Processed foods, however, are usually capable of prolonged storage, but must be protected during storage from various forms of contamination, such as bacteria, moisture, air, sunlight etc., depending on the type of food. Packaging not only supplies such protection, but also provides an opportunity to describe the contents, give directions for use, establish brand names and quality, and generally promotes the marketing of the product.

148. In many different branches of the food industry, the cost of packaging is a very substantial part of the entire production costs in terms of investment in equipment and inventory of packaging materials and in terms of manpower and processing costs. The value of the package is sometimes as high as that of the contents, particularly if the packaging materials must be imported. Cans, for instance, may cost nearly as much as the low-cost fruits or vegetables which they may contain, and this may tend to make the finished product prohibitively expensive for domestic markets.

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149. The developing countries must be assisted to take advantage of every possible economy in obtaining packaging materials and production facilities which will provide adequate protection to the food at lowest cost. As with food processing itself, mass production leads to lower costs; the larger the need for packaging materials, therefore, the better the opportunity to reduce these costs.

(c) International standardization of process equipment

150. A worthy objective for the developing nations would be the establishment of an international commission with the objective of standardizing equipment of interest to the developing nations.

151. Such standardization would not include specific designs, which would tend to stifle healthy economic competition between equipment manufacturers, but rather, would establish specifications for flow sheets, unit operations, performance, capacities, materials of construction etc.

152. In addition to setting standards for equipment, the commission should approve standards for up-to-date food processes, recommending them for use for a certain period of time in developing countries as the most convenient, cheapest processes available at the present time. Also included should be the standardization and control of instrumentation, sanitation equipment, modern flow-sheets for main and by-products, buildings, storage facilities, refrigeration equipment, cold storage and regimes.

153. A final goal should be to develop international agreements through the creation of an International Association of Food Equipment Producers which would adhere to the established standards and whose members would exclusively offer standardized equipment to developing countries.

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154. A successful standardization programme would offer the following advantages:

- (a) Minimal mistakes in the choice of flow-sheets;
- (b) No undersized factories unable to compete in international markets;
- (c) Standardized productivity and standardized quality of food product;
- (d) Cheaper equipment, spare parts and other requirements;
- (e) Shorter deliveries and lower installation costs;
- (f) Easier training of personnel;
- (g) Lower cost of standardized packaging equipment and material;
- (h) More confidence in foreign markets;
- (i) Generally lower investment capital needed; and
- (j) A better basis for evaluation of equipment quotations.

155. The standardization programme should also have another target. Many food processing lines are suitable for one or two products only so that the processing line is restricted to part-time operation and is not adaptable to diverse market opportunities. The goal of standardization should be to provide facilities for multi-purpose operations e.g.:

- (a) Canning lines which can process fruits, vegetables, meats, milk etc.;
- (b) Chilling and freezing units which can process bread, meat, fish, milk etc.;
- (c) Juice-producing lines for fruit, vegetables, soft drinks, berries, grapes etc.;
- (d) Oil-seed processing plants for cotton seeds, palm kernels, soya, sunflower etc.;
- (e) Sugar-processing plants for cane and beet sugar;
- (f) Drying equipment for fruits, vegetables, cocoa beans, roots etc.

It will take much time and money to achieve such standardization, but the advantages would be great enough to justify the effort and cost.

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(d) International standardization of bids and offers

156. In close co-operation with UNCTAD and other international trade organizations the task of the United Nations should be to try to promote international standardization of bids and offers for food processing equipment, for complete food-processing lines and for complete "turn-key" factories.

157. One of the more intricate problems in attempting to evaluate offers on the spot in developing countries results from the fact that until now the producers of food equipment have not tried to standardize bids and offers.

158. Bids and offers, together with pertinent specifications are so different in content and in form that a selection or evaluation of parallel offers has become an insurmountable problem. This is true in spite of the fact that different bids are usually based on the same unique feasibility study.

159. A great help to developing countries would be a clear standardization of different types of contracts, e.g.: contracts for "turn-key" factories; contracts for delivering complete equipment, buildings and "set-up"; or contracts including the training of personnel to establish permanent technical management. Contract standardization would also benefit developing countries by protecting them from mistakes or deliberate attempts to mislead or defraud.

IV. DEVELOPMENT OF SELECTED BRANCHES AND TECHNOLOGIES OF THE FOOD PROCESSING INDUSTRY

160. All phases of food processing are of vital importance to developing countries, either as a means of providing better nutrition of their own inhabitants, or as a source of net income in world trade. Certain branches are of more importance than others in the context of this paper because of their value as a part of an over-all development programme and because of their adaptability to the economic situations which are typical in developing

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countries. The following discussion is limited to a few of the most important issues in terms of processed food production.

(a) The canning industry

161. Canning makes its contribution to the preservation and conservation of food by completely sterilizing the food so that no further microbiological or enzymatic activity remains and by then holding the food in impervious containers to prevent entry of micro-organisms, oxygen, other contaminants, or loss of moisture, flavour etc. When good commercial sterility is achieved, canned products can be stored for as much as a year with little or no loss in quality and for much longer in most cases, although some flavour characteristics may deteriorate somewhat. Ordinarily, nutritional values are retained for long periods of storage.

162. The importance of canning to the developing countries derives from the wide applicability of this method of preservation to virtually all types of consumer foods: its comparatively low cost; the fact that efficient processes have already been developed for nearly every suitable food; the availability of well designed and fairly inexpensive equipment; and last but not least, the wide acceptance of canned foods in all world markets.

163. A disadvantage of canned foods is the cost of the can (or glass jar) itself. Thus, for cheaper foods, the container may cost as much or nearly as much as the contents so that foods in such containers cannot be afforded by poorer segments of the population. However, large scale production will reduce the costs of foods and of containers, at least partially offsetting this disadvantage. Where real dietary deficiencies exist, and where valuable foods are wasted through spoilage, temporary subsidies to support the canning industry may well be justified as an important factor in economic growth.

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164. Because canneries usually deal with perishable foods, they should generally be located in production areas, providing income to agricultural or other food-producing workers and employment to factory workers in rural areas and helping to retard excessively rapid urbanization in the developing countries.

165. Canneries tend to be labour-intensive and for the most part employ semi-skilled labour which can be trained on-the-job. Competent management and some technical skill are, of course, required.

166. The products of the canning industry are relatively easy to ship, store and distribute. As they require very little in the way of special handling since the strength of the cans protects the contents, they can be distributed successfully by comparatively primitive transport systems.

(b) Food dehydration

167. Dehydration, like canning, is basically a means of preserving foods which would otherwise decay and become useless as food for man. Once considered one of the poorest forms of food preservation, dehydration has now become sophisticated to the point where products of excellent quality, appearance and flavour can be produced from many types of food. As the sophistication of the process has increased, so has the cost of the equipment necessary to carry out the drying. In modern drying practices, except for freeze drying, the cost per pound of water removed from food products can generally be kept below \$US0.05. Freeze-drying has not yet reached the efficiency necessary to achieve such low drying costs, although this is theoretically possible. Typical freeze-drying costs are currently likely to run between \$0.12 and \$0.25 per pound of water removed.

168. Like canning, dehydration is applicable to a wide variety of foods, although

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world markets with a few exceptions such as tea, coffee, dates, desiccated coconut, cacao etc. In addition to these and other traditional foods, dried skim milk has recently become one of the valuable items of commerce and has a good market in developed as well as developing countries. The same is true of brewed "instant" coffee and tea, which, like milk, are dried by highly sophisticated processes.

169. The value of dehydration processing to developing countries is principally that of conservation of indigenous foods, although opportunities for the use of superior processes to provide exports should not be overlooked. Superior quality and market value which might be imparted to tea, coffee, beans, cacao beans etc. by modern drying technology are examples of such potential opportunities.

(c) Protein production

170. There can be no doubt about the gravity of the need for significant increases in the protein of the diet of developing countries. No knowledgeable authority disagrees. Two simple statements are sufficient to present the basic facts.

- (a) Man requires about 54 grams of protein daily to retain a healthy nutritional condition;
- (b) Less than 15 grams/day of protein is considered to be in the danger zone, and about sixty per cent of the world's human population is said to be in this category.

171. It is further noted that the more serious conditions of protein malnutrition are concentrated mostly in the developing world, the tropics and subtropics. Much of the cause of social unrest, slow economic development, administrative malfunctioning, and other problems of the developing world may lie in protein malnutrition.

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172. Protein production for human consumption from vegetable sources cannot be realized without large profitable industrial facilities. The new non-conventional resources of protein for human consumption are products of highly mechanized, automatized units.

173. Developing countries can increase the protein level in domestic diets by:

- (a) Growing and processing protein-rich crops (such as soya) into products which can be introduced directly into the human diet;
- (b) Raising protein yields through the use of nitrogen-rich fertilizers;
- (c) Producing animal protein through fish meal production and animal husbandry; and
- (d) Special fermentation of hydrocarbons and carbohydrates.

174. The successful revolution in agricultural production of animal protein foods in the United States is closely connected with the successful cropping of soya (introduced only in the last thirty years), alfalfa and other protein rich plants, and processing them without the loss of proteins. In developed countries there is a steady milk and meat production, based on grazing. This is not the correct choice for developing countries, however, because the climate is generally too arid so that pastures dry up in the summertime, and because of the inefficient use of land. The production of concentrates and animal feeds is a better method for producing cheaper proteins. The potential sources of vegetable protein should be determined and a programme for processing such raw materials should be established for all protein-deficient developing countries.

175. None of the developing countries can afford to rely on mass production of protein or protein-enriched staple foods from imported raw material. The raw material for production of protein concentrates or protein-rich foods ought to be based on domestic oil-bearing seeds, legumes, fish catches, the products

of animal husbandry etc. The production technique must be equivalent in efficiency, size, quality, production and depreciation costs to the highest level achieved in the developed countries.

176. All animal-derived foods (except fats) are rich sources of high quality protein and this includes not only the flesh but also the organs of healthy animals. The term "animal-derived" also includes fish, eggs and dairy products. Developing countries which have the potential for producing ample quantities of these proteins are in an enviable position.

177. In countries where arable land is scarce, methods more efficient than animal husbandry should be found for producing the necessary protein. The preferred method is the use of land to grow protein-rich crops which can be quickly processed into protein concentrates for direct human consumption. In this way only will full use be made of the protein-producing capacity of the country. The inefficiencies of domestic animals as converters of vegetable-protein sources for human use is shown by the following yields of edible animal protein as a percentage of vegetable protein consumed by the animal:

Cow	23
Pig	12
Beef	10

A desirable method for increasing (including milk) the use of vegetable-protein concentrates is for these products, which have little taste of their own, to be added in quantities of perhaps 5-20 per cent directly to the traditional diets of the population. In many instances, these additions of nutritionally valuable protein would have little or no effect on the taste, appearance or texture of familiar foods, while contributing greatly to the health of the consumer. Typical uses as additions to rice and other grains, baked goods, sauces and starchy foods prepared from roots and tubers.

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178. Complete, efficient, commercial processes have been developed for producing protein-rich meals and flours from oil-seeds, such as peanuts and soya beans. This type of process, if established in developing countries which have a capability for growing protein-rich crops, could be valuable both for correcting protein deficiencies in the diet and for providing important commercial items for export. Even the production by the developing countries of protein-rich meals for animal feeding, though less efficient than direct human feeding, can have importance by increasing the quantity and quality of animal protein available for domestic diet or for export.

179. A tentative proposal to solve the problems involved in the transfer of "know-how" of protein mass production to the welfare of the hungry world is to establish under United Nations sponsorship, an international pool of technical and economic "know-how", whose international members would agree voluntarily that all patents, "know-how" and experience in protein production would be collected freely or bought under optimal conditions by the technical staff of the pool and released to developing countries.

(d) Processing carbohydrate foods

180. Modern processing of carbohydrate is important to almost all of the developing countries because such foods are the most important and the cheapest sources of energy in the home diet. The present processing technique for such raw materials as, for instance, rice, millet, Guinea corn, arrowroot, tapioca, sweet potato, cassava, yam etc. is mostly a family business in tropical countries. The grains and roots are ground or extracted by very tiresome handwork a few hours before consumption by the family. If not consumed promptly, they will spoil.

181. There are many problems linked to the industrialization of processing of this important food in developing countries. Apart from the non-existence of an industrial technique, one of the most intricate problems is the collection of the surpluses of hundreds of thousands of farmers, and the transport to an industrial plant with an up-to-date production capacity of about 20-50 thousand tons a year. The other very difficult problem is to introduce the new stabilized products to the customer whose traditional diet will be changed thereby.

182. Efforts have been made to accomplish the industrialization of carbohydrate food processing with the help of demonstration plants. Such attempts should be assisted by international help, especially if a well engineered and economically and technically well backed project has been submitted by the requesting government and the main problems of raw materials, processing techniques and markets - have been successfully solved. It is to be expected that such an integrated, agro-industrial plant would have difficulties in the first years, especially with respect to the development of home markets and the realization of exports if possible.

183. The fact that a staple carbohydrate food is more or less competitive in price with imports of other similar carbohydrate staple foods, and that staple food is always at a high level of production in agriculture and of mass consumption by the populace is a good basis for sound and relatively fast industrialization.

184. It is worthwhile to emphasize that some milling and extracting techniques already developed for staple food in highly developed countries, (e.g. starch and flour from wheat, corn, potato and other sources) is applicable with few changes to the raw materials which dominate as staple foods in tropical and sub-tropical countries. Generally, the problem of the selection of the appropriate size of the plant in this case depends mostly on special requirements and

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situations pertaining to the particular countries or location. As a general rule, such a plant should not be under-sized, but on the other hand, the criteria of minimum capacity in developed countries are not always appropriate for the developing countries.

(e) Processing fats and oils

185. The processing of fat and oil-bearing materials is of tremendous importance to sub-tropical and tropical countries because of their climate which provides the best conditions for growing rich vegetable-oil-bearing crops. The processing of palm kernels, cocoa beans, ground nuts, sesame and castor seeds and many other oil-bearing materials is a large source of additional export value to developing countries, a basis for more intensive domestic processing and a source of protein-rich material (the press cake) for modern feed-stuff production. To assist the development of this important part of food processing industry is a worthy task.

186. While a surplus of native oil-bearing materials exists in many tropical developing countries, there is at the same time a deficiency in fat for human diet and protein-rich feed material. Many quantities of oil seeds, nuts and oil-bearing materials are exported by developing countries to Europe and the United States and later re-imported into the developing countries as refined oil and livestock feed. It will be useful to develop an all round, standardized unit process for the extraction of vegetable oil from most of the oil-bearing tropical materials, leaving only a small percentage of fat in the cakes. Standardizing will make cheaper equipment available; the protein-rich cakes will remain for use by the developing country; and transport costs for the exported oil will be lower because it can be stored and shipped as liquid oil.

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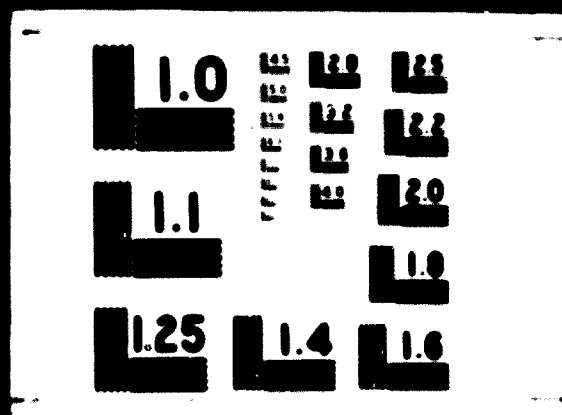


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(f) Production of vitamins, enzymes and extracts of spices

187. Virtually all of the world's supplies of spices and seasonings originate in developing countries where soil and climate conditions favour the growth of the vegetation producing these highly valued items of commerce. Few, if any, of the developed countries have suitable climates to permit competition in this field of production. The tropical or semi-tropical climates of many developing countries are also suitable for the production of important vitamins, enzymes and flavouring agents such as "essential" oils.

188. A vast field of food processing could be promoted in many developing countries to separate, extract, refine and purify the highly valued concentrates of vitamins, enzymes and spice extracts which can easily be distributed all over the world. For instance, different drugs, tenderizers, flavouring agents and components, bio-catalysts, aroma enhancers and other high-priced materials needed in the final operations of the textile, leather, food and pharmaceutical industries could be produced.

189. In regions where the necessary raw materials are not now being grown, these could be planted and a profitable industry developed to process the agricultural products into commercially important exports.

(g) Ready-made and convenience foods

190. "Convenience foods" as used in this paper may be defined as semi-prepared processed foods which require little preparation time, only simple equipment, and little or no knowledge of complex, time-consuming recipes. Most of the work of preparing the food for eating has been "built-in" by the processor, who can perform this pre-preparation much more efficiently on a large scale than thousands of consumers can do on a small, one-family scale. The large-scale processor will have less waste and spoilage, will cause less deterioration of

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natural nutritional value of the food, and will produce a more sanitary, stable product than home preparation, on the average.

191 The development of readymade foods production makes possible:

- (a) An up-to-date housing programme (requiring a small kitchen only);
- (b) An easy change in human diet habits;
- (c) A higher sanitation and nutrition level;
- (d) Catering service to schools and to large industrial enterprises;
or
- (e) Catering service to military forces.

Such production can expedite economic development through important savings in human work, investment and raw materials.

192. It seems at first glance that such a proposal for industrial production of readymade and convenient foods may not be appropriate for a relatively poor developing country because such production was introduced to the already developing countries only in recent years. However, convenience foods have now become the fastest growing branch of the food-processing industry in those countries. In our view, it would be worthwhile to undertake a study in order to figure out the expenses, the time needed, the auxiliary services to be organized, and the level of culture to be reached for a country to overcome its low diet standards via the traditional trend of development. This should be compared with the investment and time which would be necessary to establish the production of readymade foods and to organize markets following the pattern of developed countries. The production of readymade foods would have wide impact on the whole development of food service in schools, hospitals, institutions, armed forces and big industrial enterprises.

(h) Baby-foods

193. The processing of baby and infant foods is a necessary development taking place in developing countries with the help of United Nations agencies (UNICEF, UNESCO, FAO and WHO). The damaging effects of infants and child malnutrition on the future well-being of nations where such conditions occur is well recognized by nutritional authorities. When infants and young children are converted from breast feeding to the deficient diets of their parents, irreparable harm is done. This could be avoided by establishing a well-planned baby-food industry in developing countries.

194. An international organization should be selected or assigned to cooperate directly with the United Nations agencies along the following lines:

- (a) Organize meetings with process equipment producers in the United States and Europe to develop a single processing line suitable for meat, fruits and vegetables and another processing line suitable for dry milk, pastries and baby-food products derived from grain;
- (b) Organise on a regional basis teams of technologists, nutritionists and specialists for childrens' diseases, to develop new baby-food formulae for each region, utilising home-grown fruits, vegetables and grains;
- (c) Evaluate every baby-food programme financed by United Nations agencies by controlling the technical and the sanitation standards of equipment;
- (d) Directing a special work programme to the field of milk processing for baby-foods, because of the high standards needed for this product. At present, many new and interesting techniques are being developed. Today it is possible for instance, to separate bacteria by centrifugal force. This is a development which can be applied successfully in developing countries where highly infected raw milk is processed, because the new equipment is cheaper and as sanitary as other more expensive equipment;

- (e) Determining international standards enriching additives for baby and infant foods. International standards do not exist at present and national standards vary considerably and are often influenced by aggressive vitamin producers;
- (f) Developing research projects to offset the general lack of experience in this new and quickly expanding field of baby-food processing. A special effort should be made to find a packaging material cheaper than glass jars and tin cans. The best way to fulfil all these needs would be to create a world research centre for baby-food processing.

(i) Water technology and water saving processes

195. In developing countries, water should be used and re-used on a multiple scale. In developing countries we have almost everywhere, at these low levels of water consumption, a water deficit which is the main obstacle to a higher standard of life. Water purification schemes and water-saving technology, in addition to long range projects of new water sources and water desalination, should be included in efforts to assist developing countries.

196. In a report published by the United Nations (ST/ECA/82/NY 1964), it is shown that many of the developing countries face an acute water shortage, that the majority of the population drink brackish water, and that there are costly losses of livestock as a result of water scarcity. "In general, in the areas surveyed, water shortage is the principal limiting factor to economic development".

197. New sources of water can only be found by expensive investment in ground water development, dam construction or stream flow regulation, but large expenditures are not available in developing areas. The present supply must therefore be better utilized by decreasing waste or by re-using and purifying effluent water by chemical, biological and mechanical treatment.

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198. Water processing for these countries becomes as important as new water sources and an organization should be designated to deal with this important problem. In the United Nations Department of Economic and Social Affairs, the Resources and Transport Division, inter alia, published the aforementioned report, but their task is not to develop a water treating industry in developing countries. For every developing country, a programme for developing water resources and water processing facilities should be worked out in close co-operation with the respective Governments and with the help of experienced societies specializing in water technology. Such programmes should include:

- (a) Surveys of the general, regional and aerial situation in water housekeeping;
- (b) Necessary investments for new water from conventional sources;
- (c) A study of possible new resources through wider investments (imports, canals, melioration schemes or desalination);
- (d) A concrete proposal for the near future for investments in re-using water by industrial treatment; and
- (e) Proposals to establish a centre for general research in water technology and housekeeping.





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