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P A P E R I I

SOME ESSENTIAL REQUISITES FOR INDUSTRIAL DEVELOPMENT OF
RENEWABLE NATURAL RESOURCES

The FAO Contribution to this Symposium includes in addition to the one mentioned above six other papers entitled:

- I: The Economic Significance and Contribution of Industries based on Renewable Natural Resources and the Policies and Institutions Required for their Development.
- III: Food and Food Products Industries.
- IV: Industries Processing Agricultural Products other than Food.
- V: Development of Forest Industries.
- VI: Fisheries Industries.
- VII: FAO's Relations with Industry through the Freedom from Hunger Campaign.

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SOME ESSENTIAL REQUISITES FOR
INDUSTRIAL DEVELOPMENT OF RENEWABLE NATURAL RESOURCES

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SOME ESSENTIAL REQUISITES FOR
INDUSTRIAL DEVELOPMENT OF RENEWABLE NATURAL RESOURCES

Role of Agricultural Requisites

1. The need to raise the present very low productivity of agriculture¹⁾ in the developing countries is too well known to call for elaboration. It is vital to increase food supplies, to provide more agricultural raw materials for local industry, to expand exports, and, as a result of these various operations, to raise the level of living and provide a greater volume of more remunerative employment. The process by which the existing low technology can be transformed to an advanced one is complex, since it calls not only for very considerable material resources, but also for far wider diffusion of technical and managerial skills than is at present available in the developing regions. These skills acquire special significance given the interdependence of the factors working for greater productivity.

2. Some of these factors may be defined as institutional, since they presuppose the alteration of existing socio-economic practices such as share cropping, or the setting up of new or more efficient organizations for, say, the supply of credit. Others fall under the heading of infrastructure - roads, irrigation canals and flood control. However, a vitally important third group consists of material inputs which are often but not always, the fruit of research and of a highly industrial technology. This group consists in the main of implements and machines (including transport), fertilizers, pesticides, seed supplies, animal fodder and feeding stuffs and animal health requisites. A related group of inputs are applied at the pre-processing, processing and marketing stages. The present paper sets out to analyse only the main aspects of the problems arising in this connection. A selected list of FAO papers dealing with a number of requisites for industrial development of renewable natural resources is attached in the appendix to this paper.

Tools, Implements and Machines

3. At the present stage of technology, agriculture in many of the developing countries relies mainly on hand-operated or animal-drawn implements. It is probable that, despite the theoretical availability of power-driven machines, agriculture in these areas will continue for a considerable time to rely on such equipment. It is therefore important to devote the greatest attention to the improvement of, for example, manual implements and of animal-drawn ploughs and carts, as well as to simple machinery for grading, milling, extracting, and other forms of initial processing.

4. It is perhaps worth mentioning that India and Japan have both carried out research in this field, and striking results have been obtained by FAO experts in East Pakistan in connection with the introduction of the Japanese plough for rice farming. This implement has reduced the time needed for tillage to a very great extent and has enabled the farmer to work much faster at a critical point in the season when labour is short, and thereby to obtain a second rice crop.

5. The production of less sophisticated tools and machines used in agricultural, forestry and fishing industries has received little serious consideration, particularly by small scale industries. The production of tools, implements and simple machines for use in agriculture and forestry is particularly well adapted to

1) Agriculture here includes animal husbandry, fisheries and forestry.

small scale industry, or to handicraft establishments. Even though small industries constitute a distinct sector with problems and characteristics of their own, their promotion and development should always be treated as a part of the overall industrial development program. These simple requisites cover a wide range. They are produced by enterprises ranging from small blacksmith and carpentry shops to large assembly plants and factories employing vast numbers of workers and heavy plant. Collectively, the industry is loosely termed the Agricultural Engineering Industry, but the complexity and wide application of certain products and components, such as power units, pumps, etc., mean that there is no longer a clear-cut dividing line separating Agricultural Engineering from General Engineering.

6. There are few developing countries in which there are not already workers in metals and wood who are engaged in traditional crafts, and who could, with little encouragement or additional facilities, produce hand tools, animal drawn equipment, transport vehicles, and simple machines for use in agriculture and forestry. The blacksmiths, tinsmiths, cartwrights, general metal workers and carpenters already established in both urban and rural areas represent a vast potential production capacity which could supply many of the rural producers' needs. Not only manufacturing of equipment should be considered when thinking of these workers, but also the possibility that their small rural enterprises may be simultaneously developed as servicing units for the equipment used on local farms and forests. For instance, blacksmiths already engaged in the manufacture of implements and household goods can be trained to repair farm implements and hand tools. As a next step some of them can be trained to become capable of installing and repairing irrigation pumps and to branch out into new fields of activity as the new types of artisan and craftsman needed in an industrializing economy.

7. The next step in technological progress is from this type of equipment to simple power mechanization. Mechanization is often regarded as differing from other inputs such as fertilizers, since its most obvious effect is to reduce the number of workers, or more exactly, the number of man-hours needed to obtain the same output from a hectare of land, whereas the effect of fertilizer is to raise the yield per hectare, while, by and large, leaving the manpower unchanged. Power mechanization improperly planned and introduced, may, in fact, render a part of the existing labour force surplus and therefore could give rise to acute problems in countries with intense population pressure. It is a fallacy, however, to imagine that mechanization, in combination with other improvements, cannot in many cases result in the maintenance of the existing level of employment or even in an increase in the number of workers through, for example, the diversification of crops and the introduction of rotations and double or triple cropping.

8. Since developing countries usually have a plentiful supply of farm labour, it is often argued that power mechanization is undesirable. This argument is open to considerable reservations. For one thing, machines often replace animals rather than men, and hence do not throw manpower out of work. On the contrary, the draft animals no longer have to be supplied with food and the land thus freed can be used to supply crops for human consumption or meat and dairy products as a result of the switch from draft cattle to beef or dairy livestock. However, it is unlikely that power mechanization will quickly produce striking results in this respect in developing countries, because it will often be preceded by a switch from manpower to animal power, which will be more within the reach of the average small farmer.

9. There are, however, many other cases in which the adoption of power mechanization is indicated. Thus, in large-scale plantation or cooperative type production schemes, the use of power driven equipment is essential if extensive field operations are to be carried out economically. Similarly, power equipment has proved indispensable for opening up new lands in such countries as Brazil and in fairly empty areas of densely populated countries, e.g. northern Japan. Mechanization, too,

is the only way of developing land where the tsetse fly or other pests rule out the use of animals, where semi-arid or other marginal land can give crops only in certain years and if cultivated at specific times in the season and where, as is sometimes the case in developing countries, there is a local shortage of labour.

More generally power mechanization in its early stages, which usually consists in the use of tractors and allied equipment, can often increase yields by improving and speeding up tillage and allowing seeding to be carried out at the optimum time.

10. In the African countries, as a whole, there is a general trend towards increasing use of mechanical power units and power operated equipment. The increase is most marked in land clearance and development of new farming and forest lands, and in related work such as the construction of roads and irrigation and flood control structures, and in large scale soil and water conservation schemes. In some countries there is also a marked increase in the use of mechanical power units for pumping water, and in the preparation of land for cropping, and in cultural and harvesting operations.

Mechanization of afforestation processes is a factor that although requiring heavy additional expenditure, has contributed significantly in raising timber yields from plantations of man made forests in Eastern and Southern Africa. The use of heavy duty tractors for land clearance, stump ripping and cleaning and deep ploughing and of lighter equipment for cultivation are all receiving wider attention. Development of such techniques has led to high yields on land, for example, in Zambia formerly regarded as having a low forest potential.

11. Most developing countries do not yet possess the necessary means to start manufacture of tractors and power driven equipment. However, it may sometimes be possible to make a start on the simpler types of machines which are put into production after experiments have proved their suitability for local conditions. If the demand is high enough, and conditions are appropriate for the development of such a manufacturing industry, the first stage could well be the setting up of an assembly line to build up complete tractors and machines from imported parts and components. As the next step, these parts and components may be produced locally and fed into the assembly line. This method of establishment has the great advantage that there is stimulation of small part and component manufacturing enterprises, that there is not a sudden demand for great capital investment in machine tools and plant, and that there is not a concentration of industry in only one area.

12. However, even when reasonably priced machines are available, the problems still remain of enabling the farmers to buy, use and maintain them. Often they will need credit facilities. More often still, the farms are too small to carry overhead costs (including the servicing of capital) of even a small tractor. It may therefore be necessary to devise arrangements for the multi-farm and joint use of tractors and machines.

Maintenance services are essential if mechanization is to succeed. The working life of, for example, a tractor, is often reduced by half or more through rough handling and lack of care. A concentrated drive by extension workers and the personnel of firms manufacturing and selling the machines is needed if farmers are to be educated to make the best use of them.

Mechanization becomes much easier the further it progresses. It has proved undesirable to launch new techniques of this kind in a country where the source of power in farming is almost overwhelmingly human or animal, unless there has been most careful preparation and calculation of potential economic benefit.

Fertilizers

13. Fertilizers represent an agricultural requisite which has substantial and immediate prospects of increasing agricultural productivity. Fertilizer consumption in African countries, however, is very low. In 1962/63 it was only 833,000 tons of plant nutrients - 405,000 tons of nitrogen (N), 314,000 tons of phosphorus pentoxide (P_2O_5) and 114,000 tons of potash (K_2O). This quantity represents a 41 percent increase over consumption in the year 1957/58, but is only 3 percent of the total world consumption in 1962/63, and the average application at 3 kilograms per arable hectare is the lowest of any region in the world. The United Arab Republic accounted for the larger rise in the continent's consumption (manufactured in the form of lithium nitrate)* between 1957/58 and 1962/63.

14. It is clear that the required increase in crop production in African countries cannot be achieved without a great expansion in the use of fertilizers. Available information indicates a wide spread nutrient deficiency of African soils, and the general occurrence of response to fertilizers throughout Africa shows the deficiencies of one or more of the three primary plant nutrients - nitrogen, phosphorus and potassium. Deficiencies of secondary nutrients also occur, but less generally. It is important, however, to bear in mind certain very pertinent observations made in the State of Food and Agriculture 1963 (p.159) : "Some knowledge on the part of farmers of the methods of using fertilizers and their effects is, of course, a precondition for using fertilizers. However, knowledge by itself is not enough. Certain economic and social factors are also important".

These include : the price relationship between fertilizers and the crops to which they are applied, together with the market outlook for these crops, which largely determine the profitability and incentive for using fertilizers; the level of incomes of farmers and the availability and cost of credit; these largely determine whether farmers can afford the initial outlay for fertilizers; conditions of land tenure, which if unfavourable may greatly reduce the incentives to use fertilizers; adequate distribution facilities to ensure that supplies of fertilizers are available to farmers at the right moment.

15. Their relative importance will naturally vary with the circumstances of the particular country, and they are to a considerable extent interdependent. It is worth emphasizing, however, that each of them can be influenced by government action if the policy of the country is to stimulate the use of fertilizers as a means of increasing agricultural production. Yet another factor which may influence the consumption of fertilizers is the relation between land and population, for cultivation naturally becomes more intensive when land is scarce. In short there is no generally valid formula for the application of fertilizer. Different amounts and combinations are required for different types of land, crop and climate. In particular, sound instruction and farm management practices, and good seed can, in conjunction with judicious use of fertilizer lead to a sharp increase in yields.

16. The question of a domestic fertilizer industry will arise in a growing number of countries, especially where petroleum has been discovered. The fertilizer industry generally represents the first major chemical enterprise in a developing country, particularly when long term planning commences. Indeed, plants are already in operation in, e.g. Algeria, Kenya, Morocco, Tunisia, UAR, Zambia and others are under construction. Most of the present production is concentrated in UAR and Morocco.

* Source : FERTILIZERS : An annual review of world production, consumption and trade, 1963, FAO, Rome.

17. As observed in the State of Food and Agriculture 1963 (pp.171-172), " The decisions to start manufacture (of fertilizers) may be based on a desire to save foreign exchange; it may be due to political reasons; or it may be due to availability of raw materials."

18. These factors operate in a variety of ways. The lower limit of plant size for economically producing fertilizer nitrogen, for example, is put at around 30,000 tons of nutrient per year. Only a few of the newly developing countries are now actually using that much. But this figure may be much lower if there are ample local supplies of cheap raw materials or energy. Anticipated development in other fields again may need to be considered. A rapidly expanding steel industry may make coke-oven gas or basic slag available; the discovery of petroleum or natural gas or the establishment of a large refinery may make raw materials available. These may also be decisive factors in indicating which type of plant can be most economically built and what it shall produce. Here again a long-term view has to be taken. For example, it is now apparent that for many years there has been undue emphasis on fertilizer nitrogen in a number of countries. If a balanced program is to be evolved, either plants for phosphorus and potash production must be set up, or the materials must be bought abroad.

19. A key question in making the decision whether or not to manufacture fertilizers is the cost of production and in turn, the cost to the farmer who is going to use the fertilizer. If the cost of production is such that the farmer cannot afford to buy it, or if the local demand is so limited that the home-manufactured fertilizer cannot be absorbed by the home market, excess production will have to be sold on a highly competitive worldmarket. A developing country might therefore under certain conditions be well advised to import its fertilizer until a substantial demand has developed, unless the foreign exchange situation is such that importing is out of the question.

20. Also in considering the economic development of the country as a whole it must be appreciated that, once a factory is built, it provides very little in the way of employment, because fertilizer manufacture is not labor-intensive. Cost as well as other factors must be considered at a very early stage in the planning. The factors affecting cost are numerous, and include local availability of suitable marginal and labour staff, low cost raw materials and power supply.

21. With fertilizer factories in general and with factories based on ammonia synthesis in particular, the size of the factory affects very profoundly both capital cost per ton of installed capacity and also production costs. Comparing a factory for the production of, say, 100,000 tons of nitrogen per year with one of 20,000 tons, the capital cost per ton of installed capacity of the smaller factory could well be double that of the larger. It is indeed doubtful whether the smaller factory could produce at prices competitive with worldprices for imported fertilizers from large factories, notwithstanding the sea freight and possibly customs charges on imported fertilizers. The problem is intensified if the plant is not operated at full capacity. In fact, the effect of idle capacity on production costs is more serious than almost any other factor.

22. The commercial phosphate materials produced in Africa include single and concentrated superphosphate, basic slag and a small amount of "other phosphate fertilizers".

Between 1958/59 and 1963/64, output of phosphate rock in Africa increased by 28 per cent. Over the whole five-year period under review, the largest contribution to the increased supplies came from Morocco with 2,121,000 tons, followed by Senegal with 485,000 tons. During the same period, output of phosphate rock had decreased sharply in Algeria (38 percent) and has been rather erratic in Tunisia.

Morocco is today the largest exporter of phosphate rock in the world, accounting in 1963 for about 40 per cent of total exports, and is second only to the United States as a rock producer, accounting for about 20 per cent of world output. Recent estimates indicate that reserves of phosphate rock in Morocco may exceed 30 million tons of all grades.

Deliveries from Tunisia showed a noteworthy increase to nearly 2 million tons in 1963.

During the same year, deliveries from Togo and Senegal totalled 476 and 455 thousand tons respectively.

Looking ahead, there is every prospect that the African fertilizer industry will continue to grow in importance during coming years, and will continue to be an example of industry generated by an expanding agricultural production.

Pesticides

23. Intensification and expansion of crop production brings into growing importance the general class of requisites known as pesticides, herbicides, insecticides and chemicals used for the control of plant pests and diseases, weed control, animal pests, etc.

Although there is a tendency for increasing emphasis to be placed on biological methods of control and on the production of varieties of plants which are resistant or even immune to specific diseases, it is probable that chemical controls will continue to be the most important and powerful weapon in combatting weeds, insects, rodents and other pests, animal pests and diseases, and the plant diseases caused by fungus, bacteria and viruses.

24. Conservative estimates of the losses in production and storage of farm crops due to plant pests and diseases today stand at roughly one-quarter to one-third of the total production.

Control of pests and diseases therefore holds out hopes for great increases in the quantity of food for growing populations. This, of course, includes measures to be taken for the control of animal pests and diseases.

25. Pesticide production is basically the concern of the chemical industry, and production of pesticides in African countries is at the present time limited, the greater part being imported. Chemical industries are, however, being established in a growing number of countries, and the addition of pesticides to the range of products of the new chemical industries is expected to take place very rapidly and thus enable the chemical industry to contribute to the vitally needed production of food and other products from farms and forests. However, unless thoroughly tested and used under very strict control, application of pesticides and other chemicals can be very dangerous, due to toxic residues.

Seed supplies

26. The production in quantity and quality of every crop is dependent upon the inherent potentiality of the seed that is put into the soil. No matter how good the cropping system may be, or how heavy the fertilizer dressing applied, the crop obtained is dependent on the yielding capacity, the disease resistance and other abilities of the particular variety that is used. At all levels of soil fertility the varietal characteristics of the seed used are limiting factors in the yield that is obtained and the quality of the product. This natural law is of still greater importance, especially for perennial crops where yields for many years depend on the same seed, such as forage crops, tree crops and others.

27. Many industries based on agriculture have now realised the importance of high quality seed for agricultural products to be used for processing, for example, milling, canning, sugar, textiles and other industries. In countries such as U.S.A. Canada, Argentina and Germany, the above industries have already developed their own seed branches in order to make available to the farmers seed with improved varietal characteristics for their particular conditions and industrial purpose instead of those which are commonly used. Many good examples can be given of the prospects arising from the usage of high quality seed of superior varieties, accompanied, of course, by an appropriate improvement in plant nutrition and plant culture. Present day maize hybrids in the U.S.A. yield 40-45 percent more than non-hybrid varieties. In Mexico, yields of wheat increased from 8.8 quintals per hectare in 1952/53 to 21.9 quintals per hectare in 1963/64, due to the using of superior seed of improved varieties. In the U.A.R. the rice yield increased from 37.9 quintals per hectare in 1952/53 to 58.4 quintals per hectare in 1962/63.

Also in the U.A.R. and in some other countries seed farms and seed inspection laboratories are developing rapidly.

28. These examples demonstrate that seed is not only the most important of the raw materials used by farmers for increased yields, but that its use also leads to the best possible profit - not only for the cultivator but also for those involved in industry. It must be realised that measurable results and continuing success can only be achieved when governments support and encourage the development of a competent seed industry, including plant breeding, variety testing and maintenance, planned propagation, official organisations for seed certification, processing and storage plants and the proper organisation of seed distribution.

One of the chief problems of the seed industry is the establishment of processing and storage plants. When a grain or seed lot has been harvested and threshed it always contains a number of impurities such as straw and chaff, sand, dust, other crop and weed seeds and smut kernels, as well as a certain amount of broken, light unripe and shrivelled grains which often have a high moisture content. In order to segregate these impurities and to obtain a dry, pure lot, the grain or seed should be cleaned, dried and processed in various ways depending on the amount and type of impurities.

29. By adopting effective development programs for seed processing and storage, governments not only decrease the often enormous losses and increase the market value of the grain, but strengthen the home market and open up possibilities of exports. By sowing only seeds of improved varieties from which impurities have been removed, the countries are therefore assured of high crop yields and better qualities.

The establishment of the seed industries in African countries is an absolute essential to agricultural development, and industrialization plants must include plans for their development.

Animal Fodder and Feeding Stuffs

30. Renewable natural resources of animal origin include a variety of products such as meat, milk, cheese, wool, hair, eggs, bones, hides and skins. Each is the basic material for various industrial developments. (See also the Papers No. III and No. IV dealing respectively with "Food and Food Products Industries" and "Industries Processing Agricultural Products other than Food".)

Of the requirements for animal production - a branch of agriculture of increasing importance to the majority of African countries - animal fodders and feeding stuffs are of first importance, and increased animal production is dependent

on ensuring supplies of animal feeds and fodders.

31. Whilst, in African countries as a whole, the greater part of animal fodder requirements are now obtained from natural grazings, and efforts are being made to increase the yield and quality of the produce from natural grazings, the production of fodders - chiefly hay and ensilage - on cultivated lands is steadily increasing. Improved crops, and cultivation methods, and methods and techniques of fodder conservation are rapidly extending, and the way is opening up for the use of a wide range of new fodder making handling and conserving equipment. Speed is the essential in quality fodder production, and speedy working can seldom be achieved by relying solely on manual labour to handle the increasing amounts of animal fodder that are necessary to enable an expansion of animal production to take place. The use of power equipment for fodder crop production, handling and conservation is expected greatly to increase. Extended use of fertilizers, pesticides and improved seeds will also play their part in increasing fodder production.

32. Increasing use is being made in animal feeding programs of compounded and more concentrated feeding stuffs, using cereal and leguminous grains, and many by-products of oil milling and other products processing industries, that are both palatable and nutritious. Amongst the more bulky of these by-products are the seed bulks from buckwheat mills and cottonseed oil extracting plants. More concentrated feeds result from the removal of the outer grain layers in the milling and preparation for human consumption of cereal grains, for example wheat bran and middlings; rice bran and polishings; oat dust and middlings; barley feed and rye millings; maize bran and maize germs; germ meal; gluten feed and meal; maize oil cakes and flaked maize are all valuable feeding products from milling and starch making industries. Residues from oil extraction and pressing plants and from the sugar industry have wide use as animal feed. In the same way a regular demand exists for both wet and dry brewers grains and distillery grains. From abattoirs and slaughter houses blood, meat, bone or meat and bone meals may be used to prepare animal feeding stuffs, especially for the poultry industry. Similarly, from the fish processing industry fish residues and surpluses may be used for animal feeds. (See also Paper No. VI : "Fisheries Industries").

33. The preparation of animal feeds, both simple and compound is a growing specialised industrial activity in many African countries, and is a development to be foreseen in all countries where animal production is expanding.

Feed preparing and mixing plants vary appreciably in size and scope, and so do the pieces of equipment needed. Basically, these feed mills contain weighing, sifting, grinding, mixing, storing, pelleting and packing units, testing and quality control equipment, and facilities for lifting and transporting raw materials and finished products.

Animal Health Requisites

34. Amongst the wide range of animal health requisites which must be provided to ensure a successful program of increased animal production, the supply of vaccines for the immunisation of domestic animals against contagious diseases is of great importance on the African continent.

The production of vaccines, and their application in the field, were in fact the first and only activities of the Veterinary Service for several years. Before any attempt was made towards the improvement of livestock production, it was imperative that livestock should be protected as fully as possible against epizootics such as rinderpest.

The position has gradually changed over the years, and the production of

vaccines is now undertaken by different types of organizations, sometimes working together in a single country.

The size of vaccine producing establishments varies widely from country to country, notwithstanding the number of livestock present. Some laboratories issue only a few thousand doses of vaccines a year, whilst others supply quantities as high as twenty million doses and more.

35. The large quantities of vaccines needed to protect the livestock of Africa must be guaranteed to be potent, safe and viable. At present biological control of vaccines is normally done in the laboratory where they are produced. This is not entirely satisfactory. Laxity in control sometimes occurs, and even a complete lack of control has been encountered. This is liable to occur when the staff in charge is not fully competent in the difficult procedures involved. It must be emphasised that, as far as is practicable and after careful evaluation of the situation, vaccine production for veterinary purposes should be concentrated in larger, well-equipped and completely staffed institutes and that very strict control over safety, potency and viability should be exercised on every batch of vaccine.

Special Requisites in the Fishing Industry

36. Paper No.VI : "Fisheries Industries" deals with the problems associated with industrial development in fisheries, which differs from the other industries based on renewable natural resources. Fishing and the fisheries industries involve the exploitation of a raw material source which cannot be easily quantified as is possible with trees, livestock and field crops, because the catching of fish is a hunting effort by comparison to the harvesting of a land crop.

37. The fishing boat, equipped with the necessary fishing gear, is the primary tool for raw material production in the fishing industry. Since fishing boats and gear represent the largest single item of capital investment in a fishery industry, the possibility of supplying these through local construction offers considerable opportunity for developing a supporting industry based on boat-building. The development of the boat-building industry has gone hand in hand with the development of forest product industries, where advances in the manufacture of special lumber and marine-type plywoods are providing highly suitable materials for wooden boat construction.

At the same time that boat-building offers opportunity for local industry, the manufacture of cordage, ropes, fishing nets and other items used in the construction and operation of fishing vessels opens up further possibilities for local industries to be established.

38. As fishing operations progress from small non-power craft to larger motor-driven and mechanised craft, the matter of adequate harbour facilities becomes of increasing importance.

Amongst the harbour facilities increasingly required as the fishing industry develops are maintenance and repair units for the fishing vessels, together with mechanised repair facilities for motor vessels, fueling stations, ships stores and fishing supplies, and ice manufacture and supplies for use both on the fishing vessels and during subsequent marketing operations.

Pre-processing

39. As farmers in the developing countries move from subsistence to a cash economy they gradually come to see that it pays to meet, so far as possible, the preferences of the market with regard to the form and quality of their produce. At the same time,

though, their increased production activity leaves them with less time for manual preparation: more and more they are coming to rely on technical equipment provided by industry. This is normally fairly simple equipment, but to the extent that it helps them to put a better product on the market with less time and effort, so it gives them the opportunity and incentive to expand their output further and invest in more complex, larger scale machinery.

40. In certain parts of the world, grain crops are still harvested by uprooting the whole plant by hand before threshing out the grain with a flail or stick. This is naturally a time-consuming process which severely limits the acreage that a family may hope to deal with. The use of a bill-hook or scythe speeds up the process considerably while a binder and combine harvester respectively make possible a very much greater output still. At the same time, the use of larger scale equipment itself induces increased production, since farmers are anxious to employ it to full capacity. This general stimulus to farming may be seen in the progressively widening sphere of industrial participation in agricultural pre-processing activity.

41. The basic requirements for many agricultural products are that they should be clean, dry, and uniform in quality. The means by which producers achieve these standards provide interesting illustrations.

42. The sun-drying of groundnuts or maize cobs does not need complicated equipment - though it may be noted that corrugated iron sheets make a good drying surface. But for arabica coffee, where the drying process has to be carefully controlled, specially made yet simple mesh trays are now recognised to be a well-worthwhile investment. Similarly, the drying sheds for hides and skins, although employing for the most part local materials, will make use of wire gauze to keep out flies. The efficient drying of pyrethrum, on the other hand - especially in the wetter areas - often calls for a special barn. Artificial driers, either locally constructed or initially imported are also coming into use and often prove to be a profitable investment.

43. The cleaning process may be simply a matter of sieving and winnowing, but improved procedures, such as for example, the washing of coffee beans after fermentation, increasingly make use of specially constructed equipment - in this case cement-lined washing tanks and channels. (These channels also serve as a quick method of separating the light from the heavy coffee). Apart from cleaning and grading, many products have to be field-processed before sale; and here too increasing use is being made of advanced techniques.

Maize and groundnut shellers, hand operated, make light work of what used to be a tedious labour. Tobacco barns are being constructed of improved design with more accurate means of temperature and humidity control. With increasing prosperity some farmers are able to hold back part of their produce from the market until more favourable prices are obtainable. This is useful and beneficial when it leads to more orderly disposal, but there is a parallel need for improved storage facilities and structures on the farm and treatment against insect pests.

44. The marketing system itself is making increasing use of industrial methods in a constant attempt to present agricultural products in a form that is acceptable to more sophisticated consumer tastes. Grading and packing machinery is now operating on a much larger scale than even ten years ago; and these methods are now leading to a much more clearly expressed demand on producers for definitely specified types of produce. The makers of breakfast cereals and standard flours; the quick-frozen food market; the meat packers; the fruit and vegetable canners, are in their respective spheres, by the nature of their demand, causing farmers to respond in a similar way to the pressures of economic advance, by investing in better equipment and themselves making use of larger scale methods. To the extent that this reduces some of the normal risk in farm enterprise and results in a cheaper cost of

production the trend is wholly to be welcomed.

Packaging

45. Increasing separation of producers and consumers due to urbanization and economic specialization results in increased transportation of agricultural commodities from the farms to the retail shops. Careful packing to preserve goods in transport becomes essential in order to reduce losses to a minimum. During the first stages of development, packing is of little importance since quantities handled are small and transport distances short. Farmers use their own farm produced containers with little or no regard to quality, weight and transport costs of packing materials. At a later stage of economic development, this original situation reflects itself in scores of different containers being used for one and the same commodity at one and the same market. Nevertheless, the larger demand for containers leads to the emergence of a special rural handicraft in which boxes, trays, baskets, etc. are being produced. With further development and the introduction of standardized containers, the avenue for the establishment of small-scale rural industries develops. These industries could often be an important user of locally produced or imported timber, as well as a place of employment for surplus labour in rural areas.

46. With a further raising of living standards, consumer demand for marketing services increases and more and more consumer prepacking is necessitated. Although this level has not yet been reached in Africa, it must be expected to occur in the supply zones of the richer urban areas, and possibly also in places of export of agricultural produce, including supply to shipping and air lines. A special field for careful prepacking is the production of deboned meat or meat cuts for export at which many African countries aim. To facilitate such a method, modern new slaughterhouses, or in the cases of fruit and vegetables, modern packing stations, must be established. These facilities are progressively moved into the production regions to cut back transport costs and also to make use of cheaper rural labour.

47. With new packing methods, new packing material will be needed. Although this material, e.g. waxed paper, cardboard, aluminium foil, plastics, is originally imported from abroad, the trend is toward the establishment of local manufacturing plants, using domestically produced raw materials or operating under licence of foreign companies.

48. A particularly important development in the field of packing and preservation is the canning of perishable produce, e.g. meat, fruit and vegetables, and possibly milk and milk products. Canning is sometimes the only possible way for packing produce for export since it allows for processing and thereby complete disinfection of raw materials - export of raw or frozen meat from Africa to Europe is prohibited because of sanitary regulations in the importing countries; some countries do, however, permit the import of canned processed meat.

When commencing such operations, resource must generally be had to importation of tinsplate from abroad. With the high cost of transport and tinsplate this makes canning only marginally profitable until locally produced tinsplate from a neighbouring country becomes available. The repercussions upon industrialization are obvious.

49. In summary, it can be said that suitable handling methods for the different agricultural products aimed at ease of handling and reduction of losses, have given rise to the establishment of a whole new industry. Preparation of packing materials of numerous types and shapes can also become an important rural industry.

Transportation

50. Inadequate transport facilities are largely responsible for the continuance of subsistence farming in many areas. Deficient communications limit the range of marketing, confine sales to nearby consumers and thus prevent optimum utilization of agricultural land and modernization of farming practices. Producers in many countries are constrained, through lack of farm to market roads or by high freight charges resulting from inadequate means of communication, to concentrate on certain crops, not necessarily those most needed or most economic. In particular, production of perishable produce is restricted by lack of transport possibilities. Provision of transport facilities should therefore be one of the first steps in the improvement of agriculture and promotion of industrial development based on renewable natural resources.

For perishable products, transport facilities must aim firstly at speed and secondly at good travelling conditions so as to keep losses at a minimum. For all products reduction in total marketing costs should result from improved transport.*

51. The type of transport used will vary from country to country and product to product. Road transport offers the advantage of great flexibility in operation and the possibility of providing door-to-door service with all the savings in loading and unloading that this implies. Railways are particularly suited to the transport of bulky goods such as grains and root crops; the major difficulty lies in the extremely high initial investment which makes their construction uneconomic if only agricultural crops are to be transported. Exceptions are, of course, the estate railways on sugar, sisal and other estates. Water transport, although very cheap, generally implies frequent handling of produce before it reaches the final consumer, thereby often cancelling any cost advantage originally gained. Air transport for agricultural produce is restricted to high quality, small quantity items such as early vegetables and prepacked deboned meat.

52. Development of transport facilities will in most cases result in increased rural industrialisation and expansion of employment opportunities. The construction of a new road opening up a new agricultural region will necessarily lead to an increased demand for motor vehicles or initially at least improved animal-drawn carriages. The servicing of this new pool will require a substantial number of servicing stations and repair shops, as well as maintenance services for the new road. In turn, the existence of an all-weather road allows food processing industries to penetrate newly opened areas and resulting changes in agricultural production patterns will firstly lead to increased demand for means of production, and secondly consumer goods.

It is important to note in this connection that development of transport facilities in many regions in Africa is based mainly on improving agricultural

* Present day transport facilities in Africa are largely still those established before independence and primarily constructed to facilitate movement of export crops and mineral from the interior to the ports. A secretariat document 1/ prepared for the ECA/BTAO/FAO Conference on Pulp and Paper Development in Africa and the Near East, held in March 1965 in Cairo, pointed out that in general the various transport services were established to carry raw materials to the industrialized countries of the world so that the shipping lines operate between African and European ports with relatively little coastal trade, and the railways are penetrating lines built from the ports to serve the hinterland or to evacuate minerals.

1/ Appraisal of the Regions "Other Pre-Requisites for Pulp and Paper Production"
ECA/BTAO/FAO CONF./SEC PAPER III

production conditions, e.g. feeder roads to rural areas, but their existence provides the prerequisite for penetration of other industries into hitherto undeveloped areas where they can make use of relatively cheap and abundant labour.

Since many agricultural products are bulky and perishable, transport costs are taking up a rather high share of the total marketing margin. Primary and secondary processing industries therefore tend more and more to be established in the producing regions.

Refrigerated Storage and Refrigerated Transportation

53. The manufacture of refrigeration equipment and the construction of transport vehicles and holding facilities in which it is installed, is a growing industry intimately related to the production and marketing of food, both of vegetable and animal origin. Refrigeration equipment is used in the transport and storage for distribution of much fresh produce - meat, fish, milk and milk products, and many fruits and vegetables for example, and increasingly in the marketing of frozen foods. In the USA over 3.6 million tons of food valued at \$ 3,000 million are distributed frozen. Elsewhere refrigerated marketing operations are on a smaller scale, but are growing rapidly.

54. There is no doubt that refrigeration will play an increasing role in the improvement of agricultural marketing in certain regions of Africa for example. Its extended use not only contributes to a reduction of physical losses and a more even supply of agricultural products throughout the year, but also enables producers to reach distant markets which are at present outside the scope of unrefrigerated marketing channels. In this way it provides an incentive for expansion of output and earns much needed foreign exchange for the country.

55. The simplest methods of refrigeration during transport is packing with ice as is common with chicken and fish, or the use of railcars fitted with ice bunkers and fans to distribute the cold air coming off the ice. This creates a demand for ice plants which are playing an increasing role in the marketing of agricultural perishables in South East Asia, for example. Transport vehicles may also be refrigerated mechanically by a diesel, gasoline, or diesel-electric engine. The air is usually blown directly into the cargo from a cooling coil or through an air space or jacket surrounding the load. In more advanced units the temperature can be adjusted to any required level and maintained there by means of thermostatic controls.

56. As a measure of the demand for refrigerated transport vehicles in agricultural marketing the Sunkist citrus marketing organization in California ships 69,000 carloads of citrus annually. All are shipped under controlled temperature conditions approximately two-thirds by rail and one-third by truck. In 1963 there were reported to be some 500 refrigerated rail and road vehicles in Greece engaged in fruit export transport and in meat distribution. Supplying of equipment to meet such needs can provide a starting point for a substantial line of industrial development. Twenty refrigerated road vehicles have recently been built in Turkey, for example, with many parts from domestic manufacture.

57. For maximum benefit from refrigerated transport special equipment and facilities are also needed at the despatch and receiving ends of the marketing channel. At the production point precooling equipment, refrigerated cold stores for assembling of produce awaiting shipment and freezing plants find an important role.

The use of precooling equipment in marketing is increasing. Broiler chickens marketed ready to cook are cooled in cold flowing water usually in a long trough or tank through which the produce passes as it is sprayed or submerged in refrigerated water. Another and more costly type of precooler employs the vacuum principle.

This is extremely fast, efficient and involves a minimum of moisture loss.

58. A relatively small scale freezing plant for peas or spinach for example, involves an investment in equipment, and installation of buildings of some \$ 200,000. A larger enterprise capable of handling 25 to 30 tons of beans per eight hour working day requires an outlay of over \$ 1.5 million. In the developing countries the export of prawns to the U.S.A. has been the basis of some of the first initiatives in this field. Packing and freezing plants of this type are operating successfully in Karachi Alexandria (U.A.R.) and Dammam.

59. Cold stores requiring insulation material, refrigeration units compressors, air blowers, temperature control equipment, etc. in their construction are used both on a short term basis to facilitate assembling and distribution, and to extend the marketing season. Specialized cold stores are being established in producing areas where, for instance, apples or potatoes are stored for several months at temperatures of about 0°C and 6°C. Refrigerated storage capacity for potatoes in India, for instance, reached about 70,000 tons in 1960. Also expanding in their coverage are multi-commodity cold stores where various commodities can be held at temperatures in accordance with the requirements of the products to be stored at freezing temperatures between about -12° to 20°C or at 0° to 6°C. The length of storage might vary from a few weeks to several months, depending on the market requirements. These cold stores are also used for storing imported frozen or chilled foods for a few months until it is distributed to retailers, or for locally produced food to even out seasonal fluctuations of supply, for example, meat, eggs, butter, poultry, fruits and vegetables.

Refrigeration equipment is widely used to hold such produce at correct temperatures until reaching the retail outlet and consumer. One link is the refrigerated distribution warehouse where produce awaits local delivery. Refrigerated display cabinets in retail markets and shops or small cold chambers in order to hold over perishable stocks which are not sold on the day of delivery complete the cold chain.

The refrigeration equipment required at the various stages in agricultural marketing is yet another illustration of the way agriculture and manufacturing industry are inter-related.

Processing Equipment and Machinery

60. The FAO Contribution to this Symposium includes some more papers, which deal respectively with :

- (a) Food and Food Products Industries (Paper No. III).
- (b) Industries Processing Agricultural Products other than Food (Paper No. IV).
- (c) Development of Forest Industries (Paper No. V), and
- (d) Fisheries Industries (Paper No. VI).

These papers also refer to certain requisites such as tools, equipment and machinery, but the scope of this and the other four papers does not permit detailed discussion of the great variety of requisites required for the establishment of industries utilizing raw materials, derived from agriculture including animal husbandry, forestry and fisheries.

61. Processing tools, equipment and machinery are already increasingly manufactured in a number of developing countries.

Such a development will have to be accelerated, and offers at present a greater opportunity for implementation since manufacturers all over the world have been giving, over the past 15 years, more attention to the development and subsequent manufacturing of simplified equipment and machinery, that can be used in small and medium sized processing units.

This is of tremendous importance, because it is clear that industrial development does not need to be implemented solely through the establishment of large-scale enterprises, involving high capital investment in buildings, plant layout as well as in human resources.

All commodities, however, cannot be processed industrially in small to medium sized plants. There are now, however, available for quite a considerable number of commodities commercial pilot units that can operate economically if properly managed.

62. Such pilot units offer unique possibilities for use in rural areas in the training of operators at various levels, and of managers, and the demonstration of suitable processing techniques and technologies. Once such a pilot unit is operating satisfactorily - which can be achieved under proper guidance in a relatively short period of time - it is easy to enlarge the capacity by adding another line of equipment.

If carefully planned in advance, especially with reference to requirements such as water and power supply, building structure, loading and unloading facilities, and also taking into account future supply of raw materials, such a pilot plant can rapidly expand in accordance with raw material supply and market demand.

63. From a national viewpoint there is much in favour for such a development, which will greatly up-lift existing socio-economic conditions in rural areas, and can be instrumental to stop the unhealthy, often unethical and uneconomic process of urbanization. (See also in this respect Paper No.I : "The Economic Significance and Contribution of Industries based on Renewable Natural Resources, and the Policies and Institutions Required for their Development").

64. FAO - as a service to its Member Governments - is continuously publishing a number of specific documents - Studies, Development Papers, Informal Working Bulletins and Periodicals - which describe the variety of tools, equipment and machinery suitable for use in the industries based on renewable natural resources.

Some of these requisites can be made locally, others will have to be imported initially, but at a later stage will need to be manufactured in African countries.

65. In addition, these papers also outline selected methods and processes, and how each piece of equipment and machinery is used in plant operations. They are of great educational value by indicating how process improvements can be made step by step, and are therefore very useful in the establishment of training programs and demonstration projects.

A number of these documents deal with commodities that are of importance to African countries, and a selected list is attached to this paper as an Appendix.

Planners of products processing industries also make use frequently of these papers, which furthermore have been found useful in many FAO operated field action projects which were initiated at Governments request.

66. FAO - also at the request of Governments - supplies frequently indicative cost figures and pilot plant layouts based on a variety of requisites at present available in world markets.

Conclusions

67. It is vital to ensure that these various requisites are used if possible in conjunction, since, if employed in isolation they are not likely to give approximately potential contribution to economic development. The same proposition holds true regarding the interdependence of these requisites and the institutional and infrastructural factors referred to at the beginning of the paper and also dealt with in Paper No.I.

There is, of course, no mechanical formula for the appropriate combination in which these various factors should be supplied. This must be devised on a case-by-case basis and elaborated in the light of careful and extensive planning, research and experimentation.

68. The problem of the local manufacture of these requisites is a separate issue, and one which will presumably take a rather longer time to solve, since it is substantially conditioned by the degree of industrialization of the country concerned.

- A P P E N D I X -

REFERENCES OF FAO PUBLICATIONS ON SELECTED REQUISITES
FOR INDUSTRIAL DEVELOPMENT OF RENEWABLE NATURAL RESOURCES

FAO Agricultural Studies

- No.7 (1949) Better utilization of milk
- No.8 (1949) Rinderpest vaccines
- No.12 (1950) Some aspects of food refrigeration and freezing
- No.23 (1953) Milk pasteurization : planning, plant operation and control
- No.34 (1957) Meat Hygiene
- No.38 (1958) Advances in cheese technology
- No.43 (1958) The efficient use of fertilizers
- No.55 (1961) Agricultural and horticultural seeds
- No.56 (1961) Manual of fumigation for insect control
- No.59 (1963) Milk plant layout
- No.60 (1963) Processing of raw cocoa for the market

FAO Agricultural Development Papers

- No.25 (1953) Equipment for the ginning of cotton
- No.26 (1953) Equipment for the processing of long vegetable fibers
- No.27 (1953) Equipment for the processing of rice
- No.32 (1953) Small farm implements
- No.49 (1955) Flaying and curing of hides and skins as a rural industry
- No.51 (1955) Problems of animal feeding in Europe
- No.54 (1956) Processing of cassava and cassava products in rural industries
- No.58 (1956) Olive oil processing in rural mills
- No.60 (1956) Water-lifting devices for irrigation
- No.63 (1958) Copra processing in rural industries
- No.65 (1960) Irrigation by sprinkling
- No.66 (1960) Agricultural machinery workshops : design, equipment and management
- No.67 (1960) Farm implements for arid and tropical regions
- No.68 (1960) Rural tanning techniques
- No.70 (1960) Meat handling in underdeveloped countries : slaughter and preservation
- No.72 (1962) Dates : handling, processing and packing
- No.75 (1962) Processing and utilization of animal by-products

FAO Marketing Guides

- No.2 (1957) Marketing fruit and vegetables
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Yearbook of fishery statistics

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No.6 (1953) Raw materials for more paper : pulping processes and
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FAO Forestry Development Papers

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No.4 (1955) Handling forest tree seed

FORESTRY EQUIPMENT

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throughout the world
(1962) Directory of wheel and crawler tractors produced
throughout the world
(1957) Log saw catalogue

Forestry equipment notes

Informal Working Bulletins in the FAO Agricultural Engineering Series

- No. 5 The Processing of cocoa (OP)
- No. 11 Methods and machinery for harvesting, threshing, cleaning and grading of forage crop seeds
- No. 15 Methods and equipment for rice testing
- No. 20 The processing of coffee
- No. 21 Portable equipment for sampling and temperature measurement of bulk grain
- No. 23 Rice drying: principles and techniques
- No. 24 Some essential considerations on the storage of food grains (cereals, legumes and oilseeds) in tropical Africa