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TECHNO-ECONOMIC ASPECTS OF AGRO-INDUSTRIALIZATION

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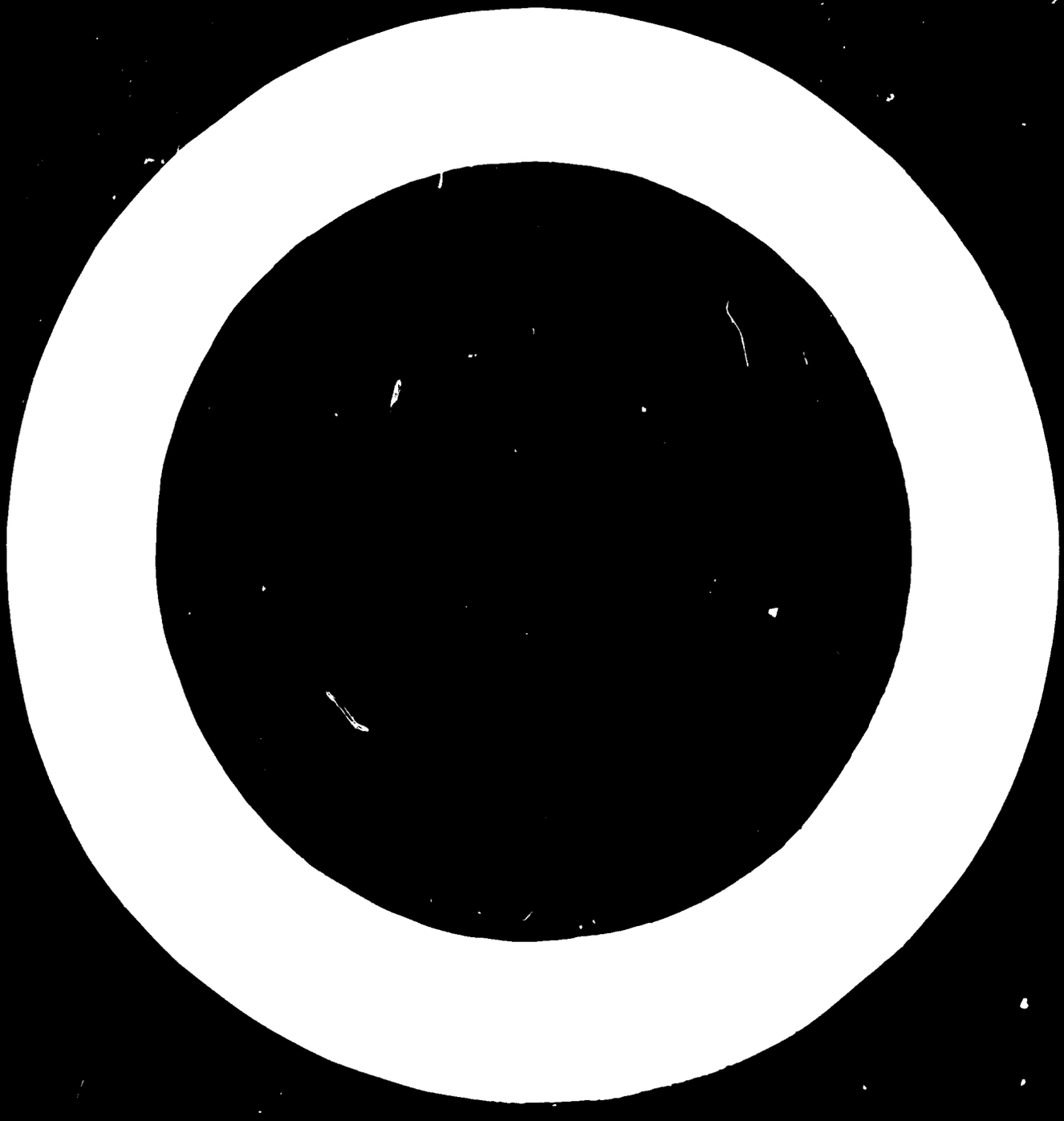

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I. THE FOOD PRODUCTION IN DEVELOPING COUNTRIES

Superficially speaking, there would seem to be no particular difference in the policies and approach taken towards food production by an advanced or by a developing country. For both, food production remains a not insignificant factor in their national economies. This holds true even for economies where standards are high and the position held by industry insuperable. Food production is seen to be absolutely necessary in order to avoid being fully dependent on imports, as well as to ensure that the soil utilization factor and production figures in the country are kept high.

It is interesting to note that food production undergoes a quantitative and qualitative change in the period of industrialization, there being a distinct switch from one assortment of products to another, a case in point being the changeover from staple foods to fresh food or industrial raw material. Even more evident is the change in productivity resulting from the application of industrial technology to all phases of the food production process from the field through the factory to the consumer.

It is equally interesting to observe — for the want of a better word — the antagonism or friction between the various indispensable units in the self-same production process, representing as it does a series of diametrically opposed forces rather than factors in a balanced production programme. The conflicting interests of the various interested parties prohibit the transmission of higher prices, and thus advantages to the farmer in times of shortage, thereby stifling any interest the farmer might have had in increasing his supplies to meet the increased demand.

This simple illustration is indicative of conditions in both developed and developing countries and their very existence more often than not prevents the application of modern food production techniques in numerous developing countries, in addition to hampering any quick decision on successful investments. It would seem that the very long production chain with its host of attendant obstructions can only be changed with the aid of fundamental political and social changes extended over the next 100 years of development. However, one cannot ignore the fact that, contrary to the established practices of many developed countries, a fully integrated food production process has been set up under almost identical conditions, successfully excluding many of the conflicting interests normally associated with this field.

The major difference between developed and developing countries in the field of food processing is the lack of market in the latter. In the majority of such countries, food is consumer-produced and mostly consumer-processed. Despite the great importance of this factor, industrialization plans invariably fail to take the absence of a suitable market into consideration. Experience in UNIDO alone has shown over and over that industrial food processing plants have been established at no small cost in areas where suitable markets were quite unpractical. At the same time, we have come to realize, comparatively speaking, that much more money and time, coupled with lower prices and a more concentrated form of promotion, is necessary to develop a new market in a developing country than to extend the market to the same extent in a developed country. As a consequence, we learned that markets in developing countries cannot be established on the basis of low-level production plants, but that only modern export-oriented plants guaranteeing high technical standards and performance can ensure the gradual subsequent development of the domestic markets.

Conventional infrastructures are often faced with unsurmountable obstacles on account of such factors as climate, lack of skills and finance in developing countries, and extensive food processing schemes and industrialisation programmes are doomed to failure. On the other hand, the unconventional approach implicit in the integrated agro-industrial method mentioned previously can be applied in just such circumstances without any need for the whole gamut of political and social infrastructures: the exploitation of mineral resources throughout the world is indicative of its success.

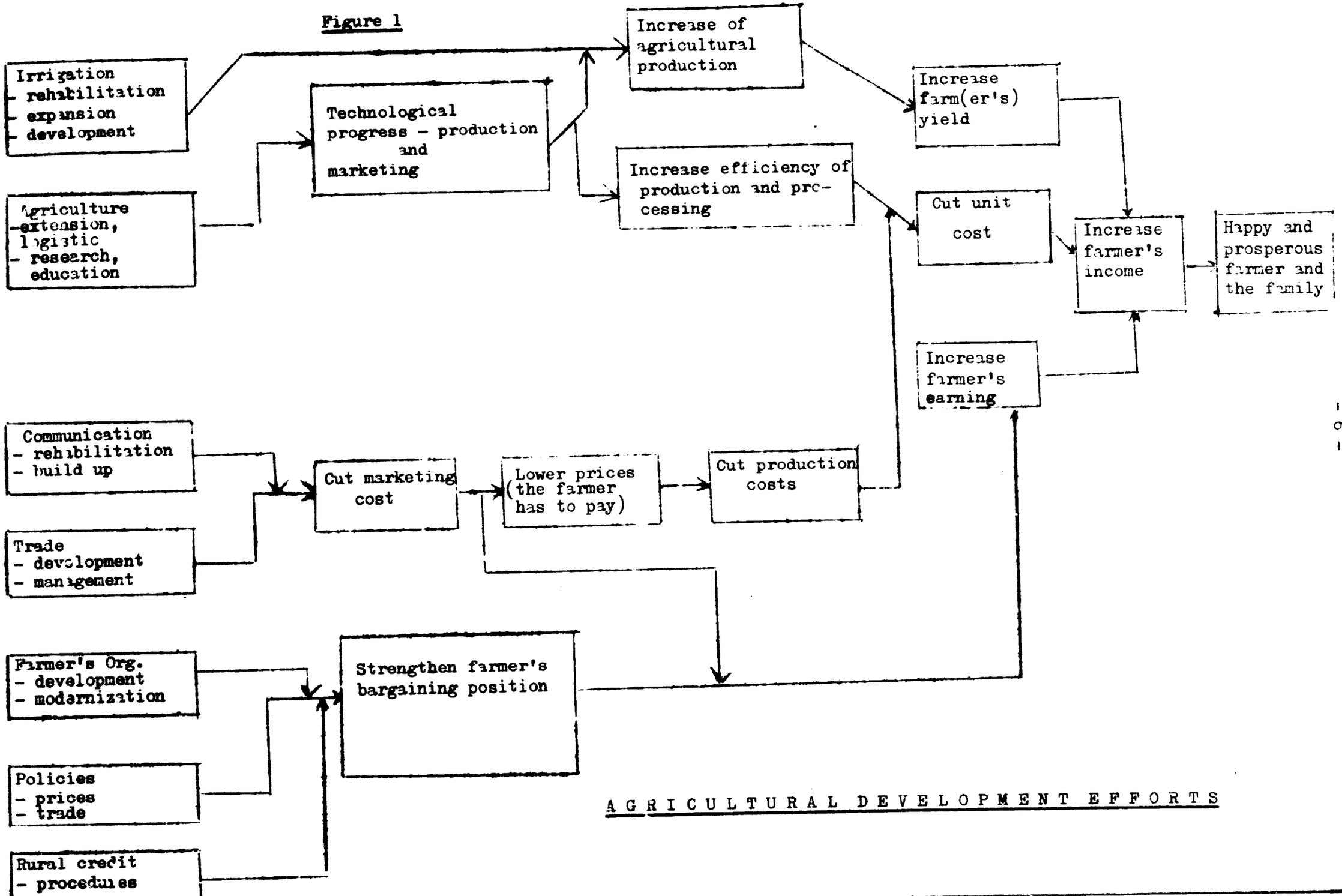
Despite, or possibly just because of its clarity and directness, the method has met with considerable resistance. The hide-bound conservatism of food production with its traditional approach towards science and technology tends to consider the industrial aspects and a techno-economic approach with all its social and political conotations to be a direct result to human relations and the contribution of the country concerned.

However, with the aid of the flow chart below (Figure 1), it can be shown that the motivating forces behind most investments in the food industries of developing countries were social and human, the ultimate aim being to ensure the happiness of the farmer and his family. Industrial production is admittedly concerned solely with getting increased returns on capital invested, but it is at the same time possible to huminize the process.

The basic dichotomy between the acceptable and industrial approach towards food processing is that the industrial approach, seen from the techno-economic aspect, is no longer concerned with satisfying the human need for food. The sole motive is profit, best achieved by selling industrial products to the willing consumers. Should the consumer lack willingness, he is coerced by means of attractive packaging, persuasive advertising and euphoristic, unsubstantiated claims. The producer's fundamental aim is still to sell as little as possible for as much as possible, feelings and ideals counting for naught.

Most advanced nations have come to realize the urgency of the situation, and special drug and food administration services have been set up to supervise the industry and establish minimum standards. The outcome is a cloak-and-dagger struggle between the two parties indicating the modern food processing has become an integral part of industrial economy while clear-cut policies would help to pave the way for considerations other than profit-making, thus ensuring investment in food-processing facilities along the whole line of technical production, from the producer right to the consumer.

Figure 1



A G R I C U L T U R A L D E V E L O P M E N T E F F O R T S

II. THE PRODUCTIVITY OF FOOD PROCESSING

The increased application of industrial technology to the agricultural sector is recognized as a major attribute of soci-economic development in all countries, both developed and developing. This has resulted in a trend away from the small, family-unit farm towards more complex systems of economic organization, such as fully integrated agro-industries. For example, the United States Department of Agriculture has forecast that by 1980 the average farm size in California will be 2,100 acres in contrast with 835 acres which was the average size of California farms in 1968.

The economic rationale for the trend from small- to large-scale agricultural production is illustrated by two examples of total production costs of freshly harvested tomatoes delivered to the factory: first based on a system of small-unit production in Trinidad and Chad; the second concerning large-scale production in California, USA:

> In the first example, the cost of production was about US$0.08 per lb for Trinidad and Chad; the tomatoes had been planted, cultivated, harvested and marketed by individual farmers, using approximately one-fourth of an acre for this crop.
>
> In contrast, the average cost of production on a fully mechanized, large-scale farm, owned and operated by a tomato processing plant in California, was only US$0.02 per lb delivered to the plant. The mechanized harvesting of tomatoes on this 8,000 acres was at an average distance of 4.5 miles from the processing plant.

Table 1

Comparison of the small- and large-scale industrial Production of tomatoes

Small-scale production	Titles	Large-scale industrial production
0.25	Acres of tomatoes under cultivation	8,000
ca. 800	Yield per acre	ca. 4,000 kg
Poor variety with an average of 4.8 per cent of dry substance	Varieties	Special varieties, streamlined for the production of: whole peeled tomatoes canned, tomato purée, tomato paste concentrated, tomato juice and for tomato ketchup; average for paste: 6.2 per cent of dry substance
Farmer's US$0.20/h/man	Income of the farmer respective industrial worker	The worker is employed all year round, first on the farm, then in the factory US$3.20/h/man
US$0.08	Total cost of one pound tomatoes delivered to the factory	US$0.02
US$393,-	Factory cost per ton of dry substance */	US$74,8 per ton

*/ The world market price of one ton of dry substance, estimated at 28 per cent tomato paste, in cans of one gallon is US$400 to US$450.

Therefore, the cost of producing industrial tomato paste on a small scale (50 tons per day), where raw material accounts for 50 per cent of total costs, is US$800 per ton on the basis of dry-substance content. On the other hand, when tomatoes are processed on a large scale (200 tons per day) in modern industrial facilities, the cost of tomato paste production, where raw material represents 75 per cent of the total costs, does not exceed US$100 per ton, again on the basis of dry substance content.

The final picture is as follows:

	US$ per ton
Tomato paste from rural industry	800
World price for 1 ton of dry tomato paste	425
Tomato paste from integrated agro-industry	100

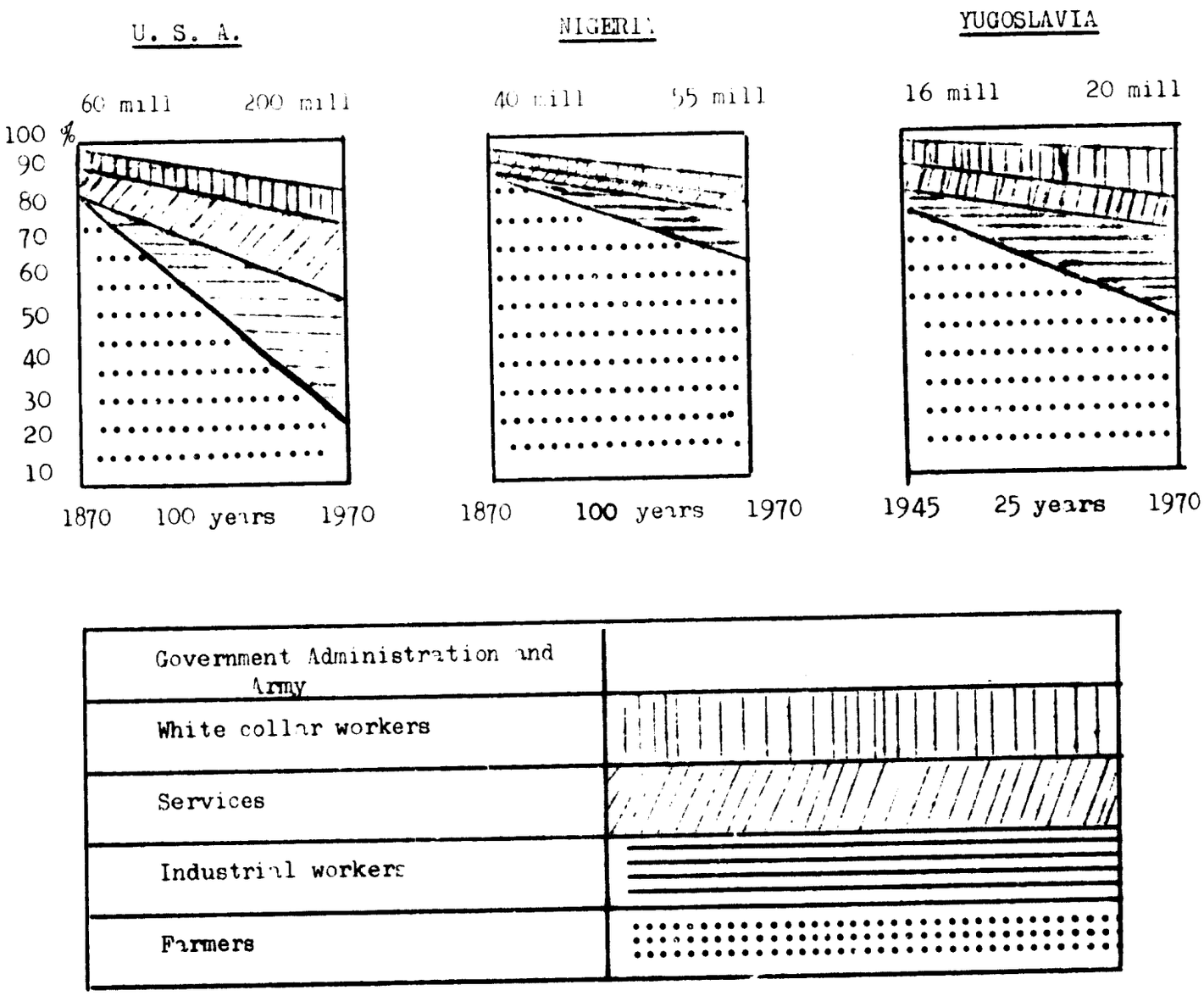
These are two extreme examples, and that there are many intermediate cases that could be cited. For example, in Italy (the biggest tomato paste producer after the USA) the over-all cost of production does not exceed US$300 to US$320 per ton of dry substance. Moreover, Italy is able to export large quantities of tomato paste without granting special subsidies. The more extreme examples were offered as a basis for the discussion of trends and principles relating to agro-industrial development. There are, of course, many alternatives. Thus, while there is no dispute regarding the existence or the desirability of the trend toward the industrialization of the agricultural sector, there is a wide range of opinions concerning the techniques and institutional arrangements most appropriate for accelerating this process.

In order to put the problem in a broader perspective, it is necessary to consider the profound impact that industrialization has had on the social structure of rural communities in some countries.

Figure 2 below illustrates the changes in social structure that are associated with industrialization. The three examples represent countries at varying levels of industrial development and suggest a correlation between industrialization and change in social structure.

Figure 2

The change of social structure in selected countries



III. DEFINING INDUSTRY

Before considering how to successfully industrialize rural areas, or how to change the social structure of the rural community, we should agree on a definition of industry. When I asked a friend for a definition, he gave me this reply from H. Singer, USA: "It is difficult to define a giraffe. But the moment you see one, you know what it is". Some authors (Chenery, Mandelbaum) use the term industry in a very broad concept to include manufacturing, mining, construction, power and handicrafts. Other authors (Hoffmann and Myrdal) restrict their definition of industry to manufacturing. In the United States, a wide range of large-scale agricultural operations are regarded as industries, such as the chicken industry and the soybean industry, which cover an entire field of vertically integrated processes from the production of special chicken animal feedstuffs to the marketing of frozen and canned chicken in chain or department stores. The United Nations decided to include only "manufacturing" when dealing with processes and problems of industrial development in developing countries.[1] In limiting the term "industry" to manufacturing, we are still faced with the problems of defining and demarcating industrial production in relation to other economic activities. According to the United Nations definition, manufacturing is the mechanical or chemical transformation of inorganic or organic substances into new products.[2] This definition, however, has specifically excluded biological processes in order to make a distinction between industry and other economic activities, particularly agricultural production. This raises certain conceptual problems when biological processes are used in the manufacture of foods, pharmaceuticals, chemicals, beverages, and when the modern agro-industrial processes have integrated the sequence of mechanical, chemical and biological operations to such an extent that no clear-cut distinction can be made.

The main criteria for the concept of industrial production can be defined as follows:

(a) A significant transformation of various imports into new commodites;

(b) Production of commodities very distinct from raw materials with a higher, added marketing value;

1/ Processes and Problems of Industrialization in Developing Countries, U.N. New York, 1955 (Sales No. 55.II.B.1) page 2

2/ United Nations International Standard Industrial Classification of Economic Activities, New York 1968 (Sales No. E.68.XVII.8) page 28

(c) Production is a continuous process or a set of consecutive operations integrated in a processing line requiring both extensive production planning and production engineering;

(d) Industrial production is characterized by a substantive division of labour among production activities and between management and production itself;

(e) A relatively high capital/labour ratio and a high concentration of production capacities concentrated in one location; and

(f) A relatively high productivity/labour ratio combined with an extenutilization of power, power-driven machinery, automatic transport, and mechanization.

In other words, all manufacturing activities that can be characterized by the above criteria can be regarded as industrial activity, in spite of the fact that source or quality of raw material, processing operations and marketing methods have a major impact on our definition of industrial activity.

Capital intensive industry

The often-used criteria of capital intensive industry can sometimes be misleading because the capita/unit of product ratio is far more relevant to the structure of industrial production than is the capital/labour ratio. For example, Thailand has 10,000 small artisanal rural rice mills. In order to reconstruct the present milling capacity, Thailand invest yearly four to five times more than would be necessary for the same capacity based on a modern commercially sized wet-rice milling process. These plants would produce 10 to 14 per cent more whole rice kernels, and the whole rice oil and protein content of paddy (dovering 50 per cent of the national consumption of rice oil and vegetable protein, which is presently going to waste entirely) could be recovered for human consumption.

The traditional concept of industry - as pictured from 50 to 60 years ago - a red stone, dark building with a boiler house and a high chimney - has to be replaced by a more flexible concept appropriate to the industrialization of rural areas. Indeed, we maintain that the type of large-scale agricultural production described above is industrialization par excellence.

IV. WHAT KIND OF INDUSTRY SHOULD BE FAVOURED?

This question brings us to the heart of the problem. Generally speaking, there are three ways to industrialize a rural area:

(a) By industrial activity which differs widely from present economic activities and which uses new raw materials, applies industrial techniques for the production, and provides a diversified range of products;

(b) By introducing improved techniques and services in agricultural production and animal husbandry; by raising the productivity of individual farmers through increased mechanization; by establishing co-operatives for the selection of breeds and for common small-scale processing of different field crops and animal products; by improving marketing methods; by the supply of irrigation water to individual farmers; by reclaiming land; and by providing multiple services of agriculturists, veterinarians, sanitarians, schoolmasters, lawyers, administrators, etc. to the area, thus raising and improving the standard of life of the average citizen; and

(c) By application of the above industrial methods of production in the form of partly- or fully-integrated and specialized agro-industrial production, thus abruptly changing the social and economic structure the community.

The feasibility of any one of the above approaches will depend on the particular conditions existing in the various countries under consideration. There is no general rule or approach to be applied in all situations. The first approach is practical only in those areas which possess an ideal set of preconditions to development, such as: a particularly good supply of newly-developed raw materials (ores, minerals, mineral oil, etc.); a special accumulation of expertise, skills, patents and capital; and an increasing demand for those products a particular country can produce with the resources at its disposal. The existence of such a set of preconditions would permit the industrialization of the agricultural sector, along with related changes in the social structure, with a minimum of social, economic, and political problems. However, since these conditions seldom exist in developing countries, the first approach may be discarded from our discussion. This leaves us with the difficult task of appraising the relative merits of the gradual and the extensive approaches. In other words, one must attempt to determine if, generally speaking, it is more desirable to industrialize the agricultural sector gradually by providing a limited range of services and organizations within the existing social structure (based on individual, small farm holdings) or rapidly by the introduction of fully integrated agricultural complexes, which

will radically alter the pre-industrial social structure, thus transforming a stagnant rural economy into a dynamic component of the national economy.

In view of the fact that only the Government of a particular country is competent to select a particular path to agro-industrialization, our role is to provide such a Government with an objective appraisal of the various alternatives. Therefore, we should **always** put to ourselves the question: 'Is it permissible to recommend an approach to developing countries which is regarded as obsolete in developed countries?

It is clear that progress can be made by gradual improvement of agricultural production and there are circumstances under which no other way is possible. However, because there are several variations between the two extremes of gradual and immediate industrialization of the agricultural sector, the selection of a particular approach should only be made after a thorough study of the various alternatives within the context of a specific country's social, economic and political environment.

The advantages of agro-industrial projects are:

(a) **Agro-industrial** projects are bankable. It is **easier** to acquire finance sources, both domestic and foreign. Industrialization of rural areas by a gradual process can be financed only from public funds and has to be subsidized for many years.

(b) Agro-industrial production produces a chain reaction. It catalyses its own growth by profits which can be reinvested partly for enlarged agro-industrial production and partly for the reconstruction of the rural areas, i.e. for improvement of social and political conditions, and for investments in services, cultural development and in the further diversification of industrial activity.

(c) Integrated agro-industrial production can be established:

- with far less investment per unit of product;
- in a very short period of time;
- with far less skilled labour;
- with few risks;
- as sufficiently viable to meet foreign competition, thus creating exports;
- to satisfy a growing demand for agricultural products on the home market; and
- with a substantively reduced level of investments in the micro-structural prerequisites of rural development.

(d) Integrated agro-industrial production would appear to be the only feasible approach to the development of reclaimed territories or vast virgin lands under very heavy conditions of tropical and sub-tropical climates and soil structure. The great number of failures and the few cases of success in this report have shown that only the

establishment of viable, agro-industrial combines can provide a basis for upgrading the living standards of white collar and other workers - to provide not only conditions for their survival, but to establish an economically vigorous community with a modernized social structure, and with the necessary material and cultural services. In the following discussion, we will concentrate mainly on integrated agro-industrial food production and marketing.

V. TECHNOCRATIC ASPECTS OF INTEGRATED AGRO-INDUSTRY

Unified technology of the process

One of the first prerequisites in formulating a viable programme for integrated agro-industry is to include the three main fields of the hitherto separated activities in one unified production process, which starts with the large-scale production of primary crops in the fields and proceeds through all the stages of a sophisticated industrial process to the distribution of the final food products in home and foreign markets.

There are a great number of economic and technological reasons for such a unified, integrated process. Some examples are given below:

(a) Today's sugar factory is unprofitable if:

- daily processing of sugar cane or sugar beet does not reach at least 4,000 - 5,000 tons per day;
- the production costs of the raw material exceed a certain limit;
- the average distance from the factory exceeds 10 km;
- the average yield of cristalized sugar does not reach a certain minimum;
- if the daily supply is not organized so that the period between harvesting and processing can be reduced at least to 24 hours;
- the factory is not supplied during the whole season at an average of 85 to 90 per cent of the capacity.

It would be extremely difficult to organize, according to these criteria, the supply and the flow of sugar cane in co-operation with 20,000 farmers, who plant 0.5 to 0.2 acres of sugar cane each. It would be easier to achieve this by integrated agro-industrial production.

(b) Today's meat processing factory is unprofitable if:

- the flow of supply, the price and the quality of raw material is not relevant to requirements;

- the yield of prime cuts is not up to a certain minimum;
- the daily capacity does not exceed a minimum level of, say, 500 pigs a day, 150 to 200 cattle a day, 5,000 to 10,000 chickens a day;
- the entire quantity of byproducts (hides and skins, fat tissues, bones, glands, blood, intestines, heads) and wastes are not fully exploited to produce: meat extract, gelatine, shortenings, meat and bone meal, pharmaceutical and other products, etc.;
- the processing facilities are not technically and sanitarily competent to produce the quality, quantity and assortment of goods required by an expanding domestic or a sophisticated and changing world market;
- an appropriate marketing organization, backed by technical storage, transport and marketing facilities, is not provided by the management of the enterprise; and
- the marketing department does not dispose of a minimum quantity of certified standardized meat products corresponding to the trading and sanitary prescriptions of domestic and foreign markets.

Many meat processing factories established in developing countries, which have not been able to satisfy these criteria, have either operated at a loss, closed down, or have neber been put into operation. This emphasizes the fact that only profitable, integrated meat processing operations can be safely recommended - especially in developing countries.

A home market or an export market can sometimes be developed through small scale operations, by isolated investments, and by filling a persistent gap. But the rate of industrialization by this method is too slow and the risks are too high to attract the scarce capital to be found in developing countries.

VI. PROCEDURE OF PLANNING A LONG-RANGE DEVELOPMENT PROGRAMME

The traditional procedure which is based on existing soil characteristics, climate, traditional crops, agricultural surpluses, and the present assortment of products, should be abandoned as soon as possible. For example, it is not sufficient for a profit-minded industrialist to plan the future meat production of Iran by sheep husbandry only, because sheep is a traditional part of the Iranian animal husbandry or a traditional dish for the Iranian meat consumer. There are sufficient economic and technological reasons that sheep production has

nowhere in the world become a major supplier of meat, and that the Australian sheep husbandry has shifted mainly to wool production.

The market-minded planner of today's integrated food industries must thoroughly explore the existing and the future demand on the domestic and the world markets, and must assess the priority of the most profitable (not the most deficient) commodities. He must then turn to the raw material resources and explore the possibility of large-scale industrial production of these resources according to the market factors. Here he has to estimate the investment and production costs of raw materials delivered to the processing facility. At this stage of programming, the planner selects the optimum-sized processing facility which will permit the complete utilization of products and byproducts of the previously assessed agricultural production - correcting or eliminating from the first agricultural programme all unbalanced factors and quantifications. After he has calculated final investments in the processing and distribution facilities, and estimated the final costs of production, he is able to study the market for a second time in view of more clearly defined quantities, timing, qualities and prices. The second study of the market will certify the viability of the programme, or will indicate minor or major corrections which may be required throughout the integrated planning process.

On the basis of such a long-range programme, which should not pretend to replace an existing rural economy, but to be the progressive part of it, locations, zones and areas can be explored to determine where such programme can be gradually implemented.

VII. STRUCTURE OF INTEGRATED AGRO-INDUSTRIAL FOOD PRODUCTION

Analysing the structure of present agro-industrial integrated combines, both in capitalistic or so-called socialistic countries, we can identify some groups or levels of activities which are fundamental and which characterize the organization, the function, and the rationale for a unified industrial process in those combines.

These groups are as follows:

(1) Production of basic crops and collection or catch of raw materials:

This group embraces all large-scale agricultural operations involved in the production of industrial crops, streamlined by variations for the industrial production, the catch of fish and the collection of wild, spontaneously grown vegetable or animal raw materials.

(2) Pre-processing, transport and storing of basic crops, catches and pre-processed products:

This group includes harvesting, cropping, operations, cold storage, sorting, upgrading, drying, washing, dehydrating, chopping or other pre-processing of raw materials for the purpose of preservation in a cleaner or more concentrated form for further industrial processing.

(3) A basic food processing industry adjacent to production of raw materials:

This group includes the basic, primary food processing industries such as: the production of sugar, fruit and vegetable preserves, vegetable oil, oil cakes; the production of flour for the purpose or processing basic isolated food commodities and to separate by-products needed elsewhere. Mostly this group of primary food industries is closely associated with the production of the raw materials.

(4) Production of animal feedstuffs for up-to-date animal husbandry:

Industrial production of animal feedstuffs is the basis for an up-to-date, successful animal husbandry, of the industrial ranching type. The producer of animal feedstuffs is today's most important entrepeneur in the establishment of profitable meat, egg, milk and wood production.

(5) Production of animal proteins by industrial ranching:

This group consists of industrialized animal husbandry based on the fattening or feeding of a large amount of animals in "animal protein factories", which are often located very near to the markets or to adjacent processing facilities (slaughter houses, meat processing, dairy plants, etc.) creating a logical combination of the animal feedstuff factory - industrial ranching farm - processing facilities - marketing facilities.

(6) Food production for direct consumption:

This group is the fast-growing, secondary food processing industries supplied by raw materials directly from groups 1, 2, 3 and 5. These materials are combined into a rich assortment of ready-made foods which can be distributed directly to or consumed by the individual purchaser. This is accomplished by developing labour-saving engineering techniques for products of a high nutritional value.

(7) Distribution and marketing activities:

This group consists of all technical and commercial facilities (cold stores, cold transport facilities, catering services, restaurant and department store chains, etc.) necessary for the regular supply of food products to the home and export markets.

Integration of all these groups of operations is not always necessary; sometimes a group can be eliminated or can be replaced by co-operative operations. Sometimes it is not feasible to implement all the operations at once but only gradually. It is clear that the assortment of operations at each level has to be selected according to the procedure explained in the programming part of our discussions. Some lines of food products can be successfully developed also by small-scale individual operations.

VII. CONCLUSIONS

It is equally clear that whenever integrated food processing is feasible it should be preferred to all other programme - especially in the case of developing countries.

The industrialization of rural areas has to be programmed and implemented under the leadership of industry - the only entrepreneur capable of applying objective criteria to all operations, thus maximizing the benefits associated with the application of industrial technology to the agricultural sectors of developing countries.

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