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The Economist and Farm People in a Rapidly Changing World

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By THORKIL KRISTENSEN

Secretary-General of OECD

THE APPROACHES AND FINDINGS OF ECONOMISTS[1]

Introduction

ECONOMISTS think in terms of demand and supply. This paper will therefore try to give some elements of an answer to the following three questions:

1. How are demand for and supply of agricultural products likely to develop in the foreseeable future?
2. What will be the ensuing consequences for farm people in various parts of the world?
3. What, if any, are the policy implications of our findings?

The great paradox of present-day agriculture must be in our mind all along. Until recently our planet has been split up into two nearly isolated parts. On the one side we have the rich countries and in particular the western-type market economies (including Japan, Australia and New Zealand) where markets for some commodities have tended to be overloaded because production was pushed by protection and subsidies, which again were motivated by the income gap between farm people and the more fortunate urban sectors of the economy. On the other side we have the poor, less developed countries with widespread malnutrition and often under-nourishment. Their very poverty has prevented them from buying in a big way the food surplus that the richer nations can produce.

However, in recent years some of these countries have increasingly become net importers of food from the developed countries. The question therefore is whether this is the beginning of a development that will gradually link the two parts of the world closer together and thereby contribute to a change in the demand/supply relationship within agriculture in the developed countries.

This being one of our main problems we shall distinguish to the extent possible between the developed countries (here called DCs)[2]

[1] This paper is written at a time when the author has just started a major study of the World Food Problem within OECD, in close co-operation with FAO. The views expressed should therefore be considered as provisional and subject to revision.

[2] North America, Western Europe, Japan, Australia and New Zealand.

on the one hand and the less developed countries (LDCs) on the other. Unfortunately, we have to treat the centrally planned countries as a special group, partly because of their special trade systems and partly because information about some of them is scarce. In fact, they consist, economically speaking, of two groups of countries: Eastern Europe and U.S.S.R. can be considered as developed countries and we shall write *DC*s when they are grouped with the western-type developed countries. On the other hand, mainland China, Mongolia, North Korea and North Vietnam are less developed countries and we shall speak of *LDC*s when they are grouped with the LDCs which represent the rest of the world, i.e. the regions not so far mentioned.

Another distinction to which we shall pay some attention is the one between *plant production* (crops) and *animal production* (livestock production). Plant production is not only the basis of animal production; it is also, economically speaking, the most unique of the two. Animal production is more similar to other processing industries, transforming raw materials into finished or semi-finished products.

Plants have the unique quality that they can produce organic matter, food for men and animals, by extracting carbon dioxide from the air and combining it with water and a few minerals in the soil. To do this they use the energy contained in sunlight. We talk nowadays about utilizing solar energy directly for productive purposes. This is what plants have been doing for millions of years and this is why land is so essential to agriculture. The more land, the more sunlight (and water) used. Therefore, other factors of production cannot in the true sense replace land, but can only help us better to utilize existing land, within certain limits set by nature.

What animal production does is mainly to transform some of the organic matter obtained from plants into other forms of organic matter. Thereby we lose most of the calories contained in the plants. They are used to keep the animals alive and give them the energy they need to move around (and maybe work for man). The small remaining part of the calories contained in fodder comes out as animal products which, on the other hand, are normally attractive foods of high nutritional value. Animal proteins, in particular, are important food elements which only the rich nations have in sufficient quantities because the poor peoples cannot afford to spend the many plant calories it takes to produce them.

Therefore, the food problem of the world splits itself into two problems: (1) How much organic matter will plant production give

us *per capita* under certain economic conditions? and (2) How much of these plant products can we afford to convert into much smaller quantities of attractive animal products, often of high nutritional value? Today the answer to these two questions is very different in the *DC*s and the *LDC*s. It has been estimated that in 1955 no less than about 12 billion crop units were converted into animal products, mainly in the *DC*s, while only 6 billion crop units were consumed as vegetable foods of which grains are the most important, especially in the *LDC*s.[1] The difference between the two parts of the world was most spectacular concerning consumption of animal protein *per capita*.

One of the questions of the future is to what extent new, science-based techniques will modify the patterns of food production and consumption. It is partly a question of developing sorts of various plants which can, nutritionally, better replace animal products (though probably remaining less attractive for rich people!), and partly a question of producing new kinds of food outside of agriculture. Some remarks on these projects and their possible impact on agriculture will be made in the following section.

I. *Demand and supply*

The simplest way to form an opinion on future demand and supply of agricultural products is by extrapolating recent trends. It has, however, to be a *modified* extrapolation, taking into account what we know about the various factors determining demand and supply respectively and the conditions of their future development. It is therefore convenient to discuss briefly the nature of these factors before presenting some illustrative projections for the remainder of this century.

The bulk of agricultural production is, of course, consumed as *food*. However, according to FAO[2] some 12 per cent. of world agricultural production consists of non-food products such as coffee, tea, tobacco, some oilseeds, fibres and rubber. Since these products are nearly all crops (the main exception being wool), it is in a way more interesting to compare them with food crops; i.e. to keep livestock out of the comparison. The result is that in the *DC*s food crops represent 29 per cent. of total agricultural production, compared with 9 per cent. for non-food products. In the *LDC*s[3] the corresponding

[1] Thorkil Kristensen and associates, *The Economic World Balance*, Copenhagen, 1960, Table V–7.

[2] *The State of Food and Agriculture 1965*, Tables II–5 and II–6, p. 22.

[3] Excluding mainland China.

percentages are 57 and 15. Thus, in both areas non-food products must cover a sizeable part of agricultural land. Their relative importance has been increasing in the *LDC*s, but decreasing in the *DC*s. One of the uncertainties of the future is how large a proportion of their agricultural land the *LDC*s will have to divert from food production to non-food export production. It seems doubtful whether the relative importance of these products will go on to increase in *LDC*s since demand for coffee and tea is not rising fast[1] and fibres and rubber must compete with synthetic products. For the world as a whole the relative role of non-food products has been slowly decreasing over the last decade or so.

In the following we shall assume that the relative share of non-food products in total agricultural production does not change significantly.

Turning now to food, future *demand* will mainly depend on the growth of population and of income *per capita*. With rising incomes food consumption increases but its share in total consumption decreases, especially where incomes are already high. This is expressed by the *income elasticity* of demand which is high in the poor countries but very low in a country like the United States. The following projections are based on FAO work concerning income elasticities.

There are of course some secondary factors that have a certain influence on demand for food. We shall briefly mention a couple of such factors which, taken together, may give a partial explanation of the fact that in recent years food consumption in *LDC*s has risen much more slowly than existing statistics about incomes and population would lead one to expect.[2]

First, in the present phase of population development *children* constitute a large and growing share of total population in the LDCs and children, especially young ones, eat much less than adults. Secondly, *income distribution* in many LDCs has probably developed in a way that reduces growth in food consumption. In most LDCs a small urban sector has a much higher average income per head than the large farm sector and therefore a much lower income elasticity of demand for food. Now, it seems that in many countries farm incomes have been nearly constant for some years due to unsatisfactory growth

[1] In the *DC*s. With rising incomes demand for non-food products may, however, increase faster in the *LDC*s.

[2] FAO: *The State of Food and Agriculture 1964*, Table II–8, p. 34, shows an annual increase in food supply (and thus in fact in food consumption) of about 0·3 per cent. a year per head while existing information about incomes and income elasticities would indicate an increase of at least 1 per cent. a year.

of agricultural production. Most of the income increase, therefore, has taken place in the small urban sector, which means that the actual income elasticity has been below its normal level. This is on the whole likely to remain so for some years to come. If, at a later stage, farm production starts to increase faster, then farm incomes will also increase faster and so will consequently the food consumption of farm families. The quantities brought on to the market may therefore not increase quickly for some time to come. It is important to bear this in mind when evaluating the future.

A third secondary factor determining demand for food is the *prices of food* compared with other prices. In recent years there has been a relative increase in food prices in a number of important LDCs, no doubt due to a certain shortage of food. This should normally lead to a reduction in the demand for food as it does undoubtedly in the urban sector. For the farmers, however, higher food prices mean better incomes and, this being so, will they eat more or less? No satisfactory answer can probably be given to this question today, but with the rapid growth of the urban sector total food consumption should increasingly become responsive to price movements.

Concerning *supply* of food, one of the main determining factors is, of course, the size of demand. Roughly speaking, demand and supply must equal since changes in stocks are normally small compared with world production. There are, however, independent factors of production limiting the elasticity of supply so that demand and supply must mutually adjust to one another through changes in prices or other means of influencing the patterns of consumption and production.

Of these factors of production the general *environment* in which agriculture has to work plays a role that is certainly important but also difficult to express in quantitative terms. If the society in question is rich in resources and well governed, endowed with an efficient public administration, good means of transport and a high level of education, then the environment is favourable to agricultural production. It is also favourable to economic growth in general and therefore to a steady increase in the level of incomes. There is here a certain automaticity. An improvement in the environment tends to increase both the supply of and the demand for food just as we have noted that an increase in agricultural production in the *LDC*s will almost automatically entail an increase in the food consumption of farm families.

It is an important aspect of the world food problem that since the nutritional standard of the *LDC*s is so low those factors that are most powerful in increasing their food production will at the same time substantially increase their demand for food.

In addition to the environment there are, of course, *specific factors* of production in the agricultural sector itself. We shall group them in four categories: land, labour, capital and knowledge.

Land is the original factor of production. In the primitive societies of food gatherers only a small amount of labour was required to collect the products of the land. Later on more and more was added, first of labour and then increasingly also of capital and knowledge. Within certain limits labour can be a substitute for land, capital for both land and labour and knowledge for all the three other factors. However, as mentioned in the Introduction, land remains essential as receiver of sunlight and rain, indispensable for plants and therefore also for animals and men.

To measure land in hectares is not altogether satisfactory because of differences in soil, slope and climate. For vast regions these differences tend to equal out and therefore we shall cautiously measure land in hectares with a distinction, however, between arable land and permanent grass. According to certain estimates the former may on the average be some four times as productive per hectare as the latter but that of course varies with climatic conditions and patterns of production.

Since most *LDC*s are tropical countries it would be of interest to have a general impression of the comparative value of tropical soils. They have disadvantages, especially the great risk of erosion, but also advantages because there is no winter so that more crops per year are possible when enough water is available. Historically, on the whole they may have been at a disadvantage but with the progress of science and technology their comparative value should increase.

Labour has been applied to land in increasing quantities throughout history. The number of farm workers per hectare is now going down, sometimes rapidly, in the *DC*s. It is still going up, however, in the *LDC*s and this is likely to go on for a long time to come. The difference in labour intensiveness between agriculture in the two regions is therefore likely to become more and more spectacular and more will have to be said about this important problem in what follows.

Capital in agriculture consists of domestic animals, buildings,

machinery, irrigation systems and such current inputs as seeds, fertilizers, pesticides, etc. Of great indirect importance for agriculture is also the investment in the so-called agro-allied industries, producing inputs such as fertilizers and processing the farm products to adapt them to the requirements of the markets. Likewise, a good transportation system and co-operative or other mechanisms for the commercialization of the products are important.

Recently much capital investment in the *DC*s has been made with a view to mechanization, the main purpose being to replace labour. With abundant labour the *LDC*s are more in need of current inputs such as improved seeds, fertilizers and pesticides. Also as regards the pattern of agricultural investment, therefore, the two regions are likely to remain rather different for a long time to come.

Knowledge is here conceived of in a wide sense. It is more than technical know-how since it comprises also commercial and managerial experience as well as, in fact, general education. The latter is important because it increases the capability of man to absorb new technical or other specific knowledge. It also, as a general rule, enhances his receptivity to innovation.

Knowledge has, so to speak, two dimensions: the amount of knowledge times the number of people who possess it. What is needed, therefore, is research to increase the amount of knowledge and education, various means of communication and advisory service to spread it. Knowledge, once produced, is a free commodity. You only have to spread it. Therefore, basic research undertaken in the *DC*s can be utilized by the *LDC*s and this is one of the main elements in development. In agriculture, however, so much depends on the soil, the climate and other local conditions, and therefore very often the techniques of the rich countries cannot be transferred as they are—in fact, much less so than in industry. This is why *adaptive research*, undertaken on the spot, is likely to be one of the high priorities of the next few decades.

In view of what has been said, what is likely to be the future pattern of demand and supply in the various regions?

In proportion to total population the *LDC*s have on the average more agricultural labour but less agricultural land than the *DC*s. They also have much less capital and knowledge and it is therefore no wonder that their production per head is much smaller. Their production per hectare is also smaller than in the *DC*s but in spite of some much publicized extreme cases the differences are smaller than

often believed. For the years 1957–60 the FAO has calculated the following average yields (100 kg/ha) for some major crops:[1]

	DCs	LDCs
Wheat	13·3	9·4
Rice, paddy	38·4	19·1
Other cereals	18·0	9·0
Starches	122·2	74·5
Pulses	6·5	6·3

Later information does not seem to indicate substantial changes in the relative yields of the two regions.

In the future the *DC*s will have somewhat less land per head of population than today and also substantially less agricultural labour, but more capital and knowledge. The *LDC*s will, in comparison, have much less land but more labour, capital and knowledge.

Concerning *land* some projections are possible. In the following table, which shows area in hectares per head of population, it is assumed that the area of agricultural land will remain what it was in 1960. Some extensions are still possible, mainly in the *LDC*s, but they are now rather limited and the quality will be lower than average. At the same time, urbanization and population growth will require more land for non-agricultural purposes, especially in the *LDC*s where population will grow fast and where urbanization on a large scale can be expected. The table is based on FAO data concerning land and on the United Nations projections for population (high variant).

TABLE 1

	*DC*s			*LDC*s		
	1960	*1980*	*2000*	*1960*	*1980*	*2000*
Arable land	0·7	0·5	0·4	0·4	0·2	0·14
Permanent grass	1·3	1·0	0·8	0·6	0·4	0·24
Total	2·0	1·5	1·2	1·0	0·6	0·38

It will be seen that by the end of this century the *DC*s are likely to have three times as much agricultural land per head of population as the *LDC*s.

Concerning *labour* the relative positions of the two regions will no doubt develop in a way very different from the one just indicated for land. The total labour force in agriculture will go down in the *DC*s

[1] *Third World Food Survey*, 1963, Table 10, p. 21.

but it is still likely to grow in most *LDC*s throughout the remainder of this century. Already now the percentage of the total population employed in agriculture is much lower in the *DC*s than in the *LDC*s and the same is true of the number of farm workers per hectare of agricultural land. In both respects the differences between the two regions are likely to increase very substantially. Complete statistics are not available but some information on levels and trends exist which makes it possible to get at least a rough idea of the orders of magnitude.

As will be demonstrated in Section II agriculture in the *LDC*s will become more and more *labour intensive* while in the *DC*s it will become more and more labour extensive (but capital intensive). There will, of course, be wide variations from country to country but by and large this great disparity in labour intensiveness in conjunction with the difference in climate means that we shall have two very different kinds of agriculture in the two regions even if the relative gap in endowment with *capital* and *knowledge*, the two remaining specific factors, should gradually begin to narrow.

On the basis of the indications about the determining factors given above we shall now make some illustrative *projections* of future demand and supply of food in the two main regions (Table 2). They cannot be *forecasts* since we do not know to what extent the assumptions will prove to be realistic, and they do not comprise the centrally planned countries.

Though no projections are made for the centrally planned countries the table implies that these countries, taken as a group, will have virtually no net imports or exports throughout the period. There is here an element of uncertainty that may be of some importance.

As already mentioned, the table is not a forecast. If, however, the assumptions should prove to be reasonably realistic, it would imply that the *DC*s progressively would become net exporters of food to the *LDC*s. In 1980 the net transfer of food would represent some 10 per cent. of the production of the *DC*s and about 13 per cent. of the consumption of the *LDC*s. In the year 2000 the corresponding percentages would be about 18 and 20. It must be expected that the transfer will in practice mainly consist of a few commodities, especially grain and milk powder. For these products the percentages would therefore be higher.

There would, of course, be large disparities within the two regions. Most of the net exports would come from North America, Australia and New Zealand. Most of the net imports would go to the Far East,

including India and Pakistan. The Near East might also be a net importer while Africa and Latin America might on the whole be close to equilibrium with some countries being net exporters, especially in Latin America, while others would be net importers.

TABLE 2

	*DC*s			*LDC*s		
	1960	*1980*	*2000*	*1960*	*1980*	*2000*
Total, billion $						
Demand	80	113	151	47	89	170
Production	78	125	186	48	77	135
	−2	+12	+35	+1	−12	−35
Annual increase per cent.	1960–1980		1980–2000	1960–1980		1980–2000
Demand	1·75		1·5	3·25		3·3
Production	2·4		2·0	2·4		2·8

(Assumptions: The assumed growth rates for demand are based on (1) United Nations population projections (high variant for *DC*s 1960–2000 and for *LDC*s 1960–70, medium variant for *LDC*s 1970–2000); (2) growth of Gross Domestic Product as in recent years with some progressive slowing down in *DC*s and some speeding up in *LDC*s on average; (3) income elasticities as estimated by FAO combined with the assumption that in *LDC*s total private consumption will increase more slowly than Gross Domestic Product because the rate of investment must be increased.

Concerning food *production* the assumed growth rate for the *DC*s for 1960–80 corresponds to actual growth in 1955–65. For the *LDC*s the rate for 1960–80 is slightly higher than actual performance 1955–65 in spite of the fact that growth was slowing down after 1960.

It will be seen that for the years 1980–2000 a slowing down is foreseen in the *DC*s while at the same time a faster growth of production is assumed for the *LDC*s. This implies that they should begin to make more progress towards the end of the century.)

The question is, of course, whether a trade pattern of roughly such a character is likely to turn up in practice. Though the elements of uncertainty are very great, it is nevertheless worth noting that while the *LDC*s as a group were net exporters of grain before the war (some 10 million tons a year) they became net importers after the war. For the decade 1955–65 total agricultural imports of the *LDC*s have grown faster than those of the *DC*s while the reverse is true for exports.[1] It should also be recalled that, as mentioned above, by the

[1] FAO. *The State of Food and Agriculture 1966*, Tables II–8 and II–11.

year 2000 the *DC*s will as a group have about three times as much agricultural land per head of population as the *LDC*s and they will also at that time still be more richly endowed with capital and knowledge. They should, therefore, have a *comparative advantage* concerning agriculture, despite the large number of farm-workers per hectare in the poor countries. This being so, it would not be surprising if they were net exporters of food.

This supposition is also supported by the fact that, as mentioned earlier, modern techniques are more easily transferred to the *LDC*s as regards industry than they are as regards agriculture, where adaptation to climatic and other conditions requires more time and great efforts. Private capital is also most easily attracted from the rich countries to industry where enterprises are big and where a small number of managers, technicians and skilled workers will be sufficient, while in agriculture modern knowledge must be brought to many millions of farmers in remote villages. That abundant and cheap unskilled labour will be available for industry within the rapidly growing urban population of the *LDC*s is evident. The rapidly increasing (though still modest) exports of manufactured articles from some *LDC*s are therefore likely to grow further as a counterpart to the mounting imports of food.

Will *new techniques* to any considerable extent modify the picture that emerges from the foregoing considerations?

As already mentioned, non-agricultural products are beginning to compete with certain products of agriculture, mainly fibres and rubber. More far-reaching consequences could be foreseen if it became possible also to produce food outside agriculture. Experiments are going on concerning food production on the basis of algae which would then be cultivated on a large scale. Another series of experiments deals with the cultivation of micro-organisms, such as yeast, fed on petroleum (which is an organic product).

It seems quite possible that over the decades to come these and other new methods of food production may reach such a level of perfection that they can begin to compete with food produced by agriculture. One of the questions is whether—and when—some of them can become competitive as regards costs of production. This problem has a certain similarity with that of nuclear energy beginning to compete with traditional sources of energy.

Returning for a moment to the projections given above it seems reasonable on the basis of existing knowledge to assume that non-

agricultural foods will not influence the situation in 1980 in any considerable way but that they may be of some importance in the year 2000. It should probably be added that the preparation of the new techniques will in all probability require much capital and knowledge. It is therefore likely, at least for some time to come, to be carried on primarily by the *DC*s. Consequently the new techniques may not in the near future exert any perceptible influence on the trade balance between the *DC*s and the *LDC*s, but this could change at a later stage.

Less revolutionary are a number of efforts going on to increase and improve the *protein* component of the present food basket, particularly in the *LDC*s where the shortage of proteins and especially of animal proteins is much more pronounced than the general shortage of calories.

Fisheries can be further developed but it would hardly be realistic to expect that the catch of fish and other sea food will grow faster than will agricultural production which in our projections is assumed to increase by 155 per cent. during 40 years in the *DC*s and the *LDC*s taken together. Sea food is therefore likely to remain a small, though nutritionally valuable, part of total food consumption.

More important may be the efforts going on to increase the protein content in certain plants and to improve the composition of these plant proteins. In general, animal proteins have had a higher nutritional value than plant proteins because of their composition of various amino-acids. The experiments now going on aim at developing varieties of certain plants in such a way that they can replace animal proteins in a much higher degree than in the past.

The importance of this is that it may reduce the extent to which mankind will have to use the roundabout way of animal production, in order to get enough protein of the desirable composition.

This brings us back to the relation between plant production and animal production mentioned in the Introduction. Reference was made there to an estimate that in 1955 roughly speaking twice as many crop units were used as fodder for animals as those consumed directly by man. During the last decade the relation between crops and livestock production has remained virtually constant in spite of the fact that with rising incomes animal food is an increasing component of the food basket. The reason is partly that the increase in total food consumption due to the rapid population increase of the *LDC*s consists mainly of plant foods

(especially grains). Another reason may be that the number of draft animals has been reduced. At the same time improved feeding methods now permit a certain quantity of animal food to be obtained from a smaller input of fodder. This means that even if livestock products represent the same percentage of total agricultural production as ten years ago they do require a slightly smaller percentage of the quantity of plants grown by farmers.

Even today some 60 per cent. of all crop units go through domestic animals, but this represents a much smaller part of the calories we consume because on the average it takes about seven calories of fodder to produce one calory of animal food. The roundabout way of animal production is therefore a luxury which only rich nations can afford to any considerable extent. In North America some 85 per cent. of all original calories go through the animals compared with only some 25–35 per cent. in Africa and the Far East (and the calories eaten by sacred cows in India do not give much food to man). If the *LDC*s are to have the same quantity of animal food per head of population as the presently rich countries the total plant production for food and feed will have to increase enormously.

It is therefore a question of great importance whether some plants can be developed so as to contain proteins more equivalent to those obtained from animals. Even so, however, animal food seems likely to remain more attractive to those who can afford it though efforts are now being made to produce vegetable proteins in forms that make them look like meat, etc. It is, therefore, an open question how large a share of the plants which world agriculture can produce will continue to be used through the costly roundabout process of animal production where six out of seven calories are lost.

II. *Consequences for farm people*

If production of and trade in agricultural products develop roughly speaking on the lines indicated in the foregoing section, what will be the resulting changes in the number of farm people in the various parts of the world and in the conditions under which they will have to work?

Here again a modified extrapolation of recent trends is the only way to get an impression of the possible development. Quantitative projections are, however, more difficult to make in this case than in the former. It is easier to calculate what will, under certain assumptions, be the volume of total agricultural production than it is to say

by how many farm people this volume will be produced and what the incomes of these people will be.

Nevertheless, enough has already been said above to give us some useful food for thought concerning the future world of farmers.

First of all, there are likely to be *two worlds* and they are likely to be very different for a long time to come. In the *DC*s the number of farm people will go down, often rather rapidly. By the end of the century only about 5 per cent. of the population may be living on farms. In most—probably all—*DC*s there will be fewer but bigger farms. Mechanization will spread and common services will be organized for research, for input procurement and for marketing and processing of the products. They will use computers and develop scientific management like other modern industries.

In the *LDC*s on the contrary the number of farm people will continue to grow, in many countries probably for a number of decades. The density of farm people on the land will therefore increase for a long time to come. It is difficult to see how it can be avoided that this will lead to a further increase in the number of farm holdings and therefore to a further reduction of the average size of farms which is already very small in many countries.

This being so, mechanization of the type now spreading in the *DC*s will normally not be possible. There are, of course, exceptions, especially in Latin America and parts of Africa and also in other parts of the presently less developed world where it will be profitable to undertake a certain mechanization, often with small-scale machinery, not so much in order to save labour as in order to do certain things that are now impossible, and to get sowing and harvesting done quickly when the weather is good.

It remains, however, that in a very important part of the *LDC*s the agricultural land will be crowded with people. Agriculture will be labour-intensive whereas in the *DC*s it will be labour-extensive but capital-intensive.

Is it at all possible to quantify these broad indications and get at least some ideas of the orders of magnitude?

We have reasonably good information about the distribution of the total population between agriculture and the non-agricultural sector in 1960. If we make the same assumptions concerning population growth as in Table 2, the problem remains to get an idea of the rate of urbanization in the two regions or, more precisely, to make assumptions concerning the possible annual growth of population within each

of the two sectors, agriculture and non-agriculture, in each of the two regions. On this point information is sufficient concerning recent trends in *DC*s but less good concerning *LDC*s, and in both cases projections based on past development are bound to be rather uncertain.

A certain pattern of development seems, however, to emerge from experience in many countries. In the early stages the non-agricultural sector is very small and though it grows much faster than the agricultural sector the latter also grows in absolute terms. Later the number of farm people ceases to grow, and instead starts to decline slowly, then faster and finally again more slowly until it has become very small as in the United Kingdom where it is now between 3 and 4 per cent. of the population.

The following projections are based on some scattered information, partly unpublished, which illustrates this pattern. It cannot be stressed too much that their purpose is only to indicate possible orders of magnitude. Even so, it is hoped that they may help to give some ideas about the nature of the problems of the next generation. They do not comprise the centrally planned countries on which, however, a few remarks will be made later.

In Table 3 the figures are rounded but correspond in general to the population assumptions underlying Table 2. For the year 1960 the figures for the two sectors are based on existing information.[1] The assumed negative growth rate for agriculture in the *DC*s is slightly lower than the actual annual reduction in the agricultural labour force in OECD countries during the decade 1954–64.[2] In that decade the speed of reduction was accelerating somewhat from the first 5-year period to the second but, as mentioned above, this speed must become slower again at a later stage when agriculture's share in total population becomes very small.

The figure for the non-agricultural sector in the *DC*s is found as a residual. However, its annual growth seems in general consistent with direct information concerning this sector.

The most difficult problem is to make an assumption concerning growth of the two sectors in the *LDC*s and it is here that the uncertainty is the greatest. The two growth rates in the table are partly based on published figures on agricultural population in past years and partly on the assumption that the non-agricultural population

[1] FAO. *Production Yearbook 1965*.
[2] ECD. *Manpower Statistics 1954–64*, 1965.

will grow at a rate that is slightly more than 1·6 times the rate for total population. In the past decade this relative growth rate seems to have been somewhat higher but it should decrease with further development. In the *DC*s it should be about 1·3 for the period 1960–2000 if the assumptions of the table are reasonably realistic. This relative growth of the non-agricultural population is probably one of the best indicators of the process of economic growth.

TABLE 3

	1960		*2000*			*Annual increase per cent.*
	million	*per cent.*	*million*	*per cent.*	*1960 = 100*	
Population						
*DC*s						
Agriculture	115	18	50	5	43	−2·0
Non-agriculture	525	82	950	95	181	1·5
Total	640	100	1,000	100	156	1·1
*LDC*s						
Agriculture	920	66	1,480	40	161	1·2
Non-agriculture	460	34	2,170	60	472	3·9
Total	1,380	100	3,650	100	264	2·4

It will be seen that under the assumptions of the table the number of farm people in the *DC*s would be reduced by more than 50 per cent. before the end of the century and they would only represent a small fraction of total population. In the *LDC*s, on the other hand, their numbers would increase substantially and they would still represent 40 per cent. of the very large population the region would have at that time. Even so, the non-agricultural population of the *LDC*s would have multiplied by nearly five times during 40 years and it would be more than twice as big as the non-agricultural population of the *DC*s. This would imply that industrialization of the poor countries would be well under way in the year 2000. The large increase in the urban population would, of course, have created many problems.

A short note on the centrally planned countries might be added to complete the picture. In eastern Europe and the U.S.S.R. agriculture in 1960 represented about 35 per cent. of total population compared with 65 per cent. in mainland China. This region, therefore, also falls into two rather sharply distinct parts though the difference

between the more developed and the less developed part is not quite as pronounced as it is for the countries discussed above. With that modification the foregoing considerations should to a large extent also apply to the centrally planned countries. The same is probably true of what will be said below concerning the economic conditions of farm people in the *DC*s and the *LDC*s.

How are these conditions likely to develop during the next generation?

The starting-point is a situation where there is a substantial income gap between farm people and other people both in the *DC*s and in the *LDC*s. The non-farm sector has on the average higher incomes than the agricultural population and this phenomenon is particularly pronounced in a period of rapid economic growth because demand expansion primarily goes to the non-farm sector. In fact, this income differential is the main force that keeps people moving out of agriculture and into the expanding sectors of the economy.

In general, the relative income gap seems to be wider in the *LDC*s than in the *DC*s.[1] This is not surprising since, as already mentioned, modern techniques are much more easily transferred to industry than to agriculture in tropical areas.

In the *DC*s the relative income gap was on the whole increasing in the first part of the post-war period. In the post-war period, however, productivity in agriculture has been catching up with other lines of production, and also the development of prices in agriculture compared with other prices has been slightly less unfavourable to farmers in recent years than in former times. Is the relative income gap about to reach its culmination?

This cannot be statistically demonstrated, partly because the new period, if there is one, is still too short to give a solid basis for an evaluation, and partly because annual fluctuations make it difficult to establish a trend. Two basic factors, however, seem to make it likely that the relative income gap in the *DC*s will be reduced during the next generation.

One is the increase in productivity that is bound to come as farms become larger and more mechanized. The assumptions of Tables 2 and 3, taken together, would mean that in the year 2000 some 50 million farm people would produce more than twice as much as 115 million produced in 1960 (namely $186 billion compared with $78 billion). Production per man would have increased

[1] FAO. *The State of Food and Agriculture 1965*, Table IV–3, p. 59.

by about 450 per cent. or 4·3 per cent. per year. This is more than productivity is growing in the non-farm sector. The other factor is the relative improvement of farm prices that appears likely when the large import demand from the *LDC*s is added to the outlets for agriculture in the rich countries. Already during the last few years the trend in export prices seems to have undergone a slight improvement. On the whole it seems likely that the relative—and probably later on the absolute—income gap in the *DC*s should begin to narrow. This would be a natural corollary of the fact that the movement of people from agriculture to other sectors might towards the end of the century reach a point where it no longer needs to be continued, at least in the more advanced *DC*s. This would represent a kind of maturity in the transformation of our societies which is normally called development.

Once more the picture is quite different in the *LDC*s. There, according to Tables 2 and 3, some 1,480 million farm people in the year 2000 would have a production worth about $135 billion, compared with a quantity worth $48 billion produced by 920 million people in 1960. The increase in production per man would be only 75 per cent. or 1·4 per cent. per year. This is a slower growth than the one represented by the non-farm sector. It could then well be that the already wide income gap in the *LDC*s will widen further. It is, however, likely that a general sellers' market for food will somehow improve the relative prices obtained by farmers.

Why is it that production per man in agriculture seems likely to increase so much more slowly in the *LDC*s than in the *DC*s where it is already much higher? Even if one makes some changes in the assumptions there will be a wide margin between the two growth rates, here projected to be 1·4 and 4·3 per cent. respectively.

The explanation is twofold. First, to introduce modern techniques in tropical agriculture will take a long time because methods must be adjusted to local conditions and the farm population is still to a large extent illiterate. Secondly, and this is more important, the labour force will go down rapidly in the *DC*s whereas it will go on increasing in the *LDC*s.

Today there is much more land, capital and knowledge per farm worker in the rich than in the poor countries. This is why production per man is more than ten times as big. In the coming decades the relative position of the *LDC*s should improve somewhat concerning capital and knowledge but it will further deteriorate concerning land.

In 1960 a farm population of 115 million in the *DC*s had 37 million hectares of arable land (since permanent grass requires little labour arable land alone may be the best indicator in this respect). This makes 3·22 hectares per person. In the *LDC*s 920 million farm people had only 680 million hectares or 0·74 per person. If we assume, for the reasons mentioned earlier, that the total area will not change substantially the opposite movements in the agricultural population of the two areas will by the end of the century have increased the area per person in the *DC*s to 740 hectares but reduced it to 0·46 hectares in the *LDC*s. This means that on the average each person in the farm population of the *DC*s will have fifteen times as much land as the average person in the *LDC*s agriculture. We could also turn it round and say that per hectare of arable land there will be fifteen times as many farm people in the *LDC*s as in the *DC*s.[1]

These are impressive figures. It is therefore appropriate to ask the question: how can such a large number of persons per unit of land be really productive? In the *DC*s agricultural production keeps increasing in spite of a rapid decline in the labour force. If there is likely, as indicated above, to be some small scale mechanization in the agriculture of the *LDC*s it is difficult to escape the conclusion that the production in the year 2000 might be almost the same with a substantially smaller farm population than the 1,480 million of our projections.

This evokes the often discussed question of under-employment in *LDC*s agriculture. It seems almost certain that with so many people on the land marginal labour productivity must remain small. Already in many *LDC*s people are leaving agriculture faster than industry and other sectors of the economy can absorb them, and this seems likely to go on for a long time to come.

It is true that in *Japan* the number of farm people per hectare is also very high, in fact higher than in most *LDC*s. But the environment is better, with much more capital and knowledge per farm worker than in the *LDC*s, and now the farm population in Japan is declining rapidly as in other *DC*s. The experience of Japan therefore does not indicate that a high density of farm people on the land is a long-term solution.

Though the projections in this section are bound to contain a considerable margin of error concerning the possible situation around

[1] Also in the group of centrally planned countries the more developed part of the region will have much more land per person in agriculture then the less developed part.

the year 2000 it is tempting, in conclusion, to look still further ahead. What will happen in the twenty-first century?

It is easy to say that we do not know. But it is more constructive to use our imagination because it is in this century that action must be taken if the arduous task of preparing a better life for the larger part of mankind is to succeed, even if the full results will only come over a long period.

In the twenty-first century agriculture in the *LDC*s will be able to have a much faster productivity growth on one condition: that population growth slows down very substantially. If total population increases only imperceptibly there will be a possibility for the same large scale reduction in the *LDC*s farm population as we are now witnessing in the *DC*s. Only then will western-type mechanization and other improvements permit a rapid increase in production per man. A slower population growth will also facilitate a large increase in capital per person and the raising of the standard of knowledge required by modern productive methods.

At the same time non-agricultural food and plants with a richer and better composed protein content may permit the whole world population to have a better nourishment. If this object were to be attained through an increase in animal production where seven calories of fodder are needed to produce one calory of food it is hardly possible to imagine the yields of crops that would be needed before the *LDC*s had reached the nutritional standard of the presently rich countries.

Thus, in the next century the gaps that are now widening may begin to narrow and the agricultural patterns of the two regions may become more similar. But only on certain conditions concerning measures to be taken. It is therefore time to discuss the implications of our findings for policy.

III. *Policy implications*

It is to this section in particular that applies what was said in a footnote on the first page of the present paper: that the views expressed are provisional and subject to revision because the author has just started a major study of the problems involved. Furthermore, the subject is far too vast to be treated properly in a short article.

Any discussion of policy should start by stating what the objectives of that policy are. Here it will be assumed that policies aim at raising the economic level and thereby the nutritional standard of the poor

nations and to reduce the income gaps between farm people and other people both in the *DC*s and the *LDC*s.

The main problems obviously exist in the *LDC*s because of their low general economic standard and their wide income gap. The problems of the *DC*s have even got their present character to some extent as a consequence of what has happened in the *LDC*s and this is likely to remain true in the decades to come. We shall therefore look first at the *LDC*s.

Reference has already been made to the *population problem*. This will not be discussed further here where it is reasonable to concentrate on policies more directly related to agriculture. Suffice it to say that the sooner a substantial reduction in birth rates begins, following the rapid decline in mortality, the easier will it be to solve many of the problems of the densely populated *LDC*s.

To an increasing extent these countries now have *development plans* in order to formulate their policies for economic progress within the framework of a coherent system of ideas based on facts and on rational thinking. It is often said that agriculture has been neglected in many of these plans and should be given more attention in future planning. This is probably true but it is also an over-simplication. Agriculture depends on the *environment*, as mentioned in Section I, and this means that its development is closely linked to the development of other sectors. Two basic arguments can be given to substantiate this fundamental proposition.

The first is that traditional agriculture is based on a very long experience and therefore no doubt in its own way often has reached a certain standard of perfection, i.e. capability to serve the needs of the traditional societies. As already mentioned, yields in the *LDC*s are on the average higher than is often realized, compared with those of the *DC*s. This means in practice that a real breakthrough cannot be expected from an improvement of traditional methods, but only through entirely new methods, e.g. through the use of fertilizers, pesticides and improved seeds and breeds as well as modern, if simple, tools, etc. These inputs must be purchased and farmers must therefore also have something to sell. Subsistence farming must be transformed into farming for the market. The rapid increase of the urban population should facilitate this process. Therefore, marketing mechanisms and means of transport must be developed. Villages can no longer be isolated. The conclusion is that expansion of agriculture requires the development of a number of so-called *agro-allied*

industries to produce the new inputs and often also to process the outputs. Furthermore, research, education and advisory service are required to enable the traditional peasant to become a modern farmer.

The second argument is that marginal productivity in agriculture will remain low if the density of farm people becomes very high. Not that this productivity is zero, as is sometimes alleged. It is enough to know that it will remain low compared with productivity in many industries and services. It is one of the great unknowns to what extent this will actually be so. On the whole it seems likely that modern methods will increasingly make it uneconomic to keep a large part of the population in agriculture as used to occur in the *DC*s. In our projections it is assumed that the non-agricultural population of the *LDC*s will multiply by nearly five times in 40 years. Total production would probably be larger if industrialization could develop even faster.

A one-sided emphasis on agriculture can therefore not be recommended. In this connexion it should be stressed that *self-sufficiency* in food is not in itself something that a country should necessarily aim at. Industrial countries like the United Kingdom and Germany have had their most rapid expansion in a period when they were importing a substantial part of their food. They would have had a lower standard of life—and of nutrition—if they had done more than they actually have (which is already too much) to keep an artificially high proportion of their population on the land. It is very important that the densely populated *LDC*s do not get stuck with misconceived ideas about the virtue of producing all their food at home instead of putting more manpower into industries where their competitive position is stronger (e.g. because of cheap labour).

This is not to say that agriculture should not have a high priority in development plans but only to stress that it should be part and parcel of a harmonious development of the society as a whole. This in fact is the best way of making agriculture itself efficient.

It would be futile to go into details in discussing the numerous things that could be done to render agriculture in the *LDC*s more productive. Many of them are of a technical nature and they must vary from one country to another, depending on climatic conditions, the level of education, etc. We shall therefore focus our attention on a few major *economic* aspects of the problems.

Of the four specific factors of production mentioned in Section I

(land, labour, capital, and knowledge) it will probably be desirable to give *knowledge* a particularly high priority in the next few years. That will help the countries in question to avoid many mistakes and thereby not only to save capital which is scarce but also to avoid the frustration that is inescapable when a great effort leads to a poor result. In particular, the emphasis should be on *adaptive research.*

Basic research is often undertaken with best results in the *DC*s which have the necessary expensive equipment and the big teams of highly trained scientists required. But modern methods must be adapted to local conditions. A special variety of maize or rice can be successful in some countries but a failure in a different kind of climate or soil. Likewise, tools must be constructed with due regard to local conditions.

It is a commonplace to say that in most *LDC*s the use of fertilizers should be greatly extended, that pesticides should be used as needed and that irrigation or drainage—or both—can be very productive in many areas. But what combinations of these inputs are fitting under certain natural conditions? Experience seems to make quite evident that one-sided emphasis on one kind of input is normally a mistake and this is in conformity with general economic reasoning. A certain amount of certain fertilizers gives a better result if at the same time plants have enough water but not too much, if they are protected by the right pesticides, etc. But it takes adaptive research to find out what the best combinations are. Fortunately, this is a kind of research where in many cases medium-level research workers can do much of the local work, guided by a limited number of high-level experts.

Then the new knowledge must be brought to the farmers. Extension service is an obvious need in most *LDC*s. It requires training colleges for the village advisers but in addition a certain professional training for the young farm people themselves will become more and more desirable.

Development of agro-allied industries and of the transportation system have already been mentioned. They should be developed at an early stage but once more adaptive research must be mentioned as a means of finding out what form they should take.

Finally, there should be the necessary *incentives* for farmers as they become elements in the machinery of a market economy. This can be a question of having systems of *land tenure* that give to farmers good profits if they are good farmers. It can also be a question

of permitting *prices* to play their role in adjusting supply and demand to one another. This includes external supply and external demand. Food products should be imported when they can be obtained more cheaply than by home production. And agricultural products should be exported where this is the best use of available resources.

If these measures and others that could be mentioned in a more complete list are to be done adequately, an enormous effort will be required of the *LDC*s. Turning now to *the policies of the DC*s it follows that the first thing to stress is the need for sufficient *development aid* and for aid programmes that are formulated more with a view to the real needs of the recipient than is sometimes the case today.

If agriculture is going to play an increasing role in the development plans of the *LDC*s then aid to agricultural development must play a larger role in the aid programmes of the *DC*s. In consequence of what has been said above there is a particular need for help to create resources for adaptive research. In a general way higher education and parts of professional training in the *DC*s should aim at providing for the increasing force of advisers and experts that is needed as the core of technical assistance.

At the same time *basic research*, even regarding many problems of tropical agriculture, can best take place in the *DC*s. The same is true of research concerning the new techniques in food production already referred to. This may eventually become something very important.

Since about 1954 *food aid* has been a rather important element in the total flow of development aid. Most of it has come from the United States which accumulated large stocks, especially of cereals, because it had decided to support its own agriculture through government purchases of various farm products.

The situation in this field is now changing. The surplus stocks of cereals have diminished during the last five years and after the large sales to India in 1965–6 they no longer exist, at least as far as wheat is concerned. The United States has therefore permitted its farmers to increase the acreage of wheat and rice. When food aid has come out of current production it is, of course, more of a sacrifice than when it has been taken out of stocks already accumulated in order to support domestic agriculture. The question is therefore now discussed what should be the attitude of *DC*s in general towards food aid. In view of

the large increase of the food import requirements of *LDC*s that can be expected this is a major problem.

In principle, food aid is not very desirable. It is better that sufficient general, financial aid be given so that the *LDC*s can make the necessary purchases of food, machinery for development and other things abroad on a commercial basis.

Food aid is a special kind of *tied aid*, i.e. aid which the recipient country is bound to use for imports from the donor country, sometimes even for imports of certain specified things. Food aid, therefore, has some of the usual drawbacks of tied aid. It can diminish competition in international trade, sometimes to the detriment of food exporting *LDC*s. Besides, it does not always meet the most important needs of the recipient country and there have probably been cases where it has reduced the interest of the recipient country in the promotion of its own agricultural production. If it contributes to a reduction of, say, grain prices this can also be harmful to agriculture in the country in question.

If the recipient country would in any case need to import the food items in question some of these unfortunate repercussions can to a large extent be avoided In practice most food aid has been received by such countries. In a general way it is important only to give food aid in such cases and under such conditions that it does not have a harmful effect on trade or on agricultural production.

This can be done in a particularly efficient way if the food provided as aid is *channelled* so as to reach consumers who would not normally buy the additional food they receive in this way. Meals at schools and hospitals are examples of such food aid. The *World Food Programme* has done a constructive piece of work in this and related fields which deserves to be supported.

If it is true that food aid, like other tied aid, can have some drawbacks, it is, of course, also true—once more like other tied aid—that if in a certain case the choice is between food aid and no aid, then food aid is normally to be preferred. In the past it has been an advantage that the accumulated food stocks were already paid for. But how will it be in the future when food aid represents current production to be bought by means of new money to be appropriated by parliaments?

Here a difficult problem is likely to come up. If total exports of food (mainly cereals) to *LDC*s are to become very important some of them will be commercial and others will be 'food aid exports'. All

exporting countries will wish to do the commercial exports and there may be difficult discussions on how to share the burden of food aid. It should, of course, be seen as a part of the total flow of aid, but this problem is an additional argument for getting back before too long to a combination of financial aid and commercial exports of food.

Another consequence of these exports has already been mentioned. They represent an additional source of demand for the farmers of the *DC*s. Export prices may therefore become better than in recent years and since agriculture in the *DC*s will at the same time become more and more rationalized and concentrated on bigger farms it will not need to be supported to the extent it has been in the past. Therefore, the often very high guaranteed prices in the various countries can be reduced. This will have two very important consequences.

The first is that governments will save money. Where the support to agriculture has been paid directly by the consumers through high food prices the savings will in the first instance be made by them, but governments know how to find the money if they want it. Since total aid given in various forms to agriculture in *DC*s is a larger sum than the total flow of aid to *LDC*s, reduction in aid to agriculture can finance a very substantial increase of development aid.

The other consequence is that the present difference between the low export prices for farm products (which are import prices in other countries) and the high internal prices in most countries can begin to diminish and eventually disappear. Trade in agricultural products can then be made more free because the purpose of the many trade barriers existing in this field was exactly to maintain the internal prices at a level often much higher than export/import prices.

This brings us to the last point that should be mentioned: *trade policy*. It is not only trade in agricultural products between *DC*s that should be liberalized. An equally important problem is these countries' trade policy *vis-à-vis* the *LDC*s. Three aspects of this question are relevant here.

1. If the *LDC*s are, as a group, to be large net importers of food during a long period to come, they will have to be net exporters of something else. It is generally agreed that the scope for an expansion of their traditional exports of primary products is limited but some of them can become rather large exporters of *manufactured articles* if they are allowed to. A development in that direction is already under way and the large and rapidly increasing urban labour force in *LDC*s is beginning to attract

capital from *DC*s, sometimes directly with a view to building up export industries. Access to the markets of *DC*s is therefore important.

2. Concerning exports of *tropical products* an abolition of customs duties in *DC*s would help, but since demand is on the whole rather inelastic it may help consumers in the rich countries more than producers in the poor countries. The real solution may as a rule rather be an arrangement like the International Coffee Agreement where a stabilization of prices is aimed at, partly by means of an agreed limitation of exports.
3. In the markets for some agricultural products *DC*s are competing with *LDC*s. Examples are sugar, tobacco and cotton, and in some cases also meal and cereals. Sometimes in such cases the *DC*s maintain protection or support measures that are harmful to agriculture in *LDC*s, and these are no doubt products that are produced on a rather large scale in countries where natural conditions for their cultivation are not the best. Here competition on equal terms should be established.

The picture would not be complete if it were not added that *LDC*s also sometimes create difficulties for one another through protectionist measures, both concerning manufactured articles and agricultural products. It is perhaps appropriate to say, in conclusion, that for the sake of brevity it has been necessary here to treat the *LDC*s as one group to a higher degree than is desirable. Taken together, they may become net importers of food, but some countries within the group will certainly remain net exporters. The *LDC*s have a number of features in common, but there are also many differences between them, and it seems more likely than not that in the course of their future development some of these differences will become more accentuated.