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AGRICULTURE TOWARD 2000: THE LONG TERM PERSPECTIVES OF CONTEMPORARY ISSUES IN WORLD FOOD AND AGRICULTURE

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Introduction

This paper presents the main feature of a recent major study by FAO, hereafter referred to as AT 2000. After outlining the scope and methodology of the study, this paper gives summary results and concludes with a brief identification of the salient aspects of the strategies suggested by the analysis.

A purpose of the study was to provide governments and the United Nations with quantified perspectives of world and country group demand for, and production and trade of food and agricultural commodities, including implications for such areas as nutrition, investment, assistance, and research. Pre-publication results of the study were the major source for the food and agricultural component of the UN International Development Strategy (IDS) adopted in 1980. A second purpose was to provide FAO, its member governments, and other qualified users with a detailed quantification on a common pattern of possible alternative paths of change in the agricultural sector of 90 individual developing countries.

The analytical instrument built for the study—the family of models, data bank, and analytical procedures—will be kept in working order. The results of the study for each of the 90 developing countries have been sent to the countries concerned, and, at the time of writing, comments on these results as well as agreement to release the individual country data without limitation are awaited.

Scope and Methodology

AT 2000 is an analysis of the agricultural sector of the entire world, with the exception of China, to the year 2000. The focus is mainly on assessing the requirements and potential for improvements of the food and agricultural situation of the developing countries.

All the analyses are conducted country by country for 90 developing countries (accounting for 98 percent of the population of the developing countries, excluding China) and all 34 developed countries. Production prospects for the developing countries are analyzed in greater detail than for developed countries.

The analysis covers 28 crop and 6 livestock commodities or commodity groups. It starts with exogenous growth rates of population and total GDP as inputs into detailed projections of food demand. Projections of nonfood industrial demand are added to make up projected total final demand. Two intermediate demand categories (feed and seed) and an allowance for post-harvest waste are projected jointly with production.

The next step in the analysis is to set for developing countries a vector of preliminary production targets by commodity which, together with the vector of final domestic demand, is entered into a model which internally calculates the feed, seed, and waste components, and draws up balancing equations for each commodity of production, total domestic demand, and net trade (Supply-Utilization Accounts or SUAs). Production targets are defined in the first instance in terms of desired levels of self-sufficiency for the deficit commodities, and desired levels of exports for the exportable commodities. From this phase onwards, the core of the analysis is concerned with: (1) testing and establishing, after iterative revisions, the feasibility of the production targets; and (2) ensuring international compatibility of the trade balances of the individual countries.

Feasibility of the crop production targets in each country is tested against constraints imposed exogenously by specialist advice concerning availability and possible expansion of the land and water resource base (in terms of six classes of rainfed and irrigated land) and possible gains in yields in each crop and land

class. The starting crop mix in each of the land classes is based on historical and current patterns, needed future increases to attain the targets, and agro-ecological considerations. In the system, the production structure of the crop sector is described in terms of 168 production functions (28 crops and 6 land classes). These production functions are in per hectare terms and relate yields to a vector of 7 input-output coefficients.

The feasibility test ensures that the land availability constraints by class are not violated when the entire crop production programme is considered. If violation of the constraints is indicated by a separate submodel, production targets are revised iteratively until a programme is arrived at which respects all the land constraints.

Livestock production estimates cover six livestock species and six products, and, basically similar to the approach taken for crops, test the feasibility of the preliminary production targets. The main constraints explored are feasible growth rates in numbers of animals, off-take rates, carcass weights, and milk per animal, as influenced by feed availability and other supporting measures.²

The vector of feasible production targets thus established replaces the preliminary one in the SUA model, and new demand, production, and trade balances are derived. The trade balances of the developing countries are summed up by commodity, informal net trade projections for the residual developing countries (including China) are added, and the resulting vector is the net trade position of the developing world. This is confronted with alternative net trade outcomes of the developed countries. The latter are derived from their own demand projections and alternative projections of production, ranging from trend continuation to maintenance of their self-sufficiency rates of the late 1970s to assumed policy induced adjustments favouring agricultural exports of the developing countries. All production alternatives for developed countries are assessed to be feasible.

The confrontation of the net trade vectors of the two groups of countries indicated that deficits of the developing countries could be easily covered or more than covered by net surpluses of the developed countries. The most frequent need to revise arose with respect to net surpluses of the developing countries of such commodities as sugar or vegetable oils, reflecting the trends in the developed countries to increase their self-sufficiency in these sectors. These downward revisions were distributed, by and large proportionally, among the developing countries exporting that particular commodity and, for those countries, the SUA and production feasibility models were run again. All these iterative revisions and adjustments result in a set of country production programmes which are feasible in relation to national demand and production conditions and internationally compatible with each other.

Subsequently, and for the developing countries only, the input-output model estimates input requirements: modern and traditional seed, three types of fertilizer, pesticides, and total power expressed in manday equivalents. A separate submodel breaks down the latter into its components of draught animals, labour, and machinery. The power supplied by draught animals, projected separately, is subtracted from total requirements. The balance is distributed between labour and machinery according to an economic relationship linking mechanization to per caput GDP in each country, subject to constraints concerning maximum permissible density of tractorization and mandays supplied to the crop sector per member of the agricultural labour force.

Another submodel is used to estimate investment requirements for 26 capital items ranging from land extension to first stage processing facilities. Estimates of physical units are subsequently valued at 1975 unit costs. The increment in physical assets (e.g., irrigated areas) between base and projection years represents the net cumulative investment requirements of the period to which replacement investments are added to obtain gross requirements. Replacement

investment in any particular year is equal to gross investment of the n preceding years, where n is the life of the asset.

The nutritional situation is evaluated in terms of per caput calorie levels of the demand projections and their significance for the incidence of under-nutrition. The latter estimates the number of people with calorie intakes below 1.2 BMR (Basal Metabolic Rate) and are derived from income distribution parameters together with the implicit demand functions for calories.

The study assumes substantial improvements in the quantity and quality of institutional services, particularly those directed to small farmers; institutional requirements were not modelled globally but case studies explored alternatives within AT 2000 quantification for selected countries.

AT 2000 projections are not predictions but rather possible outcomes under three different scenarios. Scenario A takes as its starting point the GDP growth target of the UN IDS for the developing countries of 7.0 percent per year (but broken down into individual country growth rates) to determine demand. Its production projections correspond to what may be termed "reasonable maximum feasible" self-sufficiency levels. Scenario B is based on an intermediate GDP growth assumption for the developing countries of 5.7 percent per year and on production growth rates generally around halfway between past trends and those of scenario A. For reasons of space, the results of this scenario are not reported in the present paper. The trend scenario depicts possible outcomes of a continuation of past trends in production and consumption by country and commodity without reference to GDP growth assumptions. Constraints to avoid negative growth rates are imposed for per caput calories and for production of individual commodities. The scenario A results for these two variables constitute upper level constraints to prevent trend projections from exploding.

Scenario Results

This section focuses predominantly on the high growth scenario A, with selective reference to the trend scenario. The major objective of this scenario is to assess the possibilities of and requirements for accelerating agricultural production in the developing countries. Not all developing countries have had unfavourable trends; 33 of the 90 countries, accounting for 47 percent of their total agricultural production, had growth rates exceeding 3.0 percent per year (3.7 percent as a group) over the period 1966-1980. Detailed analysis indicates that it would be feasible to maintain this growth rate in the future for the group as a whole, although the production performance of individual countries would have to accelerate in some cases.

The remaining 57 countries, however, had production growth rates below 3.0 percent (2.1 percent as a group) and growth was under 1 percent or negative in 16 countries, compared with the group's population growth rate of 2.4 percent. The food and agricultural situation of the developing countries as a whole would, therefore, depend crucially on the possibility of the lower performance countries doing much better. Detailed evaluation indicates that with appropriate policies the growth rate of this group could be raised to 3.7 percent³ whereas even with the optimistic constraints referred to above, past trends would result in a future growth rate of 2.4 percent compared with population growth projected to be 2.3 percent per year.

Different regions and countries would rely on different mixes in area and yield growth. For example, India alone would account for over half the additional irrigation shown in table 1, while almost all the increment in rainfed area would be in Latin America and Africa. Grouping countries according to land scarcity (ratio of land under crops to total land potentially usable for crop production) shows that at one extreme 17 countries already use more than 90 percent of their potential land (95 percent as a group). That group which includes some of the most populous developing countries and has 46 percent of the 90-country

Table 1. Inputs to Production in 90 Developing Countries

Item	1974-1976	2000
Rainfed area (million ha)	633	768
Irrigated area (million ha)	95	148
Cropping intensity - rainfed	0.70	0.77
Cropping intensity - irrigated	1.07	1.30
Cereal yields (tons/ha) - wheat	1.29	2.29
Cereal yields (tons/ha) - paddy	1.95	3.17
Cereal yields (tons/ha) - coarse grains	1.02	1.72
Fertilizer use (growth rate in percent)		8.1
Agricultural machinery (growth rate in percent)		8.4
Commercial energy (million tons, oil equivalent) (1980)	36	178
Primary sector investment, gross (growth rate in percent)		4.4
Primary sector investment, gross (as percent of agricultural GDP)		26

population, could expand total area under crops by only 2 percent over the next two decades. Production increases would therefore have to rely on yield growth (86 percent on the average) and increase in cropping intensity from already high levels. At the other extreme, 29 countries accounting for 15 percent of the 90-country population had only 15 percent of the potential land under crops and could therefore expand production by increasing land area by 66 percent and yields by 31 percent. Differences in mechanization are also striking--by 2000, Latin America would obtain 54 percent of total power input to crop production from machinery, as against 8 to 9 percent for Africa and the Far East.

Sustained growth in production will have to depend increasingly on fairly rapid modernization of the production process, although the forms it takes will vary considerably amongst countries; e.g., in Latin America, increasing mechanization must substitute for slow growth in the agricultural labour force, while in the Far East great reliance must be placed on expansion of irrigation, improved seeds, and fertilizer. Current inputs, including intermediate use of agricultural products, presently around 20 percent of the gross value of output, will need to increase to a 90-country average of 30 percent by 2000.

The estimated investment rates of primary agriculture of 26 percent (gross) or 15 percent (net) required by 2000 emphasize that the modernization process and the acceleration of growth cannot be cheap. The implicit internal rates of return (average for 1980-2000) of 5.9 net and 4.3 gross certainly do not confirm some conventional beliefs that developing country agricultural growth is not capital intensive. Investment here includes all needed additions to the assets of the sector, including those not giving rise to visible and recordable financial

transactions; e.g., growth of livestock herds. Moreover, the gross estimates take full account of replacement requirements.

The significance of these production increases can be readily appreciated by comparing them to projected growth of domestic demand. The group of low income countries (40 countries with per caput GDP under \$300 in 1975) increased domestic consumption at 2.6 percent (population at 2.4 percent) and consequently their overall agricultural self-sufficiency declined from 102 percent in 1966/1967 to 99 percent in 1978/1979. Sub-Saharan African countries were prominent in this group. By contrast, middle income countries (all others) experienced vigorous growth in domestic demand at 3.8 percent annually from 1966 to 1979, partly met by food imports as reflected in overall agricultural self-sufficiency falling from 113 percent to 107 percent.

Continuation of these trends would bring little improvement in per caput consumption in low income countries. Their food imports would have to increase further and overall agricultural self-sufficiency for the group would decline to 97 percent by 2000 even if declining per caput consumption in a number of countries were to be arrested. Middle income countries would continue to improve their nutritional situation and thus increase disparities within the developing world, but at the cost of continued growth in food imports and small further declines in overall self-sufficiency to 105 percent by 2000.

Policies and Strategies

The world framework of agriculture will probably not change fundamentally between now and 2000 except that the pressure on parts of the sector would mount severely. The major concern in world food and agriculture is therefore undoubtedly to help extricate the low income countries from the trap of low production, low consumption, and rapidly increasing dependence on outside food supplies.

The AT 2000 study concludes that this objective could be generally met, although only if the broader goal of GDP growth at around 7.0 percent per year is also attained. Low income countries must participate fully in the growth process. No economically or politically feasible alternative exists to the necessity for the great bulk of the approximate doubling in food demand in the developing countries between 1980 and 2000 being met from their own production, chiefly by increasing yields (including multiple cropping). The implication is one with which agricultural economists are familiar--a steady transformation is required of traditional farming methods (which have usually been oriented basically to security of yields) into higher yielding technologies. This change is already coming about but is limited in speed and extent.

There is no quick solution. What is evident, however, is the need to shift completely away from earlier models of national development in which policy priority went to industry, with energy and armaments also coming to the fore recently, while agriculture was considered a sector with low capital requirements capable of supplying funds and an increasing surplus of food for the rest of the economy without much attention. By quantifying in detail, country by country, the physical requirements for better agricultural performance, AT 2000 underlines the need for more balanced policies. Most developing countries therefore need to review very critically their policies bearing on food and agriculture so as to improve incentives to and supplies of production requisites for farmers and to enlarge the flow of credit and investment funds. In many developing countries, sustained production growth (and the need for adequate growth in demand to sustain output expansion) will require increasing the access of small farmers to production resources and services.

The role of research and extension will be vital in the modernization of developing country agriculture. While basic research must continue into various aspects of tropical and arid zone agriculture (notably as to how continuous mechanized farming can be carried on in tropical zones with fragile soils, the greatest need is for adaptive research which can pay off fairly quickly. Those planning long term research programmes should recall that about 80 percent of the increase to 2000 in world demand (excluding China) for agricultural products will come from developing countries. At present, at least that share of world research expenditure is made in developed countries, primarily for the benefit of their own agriculture. Results of expanded research must also be brought to the farmer. The estimate of a four-and-a-half-fold increase in trained field level extension workers between 1980 and 2000 simply to provide one for about every 500 farmers in irrigated farming and one for every 1,000 farmers in rainfed farming underlines the magnitude of the expansion required in the capacity of training institutes.

AT 2000 is neutral as regards prices which enter the models only for deriving aggregates.⁴ The whole thrust of the supply-demand analysis, however, points to the need to improve incentives to producers in the majority of developing countries. This will require modification of the common policy in which controlled prices favour urban populations. But incentives are a broad package, and the study advocates more attention to assurance of future prices, of raising the actual return to the farmer through improved marketing, and, as noted, to considerably greater access to credit and other services. Increasing requirements of manufactured inputs to farm production must be available. Efficiency and stability in the administration of the country cannot be quantified, but are clearly of the first importance to agriculture. For instance, in every developing country which suffered civil war or other serious internal disorder during the last one or two decades, agricultural production growth was temporarily checked and often fell in absolute quantities.

The scenario results point to the continuation of widespread and serious undernutrition. The frequent question of whether production or distribution presents the more important policy issue is unhelpful. The two are intimately interrelated; at any one time there is need and great scope for nutritional improvements through better distribution of income and access to income earning assets, while over the longer run the imperative of good production growth is the dominating influence.

Policy must, however, turn to ways of improving the purchasing power or the food producing capacity of the poor if serious undernutrition is to be reduced sharply. Economic growth alone, even at high rates, would take far too long. Policymakers must therefore explore the full range of possible measures ranging from substantial land reform to subsidized food for selected groups of economically vulnerable people. Where large scale land redistribution is not politically realistic, policy must turn to more limited measures to raise rural labour productivity and to protect the consumption levels of low income urban populations.

The third set of policy implications is international. World agricultural trade would continue to rise under any of the scenarios, and developed countries would enjoy expanding markets for cereals and livestock products. To enable developing exporters also to expand sales of products which could be provided in greater volume (such as sugar, vegetable oils, and citrus), protection would have to be reduced in developed countries. USSR and Eastern European consumption of imported tropical products is low. Since growth in developed country farm output (at the 34 country group level) cannot at best be higher than in the past, and would need to be lowered under scenario A outcomes for developing countries, present structural adjustment problems being experienced by developed countries would continue.

The real issue of future food imports of developing countries is not one of the physical capacity of exporters to generate supplies, but rather one of institutional and financial arrangements. In the end, much will depend on the developing countries' capability to pay for increased imports, and this is not independent of international policies affecting their capacity to earn foreign exchange. If production in low income countries remained at trend levels, their cereal import requirements would rise fourfold. The future arrangements for concessional cereal imports could therefore have substantial implications for the ability of low income countries to improve diets through increased imports. ◊

External assistance to agriculture is another international issue raised by the scenario findings. AT 2000 emphasizes the heavy investments in agriculture implied by modernizing production. Despite misgivings often expressed as to the effectiveness of some aid, it is difficult to see how low income developing countries could meet the heavy investment needs of agriculture which AT 2000 points to without additional help. The study proposes that aid provide approximately 1 dollar in 6 of their investment expenditure in primary agriculture.

In sum, while most of the world should continue to experience acceptable, (although not trouble free) conditions in food and agriculture, dismal prospects for a large minority of poor countries and poor people from a continuation of long term trends imply the need for some radical reorientation of national and international policies. AT 2000 enables clearer definition to be made of the nature, magnitude, and location of a number of these issues, and the present paper has highlighted some major issues concerning production, distribution, access, trade, and assistance. The full study is, of course, much richer in its coverage and analyses.

Notes

¹FAO, Rome. The authors are the members of the core team which prepared the study between 1978 and 1981. FAO is not responsible for the interpretations presented in this paper.

²FAO is now developing this approach into a more formal quantitative planning model for livestock production.

³That this assessed potential production growth equals the past performance of the higher growth group is a coincidence; countries were assessed individually. More broadly, however, the result reflects the fact that, on the whole, low growth countries have adequate potential for increased production.

⁴The assumption of constant prices in agriculture is considered realistic in view of the post-World War II tendency for these real price levels to decline slowly. Pressures on costs may in future check this tendency, but in view of the huge underutilized production capacity in developing countries as assessed by the study, there seems to be no reason to expect any permanent, marked rise in real food prices for the remainder of the century.

Reference

FAO, *Agriculture: Toward 2000*, Rome, Nov. 1981.