International
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Analysis

OPTIONS

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Hunger amid abundance

World Bank statistics indicate that over 700 million people in the world suffer from chronic malnutrition. Most of them are children. About 15 million children a year starve to death – more than 40,000 a day.

Yet these children are starving in the midst of abundance. There is no global food shortage. In the rich countries of the world, headlines are made by mountains of unsold wheat and butter, by lakes of milk.

The citizens of the United States of America can afford to spend on feed for their household pets as much money as would be needed for the global eradication of hunger.

The amount of grain required to feed all the hungry of the world is tiny compared to the accumulated stocks – between one and two percent of world grain production. India, so recently seen as a classic case of a country that could not feed itself, alone has 30 million tonnes stored away. This is not simply a matter of prudence: the grain is unsold because the poor cannot afford to buy it.

Such has been the success of the 'Green Revolution' in the South and industrialised farming in North that by 1981 the world food supply, measured in calories, was 17 percent more than required to provide everyone in the world with an adequate diet.

Last year, the European Communities' intervention stocks of butter amounted to 86 percent of a year's domestic consumption; skimmed milk stocks were 60 percent, and grain stocks 11 percent of consumption. In the USA, grain in storage was equal to 28 percent of domestic demand.

In 1984, when the famines in Ethopia and Sudan were front-page news, the European Communities had a grain surplus sufficient to feed 50 times the com-

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bined populations of these two countries.

Meanwhile, the governments of the USA, Europe and Japan are groaning under the burden of farm subsidies. Last year, they spent $100 billion to protect their farmers against low prices caused by agricultural overproduction. Half that amount went to farmers, the rest to pay for bureaucracy and storage.

Yet even the huge sums poured into supporting agriculture in the industrialised countries are not sufficient to save thousands of farmers from bankrupcy. Even on its own terms, the present agricultural system no longer works.

Research by IIASA's Food and Agriculture Progam (FAP), and collaborating institutions in 20 different countries over the past ten years, has led to the conclusion that the twin problems of hunger and glut, though separate from each other, stem from a common cause – a malfunctioning world food system.

This system arises from the sum of national policies which, at least until recently, appeared eminently rational. It is only natural for countries to seek a degree of self-sufficiency in food, and to try to bridge the gap between farmers' incomes and those of other groups.

In fact, the world trade in agricultural goods represents only a small share of total production, and only for a few countries is its role so significant, on the face of it, as to make adjustments a high priority. Nevertheless, the market plays a major part in determining prices throughout the world. This international trade is dominated by a few rich countries.

The system is full of distortions, but as the FAP has established, even if these were corrected the hungry would not necessarily benefit. Markets serve those who are part of them – but the poor remain at the margin, and the market adjusts in ways that leave them hungry. While some of the hungry are separated from the market by physical barriers, the majority are unable to participate through sheer lack of income, and it is this that the world food system helps to perpetuate.

In the 19th century the wealthy achieved their economic development partly by exporting surplus labour and exploiting the resources of other countries. The FAP economists have demonstrated that today, if the barriers to international migration were removed, the resultant flow of labour from the poorer countries to the rich would help to equalise worldwide income levels, eliminating hunger. Yet this migration is politically impossible.

This, in terms of fashionable neo-liberal economic theories, would justify 'aid' as compensation for the rent charged by the rich at their 'fence'. But as FAP's findings show, the rich need no moral arguments for stepping up their aid effort: they would gain by giving more.

FAP's findings have come from constructing a model of the world food system and running various scenarios with it, using different assumptions, to test the outcome of given events or policies. Only by analysing national policy responses within the context of the global economic system is it possible to arrive at realistic conclusions.

As will be seen from the results of the simulation runs, the world food system is remarkably resilient. It can adapt to a wide range of situations, always transferring the burden of adjustment to the poor and the hungry. It resists both altruistic solutions and free-trade recipes.

This is because, while markets are an efficient means of allocating resources, they do not ensure a desirable distribution of income, either within or between nations. Within national boundaries, there are redistributive policies to blunt the suffering associated with poverty, yet at the international level, such policies scarcely exist.

FAP's conclusions give no grounds for despair. The research has shown that, by understanding the roots of injustice, means of fighting hunger can be found. It has shown that a combination of measures to help world markets function more efficiently, and national and international income distribution, could eliminate hunger. ■

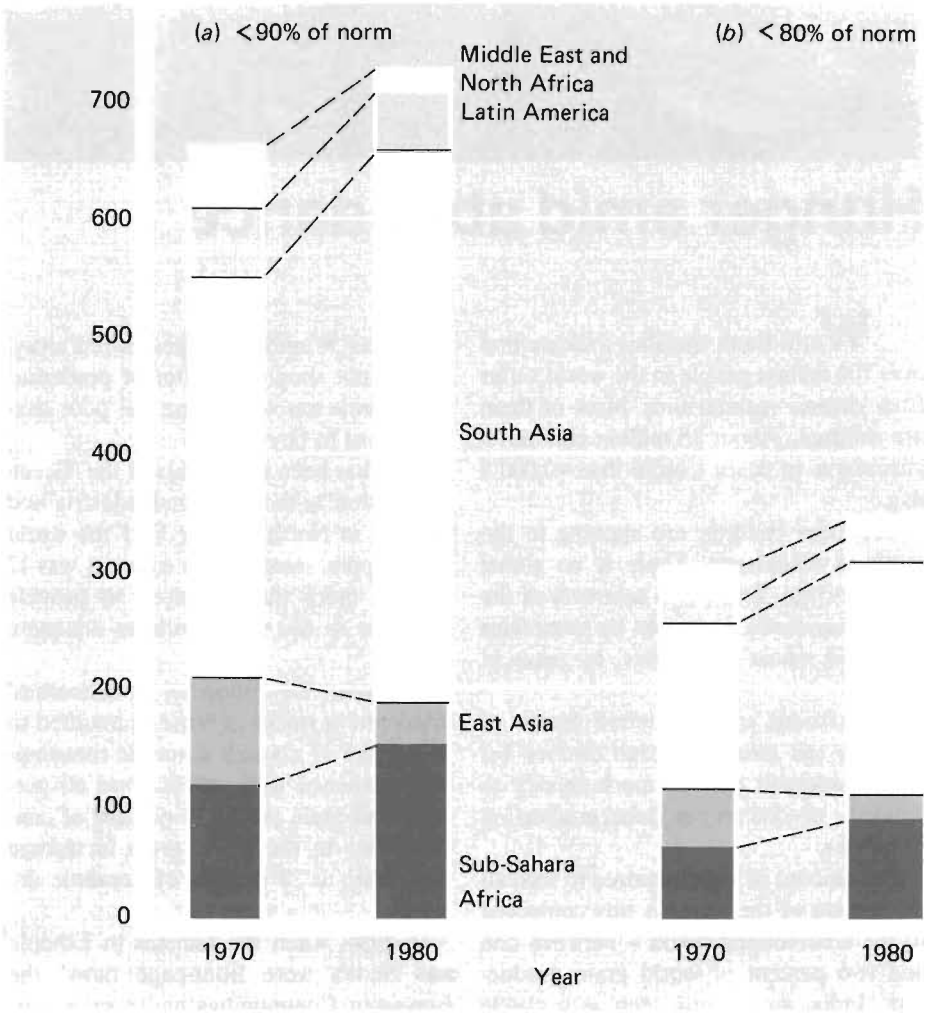

Fig. 1: Population with calorie deficiency (World Bank estimates).

Who are the hungry?

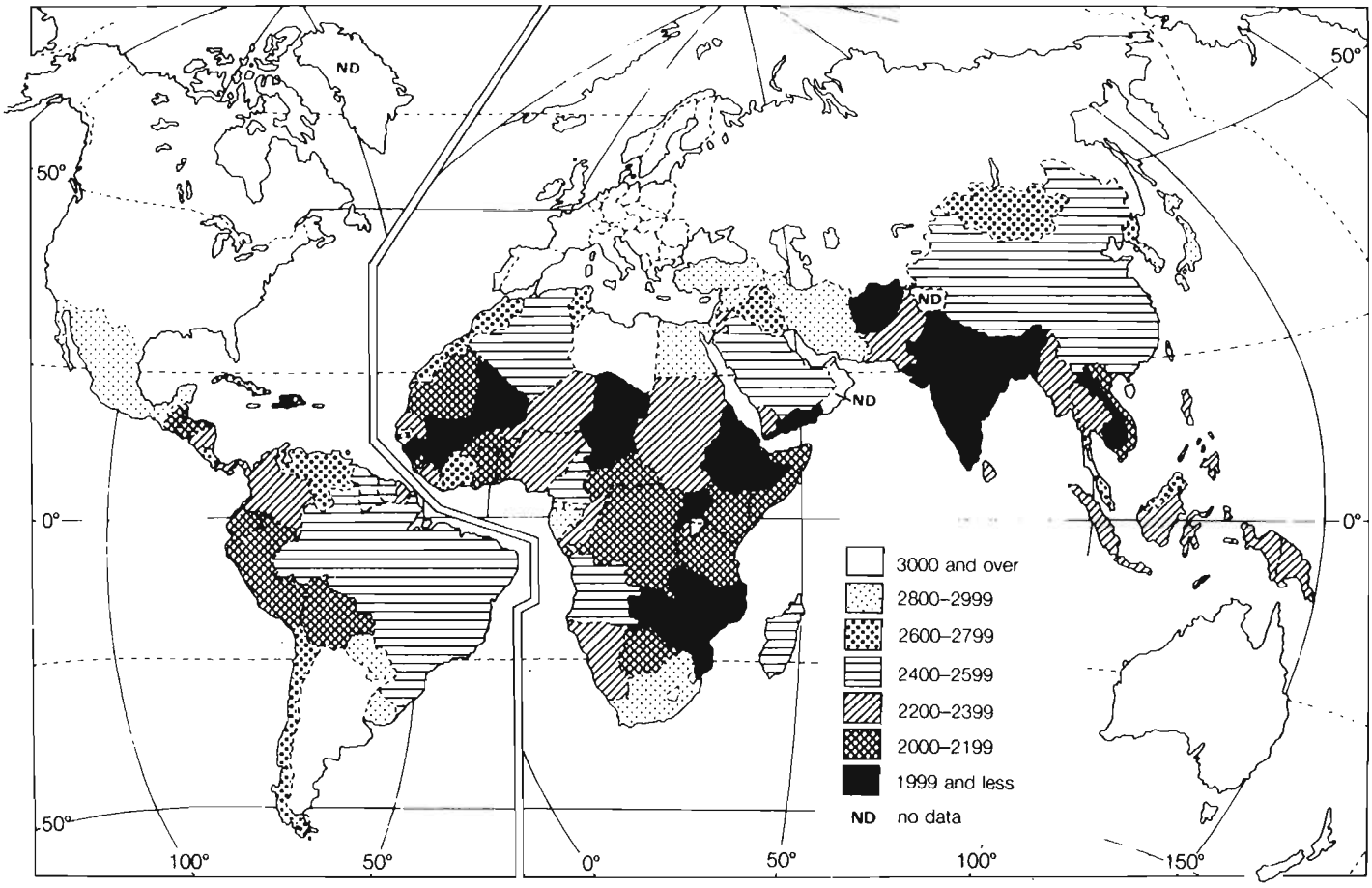

Fig. 2: Food supply in calories available per head, per day, 1978–80 average (source: FAO, Production Yearbook 1981, The World Food Problem 1950–1980 by David Grigg)

Everyone knows that there are many hungry people in the world today, but who are they, where are they, and in what numbers? The problem is hard to quantify, as hunger itself is a subjective concept – apart from the spectacular cases of famine, there are many millions who are chronically undernourished.

World Bank and UN Food and Agriculture Organization estimates indicate that, according to the criteria of malnutrition established in 1980, there were between 500–800 million chronically undernourished people in the world. For instance, the World Bank put the numbers receiving less than 90 percent of the necessary calorie intake in that year at 730 million. Both organisations' figures point to a slight increase in the absolute numbers of the starving, as compared with the 1970 level, though they report a decline in proportion of the hungry to total world population. The statistics show that a majority of the hungry were living in South Asia and Sub-Saharan Africa, and some in Latin America. In other words, with some significant exceptions, it is possible to speak of a 'hunger belt' straddling the equator.

By and large, the hungry are also the poor – those too poor to buy food. Their incomes are small because they own insufficient productive resources of capital, land and marketable skills. Moreover, because at best they earn barely enough to cover their needs, they are highly vulnerable to shocks such as natural disasters, wars, falling prices of the products they sell relative to those of products they buy.

Most poor people live in poor countries. These nations have severely restricted options for dealing with poverty. They could increase the demand for the assets of the poor – mainly their labour – or add to their productive assets by transferring land or capital to them, but both are difficult and slow-working approaches and brake overall economic growth. The only alternative would be direct income support, but again this would compete with the limited means available for public investment, slowing down development. As for direct overseas food aid for the hungry, it has been shown that this often reduces local food production.

The poor, by definition, have only limited access to the markets for food, so adjustments to those markets do not touch them significantly. The latent demand of the poor for food (i.e. their biological needs minus effective demand) is not automatically translated into effective demand stimulating their countries' food markets; likewise, where there is additional supply this will not necessarily reach them, since their purchasing power may still be too weak.

Many of the hungry live in isolated rural areas. Both the urban and rural poor tend to earn their incomes by offering unskilled labour on markets that have more than enough of it. As for farming by the poor, especially in Africa the technologies used are often too primitive to provide enough food for subsistence. ■

Modelling the world food system – the Basic Linked System

IIASA's research has provided a framework for analysing the world food system, viewing national agricultural systems as embedded in national economies which in turn interact with each other at international level.

In cooperation with the Centre for World Food Studies, Amsterdam, the Food and Agriculture Program constructed a system of models designed to reflect the structure of the world food system. This is the Basic Linked System (BLS) – an interacting set of some 34 models, based on common principles and thus comparable, consistent and able to communicate with each other.

The approach of BLS is that of applied general equilibrium, at national and international levels. Countries, and groups within them, are portrayed interacting to reach equilibrium. The model is in general equilibrium because physical quantitities of commodities are in balance, as are monetary valuations of countries, individual producers and consumers. Since all countries are included, there are no infinite sources or sinks of goods and currency, so the effects of, and feedback from, policy decisions cannot be masked.

BLS has a large and rich data bank, assembled from different sources but made perfectly consistent, checked and revised. The data handling routines are flexible enough to permit the structure to be changed in the light of events, and to allow new ideas to be experimented with.

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To arrive at a realistic model, it was necessary to go into detail. Most food is traded within national borders, and these markets do not all function in the same ways. BLS therefore comprises models covering in detail 18 individual countries. These were mostly developed by scientists in the countries themselves. There are also detailed models for the EC and CMEA, so that in all, around 80 percent of world population, agricultural production and food consumption are dealt with to a high level of precision. The remaining fifth is covered by 14 somewhat simplified country-group models, e.g., for 'African Medium Income Exporters', 'Latin American High Income Importers' and so on.

BLS differs from other global policy models in a number of ways. Firstly, the applied general equilibrium approach ensures an unusual degree of consistency of physical and financial flows, accounting for secondary effects and adjustments. Secondly, BLS distinguishes a wide range of commodities – 10 at the international level – and the interactions between them. In addition, the system takes account of official policies, including reactions to changes in those of other governments or in world prices.

It is important to underline that identification, estimation and validation of parameters for the national models were based on empirical time series for a period of 15–20 years, generated on the basis of national statistics and international data sources.

BLS has its limits, too. The national models are not detailed enough for comprehensive national policy analysis, and BLS is not a short-term forecasting tool. Its purpose is to generate scenarios that provide an insight into the nature of the world economic and food system, and to explore the effectiveness of policy alternatives.

The building blocks

The building blocks of BLS are the national policy models, each of which reflects the specific problems and charac-

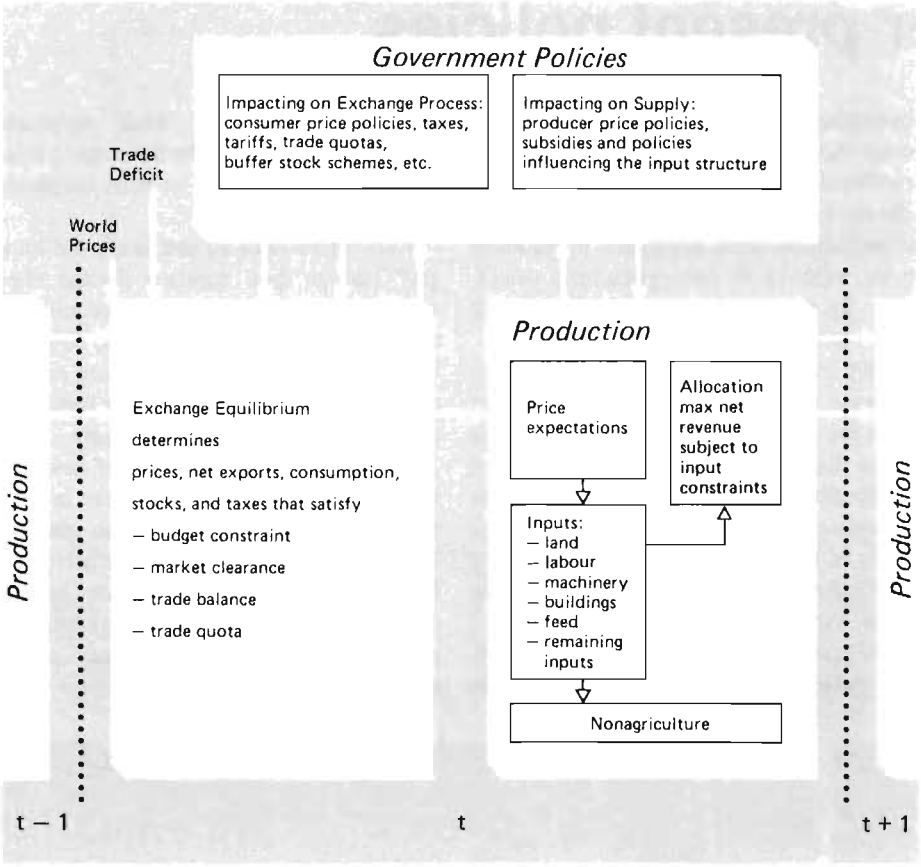


Fig. 3: Information flows in a typical national model.

teristics of the nation in question. Fig. 3 shows the information flow in a typical model.

Each country is conceived as having three basic components: production, exchange and policy. As the diagram indicates, past prices and government policies affect production decisions. Production in each sector accrues to the sectoral groups. The income this amounts to is determined by commodity prices and exchanged volumes.

For instance, if farmers have grown two million tons of wheat and one of rice, they will have an income of twice the price of a million tons of wheat plus the price of a million tons of rice, minus the cost of producing wheat and rice. These initial entitlements of the different products for the various groups may be redistributed by government policies.

Given these entitlements and world prices, groups trade among themselves under the influence of government policies. The resulting exchange equilibrium determines domestic prices, net exports, tax rates and consumption patterns of different income groups. In the process of exchange, all the markets are cleared within the national balance of trade constraint, income and resource constraints faced by the various actors.

Each model distinguishes the behaviour of three types of agents: producers, consumers and governments. The manner in which the behaviour of these agents is represented differs from model to model. Some models of the developing countries distinguish between social classes, identified on the basis of assets, such as land or equipment, and the product distributed to these classes as income entitlements.

Consumers' demand behaviour is expressed using estimated equations – one for each commodity – expressing consumption as a function of income and price. For some developing countries, a separate demand system is estimated for each class from time series of household expenditures, so that groups associated with hunger and poverty are specifically dealt with.

The models of the different countries interact through trade, aid and capital flows. Given a set of world prices, a country model can be viewed as adjusting its policies, and responding with the amounts of exports and imports it would like. But the desired exports and imports of all countries must be compatible, so the prices must be found that make them so.

To represent the linkage between national economies, a first round of exports of all the countries is calculated for an assumed set of world prices, and international market clearance is checked for each commodity. World prices are then revised and transmitted to the national models, generating new domestic equilibria and net exports. The process is repeated until the world markets for all the commodities are cleared. At each stage, the domestic markets are in equilibrium. An international agency, such as a buffer stock, can also be included.

These steps are taken on a year-to-year basis, and simulations over 20-year periods are used to project the consequences of various policies, for individual nations and the system as a whole.

A number of variables remain exogenous: the values assigned to them come from outside the system. For instance, population and its growth is taken from UN and International Labour Organization projections, while upper limits on land available for cultivation are estimated on data from FAO.

The models in the BLS have been tested by running them for the historical period, 1970–80, and comparing the prices yielded with actual world food prices. The models have also been run independently and linked together, to see if they behave reasonably.

The project team

The development of BLS involved many people in the FAP and its network of collaborating institutions. The core research at IIASA was set up by Ferenc Rabar, who was Program Leader from 1976–80, and from 1986 until June 1987. Kirit Parikh was Program Leader from 1980–86. Other members of the program core were Günther Fischer, Klaus Frohberg and Michiel Keyzer.

Members of the program core were responsible for all aspects of model development and analysis. Conception of the system, and development of the algorithms for the computation of national and international equilibria were done by Michiel Keyzer. Many others, from a number of different countries, contributed to aspects of BLS at one time or another. ■

Prospects under present policies

The reference scenario of the BLS assumes that the policy regimes in the various countries continue along past trends without drastic changes. It thus serves as a 'neutral' point of departure, from which various policy scenarios take off as variants, their impacts being seen as deviations from the reference run.

The reference run is based on a four percent global GDP growth rate, and one of 5.4 percent for the developing countries. The latter is broadly in accordance with the experience of the 1970s, and with recent projections by international organisations, though the stagnation of the world economy and adjustment problems of numerous developing countries in the current decade have meant that growth has been slower.

The reference scenario presents the perspective of a world in which the effective demand for food grows substantially owing to higher incomes and larger populations, but this demand is met with very modest increases in agricultural prices.

The increases in demand for the various agricultural commodities range from 1.6 to 2.3 percent over the years 1980–2000. Meat and milk demand grow fast in developing countries, reflecting their particular sensitivity to the rapid increases in income there. Meanwhile, the shares of the various country groups in global demand change significantly, with that of the developing countries increasing. National policies, aimed at maintaining given levels of self-sufficiency, mean that most of the additional demand is met from local production rather than foreign trade.

Increased demand is responded to by growth rates in supply of between 1.1 and 3.4 percent per annum. Food supplies grow faster than average in the developing countries, where the full potential of the 'green revolution' remains to be exploited. Thus, in the Third World wheat production rises by an annual rate of over three percent and that of protein feeds by 2.8 percent. Overall, the improvement in farm output is more than enough to compensate for population growth.

Prices change relatively little, overall, but there are shifts in relative prices, with wheat becoming cheaper by an average of 0.4 percent per annum to the end of the century, and bovine and ovine products becoming dearer to the tune of 2.2 percent. Apart from the latter, the only agricultural products to become significantly dearer are dairy products and non-food commodities. The aggregate agricultural price, relative to non-agricultural prices, rises by only eight percent over the 20 years to the year 2000.

The importance of trade continues to increase up to the end of the century, as does the degree of interdependence, in the sense that the proportions of total global production that are traded grow in the reference scenario. The main expansion of trade is in the commodities exported by North America and Oceania, whereas the main exports of developing countries – mainly protein feed – rise relatively slowly. The developed market economies increase their net agricultural trade surpluses whereas the deficits of the developing market economies increase or their surpluses are decreased.

And where does all this leave the hungry? Though their numbers decline after 1990, by the year 2000 there are still 400 million of them, compared with 510 million in 1980, implying a reduction of just one percent per year. True, the incidence of hunger decreases more markedly – from 23 percent of the populations of developing countries in 1980 to 17 percent in 1990 and 11 percent at the end of the century. The fact remains, though, that increased food supplies do not eradicate hunger under this scenario, even with its comparatively optimistic assumptions about economic growth. ■

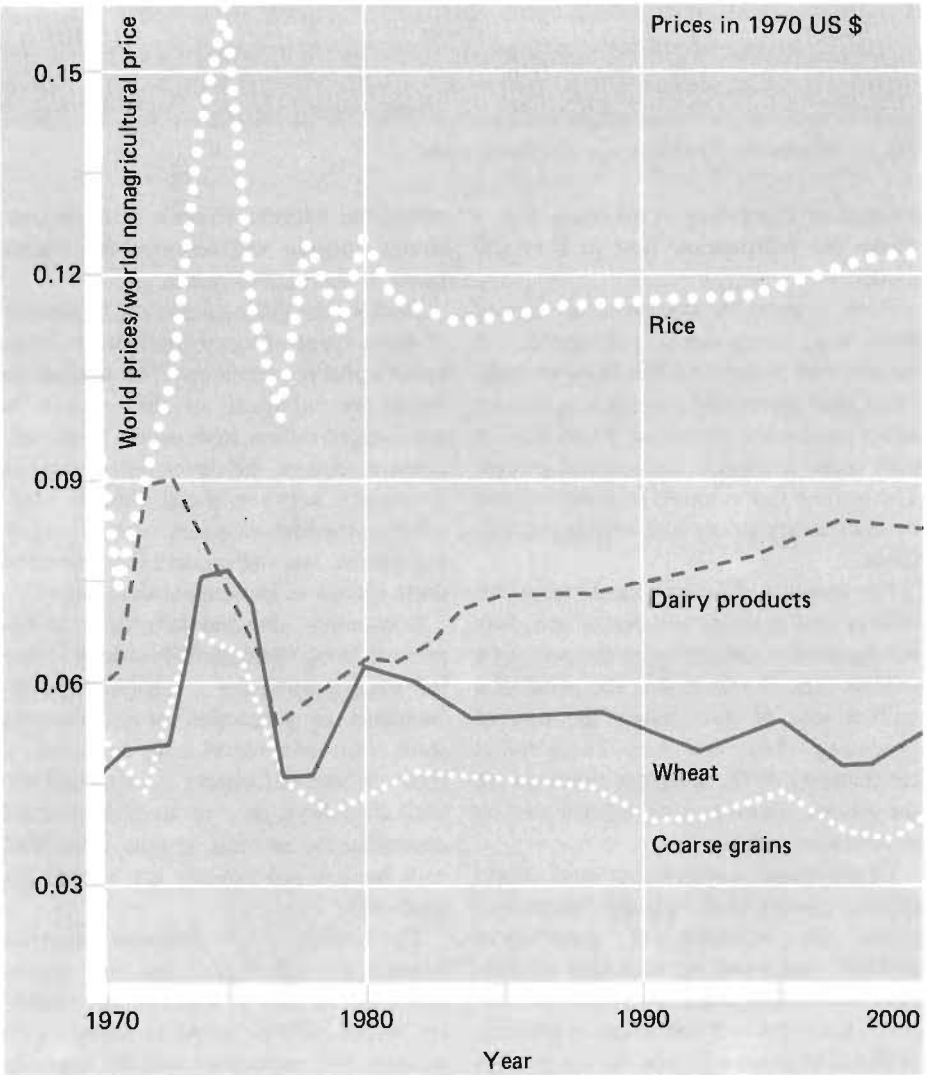


Fig. 4: Relative world market prices in the reference scenario.

The system adapts – hunger remains

There is some evidence to show that world food grain prices are sometimes artificially raised by government policies and some large exporters, preventing poor countries from importing more. Thus, not just prices but also hunger is kept at a higher level. But what would happen if prices were kept lower, permitting poor countries to import more?

Improved supplies

FAP used a scenario to test the effects of a major increase in grain supplies. As a first step, it was assumed that a hypothetical country entered the market with the intention of selling, at any price, 50 million tonnes (mt) of wheat per year, which it got as "manna from heaven" to help poor importers. The 50 mt were chosen as a sufficient volume to meet the cumulative food deficits of all who do not now obtain a minimum satisfactory diet.

An immediate result of the extra wheat on the world market is that the international price falls by more than one third, also pulling down other food prices. Also, major wheat exporters cut their exports, raising their stocks, and importers increase their imports. Later, the exporters reduce their production, too, and meanwhile the importers scale back their own wheat output in favour of cheap imports, and reallocate their production, especially to beef.

By the end of the simulation period, more than 85 percent of the "manna" has been absorbed by the system, through production falls, and less than 3 mt are left for human consumption, once feed use and buffer stocks are accounted for. About 10 million people less are hungry at the end of the century than would otherwise have been the case. Even the short-term impact, as measured by the 1985 comparison, amounts to only 31 m undernourished people out of 490 m. The market adjusts without taking account of the needs of the poor.

This scenario is not as far-fetched as it sounds. There have been serious suggestions that people in developed countries might help the hungry by consuming less wheat – for instance by eating less meat. Since not producing a kilogram of meat saves more than four kilograms of grain as feed, the idea has intuitive appeal. FAP therefore ran a "vegetarian" scenario, in which the demand for meat in the developed market economy countries was gradually reduced by 50 percent over the period 1981–1990, but demand for cereals, vegetables, etc., proportionately increased to bridge the resultant calorie gap. This would release about 110 mt of feed grains.

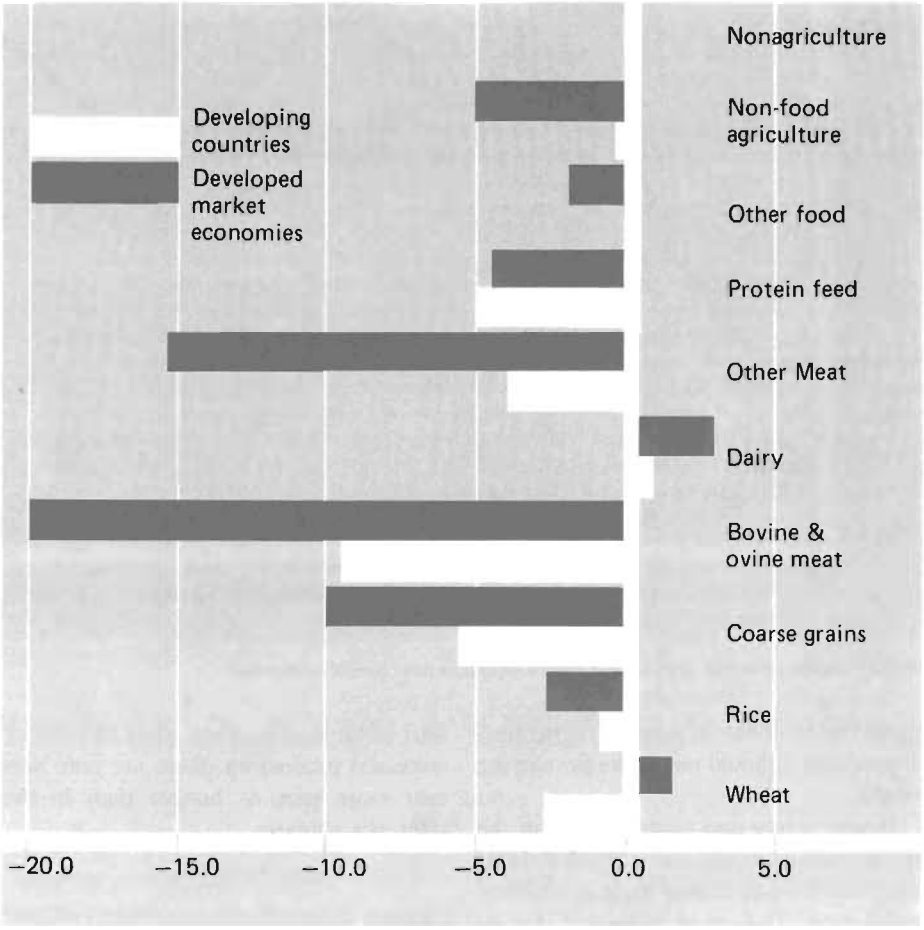


Fig. 5: Percentage changes in agricultural production by 2000 in "vegetarian" scenario relative to reference run.

The simulation indicates that the cut in meat consumption is partly nullified by lower prices, which stimulate demand. Moreover, as the demand for feed grains is nevertheless reduced, so too is production of them – but grain consumption rises, mainly in the developed countries. By the end of the century, exports from the latter to the developing countries are only 13.5 mt higher than they would otherwise have been, and in the latter production has been hit by lower world prices. Human grain consumption in the developing countries is up only 0.5 percent in the year 2000, by comparison with the reference scenario. As for the hungry, their numbers are reduced by seven percent, or 34 million people, by the year 1990, but the gain is largely swallowed up by the end of the century.

It seems, then, that additional supply does not help the poor unless it can somehow add to their income. The needs of the hungry have no place in the world food system.

Tighter supplies

If increased food supplies and lower prices do not help the hungry very much, what effects do their opposites have? Many developing countries tend to keep agricultural prices low and tax agriculture, reducing farmers' incentives. They are often advised by economists from industrialized countries to reverse these policies. And indeed, assuming that higher world prices were at least to some extent

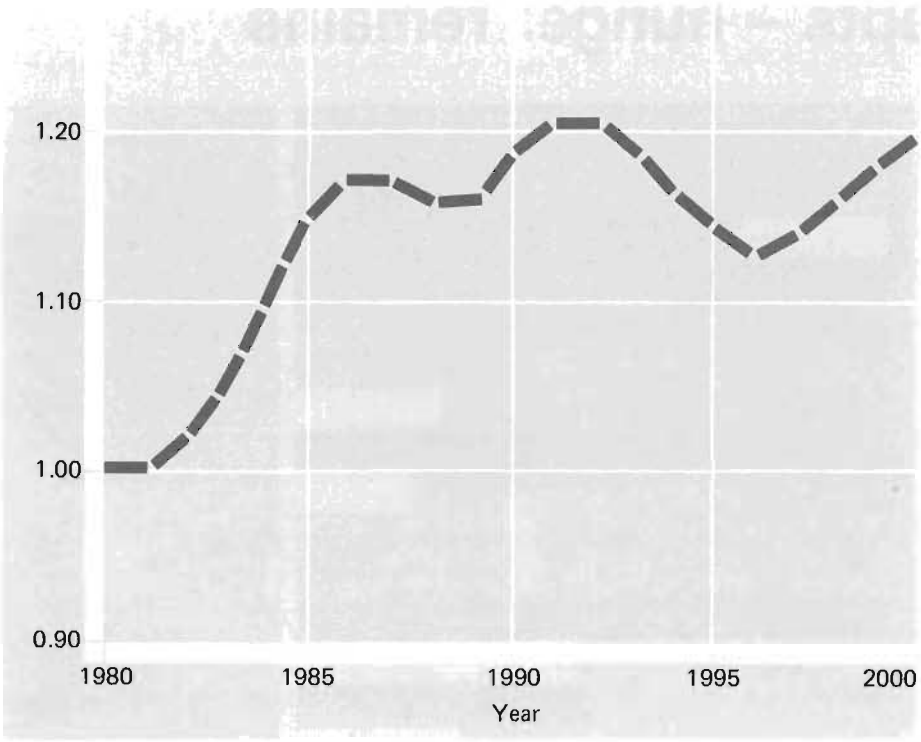


Fig. 6: Index of world agricultural price relative to non-agricultural prices

passed on to domestic markets, agricultural production should rise in the developing world.

Lower supply and higher prices on the world market would result if the OECD countries were to reduce their agricultural production. This could happen if, for instance, the environmental concern represented by the European 'Green' parties culminated in moves to reduce the use of chemical fertilizers and restrict the extent of land cultivation. FAP constructed a 'green' scenario stipulating a 50 percent tax on fertilizers in OECD countries and a reduction of one fifth in the cultivable area. Does this trigger another 'green revolution' in the Third World?

The changes, introduced between 1982 and 1990 in OECD countries, result in a loss of 5.8 percent in agricultural production. In consequence, the world wheat price is 55 percent above its reference scenario level in the year 2000, while the difference for farm prices as a whole is 14 percent. As expected, agricultural production in developing countries rises during the period – but only by 2.5 percent above reference scenario level, while wheat and coarse grains output are both over 12 percent higher. Yet the higher domestic prices that promote increased production also lead to a lower intake of calories in most developing countries. Even at the start of the next century, after 15 years of increased production, there are nine percent more persons hungry than in the reference scenario.

This happens with long-term adjustments, but what of short-term shocks? Again, the burden is borne by the poor, as shown by BLS scenarios designed to demonstrate the results of bad harvests. A production shortfall in the North is mostly transmitted to the world market, because consumers there can afford to pay more for their food. The overall agricultural price level rises by 15 percent by comparison with the reference scenario. But a shortfall in the South is absorbed by people there, who consume less; prices rise by 11 percent.

The results of the two runs, in terms of average daily calorie intake and numbers of hungry, show that it makes little difference where the weather shock takes place: the poor are hurt by high world prices regardless of the factors that bring them about. In the one instance (North), there are 40 million more hungry people in developing countries; in the other (South), 42 million more.

The conclusion, then, is that while lower food prices do not necessarily eliminate hunger, high-price scenarios yield increased numbers of starving, despite the consequent higher long-term food production in developing countries. ■

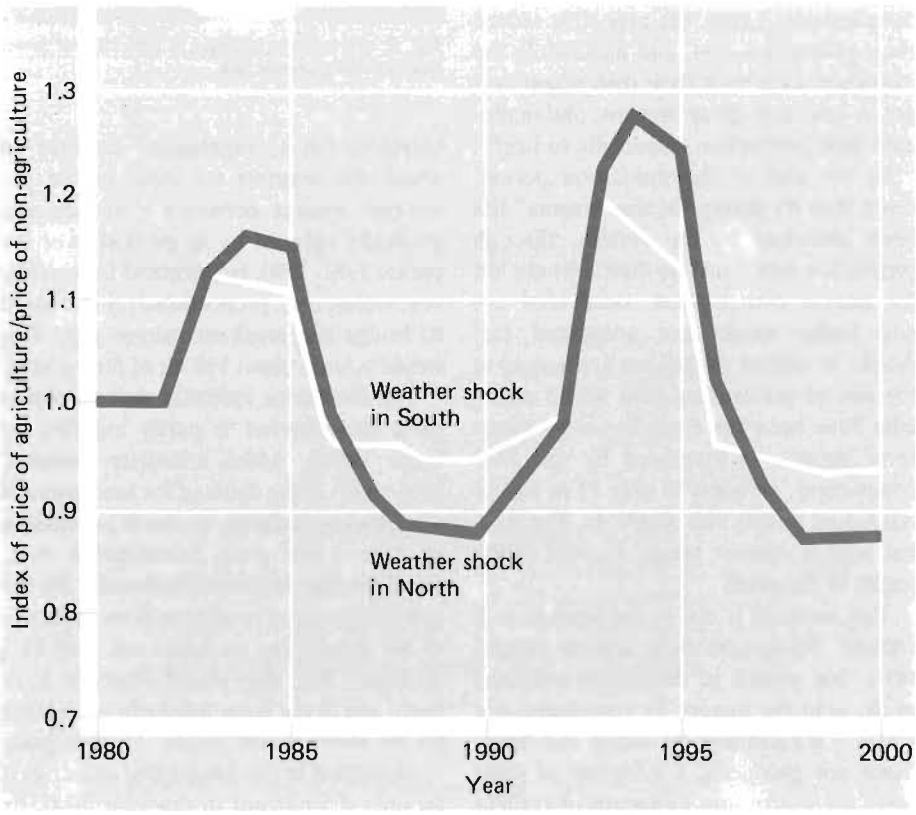


Fig. 7: The weather shock scenarios.

Free market world trade policies – would trade liberalisation conquer hunger?

International trade in food is characterised by a high degree of protectionism. In the industrialised countries, governments intervene to guarantee a given degree of self-sufficiency in food, and to bring agricultural incomes closer to those of other sectors.

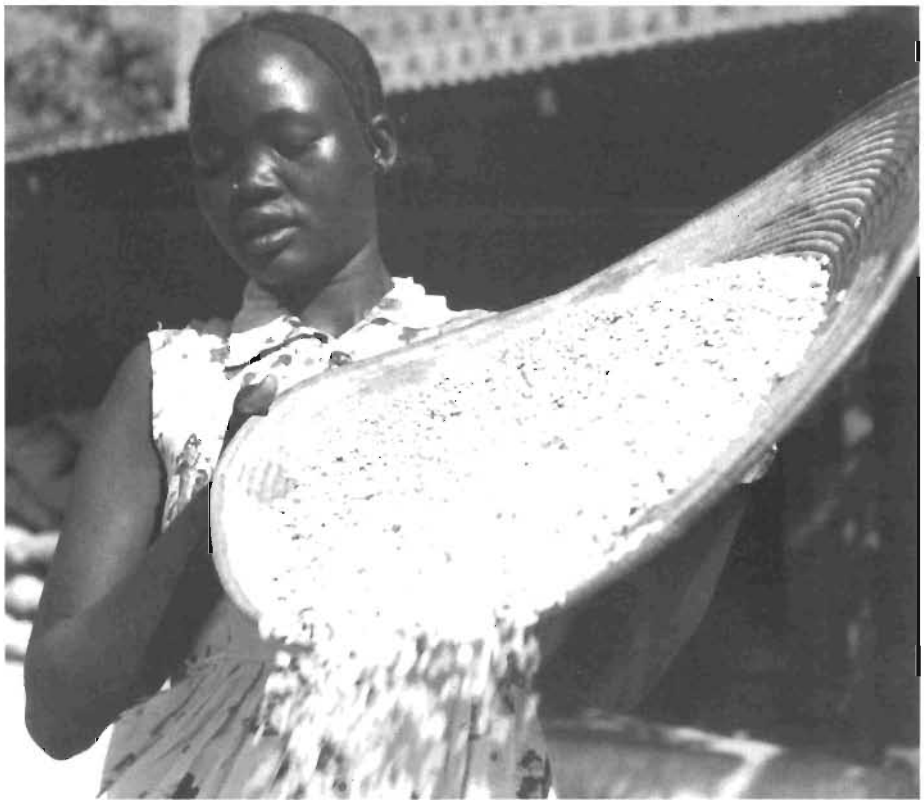
Developing countries, which are often encouraged to liberalise their foreign trade, in fact tend to protect their farmers less than the industrialised nations. Indeed, those in the early stages of development are often driven to negative protection: they tax agriculture so as to replenish governmental budgets.

The high domestic food prices in industrialised countries lead to surpluses. These have partly to be dumped on the international market, hitting other exporters but helping importers. The world food market is heavily distorted – but many countries can live with this, as international trade accounts on average for only 15 percent of total food production.

Protectionism takes many forms, not all of which can easily be quantified. The nominal rate of protection – the percentage by which the domestic price for a particular commodity exceeds the world market price – is only a rough yardstick but yields interesting comparisons. By this measure, in the mid-1980s Japanese protection stood at over 170 percent, that in the EC at more than 50 percent, and that in the USA at almost 50 percent.

Against this background, it is important to assess the potential consequences of agricultural trade liberalisation, for which there have been many calls in recent years. One would expect structural changes, leading to improved resource allocation and thus faster growth – but for whom? Gains and losses are rearranged, but the market does not ensure a just distribution of income.

To win insights into the potential effects of liberalisation, IIASA's Food and Agriculture Program ran scenarios assuming removal of all trade barriers and price distortions in agriculture: by OECD countries alone; by developing countries alone; and by all.



United Nations

Liberalisation by the North.

When the OECD countries remove their border protection, world agricultural prices, relative to those of non-agricultural goods, rise by about nine percent more than in the reference run. This average masks larger changes, ranging from −2 percent for non-food farm products to +31 percent for dairy products. Cereals and rice prices rise strongly, and animal products also move up.

Developing countries' terms of agricultural trade worsen, as it is their imports that rise most in price. In terms of economic growth, they are also marginal losers, whereas the OECD countries have a gain of 0.57 percent of GDP up to the year 2000, as a result of faster growth by their non-agricultural sectors. Among the developing countries, the agricultural surplus nations gain but importers suchs as Egypt lose.

There is a slight gain in global agricultural production over the 20 years, relative to the reference scenario, this coming from a 1.5 percent increase in Third World output. Surprisingly, US farmers maintain their income despite the loss of protection, and EC farmers suffer only a relatively minor loss of income. Higher prices and restructuring, along with improved opportunities for labour to migrate out of agriculture, limit damage to farmers' incomes. In developing countries, farm incomes profit from liberalisation by the OECD, but the negative effect on GDP more than offsets the benefits for low-income groups, and hunger increases marginally.

The developing countries would thus profit little from liberalisation by the OECD alone, except in the case of some commodities with depressed price levels.

Liberalisation by the South

When developing countries apart from China liberalise, but OECD countries do not do so, world prices decline slightly on average. There are steeper falls for prod-

ucts of special export interest to developing countries, whereas the prices of their agricultural imports tend to rise. The consequences for domestic prices differ from country to country, as some have relatively high positive protection whereas others have negative protection.

The overall fall in prices is explained by the fact that developing countries are the major exporters of non-food agricultural products, and in many cases currently tax such exports. Meat becomes cheaper because of increased output, but wheat prices rise slightly as a result of reduced production and higher imports by developing countries. With the exception of cereals, overall agricultural production increases relative to the reference scenario.

Dearer agricultural imports and lower-priced exports create a significant loss in the terms of trade of the developing countries, mirrored in a gain for the North. Despite increased export volume, their agricultural trade surplus at current prices declines. In terms of global economic growth, the scenario records a rise of just 0.05 percent, with developed market economies showing gains and the developing countries, as a group, losses. The middle- and lower-middle income countries are on average worse off, but the poorer ones tend to benefit.

All groups show reductions in hunger, the overall drop being 4.6 percent, as compared to the reference scenario up to the year 2000 – but India and Pakistan do better. Though the impact on starvation is slight, liberalisation by developing countries does, on balance, appear a desirable policy for many. However, domestic rigidities in labour and capital markets may prevent realisation of the benefits, requiring additional measures.

It remains to ask what would result from liberalisation by all market economies. In this scenario, relative agricultural prices increase on aggregate by five percent as compared to the reference scenario. Most commodity prices show their largest increases – but not the main exports of developing countries, while their imports show higher price rises than when only the OECD liberalises.

The changes in global agricultural production levels are again modest, the largest being an increase in meat production. Wheat, rice and coarse grains output are little altered, as compared with the reference scenario. The geographical pattern of production shifts, with developing countries raising output of all commodities except coarse grains, and developed countries producing less of some commodities.

OECD countries obtain an overall 0.63 percent improvement in GDP by the end of the century, as compared to the reference run, while developing countries – with widely varying individual results – take an overall 0.22 percent loss. World trade increases substantially, and the developing countries improve their agricultural balance of payments. Yet the gain in revenues is small compared to the resources needed to wipe out hunger, which increases by 1.4 percent up to the year 2000, owing to higher food prices.

The liberalisation scenarios thus suggest that arriving at the 'right' prices for agricultural goods leaves the hunger problem unsolved. The interest of the industrialised countries in liberalisation is confirmed – and this would seem to colour the current discussion of world agricultural trade, while the hunger issue is pushed aside.

An important finding is that it matters for developing countries thinking of liberalising their agricultural trade who else does likewise. For some countries, benefits are greatest when OECD nations continue to protect. Attempts to impose the same recipes on numerous different developing countries are seen not to be in the best interests of all. ■

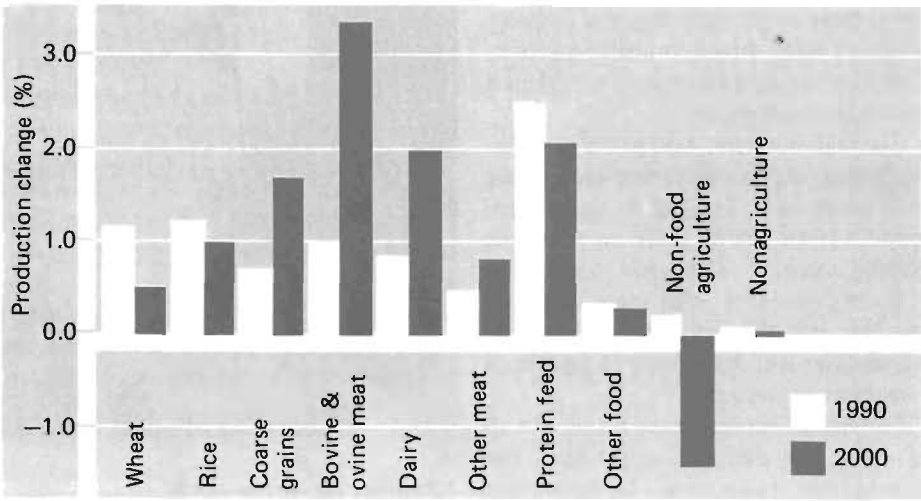


Fig. 8: Global production under OECD liberalisation scenario relative to reference run.

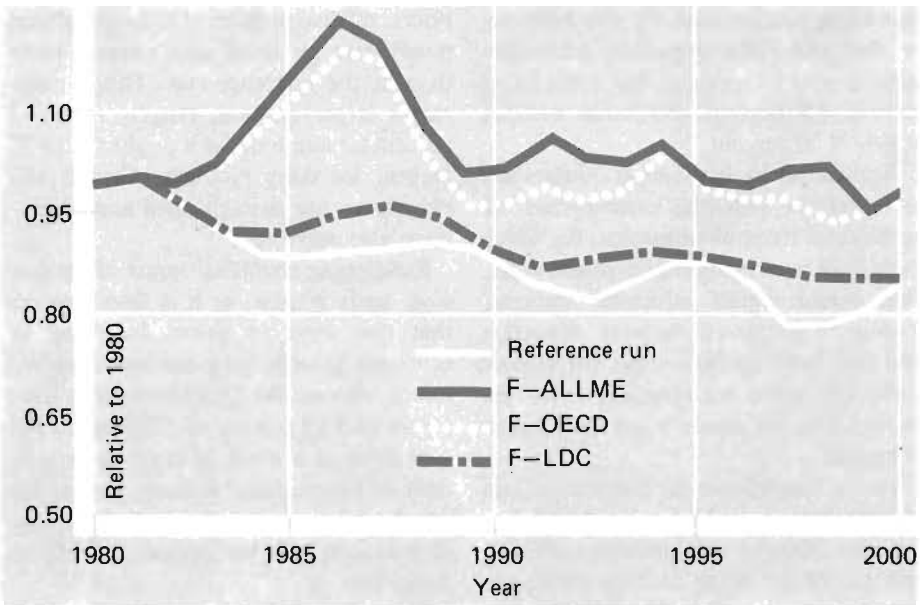


Fig. 9: Index of world wheat prices under various trade liberalisation scenarios.
F – ALLME: all market economies liberalise; F – OECD: OECD liberalises alone;
F – LDC: Less developed countries alone liberalise

The case for aid

If changes in the world food system have scant impact on hunger, because the poor remain largely outside the system, it becomes necessary to consider direct assistance to low-income groups. This would imply some form of income redistribution, at national and/or international level, through financial transfers or in other forms. The effects of various policies aimed at helping the poor have been tested with the BLS.

Domestic redistribution

The majority of the hungry still live in South Asia, especially the Indian sub-continent. The BLS includes a detailed model for India, allowing evaluation of policies specifically designed to help the hungry.

In India, an income subsidy is provided to urban food consumers through ration shops that sell staple foods at subsidised prices. But should the system be extended to rural areas? The Indian model was run with the assumption that all low-income groups were provided with 100 kilos of wheat per capita/year at 20 percent below market price.

If fully used, the subsidy would provide the lower-income half of the population with about 10 percent more calories – but that is not what happens. Lower-income households would still find it cheaper to eat grains considered inferior by others, so they would take up only a fraction of the subsidised wheat. Morever, the cost of rationing would bite into public-sector investments, lowering the economic growth rate and thus incomes, too.

In countries where incomes are low because of lack of employment opportunities, there is an obvious case for creating jobs, especially in rural areas. Would rural works programs be the answer? FAP assumed that the two rural classes in India with the lowest incomes participated at an annual rate of about 200 person days per family, receiving a wage of about six rupees per day in the form of wheat.

This results in a major improvement in the food situation of the poorest rural classes. If the program is paid for from extra taxation, overall economic growth accelerates, too – but the tax effort needed to finance such widespread projects is beyond what can reasonably be expected. On the other hand, if the program replaces regular public investment plans, economic growth declines.

In short, attractive as the prospects of such policies are for eradicating hunger, these runs suggest that it is beyond India's means to finance them from internal resources. This situation is, of course, typical for most of the countries where the poor live, pointing to a need for increased foreign aid.

Foreign aid

Additional inflows of money from abroad would have to come in the form of aid, as commercial capital is attracted by opportunities for returns which the poorest countries can scarcely offer. But what would the cost be of non-market policies that would rid the world of hunger?

At present, the developed market economies devote about 0.35 percent of their collective GDP to concessional aid. One FAP scenario assumes that aid is increased by levying a tax on developed countries equivalent to 0.5 percent of GDP, and distributing the proceeds to countries with an annual per capita income of $1,500 or less in 1970 dollars. It is assumed that countries with an average per capita income of $100 get five times as much of this aid as those with $1,000 per capita. The scheme is assumed to start in 1982, and together with other flows is taken as bringing total aid to 0.85 percent of developed countries' GDP by the year 2000. It is further assumed that neither trade liberalisation nor redistribution within the developing countries take place.

If the additional aid is used for capital formation, per capita GDP in developing countries grows by 5.3 percent more than in the reference scenario, up to the year 2000 – and by 24.7 percent more in the poorest countries. There is a reduction of 32 percent in hunger. If the money is spent directly on food consumption rather than investment, this results in slower increase of economic growth but up to 1990 the decline in the number of hungry people is almost twice as great; by the end of the century, though, the difference has disappeared. The investment-based path would probably be more sustainable, should aid be cut off at some point. As for the developed countries, they record negligible

United Nations

Ploughing in Indonesia, where development programs have brought large increases in rice output.

United Nations

Spraying at demonstration farm in Laos

losses in GDP as a result of increase in aid. Extra aid permits additional exports to recipient countries. By the year 2000, the donors' GDP is just 0.2-0.4 percent lower than in the reference run.

Another FAP scenario, named 'MARS' (mutual arms reduction scenario), has shown that redirection of resources from military spending into capital investment and aid would, as might be expected, lead to improved economic growth for developed and developing countries, to higher agricultural production and a substantial reduction in hunger.

Mutually beneficial policies: aid with liberalisation

Another scenario assesses the effects of a combination of additional aid, along the above lines, and general trade liberalisation. This time, all are better off. Such is the impact of the extra imports by developing countries that OECD members' GDP increases by 0.75 percent, relative to the reference scenario, whereas with general liberalisation alone the gain was 0.48 percent. More than half of the additional aid effort is recaptured.

Liberalisation blunts the impact of aid on the hunger problem, reducing the numbers of the undernourished by five percent less than under the aid-alone scenario. Higher food prices through liberalisation are the main reason for this effect. The gain of the rich countries through this policy mix is, thus, partly the loss of the poor.

A further option would increase the effectiveness of aid, such that hunger might be eradicated at the same time as trade barriers were removed: this is income redistribution in developing countries, as outlined in the Indian example, but financed by foreign aid.

The same Indian rural works programs, financed by foreign assistance until the late 1990s, would by then have generated sufficient resources for the rural works programs to be domestically funded. The cost of projects sufficient to eliminate hunger is put at $3.6 billion per year in 1985, falling to $3.1 bn in the year 2000. In this scenario, per capita income at the start of the 21st century remains at reference scenario level ($182) whereas without aid it would be only $155.

If aid, liberalisation and redistributive policies in developing countries were combined, major progress could be made towards eradicating hunger. The real cost to the wealthy nations would be negligible, as they would reap the gains of liberalisation, removing their costly farm subsidies and surpluses, while much of their aid expenditure would return as additional export earnings.

In this variant, the international community would behave similarly to national governments, which to some extent permit markets to function freely, but would also open to possibility of intervening to protect low-income groups. The world as a whole would benefit from free trade, but income redistribution would ensure that the poor shared the gains. ■

The future of BLS – a network of centres

Following ten years of painstaking research at IIASA and collaborating centres, the Food and Agriculture Program is coming to an end, and its findings are being presented in participants' books. But FAP has created a powerful analytical tool for agricultural research – the Basic Linked System – and this will live on.

As BLS can be owned, transferred and used for different purposes, it has been decided that an international network of centres will be created for its further application. Countries which wish to do so will be able to include more detailed representations of their own agricultural sectors and/or economies into the flexible structure of the system.

A North American Centre (NAC) has been set up to operate, develop and apply the BLS at Iowa State University, for a consortium including the United States Department of Agriculture and Agriculture Canada. The model will be used to make long-term projections for US, Canadian and world agriculture, and to evaluate trade, development assistance and domestic natural resources policies. Initially, activities will be devoted to enhancing the North American components of BLS and specialising them for the study of trade policy and resource use patterns.

An Eastern European Centre, based in Budapest, is also in the process of being created, assuring access to the model for Eastern European countries.

Terms and conditions have been negotiated with these centres to ensure that training will be available to organisations, approved by IIASA and its National Member Organizations, which mean to establish centres within the next three years.

Other regional and national centres may be set up, in addition to those in the USA and Hungary, following expressions of interest from scientific organisations in the GDR, France, India, Japan, the Netherlands, Poland and Soviet Union. A joint Western European Centre for the FRG, France and the Netherlands is also under discussion. The centres in the network will hold annual conferences on world agriculture and modelling for the BLS. ■

Three Books

The IIASA Food and Agriculture Program has given rise to three books explaining its work more fully than is possible in an issue of *Options*. One is already in press, and the other two will shortly go to the publishers. Here we present brief summaries:

Toward Free Trade in Agriculture
K. Parikh, G. Fischer, K. Frohberg, O. Gulbrandsen.
Published by Martinus Nijhoff, 1987 (in press).

The book deals with distortions in agricultural trade and the potential impact of their removal. The analysis is based on results obtained from the Basic Linked System. Results include the new steady-state solution after removal of trade barriers, and the adjustment path to reach it. Numerous tables, graphs and bar charts are used to support the discussion.

Before presenting five scenarios on trade liberalisation, the authors quantify the most important protective measures used in agricultural trade, provide a brief overview of the model system, and discuss the outcomes of the reference scenario with which others are compared. The five trade liberalisation scenarios differ in respect to countries which are assumed to participate. Three deal with liberalisation by OECD countries alone, one with liberalisation by all developing countries except China, and one with free trade in agriculture among all countries except the centrally planned economies. Results are presented on a country-by-country basis, and a list of indicators provides for evaluation of the outcome of the policies, showing losers and gainers.

The outcome of the simulations indicates that gains from liberalising agricultural trade are relatively small. Nevertheless, in most developed countries gains exceed the amount currently devoted to development aid. Whenever developed countries participate in trade liberalisation, it is found that the level of hunger in the world increases owing to rising food prices. On the other hand, when developing countries liberalise, most gain in income terms, and hunger is also slightly reduced.

Linked National Models: A Tool for International Policy Analysis
G. Fischer, K. Frohberg, M. Keyzer, K. Parikh (in preparation).

The volume introduces Applied General Equilibrium (AGE) analysis, and uses its concepts to construct a set of empirically estimated national models. The characteristics of the Basic Linked System are described.

The behavioural responses of consumers and producers are kept consistent with micro-economic theory. National governments are considered as important actors in the system, and a wide variety of policies is permitted to each administration, including taxes, tariffs, subsidies, etc.

The first chapters explore the theoretical background of the FAP modelling exercise at IIASA. An overview of applied general equilibrium models in economic analysis is provided, followed by a detailed mathematical description of the approach taken to BLS. Requirements for, and the formulation of, the AGE national model are discussed, the innovative methodology developed to link various national models through trade and financial flows is described, and possible uses of the modelling system for welfare analysis are indicated.

The second part describes the econometric specification of the model equations and empirical estimations of the parameters. The third presents the properties of the estimated models in terms of summary statistics such as validation, elasticities, etc., providing insights into the behaviour of the models. The use of BLS in policy analysis is illustrated. Finally, some suggestions for further development of the approach and the system are presented.

Hunger: Beyond the Reach of the Invisible Hand
G. Fischer, K, Frohberg, M. Keyzer, F. Rabar (in preparation).

The analysis explains why hunger cannot be alleviated through market mechanisms alone. It presents the results of various simulations, carried out with the FAP models, which reveal the nature of national and international food and agriculture systems. The authors attempt to answer such questions as: Why does chronic hunger persist in the midst of a globally adequate food supply? What policies would promote growth with equity and rapidly reduce hunger?

The book concludes that the world food system consists of national agricultural systems which are interdependent. Because they are partly autonomous, but are also linked together, nations take rational actions which can combine to yield a result none intends. Neither purely national nor purely international policies suffice to eradicate hunger and glut.

It is argued that the world food system includes market forces, but is more than the market. It includes millions of people who need food but have no income with which to demand it on the market, and it includes a wealth of non-economic forces.

The system is described as one in which a large number of nations are now non-viable, and others may be vulnerable in the future, lacking the resources to produce sufficient food, or being at risk from natural or man-made disasters.

The book maintains that policies for national viability must be flexible, as a number of factors may change over time. The system is also one that accumulates inequity, the book shows: those who win can gain still more in the future; those who lose go on losing. The system distributes food to those who already have enough, and burdens those less fortunate. Moreover, this behaviour is seen to resist even major changes that do not restructure the system.

The book goes on to enumerate changes that could end hunger and gluts. It demonstrates that these could be drastically reduced if the world market were so liberalised that labour could flow freely – an unrealistic aim in today's world. However, maintaining both migration barriers and national policies, an international system of income redistribution could eliminate hunger, the authors argue. They propose transfers along the lines of an insurance system to protect nations from current poverty or future disaster.

The authors show how such a system, if accompanied by trade liberalisation, would yield economic gains sufficient to finance the redistribution without hindering economic growth or weakening the position of the donor countries. Moreover, they argue that the effect of migration barriers can be interpreted as a rent, and as such justifies redistribution as a moral obligation towards those who are fenced out. ■

News from the Institute

Developments in Collaborative Research

A collaborative bilateral two-year agreement has been signed by the Finnish National Program "Technology, Economy, Society" and the Bulgarian Committee for Applied Systems Analysis and Management to pursue research on *Technological and Management Development in Different Branches of Industry* through both independent and joint studies. Using IIASA's Management of the Technological Life Cycle Project methodology, the two parties will employ national research groups and agencies to investigate common problems of technological development related to economic conditions particular to the two countries. The results of the study in the form of comparative analysis and recommendations for policy-makers will be discussed at roundtables, workshops and seminars, and will be presented to IIASA for further dissemination and broader use.

IIASA has signed a Memorandum of Understanding with the Center for Agricultural and Rural Development (CARD) of the Iowa State University (ISU) in Ames, USA, for the establishment of a *North American Center for the Food and Agriculture Program (FAP) Model*. As FAP has reached a concluding stage, it is very important to transfer the results of the methodological work to some other centres, so that they can be used after the dissemination work has been completed by the Program. According to the agreement, the program and data tapes have been transferred to CARD/ISU, and it has been agreed that IIASA will provide the necessary consulting help as well. CARD/ISU will also work on the further development of the model structure and make the results available to new interested national centres. The agreement with CARD/ISU is not an exclusive one. The organisation of new centres is under way.

A collaborative three-year agreement was signed between IIASA's Integrated Energy Systems Project (IES) and two Bulgarian research organisations – the Institute for Nuclear Research and Nuclear Energy and the Institute of Organic Chemistry of the Bulgarian Academy of Sciences. The subjects of the agreement are: the study of conditions for providing IES and their economic assessments in regions with different patterns of energy demand, and availability of indigenous fossil fuel resources; and impact of technical progress on the evolution of the energy technologies. In the final stage of the study, it is planned to have an international conference on IES in Bulgaria.

IIASA has signed an agreement with Management Tools and Information Services Inc. (MANTIS) of Boston, Massachusetts, USA, to undertake a joint research effort to develop a *New Methodology for the Assessment of Technologies and Business Strategies*. This development will utilize the extensive experience of MANTIS in assessing business strategies and the extensive research of IIASA on the dynamic behavior of technologies in performance, cost, diffusion and substitution. The approach will require active user participation to identify parameters to characterize and evaluate technologies to facilitate and enhance policy and business decision.

The Population Program has been awarded a grant by the Ford Foundation. The purpose of the grant is to conduct a *Study of the Worldwide Youth Cohort and Its Socioeconomic Consequences*. A graph of the age distribution of the world's population clearly reveals a discontinuity or bulge corresponding to those born around the year 1950. Similar graphs at the national level reveal the discontinuity phenomenon to a greater or lesser degree in different parts of the world. While the existence of this phenomenon is readily apparent, its demographic causes are not well understood.

IIASA signed an agreement for scientific cooperation with the Working Consulting Group on Long-Term Forecasting (WCG) of the President of the USSR Academy of Sciences. According to the agreement, WCG will collaborate with two Projects within IIASA's Technology, Economy, and Society Program, namely, Integrated Energy Systems (IES) and Methane Technologies (MET). Main subjects of collaboration are in the field of *Economic Assessment of IES in Regions with Different Energy Demand Patterns*, as well as *The Impact of Technological Progress on the Evolution of the International Natural Gas Markets*. The agreement covers the period 1987-1989, and provides mutual exchange of methodology and models according to the research plans of IES and MET.

IIASA has been approached by the Research Institute on Tertiary Activities of the Italian National Research Council to conduct a *Study on the Effect of Barriers and Their Removal on Mobility of Persons and Freight Traffic*, to be undertaken by *Dr. Cesare Marchetti* of IIASA.

A collaborative agreement was signed between IIASA's Acid Rain Project and the Committee for Environmental Protection of the Bulgarian Council of Ministers. The agreement specifies that a *Bulgarian National Acid Rain Model* will be developed based on IIASA's RAINS (Regional Acidification Information and Simulation) Model, which will be made available for use on a personal computer. The Bulgarian counterpart will provide national data needed to improve and test some of RAINS' submodels.

The "Milan Vidmar" Elektroinstitute in Ljubljana, Yugoslavia, has requested IIASA to assist in their energy research through a collaborative effort funded by DO Informatika EGS. In particular, IIASA will transfer the MESSAGE II Model (Model for Energy Supply Systems and Their General Environmental Impact) and supporting software, and provide assistance in the implementation of the computer codes. Furthermore, once the model is installed, IIASA will offer advice on the formulation of scenarios and other broader issues concerning future energy outlooks in Europe and the World.

A two-year research contract was signed between IIASA and the Dutch Ministry for Housing, Physical Planning, and the Environment (VROM) sponsoring work

Honors and Awards

Director Thomas H. Lee has been made Honorary Professor of the Academy of Sciences of the People's Republic of China.

Dr. Peter Duinker, of the Biosphere Project, was awarded the Fraser Inc. (Edmundston, Canada) Prize for Excellence in Forestry.

On 28 April, *Dr. Leen Hordijk*, Leader of the Acid Rain Project, was awarded a medal by the Polish Institute for Meteorology and Water Management (IMGW) in Warsaw, for his personal contributions to the scientific cooperation between Poland and IIASA in the field of Acid Rain. The medal was first issued in 1976 by IMGW on the occasion of 200 years of meteorological measurements in Poland.

Professor Robert E. Munn, Leader of the Environment Program, was awarded an honorary plaque by the Canadian Environmental Assessment Research Council (CEARC), in recognition of his contributions towards the improvement of environmental assessment in Canada, and in appreciation of his role as a founding member.

on decision support tools for *Interactive Risk Assessment for Chlorine Transportation in the Netherlands*, continuing work sponsored by VROM in 1986. The Advanced Computer Applications Project will carry out research and development on a *graphics-based intelligent interface* to a large *fault-tree analysis and consequence modelling* system. The project will develop easy-to-use software including geographic database management and display facilities, integrating pre- and post-processors for the risk assessment package SAFETI (Technica Ltd., London). The system will be applied to problems of production, transportation, and use of chlorine in the Netherlands.

A Memorandum of Understanding has been signed between IIASA and the Hungarian Committee for Applied Systems Analysis – represented by the Karl Marx University of Economics and the Computer Center of the Hungarian Planning Office in Budapest - for the establishment of a *Hungarian Center for the Food and Agriculture Program Model*. According to this agreement, the Basic Linked System of the Food and Agriculture Program will be implemented in Hungary to: use it for agricultural policy analysis of Hungarian economic research and education; provide methodological consultation for other countries; develop it, when needed, for the Hungarian users. The specific feature of this agreement is that an attempt will be made to implement the system on an IBM PC, which would considerably extend its application possibilities.

A new contracted study agreement was signed recently by IIASA and the Hungarian Research Center for Water Resources Development (VITUKI). On the basis of this agreement, VITUKI continues the contribution to IIASA's *Decision Support Systems for Managing Large International Rivers* (LIR) Project. The agreement covers four activities in 1987: (a) the preparation of a hydrological database management system is a joint effort of WMO and VITUKI (the system will be made available to IIASA for use in LIR); (b) in LIR the development of a pilot area for testing hydrological models is contemplated (the hydrological data from the pilot area are provided by VITUKI in already processed form); (c) as a component of the decision support system, a model will be delivered for the simulation of the propagation and impacts of accidental pollution (this model can be well utilised in the case of such accidents like that of the Sandoz Company on the Rhine); (d) a computer program was prepared last year to aggregate and evaluate water quality data. The application of the system on the Hungarian stretch of the Danube is this year's task.

IIASA's System and Decision Sciences Program and the Japan Institute of Systems Research (JISR) signed a two-year study agreement on *Interactive Modelling and Decision Support Systems*. One of the primary aims of the project is to design computer-aided problem solving systems as qualitatively new tools for the analysis of concrete problems. Another aim is to introduce the new decision support systems developed in Japan to IIASA, and vice versa. Research will be performed in the following directions: modelling methodologies for developing structural, impact and evaluation models; development of algorithms for interactive optimisation or satisficing methods; and design of user-friendly computer systems for modelling and optimisation or satisficing. Several joint scientific meetings, both at IIASA and in Japan, are planned to exchange the developments of the project. Besides JISR, scientists from four other Japanese universities will participate in the cooperation. Coordinators are *Professors Alexander Kurzhanski* and *Andrzej Lewandowski* from IIASA and *Professor Yoshikazu Sawaragi* and *Dr. Yoshiteru Nakamori* from JISR.

Two one-year contracted study agreements were signed between IIASA's New Logistics Technologies (NLT) Project and (a) The International Society for Inventory Research (ISIR) in Budapest, and the Hungarian Committee for Applied Systems Analysis; and (b) the Academy of Economics in Katowice, and the Polish Academy of Sciences. According to the agreements, the research teams in Hungary and Poland will be providing macroeconomic analysis, statistical data, and case studies describing and evaluating the operation and the efficiency of the existing (acting) logistic systems, as well as development trends, the influencing factors, and the socioeconomic consequences using a predescribed format. The Hungarian team will also collect data from the NLT Project's collaborating research groups in different countries, and set up and maintain a computer data base that will be used for cross national analysis of logistic structures and strategies. The results of the studies in the form of national reports will be presented at a workshop, which is planned to be held in Sopron, Hungary, in November 1987.

IIASA's Population Program and the Institute of Control Sciences (IPU) of the Academy of Sciences of the USSR in Moscow signed a collaborative agreement for cooperation in the field of modelling dynamic processes in heterogeneous populations. The agreement covers the six-year period between 1987 and 1993. IPU and IIASA have agreed on the following two main themes of joint research: (1) Development and testing of models, algorithms, and visualisation methods of dynamic processes in heterogeneous populations, and (2) Development of methods or estimation of risk factors concerning the present and future state of the population.

A study agreement has been signed between the Forest Case Study Group of IIASA's Biosphere Project and two institutions in Poland – the Agricultural Academy of Warsaw, and the Institute of Agricultural and Forestry Engineering. The agreement calls for collaborative work on technical papers and data relating to wood supply and utilisation in Poland up to the year 2020, with emphasis on expected effects of continued forest decline attributed to air pollutants.

Taking into consideration the mutual interests of IIASA's National Member Organisations and the importance of socioeconomic conditions and consequences of technological progress, IIASA's Technology, Economy, and Society Program and the Institute of Economics and Industrial Engineering (IEIE) of the Siberian Branch of the Academy of Sciences of the USSR in Novosibirsk, signed a three-year scientific cooperation agreement. Main subjects of collaboration are in the field of social aspects of technological development, both in East and West countries.

Scientific Meetings

Eighteen participants from six countries and IIASA attended the *Task Force Seminar on New Advances in Decision Support Systems*, held in Laxenburg, 26-28 January. The discussions covered the issues of new developments in decision support systems, and new frameworks for extending and intensifying international scientific collaboration in this area.

The University of Karlsruhe, the German Research Society, the German Academic Exchange Service (DAAD) and IIASA cosponsored the *Workshop on Advanced Computation Techniques, Parallel Processing, and Optimisation*, held in Karlsruhe, Federal Republic of Germany, 23-25 February. The purpose of the meeting was to continue the discussions of the "Summer School on New Methods in Optimisation Theory and Techniques", which was organised by IIASA and the University of Calabria, and held in September 1985. A special goal of the workshop was to deepen the basic understanding of parallel algorithms in optimisation and control theory. Some 40 participants from 12 countries presented and explained new techniques and procedures for the development of new methods based on advanced computational techniques. The impact on other fields of research, e.g. physics, engineering, and economic forecasts, was also analysed. Co-chairmen of the workshop were *Professor Alexander Kurzhanski*, Leader of IIASA's System and Decision Sciences Program, and *Professor Dieter Pallaschke*, from the Institute of Statistics and Mathematics of the University of Karlsruhe.

Meeting of the Team of Experts on Remote Sensing and Forest Decline, Laxenburg, 11–22 March.

Task Force Meeting on Technological Risk in Modern Society, Laxenburg, 18–20 March.

IIASA's National Agricultural Policies Program held a Task Force Meeting on *The Feasibility Study on Sustainable Agriculture* in Sopron, Hungary, from 3 to 5 March, hosted by IIASA's Hungarian National Member Organisation (NMO) – the Committee for Applied Systems Analysis. The purpose of the meeting was to discuss the NMO's proposals on this topic, to specify the research tasks, and to identify possible collaborating institutions. Seventeen representatives from nine NMO countries participated in the meeting.

The Academy of Sciences of the GDR and IIASA cosponsored the *International Workshop on Model-Oriented Data Analysis*, held in the Eisenach Castle, Wartburg, GDR, 9-13 March. The general aim of the workshop was to support links and developments that promise to connect scientists working in statistics, system theory, natural sciences, and applications. Forty-two participants from 16 countries and IIASA discussed the following topics: design of experiments; resampling methods; and nonlinear regression models. The participants of the meeting recommended organising similar meetings on a regular basis. The proceedings of this meeting will be published.

Fifty-seven participants from 12 countries and IIASA attended the Meeting of the Team of Experts on *Remote Sensing and Forest Decline*, held in Laxenburg, 11-12 March, and cosponsored by the Electric Power Research Institute (USA) and the Finnish Institute of Management. The objectives of the meeting were: to generate a state-of-the-art report on remote sensing and forest decline; to stimulate researchers in the field to engage in international cooperation; and to make an evaluation of a method developed by the company Satimage (Sweden) to identify forest decline by satellite pictures. The following is an excerpt of the resolution produced by the team of experts:

"IIASA can play an important role as catalyst and facilitator of development of (a) improved methods of remote sensing, and (b) internationally accepted protocols for ground and remote sensing data collection for decline estimation. This can be carried out through networking and meetings at the Institute, taking advantage of the Institute's ability to bring scientists from East and West together".

A task force meeting on *Technological Risk in Modern Society* was organised by IIASA in cooperation with the International Atomic Energy Agency (IAEA), was held in Laxenburg, 18-20 March. The purpose of the meeting was to design a research agenda for work related to safety issues, and to the control and management of accidents in power systems or other potentially high-risk utilities. Forty-eight participants from 14 countries, IIASA, and IAEA attended the meeting, which was divided into the following three main sessions: regional risk management; man machine interaction; and management of environmental consequences. There was also a special session covering special topics, including the presentation of videotapes on Chernobyl and on crisis management.

Within the framework of the Dendrochronology, Biosphere, and Acid Rain Projects of IIASA's Environment Program, a Workshop on *Forest Decline and Reproduction: Regional and Global Consequences* was convened in Krakow, Poland, 23-27 March, organised in cooperation with the Systems Research Institute of the Polish Academy of Sciences and the International Union of Forestry Research Organisations (IUFRO). The objectives of the workshop were: to seek a consensus about the status and knowledge of forest decline, especially in Europe; to identify the choices that international organisations, the forestry community, governments, and industry must face; and to discuss ways to avoid further forest decline and facilitate the sustainability of the forest sector. The meeting was attended by some 90 senior scientists and agency representatives from East and West Europe, North America, Scandinavia, and Japan. In addition to presentations of some 60 papers on forest decline, the workshop organisers and a number of key speakers prepared a set of resolutions that were

adopted by the workshop participants. Briefly, the resolutions call for reductions in air pollutant emissions, improved monitoring of the extent and growth rate of forest decline, more research in specific areas, and increased international cooperation. A copy of the final resolutions from the workshop is available, and proceedings are being prepared.

In order to exchange views on issues of mutual interest and to improve working relations, a joint meeting of the Club of Rome's Executive Committee and IIASA was held in Laxenburg on 25 March. The meeting was co-chaired by *Academician Jermen M. Gvishiani*, Chairman of the IIASA Council, and *Dr. Alexander King*, Chairman of the Club of Rome.

The 28th meeting of the IIASA Council was held on 26 March, under the chairmanship of *Academician Jermen M. Gvishiani* (USSR). The Council examined IIASA's current activities and management issues, and was informed about the progress of the work carried out by the Task Force on Technological Risks.

On 26 and 27 March, 32 participants from 13 countries and IIASA met in Laxenburg for the Task Force Meeting on *Cross National Comparison of Transport Inventory and Logistic Structures*. The aim of the meeting was: to exchange information on ongoing national logistic research projects, and to define better the tasks and roles of IIASA's Logistics Project; to set up the IIASA data base, plan cross national studies, and data acquisition; and to plan a joint book. The next meeting is planned to take place in Hungary, November 1987, in order to present the contributions to the joint book, before the final revision and editing. Publication is planned for early 1988.

The Hungarian Academy of Sciences, the Royal Society of Canada, the Royal Swedish Academy of Sciences, the UNESCO Man and Biosphere Program, the Swedish Council for Planning and Coordination of Research, and IIASA's Biosphere Project cosponsored the *International Symposium on Ecosystem Redevelopment: Ecological, Economic, and Social Aspects*, held in Budapest, Hungary, 6-11 April. The symposium was organised in response to the growing recognition that an ability to restore damaged ecosystems to a condition that can sustain productive human activities is an important component of economic and development planning. Forest decline, soil salinisation, desertification, and lake acidification are examples of problems where sustainable development strategies will have to include a significant restoration component. Forty environmental scientists and restoration practitioners from 16 countries and IIASA met to review the problems of ecosystem restoration, and to assess the present technical and institutional abilities to implement restoration plans. The basis for this assessment included 24 papers that were presented and discussed in four working group sessions. On the last day, the technical findings of the symposium were presented to a panel of distinguished policymakers and advisors. The panel was then asked to comment on the relevance of these findings to development planning, and to discuss steps that might encourage better implementation in the development process. Selected case studies will be published together with appropriate overview chapters in the UNESCO-MAB book series, issued through Cambridge University Press.

As a follow-up to the discussions of the Vienna III Conference, held in June 1986, the Italian Committee for East–West Economic, Scientific, and Technical Cooperation organised the *International Conference on Cooperation Between Market and Planned Economies in Europe*, held in Venice, Italy, 12-14 April. *Academician Jermen M. Gvishiani*, Chairman of the IIASA Council and Chairman of the Executive Committee of the International Council for New Initiatives in East–West Cooperation, delivered a welcoming address. *Director Thomas H. Lee* and *Mr. Thomas Jozseffi*, from the Office of Sponsored Research, also participated in the Conference.

The World Health Organisation (WHO) Regional Office for Europe, in cooperation with IIASA, organised the *Planning Meeting on the River Danube Water Quality Protection Project*, held at Laxenburg, Austria, 22-24 April, to adopt a work plan for the project sponsored by UNDP/WHO. The WHO project is closely related to the objectives of IIASA's Large International Rivers (LIR) Project and involves

Joint Meeting of the Club of Rome's Executive Committee and IIASA, Laxenburg, 25 March

Task Force Meeting on Cross National Comparison of Transport Inventory and Logistic Structures, Laxenburg, 26–27 March

all the Danubian countries. Thirty-one representatives of governments and national institutes of the riparian countries, as well as of international organisations dealing with management of water resources and water quality of the river Danube attended the meeting. Participants were requested to investigate the possibilities and conditions of taking part in the activity of the LIR collaborating network assisting the implementation of the project, either by providing data for the application of decision support systems (DSS) in investigating various policy options in land-use and water management, or by preparing some components of the program in the form of a research report or model.

Under the collaborative agreement between IIASA and the USSR Committee on Ecologically Sustainable Development of the Biosphere, the USSR State Committee for Hydrometeorology and Control of the Natural Environment and IIASA organised a meeting on *Criteria of Sustainability of the Biosphere*, hosted by the Leningrad Scientific Center of the USSR Academy of Sciences, held in Leningrad, 25-28 April. Twenty-nine participants from three countries and IIASA held discussions on the problem of defining useful criteria of sustainability. Working groups convened on three topics: (a) global sustainability of life support systems (e.g., greenhouse-related climate change); (b) regional sustainability of life support systems (e.g., acid deposition); and (c) regional sustainability of living resources (e.g., fisheries, agriculture).

Forty-eight academics and researchers, as well as officials from governments and international organisations concerned with the steel industry in 12 countries attended the *Workshop on Life Cycle Theory and Management Practice*, organised jointly by the Bulgarian National Committee for Applied Systems Analysis and Management, and IIASA, held in Sofia, Bulgaria, 27-29 April. The objectives of the workshop were to review the General Life Cycle Concept, and to discuss its implications in management with special regard to the steel industry. In keeping with these objectives, the meeting focused on IIASA's comparative advantage to learn through the experience and research results of all the participants. Special management issues and implications of the Life Cycle Concept in different countries were discussed, as well as future collaboration between the participants and IIASA. Cosponsors of the meeting were the Bulgarian Committee for Research and Technology, the Engineer and Implementation Economic Association "Avangard", and various Bulgarian companies. The Bulgarian daily newspapers and some technical and management magazines published short informational columns about the workshop.

As a follow-up to IIASA's Workshop on Children and Computers, held in Albena, Bulgaria, 3-4 May 1984, and the First International Conference on Children in an Information Age, held in Varna, Bulgaria, 6-9 May 1985, which recommended periodical international conferences on this theme, the *Second International Conference and Exhibition on Children in the Information Age: Opportunities for Creativity, Innovation, and New Activities* was held at the National Palace of Culture "Lyudmila Zhivkova" in Sofia, Bulgaria, 19-23 May. Organised jointly by IIASA, Committee for Science to the Bulgarian Council of Ministers, Bulgarian State Committee for Research and Technology, UNESCO, IFIP, UNU, WHO, and the "Lyudmila Zhivkova" International Foundation, over 400 scientists, educationists, and company representatives from 40 countries and six international organisations met to discuss the meaning of computer literacy, educational policies, and creativity. IIASA was represented by *Director Thomas H. Lee, Professor Tibor Vasko*, and *Professor Shoji Shiba*. Some 70 papers were presented. The official closing session, chaired by Professor Vasko, was also attended by the Bulgarian Deputy Prime Minister *Dr. Georgi Iordanov* and *Mr. Vladimir Zhivkov*, President of the "Lyudmila Zhivkova" International Foundation. The event was widely covered by Bulgarian, Japanese, and other media. The outcome of the conference and the invited papers will be published by Pergamon Press.

A task force meeting on *Safe Technological Systems* was organised and held at IIASA, 11-12 May. Nineteen specialists, from both academia and industry, from 13 countries and IIASA met to review and discuss principles and issues related to the concept of (inherently) safe technology. Instead of taking a given design and looking at ways and means to improve its safety, the meeting attempted to look at the impact of design principles and different types of tradeoffs on the generic safety of technological systems. Divided into three sessions, the participants dealt with the following issues: session (a) on technical concepts – technical safety criteria, design principles, man machine interaction, and problem perception in different industrial sectors; session (b) on general safety criteria – complexity vs. safety, human factors, safety and risk definitions, and failure chains; and session (c) on policies and constraints – societal, economic, and institutional constraints, procedures, institutions, regulations, and licensing.

In order to improve communication and understanding between researchers and negotiators; to bridge or diminish the gap between the theory and practice of negotiations; to discuss and assess research results; and to foster and enhance collaboration and coordination of research and other activities related to the processes of international negotiations, IIASA organised the *Conference on Processes of International Negotiations*, held in Laxenburg, 18-22 May. Ninety participants from 18 countries and four international and multilateral organisations discussed the following topics: role of international organisations and other multilateral mechanisms in international negotiations; international trade negotiations; cultural, psychological, and political factors in international negotiations; theoretical foundations and methods of analysis; decision sciences foundations and computer-aided negotiations tools; and education and training for international negotiations. Various newspapers reported about the meeting.

Conference on Processes of International Negotiations, Laxenburg, 18–22 May.

Miscellaneous

Academician Ludwig D. Faddeev, President of the International Mathematical Union and Deputy Director of the Leningrad Branch of the Steklov Mathematical Institute of the USSR Academy of Sciences, visited the System and Decision Sciences Program to discuss collaborative research. On 4 March, Academician Faddeev delivered a lecture entitled "On the Interaction of Physics and Mathematics in Modern Times". (27 February–6 March)

IIASA is glad to welcome a new member of the Council: *Professor Dr. Wilfried Nöbauer*, of the Austrian Academy of Sciences, who succeeds *Professor Dr. Gerhart Bruckmann*. Professor Nöbauer is from the Institute for Algebra and Discrete Mathematics at the Technical University of Vienna. In recognition of his important contributions to IIASA, Professor Bruckmann has been awarded the title of *IIASA Honorary Scholar*.

Mr. Song Jian, Chairman of the State Science and Technology Commission of the People's Republic of China (SSTCC), Beijing, visited IIASA with a delegation of Chinese officials to get acquainted with current research activities, and was briefed on the progress of the joint IIASA/SSTCC Project on Expert Systems for Integrated Development of the Shanxi Province. Mr. Jian also delivered a lecture entitled "Recent Development of Science and Technological Policies in the People's Republic of China". (24 March)

Academician Eugeny M. Primakov, Director of the Institute of World Economy and International Relations of the USSR Academy of Sciences in Moscow, visited IIASA to get acquainted with current research activities. On 27 March, Academician Primakov delivered a lecture entitled "Some Aspects of Recent Developments in the Internal and Foreign Policy of the USSR". (25–28 March)

In connection with IIASA's 15th Anniversary, the Bulgarian National Committee for Applied Systems Analysis and Management has organised a series of events in 1987, united in a special program called "IIASA Days in Bulgaria". The first stage of the program was a meeting on an *International Network for Scientific Cooperation*, held in Sofia, 1-3 April, with IIASA *Deputy Director Boris Segerstahl's* opening speech on "Technological Risk Research at IIASA", delivered to a forum of specialists and managers.

After attending the International Symposium on Ecosystem Redevelopment in Budapest, Hungary, 6-11 April, *The Honorable Charles Caccia*, Member of the Canadian Parliament and former Minister of Environment, Ottawa, Ontario, visited IIASA to be briefed on current research activities, specifically in the fields of Biosphere and Acid Rain. Mr. Caccia was accompanied by *Mr. Ron Thomas*, Scientific Attaché of the Canadian Embassy in Vienna, Austria. (15 April)

Academician Tatiana Zaslavskaya

From 5 to 6 May, *Director Thomas H. Lee*, *Deputy Director Boris Segerstahl*, and *Mr. Thomas Jozseffi*, from the Office of Sponsored Research, visited the Joint Research Center (JRC) of the Commission of the European Communities (CEC) in Ispra, Italy, to discuss the status of ongoing cooperation, as well as to explore possibilities for new areas of collaboration. A Memorandum of Understanding was signed by Director Lee and *Professor George R. Bishop*, Director General of JRC, which expresses the mutual interest of both institutions to undertake a more general exchange of information on specific subjects presently being researched at both the JRC and IIASA, including all aspects of research on Environment, Decision Support Systems, Industrial Risk, etc.

Mr. Song Jian

Academician Tatiana Zaslavskaya, President of the Soviet Sociological Association, Honorary Member of the International Sociological Society, Head of the Sociological Department of the Institute of Economics and Industrial Engineering of the Siberian Branch of the Academy of Sciences of the USSR in Novosibirsk, and an IIASA alumnus, visited IIASA for collaboration and discussions with members of the Technology–Economy–Society (TES) and Population Programs, and participated in the Advisory Committee Meeting of the TES Program (3-4 June). During her visit, Academician Zaslavskaya delivered a lecture at the Creditanstalt-Bankverein in Vienna (18 May) to a forum of banking and industrial specialists and managers. The presentation was on "Social Policy in the USSR and Its Economic Impact". Similar lectures were given at various other Austrian banks and IIASA. A press conference was also organised by the USSR Permanent Mission for journalists accredited with the UN organisations in Vienna, and special interviews were broadcast on Austrian TV and radio. (18 May–12 June)

IIASA's Dutch National Member Organisation (NMO), the Foundation IIASA–Netherlands, organised four presentations of the Environment Program for different audiences. *Professor Robert E. Munn*, Leader of the Environment Program, introduced the research activities with emphasis on the Biosphere Project and its European Case Study. *Dr. Leen Hordijk*, Leader of the Acid Rain Project, demonstrated the use of IIASA's RAINS (Regional Acidification Information and Simulation) Model on a personal computer. The first meeting was with the official Dutch NMO Advisory Council. At the second meeting, a number of science journalists from Dutch newspapers were briefed. The third meeting was convened by the Director General of the Ministry for Housing, Physical Planning, and Environment, and was attended by high-level policy advisors of that ministry and the Ministry of Economic Affairs. Several represen-

tatives from industry and electricity producers were among the participants. In a fourth meeting, IIASA staff briefed eight members of the Second Chamber (the Lower House) of the Dutch Parliament, who form the House Committee on Environment. (25–26 May)

Academician Alexander L. Yanshin

Academician Alexander L. Yanshin, Vice President of the Academy of Sciences of the USSR, Chairman of the Executive Council on Biosphere Problems, and Director of the Institute of Lithosphere in Moscow, visited IIASA to get acquainted with current research activities and to discuss further cooperation on environmental problems. On 2 June, Academician Yanshin delivered a lecture entitled "Environmental Problems and Solutions in the USSR". (26 May–6 June)

New Publications

Books

Insuring and Managing Hazardous Risks: From Seveso to Bhopal and Beyond. P.R. Kleindorfer, H.C. Kunreuther, editors. Published by Springer-Verlag, Berlin, Heidelberg, New York, London, Paris, Tokyo. ISBN: 3-540-17732-9.

Dynamical Systems. A.B. Kurzhanski, K. Sigmund, editors. Proceedings of an IIASA Workshop on Mathematics of Dynamics Processes, held at Sopron, Hungary, 9–13 September 1985. Published by Springer-Verlag, Berlin, Heidelberg, New York, London, Paris, Tokyo. ISBN: 3-540-17698-5.

These books are available from your regular supplier and the publisher.

Research Reports

RR-87-1. *The Automobile Road to Technological Change*. N. Nakicenovic. 32 pp. Reprinted from Technological Forecasting and Social Change, Vol. 29 (1986). Available for a handling charge of US $5.00.

RR-87-2. *International Energy Workshop: A Progress Report*. A.S. Manne, L. Schrattenholzer. 34 pp. Reprinted from OPEC Review, Vol. 10 (1986). US $5.00.

RR-87-3. *The Industry–Technology Life Cycle: An Integrating Meta-Model?* R.U. Ayres. 32 pp. US $5.00.

RR-87-4. *Acid Rain Abatement in Europe: Two Progress Reports*. L. Hordijk. 17 pp. Reprinted from Acidification and Its Policy Implications, T. Schneider, editor, 1986, and from Atmospheric Environment, Vol. 20, No. 10 (1986). US $5.00.

RR-87-5. *Acidification of Forest Soils: Model Development and Application for Analyzing Impacts of Acidic Deposition in Europe*. P. Kauppi, J. Kämäri, M. Posch, L. Kauppi, E. Matzner. 24 pp. Reprinted from Ecological Modeling, Vol. 33 (1986). US $5.00.

RR-87-6. *The National Model of Sweden*. O. Bolin, E. Rabinowicz. 49 pp. US $7.00.

RR-87-8. *Capital Goods for Energy Development: Power Equipment for Developing Countries*. J.K. Parikh. 34 pp. Reprinted from Annual Review of Energy, Vol. 11 (1986). US $5.00.

RR-87-9. *Environmental Conflicts: The Case of Acid Rain in Europe*. J.-P. Hettelingh, L. Hordijk. 14 pp. Reprinted from Annals of Regional Science, Vol. 20 (1986). US $5.00.

RR-87-10. *Bhopal: Lessons for Technological Decision-Makers*. R.U. Ayres, P.K. Rohatgi. 26 pp. Reprinted from Technology in Society, Vol. 9 (1987). US $5.00.

RR-87-12. *A Hybrid Approach to Information and Decision Support Systems: Hazardous Substances and Industrial Risk Management*. K. Fedra, E. Weigkricht, L. Winkelbauer. 6 pp. Preprinted from Economics and Artificial Intelligence (forthcoming), Pergamon Books Ltd. US $5.00

Blundering Into Disaster: The First Century of the Nuclear Age. R.S. McNamara. Dr. Bruno Kreisky Lecture Series, No. 2, 15 pp. US $5.00.

These publications are available from the IIASA Publications Department.

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* to promote international cooperation in addressing problems arising from social, economic, technological and environmental change;
* to develop and formalize systems analysis and the sciences contributing to it, and to promote the use of the analytical techniques needed to address complex problems;
* to create a network of institutions in the countries with National Member Organizations and elsewhere for joint scientific research;
* to inform policy advisors and decision makers about the application of IIASA's work to current problems.

National Member Organizations

Austria – The Austrian Academy of Sciences; **Bulgaria** – The National Committee for Applied Systems Analysis and Management; **Canada** – The Canadian Committee for IIASA; **Czechoslovakia** – The Committee for IIASA of the Czechoslovak Socialist Republic; **Finland** – The Finnish Committee for IIASA; **France** – The French Association for the Development of Systems Analysis; **German Democratic Republic** – The Academy of Sciences of the German Democratic Republic; **Federal Republic of Germany** – The Association for the Advancement of IIASA; **Hungary** – The Hungarian Committee for Applied Systems Analysis; **Italy** – The National Research Council; **Japan** – the Japan Committee for IIASA; **Netherlands** – The Foundation IIASA-Netherlands; **Poland** – The Polish Academy of Sciences; **Sweden** – The Swedish Council for Planning and Coordination of Research; **Union of Soviet Socialist Republics** – The Academy of Sciences of the Union of Soviet Socialist Republics; **United States of America** – The American Academy of Arts and Sciences.