Food, soil, and agriculture

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Throughout history, one of mankind's central battles has been against hunger, and it is only in the last hundred years that a good share of humanity has been reasonably well fed. To the shame of a prosperous world, however, nearly half a billion people receive insufficient food or are malnourished. Many factors influence this tragic situation. In the first instance, often not enough food is produced or imported to provide a satisfactory base for the diet and secondly, although the world or a given nation may have enough food available, its distribution may be so uneven that many people remain hungry. In the first case efforts to enlarge the food supply are needed; in the second, a better distribution of productive assets and income among the people. In most instances improvements are needed on both fronts.

Land – the combination of soil and climate – represents the most important base for food and agricultural production. In traditional agricultures land and labour provide practically all the input to agriculture. But as agriculture moves towards commercial production, a large share of production increases are due to the use of improved technologies incorporated into purchased inputs, such as fertilizers or mechanical power.

Based on recent studies carried out by FAO, this article attempts to summarize the present world food situation, analyse indications for its future and to discuss the role of soil and agricultural land in support of food and agricultural production.

It is a platitude, but at the same time the truth that, at the world level, consumption and production of food have to balance (ignoring here year to year storage issues). This balance however is achieved by the poor of the world going hungry on a diet well below the standards required to carry on a productive and healthy life. In 1975 there were 56 developing countries where average daily caloric intake per person was below the minimum energy requirements. This is without considering the need to produce at least 10% more than this standard to allow for unequal distribution in food intake. Added to these difficulties is the low level of preparedness at the world level to deal with fluctuations in food supplies. Given the variability of weather and many other factors, it is estimated that for reasonable food safety at the world level, there is a need for at least 17–18% of the world's food (meaning here mainly cereals) requirements to be available in carry-over stocks. In 1981 the world cereal stocks reached 14% of consumption. their lowest level since the crop year 1975/76 which was recognized as a world food crisis.

Food production in the world has been growing at about 2.4% each year in the period 1970–80. The beginning years were slow, there was some recovery in the middle period, but the decade finished with poor crops in many regions. Food production can best be measured by changes in cereal production. Direct consumption of cereals makes up about half the dietary calories in the world, but reaches 61% in developing countries. In developed countries for each kilogram of cereal eaten, 2.4 kg are used as feed for livestock (1974/76). Cereal production has risen from 1245 million tons in 1970 to 1569 million tons in 1980, representing an annual growth of 2.4%.

In the developed market economies, growth of cereals production was 3.3% each year. With a slow growth in demand, their export surpluses grew from 26 million to 89 million tons between 1970 and 1980. While making progress in cereals production, centrally planned economy countries in Europe have not been able to meet their rapidly rising demand and thus have had to resort increasingly to cereal imports, which reached 43.5 million tons in 1980. For the developing market economies, cereal imports grew rapidly and for many such countries they became a serious financial burden. Gross imports of cereals reached 63.5 million tons in 1980 and although exports rose to 25.7 million tons, net imports were still very high at 37.8 million tons. Including centrally planned developing countries, total cereal imports were 52.5 million tons in 1978/79.

The growth in demand in developing countries was fuelled both by a rapid rise in population and by rising incomes in many countries. Furthermore, the rapid rate of urbanization has added to the problem by creating a need to increase *marketed* supplies at an even faster rate than total supplies.

The demand for cereals shows the highest response to changes in the income of the poor who spend a substantial share of any increased income on cereals for food. Thus any redistribution of wealth which would place more income in the hands of the poor could boost demand for cereals very substantially. If at the same time the availability of food were to be improved, this would lead to greatly improved nutrition and a major reduction in the number of hungry.

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Cereals production, consumption and trade, 1978/79 and 1990 (1000 million tons)

	1978–79 Actual	1990 (estimated) Trends	AT 2000 [2]
90 Developing countries			
Production	391	518	569
Consumption	428	590	626
Imports	37	72	57
Per caput daily calories from all food	2 262	2 327	2 447
34 Developed countries			
Production	818	975	975
Consumption	763	857	857
Exports	55	118	118
Per caput daily calories from all food	3 395	3 378	3 378

Outlook for the 1980s

Two recent studies by FAO provide a useful basis from which to review food outlook for the coming decade. The study on agricultural commodity projections 1975/85 estimates two levels of demand and supply for agricultural commodities, based on past performance and its adjusted extrapolation into the future [1]. The other study *AT 2000* looks normatively at world agriculture up to the year 2000 and explores the feasibility of reaching a better agricultural situation than past trends might indicate [2].

The two estimates for 1990 are shown in the Table. It can be seen that if past trends continue, developing countries will face an unbearable burden of cereal imports. There may also be some questions, whether the exporters from developed countries could provide such large volumes for export in addition to covering their own growing needs. Under these conditions, the likely result would be an increased cereal price, dampening demand and somewhat higher production levels. As a result poor cereal-importing countries would suffer, and it is also likely that feeding cereals to livestock in developed countries would be reduced.

The results of the AT 2000 study on the other hand demonstrate that, with additional effort, more support from governments, and improvements in political stability the world could be in a position to provide sufficient cereals to greatly increase food intakes in developing countries, to reduce the numbers of the hungry, and also to meet increased demands in developed countries. Much will depend, in this world balance, on the success to be achieved in centrally planned economy countries in raising their production fast enough not to create large import demands on the world cereal markets.

The changes in the world's pattern of agriculture which would lead to the second, and much preferred development, will be outlined in the remainder of this article.

Soil and agricultural land

Several estimates* exist of the magnitude of the world's potential arable land. In general they indicate that about 25% of the ice-free land is suitable for cultivation, and that at present close to half of this is cultivated – amounting to about 1500 million ha. Of the total potential, about 30% – 850 million ha – is in developed countries and 820 million ha of this are already in arable use. Opportunities for further expansion of the arable area are thus very limited. In developing countries only about 40% of the potential is used and there are major opportunities for expansion. However, the opportunities for expansion are spread rather unevenly among regions and countries. It has been estimated that by 2000, an overwhelming majority of the population of the developing countries will live in countries where opportunities for expanding the arable area will have been largely exhausted. At the same time some of the large tropical countries of South America and Africa will still have substantial land reserves left for development.

Estimates for losses of arable land through degradation vary widely and often represent judgements rather than substantiated facts or statistical knowledge. The main factors usually considered are erosion from wind and water, and salinity and alkalinity usually connected with irrigation in arid areas. FAO's own estimate indicates an annual loss of 5–7 million ha.

The other major factor is loss of arable land to alternative uses, among which non-agricultural uses (urban, industrial, communications, etc.) are the most important. The magnitude of these losses has been estimated at about 8.6 million ha for 1963–78 in Western Europe. They are difficult to estimate for developing countries.

Detailed estimates have been made in AT 2000 of the land areas which could be brought into arable use in 90 developing countries. Combining these with other estimates for the rest of the world, it appears that by the year 2000 approximately 180 million ha could be added to the arable area of the world, representing an addition of 14%. About 85% of this addition could be in the developing countries, with a heavy share in South America and Africa.

Increasing land productivity

Increasing the productivity of arable land can proceed along two main paths: increasing the number of crops grown each year; and increasing the yields of the crops harvested. Both of these are important, but in general, the contribution of yield to increased production is

* Buringh et al estimated potential agricultural land as 3419 million ha for the world and 2194 million ha for South America, Africa, and Asia These are slightly higher than those estimated by the US President's Science Advisory Committee [3]

dominant. For the period 1980 to 2000, AT 2000 estimated that about 65% of the increase in agricultural production in the 90 developing countries could come from increases in yield while 25 and 10% would come from increases in arable land and cropping intensity respectively. In developed countries an overwhelming share of the increase in future output would come from higher yields, just as in the recent past.

Thus improving the productivity of already cultivated land is the central issue in increasing agricultural production. Action can be taken on two fronts. On one side major investments need to be made for land amelioration. These would cover irrigation, drainage, flood control, erosion control works, and investiments in motive power for cultivation. The AT 2000 study estimated that US $265 billion would be required between 1980 and 2000 in investments for land improvements so that the proposed production targets could be met. Among the improvements would be an addition of about 50 million ha to the irrigated area in the 90 countries covered.

Parallel to this, major increases will be required in current inputs, especially of those coming from outside of agriculture. Use of inorganic fertilizers has been growing at about 6.5% per annum between 1970 and 1980 and reached 99.4 million tons of nitrogen, phosphorus, and potassium in 1977–78. It is likely that in developed countries past trends will continue. In the 90 developing countries, to reach production targets of AT 2000, use of inorganic fertilizers is required to rise from 19 million tons in 1980 to 43.2 millions in 1990. These large magnitudes point to the need to optimize fertilizer use, especially in the light of rising prices of fossil fuels which influence fertilizer prices.

Research for the 1980s

The growing pressures on the world's land resources will result in problems requiring a major research effort. The first group of problems relates to increased soil degradation. The research to alleviate this will have to incorporate not only physical and biological solutions, but also pay much more attention to the socio-economic context in which the conservation programmes need to succeed.

The second major area for research on land resource is to make better use of low-capacity or problem soils. This could be by reducing the existing limitations, such as changing physical or chemical characteristics of the soil, or by developing plants and production techniques which reduce the detrimental effects of constraints. Example of these are acidity, salinity, and aluminium toxicity.

Finally the broadest and more important area is that of research to enable more intensive use of better-quality land. Research topics here may relate to optimal plant nutrient management, soil moisture management, and developing cultivation techniques with minimum commercial energy requirements. Making plants more

A farmer spreading fertilizer in a rice field in the Upper Solo River basin of Indonesia. Through the use of nuclear techniques by the Joint FAO/IAEA Division, farmers in the Third World can take advantage of more productive strains of rice, more efficient ways of using fertilizer, and better water management methods. (Photo FAO)

productive will involve research aimed at increasing photosynthetic efficiency, nitrogen fixation, disease and pest resistance, improved weed control, and bio-engineering to adjust plant types to maximize production potentials. Improved rotational systems for the achievement of many of the above goals will become increasingly important, as the potential problems or inappropriate cultivation practices become evident.

In conclusion, food supplies of the world could meet the rapidly rising demands that are made on them, if agriculture receives sufficient attention and resources. Even with most modern development, land remains the base for agriculture, and optimal use of the world's land resources is thus crucial for future agricultural production.

References

[1] *Agricultural commodity projections 1975–85* FAO, Rome (1979)

[2] *Agriculture: Towards 2000* (AT 2000) (Preliminary report) FAO, Rome (1979)

[3] **P. Buringh, H.D.J. van Heemst and G.J. Staring** *Computation of the absolute maximum food production of the world* Wageningen, Netherlands, (1975).

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