Food Production, Population Growth, and Environmental Security

by

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Framing the Food Question

There are two broad criteria by which one can judge humanity's success in feeding itself: (i) the proportion of people whose access to basic nutritional requirements is secure; and (ii) the extent to which global food production is sustainable. Even though the two are related, they have usually been discussed separately in popular writings. This has had unfortunate consequences. Writings on (ii) have often encouraged readers to adopt an all-or-nothing position (viz. the future will be either rosy or catastrophic), and this has drawn attention away from the economic misery that is endemic in large parts of the world today. On the other hand, writings on (i) have frequently yielded no more than the catechism that the nearly 1 billion people in poor countries who go to bed hungry each night do so because they are extremely poor. In short, if (ii) has focused on aggregate food production and its prospects for the future, (i) in contrast has isolated food-distribution failure as a cause of world hunger. In this article we will adopt the view that (i) and (ii) should not be studied separately, that their link can be understood if attention is paid to the dynamic interactions between ecological and economic systems operating primarily at the geographically localized level.

Global Sketches

World population has increased at an average annual rate of a historically-high 1.8 percent since 1950. However, cereal production (accounting for more than 50 percent of the energy intake of the world's poor today) has more than kept pace: it has increased from 275 Kg per person in the early 1950s to 370 Kg per person in the early-1980s. For the world as a whole, this has been accompanied by improvements in a number of indicators of human well-being, such as gross output per head, accepted infant mortality rate, life expectancy at birth, and literacy. Much of the complacency economists have displayed in recent years about food availability (among the most recent example being Simon, 1996, The Economist, 1997) can be traced to these recorded improvements.

The problem with this complacency is that conventional indicators of the standard of living pertain to commodity production, not to the natural-resource

base upon which all production depends. These indicators cannot say if, for example, increases in gross national product (GNP) per head are not being realized by means of a depletion of natural capital; in particular, if increases in agricultural production are not being achieved by a "mining" of soil, lowering of water tables and impairment of other ecosystem services. Such impairment can easily go unrecorded, because the use of ecosystem services all too often involve transactions that are not mediated by an effective "price system" (economists call such phenomena "externalities"). This means that it is possible for the prices of agricultural commodities to fall over time even while their real costs of production are rising. By concentrating on current-welfare measures, such as GNP and life expectancy at birth, economists, journalists and political leaders have, for the most part, wrongly, bypassed net national product (which is GNP minus the depreciation of all forms of capital, including natural capital), and thereby the concerns that ecologists have repeatedly expressed about the links that exist between continual population growth, increased material output, and the state of the natural-resource base. And because these concerns have been neglected even in the technical literature, we are unable today to identify with confidence the reasons underlying the recent per caput decline in world cereal production, from 370 to 350 Kg per person from 1984 to the early 1990s (Pinstrup-Andersen, 1994).

During the present decade, cereal production per head has declined at an annual rate of 0.7 percent. Production per hectare has continued to grow, but at a decreasing percentage rate. Some argue that the decline has been due to a lack of incentives on the part of farmers to produce food (e.g. reduction in government subsidies in some parts of the world; civic disconnection and insecure property rights to land and water resources in other parts of the world, such as Africa and the former Soviet Union), while others point to resource degradation (e.g. soil erosion, increased water scarcity, paving over of farmland, and rising soil salinity) and droughts in various poor regions as the prime cause. But the two reasons are in all likelihood connected, some perhaps even synergistically related. If they are so related, neither is a prior cause of the other. This has implications for policy

analysis (Dasgupta, 1993, 1998; see below).

Ecologists' findings suggest that a near-50 percent increase in world population, allied to a doubling of gross world product per head, by 2030, would create substantial additional stresses in both local and global ecosystems (Vitousek et al., 1986; and the Symposium on the scale of human activity in Science, 1997). Global "demand" for food could easily double over the period 1990-2030, with two and a half to three-fold increases in the poorest countries (Crosson and Anderson, 1994). Of particular concern are Asia and Africa where, over the next fifty years, plant-derived food-energy requirements are expected to increase by a factor of 2.3 and 5, respectively, with a more-than-sevenfold increase expected in those countries where the diet is based on cassava, yams, taro or plantains (FAO, 1997).

Population growth would appear to be the greatest contributory factor to the projected increase in food needs. A smaller, yet significant, factor is economic growth itself, which leads to a shift from cereal to meat in the dietary habits of many whose incomes rise. As is well known, animal metabolism (especially that of cattle) is not very efficient in the conversion of plant food. Thus, growth in average income generates an incentive for farmers to shift land away from the production of food-grain toward that of cereals as feed-grain and toward grazing grounds. In terms of calories, the shift is disproportionate because of the inefficient conversion process. This would go to impoverish the poor further if grain prices were to rise in order to equilibrate the market (Dasgupta, 1993, 1998).

The prospects for a suitable response to such increases in food requirements depend on our ability to manage constraints on both the supplies of production inputs and the consequences of the use of these inputs. Under present management practices, for example, the peak of sustainable marine fisheries production appears to have been reached, and many of the world's major fisheries are now in decline (Safina, 1995). Some 20 percent of the world's population depend on local fisheries for protein. Aquaculture would appear to have a somewhat limited potential to replace fisheries, because its expansion is much dependent on resources derived from the oceans, such as fish meals (Folke et al.,

1998). Moreover, economic limits to available arable land and renewable fresh water are being reached in many parts of the globe (FAO, 1995; Daily, 1995; Postel, et al. 1996). We may conclude that most increases in food production will have to continue to come from increased yields on land already in production.

But there are obstacles here (Waterlow et al., 1998). First, many of the genetic resources required for crop improvement and the development of improved varieties (e.g. gene banks, land races, wild-crop relatives, and biodiversity generally) are being destroyed. Second, a number of the ecosystem services that underpin productivity are under continual threat (e.g. natural pest control, pollination, regulation of the hydrological and mineral cycles, natural renewal of soil fertility, natural erosion control, purification of air and water; see Holdren and Ehrlich, 1974; Daily 1997). And third, projected changes in climates portend enhanced difficulties with pest control and crop yields. Many pests are currently restricted in both geographic range and local abundance by climate. Important crops (e.g. rice) are often planted in places that are at the limit of their climatic tolerances. Put briefly, changes in extreme climatic events accompanying "global" climate change would present an additional threat to food security (IPCC, 1997).

Food Viewed Through a Local Lens

As a general rule, tightening of food supplies (whether globally or only regionally) increases the threat of hunger for the world's poorest people: people operating at the margin can easily be tipped into a state of destitution. Moreover, local problems of production and distribution can be exacerbated or ameliorated by global circumstances, such as of climate and trade. To ask merely whether global food supplies can be sustainably increased to meet future requirements misses much of the question. Food scarcity manifests itself locally, so efforts to alleviate it must be tailored to local circumstances. To do otherwise is akin to doctoring a sick person on the basis of global health statistics. Correct diagnosis of the problems at the population-food nexus is usually a local, often even a household matter, although appropriate treatment may require regional and global support. For example, soil erosion does not currently appear to be a serious threat to global

agricultural capacity, but at local levels all around the world it presents major problems to the people affected (Crosson, 1995). To take another class of examples, decisions on fertility and on allocations concerning education, child-care, food, work, health-care, and the use of the local natural-resource base are in large measure reached and implemented within households. So their connections should ideally be studied with reference to a myriad of communitarian, household, and individual decisions. In short, if we are to obtain a futuristic vision of global food prospects, we need to adopt a local, contemporary lens. Thus it has been argued that, in many identifiable local circumstances, poverty, hunger, high fertility, degradation of the local natural-resource base, and civic disconnection are related to one another. It has also been argued that, although none is the prior cause of the other, each influences the others over time, often synergistically for periods (Dasgupta, 1993, 1995; the experience of large parts of sub-Saharan Africa during the past three decades suggest this type of synergies). This too has implications for policy that we will sketch below.

Moving into a More Nonlinear Domain?

Such synergies as we have alluded to may well be a signal that the global food system is moving into a more non-linear domain. They would imply that the environmental pressures exerted by growing populations rise more than in proportion to the growth, other things the same. Moreover, in agriculture, for example, the consequences of a given shock today to the production system would likely be proportionately greater than in, say, 1970. There are four reasons why the latter may be so. First, at our current agricultural-knowledge base, the food production system today is almost surely closer to thresholds than it was three decades ago. Second, the food system is losing genetic heterogeneity: whereas farmers once planted a diversity of crops and land races in a region, they are now increasingly planting monocultures of the strain promising the highest yield under "typical" conditions. Thus, the vulnerability of crops to "atypical" weather events or pest outbreaks will probably increase if projected changes in climate, including a

higher frequency of "atypical" weather, are borne out. Meanwhile, cropbreeders will have less genetic material with which to develop higher-yielding crops more resistant to insects and disease. Third, the world is becoming more tightly coupled through "globalization", making local or regional problems more likely to be propagated globally in the absence of adequate international insurance arrangements. To be sure, increased engagement in the global food market gives poor regions access to cheaper food; but over time it could also make them more dependent on food imports and, thereby, more susceptible to surges in grain prices triggered by occasional production shortfalls in important producing regions. Fourth, increased intensity of crop and livestock production and centralization of food processing leaves large regions vulnerable to disease outbreak (among human beings, crops, and livestock), and to reduced efficacy of antibiotics.

Suggestions for Thinking About Policies

Threats to environmental security very often come allied to institutional failure. Thus, when thinking about environmental security, particular attention needs to be given to the institutions in which individuals, households, firms, and communities go about their business. So institutional reforms, at the global, national, and local levels should today be at the top of the agenda of public discourse. Evidence suggests that open societies, harbouring secure property rights (be they private or communal) and avoiding flagrantly distortionary fiscal policies are not only desirable in themselves, they would also appear to be good for the sustainable management of the natural-resource base.

One aspect of such institutional reform should be increased public investment in agriculture and in rural areas in poor countries. Modern economics suggests that such investment needs to be directed at new technologies and institutions at the local level involving, among other things, health-care, family planning, and education (the latter, when aimed at women, has been found to be an important determinant of fertility behaviour). Modern economics also directs attention to the importance of dissemination of technical knowledge to local populations and to the need for local populations to be in a position to adapt new

knowledge to their particular circumstances. Greater public investment needs to be made in the global biophysical and institutional assets that are crucial to increasing yield: gene banks, local land races, protection of wild crop relatives and biodiversity generally, both for genetic material and for ecosystem services. We will stress the importance of genetic material and ecosystem services here because it continues to be neglected in the development literature.

At least 75 percent of the global yield increases achieved over the last 40 years is attributable to advances in scientific knowledge and technology of the sort embodied in the Green Revolution. Moreover, an increasing share of research expenditures in agriculture will be required merely to maintain yields, thus impeding the process of innovation. Despite this, vital research needed to bring agricultural activity into balance with the environment's capacity to sustain it is not currently being translated into the funding for, say, national agricultural research institutions and those under the Consultative Group for International Agricultural Research (CGIAR).

A prime target for national and international economic policy reforms should be ratification and implementation of international agreements on the environment. We would also propose the establishment of local "foresight institutions", whose purpose would be to monitor key local trends in aspects of food production to inform local and global policy. Fine tuning a system as complex as the food system and capitalizing on the potential for institutional changes to boost food production in a sustainable fashion will require much more detailed local information than is typically available today. For instance, trends in the effects of soil degradation on land productivity are extremely important but not well understood and so vigorously disputed (e.g. Pimental, 1995; Crosson, 1995). Similarly, the geographic occurrence and security of dwindling populations of wild crop relatives is also poorly known.

Translation of data into a workable set of social indicators is an important additional task: they enable policy debate to be conducted in an illuminating manner. In this context, "green accounting" and general progress-indicators are

needed, mostly at the local level, where they are likely to trigger off the most rapid and powerful policy response. Developing the local capacity to collect and distribute information is integral to any sustainable development programme.

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