Meeting Tomorrow's Global Food Needs: A Moral Imperative

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Abstract

Percentage increments in global crop and livestock yields are slowing. Percentage increments in global food demand may outstrip growth in food supply, causing food prices to rise to year 2040. Fortunately, the world seems headed for zero population growth by year 2100 and developed nations face no great economic, technological, or environmental hurdles in feeding themselves well. Sub-Saharan Africa and selected other developing countries face severe food security problems, however, but none severe enough to justify cutbacks in food production to bring world population in line with global carrying capacity. Food security is within reach of any country willing to address its socioinstitutional constraints and adopt the proven standard economic model.

The question posed by the symposium's title "Is It Ethical to Increase World Food Production?" is answered by a slight rephrasing of the title assigned to my presentation: meeting tomorrow's global food needs is a moral imperative. The title assigned me tips the hand of the symposium planners: they come from the moral imperative school of ethics. They are in good company. Christians are bound by the biblical commands to "love thy neighbor" and "to be our brothers' keeper." Secular humanists also have little choice but to strive for global food security defined as access by all people at all times to sufficient food for a productive and healthy life (Tweeten 1997a, p. 226).

So much for the moral imperative school. Many, if not virtually all, economists are of the utilitarian ethical school. I, personally, experience no conflict between the moral imperative

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school and the utilitarian schools of ethics. The imperative to "love thy neighbor" is equivalent to the utilitarian objective of promoting the public welfare.

Moral imperatives provide absolute moral guides that have difficulty addressing tradeoffs in meeting food needs among people and over time. The essence of utilitarian ethics embodied in neo-classical economics from predictive (positive) and normative standpoints is to pursue an activity if benefits exceed costs. Thus, neo-classical economics offers a rich conceptual framework for measuring how best to allocate resources over time and among people (see Blue and Tweeten for marginal utility of income). Within that framework, this paper makes a case that efforts to increase food production for a food secure world not only is morally justified, it also is technically, environmentally, and economically feasible. Increasing food output to meet the needs of consumers today need not compromise future food security or the environment.

The paper briefly outlines the past and present global food security situation, then projects future food supply and demand to measure the magnitude of challenge in meeting future food needs. Final sections address environmental and natural resource constraints.

Past and Present Food Security Situation

The world has made impressive progress indeed towards food security. Numbers of undernourished people in developing countries fell from 917 million in 1969–71 to 839 million in 1990–92 and are projected to fall to 680 million in 2010 according to FAO estimates (Table 1). The spectacular 207 million reduction in East and Southeast Asia more than offsets the 112 million addition to the number of undernourished people in Sub-Saharan Africa between 1969–71 and 1990–92.

Per capita dietary energy supply (DES), a useful indicator of food production per person, increased 0.52 percent per year for the world and by even more (0.78 percent per year) in developing countries between 1969–71 and 1990–92 (Table 2). Progress is expected to slow—FAO predicts DES will increase only 0.33 percent annually from 1990–92 to year 2010.

Table 1. Actual and Projected Undernutrition in Developing Countries.

	Actual			Projected
Country	1969–71	1979–81	1990–92	2010
	million persons (percent of region total)			
Latin America and the Caribbean	53 (19)	48 (14)	64 (15)	40 (7)
South Asia	238 (33)	303 (34)	255 (22)	200 (12)
East and Southeast Asia	475 (41)	378 (27)	268 (16)	123 (6)
Near East and North Africa	48 (27)	27 (12)	37 (12)	53 (10)
Sub-Saharan Africa	103 (38)	148 (41)	215 (43)	264 (30)
TOTAL, developing countries	917 (35)	904 (28)	839 (21)	680 (12)

Source: FAO 1996a.

One region of the world, Sub-Saharan Africa, seems to be losing the capacity to feed itself. Food production per capita has been falling, and the number and incidence of food insecure persons increased from 1979–81 to 1990–92. Numbers are expected to grow at least to year 2010. The International Food Policy Research Institute (Rosegrant, et al., p. 15) projects that the region's imports of all cereals will grow from 9.4 million metric tons (mmt) in 1990 to 26.1 mmt by 2020. Paying for such imports will be a major challenge.

Table 2. Average Per Capita Dietary Energy Supply.

	Actual		Projected
Classification	1969–71	1990–92	2010
	calories (output)/day (annual % increase from previous period)		
Developed countries	3190	3320 (0.23)	3390 (0.06)
Developing countries	2140	2520 (0.78)	2770 (0.50)
World	2440	2720 (0.52)	2900 (0.33)

Source: FAO 1996b, p. 2.

Global Food Supply and Demand to Year 2050

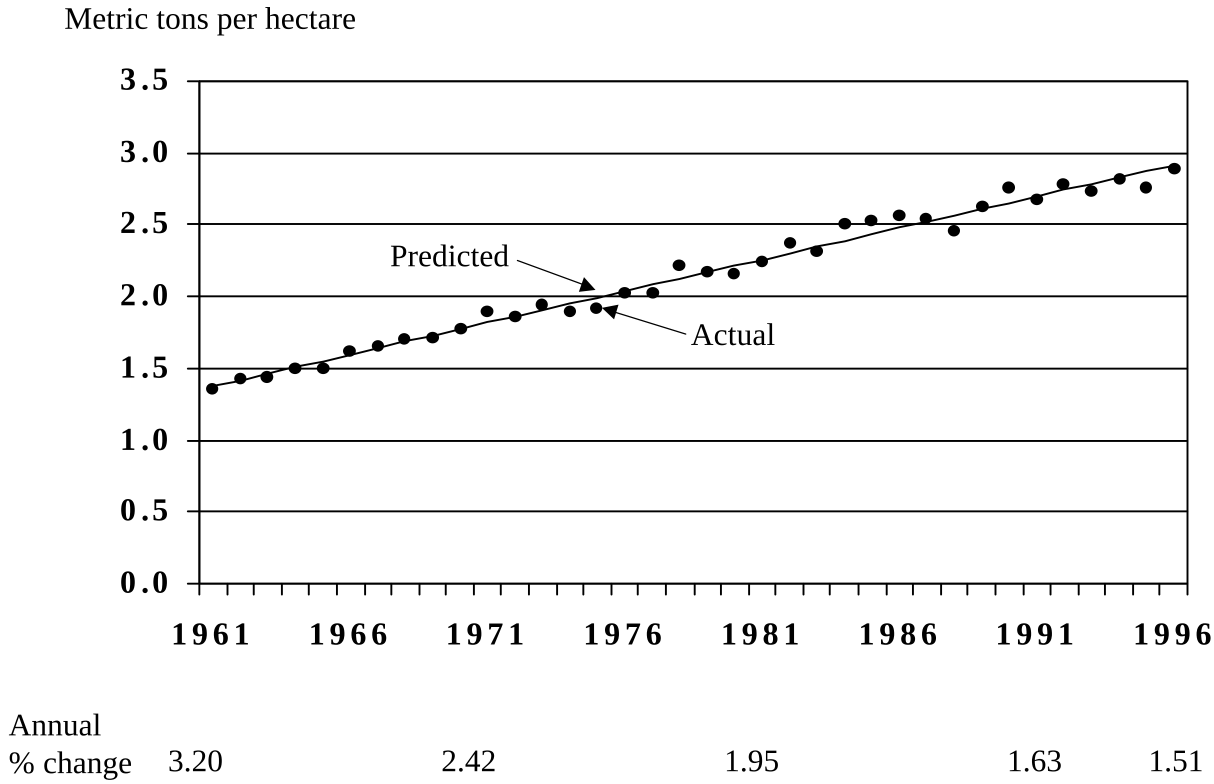
Some striking historic trends give clues to the future global food supply-demand balance.

Supply

The most profound historic pattern for the global food supply is the linear (straight line) yield trend which holds for all major crop categories and is illustrated for cereals in Figure 1. Worldwide yields of cereals, which provide over half of our calories and are the commodity of choice for storage and transportation, increased on average by 30 pounds per acre from 1961 to 1996. The percentage rate of trend increase fell from 3.2 percent in 1961 to half that rate in 1991 and continues to fall (Figure 1). Yields of the other major crop categories—vegetables and melons, pulses, roots and tubers, and oilseeds—also display linear trends. Weighted percentage rates of increase in all crop yields to year 2050 assuming the 1961–96 linear trend continues are shown in the top row of Table 3.

Rates of increase in livestock output per pound of feed are expected to continue to grow less rapidly than crop yields. Data are scarce on livestock yields, but the Office of Technology Assessment projected that U.S. pounds of beef per pound of feed and pounds of pigmeat per pound of feed would each increase only 0.2 percent per year from 1982 to year 2000, well below expected crop rates shown in Table 3.

Figure 1. World Cereal Yields, 1961 - 1996.



Source: FAO (1997)

In addition to crop and livestock yields, a third important element of food supply is area in crops. Global cropland area has increased just over 1 percent annually on average since 1961. In the future, new cropland from drainage, clearing, irrigation, and other sources will be offset markedly by cropland lost to forestation, grazing, desertification, salinization, waterlogging, development, and other uses. World cropland area is unlikely to expand significantly without considerably higher farm commodity prices. Additional land is available for cropping if needed, but is of lower productivity and is subject to erosion or other environmental hazards.

Table 3. World crop supply (yield) and demand (population and income per capita) trend growth rates by selected years.

	Projected					
Supply or demand	2000	2010	2020	2030	2040	2050
	(Percent per year)					
Supply (crop yields)						
Total (weighted average)[a]	1.28	1.14	1.01	0.92	0.84	0.77
Demand						
Population gain						
UN (medium)	1.44	1.24	1.08	0.88	0.65	0.48
Income effect gain[b]	0.31	0.29	0.27	0.24	0.22	0.20
Total demand gain						
UN pop. plus income	1.75	1.53	1.35	1.12	0.87	0.68
Excess demand						
Demand less yield gain	0.47	0.39	0.34	0.20	0.03	-0.09
Price impact						
Price flexibility (3.0) times excess demand	1.41	1.17	1.02	0.60	0.09	-0.27

[a]Linear yield trends weighted by calorie shares.
[b]See Tweeten 1997b, Annex Table 1.

Other potential sources of food supply gains such as irrigation and ocean fishing have been falling off in recent years but offer promise for the future with proper incentives and management. Africa could significantly expand irrigation, and temperate zones such as the U.S. cornbelt could receive supplemental irrigation if crop prices provide incentives.

Because of difficulty in expanding crop area, aggregate food supply trend in Table 3 is represented by aggregate crop yield trend. Assuming that livestock yields increase at the same rate as crop yields and that cropland area remains constant, global farm output (which increased over 3 percent annually in the 1960s) will increase at an annual trend rate of only 1.3 percent in year 2000 and 0.8 percent by year 2050.

Food Demand

If world population would continue to grow at the 2 percent annual rate of 1970 or the 1.5 percent rate of 1996, the future portents of declining percentage gains in food production per acre would be sobering indeed. But we are in the midst of a remarkable turnaround (inflection point) in global population growth. For centuries, population has been increasing exponentially—at an increasing rate—as predicted by Thomas Malthus exactly two centuries ago. But demographers predict population will increase at a decreasing rate to reach zero population growth (ZPG) by year 2130 or earlier.

The best available estimates of ZPG population and year of arrival are shown in Table 4. Two especially credible estimates are from the reputable International Institute for Applied Systems Analysis (IIASA) projecting 10.5 billion people and the United Nations (UN) medium estimate projecting 10.3 billion people at ZPG. Adding to population growth the expected food demand growth of about 0.3 percent per capita annually due to income, overall demand for food is expected to grow by 144 to 147 percent by ZPG (Table 4).

Table 4. Total and annual food demand growth to ZPG from 1995.[a]

Study	ZPG Population[b]	Year of ZPG[b]	Food Demand Growth from 1995[c]
	(Billion)	(Year)	(Percent)
IIASA (Lutz *et al*.)	10.5	2084	144
UN (medium)	10.3	2094	147
World Bank (Bos *et al*.)	11.3	2128	201

Source: see Tweeten, 1997b.

[a]1995 world population 5.6 billion; 1999 world population 6.0 billion.
[b]When data from the source were incomplete, the ZPG population and year were projected using a quadratic equation fitted to available data.
[c]Assumes per capita demand grows 0.3 percent/year from income.

The above projected requirement for food supply to increase about 2.5 times from the 1995 level to meet demand at ZPG could be less based on alternative demographic projections. Steven Mosher, president of the Population Research Institute, projects global ZPG to arrive at 7 billion people by year 2030; David Seckler of the International Irrigation Management Institute and Michael Rock of Winrock International project ZPG at 8 billion by year 2040; and Dennis Avery of the Hudson Institute projects ZPG at 9 billion or less by year 2040. If these projections are realized, food demand growth will be less than shown in Table 3 and real farm prices likely will continue to fall. While the assumptions underlying estimates of Avery, Mosher, Seckler, and Rock are not explicit, their projections may inadequately account for *population momentum* from the large numbers of women in developing countries who will be in child-bearing ages to year 2030. Of course, population projections by agencies and individuals undergo frequent revisions.

Supply-Demand Balance

The global food supply-demand balance is projected to year 2050 in Table 3. Demand growth is the medium United Nation's projection. Trend supply growth as measured by linear crop yield projections is expected to fall short of demand growth by 0.5 percent in year 2000 and by 0.03 percent in year 2040, after which supply growth is expected to exceed demand growth.

Real prices for farm food ingredients could increase 1.4 percent per year in 2000, falling to 0.09 percent per year by 2040. This trend contrasts sharply with the 0.6 percent annual average decline in real farm prices from 1910-14 to 1996.

The conclusion is that, even allowing for error, world food supply-demand balance is likely to be tighter over the next 3-4 decades than in recent decades. Affluence coupled with the "noise" of weather shocks from year to year will mask real food price gains in industrial countries. Americans, for example, spend about 2 percent of their incomes on farm food ingredients. Hence, even a doubling (absurd) of farm level food prices would reduce their real income only 2 percent. That is equal to normal economic growth of just a single year. Thus, affluent societies will hardly notice tighter food supplies except for occasional food price spikes.

Farmers and low income consumers at home and abroad are likely to notice the change, however. Because farmland earnings are a residual, real farm prices rising 1 percent per year on average would raise real land earnings and prices in excess of 1 percent per year. The major problem will be for consumers of Africa and other low income countries who will have difficulty competing with more wealthy regions for food.

Policies to Provide Food Security

The foregoing analysis indicates that the world can continue to feed itself without significant food price increases and without heroic measures to reduce population growth. However, family planning information to allow parents to have no more children than they want coupled with a serious commitment of nations to raise productivity of agriculture will be central to food security.

Key constraints that could thwart meeting future food needs are:

1. Environmental degradation, including natural resource depletion.
2. Lack of agricultural productivity growth.
3. Socioinstututional failure.

Space limitations preclude in-depth treatment of each of these issues, but some observations are offered below.

Environmental Degradation and Natural Resource Depletion

So-called Kuznets Curves trace the relationship between economic progress and environmental degradation. A common pattern is for economic development first to degrade the environment. At later stages of growth, many environmental problems are addressed and diminished (World Resources Institute, Chs. 6–12). Compared to the 1950s, in the United States water erosion of soil has fallen by half, the quality of river and lake water has improved, city air is cleaner, wildlife has become more abundant, and food has become safer from chemicals and pathogens (see Tweeten and Amponsah). Groundwater contamination by agricultural chemicals is manageable, solid waste disposal is tractable, forest area is increasing, and (except for immigration) the nation is headed for zero population growth.

Globally, perhaps the major concern is depletion of fossil fuel, phosphate, and water supplies. Biotechnology and other emerging technology will continue to expand output available from farm production inputs, but some analysts contend that petroleum could become very scarce in 60 years and coal in 200 years (see Tweeten and Amponsah). Economic petroleum reserves may be gone before the world reaches ZPG, but coal, shale, tar sands, wind, sun, and nuclear sources offer energy adequate for hundreds of years. Even if an affluent world runs short of energy, it will take care of its most basic need—food. Greenhouse gases continue to build in the atmosphere, but evidence of global warming remains weak. Global warming, even if it occurs, does not seem to threaten global food and timber supplies although it would cause major disruptions in food supply among regions (Schimmelpfenning, pp. 28–31).

Perhaps the major concern is phosphate, a basic building block of nature with no substitutes, but known reserves are adequate for about 250 years (Tweeten and Amponsah). More reserves may be found, supplies recycled, and scientific solutions found to stretch available supplies.

Limited water supplies will especially constrain development in North Africa, the Middle East, and India. Science will be challenged to use biotechnology and other means to raise agricultural output by year 2100 more than as much as improved seeds and breeds, synthetic fertilizers, irrigation, and pesticides improved agriculture in the past 10,000 years of its existence.

Investment in Productivity Growth

On average from 1982 to 1992 the U.S. annually lost 377,400 cropland acres or 0.08 percent of all its cropland area to urban development (see Tweeten forthcoming) and another 0.05 percent of cropland productivity to soil erosion (see Crosson). During the same period, aggregate output of crops and livestock per unit of all production inputs increased 2 percent annually (Ahearn *et al.*, p. 5). Hence, each year of productivity gains from science and technology offset 20 years of productivity loss to urbanization and erosion. Such productivity gains are within reach of developing countries that follow proper policies.

As noted in Table 2, all regions of the world show major progress in raising food output per capita and reducing population growth except Sub-Saharan Africa. Africa invests only 0.5 percent of its agricultural gross domestic product (GDP) in agricultural research in contrast to the U.S. which invests over 3 percent and many other industrial nations which spend over 2 percent of agricultural GDP on agricultural research and extension. Clearly, Africa invests too little to be food secure.

Ability to expand cropland has enabled Africa to expand food production despite slow yield gains. It is notable that Africa's falling per capita food production is not the result of production gains lagging behind other regions (Mitchell *et al*., pp. 50, 169), but rather its little progress in movement through the demographic transition to lower birth rates. Food insecure countries, being poor, face a challenge bidding against industrialized countries for food. Of course, developing countries that are net exporters of food will gain from higher food prices. But many export coffee, cocoa, and tea—items which may not share in general food price gains.

Socioinstitutional Constraints

A key to a better environment, ZPG, and food security is economic progress. The *food security dilemma* is that economic growth bringing these major benefits also generates more greenhouses gases and depletes natural resources. The difficulty is exacerbated as growth accelerates in China, India, and other developing countries with large populations. All nations can be prosperous together, and the market will set prices to constrain use of scarce resources such as fossil fuels and encourage use of service activities favored by people to raise quality of life. Taxes or other means must be used to internalize external costs of pollution, however, to avoid the "tragedy" of common property such as air.

Affluence has moved nations through the demographic transition to the enviable current outlook for zero population growth. To achieve food security, developing countries have no alternative but to follow sound economic policies to promote affluence leading to ZPG and financing agricultural research, infrastructure, and environmental programs.

I (Tweeten 1997a, pp. 251, 252) have advanced a *food security synthesis* to discipline thinking. The synthesis is that

- Food insecurity is caused mainly by poverty.
- The cure for poverty is broad-based, sustainable economic development which will directly or indirectly (through transfers) raise buying power of people. "Broad-based" refers to development that reaches women, minorities, rural people, and indeed the broad spectrum of population through human resource investments and access to opportunity.
- Economic development is attainable by any country willing to follow the *standard model* that relies mainly on markets but with a supportive government policies providing public goods and correcting externalities (Tweeten 1997a, pp. 232–243). I describe the standard model in detail elsewhere, but note here that the choice of the market over central planning is no longer ideological. The choice is empirical as evidenced by the economic and food security success of South Korea over North Korea, of Hong Kong and Taiwan over China, and of Chile over Cuba.
- Countries do not follow the standard model partly out of ignorance, but mostly due to political failure. Ending even the worst policies produces losers who stop reform if they are in positions of authority.

- Political failure traces to institutional failure such as lack of a representative government. Failure to protect property rights or granting monopoly power to a privileged few also retards progress.
- Institutional failure traces to cultural factors such as tolerance of corruption and despotic rule. Another problem is tribalism that leads to nepotism, factionalism, and violence.

Socioinstitutional change, the key to ending food insecurity, will not occur unless the people want it. Several food insecure countries in Africa give increasing evidence that they want to change. The United States and other developed countries can encourage and facilitate that change by opening markets to trade and by sharing knowledge to bring food security, but outsiders cannot force the change.

Conclusions

Global food output can meet the needs of people for the foreseeable future. The only moral justification for halting food expansion today would be to avoid starving people of future generations. This paper provides evidence that we do not face that moral dilemma, and our best efforts can go into better meeting food needs of all today *and* tomorrow.

The trend towards zero population growth is a recent but seminal happening with felicitous portents for sustainable global food security. This analysis indicates that maintaining the historic (linear) increase in food supply of the past four decades for another food decades will see us through a tight supply-demand balance to ZPG after which the going may get easier. Food security seems attainable with current or only slightly higher real farm prices. Several analysts project even better news for consumers—falling real food prices (Mitchell and Ingco for

World Bank; Rosegrant *et al.* for International Food Policy Research Institute). Mitchell *et al.* indicate from their simulations that the world could feed twice today's population in 20 years. Yeh *et al.* showed in the 1970s that if pressed the U.S. alone could physically provide enough calories to feed the world. Such an outcome is only an academic exercise—such drastic measures are neither necessary nor desirable from an economic standpoint.

Some deep ecologists contend the world cannot sustain even today's population. Estimates of global sustainable *carrying capacity* range widely. In fact, carrying capacity depends on technology, diet, and a host of other factors. If the food supply-demand balance tightens, food prices will rise to encourage more technological innovation, cultivation of more acres, investment in irrigation, a shift from costly meats to more grains and tubers, and a host of other adjustments ensuring an adequate diet.

Shifting from consumption of meat to cereals and other crops would alone feed millions of additional population with no harmful environmental consequences. This is not a call for people to be vegetarians—such drastic action is unnecessary. If it becomes necessary, the market will adjust by lifting meat prices to encourage substitution of crop-based foods for livestock-based foods.

In conclusion, the outlook for technology, the environment, and natural resources promises *potential* global food security for generations. Despite adequacy of resources to provide food security for all, many people will continue to be food insecure. The root causes lie in institutions and attitudes. Nations must follow sound economic policies, relying heavily on markets but with the government doing a few things well. They must continue to invest in improved technologies to raise food production efficiency and protect the environment.

Several countries, many in Sub-Saharan Africa, will not follow proper economic policies to escape abject general poverty and food insecurity. Tribal and other conflicts will exacerbate the situation. Thus, the failure to be food secure traces to man, not nature. The moral imperative is not to constrain food production; on the contrary, the moral imperative is to address the core socioinstitutional problems such as ignorance, indifference, corruption, tribalism, despotism, family disintegration, and socialist policies that are the root cause of food insecurity.

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