Agriculture and Food Needs to 2025: Why We Should Be Concerned

Alex F. McCalla

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Director, Agriculture and Natural Resources Department, The World Bank

Introduction

Everyone agrees that the world’s population will exceed 8 billion people by 2025, an increase of over 2.5 billion in the next thirty years. Everyone agrees that most of the increase will occur in developing country cities—urban population is expected to rise from 1 billion in 1985 to 4 billion by 2025. Most everyone agrees that world food supplies will have to more than double by 2025, because of increases in income and urbanization in addition to population growth.

Given this widespread agreement on the needs or demand side of the equation and its magnitude—the greatest numerical growth in human numbers in history and a required magnitude of increased food production never before achieved—why is there so little agreement on the ease or difficulty of generating the
supply to meet that demand? The spectrum of views ranges from the one extreme, "there is no problem," to the other, "the imminent arrival of the Malthusian nightmare, unless effective population control is implemented immediately." By far the predominance of views is toward the "no problem" end, and can only be characterized as bordering on complacency.

Therefore, the puzzle that this lecture identifies is, how can intelligent students of the international food economy agree so closely on the demand side and disagree so wildly on the capacity of the world to provide the supply to meet that demand? The cacophony of views is muddying the waters and, in my view, retarding needed attention to this critical issue.

This lecture has a modest objective. It is to critically appraise the competing viewpoints and to show that, regardless of which view you prefer, the productivity improvement challenge facing world agriculture in the next thirty years is enormous. Twenty twenty-five is just thirty years away. From initiation to implementation in farmers' fields, agricultural research takes ten to twenty years to have an impact. Twenty years from now there will be at least 1.8 billion more people in the world to feed. Research and technology development to contribute to the needed production must start today. Everyday spent on further debate about whether "Malthus must wait" or "Malthus is finally right" is "fiddling while Rome burns."

Specifically, I shall do five things. First, I will review briefly the past history of "food crises" debates. Second, I will quickly summarize the demand side upon which most people agree. Third, I will summarize four
different viewpoints on the supply side of the world food equation, from the "no problem" view, as exemplified by Donald O. Mitchell and Merinda D. Ingco in their paper entitled "The World Food Outlook," to the ominous predictions of Lester R. Brown and Hal Kane in their book, *Full House: Reassessing the Earth’s Population Carrying Capacity*. Fourth, I will critically appraise the consequences of each of these scenarios for future agricultural development and technology generation needs. Finally, I will focus on the consequences of not recognizing the urgency of the productivity challenge.

**Past Debates**

The sufficiency of future food supplies has been a recurrent question in the international debate over most of the post-World War II period. The debate is most frequently driven by supply side considerations. Since Thomas Malthus wrote his "Essay on the Principle of Population as It Affects the Future Improvement of Society" in 1798, the debate has focused on the race between supply (seen to grow linearly) and population (seen to grow exponentially). New lands, new technology, and capital investment in irrigation have delayed the "Malthusian cross" (i.e. when population growth rates exceed the rate of food supply increases) for most of the world, but the debate, for how long?, has raged for years.

Immediately after World War II, there were concerns about imminent food shortages. These quickly gave way to food production surges and rising stocks
in the 1950s and early 1960s. Two bad monsoons in South Asia during 1965-66 led to resurgent concerns about imminent famine. William and Paul Paddock wrote a best seller in this period called *Famine-1975!*, which predicted imminent famine by 1975. In the late 1960s and early 1970s, Malthus was kept at bay again by expanded output. The years 1972 to 1974 saw a coincidence of events—production shortfalls in several locations simultaneously and rapid demand expansion, particularly from the Soviet Union, which caused agricultural prices to skyrocket. Grain prices tripled over an eight-month period. Global food shortages were predicted. Then U.S. Secretary of Agriculture, Earl Butz, exhorted farmers to “plant fencerow to fencerow.”

Surpluses rebuilt in the early 1980s. The United States instituted its most comprehensive and expensive supply control program, Payment in Kind (PIK), in 1983 as stocks soared. The 1988 drought brought a brief return of the issue of possible shortages, but concerns about excess supplies soon cooled the debate, at least in developed countries. Mitchell and Ingco, in their recent paper, extensively reviewed previous chapters of this debate and concluded that technological pessimists have always been wrong.

Currently, the food production versus population growth issue is the subject of some debate, but the issue is not viewed as critical, even though there are widely divergent views on what the next twenty to thirty years will hold regarding the world’s capacity to increase production to feed more than 8 billion people.

I will return to four of these widely divergent views in a moment, but first let me quickly review the demand side that most people agree on.
World Food Needs to 2025—
The Convergent View

World population will double in the next forty years. By 2025—thirty-one years from now—the median variant of projections by the United Nations suggests a global population of 8.5 billion people. A larger share of that population will live in developing countries. In 1985, 75 percent of the world’s population lived in developing countries. By 2025, more than 83 percent will live there. At present, approximately 31 percent of the population of developing countries live in cities, although there are strong regional differences. By 2025, it is estimated that 57 percent of the population in developing countries will live in cities. The number of people living in cities will quadruple from 1 billion to 4 billion. Regionally, the population in Asia will nearly double to over 4 billion, while that in Sub-Saharan Africa will more than triple from 420 million in 1985 to nearly 1.3 billion by 2025 (Table 1). The number of malnourished will rise from the current level of 750 million to over 1 billion.

In addition to population growth, income growth also increases the demand for food. Even with modest income growth in developing countries, the demand for food in 2025 will be more than double current levels of production. Further, urbanization, in conjunction with income growth, will cause the character of diets to shift away from roots and tubers and lower quality staple grains to higher quality cereals, such as rice and wheat, livestock products, and vegetables. [See Mitchell and Ingco, 1993, Chapter V, for an excellent review.] With massive urbanization will come increased need for markets and basic infrastructure as well as for urban oriented food security policies.
<table>
<thead>
<tr>
<th>Year</th>
<th>World (millions)</th>
<th>Developed Countries</th>
<th>Developing Countries</th>
<th>Sub-Saharan Africa</th>
<th>Latin America</th>
<th>Asia and the Pacific</th>
<th>West Asia-North Africa</th>
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</thead>
<tbody>
<tr>
<td>1960</td>
<td>3,019</td>
<td>964</td>
<td>2,055</td>
<td>209</td>
<td>218</td>
<td>1,505</td>
<td>123</td>
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<tr>
<td>1985</td>
<td>4,855</td>
<td>1,210</td>
<td>3,645</td>
<td>421</td>
<td>404</td>
<td>2,575</td>
<td>245</td>
</tr>
<tr>
<td>2010</td>
<td>7,191</td>
<td>1,365</td>
<td>5,826</td>
<td>916</td>
<td>631</td>
<td>3,810</td>
<td>469</td>
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<tr>
<td>2025</td>
<td>8,467</td>
<td>1,422</td>
<td>7,045</td>
<td>1,296</td>
<td>761</td>
<td>4,379</td>
<td>609</td>
</tr>
</tbody>
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**DISTRIBUTION (percentage)**

<table>
<thead>
<tr>
<th>Year</th>
<th>World</th>
<th>Developed</th>
<th>Developing</th>
<th>Sub-Saharan</th>
<th>Latin</th>
<th>Asia and</th>
<th>West Asia-North</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>100.0</td>
<td>31.9</td>
<td>68.1</td>
<td>6.9</td>
<td>7.2</td>
<td>49.8</td>
<td>4.1</td>
</tr>
<tr>
<td>1985</td>
<td>100.0</td>
<td>24.9</td>
<td>75.1</td>
<td>8.7</td>
<td>8.3</td>
<td>53.0</td>
<td>5.0</td>
</tr>
<tr>
<td>2010</td>
<td>100.0</td>
<td>19.0</td>
<td>81.0</td>
<td>12.7</td>
<td>8.8</td>
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</tr>
<tr>
<td>2025</td>
<td>100.0</td>
<td>16.8</td>
<td>83.2</td>
<td>15.3</td>
<td>9.0</td>
<td>51.7</td>
<td>7.2</td>
</tr>
</tbody>
</table>

Most observers also agree that there will be wide regional differences in the severity of hunger and malnutrition. All agree that Sub-Saharan Africa and South Asia will face particularly difficult problems. Let us recall that by 2025 these two regions alone will approach a population of 3 billion people.

The Supply Side—The Divergent Views

Perceptions of the capacity of the world to meet the above challenges vary widely. On the optimistic side are analysts who use global projection models based on past trends, which basically conclude that on a global basis the world can feed itself until at least 2010. The clearest and most comprehensive presentation of this view is by Mitchell and Ingco. At the opposite end of the spectrum is the most recent Worldwatch Institute study by Brown and Kane. Reading Mitchell and Ingco and then Brown and Kane one after the other is a study in contrasts which makes one wonder whether they are talking about the same planet.

Between these two poles are two other views. One I call the conventional scenario which argues that the challenge is serious indeed, requiring developing countries to increase significantly their capacity to feed themselves and in a sustainable fashion. The perception is that it can be done; but, if current investments in agricultural development and productivity improvement are not maintained or increased, the world will spin toward the Brown-Kane model. A fourth wildcard scenario is a hypothesis presented by Ian Carruthers called “Going, Going, Gone! Tropical Agriculture as We Knew It,” which argues that developing countries will not be able to meet their growing urban cereal demands and that the developed countries must fill the gap with greatly expanded trade.
I begin by presenting the conventional view and then turn to the other three scenarios.

Scenario 1: The Conventional View

The challenge facing world agriculture is enormous. World food production has to more than double. Until the middle of the twentieth century, expansion of cultivated area roughly kept pace with population growth. In the last forty years, the doubling of cereal output came from three sources—area expansion, increased intensity of land use (mainly through expanded irrigation), and yield increases. While irrigated area more than doubled from 1950 to 1980, its rate of growth has since slowed substantially as has area expansion in rainfed areas. The current view is that the next doubling of food production must come primarily from increased productivity (i.e. yield). Already increasing productivity in many developing countries is putting stress on the natural resource base—in some countries as much land is lost to erosion and salinization as is brought into production through irrigation or area expansion.

Therefore, the difficult challenge facing world agriculture is to double production on the same land base while maintaining or, hopefully, improving the natural resource base. These are the twin challenges of creating environmentally-sustainable production systems—productivity improvement and improved management of natural resources.

The aggregate challenge is staggering enough; but, when we begin to disaggregate food demand, the task
is more complicated. As noted, rising incomes and urbanization shift the composition of food demand. Consumers demand more diverse and higher-quality diets and need foods that can be transported and stored. While yields of some cereals, such as wheat and rice, have doubled in the last thirty years, yields of most other developing country crops—such as maize, cassava, sorghum, millet, beans, and edible legumes—have shown less rapid increases. To double again wheat and rice yields and more than double yields of other basic food products will be problematic without increased research and development efforts. While biotechnology holds the promise of significant genetic improvements, that promise is becoming reality much more slowly than earlier forecasts suggested.

This scenario implicitly views the food supply problem as basically a nationalistic one (i.e. countries are responsible for their own food security). This is generally translated to mean responsible for their own food production. Trade enters the scenario in a limited way. If food demands double, grain consumption—of wheat, rice, and maize—will increase from 1.9 billion metric tons to 3.8 billion metric tons. Trade is now around 200 million metric tons, or approximately 10 percent of the supply, and is not likely to grow as a percentage. If developing countries are to grow their own food, and if population increases 2 percent per year, then their food production must rise by 2 percent per year.

**Scenario 2: The Optimists**

Analysts have been projecting world food supply and demand balances for decades. In their simplest
form, rates of population growth are added to rates of income growth, modified by the income elasticity of the demand for food, to project a rate of growth in food needs (i.e. demand). This rate is then compared to rates of growth in productivity (i.e. production), usually made up of an estimate of new land availability plus projected yield increases. These models, therefore, are basically projections of two compounding growth rates. Any deviation between these rates either leads to food gaps or surpluses and the difference increases the further the projection. If the model has endogenous prices, then real prices either rise or fall. Over a twenty-five year time horizon a one-tenth of 1 percent difference leads to substantial divergence. In reality, of course, food gaps or food surpluses do not occur because prices in the marketplace equilibrate quantity supplied to quantity demanded. Thus, the strong focus on the direction of real prices of food over future periods.

One such model deserves our attention here. Mitchell and Ingco have produced a substantial and controversial paper in “The World Food Outlook.” After reviewing past predictions of global food shortages over the last several decades, Mitchell and Ingco concluded that the world has really done quite well. Using three indicators—real food prices, calories available to consumers, and per capita food production—they concluded that, overall, the world was better fed in 1990 than in 1960. Real food prices, except for a blip from 1972 to 1974, have continued their century-long decline. “Per capita calorie supplies in developing countries rose by 27 percent from 1961-63 to 1987-89” (Mitchell and Ingco 1993, p. 20) and overall per capita food supplies
increased at a steady pace since 1961-63" (p. 23).

Their basic question is, what can we expect to 2010? Their model is based on two critical assumptions. The first is that the global population growth rate will decline from 1.74 percent in 1994 to 1.4 percent in 2010. The second is that world grain production will grow at 2 percent per annum from now until 2010. The result of their baseline simulation model is that global food production increases will more than keep pace with increases in demand. Food imports by developing countries will increase by more than 4 percent per annum, doubling imports by 2010; but these will easily be provided by expanded exports from developed countries and reduced net imports by formerly centrally planned economies.

Among the study's conclusions are:

1. "The simulation results strongly suggest that the outlook for the world food situation is good, despite regional problems" (p. 151).

2. "It should become increasingly easy to meet the world's demand for grain if past trends in production and consumption continue" (p. 175).

3. "The most important conclusion to come from our analysis is that the world food system has many options to meet future demand" (p. 175).

4. Mitchell and Ingco's final paragraph:

   The world food situation has improved dramatically during the past thirty years and the prospects are very good that the
twenty-year period from 1990 to 2010 will see further gains. However, these gains depend on continued increases in food production along the trends of the past. This will not occur automatically, rather it will require continued investments in research to increase crop yields and in other factors of production. If past crop yield trends continue and if population growth rates slow as projected, then the gains in the world food situation seen during the past thirty years should continue. If Malthus is ultimately to be correct in his warning that population will outstrip food production, then at least we can say: "Malthus must wait" (p. 232). [Emphasis added.]

Other studies—such as "Agriculture: Towards 2010" by the Food and Agriculture Organization of the United Nations (FAO) and an International Food Policy Research Institute (IFPRI) paper by Mark W. Rosegrant and Mercedita Agcaoili entitled "Global and Regional Food Demand, Supply, and Trade Prospects to 2010"—reach similar, though not identical, conclusions. The FAO study uses the same population growth rate for 2010 (i.e. 1.4 percent), but a slightly lower rate of global production increase (i.e. 1.8 percent). The study concludes that per capita calorie supplies will rise and the absolute numbers of people suffering chronic undernutrition will decline. Production increases for grains are projected to be 2.2 percent per annum, made up of a 1.4 percent per annum increase in yield and a 0.8 percent per annum increase in area harvested.
Rosegrant and Agcaoili use an IFPRI simulation model to project to 2010. Aggregate simulation results suggest declining or constant real prices of major food commodities, which suggest optimism for future aggregate food supplies. As with the Mitchell and Ingco and the FAO studies, the IFPRI study also points to potential regional problems, particularly in Sub-Saharan Africa, but in general it is upbeat.

Their conclusion is:

If governments and the international community maintain (or renew) their commitment to agricultural growth through policy reform and sustained, cost-effective investment in agricultural research, extension, irrigation and water development, human capital, and rural infrastructure, there will be no overwhelming pressure on aggregate world food supplies from rising population and incomes. Projected per capita availability of food will increase and real world food prices will be stable or declining for key food crops. However, these aggregate price trends conceal emerging problems at the regional and country level, which show that there will continue to be problems in getting food to those who need it most (Rosegrant and Agcaoili 1994, p. 40-41).

Thus, these models project that growth in global production will keep pace with global demand. In fact, they argue that production could grow faster than
2 percent if land currently held out of production in developed countries returns to production. The conclusion is that supply will continue to press on demand leading to a continuation of the decline in real grain prices which has persisted with few exceptions for the last 100 years. They conclude that there will be no global world food problem as aggregate supply will be equal to or greater than aggregate demand at constant or lower real prices. Finally, none of the studies sees resource degradation as a critical issue. In fact, the Mitchell and Ingco study suggests less land would be needed.

They do, however, admit that there will be pockets of problems such as in Sub-Saharan Africa and South Asia, particularly where there will be problems of malnutrition. They identify this as a problem of access to food, which is a poverty problem not a food problem. If pressed, the supporters of these models will admit that a 1.8 percent to 2 percent output growth assumption is critical, and that there will, therefore, be a role for research and technology development; but they do not see global food supplies as a crisis in the next decade or two. They are generally silent about the longer-term.

**Scenario 3: The Pessimists**

At the opposite end of the spectrum we find Brown and Kane in *Full House: Reassessing the Earth's Population Carrying Capacity*. This book is in stark contrast to the Mitchell and Ingco analysis. The basic premise is that the 1990s mark the beginning of a new era where it will be much more difficult to expand food output.
Many knew that this time would eventually come, that at some point the limits of the earth’s natural systems, the cumulative effects of environmental degradation on cropland productivity, and the shrinking backlog of yield-raising technologies would slow the record growth in food production in recent decades. But because no one knew exactly when or how this would happen, the food prospect was widely debated. Now we can see that several constraints are emerging simultaneously to slow the growth in food production (Brown and Kane 1994, p. 22).

The "facts" according to Brown and Kane are different from Mitchell and Ingco. Brown and Kane say grain production expanded at 3 percent per year from 1950 to 1984, but the rate of growth dropped to scarcely 1 percent annually during the period 1984-93. Recall Mitchell and Ingco projected a continuation of the 2 percent per year growth in production that occurred in the 1980s. Further, Brown and Kane argue that production of fish has reached its biological limit and the carrying capacity of rangelands has been exceeded, requiring future food needs to be met by only the crop-land food system, whereas before it was met by all three—fish, livestock, and crops.

Therefore, Brown and Kane argue future supply trends will be subject to six new constraints:

1. The shrinking backlog of unused agricultural technology.

2. The growing human demands that are pressing against the limits of what fisheries and rangelands can contribute to increase food needs.
3. The demands for water that are pressing against hydrologic limits.

4. The declining response of crops in many countries to additional fertilizer application.

5. The substantial losses of cropland to industrialization and urbanization.

6. The "social disintegration, often fed by rapid population growth and environmental degradation [that] is undermining many national governments and their efforts to expand food production" (p. 24).

On this last point, Brown and Kane cite extensively a chilling article by Robert Kaplan entitled "The Coming Anarchy."

*Full House* presents quantitative information to back-up these basic propositions. The food production increases have slowed perceptibly in the last ten years and may slow even more in the future. Per capita grain production has fallen from a peak of 346 kilograms per capita in 1984 to 303 kilograms per capita in 1993. World grain stock, as a percentage of production, is at an all time low. Relatively little land is currently being held out of production in the United States and the European Union, and what is out is of low productivity. Bringing all this land back into production would "expand the world grain area by only 1.6 percent, not half enough to get it back to the historical high reached in 1981" (p. 99).

Further, China is losing nearly 1 million hectares or 1 percent of its cropland per year to industrialization. Brown and Kane predict that China will follow a
similar path to Japan, South Korea, and Taiwan, where their combined grain areas decreased from 8 million hectares to 4 million hectares from 1950 to 1990. Thus China, in their scenario, will experience a 66 million metric ton reduction in grain production from 1990 to 2030 and an increase of 210 million metric tons in imports—more than total world trade in the 1990s.

These facts plus others—declining fertilizer use; a falling off in yield increases in recent years in many countries (world grain yields increased 2.3 percent per year from 1950 to 1984, but only 1 percent per year from 1984 to 1993); declining investments in agricultural research; and increasing environmental pressures—lead Brown and Kane to conclude that the world is close to exceeding its carrying capacity. Their analysis suggests that by 2030 world grain import needs will “exceed exportable supplies by 526 million tons, an amount approaching the current grain consumption in the United States and China combined” (p. 188). Their bottom line is that the growing imbalance between food and people can only be redressed by frontally attacking the population issue. In sum, if Brown and Kane were to paraphrase Mitchell and Ingco’s concluding sentence, it could read “Malthus is here.”

Scenario 4: The Developed Countries Fill the Gap

The most radical scenario is one put forward by Carruthers, a professor at Wye College, in “Going, Going, Gone! Tropical Agriculture as We Knew It.”
Carruthers' view is that our traditional model of developed countries (i.e. rich) supplying the world with manufactured goods and financial services while the developing countries (i.e. poor) provide primary products—such as food, natural resource products, and minerals—is not sustainable. Carruthers' view is that in the long-run developing countries will produce manufactured goods and trade them for food from developed countries. His argument in simplified terms runs as follows:

1. Carruthers is convinced that the tropics are incapable of producing enough basic foodstuffs for burgeoning cities in the developing world—where population is estimated to be 4 billion by 2025—in the long-run. The fragile tropical and subtropical environments will be lucky to support the remaining 50 percent that still subsist from the land.

2. The trend has already started; it is developed countries—the United States, Canada, Europe, and Australia—which export food to developing countries and increasingly import labor intensive manufactured goods.

3. Production increase potentials are greater in the temperate zone because of better technology and significant areas of land held out of production. Therefore, developed countries can provide increased supplies through trade.

4. If the scenario occurs with developing countries exporting manufactured goods (i.e. from labor abundance), urbanites in developing countries will have enough income to import basic foods (i.e. grains).
The implications of this scenario are enormous. If the additional 3 billion urban dwellers are to be fed by trade, exports of grain will have to increase 4 times from 200 million metric tons to 800 million metric tons, assuming minimum consumption of 200 kilograms per capita, in next thirty years. This is—physically, biologically, and economically—a huge task. If trade does not expand this rapidly, the impact on food prices could be substantial, causing greater increases in malnutrition in poor countries. Carruthers' paper contains no numbers, so it may be that the physical magnitude of the increases in production in developed countries suggested was not fully comprehended. The United States currently provides about half of world grain exports. To maintain that share, US grain production would have to triple by 2030.

**Some Comparisons of the Scenarios**

The four scenarios presented look at the same "facts" and reach vastly different conclusions. The reasons for the differences, despite all the rhetoric, reside in four projection parameters:

1. The rate of increase in biological cereal yields to be expected over the next fifteen to thirty years.

2. The amount of new land to be added to or lost from agricultural production.

3. The amount of land subject to increased intensification primarily through irrigation.
4. The impact of environmental degradation on food production capacity.

Mitchell and Ingco assume a continuation of the rate of increase in production of the last several decades. Ninety percent of that increase resulted from yield increases. In their terms, yield is output per unit of land, which includes the impact of both biological yield increases and intensification. Presumably both the rate of growth in biological yield and irrigation is assumed to continue at the same rate as during 1960-90. Therefore, the assumption with respect to increased land area appears to be close to zero. They minimize any significant negative impact on production of resource degradation.

On the other extreme, Brown and Kane argue that biological yield growth has slowed to about 1 percent per year in the last decade and may decline further. Herein lies the major difference—a 1 percent difference in a compound growth rate over thirty years makes an enormous difference at the end of the projection period. Further, Brown and Kane argue that land lost from agricultural production, coupled with increased urban competition for water, will lead to a projected decline in irrigated acreage. Environmental degradation will further constrain production increases. Carruthers makes no explicit presumptions about any of these parameters, but must implicitly be assuming low yield growth in developing countries, very high rates of yield growth plus expanded land area in developed countries, and environmental constraints mainly in the tropics and subtropics.

The conventional scenario argues that biological yields must increase to about 2 percent per annum to
replace the contributions made by area expansion and intensification in the last three decades. These yield increases must be accomplished without degrading the environment further.

All scenarios recognize the need for sustained or increased investments in research and technology development.

One must be somewhat cautious in assuming that future biological yield increases at past rates will be easy. Research by the International Rice Research Institute (IRRI) and the International Center for the Improvement of Maize and Wheat (CIMMYT) found significant slowing in the rate of yield increases of rice and wheat under experimental conditions. Nor should we be blase about area or irrigation expansion. While the area of potentially useable arable land seems large, its potential for production has been seriously questioned in a recent study by Gershon Feder and Andrew Keck entitled "Increasing Competition for Land and Water Resources: A Global Perspective."

The trade implications of the four scenarios are also widely different. Carruthers appears to be arguing that, given population increases in developing countries, exports from developed countries would need to increase by 400 percent to possibly 800 million metric tons by 2025. Brown and Kane have export requirements which appear to exceed 700 million metric tons. The Mitchell-Ingco model sees a doubling of developing country imports by 2010 and, presumably, if the models were projected further, developing country imports could double again by 2025. This would imply a tripling of cereal trade. Finally, the conventional scenario would imply a doubling of cereal trade.
The first three scenarios raise two critical issues. First, the capacity of the developed countries and, possibly, the formerly centrally planned economies to achieve the required rate of increase, particularly given environmental concerns and resource limits. Second, the physical capacity of developing country infrastructure to handle the volume of trade projected. All of these models—Mitchell-Ingco, Brown-Kane, and Carruthers—are very cavalier in assuming that these two barriers can be overcome.

Of course, no one knows who will be right. Projections thirty years ahead, particularly those by economists, are invariably wrong. This is partly because of questionable assumptions, limited models, and poor information, but also because a dynamic world economy is self-adjusting since it does not tolerate disequilibrium easily.

The Consequences for the Future

While my own views tend to be more consistent with the conventional view than any others, this is not crucially important. Regardless of who is correct, the productivity-food production challenge for the globe is very substantial. Given the agreement on the demand side, all scenarios "require" at least a 2 percent or more per year increase in global food production. However, each scenario would have a different distribution of required relative increases. At one extreme, Carruthers places almost the entire burden of production increases on developed countries, and seems to imply a rate of increase approaching 4 percent per year—a rate never before accomplished. Mitchell and Ingco clearly imply a larger rate of increase in devel-
oped countries. The conventional view places more of the burden on developing countries and implies that virtually all of these increases must come from biological yield increases. Brown and Kane are skeptical about it happening at all. Under all scenarios biological yield increases accomplished over the last thirty years must be at least maintained or, better yet, increased.

Several other points need to be made:

1. The global requirements for production systems to be non-degrading to the environment (i.e. sustainable production systems) increases an already enormous research and development challenge. Few systems have sustained increases of over 2 percent per year, and these have often been at the expense of resource degradation.

2. Sources of increased rainfed land are limited, and the rate of increase of irrigated land has slowed considerably because of rising costs and the threat of long-term salinization. Therefore, production increases must come from yield increases. How difficult will it be to get 250 bushels per acre of corn or to increase the average irrigated rice yields in developing countries from 3.5 tons per hectare to 7 tons per hectare? Doubling sorghum yields in the Sahel from 500 kilograms to 1 metric ton per hectare is not going to help much in meeting global food security needs no matter how important it is to the Sahel.

3. The mix of crops will need to change to produce more tradable surpluses which are transportable and storable. Further, the increased foreign exchange earnings required by developing countries
for imports require a much more open trading system than we now have, even given the advances made during the Uruguay Round of negotiations of the General Agreement on Tariffs and Trade (GATT).

4. Even increasing production does not solve the malnutrition problem which will surely grow. It is a problem of access and income.

Further, we must recognize that the agricultural productivity issue is not just an issue of food supplies or even of biological food security. Let me make three quick, but very important, points in this regard. First, in the poorest countries of the world, the agricultural sector remains the most important, both in terms of employment and income generation. Increased productivity in subsistence and smallholder agriculture is a powerful engine of labor intensive growth, income improvement, and better access to food. It is a major contributor to poverty alleviation and equity improvement.

Second, more of the poorest of the poor and the malnourished currently live in low-potential areas than in high-potential areas, and rural numbers far exceed urban numbers so far (Pinstrup-Andersen and Pandya-Lorch 1994b). Thus, improvement in productivity in agriculture in both low- and high-potential areas has the multiple impact of increasing production, reducing poverty, reducing malnutrition, and generating growth, thereby improving food security broadly defined. Agricultural development is not just increasing cereal yields. Further, for the growing number of urban poor, ever-declining real food prices are a positive contribution to reducing malnutrition and poverty.
Third, increased yield per unit of land, particularly biological yield increases, reduces pressure on fragile environments. Feder and Keck argue that "...every 0.1 percent of yield increase in the period 2010 to 2025 'substitutes' for about 25 million hectares of rainfed cropland" (p. 22). Further, given that agricultural production systems are dominant users of the arable landscape, attention to environmental issues in the development of sustainable production systems is an indispensable component of any successful future strategy.

Concluding Comments

The frightening part of this story to me is that, while the challenge just outlined is, in my view, critical and immediate, funds to support agricultural development and productivity improvement are being reduced in developed countries, and aid agencies and international development institutions are reducing the share of resources going toward agriculture. This trend is made worse by the overall decline in development assistance. Even the interest of developing country governments in agricultural development appears to be in steep decline. There is at least a twenty-year lag between initiating strategic research and significant increases in production in farmers' fields. Twenty years from now there will be 2 billion more people to feed and most of them will be in developing country cities. To not recognize the challenge and increase efforts is bad enough, but it is much worse to allow existing research capacity to erode.
Explanations for the apparent neglect of a critical problem abound: the short time span of attention of politicians; perceptions of over-production and surpluses in rich countries; protectionist domestic agricultural policies, which reduce incentive prices in developing countries; aid fatigue; fiscal crises in countries of the Organisation for Economic Co-operation and Development; the end of the Cold War, which reduced the urgency for development assistance; and on and on. Regardless of the reason, the consequences of not addressing these issues now will clearly have serious future consequences. Unfortunately, extremely pessimistic or optimistic scenarios, both of which must be questioned, detract us from serious debate on this critical issue. The efforts of IFPRI through their 2020 Vision for Food, Agriculture, and the Environment are, therefore, to be applauded as they seek a broadly accepted consensus on the challenges ahead. A recent IFPRI paper by Peter Hazell entitled “Prospects for a Well-Fed World” begins to move us on that direction. More than anything, the global community needs a balanced and reasonable analysis upon which to base critical future decisions.
Bibliography


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