AGRICULTURAL PRODUCTION CAPACITY OF NORTH AMERICA'S SOIL RESOURCES

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1. Retrospective – The Perils of Projecting into Unknown Futures

To assess the capacity of agricultural productivity begs the foretelling of the future. As Arrow et al. (1995) noted, carrying capacities in nature are not fixed, static, or simple relations, but are contingent on technology, preferences, and the structure of production and consumption. Cohen (1997), too, cautions about predicting the future carrying capacity of the global biosphere since the 'answer' to this question must be probabilistic, conditional, and dynamic: probabilistic, because humans cannot perfectly predict the future; conditional, because the answer depends on choices yet to be made; and dynamic, because predictions and choices are susceptible to change.

Agricultural production is driven and modified by a variety of forces and factors, including the character, capability, and care or stewardship of the natural resource base undergirding all agricultural production systems; climate and weather; product demand (economic); technology; political events and policies; demographics; and cultural customs (e.g., dietary preferences). Therefore, to speak of the capacity of manipulated ecosystems, one must be mindful of the potential impact of unforeseen technologies, events, and demand scenarios that will certainly alter projections of agricultural capacity based on the datum of the present.

History is replete with bold prognostications of future outcomes that were well off the mark when such prophesies were later assessed against the reality of their targeted times. Cohen (1995a; 1995b; 1997) has done a comprehensive review of the literature on the many divergent projections of the earth's capacity to support and sustain various population numbers.

Projecting the capacity of agricultural production has seen its share of errant forecasts. The heralding of cataclysmic food and natural resources shortfalls has been sounded for centuries, from the Reverend Thomas Malthus (1798) to the more recent projections of Paul Ehrlich (1968; 1969) and Lester Brown (1995). Yet, despite the fact that about 15% of our global population is malnourished, global food production has more than kept pace with population growth. Between 1950 and 1997, the area planted to grain in the world expanded by 17% while total grain production rose by 190%, resulting in a 2.5 fold increase in grain productivity over this period. This rate of increased food production has more than kept pace with the global population growth rate. For the more than 800 million people suffering hunger and malnutrition, the problem is mostly one of deprived food access and poverty-induced inability to pay for available food exacerbated by political conflict, regional climatic aberrations, inadequate food distribution and storage capabilities, and mismanagement.

Malthus made his projection in 1798 that humanity's penchant for procreation would eventually outstrip his capability and capacity to feed himself. His forecast was made from a datum of a global population less than one-sixth the population in 2000. But just five years later in the second (and rarely read) edition of his famous 1798 essay on the principle of population, Malthus was more sanguine about humanity's prospects for the future, stating that "we may confidently indulge the hope" for a better future. Malthus' hope in the progress of humanity was mostly faith-based since he did not and could not foresee the globalization of markets and technological advances that allowed agricultural production to more than keep pace with population in most areas of the world (exceptions include parts of Africa, especially sub-Saharan Africa). Even Ehrlich's previously pessimistic views of humanity's future have mellowed, giving way to more hopeful scenarios (Ehrlich, 2000).

This brief reflection on past attempts to predict the future carrying capacity of the earth should caution anyone attempting such an undertaking about the pitfalls of forecasting unforeseeable futures. It is against this backdrop that the capacity of North America's agricultural production capacity will be discussed.

2. A World View: Ratcheting Up Demands on the Land

To suggest that feeding a UN FAO-projected 1.2 billion additional mouths in 2030 (Mann, 1997) will be without considerable effort is to miss the point. Not only will this expansion of humanity need to be fed, but increasing global affluence means many more people will be eating higher on the food chain. By 2020, one projection of global demand for rice, wheat, and maize sees an increase of 40%, or 1.3% per year (Mann, 1999). This double-barrel circumstance of more mouths compounded by increased affluence will require proportionately more grain production to feed both humans and the animals whose products they'll demand. Furthermore, this demand scenario is occurring simultaneously with the slowing down of the Green Revolution as most grain and other crop yield increases have decelerated over the last three decades of the twentieth century. Global cereal grain yields have slipped from annual yield increases of 2.2% in 1967-1982 to 1.5-1.3% during the 1982-1994 period. If the Green Revolution is to be revived or a second Green Revolution is to occur again, squeezing out additional yield from crops and the land will be proportionately more difficult than the first Green Revolution. The low hanging "research fruit" has already been harvested.

Exacerbating this situation is the fact that supplies of fresh water are becoming scarcer, soil quality is deteriorating across much cultivated land, and there is limited, problem-free uncultivated land left to exploit. Will humankind be able to feed itself adequately? The agricultural science consensus is that it can, but only if there is a global priority to fund the necessary research, see it applied, and distribute the produce equitably. Since food scarcity manifests itself locally, global food adequacy is meaningless without tailoring food access to local circumstances.

3. Can Global Cropland Yield More Food Sustainably?

Daily et al. (1998) posit that there are two broad criteria by which one can judge humanity's success in feeding itself: 1) the proportion of people whose access to basic nutritional requirements is secure, and 2) the extent to which global food production is sustainable. The land-soil resource base now committed to producing humanity's food will bear the brunt of yielding even greater productivity in the future.

It is not clear, according to Tilman (1998), which are greater—the successes of modern high-intensity agriculture, which have been immense, or its short-comings. Laszlo (1994) argues that the wave of optimism engendered by recent gains in food production does not account for the fact that much of this gain is unsustainable. These unsustainable short-comings of high tech agriculture manifest themselves through such impacts as degraded and eroded land, release of greenhouse gases and loss of soil organic matter or carbon (SOC), soil salinization, contaminated groundwater, eutrophication of freshwater bodies and coastal waters, high energy and synthetic chemical inputs, heavy demands on scarce water resources, increased incidence of crop and livestock diseases, and loss of biodiversity. While many of these agricultural impacts are not clearly understood and are vigorously debated (e.g.: Pimentel et al., 1995; Crossen, 1995; Avery, 1997; Daily et al., 1998; Pimentel and Skidmore, 1999; Trimble, 1999; Trimble and Crosson, 2000a; Trimble and Crosson, 2000b; Nearing et al., 2000), the fact remains that if humanity is to manipulate nearly 1.5 billion hectares of global cropland to feed itself, it must strive to do so in a sustainable manner. About 38% of this global cropland base has been degraded to some extent by poor agricultural practices, thereby reducing to some degree the yield gains provided by technology.

It is the consensus of most agronomists and allied agricultural scientists that global agriculture must accommodate high yielding production systems, albeit with more sustainable systems. Otherwise, continued agricultural expansion will consume lands and ecosystems now devoted to wildlife and a host of other land uses and ecosystem functions that would be forfeited. High technology agriculture, despite its exhaustion of resources and environmental impacts, has resulted in saving much land, habitats, and fragile ecosystems that would otherwise have been converted to cropland and pasture—a benefit that must be factored into any accounting of technology-based global food production.

Ausubel (1996) points out that, despite societies' chronic fears about the exhaustion of their potential to increase food supply, the reality is that the agricultural production frontier is still spacious, even without invoking the engineering of plants with molecular genetic techniques. There is still much agricultural production technology on the shelf that is yet to be implemented. In Iowa, the average corn-soybean grower has managed only half the yield of the Iowa master grower. Furthermore, the global situation is that the world grows only about 20%, per unit of land, of that grown by the top Iowa farmer (given Iowa's ideal agricultural natural resource base). This production ratio of producers has not changed much since 1960 (Ausubel, 1996).

Economists and non-agriculturalists tend to be much more optimistic about future trends and the earth's capacity to feed humanity sustainably. That's because agronomists, plant breeders-geneticists, soil scientists and other agricultural scientists know the challenges involved in coaxing out a second Green Revolution over the next 20 to 30 years. Economists can project trends, but agronomists and plant breeders-geneticists must deliver the future food.

Yes, global cropland can yield more food. And this food increase can be accomplished more sustainably, but not without providing the necessary incentives and policies for farmers to accomplish such an immense undertaking. Smil (2000) has provided a thorough review and assessment of our global food carrying capacity and how to sustain a global food future that eases the burden that modern agriculture puts on the biosphere. Also, Lackey (1998) has provided a blueprint on how global ecosystem management can be accomplished and made more sustainable. Technology without social science input will not get us there.

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