THE NEW ERA OF AMERICAN AGRICULTURE: UNCERTAINTIES AND CONSTRAINTS

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Throughout history there have been periodic debates as to whether future food supplies would be adequate to feed the world's populations. This decade is no exception. One such debate is defined by the extreme variations in the experts' broad images of the world's future outlook for food and varying projections of the future demands on U.S. agriculture.

The images can vary from an optimistic one of abundant and low cost food (Kahn) to that of a Malthusian doomsday characterized by widespread starvation (Hardin, 1974). The most pessimistically inclined see food scarcity as a permanent feature of society. One modern day Malthusian, Garrett Hardin, argues that there are not "shortages of food," but "longages of people," and sees starvation as the only method of restraining third-world population growth (Hardin, 1979).

A contrasting view at the other extreme is that of those individuals who feel that agriculture has "an inherent and chronic capacity for overproduction" (Quance, 1976). As yet, no clear consensus has emerged among experts as to the probable long run world food situation (Cochrane).

If the past provides a guide to the future, then there will be ample supplies of low cost U.S. agricultural products. Indeed, one author has stated in a related context that

> Those who are most easily depressed about the precarious future of Western civilization are usually people who do not know the full history of its past. [Highet]

I am sympathetic to that view — one can gain insights into the future by examining the past. For example, on at least two occasions in the United States agricultural past, agriculture appeared to be faced with barriers to expanding agriculture. The first was the apparent constraint of a limited labor supply in the early 1800s. The importance of labor in this period can be appreciated by considering

that one hundred bushels of wheat cultivated on five acres with broadcast seeding, walking plows, and brush harrows required between 250 and 300 hours of labor. With today's modern machinery, one hundred bushels required less than 3 acres of land and only 3 to 4 hours of labor [Cochrane].

This constraint was evaded by increased mechanization. Plows, harrows, planters, cultivators reapers, and threshers were all achieving acceptance and widespread use in the mid-1850s. John Deere, for example, was annually producing 1,000 new steel plows by 1849; by the mid-1850s, he was producing 10,000 per year. The invention of labor saving machinery was not accidental; it was "induced" by the relatively high price of labor.

The second constraint to the expansion of agriculture was an ostensible shortage of agricultural land. This limitation was evident by the early 1900's with the closing of the land frontier. "Land, that seemingly inexhaustible resource, was in fact exhausted. . .the number of crop acres harvested increased. . .but these acres were low production, marginal acres. . ." [Cochrane, p. 110].

Although colleges of agriculture were established in 1862, they had not developed by the early 1900's a body of knowledge on plant and animal genetics, nutrition, and disease control that was to form the basis for a science-oriented agriculture.

The apparent land constraint was also eluded: first by the use of irrigation and second by biological advances that increased yields per acre after 1940. Again these changes were induced by relative price changes.

Now, as the 1980s commence, there are those who think new constraints will become evident. One reason for this belief is that there has been a plateauing of yields of the major food crops: wheat, sorghum, soybeans, and potatoes [Wittwer, p. 69]. The reasons for this plateauing are many, but the most often cited are that the most productive lands are already being used, productivity growth appears to be slowing, rising energy costs are constraining irrigation and the use of energy intensive fertilizers, expanding production is exacting costs of soil erosion and compaction, overpumping of groundwater is reducing the availability of water, climate fluctuations and air pollution are damaging crops, and declining agricultural research support is inhibiting technological innovations [Wittwer, p. 69].

Indeed, it may be that some of the past reliance on the inputs that were relatively cheap – energy, water, land — when used on a high yielding, highly mechanized monocultural agriculture is the source of increased vulnerability in a rapidly changing world. As one author states:

> . . .the winds of change can blow swiftly across agriculture. Food abundance is based on our great natural resource but

> has become increasingly unnatural as greater energy, chemical fertilizers, pesticides and irrigation water inputs are used in increasingly concentrated and monocultured production processes very much in opposition to natural ecosystems [Quance].

If this is so, the need for new policy directions is evident. As Lee states,

> Thus, within the first half of the 1980s, the long period of adjustment and disequilibrium in U.S. agriculture, with all its attendant problems (and associated policies, programs, and institutions) may phase into a new era of limits with all its attendant problems. Should that happen, the policies, programs, and institutions designed to address the problems associated with chronic surpluses and disequilibrium would likely not be appropriate. In that case, the challenge before us is clear. [Lee, p. 16]

The Conservation Foundation Conference

Some principal concerns with respect to the future of American agriculture are that (1) the U.S. agricultural resource base no longer has excess capacity, (2) that technological advances may not be able to compensate for reduced productivity caused by such problems as soil erosion, (3) that relative price increases of previously inexpensive inputs will seriously alter the profitability of current production practices, and (4) that this trend, when combined with other factors — such as monocultural production — may make U.S. agriculture unable to maintain or expand agriculture at constant real prices.

The validity of these principal concerns was the subject of a conference sponsored by The Conservation Foundation in the summer of 1980. Papers were commissioned by recognized experts in the field, and workshops were conducted addressing seven factors thought to influence the long run future of American agriculture. Possible new agricultural policy directions were also identified.

The factors discussed were those of soil productivity (problems such as erosion and compaction), energy dependence of the present agricultural system, the competition for agricultural land by non-agricultural uses, possible shortages of water for irrigated agriculture in the West, declining levels of support for agricultural research, genetic vulnerability of major U.S. crops to disease and pests, and the possible impacts on agriculture of climatic changes — both natural and man caused.

The proceedings of this conference will soon be published in a book [Batie and Healy], but some of the more interesting conclusions are highlighted here. While the experts were not able to give unequivocal answers as to the validity of the four principal concerns

with respect to the future of American agriculture, they did address related concerns. They thereby highlighted the source of those uncertainties which prevent definitive statements on the future. While some related concerns for the future of American agricultural productivity were discounted, others were confirmed; new concerns were expressed.

First, the experts discounted some concerns such as crop monoculture creating vulnerability to pest damage or diseases. The opinion expressed by plant geneticist Jack Harlan was that the economic and ecological imperatives have determined the extent and location of the U.S.'s wheat belt, cotton belt, and corn belt. If America is to grow crops on a large scale, America will automatically have monocultures. Admittedly, there are risks involved with a monocultural agriculture, but Harlan believed that these risks are manageable.

Another concern that was discounted was that competition for land from highway construction and dam construction will continue. It was agricultural economist Philip Raup's belief that "the competition for land that was fostered by the boom in highway construction is still with us. It will be some years before the echo-effects have been assimilated in land-use patterns. But it seems reasonable to conclude the major effects are behind us." Similarly, "our dam-building era, like our highway-building era, is largely behind us."

In contrast to the discounting of concerns, agronomist Fred Swader reemphasized the importance of soil conservation and the concern that soil erosion exacts considerable costs in environmental quality and crop yields. If foreign trade pressures cause more cultivation of less suitable lands, reduction in yields per acre could be substantial if these lands are also subjected to high erosion rates. Further, there have been some studies that suggest that crop losses to soil compaction are significant — amounting to over $3 billion a year.

New concerns were raised at this conference as well. Ken Frederick, a resource economist with Resources For the Future discussed increased soil and water salinity resulting from increased irrigation. He suggested that 25 to 35 percent of the irrigated lands in the West have a salinity problem. "Undoubtedly, there will be some resulting decline in productivity and profitability."

Another concern which was expressed by agricultural economist Otto Doering was that if energy production was highly subsidized, then land used for ethanol production could remove large areas from use for food production. However, unless fuel development was highly subsidized "energy farms with special energy crops are probably not feasible on a large scale" and "food and fiber would appear to have the competitive edge for land."

Three factors in particular were identified as new constraints to an

expanding agriculture. The first was that of water supply. Irrigation cannot be expected to make the contribution to agricultural expansion that it has in the past three to four decades. Frederick's analysis suggested that, with the exception of Nebraska, where some additional expansion is probable, long-term Western groundwater irrigation is likely to decline because of rising pumping costs.

Raup corroborated this point, stating that these changes in water availability could dramatically shift the present geographic pattern of land use and greatly alter the nature of competition for land in the mid-West and Great Plains. Raup, noted that feed for cattle fed in the southern Great Plains has been grown with water from the Ogallala aquifer. He stated that "unpriced water. . .has been capitalized in part into a level of beef consumption that cannot be sustained in the long run without a return to the feed grain supplies of the Cornbelt. We have a fed-beef economy that has become dangerously dependent on an exhaustible resource base."

The second constraint is climate change. Robert Shaw, a climatologist from Iowa State, observed "agriculture as we know it has developed during an abnormally warm period in recent climatic history." Then he proceeded to argue that (1) "the climate of the future cannot be predicted" and (2) "for the present, we must be more concerned about year to year variation than long-term trends." Furthermore, humans are adding a considerable number of man-made variables to the climate system: carbon dioxide, heat, acid rain, atmospheric particulates, and intentional weather modifications.

Each future climate scenario, predicted with great uncertainty, can be associated with future yields and future agricultural production locations, also predicted with great uncertainty. A large cooling of the climate, for instance, might improve yields in the U.S. at the expense of yields in the U.S.S.R., Canada, and China. However, all long-term climate scenarios tested indicated little change in total world production. Shaw suggested, however, that a series of extreme short-term climate variations may produce serious food shortages. He questioned,

> What would be the result if a combination of events happens such that a major drought occurs in a large area of the world, at a time when no surplus grain is available in other parts of the world?. . . Who would make the triage decisions?

The third and perhaps the most disquieting factor of concern was identified by agricultural economist Vernon Ruttan. U.S. agricultural history demonstrates that increased productivity has enabled U.S. agricultural production to expand without pressing against severe physical constraints. Yet, as Ruttan stated:

> The closest analogy to the present situation in American

> agricultural history was the period between 1900 and 1925. With the closing of the frontier, productivity growth declined. The new sources of productivity growth, chemical and biological technology, did not begin to emerge for several decades. My own guess is that it will be at least another decade before the direction of technical change. . . becomes clear.

If Ruttan is right, and future productivity increases are more in line with the pre-scientific-advance era of 1925-50, and if increased demands for U.S. agricultural products do indeed materialize, then the United States may witness a return to an agriculture where increased yields depend mainly on the use of more agricultural inputs.

Land Use and Policy Implications

While America is awaiting the hoped-for new technical change, there may be a frustrating period of adjustments to constraints. Three inputs — land, water, and energy — will probably have rising real prices in the future. Several of the conference authors concluded that this in turn will mean increasing pressures for interregional shifts in crop and animal production as well as changes in production practices.

Increased irrigation costs and rising demands for U.S. grain may, for example, move the livestock industry back toward the locational patterns of the 19th century. If this happens, cattle herds will put greater demands on the land base than ever before, and upward pressures on prices are the obvious outcome. For another example, increased transportation costs may mean local vegetable produce can compete in Northeastern urban markets with imports from distant parts of the country.

The uncertainties of land use patterns resulting from the new demographics, new trade patterns, and possible new land uses, such as the subsidized use of agricultural lands for energy production, compound the problem. Thus future predictions with respect to the nature of interregional shifts and the magnitude of any pressures on input and product prices are made more difficult.

Fully apparent from the conference discussions, however, is that the present prices paid by consumers, both domestic and foreign, do not reflect the true long-run social costs of that production. Soil erosion, soil compaction, salinization, declining aquifers, water pollution and loss of wildlife habitat are not reflected in the market price of food.

Thus, what emerged from the discussions at The Conservation Foundation conference was that not only is there no such thing as a free lunch, there is also no such thing as even a cheap lunch. The

inputs in agriculture have been heavily subsidized — which causes them to be used as if they were inexpensive — but who is receiving the benefits of this subsidization is not clear. In the most broadly defined distribution, consumers of American food products have benefited. But, as Raup phrased it,

> By exporting many billions of dollars worth of agricultural products to pay for billions of dollars worth of oil imports in order to maintain an urban-suburban lifestyle that depends on an excessive consumption of petroleum fuels, we are encouraging the very suburbanization effect that threatens the destruction of agricultural production capacity. Why should we continue to export our fertility in order to pay for the fuels to commute long distances to work from rural residential homes? Is this a good way to sell the fertility of our land? This seems to be the essential question that has not been faced.

Furthermore, exporting cheap food undermines the desire of developing nations to build their own agricultural sector. As Ruttan stated, "The dominance of North American agriculture in world exports is dangerous to the rest of the world and it is dangerous to North America."

This issue of expanding exports troubled the workshop groups more than the possibility of a global food shortage **per se**. There was, however, considerable agreement that this is an age of uncertainty — in part brought on by America's increasing interdependence with the rest of the world. The uncertainties suggest the need for maintaining flexibilities within the system.

One concern is that the policies directed toward the American agriculture sector will be too centralized to maintain these flexibilities. Doering was particularly concerned that a centralized "solution" would emerge with respect to energy dependence of the farm sector; this would be unwise in a country where there are millions of farm enterprises each with different crops, climates, resources, and management. Ruttan reflected the same concern with respect to research:

> Since we do not know where we are going, it is important that the exploration for new routes be kept as open as possible. Under these conditions, centralization of research management, particularly attempts to achieve a high degree of coordination among states and between the state and federal system, may come at a high price. This is a time to encourage parallel research and development efforts. As the uncertainty increases, the value of redundancy rises.

With conditions of great uncertainty, there is also value in developing a policy to insure against extreme deviations from normal

harvests. The most obvious example of such a deviation is a climate change to one less favorable to U.S. agriculture. The amount of insurance that might be appropriate would, of course, depend on the costs and benefits (and the distribution of the costs and benefits) of the insurance strategy selected.

In many cases, an exact accounting of the net benefits of being conservative must await research findings on whether any one strategy or a mix of strategies provide enough insurance to be worth the premium paid. The insurance possibilities include: wider spatial distribution of agricultural lands, more diversity in agricultural production by region, more private and public agricultural research funding, private and public grain reserves, programs to reduce specific "threats" to agriculture, modifying government programs that encourage a structure of agriculture vulnerable to extreme events, or pricing agricultural products so as to reflect all private and social costs.

Needed research relevant to these strategies would include determination of the future costs of soil erosion, compaction, and salinization; the impacts on U.S. agricultural productivity of severe temporary or longer-run climate changes, the costs of converting non-cropland to cropland; and the trade-offs in productivity resulting from wide and more diverse spatial distribution of agricultural enterprises. In most situations, it will be easier to identify the costs incurred when implementing an insurance strategy than it will be to estimate the benefits from protecting against an extreme event.

Policy debates should not await research findings, however, if for no other reason than that policy debates can help us identify our areas of ignorance. With the present farm economy characterized by surpluses, declining prices, and credit and cost squeezes on the farmer, it may seem strange to suggest debating how we might confront possible long-run shortages.

However, the urgency of near-term problems must not obscure the importance of considering how to organize an agriculture sustainable for as long as we expect our society and economy to endure.

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