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VENTURE INTO THE UNKNOWN: WHAT LIES AHEAD FOR U. S. AGRICULTURE?

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Surely one of the principal outcomes of the Scientific Revolution of which our age is heir was to see mankind's destiny as the resolution of physical and human forces brought to bear on it and not as the whim of mythical god-creatures or, alternately, as a play of cosmic dice -- pure chance.

Whether the new introspection into our destiny, the faith in scientific method, has helped us greatly is open to question. We may wonder whether we have yet learned to manage our affairs, individually and collectively, with wisdom and charity. Fortunately, the question is one step beyond our assigned subject here.

Our concern is confined to forecasting. How well can we foresee? Future events do cast their advance shadows. How accurately can we read them? Unlike some forecasters I do not protest a lack of data but on the contrary feel the burden of a superabundance. Data bearing on the future of human affairs, or even the future of U. S. agriculture, would fill the biggest library and overrun the most miraculous computer.

All of which is perhaps only to plead a protective innocence. The caution may be unnecessary; yet more than fools march in where angels won't go. A whole army of futurists do so. Some are economists. Unfortunately, it's a game that avoids reprisal following error, and therefore invites irresponsibility.

So the sketches that follow of what may lie ahead for U. S. agriculture are offered guardedly. Care will particularly be taken to distinguish evidence carrying a reasonable degree of certainty from more conjectural judgments (otherwise known as guesses).

The Material and the Human

Briefly by way of further introduction, scholars have long argued about the relative weight to be given to the material forces shaping human affairs

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versus the nature of humanity itself and the institutions human beings establish. Engineers may lean to the former. Though an economist, I do too. To illustrate my thinking, the Scientific Revolution that dates from four or five centuries ago was indeed a marvelous release of the human spirit. It marshalled human insight and human capacity in the mission of relieving some of the social ills that marked the Middle Ages. But I am also impressed by the fact that during the centuries after the Revolution began, whole new continents of virgin resources were opened up to exploration and to what was called development but frequently was exploitation or even devastation. The experience offered opportunity to millions of people previously bereft of it. It also enriched the material content of living standards worldwide. The first is of the spirit, but the second relates to material comfort. It is hard to know which of the two is regarded as more uplifting, more salutary to continuing human society.

The shortcoming in the saga of recent centuries, the failure to conserve, will recur throughout this paper.

It is worth noting in a positive sense that although Western history of the last four or five hundred years carried its costs it made possible the establishment of enlightened social systems including democratic ones. As a social scientist I do not say that material wealth leads in any directly causal way to democratic gains. But it is usually easier for people to live together amicably when things are going well -- when living standards are being improved, when misery is relieved for a substantial part of the population, when a nation enjoys what has recently been extolled in the single word, "growth." Economic gains in our era have surely made it easier to live together.

But there is a second side to this argument and it is disturbing. It suggests a cyclical sequence in which the very prosperity that eases the burdens of living not only uses up resources but invites moral deterioration. Degeneration and decay set in, followed by civil unrest in all its forms. The Spartan life induces discipline in human behavior; luxurious indulgence does not. If our nation is slipping into economic decline, the test to social stability may arise more from moral weakness than from a modest snipping away at our material standard of living.

Adjusting to a Tightening Resource Base

I open my remarks in this manner in order to encompass the political and sociological factors that bear on our common destiny, in addition to those of resources and technology.

Moreover, the siren song that science will save us finds fewer believers these days. This is not to disparage the role of science or rule out breakthroughs, even the science-fiction one of fusion energy. But there is no prestidigitation of laboratory, no miracle to be wrought by another Thomas Alva Edison, that will relieve our nation of the need to economize, conserve, and recycle, to curb our more wasteful indulgences, and to defend our democratic institutions.

Lessened Mobility of Things and People

Adjustments to a tightening resource base can appear in many places. We think of how everyday living is affected. The bearing on industrial processes, though less familiar, may be even more weighty. I suggest as a starting point for this review how tighter resources will show up in transportation and the location of economic activity, including that in agriculture.

Cheap energy and good modes of transport have given us the wonderful blessing of mobility. A human being requires for bare existence only a few cubic feet of space but he loves access to corridors that may reach around the world. However, mobility involves considerable cost. The cost has been especially high in our nation. The United States, wonderfully endowed though it be, is not geographically compact. On the contrary, the economy of the United States probably depends on cheap transport to greater degree than any other major nation with the possible exception of the Soviet Union. Our population is divided between the East and West Coasts. Two mountain ranges and a couple of deserts divide them. The metal ores are in one region, coal in another, and mineral rock in still another place. Our most fertile soils lie near the continent's center, a thousand miles from the East Coast and almost two thousand from the West.

Moreover, we have had a deliberate policy of dispersing both people and manufacturing activity. If the Bronx is left barren no one has seemed to care.

What I am leading to is that enormous economic pressures will build up to recentralize our population and economic activity. I doubt if the outcome will take the form of revitalizing the once-dominant big cities. I look instead for a network of smaller urban centers, connected by a rebuilt transportation network.

Not least of sectors that have taken advantage of cheap transport is agriculture. It therefore is vulnerable to higher cost of transport. Inexpensive transport makes for regional specialization. More costly transport forces more integration within each region. I do not want to overstate the case; we will not return to anything approaching regional self-sufficiency. But I believe it to be inevitable that certain foods for direct human consumption, such as milk,

fruits, and vegetables, will henceforth be produced closer to population centers. I believe livestock and poultry operations will necessarily be located closer to the source of feed supply. We definitely will not continue to ship bulky feedstuffs cross-country.

The subject of livestock and poultry opens up a collateral issue of how the process of converting concentrate feeds into meat, milk, and eggs will fare in a more spare economy. It probably will come under heavy pressure. But I will touch on this later; it is only flagged here.

To sum up this part of my remarks, I look for a major relocation of agricultural enterprise. I cannot sketch the precise pattern to be expected but the broad outlines may be about as I have suggested. More remote areas such as California may feel a constriction. Centers of commercial cattle feedlots will be dispersed. The changes will be significant and not accomplished easily.

Although location of the rural population may be peripheral to my topic, a clustering pressure will almost certainly be felt. The present scatter of rural homes throughout the countryside will come to an end. The clustering will likely take place at rural nodes for public transportation. In this respect I have thought that rural people who have chosen mobile homes may be the most fortunate. The homes will be moved to the transport centers. Likewise, the "rural industrialization" trend that has taken place with so much fanfare will become much more location-specific. Rural industry too will cluster.

Anyone who likes to consider far-out ideas may want to consider the Chinese design. It is conceivable that China exhibits a pattern that other nations will copy to some degree. The Chinese have regionalized their economy, making each region as nearly self sufficient as possible. Each region has its own agriculture. Requirements for transport are reduced thereby. A considerable degree of unification or integration of economic activity within each region is attained. I don't know how high a bet to put on our patterning after the Chinese model but it is not off the board.

Agricultural Technology

I find it hard to foresee the form technology in agriculture will take. We will not revert to horse and wagon farming. Manifestly, alternate energy sources will be exploited wherever possible. They surely include use of solar energy in any feasible manner.

My view of the future leaves little room for an extended trend toward ever

bigger tractors covering ever larger expanse of farmland. Agriculture will simply have to be less capital intensive than it has been. But more is to be said. The pressure of people on land will intensify land use. Before too many years steps will be taken to protect prime farmland from developmental use. Vast acreages now in grass or timber will be cropped; but the soil will be conserved, by mandate. Terraces and other soil conservation techniques will be required by decree.

The most probable picture will be colored by developments in biomass as source of energy. If anyone could forecast the future for biomass he could delineate more accurately the shape of all agriculture. My hunch is that biomass sources of energy will prove practicable. They will constitute an added pressure on land -- a pressure additional to food and fiber requirements. In that event a casualty can be predicted, namely, the feeding of grain to livestock and particularly to beef cattle. If we press hard on our agricultural resources for food, fiber, and industrial energy, grain feeding of livestock will be doomed. We will fabricate our simulated meat from soybeans.

In a sense, though, biomass is only proxy for the whole complicated subject of substituting organic (biological or flow) materials for industrial inputs to agriculture. We use a lot of metals and chemicals that are stock and depletable, in addition to the headline-getting petroleum. The more obvious possibilities are a return to rotation of crops and plowing under legumes as replacement for nitrogen fertilizer; integrated pest management to relieve some of the need for chemical pesticides; and perhaps various other techniques now being developed by the organic farming that so many traditional technologists disparage. Organic farming as now practiced may prove to be a useful laboratory even though it need not constitute a pattern to be adopted intact.

At this point ideas offered are pretty speculative. I draw on a good paper written by five agricultural engineers who at one time were associated on our campus. (Three are still there.) Christianson et al note the growing place of computerization in management, communication, and operational techniques. "Farmers will make much greater usage of electronic control equipment," the authors say, "which will enable them to manage a more diverse system." Electronic techniques have the advantage, among others, that they are not themselves highly resource-using. Miniaturization, in fact, reduces the quantity of physical materials required in electronic devices. Moreover, the authors add, "Electronic controls will facilitate the use of integrated solar systems which today require

large amounts of human effort to maintain."[1]

The authors apparently foresee the centripetal pull of agriculture and industry toward nuclear population centers that is suggested above. Intensified farming near those centers, protected by Greenbelt rules, will establish a symbiotic linkage with urban industry. Christianson et al suggest that "the green belt and the agricultural facilities located in urban areas will use city wastes and CO_2 enrichment to enhance productivity. They will serve as an air pollution buffer as well as provide a more aesthetically pleasing urban area."

Changes in Kinds of Food and Food Preparation

Our dinner menu of the future may feature simulated beefsteaks but fabricated foods may be one of the less dramatic changes to be expected in our food supply. As is well known, processing and preparation of food is far more energy-consuming than production on the farm. A sizable part of energy used in the food system is accounted for by refrigeration -- not only cooling and freezing of foods but climate-controlling of supermarkets for the comfort of shoppers. My hunch is that techniques such as freeze-drying will replace most canning and freezing. I am not sure how changes in form of handling and preparing food will impinge on farming operations but some connection surely exists.

The Structure of Agriculture

In early 1979 Secretary of Agriculture Bergland legitimized a policy issue in agriculture that some of us had been talking about for a long time. He called it the structure of agriculture. He referred to whether U. S. agriculture will continue to be dominated by family farms or will gradually drift into big corporation farms, an absentee landlord agriculture, contractual integration, or, as a more remote possibility, a cooperative agriculture.

To agricultural engineers, the subject may have more meaning in terms of their professional careers than of the technology of farming. Yet the two are interlinked. What engineers do and how they do it have long been affected by the institutional make-up of agriculture. Machines, equipment, and installations have been designed for farms that function as independent units. Agricultural

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[1] L. Christianson, M. Shanklin, R. George, N. Meador, and G. L. Hahn, "Farming in 2025," Economic and Marketing Information for Missouri Agriculture, University of Missouri-Columbia, Cooperative Extension Service, April 1980.

engineers who design those machines, or who teach farmers how to use them, are implicitly a part of family farm agriculture. This is true irrespective of whether those engineers are privately or publicly employed.

No solid clues tell us where U. S. farming is headed. All the political rhetoric lauds the family farm. But policy and contemporary events militate against survival of that institution. Because the rest of the economy is slipping into a sort of private-corporate state, with each industry dominated by giant business entities, I think it likely that agriculture will gradually move into that system. Yet family farming has vitality and some valiant defenders. My premonition may not be justified.

But before dropping the subject I call attention again to the possibility of an institutional arrangement that has been rare to date, namely, the cooperative farm. Insofar as biomass energy proves practical on a localized basis it will likely fit a collective unit of farms better than the individual family farm. A good case can be made for closely knit local associations of farms patterned to some degree after onetime mutual insurance cooperatives and threshing rings.

The Burden of Government

At various points in the tentative forecasts offered here a role for government has been called for implicitly or explicitly. That human beings will have to use instruments of cooperative or collective action is, I believe, the least debatable part of what I have presented. At the time this text was written our citizens were in the foulest anti-government mood I have known in my lifetime. Not often admitted is that in a democracy distrust in government is distrust in ourselves. It also manifests a collective frustration that could be psychopathic.

As every historian knows, the way to minimize the role of government is to scatter a few pastoral families over a rural landscape. An urban industrial society requires a thousand more rules of conduct. A commercial-technological agriculture calls for more conduct rules than a traditional agrarian farming system. Prospects for the future of agriculture as sketched here leave no room to escape the need for collective discipline to conserve, to recycle, to conduct research, to save land from destruction.

Moreover, the need for collective discipline will be proportional to the intensity of utilization of the resources of agriculture. Most at issue is the likely extent of development of biomass. If it should go far, and the products of the soil go into use not only for food, clothing, and shelter but for ethanol,

methanol, and other fuels, social control will extend over our entire land resource.

Summary

Without charting trends or compiling data I have outlined a picture of an agriculture of the future that will feature first of all a growing pressure of people on land. The pressure will arise from the needs of people here and abroad for food and fiber. Moreover, biomass as a source of industrial energy may develop enough to add significantly to pressure on land. If that happens more acreage will be brought into cultivation, conservation practices will be made obligatory, and farming techniques will become less capital intensive and more labor intensive.

It is possible that the biggest single transformation of the agricultural economy will arise not from changed techniques in farming but from regional relocation of much of the U. S. economy owing to sharply rising costs of transport. A higher degree of regional self-sufficiency is a genuine possibility.

It is clear that farms will depend somewhat less on industrial inputs and will revert to providing more of their own power, nitrogen, and pest control. The extent of change, or form to be taken, is almost impossible to predict. But to whatever extent this direction is pursued, one casualty will be the luxury of feeding enormous quantities of grain to livestock and poultry.

One generalized outcome will be a reduction in specialization. Less specialization is likely in enterprises among regions. Moreover, individual farms may be less specialized than now, as somewhat more diversification is introduced. Production of more nitrogen on farms (via legumes) is an example of diversification in farm organization and operation.

Agricultural engineers will not be indifferent to future changes in the structure of agriculture. Suggested here is the possibility of cooperative arrangements of farms on a local basis.

I opened these remarks by commenting on the material and the institutional components of our life and shapers of our destiny. I then gave most attention to the material.

But human beings possess volition. To some extent we can choose our destiny. Whether and how well we do so amounts to a test of our collective mettle.

I suppose that I essentially offer my prognoses on the assumption that citizens of our nation and of allied nations will find it possible to deal with common

problems rationally and effectively. Yet there is no certainty that they will do so. Maturing nations encounter more problems than younger ones do. The most burning question of all is whether our citizens can democratically manage their affairs. Our destiny is not foreordained; it is to at least some extent of our own making.