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AGRICULTURE IN THE YEAR 2000:

AN ENERGY PERSPECTIVE

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Agriculture in the Year 2000; An Energy Perspective

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As an exercise in crystal ball gazing there is little that I can do to improve upon the unenviable record of agricultural economists over the last few years. In fact, I am thoroughly convinced that I cannot predict the character of agriculture or the food system in the year 2000. However, some of the relationships that will determine the character of the system can be identified and some important questions can be asked about the forces that will shape the system.

The sprint to the year 2000 is a relatively short time span, already shorter than the post World War II era. My assumptions about this era are as follows: First, I do not see any more technological change taking place between 1977 and 2000 than occurred from 1945 to 1977. This assumption purposely negates any notions that technology will solve our problems. Futurists would claim that this does not allow for enough new technology, but remember that immense changes did occur in the agricultural sector in the 1950's and 1960's. In addition, new technology that substituted other resources for energy would be reversing a long trend.

In terms of energy resources, I assume that we will still be dependent upon the same fossil fuels that we utilize today. Based on the projections of the Workshop on Alternative Energy Strategies (Wilson 1977), oil production will peak around 1990 while natural gas production has already done so. The consumption of oil may be as high or higher than it is today, but the consumption of natural gas is projected to be 15% lower in the year 2000. Fuel prices will increase, but not by as much as many imagine. The price of oil is projected at over $17 a barrel in 1977 dollars. The price of other fuels will be equivalent to this on a heat unit basis, which is critical for the natural gas projections.

Most basic energy applications on the farm and in the food system will be much the same in the year 2000 as they are today. This stems from the particular nature of energy applications in the food system, and from the fact that there are often good reasons why resources are being combined and utilized as they are today.

In 1974, roughly 22% of the energy used in the United States was for the food, fiber and forest product sector. Of this, some 16½% was for the production, processing, marketing and consumption of food and kindred products (FEA, May 1976). This food sector use is as follows:

Direct and Indirect Energy Use in the Food System, 1974

Activity	Percent of total U.S. use
Production	2.9
Processing	4.8
Marketing	1.3
Consumption level preservation and preparation	
In home	4.3
Away from home	2.8
Transportation across the system	2.5[a]
	16.5

It is more helpful to look at the energy use by fuel type in the different sectors and then consider the purpose of use in each case. Utilization by fuel type is as follows (Doering, O., E. Gavett, et al 1977):

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[a]Some of this amount is included in the earlier activities, so the column will sum to more than 16.5.

Current Direct Food Sector Use of Different Fuels

(In trillion BTU)

	Gasoline & Diesel	LP-gas and Natural Gas	Electricity	Coal
Production	945	290	391	1
Processing	130	485	459	80
Marketing	130	145	1,360	--
Home preparation and consumption	---	175	2,550	--
Away from home preparation and consumption	(———— 2,150 ————)			
Transportation	1,175	---	---	--

Most of the gasoline and diesel fuel used in production is for motive power. Fuel oil is used in processing and marketing largely for heat, while transportation requires gasoline and diesel fuel.

Most gas fuels are used on an indirect basis in production for petro-chemicals, primarily nitrogen fertilizer. The direct use given here is for grain drying, flue curing tobacco, and space heating. The gas used in processing is for heat applications, while most used in marketing is for space heating or cooling. In home preparation it is used for cooking, and away from home for cooking, space heating and cooling.

Most of the electricity used in agricultural production is for motor power and the remainder is for heating and cooling applications. That used in processing is for both heating and cooling applications. Large amounts are used in marketing to keep foods refrigerated or frozen. The electricity used in the preparation and consumption of food is for cooking, refrigeration, and space heating or cooling.

Finally, the coal is used for heat in food processing.

While this gives an indication of the specific uses by fuel type within segments of the food sector today, there are reasons for the application of energy to the food system in each case that provide us with a better basis for judging future use in conjunction with the specific knowledge about current use. Energy has been applied to agriculture in increasing amounts for the following general reasons: 1. to replace human and animal labor, 2. to increase production, 3. to lessen risk, and 4. to enhance or change product form or quality.

Given a specific reason for the application of energy in a segment of the food system, what would cause substantial change in this use between now and the year 2000? One such cause would be a change in the relative price of energy, energy substituting inputs and final products. Strangely enough, the new cadre of energy economists has tended to ignore the relative price issue, yet it is relative prices that drive or negate resource substitution. We hear that doubled gasoline prices have not reduced consumption, without being told that the price of gasoline, relative to other goods, has increased much less. In a number of cases, relative energy prices in the food system have remained much the same as in the 1960's. The operative question is; how much different will things be in 2000, in the aggregate and by regions?

Another cause of substantial change in energy use in the food system would be shortages of energy in the form, time and place it is needed. The threat of a fuel shortage, given the attendant risk of spoilage that pervades the food system, might well induce fuel switching, conservation, storage or changes in technology when relative prices would not.

How do these two factors relate to the basic reasons for applying energy to the food system as we do today? Energy has been substituted for human and animal labor throughout the food system, not only because of the direct comparative costs, but also because of the increased scale of operation possible for a given management input. Current Midwestern crop budgets allow $7 to $10 an acre for all fuels and oils, including drying fuel, for an acre of corn. At the same time land charges are $70 to $100 an acre. Given the sunk cost in machinery, the variable energy cost for motive power has been relatively minor in comparison to the cost of land and other inputs, especially with the advantages in systems, materials handling and management scale that have been gained.

Fuel scarcities are more likely to be the major motivating force for moving away from the direct use of fossil fuels for motive power. However, in the short and intermediate term this might well lead to investment in storage facilities rather than to the substitution of human or draft labor for fossil fuels. While the use of fossil fuels for motive power should continue to the year 2000, systems and equipment will be modified to improve energy efficiency in response to relative price increases or availability problems for fossil fuels.

It is likely that fossil fuels will continue to be used to lessen risk in production, processing, marketing and home preservation. In each segment of the food system, decisionmakers consider only their own energy cost against the total value of the product. Within each segment the value of the total energy input is a relatively small proportion of the value of the product, as is illustrated following:

Value of the Direct Energy Input Compared with the Value of Product

Stage of use	Value of product	Value of energy input	Energy input as a percentage of product
	---(Billion dollars)---		
Production	90.8	4.5	5
Processing	151.7	1.4	1
Marketing	144	4.7	3
Home preparation	145.3	10.3	7
Away from home	67	8.1	12

New systems that use less energy or renewable energy but result in increased risk have a severe hurdle to overcome for adoption.

We may see intermediate term changes in the type of energy that is used for this purpose. Natural gas is widely used in food preservation and processing. The equalization of the price of natural gas with that of other fuels as well as problems of availability will encourage a shift to other fuels. For example: crop drying should remain economic as a practice in comparison with field dry down and/or shorter season varieties (Peart and Doering 1976). However, the gasification of corn cobs at the farm to provide a low Btu gas for drying can be economically feasible with a doubling of LP-gas prices. (O'Hare 1977). The basic preservation and risk averting systems will stay much the same while switching between fossil fuels and the introduction of some renewable fuels occurs to allow tested practices to continue.

More change should occur in the energy used to increase production, but this would depend on changes in the relative price of production enhancing energy inputs as compared with substitute resources and final product prices. Thirty-one percent of the energy used in agricultural production is in the form of nitrogen fertilizer and 13% is for irrigation fuel.

Changes in production energy use are likely to be greatest in these two areas of indirect and direct use.

The price and availability of natural gas will be the critical factor. A current average crude oil price of $1.50 per million Btu's would more than double to $3.13 per million Btu's for oil at $17.50 a barrel in the year 2000. An equalized wellhead price for natural gas would be slightly over $3.00 per thousand cubic feet (MCF). This should not shock those intrastate markets that are currently at $2.00 or more per MCF. However, half the intrastate market in Louisiana is contracted at 25¢ or lower. Assuming natural gas at 50¢ an MCF, only $19 would be spend directly on gas in the manufacture of a ton of anhydrous ammonia. This would increase to $114 with gas at $3.00. Given anhydrous at $180 a ton in the Corn Belt, there is a potential cost increase of $95 to a price of $275 if this cost were passed through directly. However, the price of fertilizer has tended to be market-determined rather than cost-determined. Farmers paid over $400 a ton for marginal increments of anhydrous a few years ago for use on $3.00 corn. While there are conflicting views (Klepper, R., et al 1977), large amounts of chemical nitrogen should continue to be used unless the relative price of commodities and land declined substantially between now and the year 2000 (Doering, O., et al 1977).

Pump irrigation fueled by natural gas faces a proportionally more severe increase in costs. Where current gas costs might be 50¢ or less per MCF, the six-fold increase to $3.00 appears unsustainable in the light of current crop values and declining water tables (Skold 1977). We can certainly expect to see a change in the amount of water used, and in the extent and location of irrigated agriculture.

The greatest prospect for change exists for the energy used to enhance or change product form or quality. In the past, much of the energy that has been used for this purpose has been based on consumer preference. Given the wide range of energy requirements for different foods or different versions of the same food (Whittlesey and Lee 1976), there is potential for great flexibility in energy use while still maintaining basic nutritional requirements. As an example, beef production can vary in the intensity of its fossil fuel energy requirement from 1.9 Btu's of energy input per Btu of food value of retail beef to 13.4 Btu's of input per Btu of food output (Ward, G., et al 1976). The change in product form takes place at various points in the food system, and sometimes extra energy expended at one locale may be saved at another. Thus, any analysis must be on a total food system basis.

So far, this view of the food system in the year 2000 may not have been sufficiently alarmist to be the product of a true believer in the energy dilemma. However, changes in the food system over the next two decades can still be modest even in the face of important changes in resource availability. It is worth reviewing some of the forces that will have impact on the whole economic system as well as the food system.

1. The physical geology of the energy dilemma is real. There is only a fixed amount of fossil fuel resources in the earth's crust. The fact that we may be able to keep going for another 25 years at current consumption levels, with a mere doubling of real oil prices and a tripling or more of real gas prices, only indicates that more severe adjustments will be necessary after the year 2000.

2. The U.S. is becoming increasingly vulnerable to the interruption of its petroleum supplies. During the Arab oil embargo we were importing a bit more than a third of our oil; we are now importing more than half of our oil.

3. We are in a nation and in a world of growing populations. The energy projections utilized here have the U.S. consuming about the same amount of oil and less natural gas in the year 2000. This implies that more people will be consuming less on a per capita basis.

4. Finally, given the very real equity and windfall profit issues, the urge to bypass the price mechanism will make government allocation and price regulation the crucial factor in the adjustments to scarce fossil fuel resources that will take place over the next 25 years. The potential for contradictory and counter-productive activities is tremendous. Using agricultural production as an example, Secretary Bergland has urged the agricultural research and extension establishment to devote its efforts towards perfecting and disseminating more energy efficient agricultural systems. At the same time, many officials appear to want to exempt agriculture from the energy price increases that could be expected under the President's energy plan in order to hold down food prices. This is completely contradictory! If agriculture is guaranteed the energy it needs at current prices there is little incentive for technological development or adoption. In addition, if the agricultural sector is effectively shielded from energy price increases and shortages, it will be a technological dinosaur by the time the rest of the economy finally insists that it rejoins the real world.

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