ENERGY POLICY ISSUES FOR AGRICULTURE

Otto C. Doering III
Assistant Professor of Agricultural Economics
Purdue University

We are ultimately facing a *real* energy crisis. In 1963 the demand for energy in the United States was the equivalent of approximately 23 million barrels of oil per day. About half of this was actually supplied by oil, and the rest by coal, natural gas, and hydropower. By 1973 this demand had jumped to the equivalent of 36 million barrels per day (MBPD), and for 1985 the estimates of demand range from roughly 53 to 67 MBPD.

How might this demand be met from the different sources of energy available in 1985? New sources, such as solar, geothermal, breeder reactors, and fusion, might well supply as much as 1 MBPD of oil equivalent energy. Domestic crude oil production, which has been declining since 1970, was about 10 MBPD last year. With the introduction of Alaskan crude we might be able to hold production at that level between now and 1985. We will be even more fortunate if we can continue to equal last year's production of 11 MBPD equivalent until 1985. If we could double our coal production by 1985, this would contribute the equivalent of 13 MBPD. An optimistic projection of nuclear generator capacity would be the production of the equivalent of 10 MBPD, while hydropower may increase slightly to 2 MBPD. Adding all of these energy sources for 1985 gives an optimistic total of 46 MBPD oil equivalent compared with a conservatively estimated demand of 60 MBPD. The shortfall of 14 MBPD, or whatever it turns out to be, can be overcome in only two ways: conservation or increased imports of petroleum and natural gas. This is the broader national dilemma we face between now and 1985.

Last winter many sectors of the economy suffered from shortages of petroleum products and derivatives. While these shortages appeared to be a result of the Arab oil embargo, we must first realize that shortages have different dimensions. Material shortages at the source of supply usually begin the process, but all resulting shortages are not necessarily of the same dimension as the initial one. Let me distinguish between shortages due to place and time and shortages resulting from errors in product mix.

Shortages due to place and time were felt by tobacco growers in

North Carolina last year when they experienced difficulty in getting LP-gas. Summer breakdowns and the required repairs in the pipeline serving that area resulted in insufficient stockpiling of LP-gas for curing needs as well as flow restrictions. As another example, the state of Indiana learned that even though additional LP-gas supplies were available in the Gulf Coast in July and August for fall corn drying, pipeline capacity was essentially booked until midwinter. Any measure to force the delivery of LP-gas in time for harvest would only result in other needed fuels being removed from the pipeline and cause other shortages.

Our product mix dilemma was also well illustrated this past winter. The oil industry was ordered by the federal government to produce as high a proportion of heating oil as possible. This was to the detriment of gasoline production. A much milder than average winter plus a concerted conservation effort resulted in substantial excess supplies of the middle distillate fuels. Thus, long gasoline lines and short tempers were as much the result of faulty product mix as the basic crude oil shortage. I hope these experiences taught us something about the complexity of shortages.

If nothing else, agriculture and other sectors of the economy learned that energy flow in the economy is far more interdependent than we had thought. While those of us in the agricultural sector will want to focus there, we must recognize that its interdependence with the rest of the economy precludes any independent solutions. Currently, the agricultural production process accounts for only some 3 percent of national energy use. The total food and fiber system, including the provision of inputs and the delivery of products, accounts for approximately 12 percent of national energy use. In addition, from an engineering standpoint, and because of the plural nature of our political process, there can be no separate and distinct energy policy for agriculture.

CHARACTERISTICS OF THE AGRICULTURAL SECTOR

Energy-saving technologies are tempting. However, we should first remind ourselves that there are very good biological, engineering, and economic reasons why we are doing what we are today. The dramatic increases in productivity and absolute production in the last two decades have depended upon abundant and relatively inexpensive supplies of energy. This energy has allowed the substitution of machines for manpower and made possible the use of superior seed stock requiring increasing amounts of fertilizer and chemicals for weed and insect control. Energy has been a key ingredient in what we have termed the agricultural adjustment process.

Several recent attempts have been made to compare the amount of energy used in agriculture with agriculture's performance as an energy producer. The one most quoted is an article in *Science* by Pimentel, Hurd, and several others from Cornell. They concluded that for corn production the ratio of energy produced to energy consumed deteriorated slightly from 1954 to 1970. Gerald Isaacs, Professor of Agricultural Engineering at Purdue, disagrees with a few of their assumptions and has reworked their accounting as follows:

ENERGY FOR CORN PRODUCTION IN KILOCALORIES PER ACRE

	1954	1970
Nitrogen	227	941
Drying	60	200
Machinery	300	420
Fuel	340	340
Fertilizer, chemicals, seed	92	200
Transportation	45	70
Irrigation	27	34
Labor	9	5
Total input	1,100	2,210
Total output	4,133 (41*)	8,165 (81*)
Output/input	3.7	3.7

*Corn yield in bushels per acre.

The initial reaction to an energy output-input ratio of 3.7 might be discouragement. We appear to be standing still. A portion of the scientific community believes that policy measures must be based on the goal of improving this ratio in agriculture and in other sectors of the economy. But many persons do not fully realize the trade-offs involved when measures are adopted for the sole purpose of improving the energy output-input ratio. The basic question is, how much can we decide solely on the basis of calories? Granted, we have not improved our caloric ratio in corn production; but we are producing twice as much of a better quality product with a smaller labor force, and this certainly has resulted in some net economic and social benefits.

Agriculture is very susceptible to large fluctuations in absolute fuel usage and in the timing of usage. There are clearly defined optimal planting periods for the best yields and similar time constraints at harvest time. One wet snow storm can increase field losses by 5 to 10 percent. Farmers have made a substantial investment in big machine technology in order to get the crop in and out on time. This timeliness can have immense economic value.

The "lumpy flow" characteristic of farm fuel needs is an added problem for fuel transportation, marketing, and storage on the farm. Many spot shortages are shortages of transportation as much as or more than they are shortages of material. Fuel demands peak in the spring and fall for crop work and are relatively low for the balance of the year. The need, then, is for a delivery system that can sustain the heavy fuel demands either by timely high-volume delivery or through increased on-farm storage. Since there are some fuel quality problems with storage over long periods of time for both diesel and gasoline fuels, some combination of these two approaches will be necessary on most farms.

The present distribution system is severely strained by lumpy agricultural demand at a time of fuel shortages. The dispersion of agricultural production units makes government guarantees of 100 percent of the fuel needed for production almost impossible to enforce. Unless local dealers were willing to restrict their sales to other customers in advance of any anticipated lumpy demand by agriculture there was little prospect of assured fuel supplies for spring plowing, barring termination of the Arab oil embargo and a wet spring. Few states established the procedures that a farmer could follow to obtain emergency fuel supplies if his dealer was unable to supply him during the planting period.

Ultimately the farmer is competing directly with residential and other users in rural areas for local supplies of gasoline, diesel, or LP-gas. Fortunately, last winter many homeowners did lower their thermostats or otherwise increase the efficiency of their household unit. One sample of over 300 households in central Indiana increased their efficiency in the use of LP-gas for home heating by 14 percent *after* allowing for the milder winter. On a statewide basis such a saving would supply more than a third of the total LP-gas needed by agriculture in Indiana.

POLICIES TO COPE WITH FUEL SCARCITY

Rationing is not a very attractive alternative for fuel allocation under conditions of scarcity. The bureaucratic dimensions are immense. Effective rationing requires a better knowledge of the operation of each producing and consuming sector than any single group of academics or bureaucrats appear to have today. Another probable cost of rationing is the lowering of public morale. Most people believe themselves to be more deserving than many others. Those with money or some other source of power often are able to subvert the system to get what they feel they deserve. Apparently rationing is only "democratic" if brutally and undemocratically enforced.

I believe that we can continue to utilize prices to allocate increasingly scarce fuel resources, though I must admit to a personal desire to tinker with these prices. The effects of energy pricing on the economic well-being of one or more groups of consumers is not our only concern. We know that price can play a role in encouraging the development of existing fuels and their alternatives. It can also serve as a powerful incentive for the wise use and conservation of energy. Thus, we face two distinct but related issues, namely: (1) how to ensure the development and wise use of energy (a resource allocation and conservation problem) and (2) how to enhance the economic well-being of the lower-income and fixed-income segments of our population (a welfare problem).

These two issues can seldom be met by the same device. Yet, the prices we faced this past winter, and still face today, have tempted us to try. It is worthwhile examining some of the relative price changes we have recently experienced in our basic fuels at the consumer level.

COST FOR 100,000 BTU OF HEAT OUTPUT IN INDIANA

	February 1, 1973	February 1, 1974
	Cents	*Cents*
Electric heat	39	39
LP-gas	26	50
Fuel oil	18	31
Natural gas	12.6	13.3

LP-gas prices doubled nationally as well as in Indiana. This resulted in strong pressure to roll back the price of LP-gas so that it would be acceptable for low-income and fixed-income needs. I would argue subjectively that families, farms, and businesses in the middle-income or upper-income categories are now the large fuel users and will continue to be so. In absolute terms they are not only hurt more by high fuel prices but also would benefit most from a rollback of fuel prices. But rolling back fuel prices would discourage the development of new fossil fuel deposits and alternative fuels such as shale oil. Lower fuel prices would also inhibit the adoption of energy-saving technologies. These represent a step beyond conservation under existing technology. They are essential for any substantial improvement in the energy input needed for a desired level and composition of output in any sector of the economy.

There is a strong temptation at the moment to adopt such piecemeal solutions. One aspect of the problem is relieved, but others may even be aggravated. I think we may soon have to consider letting the price of petroleum and other energy sources seek a level which reflects their current and future costs of development and production. Existing regulations on the pricing of "new" and "old" petroleum and natural gas are intended to have this effect.

Admittedly, I am more than uneasy about the substantial windfall profits that would accrue to monopoly holders of existing energy sources. A whole new group of Texas millionaires was created by last year's LP-gas shortage. Yet, allowing them to take their cut by removing the price freeze was the only expeditious way to resume the flow of LP-gas through traditional marketing channels. Market concentration will confound pricing solutions.

We can attempt to legislate conservation and technological change. However, a very real problem is ignorance of the affected industry or sector on the part of legislators. Price changes can induce conservation and technological change, but severe and abrupt price changes also cause dislocations like those we have recently experienced. The advantage of the price mechanism is that energy use will tend to stabilize for all particular products or processes in relation to the direct and embodied energy use at that technology and price. The fine tuning and enforcement of government regulations to accomplish such a proportional application of conservation and technological requirements is virtually impossible.

Most of us who are concerned about the implications of high fuel prices on certain groups must realize that price rollbacks are not the only alternative. One solution would be to consider some form of income assistance to compensate for the higher fuel costs to the low-income and fixed-income families who cannot afford the increase in prices. This might take the form of "fuel stamps," increased social security or unemployment benefits, income tax relief, or even the adoption of some form of minimum income subsidy. Wisely executed, this should be less costly than the subsidization of our entire fuel economy by holding the price down.

THE POTENTIAL AGRICULTURAL ADJUSTMENTS

The expenditure for direct fuel use in 1972 for corn farmers in Indiana was $4.60 per tillable acre compared with an overall cash expenditure of $103.00 per tillable acre. Thus, only 4.5 percent of the farmer's average cash expenditure was for the direct use of fuel in the production process. This proportion drops to 3 percent for dairy farmers and increases to 4.7 percent for hog farmers. The point is that direct fuel costs are not an overwhelming proportion of per acre expenditure, and we cannot expect the farming operation to be turned upon its head to attempt to reduce this expenditure even at the current high level of energy prices.

We can illustrate this last point by looking at some of the alternative technologies that have been suggested for agriculture. Newspapers this last winter showed pictures of an English farmer's automobile powered by methane from pig manure. Within a short time journalists envisioned a world energized in this fashion, and land-grant institutions began to receive inquiries about the design and operation of the appropriate equipment. But "pig power" has a way to go before it becomes an economically viable alternative. On a daily basis 360 hogs of a 150 pound minimum weight would be needed to produce somewhere between \$1.00 and \$2.00 worth of methane gas. The investment in equipment and labor necessary for handling the required volume of manure is substantial. The process is also very temperature sensitive. Winter operation may well require up to half of the gas production to keep the process warm.

Minimum tillage was suggested by many people when it appeared that the agricultural sector would face serious fuel problems. But, again, there are good reasons why we are following present tillage systems. Traditional tillage methods are preferable on certain soil types, so we are not talking about a change that would be optimum universally. Tillage studies carried out for a number of years at Purdue indicate that there is a possible 3 gallons per acre reduction (out of a total of 6 to 8 gallons per acre) in fuel requirements between the heaviest and lightest tillage practices. However, as total petrochemical requirements are not too different between the two systems, minimum tillage might only relieve a product mix problem, such as when sufficient chemicals are available but not enough engine fuel. While reductions in tillage can save some fuel, a drastic shift in technique would not be possible on an emergency basis as it involves virtually a complete change in field equipment, operator skills, and input supplies. Moreover, with minimum tillage practices, any mistakes that are made may be more serious than with conventional tillage.

Grain drying is another area where many have proposed rapid shifts in technology. One Midwestern congressman suggested putting all the corn back in cribs where it used to be. This ignored a revolution that had already occurred in the handling and marketing of grain. While some agricultural engineers have encouraged slow-speed batch drying for a number of years, there are definite advantages to the high-speed drying systems commonly utilized in the Corn Belt today. Finally, anyone who attempted to equip himself for low-heat electric drying last year now knows that equipment cannot be changed overnight. It was no time at all before the existing suppliers of electric heating elements were back ordered through the coming year.

The alternative of switching from high-speed gas drying to low-speed electric drying raises two other important issues. First, the shift may only result in shortages for the new fuel if enough people act "rationally" and make such a switch. Can we really guarantee that a farmer who scraps his capital investment in high-speed drying and re-equips for slow-speed electric drying will be immune from brown-outs or other electricity shortages in the years to come? Second, capital stock for the production and the delivery of the old fuel might be idled while new capital stock is suddenly demanded for the production and the delivery of the new fuel now facing increased or excess demand.

Clearly, there are no easy or quick technological alternatives which will solve energy shortages in agriculture. Fortunately, some of our technical innovations developed years ago for different reasons are now proving useful because they happen to be more efficient with energy. Dry aeration is one of these. It was originally developed to improve grain quality. It utilizes current high-speed drying equipment, though some additional handling and storage capacity is required. Under proper management fuel savings of 20 to 40 percent can be achieved over existing high-speed drying systems. This is one viable technology alternative available today.

The relative prices of fuels must be an important concern for agriculture. I would argue that natural gas was priced well below its comparative utility even before the recent shift in energy prices. At current prices for petroleum products and coal, the pricing of natural gas is a national disaster. We might even want to overprice natural gas in comparison with its historic relative cost in order to reserve it for certain applications where its special characteristics make it almost uniquely suitable. If natural gas users enjoy energy at half price, we cannot expect them to be as concerned with conservation or as eager to utilize new energy technology as those who are paying twice as much per unit of heat energy.

Almost half the energy used on the farm is in the form of nitrogen fertilizer, and most of this comes from natural gas. Other technologies for fixing nitrogen are substantially more expensive and our existing plant capacity is geared to production from natural gas feedstocks. Our current production of 21 trillion cubic feet of natural gas annually is expected to drop to 19 trillion by 1985 according to the Federal Power Commission. Would we want a certain amount of natural gas reserved in some way for fertilizer production? The lack of conscious decisions may result in our using high-value, scarce resources under conditions which continue to signal users that these resources are low-value and plentiful. This is a luxury that our society cannot afford today.

SUMMARY

Where do we stand then; and what do I think we can and must do to survive?

1. We must recognize the long-term energy shortages that we are going to face over the next decade or so. Conversely, if the energy shortages are not real (and half the citizenry believes they are not), then it is imperative that this fact be established.

2. Those in agriculture must realize that there can be no separate energy policy for agriculture.

3. The capacity to identify and analyze shortages must be developed. Some aspects of shortages are within our control and can be ameliorated. We must begin to work in these areas.

4. Some decision must be made with respect to which measures of energy efficiency we believe are most appropriate for guiding energy policy relating to agriculture. The exclusive use of caloric output-input ratios is both insufficient and misleading. A much broader range of criteria needs to be established before a narrow accounting system is foisted upon us.

5. Rationing and pricing issues must be recognized as complex. Most policy measures have both primary and secondary effects. We must not be tempted to act, without further investigation, when one primary effect appears to relieve the symptoms of a narrowly conceived crisis.

6. Agricultural producers cannot be expected to adopt new practices that would be costly or risky given their relatively small expenditure on direct fuel requirements. The economic incentive to change may not exist.

7. Technological alternatives which will easily or quickly solve energy problems in agriculture are not now available. Technological change is a slow process that requires incentives and other favorable pre-conditions.

8. Agricultural producers must be concerned with alternative uses for different fuels. Whether through pricing or regulation,

there is a need to direct some fuels toward certain uses and away from other uses that could be served by a more plentiful fuel, or one that has substitutes.

Finally, when we are called upon to cope with the seemingly insoluble problems, whether food shortages, inflation, or energy shortages, we should try to maintain a sense of historical perspective and a sense of humor.