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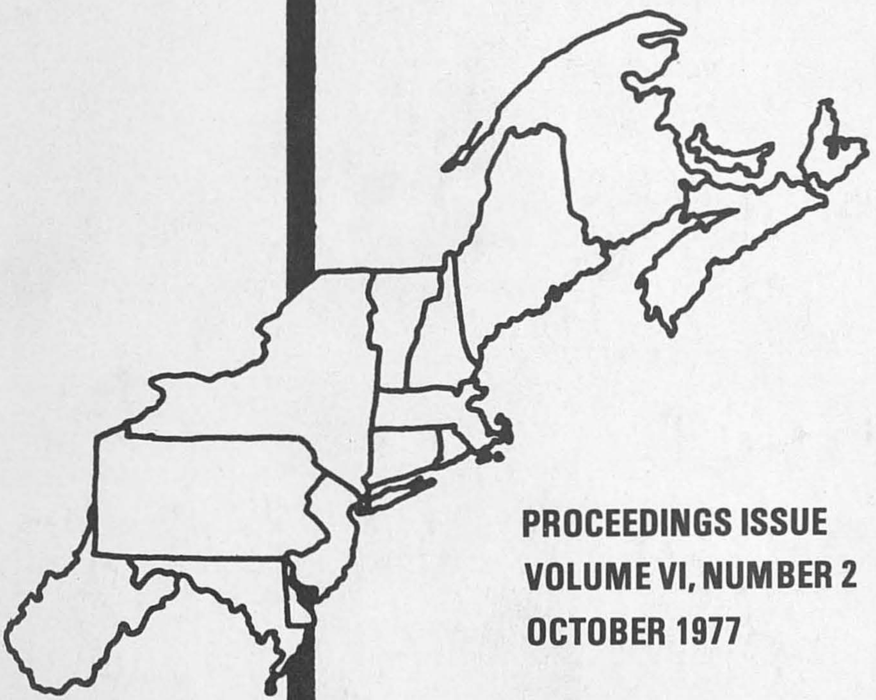

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ENERGY PROBLEMS, CONSERVATION, AND EXTENSION/RESEARCH NEEDS FOR NORTHEASTERN AGRICULTURE

George B. Rogers[1/]
Agricultural Economist
Commodity Economics Division, Economic Research Service, USDA
Washington, D.C.

George E. Frick
Agricultural Economist
Commodity Economics Division, Economic Research Service, USDA
University of New Hampshire

The purposes of this paper are: (1) to outline some of the reasons for the energy problem and to discuss current philosophies for solving it, (2) to evaluate energy use in Northeastern agriculture, particularly in production, (3) to suggest some possibilities for conserving energy, and (4) to delineate some areas for future extension and research activities.

The record on constructive response to the energy problem has not been at all good. But it may be no worse than that on other matters. There are some hopeful signs that action nationally and in agriculture is finally gaining momentum.

The Energy Problem - Issues and Solutions

The ultimate, if often revised and still debateable, limits on United States supplies of oil and natural gas have long been recognized by many who have followed these industries. Finite limits on these fuels, coupled with increasing demand, price imbalances, and waste of cheap energy are the root of our energy problem. In the future, limits on world supplies of oil and gas will become more relevant.

Innumerable studies over many years of energy technology, supply, prices, and demand, and policy options do not seem to have attracted much public interest [1, 7, 8, 9, 15]. Public awareness seems only to rise with every short-run crisis. Project Independence, calling for self-sufficiency by 1980, did not attract very widespread interest when announced and followed by a task force report in 1973 [22]. The energy crisis of 1973-74 did attract some public attention, however briefly,

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1/ The views expressed are those of the authors and do not necessarily represent those of the Department of Agriculture.

but a return to normal supplies was quickly followed by a return to consumption and politics as usual. Memories of the winter of 1976-77 are still vivid and, perhaps, will persist longer in the public mind.

Recurring short-run crises are not a good impetus, but may have to be a sufficient one for arousing public support. Every crisis seems to produce a few more converts, including some from the economic research community and from every interest group and political persuasion. A broad spectrum of ideas, solutions, and "studies" emerges, often ranging from the biased to the ridiculous. There is as much danger of some of these extremes appearing in legislative goals and policy decisions as there was when environmental, safety, health, and other matters obtained general recognition. The agricultural economics profession along with other groups must, once again, share the blame--through default--if this happens. However, the energy problem will be around a long time and effective, if sometimes remedial, work can still be done.

Much, if not enough, good work has been done in agriculture and elsewhere on energy. But the tasks that remain are immense, urgent, and challenging. They encompass the pragmatic and imaginative, the micro and the macro. The energy problem has been surrounded by mountains of rhetoric and offered solutions are often based on too few facts. Thus, the starting point for energy conservation and other phases of an energy program remains finding out how and why we now use energy, including the various levels of efficiency. Despite much rhetoric to the contrary, a considerable amount of work on measurement and conservation has been done (see, for example, [2, 3, 5, 16, 19, 20, 21, 23, 24, 25]). But such work is uneven and not complete enough. Funding and people for energy research on agriculture through the Federal-State system remain inadequate, despite the existence of research plans like that developed by an ARPAC task force [17].

Moreover, few proposed policies have been examined in enough depth to know their real impacts on target groups, prices, or supplies. In a situation where we lack so much information, some caution is indicated before imposing simple and general measures. But at the same time, it would be unwise to push the taking of positive measures continually into the future.

Consider for a moment energy prices. Lest there is a temptation to argue for simple supply-demand solutions in a perfect market setting, it should not be forgotten that energy industries are competitively highly imperfect and that prices are administered (publicly or privately). To what extent are costs plus a reasonable rate of return adhered to, is there much concealed information about real supplies, or does a short-run scarcity psychology play a major role in running up prices before they reach the consumer?

Moreover, resort to the pricing system ("deregulation" and otherwise) seems to have largely failed to curtail energy use--within the price ranges used to date. Will still higher prices do this without producing a vast array of bad side effects? Much of the reluctance to shift may be cost-related. Much may be due to the values users place on convenience in use, even to the point of suffering with temporary inconveniences. Much may be due to adherence to accepted work and life styles. Much may be due to a current lack of viable options. And much may be due--as in agriculture--to energy costs not accounting for a sizeable fraction of total costs. Should energy prices be "classified" according to particular conditions? Should they be used as a tool to produce revenue to fund changeover subsidies, incentives, or research, or is financing from general sources preferable?

Periodically, and ultimately, quantity allocation may displace purely pricing tools as the main focus of attention. This spawns various sets of priorities. During the winter of 1973-74 we rationed motor fuels according to the amount of inconvenience drivers were willing to tolerate. Rationing by the number of drivers or vehicles might be an improvement, but might affect employment unless commuters received special consideration.

Agricultural producers long assumed that they would receive 100 percent of actual energy needs. Other claimants are more numerous and more vocal! Also, severe curtailments of supply could still further offset this assumed preferential position and unless transportation groups were adequately supplied disruptions of market flow could result. Similarly, agricultural producers expected 100 percent of actual needs of heating fuels (based on "normal" weather). So did households. Last winter these priorities were reordered and even impacted heavily on "essential services," such as education, and on manufacturing. Energy conservation emerged from the shadows once again as a necessary part of energy policy.

Indeed, energy conservation promises to be one of the most tangible things in a morass of undecided political and individual issues. Conservation is a rallying point for both short and longer-range efforts. It has a place in moderating rising prices of current energy forms and in stretching more limited quantities over sustained output. Quite a few things can be done in a "business as usual" scenario. They involve attention to details and modest investments in supplies and equipment with few changes in locations, sizes, inputs, practices, and markets. In the longer-run, with conservation a better established habit, many parameters may be changed without the severe impacts they would bring in the short-run. But it is inconceivable that parameter changes be drastic enough to return American agriculture to hand labor and draft animals (see [13] and [14] for rational explanations of why we should not and cannot!).

Energy conservation has both a domestic and a foreign dimension. Judicious use of domestic supplies is joined by the balance of payments problem and our vulnerability in depending on foreign sources. Energy conservation has not been an easy concept to sell. Patriotic appeals, by themselves - unless in a period of crisis - did not evoke general and sustained response. Voluntary guidelines may elicit a varied response, particularly if overly-generalized and not reflective of real potentials. Conservation may have to be demonstrated and underwritten to accelerate progress.

Current Energy Use

The Northeast lies about at the end of the Nation's energy pipeline, and has, as yet, no new North Sea-type discoveries such as those that might make Great Britain and Norway self-sufficient for some years. Hence, the Northeast has as much stake in energy conservation as anyone. Climatic and weather conditions also result in higher rates of use for heating and sharper seasonal peaks for field operation needs.

With about 4.5 percent of the total Btu's used nationwide in agricultural production, the Northeast uses a larger share of the gasoline, a lower share of the diesel fuel, a much larger share of the coal, around average shares of fuel oil, L.P. gas, and electricity, but a much smaller share of natural gas (Table 1). One could infer from these comparisons that diesel use should increase, that natural gas shortages will impact less in total, or that the Northeast is ahead on using coal - except that very little is now being used anywhere. Table 2 shows the 1974 use and expenditures for the U.S. for various forms of energy.

Compared with the Nation as a whole, the Northeast uses a smaller share of production energy on crops than on livestock, reflecting both higher rates of use on livestock due to climate and less emphasis on many crops. Hay, corn, milk cows, small grains and corn silage are the five leading energy users in the Northeast. Nationally, corn, small grains, hay, cotton, and soybeans are the top five. Table 3 shows the relative uses of energy by the Northeast and nationwide.

Although the data source cited relates to energy use in agricultural production, an adequate perspective requires mention of some additional topics. Nationally, it is estimated that energy used in processing, distribution, and preparation of food accounts for an additional 13 percent of the Nation's energy [10]. Not only are the quantities of energy 4 times larger than use in production, but the rates of savings through conservation efforts may even be larger than in production. FEA has already had some contract studies made for developing conservation goals for agricultural processing industries by SIC codes. But it is crucial to the continued efficient operation of the food and fiber system to maintain energy availability in transportation and processing. This is especially so with perishable and seasonal commodities like fruits and vegetables, and those which are produced in continuous flow systems like milk, eggs, and broilers.

Because livestock production requires large quantities of direct energy as well as large quantities of crops as inputs, one extreme

Table 1
Energy Use in Agricultural Production, By Type, Northeast and United States, 1974[a]

	12 Northeastern States			U. S.	Northeast
	Crops	Livestock	Total	Total	as % of U.S.
Gasoline (1,000 gal.)	176,623	59,484	236,107	3,698,641	6.38
Diesel (1,000 gal.)	91,099	8,105	99,204	2,638,955	3.76
Fuel oil (1,000 gal.)	7,756	5,525	13,281	303,624	4.37
L. P. (1,000 gal.)	26,513	35,621	62,134	1,481,542	4.19
Natural gas (mil. cu. ft.)	531	291	822	164,124	.50
Coal (tons)	---	6,523	6,523	32,725	19.93
Electricity (mil, KWh)	97	1,408	1,505	32,088	4.69
Btu's[b] (billion)	73,250	18,001	91,251	2,014,228	4.53

a/ Source: Compiled from [12].

b/ Includes energy embodied in major inputs.

Table 2
Use and Expenditures for Energy in Agricultural Production, United States, 1974[a/]

Type of energy	Volume Used	Dollar cost (million)	Percents of dollar cost
Gasoline	3.7 bil. gal.	$1,870	44.08
Diesel	2.6 bil. gal.	950	22.39
Natural gas	164 bil. cu. ft.	100	2.36
L. P. gas	1.5 bil. gal.	450	10.61
Electricity	32 bil. KWh.	830	19.57
Fuel oil	304 mil. gal.	40	.94
Coal	33,000 tons	2	.05
Total	1.3 quadr. Btu	4,242	100.00
Chemicals	0.7 quadr. Btu	---	---

a/ Source: Compiled from [12].

Table 3
Relative Importance of Energy Use in Agricultural Production by Commodity, Northeast and United States, 1974[a/]

	12 Northeastern States		United States		Northeast
	Btu's (billion)	% of Total	Btu's (billion)	% of Total	as % of U.S.
Hay	21,523	23.58	200,943	9.98	10.58
Corn	15,329	16.80	600,655[c/]	29.82	2.55
Small grains	8,921	9.78	313,709	15.57	2.84
Corn Silage	8,411	9.22	82,306[d/]	4.09	10.22
Fruit	6,162	6.75	96,567	4.79	6.38
Processing vegetables	3,812	4.18	26,394	1.31	14.44
Potatoes	2,665	2.92	28,578	1.42	9.33
Fresh vegetables	2,317	2.54	23,109	1.15	10.03
Soybeans	1,955	2.14	126,875	6.30	1.54
Tobacco	1,032	1.13	44,341	2.20	2.33
Unspecified[b/]	1,123	1.23	246,447	12.23	.46
Total crops	73,250	80.27	1,789,927	88.86	4.09
Milk cows	9,569	10.49	51,981	2.58	18.41
Broilers	3,316	3.63	19,974	.99	16.60
Hens, pullets	1,932	2.12	11,785	.59	16.39
Beef	1,784	1.95	91,681	4.55	1.95
Hogs	585	.64	37,149	1.85	1.57
Misc. poultry	397	.44	854	.04	46.49
Turkeys	229	.25	7,174	.36	3.19
Sheep, lamb	189	.21	3,703	.18	5.10
Total livestock	18,001	19.73	224,301	11.14	8.03
Total production	91,251	100.00	2,014,228	100.00	4.53

a/ Source: Compiled from [12]. Includes energy embodied in major inputs.
b/ For the Northeast, unspecified crops and unspecified irrigation. For the U.S. also includes other major crops such as cotton, beet and cane sugar, peanuts, dried beans and peas, flaxseed, sweet potatoes.
c/ Includes grain sorghum.
d/ Includes sorghum silage.

energy-saving position is to shift crops to human consumption directly. But this glosses over dietary preferences, the unsuitability of some crop output for human use or some land for cropping, or the use of wastes by livestock as against other disposal options.

Recent work at New Hampshire [4] has suggested concentrate feeds could be reformulated to minimize embodied energy, but at some increase in costs since many ingredient prices are not proportionate to embodied energy. Another option is to save long-distance transportation energy through more local production of concentrate-producing commodities, or to upgrade forage inputs to reduce concentrate needs.

Short-run Energy Conservation

The choice of agricultural production as the focus of the first complete set of conservation guides [6] has its unfortunate dimensions. Much rhetoric and innumerable "studies" have cast agricultural production in the role of "energy waster," largely ignoring the fact that only 3 percent of the Nation's energy is involved. It is easy (and naive) to criticize agricultural production as being too energy intensive. Some wishful thinkers call for the return of the "good old days" - of draft animals and hand labor, or for full organic farming, or area sulf-sufficiency. These calls discount much else: yields, area characteristics, levels of living, production costs, exports, and the decline of the work ethic. Agriculturalists, thus, have much educational and political work to do, both defensively and offensively.

The bright side of the choice of agricultural production is the demonstration of a possible 15-20 percent savings in energy on the farm. This can illustrate what is possible for other sectors. Such a level of savings nationally could contribute materially to easing short-run problems, including dependence on foreign sources. It would not eliminate the gap between needs and domestic output. In the short-run and despite some hazards, this may even be unwise for several reasons, including the conservation of domestic reserves. But, a serious overall conservation effort is imperative to trim the imbalance to less painful proportions while seeking more lasting and satisfactory solutions to the total energy problem.

In the specific examples contained in the six energy conservation guides for producers, the estimated initial dollar savings in energy can be offset sometimes in part, sometimes in whole, by increases in other costs [6] . The kinds of substitutions discussed are not of the order that would revolutionize agriculture. Instead, they involve adjustments within the current system.

Estimates of possible short-run energy savings in production by commodity groupings and functions were derived from conservation guides for poultry, dairy, livestock, field crops, orchard crop and vegetable crop producers [6] . These were based on research from various disciplines.

The guides were exhaustively reviewed by researchers in these disciplines as well as by trade organizations. The inter-disciplinary contacts were sometimes frustrating, but at the same time educational and rewarding. Energy research and policy determination must have this inter-disciplinary collaboration to produce viable answers.

Estimates of energy savings represent collective judgments. Such near-term potential savings can vary considerably with the types of functions performed, among commodities, between regions, and with the individual farm. Even in aggregated form, they represent the accumulated results of partial budgeting approaches. The use of full budgeting or linear programming approaches might be preferable in designing short-run adjustments for the individual farm or in evaluating long-run adjustments. Also, one should not overlook input-output analysis as a tool for measuring aggregate changes. Some extension and updating of a recent study [18] would be necessary to recognize commodities, regions, structural characteristics, and new technology. But the energy conservation guides developed may have met the primary purpose of providing type-of-saving examples from which extension workers, companies, and individual producers can determine possible savings in specific situations. Better energy records are a necessity, not only for establishing present energy usage, but also for measuring real savings.

One way of looking at savings is by type of activity. Fertilizers and pesticides represent a substantial amount of energy when the embodied energy in manufacturing is added to that used in farm application. A somewhat conservative estimate suggests about 10 percent of these materials could be saved by more accurate and careful use. Fertilizers and pesticides accounted for more than a third of total (embodied plus direct) energy use in agricultural production in 1974. Modernized response data, plus timed application adjusted to weather conditions, should cut down usage. Any substantial substitution of organic materials would also help.

Field operations - which include tillage and preplanting, planting, cultivating, pest control, harvesting, and the associated equipment and power unit operation and maintenance - accounted for about one-fifth of total production energy use in 1974. Possible savings, with modest changes in practices, could reach about 20 percent. Among the possibilities are no-tillage and reduced tillage.

Energy savings in transportation functions might also reach 20 percent. These functions include operation and maintenance of farm pickup trucks and autos used for on-farm travel and transporting products and personnel. They required about one-fifth of total production energy use in 1974. The magnitude reflects the enjoyment of farmers - like householders and vacationers - of motor travel.

Irrigation operations - pumping water and applying it to crops by various methods - accounted for less than 15 percent of total production energy use in 1974. By better maintenance, increased pumping efficiency, and modifications in application rates and methods, energy savings of 15-20 percent might be realized. This function is most critical in the West, both under this year's water scarcity and over the long-run.

Direct energy used in livestock production (beef cattle, hogs, sheep and lambs, milk cattle, and poultry) amounted to less than a tenth of total production energy use in 1974. Accumulated changes in feeding, management, waste handling, heating, ventilating and lighting could save 15-20 percent of recent energy use. The Northeast can contribute materially in this area.

Crop drying and preservation used less than a tenth of total production energy in 1974. By various changes - partial drying, more air drying, modification of temperatures, ensiling and wet storage - from 20-25 percent of 1974 energy use might be saved. Already important in some States of the Northeast, grain drying would become a more general problem if local grain output rises.

Another way of looking at savings is by type of producer. The average dairy farm may be able to save 15-18 percent of the energy used on other than cropping operations. The largest source of savings (almost half) might come from adjustments in the milk cooling operation, mostly from precooling milk, with the balance from better maintenance of equipment, including vacuum pumps. Changes in water heating could account for an additional one-fourth of the savings, with the use of heat exchangers, preheating water, and maintenance important. Better adjustments in systems for ventilating, more optimum lighting, more accurate motor sizes and maintenance, and better maintenance and size selection of gasoline and diesel motors could save about equal shares of the balance.

Poultry producers can save 20-25 percent of the energy currently being used. About two-thirds of these savings could come from the brooding operation through the use of partial room brooding, better maintenance, and more insulation. An additional one-sixth could come from more efficient feeding and waste handling systems, with the remaining one-sixth divided between improved lighting practices and improved ventilation management.

A livestock producer should be able to save 15-18 percent of the energy currently being used. The largest potential savings may be in the areas of grain drying, and feed grinding, preparation, and hauling (nearly one-half). Changes in range and feedlot management, adjustments related to lighting and watering, ventilating and heating, and improved tractor and truck maintenance and use could account for about one-sixth each, and better regulation of irrigation for less than one-tenth.

Field crop producers might save about 20 percent of current energy used. Savings from reduced preharvesting operations might account for about one-fourth of total savings, and harvesting and drying modifications for about one-fifth. More regulated irrigation, and improved fertilizer and pesticide use could each account for about one-sixth of total savings and equipment and power unit selection and maintenance and other changes for about a fifth. Possible savings patterns on individual field crops would vary widely because of the many different commodities included and area variations in practices.

Orchard crop producers might save 20-23 percent of current energy used. Modified or different frost protection methods might account for over two-fifths, and more optimum fertilizer application about one-fifth. Reduced field operations could save under one-fifth, and more regulated irrigation, and better equipment and power unit selection and maintenance about one-tenth each.

Vegetable crop producers can probably reduce energy use 18-21 percent. More optimum fertilizer application might account for about two-fifths of this and reduced field operations less than one-third. Better regulation of irrigation, and better equipment and power unit selection and maintenance could account for about one-eighth each and more efficient harvesting for the small remaining balance.

<u>Future Extension and Research Needs - A Shopping List</u>

Carrying the results of compilations like the energy conservation guides into field application requires a positive effort by extension workers and business firms in every state. The pilot program in Kansas and Nebraska, involving the universities and State energy offices, has shown the potential for implementing energy savings in production. It should be extended to other states, and tailored to local conditions.

A state energy data base is needed on marketing like that developed for agricultural production. This might well be followed by documentation of short-run energy conservation possibilities in marketing and field implementation. Gaps in our knowledge of energy use in the food system are only too well illustrated by some studies funded by FEA [10, 11]. Rural residents should also be helped in all regions to implement home energy use conservation projects.

In the area of "technology assessment," a growing association of economists and other disciplines should result in more feasibility studies of new technology. One part of this involves the development of more energy efficient equipment. Another would apply the "learning curve" approach to relative future costs of alternative energy forms, and recognize relative future prices as they relate to adoption of alternatives. Alternatives may also mean working out mixed energy systems case-by-case.

At the micro-level more emphasis is needed on input substitution analyses. For example, what can the Northeast do to produce more feed grains and higher quality forage? What is the best balance between energy, labor, and capital?

There are many tradeoffs to be evaluated, including those between energy and environmental enhancement. Ultimately, more aggregative studies of energy-related interregional and structural impacts should follow. There is much ground to be plowed here insofar as the agriculture of the Northeast is concerned. NE-105, a regional research project, "Implications of Demand, Structure and Energy Changes for the Northeastern Broiler and Egg Industries," represents a beginning. What absolute advantage suggests, comparative advantage often destroys. A much narrowly-focused and commodity-oriented transportation matrix analysis has misled researchers into questionable conclusions about the long run future of Northeastern agriculture. It is not inconceivable that energy-related transportation and water problems, for example, may now contribute toward some reverse-migration of canning and freezing to the Northeast.

No one has looked very hard at potential economies of scale in energy use. Still another area of research is determining optimum benefit-cost ratios in programs to minimize energy use. Incentives such as subsidy payments and tax credits should be varied accordingly, and add-on taxes should be examined for effectiveness and equity. Energy rate structures also need to be studied in relation to functional uses and alternative energy sources. At some point, embodied energy in fertilizers, pesticides, supplies and equipment might also be considered in total analyses.

Work on energy conservation in processing frequently cuts across commodity lines and becomes functional, such as in fruit and vegetable canning and freezing. But much processing is commodity specific and each plant has its unique problems. Thus, the individual unit "energy audit" may be useful. Resurrection of assembly and delivery route analyses - in which Northeastern States pioneered - is overdue. Many companies have already begun.

There is a need to study home preservation and preparation of food vs. commercial processing, despite the vulnerability of some recent studies to the arrows of professional scoffers. Also ahead lies the possibility of redesigned long-distance transportation systems to curtail truck travel and extend the unit train idea. Later in marketing channels studies are needed of modified distribution systems which can reduce shopping travel. Additionally, there may be a need to identify the conditions under which consumers would accept more container standardization and less packaging.

Perhaps the biggest job of all is to persuade producers, marketers, and consumers that the energy crisis is here to stay and that everyone will have to adjust to it. For cheap energy is something none of us are likely to see ever again. But successful persuasion needs to rest on a solid extension/research base. We still have a long way to go to develop it.

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