REPORT BY THE

RELEASED

Comptroller General

OF THE UNITED STATES

Department Of Agriculture Could Do More To Help Farmers Conserve Energy

Important areas in which farmers can achieve near-term energy savings are irrigation improvements, conservation tillage, and reduced fertilizer application.

However, some farmers are not adopting energy conservation practices because they are reluctant to change from traditional methods, believing such change involves an economic risk.

The Department of Agriculture (USDA) could help overcome this barrier by providing farmers more specific information which could assure them of the cost effectiveness of suggested measures. USDA's new Office of Energy could be the focal point.

The Department of Energy is completing several energy-related agricultural projects. GAO recommends that management of these projects be transferred to USDA.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-207530

The Honorable Richard L. Ottinger
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

This report discusses opportunities for near-term energy conservation in agricultural production and Federal efforts to assist farmers in adopting conservation measures. The report was prepared at your request.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days from the date of its issuance. At that time we will send copies to the Secretaries of Agriculture and Energy; the Director, Office of Management and Budget; and to other interested parties; and make copies available to others upon request.

Sincerely yours,

John D. Heller

Acting Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT
TO THE SUBCOMMITTEE ON ENERGY
CONSERVATION AND POWER
COMMITTEE ON ENERGY AND COMMERCE
HOUSE OF REPRESENTATIVES

DEPARTMENT OF AGRICULTURE COULD DO MORE TO HELP FARMERS CONSERVE ENERGY

D I G E S T

Farming uses more petroleum than any other single industry, thus conservation improvements can have significant impacts.

The Chairman, Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, asked GAO to report on energy conservation measures farmers could adopt in the near-term and on Federal efforts to assist farmers in adopting such measures.

FARMERS COULD SAVE MORE ENERGY

Measures that farmers can adopt to conserve energy in the near-term include:

--More efficient water management, which can potentially conserve about one-fifth of the energy used in irrigation and can save substantial amounts of water. (See p. 8.)

--Conservation tillage, which involves leaving crop residues on the soil surface and minimizing plowing, disking, or harrowing. By reducing the number of tractor trips across a field, a farmer can reduce his fuel requirements significantly, compared to conventional tillage. (See p. 12.)

--More efficient use of fertilizer, grain drying, and maintenance and operation of farm machinery and equipment. (See p. 18.)

Some farmers are not implementing energy conservation actions because they are reluctant to change from traditional methods, believing such changes could adversely affect crop yield and income and are too risky. However, certain farming practices considered commonplace only a few years ago are being reevaluated in terms of energy efficiency, cost, and yield potential. (See p. 21.)

To help overcome their reluctance to change, farmers need adequate information to assure them the various energy conservation actions are cost effective. Although energy conservation information is available, it is often too general and not applicable to individual farm situations. (See p. 22.)

WHAT CAN THE FEDERAL GOVERNMENT DO?

The Federal Government, through the United States Department of Agriculture (USDA), could enhance the energy conservation assistance it gives to farmers by coordinating and focusing the energy conservation activities of its field agencies. These activities should include increased emphasis on helping farmers identify cost effective energy conservation measures applicable to their specific farming situations.

USDA's field agencies are promoting energy conservation inconsistently and without much guidance and direction from headquarters. Some field personnel told GAO they believed their efforts to promote energy conservation do not go far enough because USDA headquarters places little priority on such efforts. (See pp. 25 and 26.)

USDA recently reestablished an Office of Energy which GAO believes could play a role in assuring that farmers are provided the kind of information they need to make sound energy conservation decisions. Although the Office was not established specifically to promote energy conservation, it could, through its broad authority, serve as a focal point to coordinate and influence the energy conservation activities of USDA's field agencies. (See p. 26.)

The Department of Energy (DOE) has been involved in agricultural energy conservation through its sponsorship of several demonstration projects, including energy-integrated farm systems (an energy self-sufficiency farming concept), irrigation systems, crop-drying systems, and more efficient fertilizer manufacture. USDA has limited involvement in DOE's energy-integrated farm projects through the assignment of a technical advisor, thereby providing a link with the

farming community. However, this participation is expected to soon terminate. (See pp. 27 and 28.)

For fiscal years 1982 and 1983, no new funding for DOE's agricultural projects was requested or provided, but ongoing projects are being continued using funds carried over from prior years. Due to the funding reductions, DOE transferred responsibility for managing the projects to its Idaho Operations Office. Because of DOE's uncertain funding situation and the expected discontinuance of USDA's formal participation, GAO is concerned whether the projects will be coordinated with the farming community and also whether the information resulting from them will be readily available to assist farmers in adopting conservation technology. (See pp. 27 and 28.)

CONCLUSIONS

Energy savings potential in farming operations remains untapped because some farmers are reluctant to accept what they perceive as a risk involved in changing farming methods. USDA could help in overcoming this barrier. GAO believes farmers' reluctance to change could be reduced if they had more specific information that could assure them the various conservation actions, as applied to their individual farm situations, are cost effective. USDA's field agencies could provide farmers with this kind of information. USDA's new Office of Energy could be the focal point for energy conservation.

RECOMMENDATIONS

GAO recommends that the Secretary of Agriculture assign to USDA's Office of Energy responsibility for developing and carrying out an enhanced effort to promote energy conservation by farmers. (See p. 29.)

GAO also recommends that the Secretaries of Agriculture and Energy enter into an Interagency Agreement, pursuant to an existing USDA/DOE Memorandum of Understanding, for USDA to perform the overall management and monitoring of DOE's ongoing energy-integrated farm projects to assure that the results of these projects are made available to the agricultural community. (See p. 30.)

AGENCY COMMENTS

USDA and DOE provided comments on this report. (See p. 30.) USDA expressed concern with the report's treatment of the economics of agriculture, the potential for agricultural energy conservation, and the mechanism of information transfer to farmers. It stated that economics is the most important factor influencing agricultural energy conservation and that it is ignored in the report. USDA believed GAO both exaggerated the significance of the estimated potential energy savings in farming operations and implied that the Department's main goal was energy conservation. In addition, USDA objected to GAO's view of the Department's role in providing information to farmers, and believed the report advocated that USDA conduct a personal consulting and decisionmaking service.

GAO agrees that economic feasibility is the primary factor influencing energy conservation in agriculture. However, GAO believes that a farmer's level of awareness of energy conservation opportunities is also a key element because it reflects the kinds and extent of actions that can be taken. GAO did not attempt to make an economic feasibility analysis of any suggested conservation measure, believing that any such analysis could be misleading, since the variable nature of farming operations, including the skill of an individual farmer, would weigh heavily in determining the success of a particular measure.

GAO believes that, although the estimated annual potential energy savings is a small fraction of current U.S. consumption, this potential, 74 million barrels of oil equivalent, is a considerable amount of energy, and achieving such savings is a goal worth pursuing. GAO's report is not intended to imply that USDA's main goal should be to conserve farming energy; rather, it is intended to point out the importance of energy conservation to the Department's principal responsibilities of continued production of food and fiber.

GAO does not suggest that USDA provide a personal consulting service to farmers or make farmers' decisions. The report does suggest that through its outreach programs, USDA could provide more information to farmers on energy conservation practices applicable to their specific local conditions. USDA did not concur with GAO's

recommendation that its Office of Energy develop and carry out an enhanced effort to promote farm energy conservation and believed that such a role was beyond the scope of that Office.

GAO continues to believe that this recommendation is appropriate since energy conservation is an area in which the Office of Energy could become involved.

While both departments agreed with GAO that management of DOE's ongoing agricultural energy projects could be transferred to USDA, DOE stated it was working on a plan to assure that information developed by the projects would be available to the farming community and did not believe the transfer was necessary. USDA, on the other hand, believed such a transfer would be appropriate and should be done as soon as possible, as long as funding problems are worked out.

GAO continues to believe that management responsibility should be transferred to USDA, the agency responsible for the Federal Government's agricultural activities.

Contents

ABBREVIATIONS

ACP	Agricultural Conservation Program
ARS	Agriculture Research Service
ASCS	Agricultural Stabilization and Conservation Service
Btu	British thermal unit
CES	Cooperative Extension Service
CSRS	Cooperative State Research Service
DOE	Department of Energy
EES	Energy Extension Service
EIFS	Energy Integrated Farm Systems
FmHA	Farmers Home Administration
GAO	General Accounting Office
kwh	kilowatt hour
LEPA	Low Energy Precision Application
SCS	Soil Conservation Service
SEA	Science and Education Administration
TVA	Tennessee Valley Authority
USDA	U.S. Department of Agriculture

CHAPTER 1

INTRODUCTION

Agricultural production of food and fiber on American farms is a vital part of the Nation's economy and well being. It accounts for nearly 3 percent of annual U.S. energy consumption, representing the equivalent of about 353 million barrels of oil per year. Farming uses more petroleum than any other single industry. 1/ Energy used in farming operations has increased markedly over the last 40 years, largely because of increases in the use of mechanization and chemicals. Since 1940, the energy input into agricultural production has quintupled.

On May 18, 1981, the Chairman, Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, requested that we prepare a report on conservation measures farmers could adopt in the near-term and on Federal efforts to assist farmers in adopting such measures. His letter stated that opportunities exist for greater conservation of energy in farming operations and that Federal agencies should work together to provide a stronger and more unified effort to assist farmers in conserving this energy.

Most of agriculture's increased energy demand has been in petroleum-based fuels. The additional energy inputs since 1950 have helped farm productivity to more than double, while permitting farm labor to be halved. Unfortunately, heavy reliance on fossil fuels is a two-edged sword. Although productivity has increased dramatically, farmers are particularly vulnerable to supply interruptions and increasing fuel costs. Supply interruptions can have a severe impact on farmers because of the seasonal nature of farming operations. A fuel shortage during the critical times of planting or harvesting could seriously hinder agricultural outputs and lead to a significant increase in food and fiber prices. For example, in October 1980, a Department of Energy (DOE) official testified that an energy shortage of only 10 percent could lead to a 55-percent increase in commodity prices. 2/ He attributed this inelastic demand to the seasonal nature of farming operations.

FEDERAL ROLE AND RESPONSIBILITIES IN AGRICULTURAL ENERGY CONSERVATION

Virtually all of the Federal Government's responsibilities for agricultural energy matters are carried out by the U.S. Department of Agriculture (USDA) and DOE. Historically, USDA has

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1/USDA, "Fact Book of U.S. Agriculture," Miscellaneous Publication No. 1063, November 1980, p. 3.

2/Statement by the Chief of DOE's Agricultural and Food Processes Branch before the Subcommittee on Agricultural Credit and Rural Electrification, Senate Committee on Agriculture, Nutrition, and Forestry, Oct. 17, 1980.

been the lead Federal agency for policy matters relating to food and agriculture. Its responsibilities include assuring adequate supplies and distribution of food, fiber, and forestry products at reasonable prices and the sound management and conservation of agriculturally related soil and water resources. Because of the importance of energy to these responsibilities, USDA engages in activities relating to the supply, use, and conservation of energy for agricultural and rural purposes.

Since 1977, when DOE was established, its responsibilities have included promoting energy conservation measures through creating and implementing a comprehensive energy conservation strategy. DOE's efforts relating to agricultural production have focused on sponsoring research, development, and demonstration projects in areas such as energy-efficient irrigation systems and energy self-sufficient farming concepts. In addition, DOE has provided funds to USDA for research in certain energy-related areas, such as solar grain drying and wind power systems. According to USDA, in fiscal year 1981, DOE provided about $3 million to USDA, and is expected to provide over $1 million in fiscal year 1982.

USDA's energy efforts

Most of USDA's direct energy efforts involve research and development of alternate fuels such as alcohol and biomass, and the development of improved technologies in areas such as crop drying, irrigation, and tillage practices. Also, USDA provides information to farmers on agricultural matters generally. This information may discuss direct energy-saving benefits, such as advice on tractor tune-ups to enhance fuel economy. It may also discuss improved farming practices, such as those designed to save soil or water resources, but which also have significant energy conservation benefits. USDA's several field agencies are the primary means of providing this information to farmers.

USDA's Soil Conservation Service (SCS) provides technical assistance to farmers in conserving soil and water resources. The Agricultural Stabilization and Conservation Service (ASCS) conducts an Agricultural Conservation Program (ACP) which provides cost-sharing assistance to farmers for approved soil and water conservation and environmental protection practices. The Energy Security Act of 1980, for the first time, authorizes cost sharing under the ACP specifically for energy conservation projects. Authorized types of projects include shelter belts, 1/ minimum

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1/Shelter belts are windbreaks (trees planted to block wind) around farmsteads, barns, or other buildings. Windbreaks save energy in heated buildings by slowing the speed of winds and causing a more even distribution of air, thus reducing the air infiltration rate and heat removal rate.

tillage systems (see page 12), energy-efficient irrigation systems, and other resource management practices that have significant energy-conserving effects.

The Farmers Home Administration (FmHA) is USDA's credit agency for agriculture and rural development. FmHA makes or guarantees various types of loans for farm ownership and operation, including energy conservation projects.

The Cooperative Extension Service (CES), through its outreach efforts, provides advice and assistance to farmers on improved methods of agricultural production and marketing. This assistance may include information on energy-efficient farming practices, such as improved soil and water management and fertilizer application techniques. CES is a partnership made up of State extension services located within the land-grant colleges and universities and the Federal Extension Service, which administers Federal support to CES. CES operates an office in virtually every county in the Nation, through which it delivers applied education programs in agriculture and other subjects to individuals, families, and organizations.

In addition to the energy conservation-related activities of its field agencies, USDA conducts and sponsors research in areas having energy conservation benefits through the Agriculture Research Service (ARS) and the Cooperative State Research Service (CSRS). ARS is responsible for agricultural research performed by Federal scientists at various research centers. CSRS coordinates Federal and State research and administers funds appropriated by the Congress for State agricultural research. This research is primarily done by agricultural experiment stations in conjunction with State land-grant colleges and universities.

DOE's efforts to reduce energy consumption

DOE has engaged in efforts to reduce energy consumption in various phases of the agriculture sector, including food processing and agricultural production. Most of DOE's recent work in this area has been done by its Agriculture and Food Processes Branch in the Office of Industrial Programs. This work, for the most part, involves sponsoring various research, development, and demonstration projects that are usually conducted by private industry and universities. Major project areas pertaining to agricultural production include Energy Integrated Farm Systems (EIFS), 1/ irrigation systems, crop-drying systems, and more energy-efficient fertilizer manufacture.

1/An energy self-sufficiency farming concept.

OBJECTIVES, SCOPE, AND METHODOLOGY

The Chairman's letter requested that we prepare a report on conservation measures farmers could adopt in the near-term and on Federal efforts to assist farmers in adopting such measures. Our review was performed in accordance with GAO's "Standards for Audit of Governmental Organizations, Programs, Activities, and Functions."

In order to respond to the Chairman's request, our objectives were to identify

- --which areas offer the greatest potential for near-term energy savings in farming operations;
- --the barriers, if any, that were impeding the wide-spread adoption of conservation measures in these areas; and
- --the steps, if any, the Federal Government could take to remove the barriers and accelerate the adoption by the farmer of near-term energy conservation measures.

We looked primarily at opportunities to save energy in crop production because it uses almost 90 percent of all energy used in agricultural production. Livestock production accounts for the other 10 percent of on-farm agricultural energy use. The three farming practices related to crop production that offer the greatest potential to the farmer for near-term energy savings (irrigation, tillage practices, and fertilizer application) are discussed in chapter 2.

We did not specifically address economic considerations or financial constraints as barriers to the adoption of energy conservation measures by farmers. While we recognize the importance of economics to management decisionmaking in all sectors of the economy, we did not attempt to make an economic feasibility analysis of any suggested conservation measure. We believe that any detailed economic feasibility analyses of conservation measures could have been misleading, since the variable nature of farming operations, soil and weather conditions, and the skill of the individual farmer would weigh heavily in determining the economic success of these measures.

Our report does not address specifically the areas of soil erosion and protection of prime farmland--two areas which, according to USDA, have significant energy savings potential. These areas involve considerations which are often beyond the scope of farmers' operations in crop production. For example, protecting prime farmland concerns the problem of prime agricultural lands being converted to non-farm use. The area of soil erosion often involves large projects and includes Government programs or assistance in building dams and terraces, drainage, streambank protection, irrigation control, and others. Except to the extent that

the crop production practices of irrigation and tillage affect soil erosion, we did not include these two areas within the scope of our review.

Our review was conducted during 1981 at USDA and DOE headquarters, Washington, D.C.; USDA field offices; State and county offices; and universities. We interviewed officials at these organizations and reviewed numerous documents and Government and private sector studies pertaining to agricultural energy conservation. We selected universities that were active in agricultural research and development in several States, and we interviewed scientists and educators who are recognized authorities in their field. We also interviewed farm interest groups and obtained information from farm equipment manufacturers. We visited energy-integrated farms in Pennsylvania, Virginia, and Texas; the Georgia Coastal Plains Experiment Station; the Tennessee Valley Authority's (TVA's) National Fertilizer Development Center; and the National Tillage Machinery Laboratory in Auburn, Alabama.

We interviewed 42 farmers and many Federal and State agricultural officials in five key agricultural States: California, Illinois, Maryland, North Carolina, and Texas. We selected California, Illinois, and Texas because they are leading agricultural consumers of gasoline, diesel fuel, or liquid petroleum. We chose North Carolina because its agriculture includes a high proportion of energy-intensive crops, such as tobacco, cotton, and soybeans. Maryland was included because it has been successful in adopting conservation tillage practices on a wide scale. We conducted these interviews to learn how farmers obtain energy conservation information and what they perceived to be the barriers to more rapid adoption of energy conserving farming practices.

This report was provided to DOE and USDA for their review and comment. DOE's comments are included as appendix I. Due to their length, USDA's comments are not reproduced in this report, but are available on request from GAO. USDA's and DOE's principal concerns are summarized in chapter 5 along with our response to them. In addition, USDA made comments or suggestions concerning specific sections of the report. USDA's comments and our responses are contained in the applicable sections.

CHAPTER 2

CONSERVATION PRACTICES THAT PROVIDE NEAR-TERM ENERGY SAVINGS

Farmers can conserve energy in numerous ways. Many of the practices are readily available to farmers, and require little more than different farm management techniques to realize near-term fuel savings. Savings can be attained in many areas; the most immediately adoptable are improved water management, conservation tillage, reduced fertilizer application, and more efficient use of farm machinery and equipment.

Some energy conservation practices have several benefits. Conservation opportunities that reduce water consumption and prevent soil erosion usually help farmers reduce operating costs and conserve energy supplies. This chapter discusses a number of conservation practices that farmers might adopt to reduce fuel costs and save energy. We recognize that some of the conservation measures discussed in this chapter cannot be adopted on all farms, but one or more are usually applicable.

FARM ENERGY REQUIREMENTS

Farm energy is derived from several sources including gasoline, diesel fuel, fuel oil, and natural gas. According to USDA, gasoline and diesel fuel are the predominate fuel sources used in crop production, accounting for about 6.4 billion gallons of consumption in 1980. The following table shows USDA estimates of fuel consumption for 1980.

1980 U.S. Agricultural Energy Consumption

Fuel/Power	Consumption	Equivalent Btu's (trillions)
Diesel fuel (note a)	3.3 billion gallons	445.5
Gasoline	3.1 billion gallons	387.5
Liquid petroleum gas	1.0 billion gallons	91.8
Fuel oil	.2 billion gallons	28.0
Natural gas	93.0 billion cubic feet	93.0
Electricity	31.0 billion kwh	105.8

a/According to the Acting Director of USDA's Office of Energy, diesel fuel demand will grow to more than 4.7 billion gallons by 1990. By 1990, 88 percent of the tractors and 50 percent of the farm trucks are expected to be diesel powered. USDA and DOE are in the process of developing diesel fuel substitutes.

Source: Preliminary 1980 data, Economic Research Service, USDA.

Farm energy demand is concentrated in a few geographical areas--seven States account for almost half the energy used in farm production. These are the big grain-producing States of Iowa, Nebraska, Kansas, and Illinois; the dairy State of Minnesota; and the major irrigating States of Texas and California.

On a commodity basis, corn production is the leading energy user, consuming nearly one-fourth of all energy used in farm production. The other top commodities, each using between 5 and 8 percent of total farm energy are: winter wheat, cotton, soybeans, alfalfa, and grain sorghum.

POTENTIAL ENERGY SAVINGS AVAILABLE IN AGRICULTURAL PRODUCTION

A recent USDA study estimates that 430 trillion Btu's, or about 74 million barrels of oil equivalent, of farm energy used annually could be saved through identified energy conservation practices. 1/ This amounts to over 20 percent of current farming energy use. The following table lists the areas addressed in the study and the potential energy savings: 2/

Estimated Potential Energy Savings

Area (note a)	Annual savings (trillion Btu's)
Soil erosion management	113
Protection of prime farmland	78
Water management	73
Conservation tillage	58
Improved fertilizer use	51
Shelterbelts and windbreaks	31
Crop drying	19
Pasture & range management	7
Total	430

a/Some of the savings reflected in the appraisal study are practices that do not deal specifically with crop production. For example, soil erosion management refers to practices farmers could implement to reduce top soil loss, such as building terraces. It also involves Government watershed and other soil control projects. Except to the extent that water management and tillage practices affect soil erosion, energy savings from this opportunity area and other areas not related to producing crops were not included in our review.

1/USDA, "1980 Appraisal Part II, Soil, Water, and Related Resources in the United States: Analysis of Resource Trends," August 1981.

2/The USDA study upon which this table is based refers to the savings estimates as "maximum possible savings" for the listed areas.

The most readily adoptable areas where farmers can make near-term energy conservation improvements in crop production are irrigation (part of water management), conservation tillage, and reduced fertilizer application. Of the 74 million barrel savings potential, these three areas account for about 28 million barrels. Shelter belts and crop drying acccount for another 9 million barrels. In addition, although not listed above, farmers can save additional energy by using farm machinery more efficiently. Each of these areas is discussed below.

Energy savings available in agricultural water management

Irrigation practices provide considerable opportunities for conserving energy in crop production. According to the above USDA study, as much as one-fifth of all energy used in irrigation could be conserved through more effective water management. 1/

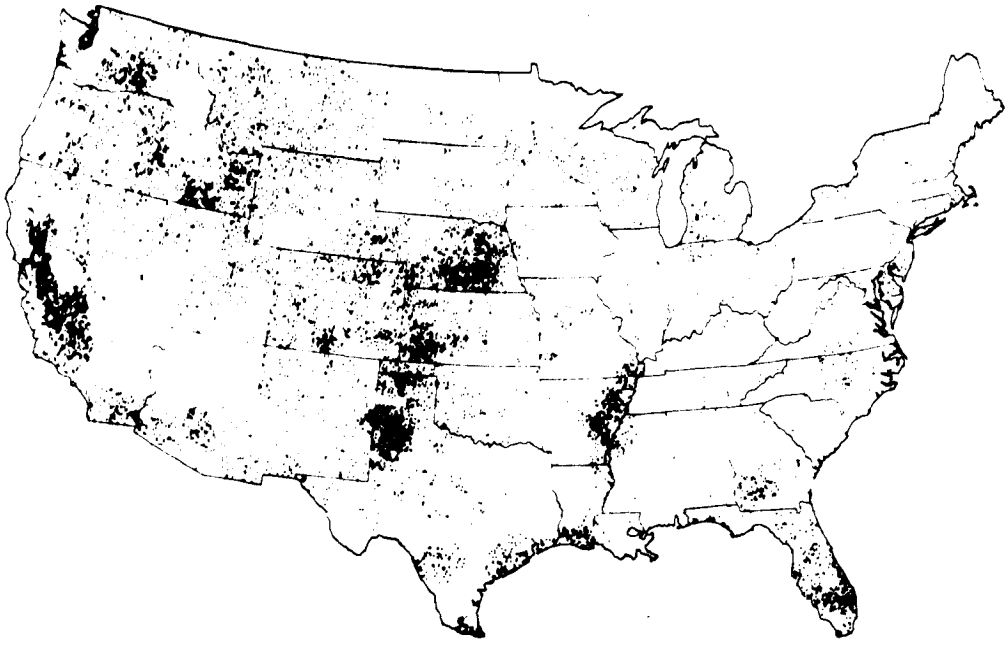
Agriculture is the single largest user of water in this country. Irrigation alone accounts for about 80 percent of all water consumed in the United States. In 1979, over 30 percent of all cropland in the United States was irrigated. Figure 1 on the following page shows the relative dependence on irrigation in some of the key agricultural States.

Essentially, better water management in irrigation involves eliminating waste involved in moving water from ground or surface sources to the crop production area. Energy is used in the process to move a given amount of water from one location to another. Energy conservation can result when sound water conservation measures are implemented. Such measures include improved pump efficiencies, improved water distribution, computerized irrigation scheduling, and water reuse systems.

1/Following our review, DOE published the results of an irrigation study done by Battelle Memorial Institute. The study concluded that American farmers could save $300 million each year by adopting more energy efficient irrigation equipment and practices. Although the achievement of that level of savings would involve new technologies and equipment, the study concluded that about two-thirds of the savings in pumping costs could be achieved by reducing the pressure of sprinkler systems and through better scheduling of water application.

Figure 1

1977 Irrigated Agricultural Acreage
(One dot equals 8,000 irrigated acres.)



Source: USDA, "Program Report and Environmental Impact Statement, Soil and Water Resources Conservation Act, Revised Draft," November 1981, p. 3-4.

Improved pump efficiencies

Improving pump efficiency offers significant potential to conserve energy. Savings are available from replacing worn-out pumps or, more importantly, making existing pumps more efficient through improved equipment maintenance.

Pumping underground water (usually referred to as ground water) is energy intensive because well pumps must bring the water from the underground storage caverns or aquifers to the surface. On many irrigated farms, pumping water and delivering it to the field requires more energy than all other farm operations combined. The amount of energy used for a well depends on the efficiency of the pump, the energy source, the size of the well, and the depth of the water source.

Many farm irrigation pumps are operating inefficiently, causing excess energy loss. USDA reported that a study in Nebraska tested 376 irrigation pumps and found fewer than 9 percent were operating efficiently. 1/ A 1980 Texas study of

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1/USDA, "A Guide to Energy Savings for the Field Crop Producer," June 1977, p. 20.

250 irrigation pumps (100 natural gas and 150 electrical) showed well pump efficiency averaged 45 percent for natural gas pumps and 41 percent for electric pumps. 1/ The study concluded that improvements to 70-percent efficiency could reduce natural gas and electricity consumption for pumping by 35 and 41 percent, respectively. The studies also showed that neglect, maladjustment, few checkups, and minimal maintenance were the primary reasons for poor fuel efficiency. In commenting on our draft report, USDA cautioned that pumps can never be 100 percent efficient and stated that the best attainable efficiency is about 80 percent.

Publicly owned utility companies in California and Texas are now providing periodic performance testing of pumps at little, if any, fee so farmers can make proper adjustments and repairs or replacements. These tests are expected to take several years to complete.

Improved water distribution

Low-pressure irrigation systems offer significant energy conservation potential in water distribution. Many irrigation systems now in use are energy inefficient. These systems grew in acceptance when water and energy were cheap. Low-pressure systems are designed to use less energy than conventional systems through more efficient water usage. Instead of spraying water in the air at moderate to high pressure, resulting in high evaporation, low-pressure systems spray water closer to the ground with little pressure. A comparison of the two systems is illustrated on the following page.

With respect to evaporation losses, another Texas study estimated that irrigation water lost through evaporation can be greater than 30 percent. 2/ A low-pressure system that has shown positive results in field tests is the low-energy precision application (LEPA) system, which deposits water directly on the ground. A Texas A & M University study compared LEPA with conventional irrigation sprinkler systems. 3/ It concluded that high-application

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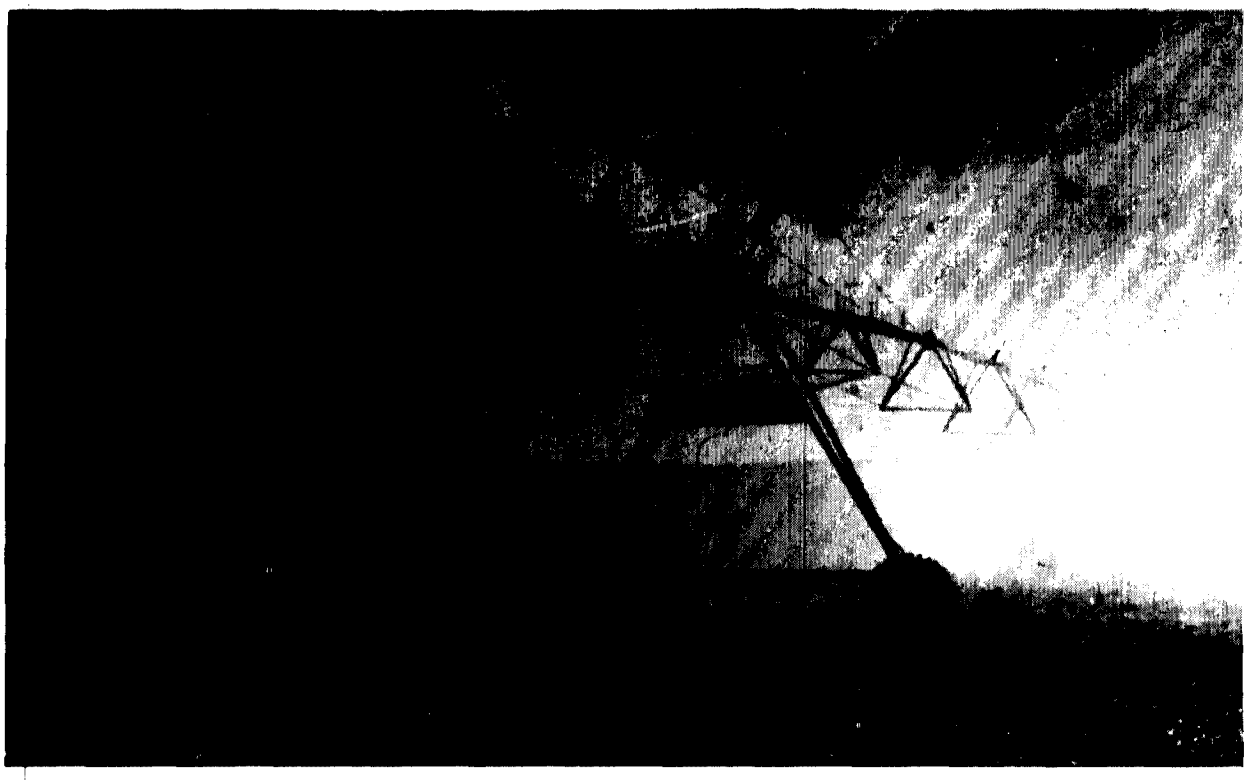
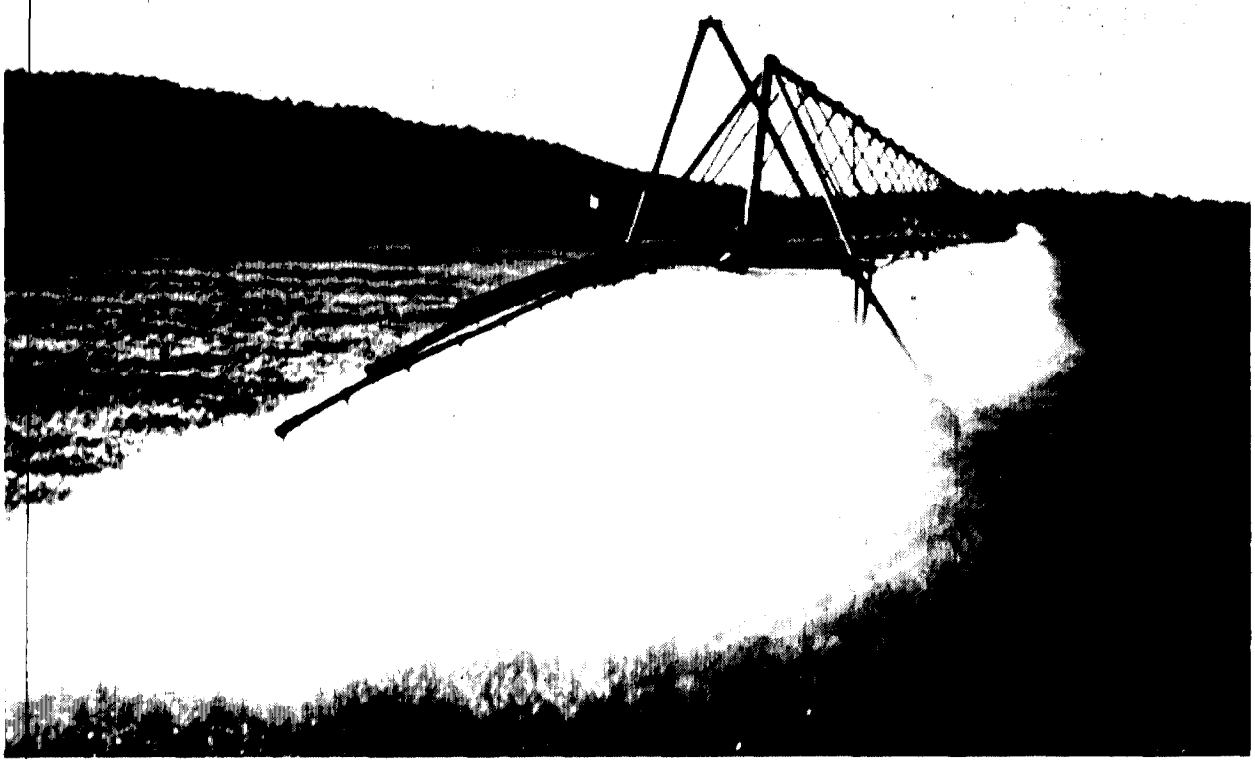
1/Texas Energy and Natural Resources Advisory Council, "Irrigation Pumping Plant Energy Efficiency Testing Procedure Manual," Report 81-01, p. 1.

2/Texas Energy and Natural Resources Advisory Council, "Texas Energy Development Fund--Energy Conserved Through Improved Irrigation System Design and Method," January 1980, p. 2.

3/Texas Water Resources Institute, "New Irrigation System Design for Maximizing Irrigation Efficiency and Increasing Rainfall Utilization," Texas A & M University, May 1980.



CONVENTIONAL MODERATE-TO HIGH-PRESSURE IRRIGATION SYSTEM SPRAYING WATER INTO THE AIR. SOURCE: USDA



LOW-PRESSURE IRRIGATION SYSTEM SPRAYING WATER CLOSER TO THE GROUND. SOURCE: USDA

efficiency, high-distribution efficiency, and very low operating pressure can give the LEPA system a major advantage in terms of energy savings.

Existing high-pressure systems can sometimes be converted to low-pressure systems at a relatively small cost to the farmer. For example, according to USDA, some high-pressure central pivot systems may be converted to low-pressure systems at a cost of only $10 to $15 per acre by simply changing nozzles and reducing the pressure of the sprinkler system. If the existing nozzles are too far apart for efficient low-pressure spraying, these can be changed and additional nozzles added at a cost of about $25 to $30 per acre. In those cases requiring complete system conversion, the cost per acre could range between $200 and $300.

Other areas

The practice of scientific irrigation scheduling is being used on medium and larger sized farms. This technique determines the amount and timing of water to be applied to the crops (usually through the use of a computer). It has proven to be an effective management technique for reducing water applications and energy use in irrigation. According to USDA, the amount of irrigation water pumped during an irrigation season could be reduced by as much as one-half without adversely affecting the yield of certain crops. For example, according to a USDA publication, when a corn farmer in Colorado applied irrigation water based on a computerized scheduling program, not only did he increase his yield as compared to neighboring farmers, but he also reduced his irrigation pumping energy requirement by 27 percent. 1/

Another effective conservation measure is a return-water reuse system. Under a reuse system, a small reservoir is constructed to capture surface run-off water. A pump moves this run-off water to other irrigated land or supplements water used for later irrigation. USDA reported that in Nebraska, reuse systems have increased irrigation efficiency by 15 percent. 2/

Energy savings available from conservation tillage

Farmers can obtain significant energy savings through more efficient management of energy in crop production. Farmers can often reduce their fuel requirements with no loss in production efficiency by adopting a form of conservation tillage suitable to their individual farm situations. Energy savings, reportedly as

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1/USDA, "Cutting Energy Costs," The 1980 Yearbook of Agriculture, p. 126.

2/USDA, "Cutting Energy Costs," The 1980 Yearbook of Agriculture, p. 129.

high as 80 percent, 1/ are realized primarily by reducing the number of tillage operations and, consequently, the number of trips across a field. 2/ By using conservation tillage, it is not unusual for a farmer to eliminate or combine as many as five crop production operations in a single growing season. A USDA conservation tillage specialist told us that, although the overall potential energy savings available from conservation tillage is reduced somewhat by additional herbicide use, farmers are concerned with on-farm diesel fuel savings, and they generally achieve such savings by adopting the practice.

Conventional tillage is designed to develop a uniform seed bed. It requires a number of operations: ripping open the ground, pulverizing it, and leveling it into a smooth bed. Plowing, disking, harrowing, and cultivating operations require a number of tractor passes over the field. Because conventional tillage moves a lot of earth, it is energy intensive.

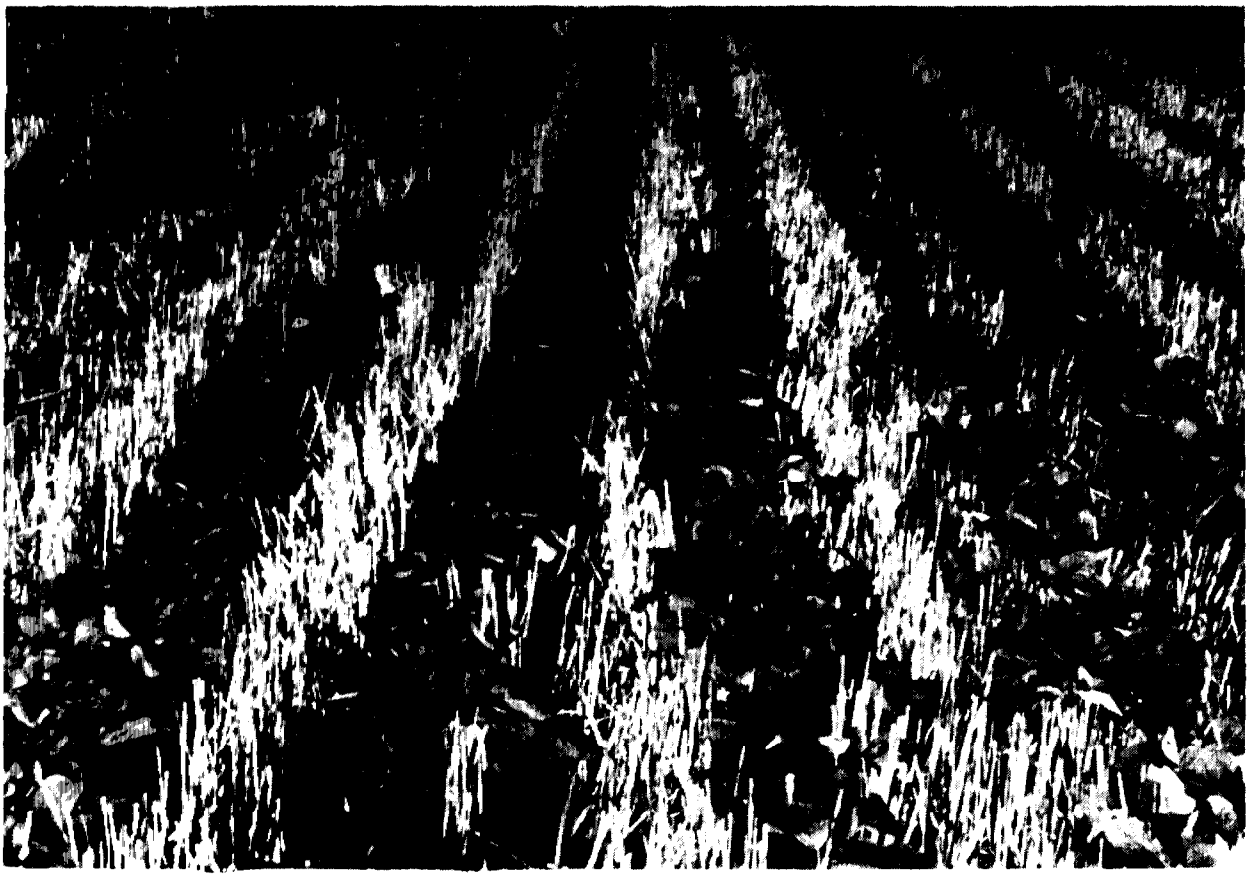
At the other extreme is no-till, a system that disturbs the soil as little as possible. The seed is drilled directly through the residue of the previous season's crop, which has been left on the soil surface. An opening is made in the soil wide and deep enough to receive the seed and cover it. Since there is little movement of soil, equipment of lower horsepower may usually be used. A no-till crop is shown on page 14, and an illustration of a no-till planter is shown in figure 2 on page 15.

Many tillage variations fall between conventional and no-till systems. Typical conservation tillage operations are chisel plowing, till planting, and disking. All of these systems eliminate some of the operations of conventional farming.

Conservation tillage practices are not new, having been first introduced in the early 1940s. Until recent years, reduced tillage practices were used specifically for the preservation of soil. The vegetation left on the field from the previous crop protects the soil from wind and water erosion. With the advent of energy shortages, conservation tillage practices have increased. USDA recently estimated that about 8 million acres of farmland are now being planted with no-till, and an additional 72 million acres are being planted with some form of reduced tillage. This compares to about 1 million acres of no-till and 26 million acres of reduced tillage in 1972.

1/"No-Till: The Oldest Known Farming Method," The Delmarva Farmer, Vol. 5, No. 46, Jan. 20, 1981.

2/According to USDA publications and other studies, however, the need for additional herbicides for weed control with reduced tillage offsets some, but usually not all, of the energy represented by the fuel saved from adopting this practice. Cost savings may also be reduced, depending on the amount of additional herbicide required.



NO-TILL SOYBEANS PLANTED IN WHEAT STUBBLE LEFT FROM THE PREVIOUS SEASON'S CROP. SOURCE: USDA

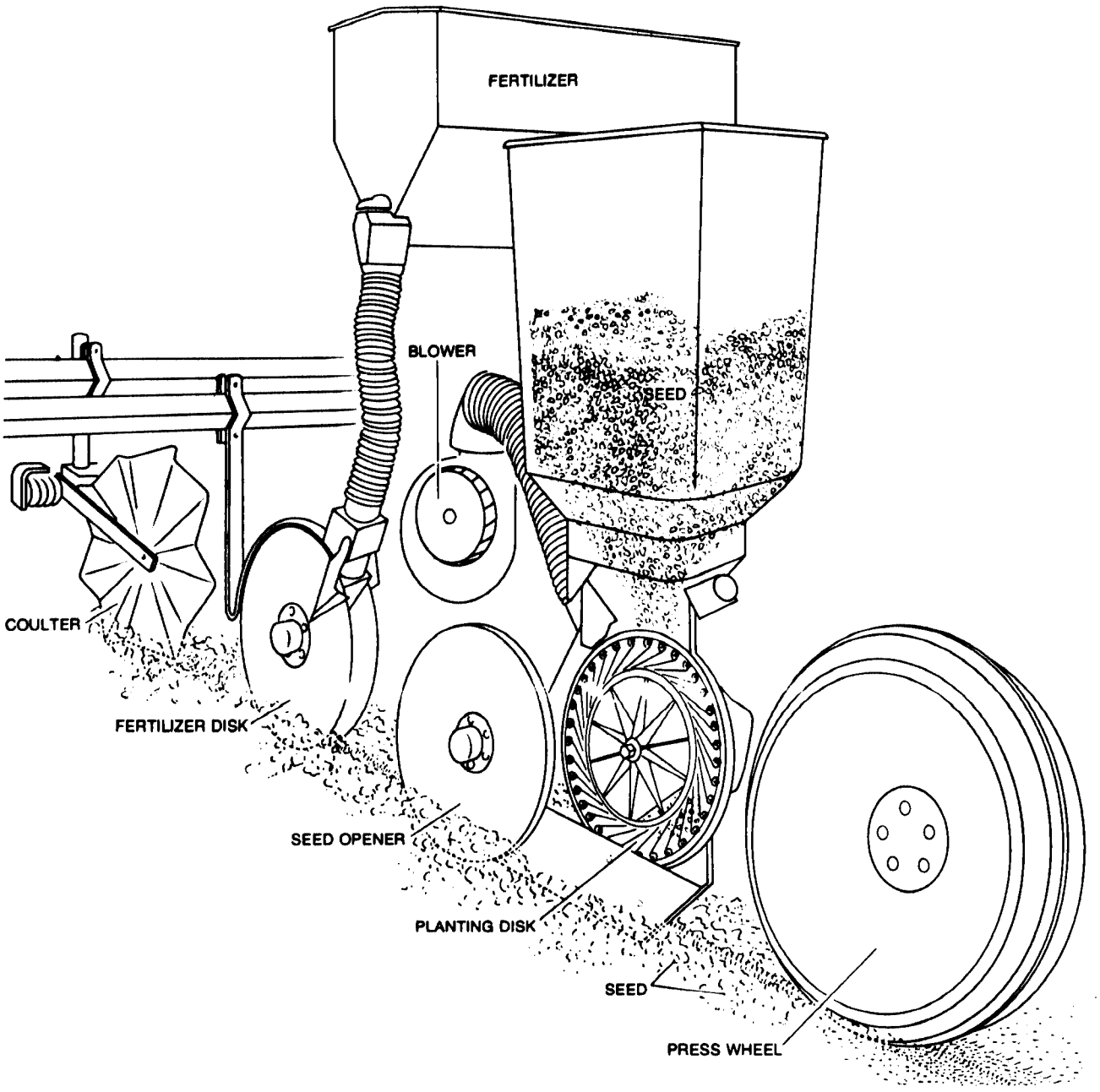
There appears to be potential for future savings. The estimated potential savings of 58 trillion Btu's shown in the table on page 7 was based on what USDA termed a "reasonable goal" of applying conservation tillage on 40 percent of the Nation's 413 million acres of cropland. Using an estimated savings of 2.5 to 3 gallons of diesel fuel for each acre tilled, USDA projected that 413 million gallons of diesel fuel could be saved annually, or about 58 trillion Btu's per year.

Conservation tillage could provide an opportunity to reduce fuel requirements in field crop production in those areas where conditions permit its application. Other studies support the fuel savings potential available to farmers through reduced tillage:

--A University of Kentucky report on no-tillage farming shows fuel is almost always saved in comparison to

Figure 2

No-Till Planter



PLANTING MACHINE employed in a no-tillage system performs several operations at once. The direction of movement of the machine in this drawing is to the left. The first wheel is a fluted coulter that opens a narrow band in the untilled soil, usually cutting also through the residue of the preceding crop, which is left on the ground as a mulch. The coulter is followed by a disk that applies fertilizer. Here the fertilizer is dry, but in some machines it is applied as a liquid. (Herbicide can also be applied at about the time of planting to control weeds.) Next comes a disk, offset from the fertilizer disk by about two inches, that opens the furrow in which the seed is to be planted. It is followed by the planting unit, which receives the seed from the container above it. The seed is forced into the slots in the planting disk by air from a blower; the air also holds each seed in place until the slot approaches the ground and the seed drops into the furrow. The last wheel presses the soil down over the seed. Several units of this kind are normally ganged together in one machine.

SOURCE: Triplett and Van Doren, "Agriculture Without Tillage," Scientific American, Vol. 236, No. 1, January 1977, p. 30.

conventional tillage. 1/ The report concluded that 7-percent energy savings can be realized in individual farming operations by using no-till for corn production, 18 percent for soybean production, and 32 percent for pasture renovation.

--The Journal of Soil and Water Conservation reported no-till average corn yields increased from 104 to 116 bushels per acre, while average soil losses declined substantially. 2/ In addition, fuel requirements were reduced from 5.5 to 2.5 gallons per acre.

In illustrating the effects of different tillage practices on fuel use, USDA estimated that for sorghum, the total fuel used from initial soil preparation through harvesting would be 4.22 gallons per acre for conventional till, 2.79 gallons per acre for minimum till, and 2.17 gallons per acre for no-till. 3/

Despite the positive energy-saving benefits of conservation tillage, some systems, especially no-till, may not be suited for every type of farm. On poorly drained soil, the mulch cover often retains more moisture than desirable during early spring. The moisture in turn retards the warming of the soil and the rate at which the crop grows. When selecting a conservation tillage technique, individual site conditions including soil characteristics, slope, crop rotation, and weather conditions must be considered. Successful use of conservation tillage depends on a management system that considers all crop needs from planting to harvest. Generally, because of the above factors and the need to apply additional herbicides and pesticides, conservation tillage requires a higher level of farm management skill than conventional tillage.

In commenting on our draft report, USDA stated that our report seemed to indicate that a no-tillage system is a panacea and that the draft did not consider other impacts which could negate energy savings. USDA stated that while reduced tillage can be an important factor in farm energy conservation, it is not universally applicable and, also, because of the greater management skills required, the risk factor is higher. In highlighting the possible

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1/University of Kentucky, College of Agriculture and Agricultural Experiment Station, "No-tillage Research: Research Reports and Reviews," Lexington, Kentucky.

2/"Conservation Tillage and Energy," Journal of Soil and Water Conservation, March-April 1977, p. 86.

3/USDA, "A Guide to Energy Savings for the Field Crops Producer," June 1977, p. 11.

disadvantages of conservation tillage, USDA stated that leaving debris from plants on top of the soil can increase the possibility of reinfestation by diseases and insects, which could in turn require additional pesticides, thereby further offsetting some of the energy saved from eliminating cultivating operations. Because of the increased need for pesticides, including herbicides for weed control, USDA stated that total energy requirements are not appreciably less for many reduced tillage practices than for conventional tillage.

USDA also stated that (1) crops grown under a no-till system do not have an economic advantage over those grown conventionally because of the added chemicals needed, (2) environmental restrictions on the use of various pesticides have made minimum tillage a less-feasible technique for energy conservation, and (3) some tillage systems require the use of rippers and bedders and this increases the amount of horsepower required, creating problems if the farm does not have a tractor large enough to do the work.

We do not believe that a no-tillage system is a panacea. Our draft report and this final report point out that, because of certain problems, conservation tillage may not be suited for every type of farm and that local conditions need to be considered. Also, we discuss the differences between no-till, which eliminates all cultivation operations, and other types of conservation tillage which do require some cultivation operations, which may reduce the level of new management skills required, and also reduce the risk as compared with no-till. And, in chapter 3, we discuss the importance to farmers of the risks associated with adopting new farming methods.

We agree with USDA that additional pesticides used with reduced tillage systems can reduce the total energy savings obtainable from the practice. However, as we note in the report, both USDA and research reports have indicated that generally more energy is saved by adopting conservation tillage than is incorporated in the additional pesticides that may be required. And, of particular concern to many farmers, there is a resultant savings of on-farm diesel fuel.

We discussed the Department's comments with USDA officials to clarify them. With respect to its comment that no-till crops do not have an economic advantage over those grown conventionally because of the additional chemicals needed, USDA agreed that its comment was too absolute and should have said that no-till crops "may not have an economic advantage * * *" rather than "do not have an economic advantage * * *." In addition, an SCS official told us that the economic differences between the two systems were generally close, with those farmers who had become experts at no-till enjoying a slight economic advantage, while those still learning sometimes suffered a slight economic penalty.

With respect to its comment that some tillage systems require the use of rippers and bedders and "this increases the amount of horsepower required * * *," USDA agreed that the wording of the comment should be changed to "this could increase the amount of horsepower required * * *." An SCS official told us that the use of rippers and bedders in certain sandy hardpan type soils that necessitate their use, does require more horsepower than normal no-till machinery, but not more than conventional machinery used on that type of soil. Also, fuel is saved compared to conventional tillage because the reduced tillage system which uses rippers and bedders requires fewer passes over the field.

We also obtained clarification of USDA's comment that, "Environmental restrictions on the use of various pesticides have made minimum tillage a less-feasible technique for energy conservation." USDA stated it was not aware of any environmental restrictions that materially affected the adoption of conservation tillage, and that its comment should state, "Further environmental restrictions on the use of various pesticides may make minimum tillage a less-feasible technique for energy conservation."

USDA stated that it supports the use of conservation tillage where it is feasible. It emphasized the importance of farmers investigating local conditions before they embark on any form of reduced tillage. We agree with USDA on this matter and believe our report conveys that message.

Energy savings available from other conservation practices

Energy savings are available from virtually every type of farming function. Many of them are quite simple and require little additional management skills. Common examples include reducing fertilizer use and adopting energy-efficient methods in areas such as grain drying and maintaining farm equipment and fuel systems.

Reducing fertilizer use is important because it conserves energy embodied in the fertilizer through the manufacturing process. 1/ Fertilizer usage could be made more efficient through

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1/Fertilizer use accounts for about one-third of the energy use in crop production. Most of this energy is accounted for in the manufacturing of fertilizer. Natural gas is used not only as a fuel, but also as a source of hydrogen gas for making ammonia, which is used in nitrogen-based fertilizers. We did not address the level of progress being made in improving the energy efficiency of fertilizer manufacture. Clearly, however, if farmers improved their application efficiency and used less fertilizer, the energy used in its manufacture could likewise be reduced.

soil analysis prior to application. Soil testing tells the user the proper amounts and types of fertilizer to be used. According to USDA, only one soil test was taken for every 133 acres of harvested crops in 1979. In commenting on our draft report, USDA stated that an overall testing rate of one in 133 acres is probably inadequate, and the rate probably should be one in 30 to 40 acres to provide adequate information on soil nutrient levels.

One procedure for reducing fertilizer use is to stagger the fertilizer applications to correspond with plant need. Under this procedure, a starter fertilizer is applied initially and later, as the crops begin to grow, energy-intensive nitrogen fertilizer is added. This process, however, according to USDA, may require additional fuel and labor which may negate energy savings from more efficient fertilizer use.

Other fertilizer practices farmers might consider include substituting animal and farm wastes for chemical fertilizer, and calibrating farm machinery to make fertilizer dispensing more exact.

Some other areas in which many farmers could conserve energy are shown below. These practices are, for the most part, relatively simple and do not require major expenditures.

--Adopt energy-efficient methods of grain drying. Examples include using stirring devices, combination drying (high-speed partial drying followed by low-temperature completion), and using cribs for exposing ear corn to prevailing winds. Solar grain drying also saves energy, but may be expensive compared to the above methods.

--Perform regular tune-ups on farm tractors and machinery, a practice that can save up to 10 percent on fuel usage.

--Keep tires of tractors and other farm machinery properly inflated for the task performed.

--Operate tractors in the proper gear for the load and condition. Improper shifting and using the wrong gear can result in a 5-percent fuel loss.

--Use radial tires instead of conventional bias-ply tires. This can improve fuel efficiency by 2 to 6 percent under certain conditions.

--Efficiently maintain fuel handling and storage systems. This can help reduce fuel loss from evaporation, spillage, contamination, and leaks. Examples include keeping tanks shaded, painted white, or underground; monitoring for and repairing leaks; and keeping equipment tanks full to prevent condensation.

--Establish shelterbelts and windbreaks. This practice can save energy in both homes and farm buildings and also help reduce soil erosion.

In commenting on our draft report, USDA said that farm equipment maintenance practices have been a part of the Extension program since tractors were first used, and that the program was intensified in 1972-73 and has been maintained ever since.

CHAPTER 3

RELUCTANCE OF FARMERS TO TAKE ADVANTAGE OF ENERGY CONSERVATION OPPORTUNITIES

Opportunities exist for farmers to save energy by taking advantage of existing near-term energy conservation measures. However, some farmers are not implementing energy conservation actions because they are reluctant to make changes in traditional farming methods, believing that changes in methods which have generally assured an adequate crop yield and income are too risky.

Many of the farmers we spoke with indicated a need for assurances that a change in farming practices would perform as claimed and not give adverse results. In addition, some farmers indicated concern over the economics of investing in high-cost items such as large irrigation systems. To assist in overcoming this reluctance, farmers need adequate information to assure them that the various energy conservation actions are cost effective.

Over many years, farmers have developed specific operating methods which they believe provide assurance that yearly operations will be successful in terms of crop yield and income. Many energy conservation opportunities we identified require changes in traditional farming practices. Farmers we talked to generally viewed changes in operating methods as risky and likely to adversely affect annual yield and profits.

Adopting farm conservation opportunities often involves changes from conventional farm management. Changing from traditional farming can be difficult for some farmers because they trust the traditional methods. Many farmers do not readily accept the changes required in conservation farming. Farmers accept certain ways of doing things as factual, such as applying herbicides, insecticides, and fertilizer based on knowledge derived from conventional farming.

However, because of fuel shortages and higher operating costs, many farming methods considered commonplace only a few years ago are being reevaluated in terms of energy efficiency, lower costs, and increased yield potential. For example, a well-tilled field, barren of all vegetation, was once considered the best environment for planting crops. Now it is becoming increasingly clear that crop residue left on the field not only can reduce energy costs, but prevents soil erosion, permits more land to be farmed, and often results in greater crop yields. Furthermore, irrigation farmers have traditionally irrigated "one more time," yet it has been demonstrated that water applied beyond a certain point in the crop growing cycle has very little, if any, effect on yield and, for all practical purposes, is wasted.

In each State we visited, concern was expressed over adopting energy conservation opportunities, primarily from the standpoint that such a change would include a whole new method of farm management, and secondly, a great deal of economic risk. Many of the farmers we talked to expressed hesitance to change their methods of farming and a need to be convinced a new method will be successful. Farmers believe that changing from traditional farming practices involves a great deal of economic risk, especially when it involves change from a relatively successful practice to one that is new and essentially unproven.

Because of the risk involved in changing from traditional farming, many farmers practice conservation farming in increments. They need to be assured, usually by experimenting themselves, that the practice will work. For example, one Illinois farmer told us he planted 5 acres of no-till corn and was very impressed with the results, obtaining a better yield than from his traditional corn crop. The following year, he still believed it was too risky and planted only 12 acres of no-till corn on his 300-acre corn farm. Also, a farmer in Maryland told us he is willing to consider anything that will save energy and not adversely affect his productivity. However, he said he needs assurances that new technologies will work.

High costs can increase the economic risk associated with investing in certain kinds of equipment. For example, considering the high costs of purchasing or modifying some irrigation systems, farmers must weigh carefully the expected benefits to be gained versus these costs. One Texas farmer said it would cost him about $1,200 per acre to have an energy-efficient irrigation system on his 5,000 acre farm.

Some Federal and State agricultural officials and farmers told us that to help overcome this reluctance, farmers need adequate information adapted to local conditions to convince them that energy conservation actions are economical, practical, and in their best interest to adopt.

Energy conservation information is being provided to farmers through various means. However, this information, because of its general nature, is not necessarily applicable to individual farm situations. An ASCS State Director told us that farmers might have to make several trips to a university to talk with extension personnel familiar with the conservation opportunity or obtain the opinions of several farm experts and technical personnel. Local conditions also affect the usefulness of energy conservation information. The weather, soil conditions, and terrain all contribute to site-specific needs that differ from one location to another. Several USDA field officials told us that much of the information available is either too technical or too general for many farmers to readily apply to their particular farming situation.

CHAPTER 4

THE FEDERAL GOVERNMENT COULD DO MORE TO PROMOTE FARM ENERGY CONSERVATION

USDA has not placed sufficient emphasis on energy conservation. As a result, energy conservation activities among its field agencies vary considerably and in many instances are a by-product of their other agricultural activities. USDA could enhance the energy conservation assistance it gives to farmers by coordinating and focusing its field agencies' energy conservation activities. These activities should include increased emphasis on helping farmers identify cost-effective energy conservation measures applicable to their specific farming situations.

Beginning in fiscal year 1982, no funding for DOE's agricultural energy conservation work was requested or provided, but ongoing projects are being continued, using funds carried over from prior years. The administration requested no funding for DOE agricultural conservation work for fiscal year 1983. DOE needs to be sure its existing agricultural projects will be properly managed and that the results of these projects are made available to the agricultural community.

PAST EFFORTS FAILED TO REALIZE ENERGY CONSERVATION POTENTIAL

Both USDA and DOE have recognized the importance of energy to agriculture and have taken steps, both individually and jointly, to reduce farmers' dependence on non-renewable energy sources. Both Departments have emphasized solutions, many of which are long range, such as developing fuel substitutes and new technology. Promoting energy conservation has not been accorded much emphasis, and most energy savings presently being achieved are incidental to the thrust of USDA's programs that conserve soil and water. DOE's agricultural work mostly entails research projects with long-term benefits and little direct involvement with farmers.

In 1977, the Secretary of Agriculture established a committee to develop a USDA strategy for the efficient use and conservation of energy and the development of energy resources in various phases of agriculture. The following year, the Secretary gave increased priority to agricultural energy matters by establishing USDA's Office of Energy. The Office was to serve as a focal point for all USDA energy-related matters. Its responsibilities included

--developing energy policies and strategies,

--coordinating programs to meet energy-related goals,

--reviewing and evaluating energy-related programs and progress, and

--representing USDA at meetings on energy matters with other Government agencies.

Among its tasks, the Office began to develop an overall USDA energy plan. In addition, the Secretary, in July 1978, announced a goal of net energy self-sufficiency in agricultural production by 1990. The goal was to be pursued through a combination of energy conservation and extensive technology transfer, including development and use of alternate fuels.

Unfortunately, these efforts were never fully implemented. The Office of Energy was not effective in developing energy-related strategies or coordinating USDA's energy efforts. The Office was abolished in August 1980, and its responsibilities transferred to a lower operating level. 1/ Work on developing a USDA energy plan ceased and, according to a USDA official, is still in abeyance, pending further direction from the Secretary's office.

Because both DOE and USDA had responsibilities in agricultural energy matters, the Secretaries of Energy and Agriculture in 1978 jointly signed a Memorandum of Understanding to clarify the roles and interests of each Department and to provide a means for cooperation between them. Among the goals outlined in the memorandum were those to assure adequate energy supplies for agriculture and to improve the energy efficiency of agricultural production.

A USDA official told us that joint USDA/DOE activities pursuant to the 1978 Memorandum of Understanding are pretty much nonexistent, with the exception of work being done to develop biomass and alcohol fuels. The reasons, according to the official, are (1) the uncertainty of DOE's continued existence as an agency and (2) inadequate staffing at both USDA and DOE.

USDA field agencies have only been partially successful in promoting energy conservation opportunities. Some field agencies do more for promoting energy conservation than others, especially those agencies which have field personnel actively involved in providing farmers with direct assistance, since they are likely to be more aware of the need for farmers to conserve energy. These efforts, however, are not uniformly focused within USDA and rarely provide sufficient emphasis on energy conservation. In addition, CES field personnel have wide latitude in determining what information or assistance they provide to farmers.

1/The Office of Energy was reestablished in USDA on December 22, 1981. (See p. 26 of this report.)

Consequently, the quantity and quality of energy conservation information provided varies among locations, depending on the agent's determination of what areas warrant emphasis and his or her level of expertise. For example, due largely to the efforts of the county agent to promote no-till farming in a Maryland county, over 90 percent of the farmland in that county and the surrounding area is now farmed with conservation tillage--primarily no-till. In another location, the agent may give some other subject, such as herbicide application, a high priority, and devote little effort to promoting energy conservation.

At the headquarters level, the former Science and Education Administration (SEA) 1/ and SCS initiated energy conservation efforts to define energy roles for their respective agencies. SCS, in 1980, drafted a position paper to assess what its role should be in a coordinated effort to reduce dependence on petroleum-based energy sources. The paper considered three levels of involvement, which included support and promotion of energy conservation, and made specific recommendations that have not yet been acted upon. SEA completed several studies to develop a strategic plan for assessing its energy program capabilities and opportunities.

USDA field personnel told us that, although they believed their energy efforts do not go far enough, they promote energy conservation indirectly through soil and water conservation programs. For example, both CES and SCS field personnel in Texas were learning how to test irrigation pumps to conserve water and energy. Also, SCS and ASCS representatives were demonstrating conservation tillage as a soil erosion prevention measure. These efforts, for the most part, are localized, as USDA field personnel said they rarely receive direction pertaining to energy conservation from the headquarters or departmental level.

Several field representatives indicated that some coordination exists at the county level because of the close working relationship at this level between farmers and Government representatives. Officials from FmHA and ASCS felt their energy conservation efforts in the field were not as effective as they could be because of the lack of priority placed on energy activities by headquarters.

1/SEA was comprised of several USDA agencies--Agricultural Research, Cooperative Research, Extension Service, and other smaller activities. On June 17, 1981, a reorganization within USDA eliminated SEA. Four program agencies--Agricultural Research Service (formerly SEA-AR), Cooperative State Research Service (formerly SEA-CR), the Extension Service, and the National Agricultural Library--report to the Director of Science and Education.

USDA SHOULD HAVE A MORE FOCUSED APPROACH TO ENERGY CONSERVATION

USDA could enhance the energy conservation assistance it gives to farmers if USDA field personnel (1) gave more emphasis to helping farmers identify energy conservation measures applicable to their specific farming situation and (2) made available to farmers the experiences of other farmers when encouraging measures which require a change in farming operations. Information on the economic and technical aspects of energy conservation measures can assist farmers in making decisions on adopting such measures. USDA, through its recently reestablished Office of Energy, could take the lead to assist field agencies in coordinating and prioritizing energy conservation outreach to farmers.

Recent events within USDA and DOE suggest the need for a more focused approach on energy matters. In December 1981, USDA reestablished its Office of Energy and realigned certain energy functions within the Department. The new Office is to be responsible for departmental energy policy development and for the coordination of energy programs and strategies for the allocation of scarce fuel resources. DOE, on the other hand, due to recent funding reductions (see below), is reducing many of its conservation activities, especially its agricultural programs. Consequently, USDA will be the only Federal agency with a major agricultural energy role.

The reestablishment of the Office of Energy indicates a recognition by USDA of the importance of energy to its agricultural responsibilities. While energy conservation is not specified as a functional activity for the Office, its Acting Director stated the Office's authority allows it to address conservation.

We found there was little coordination and emphasis on energy matters at the headquarters level. For example, the ASCS officials responsible for energy matters told us it had been over a year and a half since they last worked with USDA's Energy Staff. 1/ And, the SCS Energy Coordinator was detailed to another assignment during 1981; the position was subsequently eliminated. We believe such coordination and emphasis are necessary to both focus the activities of the various field agencies and to eliminate any potential duplication of effort. We further believe that USDA's Office of Energy, consistent with its responsibility for departmental energy policy development and coordination, could be the focal point and help assure coordination on energy conservation matters among USDA's agencies.

1/The Energy Staff was the predecessor group to USDA's newly reestablished Office of Energy.

RESULTS OF DOE'S AGRICULTURAL PROJECTS NEED TO BE MADE AVAILABLE TO FARMERS

DOE has several ongoing agriculturally related energy projects. USDA currently participates in the field management of these projects, thereby providing a link with the farming community in the projects' development. However, USDA's involvement is expected to soon terminate. Also, due to funding reductions DOE's agricultural energy conservation work can be expected to become virtually nonexistent. Because of these developments, we are concerned that the projects may be completed without adequate coordination with the farming community, and information developed by the projects may not be readily available to farmers.

DOE's agricultural energy work has mostly involved sponsoring research, development, and demonstration projects. Such projects, costing about $7 million, were designed to develop and demonstrate technologies that will increase the energy efficiency of agricultural production. A major effort is on Energy Integrated Farm Systems projects. These are intended to demonstrate an energy self-sufficiency farming concept through the production of energy from on-farm energy resources (biomass) and certain energy conservation practices, such as conservation tillage and waste heat recovery. USDA participates in the field management of these projects through the assignment of a technical advisor. 1/ At the time of our review, DOE was funding eight such projects at a cost of over $3 million; all were in the design or early implementation phases. These projects are scheduled to be completed by 1985, at which time DOE plans to issue a report on their results. DOE also funded irrigation projects which were completed during our review, and final reports are being published.

DOE's overall energy conservation appropriation dropped from about $865 million in fiscal year 1981 to about $145 million in fiscal year 1982. 2/ No funds were provided in fiscal year 1982 for the Agriculture and Food Processes Branch, and the administration has requested no funds for fiscal year 1983. Even though additional funding is not being provided, funds have been set aside from prior-year obligations to provide for completion of the EIFS projects.

1/An Interagency Agreement is in effect between the two Departments, whereby DOE provides funds to support a USDA senior scientist, with research and agricultural extension background, to provide field management and technical monitoring of the EIFS projects.

2/In addition to new appropriations of $145 million, there is an additional $240.7 million available, made up of deferrals from fiscal year 1981 appropriations plus transfers from other DOE appropriations.

As a result of the funding reductions, the organizational basis for carrying out further agricultural energy conservation efforts has been effectively terminated. DOE transferred responsibility for managing the EIFS projects from headquarters to its Idaho Operations Office. Also, in commenting on our draft report, USDA stated that there are insufficient pass-through funds from DOE remaining to allow its existing participation in the field management of the EIFS projects to continue.

Because DOE's agricultural energy conservation work can be expected to become virtually nonexistent, and USDA's formal participation in that work is expected to be discontinued, we are concerned as to whether the projects' development will be coordinated with the farming community and also whether the information resulting from the projects will be made available to assist farmers in adopting conservation technology. We believe that USDA, as the primary Federal agricultural research entity, should be responsible for the projects' overall management and control. In this way, the projects would benefit from USDA's expertise, and the process of transferring to farmers the information developed could be streamlined and made more effective. USDA's field agencies, because of their direct contact with farmers, appear to be the logical means for transferring the information generated by these projects to farmers.

CHAPTER 5

CONCLUSIONS, RECOMMENDATIONS, AND AGENCY COMMENTS

CONCLUSIONS

Agricultural production annually consumes nearly 3 percent of all U.S. energy. Because most major farm operations are energy intensive, farmers are especially vulnerable to supply disruptions and higher fuel costs. The potential for saving farm energy is great--over 74 million barrels of oil equivalent could be saved annually, much of it by farmers adopting identified energy conservation practices.

Some farmers, however, are not implementing energy conservation actions because they are reluctant to make changes in traditional farming methods, believing that changes in methods pose an economic risk. To assist in overcoming this reluctance, farmers need adequate information to assure them that the various energy conservation actions are cost effective.

USDA could better assist farmers in making decisions on adopting energy conservation measures. This could be done by developing a conservation strategy which would include providing information to farmers on the economic and technical aspects of the measures as well as their applicability to specific farming situations. We believe that such information could be provided through USDA's existing field agencies which now provide advice and assistance to farmers on all agricultural matters. At the headquarters level, the new Office of Energy could be the focal point for energy conservation.

Due to recent changes in DOE's budget, its agriculturally related energy conservation efforts will cease, and USDA's involvement is expected to terminate. We are concerned that DOE's ongoing EIFS projects, which have been funded through completion, may not be developed in coordination with the farming community and that their results may not be readily available to farmers. In our view, USDA, as the agency responsible for the Federal Government's agricultural activities, ought to manage and oversee the EIFS projects to completion.

RECOMMENDATIONS

We recommend that the Secretary of Agriculture assign to the newly reestablished USDA Office of Energy, responsibility for developing and carrying out an enhanced effort to promote energy conservation by farmers. Using its broad authority, this Office could coordinate and influence energy conservation activities of USDA's field agencies to help assure that farmers receive assistance in identifying cost-effective energy conservation measures applicable to their specific farming situations.

We also recommend that the Secretaries of Agriculture and Energy enter into an Interagency Agreement, pursuant to the general USDA/DOE Memorandum of Understanding, for USDA to perform the overall management and monitoring of DOE's ongoing EIFS demonstration projects. This should help assure that the Government's interests are protected and that the results of these projects are made available to the agricultural community.

AGENCY COMMENTS

This report was provided to DOE and USDA for their review and comment. Due to their length, USDA's detailed comments are not reproduced in this report, but are available on request from us. DOE's comments are included as appendix I.

USDA comments

USDA expressed principal concern with the report's treatment of the following three areas:

--The economics of agriculture.

--The potential for energy conservation in agriculture.

--The mechanism of information transfer to farmers.

In addition, USDA disagreed with our recommendation to assign to its Office of Energy specific energy conservation responsibility. USDA agreed, however, with the thrust of our recommendation that it manage and monitor DOE's ongoing agricultural energy conservation projects.

The economics of agriculture

USDA stated that our report ignored economics as the most important factor influencing energy conservation in agricultural production. USDA stated that economic feasibility is the primary factor in stimulating energy conservation in agriculture and that our report failed to identify the cost of energy conservation as an impediment to energy conservation efforts. USDA believed that large investments would often be necessary to add more efficient machinery, equipment, and buildings.

We agree that economic feasibility is the primary factor in stimulating energy conservation in agriculture. We believe, however, a farmer's level of awareness of available energy conservation opportunities is also a key element because it reflects the kinds and extent of energy conservation actions that can be taken. We further believe that detailed economic feasibility analyses of specific conservation measures would not have been appropriate, since the variable nature of farming operations, soil and weather conditions, and the skill of the individual farmer would weigh heavily in determining the economic success of these measures. Based on USDA's comments, we have given increased recognition to

the importance of economics in farmers' decisions about energy conservation and clarified our scope in chapter 1. (See p. 4.)

The potential for energy conservation in agriculture

USDA stated that the report (1) indicates a greater potential for energy savings than exists and (2) implies that the Department's main goal is the conservation of energy.

With respect to the savings potential, USDA pointed out that the estimated annual potential energy savings in agricultural production--about 74 million barrels of oil annually--would not have a significant impact on the Nation's energy consumption since it is only 0.6 percent of current U.S. consumption. As stated in the report, the 74 million barrels is based on USDA estimates and while we agree that it is a small fraction of total annual consumption, we believe that, in absolute terms, 74 million barrels of oil is a considerable amount of energy, and achieving such savings is a goal worth pursuing.

With respect to USDA's belief that our report implies the Department's main goal is the conservation of energy, it took exception to our contention that opportunities for short-term energy savings should be stressed in certain areas. USDA pointed out that its principal responsibility is the continued production of food and fiber for the people of the United States and the world. USDA added, however, that while opportunities for energy savings in agriculture exist and should be pursued, they should be considered as part of the whole.

In explaining its position, USDA stated our arbitrary selection of three areas of possible energy savings subverts the mission of the Department and is a basic weakness of the report. USDA said that all areas of energy savings in food and fiber production, whether resulting in short-term or longer term conservation, are its concern and to single out three areas in crop production is wrong.

We agree with USDA that its principal responsibility is the continued production of food and fiber. We are not implying that USDA's main goal is the conservation of energy. As the report points out, it is because of the importance of energy to these principal responsibilities that USDA engages in energy-related activities, including the recent reestablishment of its Office of Energy.

Regarding USDA's statement that we arbitrarily selected water management (irrigation), conservation tillage, and reduced fertilizer application as areas where short-term energy saving opportunities should be stressed, we disagree that such areas were arbitrarily selected. As stated in the report, our review looked

primarily at opportunities to save energy in crop production because it uses almost 90 percent of all energy used in agricultural production. Within crop production, the areas of water management, conservation tillage, and reduced fertilizer use offer the greatest possible savings according to USDA's own estimates. We recognize that there are numerous ways farmers can conserve energy; however, the areas we selected were on the basis of their possible energy savings.

The mechanism of information transfer to farmers

USDA objected to our view of the Department's role in providing information to farmers and stated that our conclusion that university reports are, in many cases, too technical to be of assistance to farmers represents a serious misunderstanding of the role of research in agriculture.

USDA said the report seems to imply that the Department should take a personal service or consulting role in the dissemination of energy conservation information and, further, that the report claims the lack of individualized one-on-one energy conservation planning with farmers is a weakness of the USDA program. The Department said it was irresponsible for us to suggest that a massive individualized public energy conservation effort would be warranted. USDA explained that a call for individualized services ignores the role of the Extension Service as envisioned by the Congress. USDA said the Extension Service was neither organized nor funded to perform personal services for each of the 2.4 million farms in the Nation, but rather to provide information about options and alternatives to allow farmers to make their own decisions. Finally, USDA said that while it has encouraged certain agricultural practices such as contour planting and soil erosion prevention, it has neither the authorization nor the inclination to make farmers' decisions for them.

We are not suggesting that USDA provide a personal consulting service to farmers or make farmers' decisions. Rather, the report suggests that USDA could better assist farmers in making decisions on adopting energy conservation measures through information provided by its own field personnel and its influence of CES programs, particularly the activities of the local county agents.

With respect to USDA's comment on the technical nature of research reports, this section has been eliminated from the final report. We believe that farmers' reluctance to adopt energy conservation actions results largely from insufficient site specific information rather than from information that is overly technical.

USDA's comments on our recommendations

With respect to our recommendation that the Secretary of Agriculture assign specific responsibility to USDA's Office of

Energy for developing and carrying out an enhanced effort to promote energy conservation by farmers, USDA stated that the recommendation is beyond the scope of the Office of Energy and in opposition to administration policy. USDA stated the administration believes that by deregulating energy prices, consumers will make investment decisions without Government involvement or artificial stimulation. USDA also stated that our recommendation that the Office of Energy coordinate energy conservation activities of USDA's field agencies would duplicate work already performed by several USDA line agencies and is not within the delegation of authorities to the Office.

We believe energy conservation should receive greater attention by USDA. Energy conservation is an area in which the Office of Energy could become involved. We noted that while this Office was not established specifically to promote energy conservation, its Acting Director stated the Office's broad authority would permit it to do so. Also, in its comments, USDA said that the Office has a mandate to (1) serve as a focal point for all USDA energy and energy-related matters, (2) coordinate department-wide energy policy, and (3) review and evaluate all energy and energy-related programs. We are suggesting that more attention be given to providing appropriate information to farmers concerning the benefits and specific techniques of conservation farming. This can be done by USDA's field agencies through their existing programs that provide advice and assistance to farmers on all aspects of agricultural matters.

We further believe that the Office of Energy could serve as a focal point to coordinate the energy conservation-related activities of the field agencies. We do not agree with USDA that such a role would duplicate these agencies' activities. Despite USDA's disagreeing with our recommending a coordinating role for the Office of Energy, its mandate, as stated by USDA in its comments, would seem to put it in a unique position to carry out such a role.

With regard to our recommendation that USDA manage and monitor DOE's ongoing agricultural energy conservation projects, USDA stated it would be appropriate that it perform these functions. USDA said that this would be logical, since DOE's funding for agricultural energy conservation work was terminated and no funding was requested for 1983. USDA stated further that if the projects are to be transferred, the transfer should be done as soon as possible so the Department could compare their operations with similar farming operations that do not have energy-integrated systems. In that manner, USDA said it could demonstrate to farmers the advantages of integrating renewable energy systems into conventional operations.

USDA expressed concern, however, over how any additional management activities on its part would be funded and whether a separate Interagency Agreement at the Secretarial level (which it said would create additional expense and paperwork) was necessary. USDA stated it would be reluctant to accept full responsibility

for the DOE projects unless sufficient funding was transferred with the projects to provide for proper management. We note that the general Memorandum of Understanding between the two Departments states that the specific details of the funding support to be furnished one Department by the other will be developed in specific Interagency Agreements. DOE and USDA need to resolve the financial arrangements for carrying out the activities to be transferred and include the details of such arrangements in the Agreement. Furthermore, we are not suggesting that this negotiation necessarily take place at the Secretarial level, but that the Secretaries assure that the transfer is carried out.

USDA also commented on our concern over the future management of the EIFS projects and how information developed by them would be made available to farmers. USDA said that CES (from the county agent to the director) in each of the seven States and Puerto Rico where these projects are located have agreed to participate in disseminating the results of the projects as they develop, and all have agreed to cooperate in the project development. While we agree that local CES involvement is important, we believe that as long as the projects are managed remotely by DOE, their development may not be adequately coordinated with the farming community. This is particularly significant in view of USDA's comment that its existing participation in the projects, through the assignment of a technical advisor, will soon terminate due to a lack of pass-through funds from DOE. Also, while USDA has some agreements for CES involvement in the counties or States where the projects are located, we are concerned that information on the projects' results may be confined to those areas and not receive wider distribution. Furthermore, as indicated above, USDA's comments stated that if the Department managed the projects, it could make comparisons between the EIFS projects and traditional farming operations and, in that way, demonstrate the EIFS advantages to farmers.

DOE

DOE commented on two aspects of our report:

--Whether information resulting from DOE's EIFS projects would be made available to farmers.

--The recommendation for an Interagency Agreement to transfer the management and monitoring of the EIFS projects to USDA.

DOE stated it was developing an information transfer plan cooperatively with USDA which would indicate how the results of the EIFS projects would be transferred to the farming community. DOE stated that USDA had prepared a first draft of this plan, which was under review. In a meeting with DOE to clarify its comments, an official told us the plan at this stage was only conceptual. In our opinion, how or when any of the information will be made available to farmers is still uncertain due to both

the lack of a definitive plan and financial support for information transfer and the expected cessation of USDA's formal involvement in the projects. In view of the reduced funding levels for DOE's agriculturally related energy projects and its likely effect on the projects' development and upon an effective means of information transfer, we continue to believe the management of these projects should be transferred to USDA.

With regard to our recommendation for an Interagency Agreement, DOE stated that USDA and DOE currently have an active Interagency Agreement in effect which could allow for transferring the projects to USDA. DOE stated further, however, that because of the existing coordination between the two Departments, it did not believe that transferring management of the projects to USDA was necessary.

DOE subsequently clarified its comment regarding the need for a separate Interagency Agreement. DOE officials told us that the general Memorandum of Understanding provides authority for an Interagency Agreement to transfer overall management and monitoring of the EIFS projects to USDA. They said the agencies could either modify their existing agreement or enter into a new one.

APPENDIX I

Department of Energy
Washington, D.C. 20585

APR 1 1992

Mr. J. Dexter Peach
Energy and Minerals Division
U. S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

The Department of Energy (DOE) appreciates the opportunity to review and comment on the GAO draft report entitled "Accelerating Farm Energy Conservation Efforts: USDA Could Provide More Help to Farmers." The GAO draft report recommends that, in view of DOE's recent budget reductions, the United States Department of Agriculture (USDA) be given responsibility for management and monitoring of DOE's ongoing agricultural energy conservation projects.

As pointed out in the GAO draft report, DOE is currently funding eight Energy Integrated Farm Systems (EIFS) demonstration projects. Responsibility for contract management and project monitoring of these projects has been established in DOE's Idaho Operations Office, where a highly qualified team of engineers and scientists has been assembled to assist in administering the project. Funding through project completion in 1984-85 has been provided from prior year obligations.

GAO's draft report expresses concern as to whether the information resulting from the EIFS projects will be made available to assist farmers in adopting energy conservation technology. Currently under development in DOE is an EIFS technology information transfer plan, which will indicate how the results of the EIFS projects will be transferred to the farming community. Although the EIFS program is in the early stages of implementation, the plan is being developed at this time so that, when the projects have some results to be shared, the mechanism for transmitting them will be in place. The plan is being developed cooperatively by USDA, DOE headquarters and the DOE Idaho Operations Office. The first draft has been prepared by USDA and is currently under review.

The plan will incorporate two principal means for making appropriate information available to the farming community. First, it will involve the land grant university Colleges of Agriculture with their Cooperative Extension Services and Agricultural Experiment

Stations. To date each land grant university in a state with an EIFS project has had a briefing on the project located in its state. Further, each university is being kept informed of progress on a regular basis. The plan also calls for the training of the Cooperative Extension County Agents, who will be the principal means for getting information to the local farmers. The universities will also be asked to use their publications to promote information dissemination on the projects.

A second group to be utilized will be the trade associations representing farmers. The trade associations have a wide audience, which is reached by means of trade publications published on a frequent and periodic basis. Approximately six associations have been initially identified to assist in developing a plan to disseminate EIFS program results.

With respect to the draft report recommendation for the Secretaries of Agriculture and Energy to enter into an Interagency Agreement, pursuant to the general USDA/DOE Memorandum of Understanding, USDA and DOE currently have an active Interagency Agreement in effect which could allow for transfer of the project to USDA. The USDA has worked closely with DOE on the EIFS program from its inception. USDA has provided assistance to the eight project managers by arranging technical assistance, conducting onsite and project reviews, working with the Cooperative Extension Services and attending EIFS project review meetings. The USDA provides DOE with a monthly report of its activities and has worked closely with DOE on a continuing basis. Because of the close coordination with USDA on these efforts and the capable management provided by the Idaho Operations Office, DOE does not feel it is necessary to transfer management of these projects to USDA.

DOE appreciates the opportunity to comment on the draft report and trusts that GAO will consider these comments in preparing its final report.

Sincerely,

William S. Heffelfinger
Assistant Secretary
Management and Administration

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