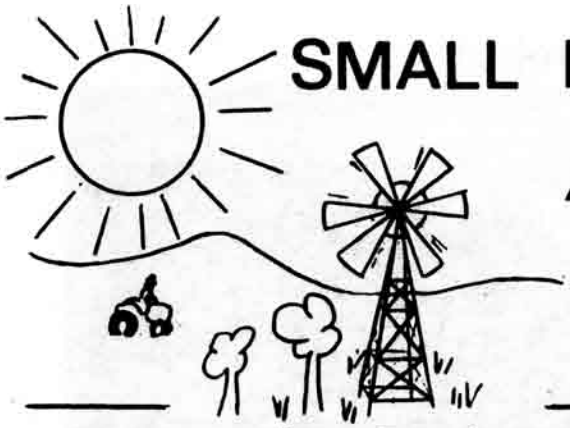


SMALL FARM ENERGY PROJECT

A Final Report Summary

"With the goal of 'energy self-sufficient farms' as the future of agriculture."

A Project of the Center for Rural Affairs

Research Project Assists Low-Income Farmers

In October, 1976, the **Center for Rural Affairs** of Walthill, Nebraska started the Small Farm Energy Project **as a three year research and demonstration project** funded by the Community Services Administration. The Project, now completed, was conducted on **48 cooperating, low-income farms in Cedar County, Nebraska.** The Center developed the Energy Project to demonstrate that the adoption of alternative energy technologies by small family farms can make positive contributions to their incomes.

Premise of the Energy Project

Use of energy in agriculture has become increasingly controversial. Our **farms and our food supply are increasingly dependent on purchased energy inputs,** vulnerable to changes in both the price and availability of fossil fuels. In the past three decades, the emphasis in American agriculture has been placed on **farm expansion with the adoption of mechanization.** The gasoline and diesel fuels necessary to operate these machines account for 70% of agricultural energy use in the Northern Plains and Corn Belt. With this dependence on fossil fuels, it is alarming to realize farm **energy costs have nearly doubled in the 1975 to 1979 period.**

At the same time, the expansion of farms by use of energy and energy-intensive technologies has dramatically altered the economic structure of American agriculture, **resulting in diminished economic opportunity for rural people.** The small farmer has been sold out to the large and expanding operator making use of energy-intensive technolgies. The complexity and expense of energy-intensive farming make intimidating barriers to young couples trying to get a start in farming. **Thus small family farmers are directly threatened by large-scale mechanization developed in an era of cheap energy.**

Implicit in these conditions is an irony: **the energy crisis is an economic opportunity for America's small family farmers.** Where creative minds are applied to the development of low-cost alternative energy systems for use on farms with limited resources, small family farmers can reduce costs of production and increase net incomes. In response to the energy crisis, the small family farmer can make use of renewable energy resources, demonstrating that skills and resourcefulness, the human factor, is once again at a premium in agriculture.

Energy Saving Demonstrations

The Project's basic objective was to demonstrate the impact of proven energy-saving innovations and conservation techniques on the energy use, cost of production, and net incomes of small, low-income farmers. It measured the energy consumption and net farm income of two comparable groups that do and do not adopt energy-producing and energy-saving practices. **Twenty-four cooperating farmers agreed to innovate with alternative energy projects on their farms.** The remaining record-keeping farmers made a pledge not to. Both groups kept detailed records. The results hold promise that **farmers can respond to the energy crisis by making more efficient use of the** energy they purchase and by producing their own energy.

The Project involves only "appropriate-use" alternative energy innovations. Such innovations are:

- **—low-cost** using locally available materials
- **—home-built** making use of common farm skills
- **—easy to manage and maintain**
- **—meeting constraints existing on the farm**
- **—cost-effective.**

By combining the common sense of the farmer with the experience of the professional, practical innovations meeting the needs of the farm are developed. Important agrarian values are supported by **this process which empowers small farmers in their community.**

Key Project Findings

Farmers participating in the Energy Project kept detailed records on farm inputs, production, and sales. Record books also provided information on field and livestock operations. The records show that there is considerable variance in the way these diversified farms operate. In 1976, at the beginning of the Energy Project, farms in the "innovative cooperator group" and in the "record keeping group" had similar energy use.

Key findings of the Project were the following:

—Liquid fuels represent 46% of energy use on the small western corn belt farm; electricity another 27%; heating fuels about 14%; and fertilizers about 13%.

—Energy consumption has increased 24.5% in the 1976-1979 period; energy expenditures increased 62.6%.

—Energy use for farm production comprises 60% of the small farm's energy consumption; 40% is for domestic use in space heating, electricity and non-farm transportation.

—The general trend among farmers toward larger horsepower diesel tractors, which compete with residential demand for heating fuels and which are less amenable to ethanol fuels, is apparent among small farmers in this study.

—A trend toward specialized farm operations was evident among participating farmers though such energy-intensive practices were shown to have **heightened dependance on energy** and vulnerability to energy price increases.

—Cost-effective solar energy innovations that farmers build themselves using locally available materials can be low-cost, easy to maintain and may be applied to a variety of farm energy needs.

—In 1979, an average of $1138 in energy expenses per farm was saved by innovating farmers, compared to their counterparts—a reduction of 17% in three years. **Nearly 70%** resulted from the adoption of energy-efficient farm practices using conventional farm technology, indicating the importance of **energy conserving attitudes and farm practices,** such as making better plans for trips to town, re-evaluating fertilizer purchases, and more frugal use of machinery.

—Various forms of alternative energy are not always appropriate for each small farm. Cost effectiveness is site or farm "specific".

An Alternative Research Project

On-Farm Research Conducted

The Energy Project has differed from most attempts at agricultural research because its purpose was not to develop sophisticated technology to enhance specialized farm output per unit of labor —the conventional approach which breeds antagonism among farmers as they race to keep up with technological change. Instead, **this Project has worked to adapt proven alternative energy technologies to the existing farm operation,** making the farmer an active participant in practical research. In this community-based approach to agricultural research, the products were not so much devices for the farm as skills for the farmer. **Actively involving the farmer in much of the research** has provided a real life situation rather than the artificial atmosphere of a laboratory farm.

This research approach **joined the practicality of the farmer with the alternative energy technologies available to him. The farmer determined whether or not the technology was appropriate for his farm.** Small farmers have traditionally been innovative and as a result the farmer is best able to deal with his problems if he is provided with some technical assistance.

The **self-selection strategy** was utilized throughout the cooperating farmer's process of undertaking an alternative energy innovation and **included the following steps:**

—Consideration of potential innovations at workshops and field-days

—Selection of an innovation suited to the farmer's needs

—Construction of the project with technical support provided

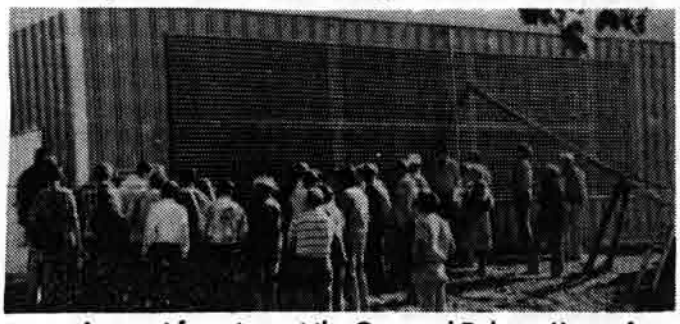
—Monitoring of the innovation's performance

—Sharing with others the experience of implementing the project

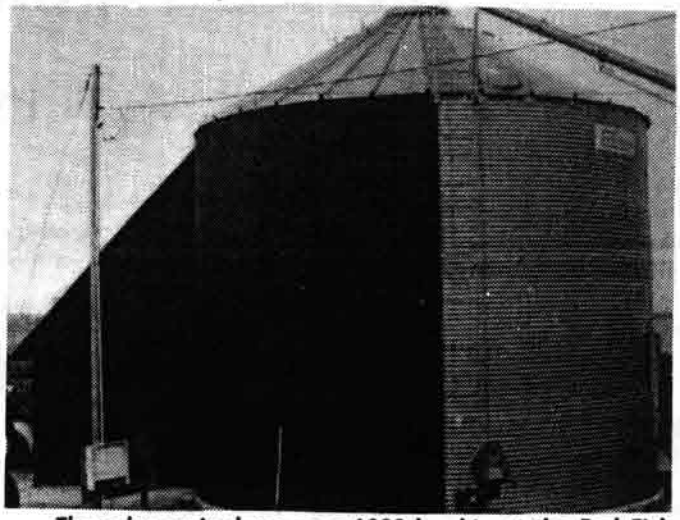
The farmer was responsible for taking the initiative during each of the stages of the process. He also had the opportunity to reject the project as inappropriate for his farm. As a result, **the group of farmers serve as a "technology review panel."** The availability of time for the busy small farmer is also an important aspect that is a consideration prior to selecting an innovation. It was nearly one year after the Project began before the first major innovation was constructed.

The innovations farmers have chosen would indicate that the **self-selection strategy has worked very well.** Monitoring of the output of the projects by the farmers themselves substantiate that **farmers are good judges of what is practical. The most popular projects have proven to be the most cost-effective.**

Another important feature of this community based research effort has been an **advisory committee** of prominent Cedar County citizens, who helped to provide local community support. By incorporating community involvement in the research process, local desires and problems can be addressed.



—A recent farm tour at the Gary and Delores Young farm provided visitors the opportunity of studying the vertical wall collector for heating the dairy barn. The dairy facility also utilizes a heat exchanger which uses heat from the milk cooling system for heating water, thereby saving energy.



—The solar grain dryer on a 6000 bu. bin at the Earl Fish farm, Belden, Nebr. Fish, a cooperator of the Energy Project, has successfully dried grain using the solar system for three years. The collector saves over $100 per year in drying costs during his corn harvest.

Project Participants

The participants in the Project were typical operators of the smaller, well-kept farms in the rolling hills of Cedar County that maintain livestock as the final product for market. **Hogs and dairy cattle are the mainstay of these family farms.**

The Project's target group was low-income farmers with net incomes within 125 percent of the poverty level established by the federal government. Average gross farm income in 1977 for Project participants was $36,000. **Net income in 1977 averaged $3,700 per farm, although energy costs, including fertilizer costs, exceeded $4,000, mostly for motor fuels and space heating.**

Farmers who participated in the Project grow corn, oats, alfalfa, and some soybeans on an average of 240 acres of cropland. Including land in pasture and the farmstead, the average **total farm size was 357 acres.** Farmers depend largely on crop rotations to maintain soil fertility though some commercial fertilizer is applied. The farms provide most of the family income and take the labor of the whole family (average size of five) even though they are fully mechanized (an average of 3.4 tractors per farm).

The difference between the small diversified farm and the large specialized farm, centers on the conflict between traditional agrarianism and modern industrial values. The following comments of Project participants describe much better than any summary their **attitudes toward farming, farm size and mechanization.**

"When you are farming a limited acreage you can't have a big investment in machinery. No matter how much money you are handling you can't live beyond your means. Now young farmers want to start on the same level their folks are at today, not realizing that it took them 30 years to get to that point."

"I think there is **a place for the small operator** because he can take care of his operation and do it right while a big operator can't. For example, a small farmer can utilize terraces and compost his manure to obtain additional production without deteriorating his basic resources, his land and water."

Cooperating farmers have spoken freely about their concepts of small farms and related issues after being associated with the Energy Project, although their concepts are not supported elsewhere within the agri-business structure. However, **with the support of a community based organization** such as the Energy Project, farmers are more open to speak out on such aspects.

Project Innovations & Energy Savings

Energy Saving Devices Constructed

Cooperating farmers invested $29,699 in 148 innovations during the three-year project. The technical characteristics of the energy innovations emphasized projects which were simple, home-built, low-cost, acceptable by the local community, matched to the farm, and cost effective. When these concepts were emphasized, the innovations supported traditional agrarian values like independence, self-sufficiency, thrift, common sense, harmony with nature, and seeing the fruits of your own labor.

Various Technologies Utilized

The technologies used can be categorized into three broad groups:

—Production of flow energy such as innovations that utilize biomass, and wind.

—Utilization of recyclable resources,i.e. the production of methane and compost from livestock manure and from municipal, feedlot, and commercial wastes.

—Conservation of fossil fuel as with insulation and weatherization, engine maintenance, minimum tillage, conservation farming practices, and farming without chemicals.

Twenty-four of the cooperators, the "innovative" group, have a variety of alternative energy innovations and energy conservation practices which they have implemented, by self-selection. In keeping with the traditional self-reliant spirit of most farmers, cooperating farmers were required to be actively involved with decision making, research, construction, and maintenance of the innovation. **The Energy Project provided technical assistance to cooperators. It also provided some cost-share assistance,** based on recommendations of the local advisory committee, as an incentive for the farmer to implement innovative projects.

Major Energy Innovations

Major innovations implemented included:

—Vertical wall solar collectors for the home
—Solar grain drying
—Solar hot water heaters for dairies
—A solar heated farrowing barn
—A wind electric generator
—Composting of manure to lower fertilized purchases
—An attached solar greenhouse
—Portable solar collector for space heating &grain drying

The most popular major innovations, the solar grain dryer and the vertical wall solar collector, have also been the most cost effective of innovations built by cooperating farmers. Both projects require basic carpentry skills, common to most farmers.

Because wind electric generators are quite complicated to build, a **cooperator's wind electric system is the Project's only major innovation that is not home-built.** The wind system has proven to be a very complex system and has often developed malfunctions which the farmer could not repair. **The wind generator has less economical feasibility than the solar collectors,** but it is probable that such systems will become more feasible in the future as energy prices continue to rise. The innovation was important to the Energy Project, providing indications that wind and electrical demand of the farm are closely matched. In addition, the wind project has involved changes in the institutional barriers affecting the connection of wind systems to utility grids.

An analysis of the potential of methane production was conducted on one of the cooperating farms. **A proposed methane plant was cancelled due to escalation of capital investment and low return on investment.** The results of the study indicated that methane production is not feasible for the average small farm of theEnergy Project. Results of the study also indicated that the **appropriate use of alternative energy technologies must take into consideration the aspects of each farm.** Application of the technology is "site specific" and is not always cost effective for all farms.

Other Innovations

Minor innovations included:

—Window box solar collectors
—Solar food dryers
—Wood stoves
—Recycling of compressor heat in dairies
—Minimum tillage
—Wind water pumping
—Use of heat exchangers in livestock buildings.

In addition to these innovations, all of the homes and many of the farm buildings were insulated and weatherized. Soil testing, installation of pressure vacuum filler caps on fuel tanks, and other conservation items were also utilized. **Cooperators were most willing to adapt conservation devices compared to other innovations.**

Energy Savings

Vertical wall collectors range in size up to 300 sq. ft. costing approximately $3 per sq. ft. **The vertical wall collector,** used primarily for space heating in the home, **has the potential to save a farmer over $100 per year over a 10-year period.** The first **solar grain dryer** built by a cooperator **cost under $500 and appears to have the potential of saving $260 a year over 10 years** when used as a substitute for more energy-intensive batch drying.

Energy Conservation Important

Although solar devices received the most publicity, it was **simple energy conservation devices and practices that resulted in most of the energy savings by cooperating farmers.** The cooperating group used approximately the same amount of energy as the record-keepers at the beginning of the Project. However, **after three years the cooperators spent $1138 dollars per year less on energy.**

—The chart to the right indicates the various energy expenditures of two groups of farms. Total energy expenditures were nearly the same at the beginning of the research efforts of the Energy Project. However, after three years, the cooperating farms spent $1138 less in energy expenditures than their counterparts in the record-keeping group. Most of the savings were due to energy conservation techniques.

Average Farm Energy Expenses

	Cooperating Farms				Record-keeping Farms			
	1976	1977	1978	1979	1976	1977	1978	1979
Electricity	$ 944	$ 992	$1,083	$1,157	$ 788	$ 830	$1,027	$1,175
Fuel Oil	209	262	231	343	191	178	189	322
Propane	265	197	201	200	336	249	357	439
Diesel	353	489	558	804	318	421	515	893
Tractor-gas	617	789	807	928	792	903	1,057	1,316
Car-gas	587	792	720	1,035	592	903	789	1,069
Fertilizer	1,011	1,045	882	1,283	1,220	1,252	1,272	1,674
Total	**$3,986**	**$4,566**	**$4,482**	**$5,750**	**$4,237**	**$4,736**	**$5,200**	**$6,888**

Diversified Livestock Farms

Lower Energy Inputs

A comparison of average energy consumption and expenditures by type of operation suggests that **diversified, general livestock farms are less vulnerable to energy price increases than dairy or hog farms of comparable size.** According to the three-year analysis of farms cooperating in the Project, **farms with dairy, beef and hogs gave consistently higher net profit per dollar spent on energy as comparably-sized dairy and hog farms.** Although the results of the analysis are preliminary, they **seem to indicate that the diversified farm was in a better position to handle energy price increases and fluctuating market conditions.** □

Continuing Activities of the Energy Project

Although the initial research and demonstration phase of the Energy Project has been completed, **several new efforts are underway to assist farmers in reducing energy costs.** Several of these efforts of the Energy Project are described in the following paragraphs.

Farm Energy Training Program

Based on Farm Experience

Organizations and agencies wanting to develop farm energy programs can now take advantage of the new **Training Institute established by the Small Farm Energy Project.** The institute offers seminars, hands-on workshops, and one-to-one consultation with program staff of client organizations. Each program is **individually tailored to meet the needs of the particular client group.**

The Training Institute's services are being **provided by the staff and cooperating farmers** of the recently completed three-year research effort **of the Small Farm Energy Project.**

Included in the Institute's curriculum are:

—Sizing up the farm for alternative energy possibilities
—conservation on the farm
—principles of retrofitting energy-saving devices
—determining cost-effectiveness before making a commitment
—rules of thumb in solar construction
—how to find the best "hardware"
—financing alternative energy devices
—monitoring and evaluating projects
—working with small farmers on various issues
—organizing community based energy projects

The Institute is **designed to serve organizations with farm memberships** or with programs serving farmers, but **can be adopted to the needs of other rural organizations** as well. The Institute is also available to assist organizations with other small farm issues besides energy conservation. The Institute is non-profit but will be supported by client fees. Fees are arranged based on the cost of providing the service required and the ability of the organization to pay.

Project Begins New Outreach

Three State Project to Use Local Volunteers

The Energy Project has entered a new phase of its efforts to assist small farmers in energy alternatives. Emphasis on **demonstration work is being conducted in a three state area** surrounding Cedar Co., **utilizing community paraprofessionals and volunteers** working with low-income farmers. The new effort, called the **Small Farms Project,** has been launched with the financial support of ACTION, a federal agency.

In conjunction with the new outreach effort, the Energy Project is teaming up with the Small Farm Advocacy Project, also sponsored by the Center for Rural Affairs. The Advocacy Project has found that providing information, technical assistance and demonstration of cost effective technologies is not always enough to initiate widespread use of the technologies. The Farmers Home Administration, for example, has denied requests for loans to finance solar innovations and it has been found that **small farmers are often discriminated against in the administration of various federal farm programs. The Small Farm Advocacy Project has been designed to reform such practices** of discrimination, particularly in the area of farm credit. Volunteers of the Small Farms Project are therefore conducting both small farm energy and advocacy work. The Project has implemented local activities "involving small farmers in energy saving, income enhancing innovations and strengthening the participation of small farmers in federal farm programs intended to benefit them." Several multi-county areas are the focal points of the outreach work in the states of **Nebraska, Minnesota and So. Dakota.**

Other Outreach Efforts

Another example of an outreach effort of the Energy Project is the "Rural Ministries Project", funded by various church denominations. This effort is similar to other outreach efforts of the Energy Project, but focusing on specific involvement of both lay and professional church people at the local and regional level. Persons interested in details of this project can contact the Energy Project for more information.

Alcohol Fuel Project Underway

Energy Project Conducts Two-Year Study

In the fall of 1979, the Small Farm Energy Project and its sponsor, the Center for Rural Affairs, were awarded a **$43,000** grant for **developing experimental farm alcohol fuel systems** in Cedar County, Nebr. The funding is being provided for a proposal submitted to the Dept. of Energy's Appropriate Technology Small Grants Program. The proposal includes provisions for a **permanent on-farm alcohol system and also a portable distillation system.**

Initially the alcohol project is **conducting experimental work with small scale equipment, and later will utilize scaled-up versions for actual farm use.**

A major element of the study is the **development of low-energy designs to improve the net energy results of on-farm alcohol production. At the same time the effort is concentrating on low-cost plant designs that are simple to operate and maintain.** Initial results of the study indicate that the farmer has much to learn before implementing an effective alcohol plant.

The new alcohol project funded by DOE represents the first venture by the Energy Project into farm alcohol production research. **The project differs from previous work of the Energy Project, since it involves development work where previous projects mainly emphasized demonstration.** □

People Involved in the Project

—**48 cooperating farms** in Cedar Co., Nebr.
—**Co-directors** are Dennis Demmel and Ron Krupicka
—**Research director** is Rob Aiken
—**Office Manager** is Janet Hamilton
—**Outreach volunteers** located in Minnesota, So. Dakota, and Nebraska

Cedar Co. Advisory Committee includes Allen Heine, Jerome Noecker, Pat Rogers, and V.E. Rossiter, Sr.

—**Sponsoring Agency** is the Center for Rural Affairs, P.O. Box 405, Walthill, NE 68067, phone 402-846-5428.