1983

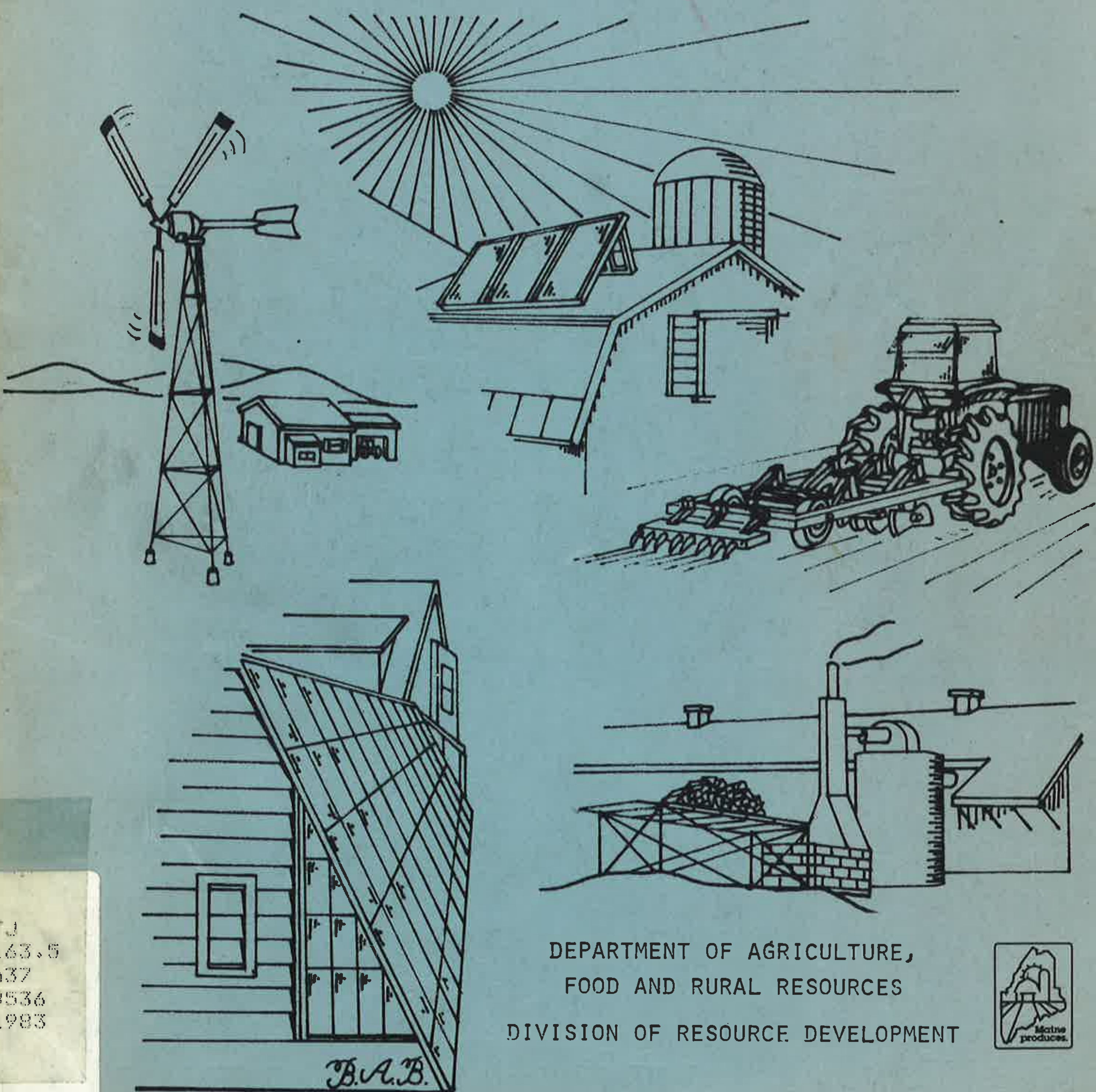
Saving Energy In Rural Maine : Or Who's Doing What on the Farm

Mane Department of Agriculture

SAVING ENERGY IN RURAL MAINE

OR

WHO'S DOING WHAT ON THE FARM



DEPARTMENT OF AGRICULTURE,
FOOD AND RURAL RESOURCES

DIVISION OF RESOURCE DEVELOPMENT

Cover by Bradley A. Blanchard

Saving Energy in Rural Maine

or

Who's Doing What on the Farm

Compiled by

Bettina M. Blanchard

Edited by

Bill Seekins

1983

Maine Department of Agriculture, Food and Rural Resources

Division of Resources Development

ABSTRACT

"Saving Energy in Rural Maine"
Compiled by
Bettina M. Blanchard*
B.S. University of Maine at Orono

The purpose of this publication is to provide information regarding the energy saving efforts being made on farms or related to agriculture in Maine. Pertinent data, such as general descriptions, names, payback periods, and cost estimates were collected in each case. This catalog will provide a source of information for those individuals interested in saving energy on the farm.

The survey of energy projects in Maine began in June, 1981 and was largely completed by December, although updating continued until the time of publication. Phone contacts, personal interviews, farm visits, and written requests for information were all part of the data collection process.

The final product, "Saving Energy in Rural Maine", has over 50 individual energy projects of 25 different types and representing 10 Maine agricultural commodities. In many cases, there is only one project of its type in the state such as methane production from manure, or evaporative vegetable cooling. Other ideas are increasing in popularity, like solar greenhouses and dairy heat exchangers. The catalog also discusses some patterns in project numbers and identifies types needing further investigation.

*Bettina Blanchard, a student in Agricultural and Resource Economics, worked as an intern for 9 months with the Maine Department of Agriculture, Food and Rural Resources, through the Center for Human Ecology Studies.

ACKNOWLEDGEMENTS

This catalogue is a result of cooperation between a number of individuals and organizations. We would first like to acknowledge those individuals undertaking the energy saving projects described throughout this publication. Their decision to undertake these innovative projects and willingness to share their ideas with others are the basis for this publication.

Special recognition goes to the Center for Human Ecology studies for making this project possible, and especially Kathie Grzelkowski for her guidance and support.

Considerable information was obtained from other state and local agencies including the Cooperative Extension Service, Soil Conservation Office, Office of Energy Resources, Department of Environmental Protection, and the Resource Conservation and Development Districts as well as the Maine Department of Agriculture, Food & Rural Resources. Several individuals within these agencies provided valuable background information and assistance in addition to identifying farm energy projects. In particular, we would like to express our gratitude to Chad Arms, Harold Brown, Amr Ismail, Terry Jones, John Badger, Nancy Holmes, Connie Irland, Don Mairs and Gary Nault.

Special thanks to Esther Lacognata and Chaitanya York for their weekly encouragement and direction and to Joan Kenney, Jo-Ellen Mazzeo, and Louise Charrette, who contributed both in the areas of administrative and typing assistance.

Cooperative Education Advisor from the University of Maine at Orono, Dr. F. Richard King, is acknowledged for his continuing guidance and supervision throughout the project.

Cover artist, Bradley Blanchard, deserves recognition for his ability, timeliness and generosity in providing this catalog with a professional quality cover.

Finally, many warm thanks to friend and co-worker Hartley Palleschi, for his encouragement, support and words of wisdom.

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INTRODUCTION

In 1981, an Energy in Agriculture Task Force recommended that the Maine Department of Agriculture undertake a systematic effort to enhance information exchange on energy saving activities in Agriculture. It is the purpose, then, of this catalog to provide interested persons a description of energy saving or producing projects including contact names and addresses to help facilitate this exchange of information.

The cooperation, enthusiasm and willingness to share their ideas of both project owners and others involved in energy research made the compilation of this catalog possible. Although this is not an exhaustive listing of farm-related energy activities in Maine, it does provide a representative sample of the types of projects existing in various commodities.

During the compilation of this catalog observations were made about the numbers and types of projects being undertaken. Some commodity groups seem to have taken more innovative steps than others to cut energy costs. Nine different types of activities, for instance, were noted in dairy operations and three types were found on apple operations. Some energy-saving ideas seem to have caught on more quickly than others in Maine. Milk heat exchangers, for example, have spread rapidly through the state so that there are many more farms than could be listed. Other types of energy projects such as methane production from manure and low cost evaporative vegetable cooling were each only found on one farm. Still others, such as solar heated young stock rooms, earth tube heat exchangers and simple air to air heat exchangers did not appear to have been tried at all in Maine. The adoption of some of these innovative energy saving projects probably awaits further research and development.

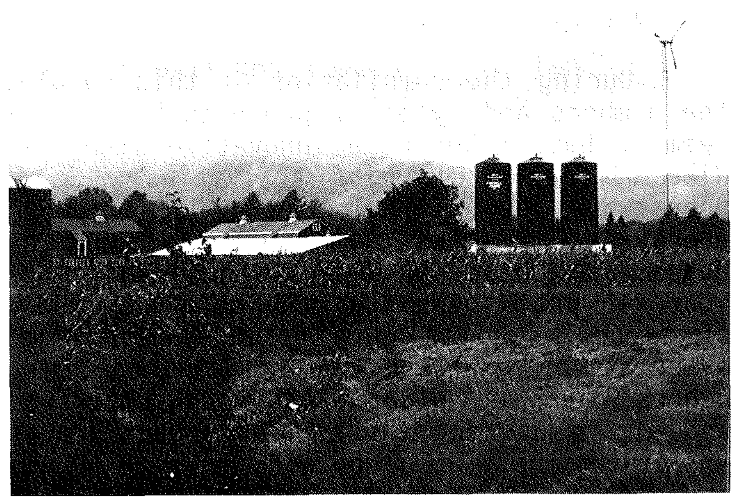
It is hoped that by providing this information about "who's doing what" that more farmers will be able to save dollars in energy-related practices.

PROJECTS

Each of the following project descriptions consist of two major elements. The first of these is a discussion of the project type, it's energy saving aspects, and how it works. The second part of each description includes the names of individuals (or firms) who are currently carrying out the projects. Specifics, such as costs, returns, and problems are listed along with the owners' addresses and phone numbers. This type of organization was adopted in order to keep the write-ups concise and to provide the reader with basic facts about the projects. More detailed information may be obtained by contacting the listed persons directly.

Wind

Wind power is being rediscovered as a clean, renewable energy source with applications to agriculture. Generally, there are two basic methods of harnessing the wind's energy. One method utilizes wind power to produce electricity (see photo #1), the other uses mechanical-energy produced directly for jobs such as pumping water.



1. On-farm wind generator helps meet electrical needs

Wind electric generators. An independent wind system generates direct current (DC) electricity which is then stored in one or several batteries for future use. A utility-tied system is another way of generating electricity from wind power. Some utility-tied systems produce 60 cycle alternating current (AC) while others generate direct current electricity then channel it through an inverter, changing the direct current to 60 cycle AC. Both types of systems are connected to the local utility providing additional power when necessary.

Wind generators are now in operation in many locations around the state, most of which are used for residential power. Below are listed several that are located on farms or that have farm applications.

Lonnie Gamble Etna Phone Company Etna, Maine 862-3000	Type: Enertech 1800 wind generator -utility-tied system -13 ft. diameter blades, mounted on a 60 ft. telephone pole -maximum production of 2 kwh in a 25-27 mph wind Savings: Projected at 50-70% of yearly electric bill Cost: Approximately $4,700
Blaine Middleswart Searsport, ME 04974 548-2978	Type: Homebuilt from spare auto parts -3-blade propellor with tail vane keeps blades turned into the wind -1000 watt invertor converts DC power to AC Savings: Projected at $700-$1000/year -pay back period estimated 10-14 months Cost: Approximately $1,900
Stan Morris Wiscasset, Maine 822-6025	Type: Enertech 4 kw generator -free standing 80 ft. tower -starts producing AC electricity at 8 mph wind speed -brakes stop propellor blades at 40 mph (to prevent generator from burning out) Cost: Approximately $13,000 Comments: originally had problems with vibration, which has been rectified
Richard Garrett Wellington, Maine 683-2892	Type: windcharger -produces DC power which is stored in a battery -battery provides most of home lighting needs Cost: Traded for it Comments: "Three trouble-free years"
Allen Trombley Presque Isle, Maine 764-6841	Type: unknown -originally designed to produce electricity and heat -65 ft. tower Cost: Generator $17,000; total investment $20,000 Problems: "High speed winds burned out the generator which was replaced several times. The entire system at this time is beyond repair"
Brian Phillips Kennebunk, Maine 967-2371	Type: Skyhawk 4 kw -utility-tied system -ideal windspeed 23 mph -selling excess power produced during peak periods Comment: Reasonably satisfied with the system

Ora Libby
Charleston, Maine
285-3461

Type: Enertech 1800
- produces AC power

Cost: Approximately $4,100; $150-$200 for auxilliary equipment (wire, tower, etc.)
- estimated pay back period 10-15 years
- also owns windcharger generator connected to hot water heater
- able to take advantage of 40% federal tax break

For more information regarding wind power and wind systems:

Peter Talmudge
Beachwood Rd., Box 497A
Kennebunkport, ME 04446
967-5945

Richard Morris
RT #1
Wiscasset, ME 04578
882-7882

Paul Stewart
Box 160A
RD #2
Houlton, ME 04730
Hodgdon School 532-9228

<u>Wind water pumpers</u>. Wind power may also help reduce energy costs by replacing the need for an electric pump. A wind pumper would not only save this amount but would eliminate the dependence on a utility for the farm water supply.

Wind water pumpers require a relatively low wind speed of approximately 3 mph, to pump water from a well or pond into a holding tank. Water is then generally gravity fed to the house and barn for use. Although only two have been identified on Maine farms, there is potential for many more since the cost is usually quite low.

Stacy and Marilyn Wentworth
Log Cabin Road
Arundel, Maine
967-4735

Type: Homebuilt
- pumps water from a large pond into a 2000 gallon holding tank
- wind speed required, 3 mph
- water is gravity fed to house and barn

Cost: Approximately $500

Comments: "Permits us to use large amounts of water needed for the farm without worrying about the cost"

Bob Harlow
North Dixmont, Maine
257-3845

Type: Refurbished 1920 windmill
- built on 30 ft. tower
- operating for 6 years
- pumps into a pressurized underground tank
- hot water preheated (to 80°) in tank above woodstove

Cost: $250 (not including 40 hours of labor)

Windbreaks. A new program has been initiated in Aroostook County to bring back the use of windbreaks. Recent studies indicate that windbreaks may save an average of 27% on yearly heating bills. In addition to their energy saving benefits, windbreaks also help to reduce snowdrifts and noise, increase property value, and protect livestock. It is necessary to design a windbreak based on topography, soil condition, wind direction, building and rcad location. (see diagram #1 below)

Gordon Johnson
Westmanland Road
New Sweden, ME 04762
896-5633

Type: 4 rows of white spruce
-each row is off-center to previous row
-using windbreaks for 15 years
Cost: Costs entailed were minimum; mostly labor required planting seedlings
Comments: "works well"

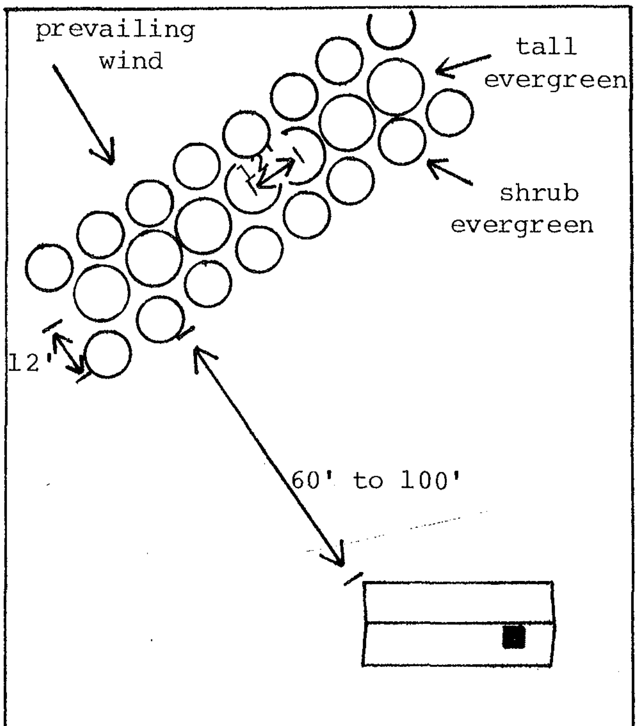


Diagram 1. Typical windbreak design

For more information contact:

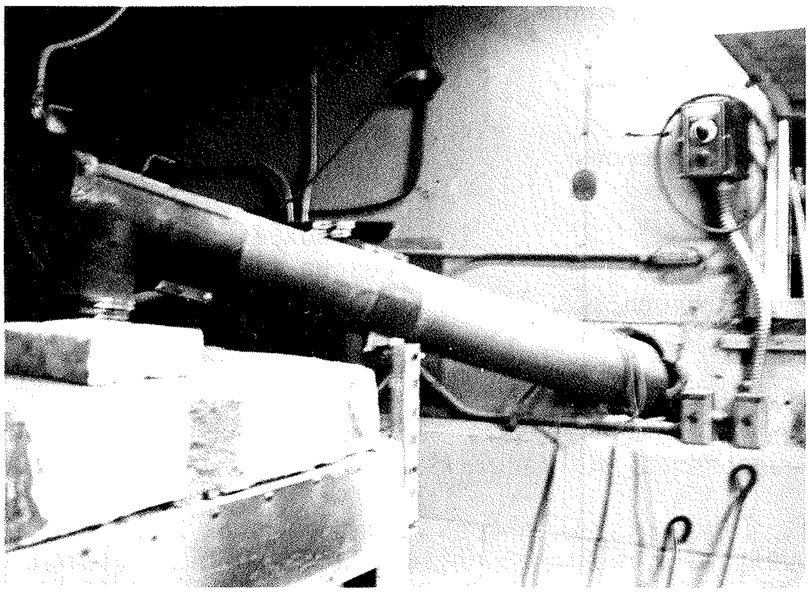
John Badger
Aroostook RCD
P.O. Box 745
Presque Isle, ME 04769
764-4126

Wood Heat Applications On The Farm

In addition to the recent shift back toward stoves and furnaces, some farmers are finding ways to use wood or wood by-products to heat a variety of different farm buildings. A majority of these systems operate automatically, which allows for the convenience of heating with oil or L.P. without the expense. Described below are a number of different innovative systems using various forms of wood and by-products as fuel.

Paul Jones
Maple Grove Farms
RFD #2
Mechanic Falls, ME 04252
346-6661

Type: Poultry litter burner (see photograph #2)
-forced draft fire, burning litter from the poultry house instead of oil
-heat produced used for heating poultry house
-the system was adapted to fit existing boiler
-poultry litter is automatically fed into furnace, flows easily
Savings: estimated at 3-4,000 gallons of oil per year
-payback period approximately 3 years



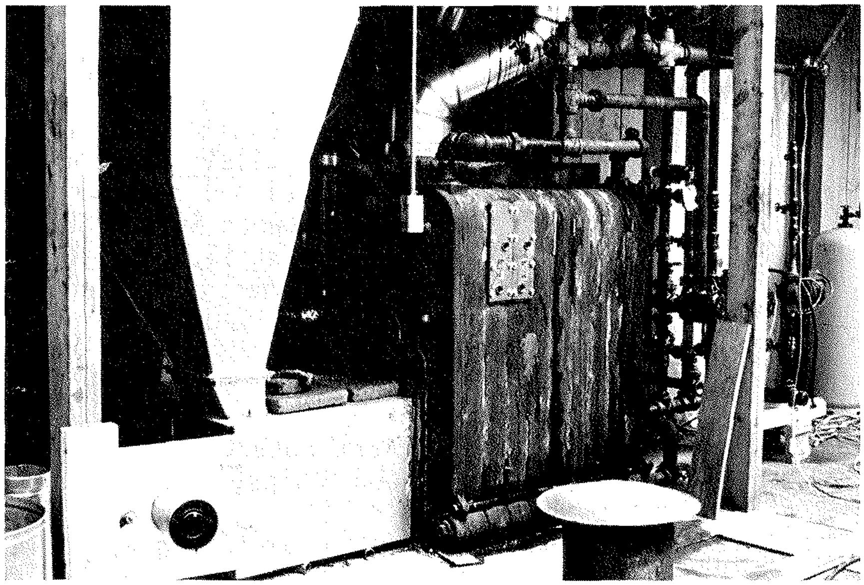
2. Paul Jones' litterburner automatically feeds litter from an outside bin

Ken Howard
Swanville
Maine
338-3376

Type: Poultry Litter Burner
-burns pelletized chicken litter
-utilizes a hot water boiler
-operating - one year
Cost: (Estimated) $8,000
Problems: Fly ash problem requires cleaning frequently
-currently not running

Allen Pinkham
Pinkham's Plantation
Damariscotta, ME 04543
563-5009

Type: Sawdust Burner (see photo #3)
-used for heating in commercial greenhouse
-sawdust is gravity fed
-sawdust bin needs to be filled once a day
-operating since December, 1981
Cost: (Estimated) $15,000 including burner, fan, boiler, time and installation
Savings: Projected 9,000 gallons of oil per year
Problems: Too much draft



3. Sawdust is gravity fed into Pinkham's burner from a vertical bin

Roger Knight
Smiling Hill Farm
781 County Road
Westbrook, ME 04092
774-8356

Type: Wood Chip Furnace-University designed system
- -used to heat farm home
- -built on to original boiler system
- -automatically loads woodchips according to thermostat setting
- -3-fuel boiler (oil, coal, wood)

Savings: Projected $3,600-$4,000

Comments: Wood chips burn at a higher efficiency than wood

Bea Bryant
Bryant Steel Works
Thorndike, ME 04986
568-3663

Type: Automatic Solid Fuel Loading System
- -wood furnace utilizing existing boilers
- -heat a large area
- -burns 16-18 hours unattended
- -wood is placed on a conveyor
- -when fire burns low conveyor adds another load
- -electric eye checks fire level
- -operating since February, 1980

Problems: Ash needs to be cleaned out once a day

Comments: A better part of the first year in operation spent working the bugs out of the system. Depending upon situation and amount of labor provided by farmer, the cost should be under $10,000
- -this system has been in operation for 3+ years

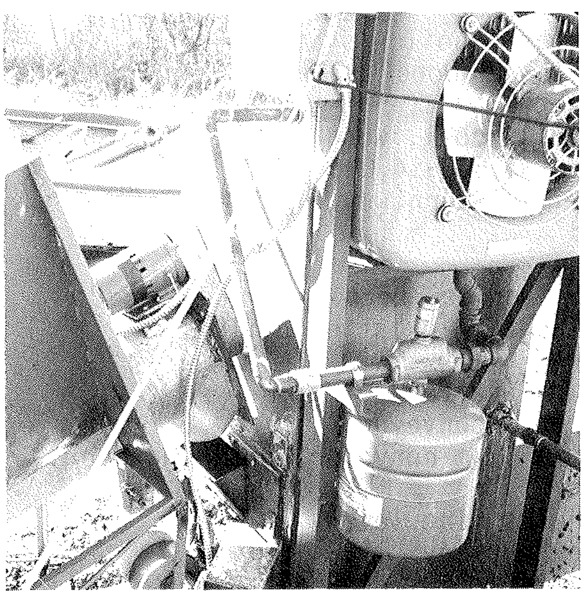
Martin Gonthier
Circle Products Co.
Biddeford, ME 04005
284-7807

Type: Poultry Litter Combustion Chamber
- -form poultry litter into pellets
- -pellets will be consumed in an auxiliary combustion chamber
- -heat utilized in poultry house
- -still a prototype system, can be improved with a better hydraulic system
- -energy cost for pellets is about $11.50/ton
- -economical if fuel oil is over $1.50/gal

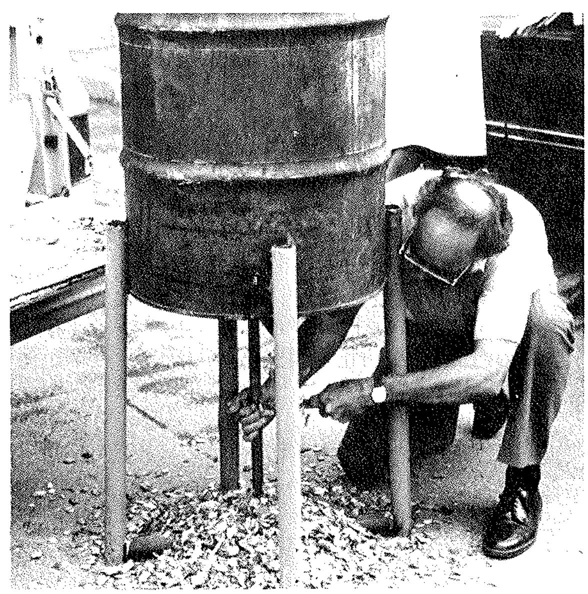
Cost: Estimated between $6,000-$8,000
Savings: Projected at $5,000-$8,000 per year
- -best time to be contacted evenings or Saturdays

Lloyd Weaver
Clark Road
Ashland, ME 04732
435-6248

Type: New automatic bulk fuel feeding system (photo #4)
- -new efficient rotary unloader (photo #5)
- -handles wood chips, sawdust and other bulk fuels
- -maximum rotor diameter is about 14 feet
- -new device mechanically measures fuel level
- -system adds fuel at exact rate consumed
- -pamphlet describing system available



4. Automatically stoked solid fuel burner designed by Lloyd Weaver



5. Lloyd Weaver demonstrates a new loading device using wood chips

Donald Hagan
Houlton, ME 04730
532-3012

Type: Wood Furnace with Heat Storage (see photo #6)
- used to heat potato storage
- furnace burns 4-5' length scrap wood
- 100 ton rocks in insulated heat storage will keep potato storage between 50-55^{o} for up to 24 hours in cold weather
- replaces 700 gallons diesel oil every 10 days
- operating 4-5 years; recently added rock storage, dampers, etc.

Savings: Estimated at $5,000/yr and up
Cost: Unknown

Walter Lamkins
Skowhegan, ME 04976
634-3575

Type: Poultry Litter Burner
- 1 million BTU boiler
- automatically feeds poultry litter and wood
- used to heat large hatchery building
- saved over $2900 in heating oil the first year

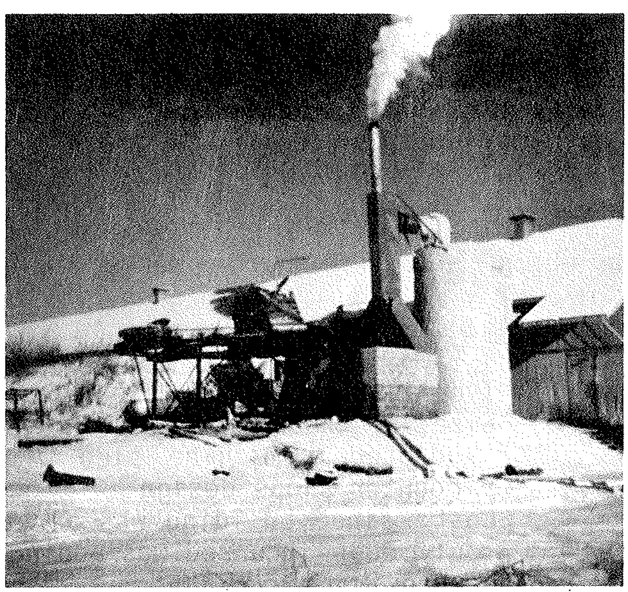
Cost: Approximately $20,000
Payback Period: 2 years

*Hatchery is currently <u>not</u> in operation

John Morrison
New Gloucester, ME
04260

926-4479

Type: Poultry Litter Burner
- originally used in broiler operation, now raising pullets
- operated for 2 years
- no longer practical for current operation
- worked well for broilers



6. Scrapwood heats Hagan's potato storage

Solar Applications

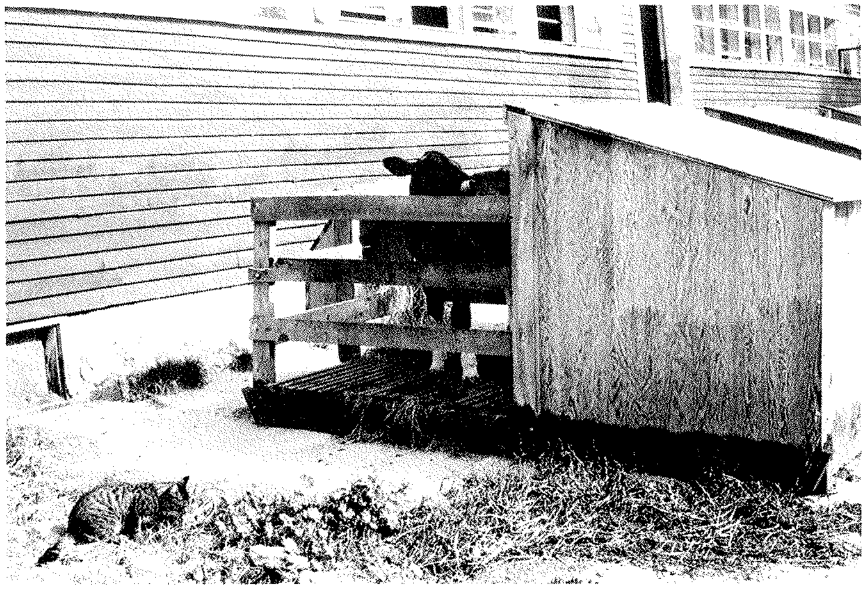
Utilizing solar energy on the farm as a way to reduce heating costs is becoming more and more popular in Maine. It may also offer crop growers a way to extend their season with little or no additional heat needed in solar greenhouses. The following sections describe in more detail some of the applications solar energy has on Maine farms.

Calf hutches. Calf hutches are being introduced as an alternative to raising young calves in a heated area of the barn. Here each calf has its own pen with a sheltered hutch facing south, to take advantage of the sun's heat. These calf shelters are relatively low cost, with the farmer doing the construction himself. For more information regarding proper use and construction contact your local extension agent. (see Appendix for a list of extension offices in Maine)

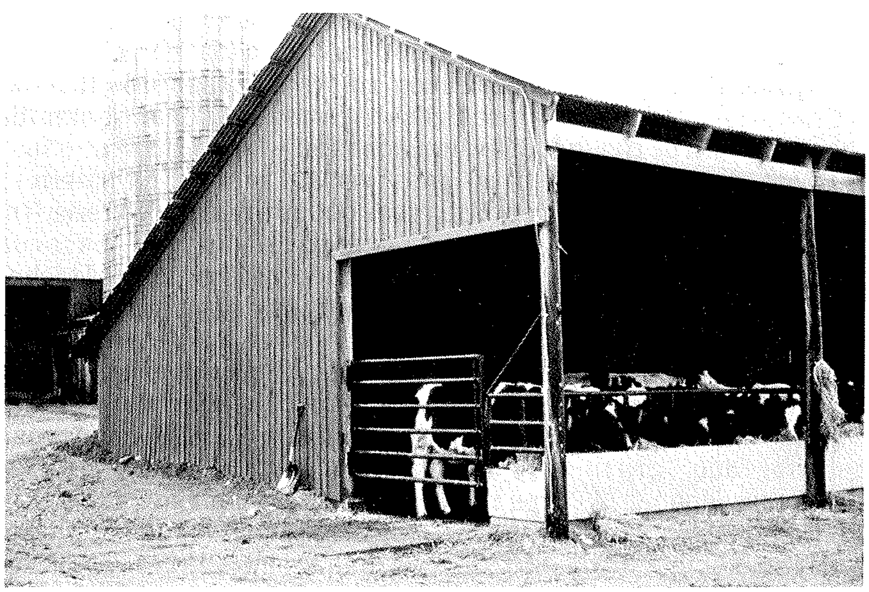
Ken Veazie Corinna, Maine 278-2662	Type: Home Built Calf Hutch -using calf hutches for over 3 years Cost: Estimated between $75-$100/hutch Comments: "Calves are healthier than inside the heifer barn"
Robert Steadman Teavey Road Clinton, Maine 453-2329	Type: Home Built Calf Hutch Size: 4' x 4' x 8' hutch -constructed using 2 x 4 frame with paperboard and plywood sides Cost: Estimated at $35/each
Frank Tozier Fairfield Ctr., ME	Type: Home Built Calf Hutch Size: 4' x 4' x 8' -materials included 3½ sheets of plywood; 10-12 2 x 4's -used for about 3 years
David Knight Smiling Hill Farm 781 County Road Westbrook, ME 774-8356	Type: Home Built Calf Hutch (see photo #7) Size: 6' x 3' Hut with pen -using calf hutches for over 10 years Cost: varies depending upon materials used

Counter slope heifer barn. A counter slope heifer barn is another energy efficient alternative young stock shelter. The barn faces south with a one foot downward slope built into the floor. (see photo #8) The slope, together with the general movement of the cows, moves the manure and bedding into the sun where it is dried. The farmer is able to save both time and bedding, while raising his heifers in a healthy environment. (Only one shelter of this type has been identified so far in Maine.)

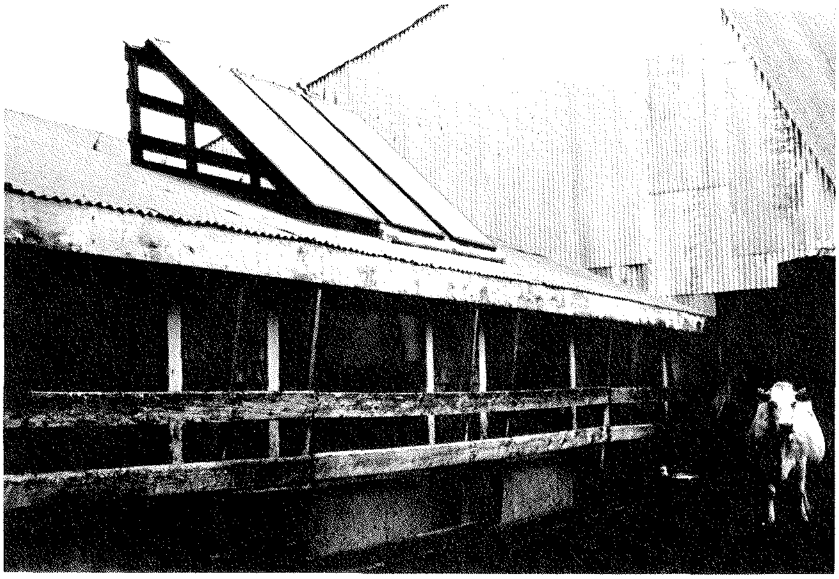
Warren Davenport Wayne, Maine 685-4956	Type: Counter Slope Heifer Barn (see photo #8) Size: 36' x 50' -adapted a machine sled with dirt floor to counter slope design Cost: since building was already constructed - only cost incurred was adding a cement floor - Approximately $1,000 -building faces southeast



7. Roger Knight's homebuilt calf hutch provides a healthy environment at a low cost



8. Davenport's counterslope heifer barn saves both time and energy



9. Three solar panels heat water for Victor Knight's dairy operation

Solar assisted dairy operations. One way solar energy can be used in a dairy operation, is to help in meeting hot water needs. A dairy farmer requires approximately 2 gallons of hot water per cow per day. Water heating for a 50 cow herd then, could cost from $500-$600 per year. One Maine farm was identified that uses 3 active solar panels to assist their water heating system. (see photo #9)

Another way solar energy can be used is to provide heating and cooling. To do this, passive solar designs generally allow sun light to reach barn interior during winter months but exclude it in summer. This can be accomplished with the correct roof overhang and placement of windows and other openings. (see photo #10)

Victor Knight
River Road
Woolwich, Maine
443-9158

Type: Active/Passive Solar Assisted Dairy Operation
- utilizes both active and passive solar designs
- operation milks between 35-36 cows/day
- free stall passive solar barn designed by a UMO Ag Engineer
- this passive solar design seems to work well except for occasional problems in winter with snow and ice build up
- in the winter, solar panels heat water to 80^{o}F, brought up to temp of 165^{o} by an oil fueled burner
- in the summer, panels heat water to 145^{o}F when an electric heater brings water to 165^{o}F

Cost: Approximately $2,000 four years ago

Smiling Hill Farm
County Road
Westbrook, Maine
775-1285

Type: Passive Solar Design
- new tie stall barn
- 50-55 cow capacity
- uses window placement and roof overhang to exclude sun in summer but allow it to enter in winter

-worked well during first winter
-solar feature is only one part of an operation designed with energy efficiency in mind

10. New solar barn at Smiling Hill Farm

Solar greenhouses. An obvious solar application to agriculture is a solar greenhouse. Greenhouses are versatile and may be built to suit a variety of needs. From small, low cost, back-door additions, to large-scale commercial units. They all provide some method of heat storage as well as a design that better utilizes the sun's energy for heat.

There are a number of techniques used in building a solar greenhouse to make it energy efficient. Double glazing is one that involves a second transparent layer, providing an air space to prevent heat dissipation. A heavily insulated north wall, earth berms on the north side, and thermal curtains are other common methods of preventing heat loss. Storage of solar heat may be done by lining the greenhouse floor with rocks or gravel. Another design involves using 55 gallon drums filled with water. Some greenhouses are so energy efficient that they require little or no back up heat system at all.

In recent years, the solar greenhouse concept has become more and more popular in Maine. In the research for this publication, over 20 individual solar greenhouses were identified. Although the following list is by no means complete, it does contain a fair representation of the variety of styles, sizes, and cost ranges for solar greenhouses in Maine.

Conrad Heeschen
Star Route
Dryden, ME 04225

Type: Freestanding Solar Greenhouse
Size: 450 square feet
- -built 1977-78
- -prototype for small commercial or market garden
- -47 page report on construction, materials, and growing experience available $10 P.P.

Comments: Visitors welcome with prior arrangement; used year-round

Jim Economou
River Road
Woolwich, ME
442-7627

Type: Hydroponic Solar Greenhouse
Size: 9' x 24'
- -this building represents a demonstration project for off-season vegetable production in Maine
- -plants are grown in shallow troughs
- -perlite is used to provide root support

Heat Storage: water filled plastic tubes, also provide support for plant shelves
- -plants fed a dissolved nutrient solution

Cost: Cost of converting greenhouse to solar hydroponic operation $750

Dick & Barbara Whitney
Beachwood St.
Thomaston, ME
354-6857

Type: Solar Greenhouse home addition
Size: 1000 sq. ft. (see photo #11)
Heat Storage: 2½ ft of gravel line bottom of greenhouse
- -utilizes double glazing technique
- -in operation for about 1 yr.

Cost: $15,000-20,000 (est.)

11. Whitney's solar greenhouse utilizes double glazing and a 2-foot rock bottom for heat storage

Kevin McDaniel
S.E.A.D.S. of Truth
RFD #1, Box 136A
Harrington, ME 04643
483-9763

Type: Low Cost Solar Greenhouse with hot water heating solar wall
-constructed summer 1981
Size: 35' x 12' x 75'
-utilizes excess heat in home
-solar wall and hot water collectors included in design

Al & Betsy Pinter
Granite Point
Biddeford Pool, ME
282-2093

Type: Solar Greenhouse which needs no auxiliary heat
Size: 18' x 10'
-built against house, set into the ground
-contains slide shutters on pulleys used at night to preserve heat
Heat Storage: eight, 55 gallon water-filled drums
Cost: Estimated BTU $6,000-$7,000
Comments: Summer visitors only, greenhouse not used year round

Albert Barden
Norridgewock, ME
696-5442

Type: Maine Organic Farmers and Gardeners Association Workshop Solar Greenhouse
Size: Approximately 14' x 14'
Heat Storage: 55 gallon drums filled with water also provide support for planting bins
Problems: Used experimental glazing (Uvex) found to crack

Jane Lamb
River Road
Brunswick, ME
725-7103

Type: M.O.F.G.A. Solar Greenhouse
Size: 7' x 11'
-foundation built below frost line
-constructed during fall workshop 1980
Heat Storage: sonobuoy tubes filled with water
Cost: Approximately $1,200

John & Jeff Skillins
Skillins Greenhouse
Falmouth, ME 04105
781-3860

Type: 2 Commercial Solar Greenhouses
Size: Total area 5,000 sq. ft.
-insulated north wall
-back-up heat propane gas
Cost: $10/sq. ft.
Savings: Projected approximately $6,000/year
Problems: Condensation on wood behind north wall, which does not ventilate well. Plan on repairing it during summer

Roak's Greenhouse
Washington Ave.
Portland, ME
772-5523

Type: Commercial Greenhouse installs energy saving devices
-converted heating system to multiple fuel system. Use lowest cost fuel available
Cost: Approximately $10,000
Pay Back Period: One year
-installed curtain used at night to cut down amount of space heated

Cost: $20,000 for 200' x 50' curtain
-added 2 layers of polyethylene to greenhouse windows to prevent heat dissipation
-insulated north wall and foundation

Tom & Sue Eastler
RD 1, Box 1043
Farmington, ME
778-6703

Type: M.O.F.G.A. Solar Greenhouse
Size: 20' x 10'
Heat Storage: crushed stone, 7 55-gallon drums, filled with water, painted black
-greenhouse also provides additional home heat
Comments: "Not completed, we still had tomato plants until end of January last year."
Cost: Approximately $2,500
Problems: Uvex - outer layer material did not hold up well. It will be replaced with glass

Composting solar greenhouse. A new concept in solar greenhouse design is one that utilizes two different energy sources under one roof. The biomass contained in the compost pile works together with the solar energy captured in the greenhouse to provide plants with a superior growing environment.

Dave Johnson/
Jeremy Farmer
Gorham, Maine
839-6478

Type: Composting Solar Greenhouse
-compost pile generates heat, moisture, and CO_2
-a slant-bin method is used to allow the plants greater access to the sun's rays (see diagram #2)
-the compost pile will heat plants from the bottom, where the leaves will trap this heat and absorb CO_2 for maximum use
Cost: less than $1.50/sq. ft. of growing space
For more information contact:

Bruce Fulford
Biothermal Energy Center
P.O. Box 3112
Portland, ME 04101

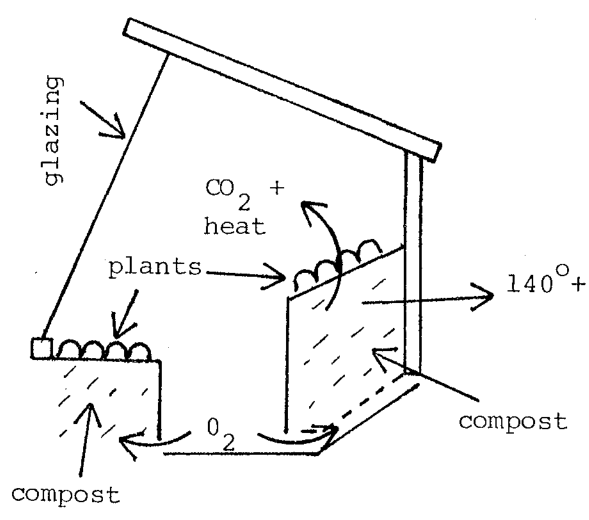


Diagram 2. Unique solar greenhouse design utilizes a compost pile for heat and CO_2.

Manure Handling and Waste Utilization

The handling and utilization of waste products on the farm has great potential for energy savings. These savings may be in the form of time and energy spent simply removing manure from the barn or there may be the reduced need for commercial fertilizer. Dairy and hog gravity manure storages substantially reduce the time and energy spent handling manure. Composting, a simple process where the nutrients are stabilized, increases the value of manure as an organic fertilizer.

Large scale composting. Large-scale composting is a method to better utilize manure. Basically, the composting process stabilizes the nutrients and kills the pathogens found in manure. The final product has a number of different uses. It makes an excellent fertilizer and also may be used as potting soil. In a dairy operation it may also be used as a feed supplement or, once dried, as bedding. Three large scale composting operations were identified on Maine farms.

Stuart Mayo
Weeks Mills Road
New Sharon, ME
778-2390

Type: Owner-designed large scale composter
- -mixes poultry and cow manure with sawdust
- -has a chemist check for proper moisture content
- -manure composted in 70-100 ton bins
- -air is forced through bins
- -process takes 43-65 days
- -operating since June 1981

Cost: Approximately $2,500 per bin including equipment

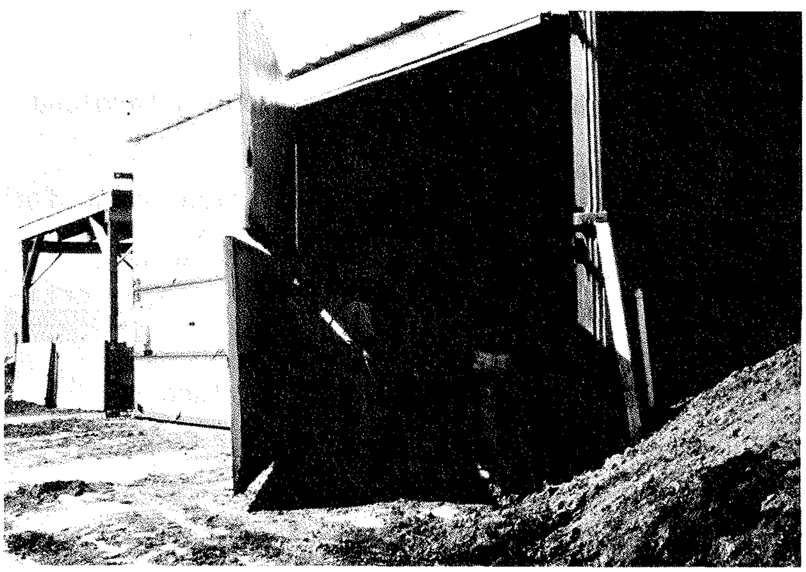
Comments: "Final product has quite a few possibilities"

Frank Tozier
Fairfield Ct., ME
453-6937

Type: Large scale commercial composter (see photo #12)
- -mix cow and poultry manure together; occasionally add sawdust
- -process is completed in 5 days once manure reaches proper temperature
- -blower turns on twice/-day, forcing air through manure

Cost: approximately $70,000

Problems: difficulty obtaining necessary poultry manure



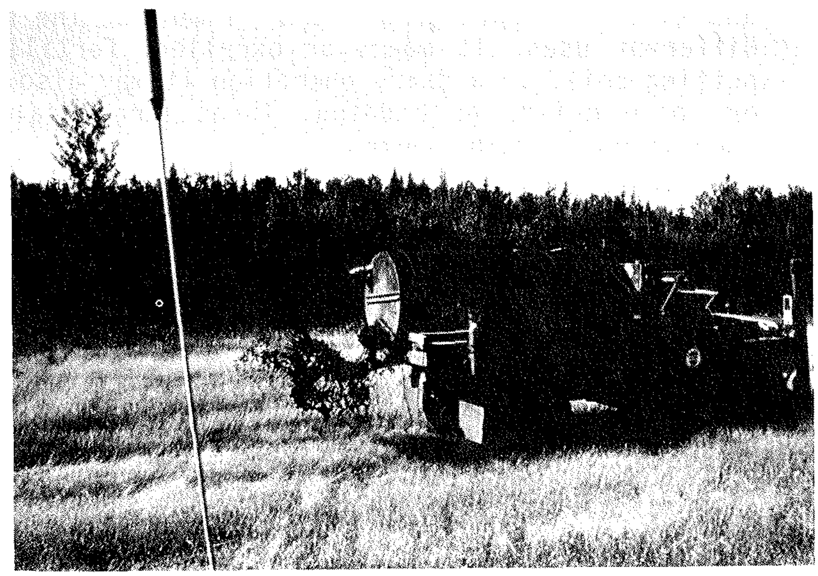
12. Tozier's large scale commercial composter and drying shed

Worden Hale
Albion, Maine
437-9262

Type: Large Scale Commercial Composter
- mixes cow and poultry manure with sawdust in manure spreader
- manure used from 68 dairy cows
- poultry manure collected from 90,000 birds four times/year
- final product used as bedding and feed supplement

Cost: will vary depending on operation

Sludge utilization on farms. Sewage treatment plants in 47 towns spread sludge on approved fields as a method for reducing farm fertilizer inputs. Area treatment plants need a place to dispose of this material and farmers are finding it a good conditioner for their soil. New York state has estimated that farmers save approximately $26/ton of sludge by reducing their need for commercial fertilizer. This figure is based on 1982 fertilizer prices and median nutrient content for sludge. In some cases, the treatment plant will deliver, spread, and incorporate the sludge all at no cost to the farmer (see photo #13). However, it is important to realize that there are strict guidelines which must be followed in order to utilize this material and site approval is necessary as well. Six represesntative operations are listed below.



13. Top dressing of a lime stabilized sludge at Rangeley Airport

John Gorham
Ft. Fairfield Utilities Dist.
Ft. Fairfield, ME
473-7440

Type: Municipal Sludge Utilization on farmland
- sludge is injected into soil
- spreading sludge since 1978
- primary use on grains (rotation crop for potatoes)

Savings: increased yield by 30% on oats

Comments: "Better soil conditioner than fertilizer"

Robert Wescott
River Road
Westbrook, ME
892-4980

Type: Municipal Sludge Used on Hayland
- spread sludge on 15-18 acres
- 1981 first year used

Harold & Leroy Souther
Livermore Falls, ME
897-2238

Type: Municipal Sludge Use on Farmland
-spread on 49 acres
-1981 first year used
Costs: None. Treatment plant responsible for spreading
Comments: "Highly recommends it."

John Julia
Fairfield, ME
453-2281

Type: Municipal Sludge Use on Cornfield
-spreading sludge for 3 years
-treatment plant will deliver free within 7-8 miles
Savings: Better than half of commercial fertilizers, approximately $15,000

Ken Brackett
Pleasant St.
Rangeley, ME
864-3777

Type: Municipal Sludge use on Hayfield
-spread on 8 acres
-spreading since 1979
-revitalizes hayfields
Costs: None. Lives close to treatment plant

Richard Shires
County Road
Gorham, ME
839-4363

Type: Municipal Sludge Utilization
-spread on 12 acres
-first year used, 1981
-sludge spread on Timothy and Arlington Red Clover
Costs: None

For more information contact:

Gary Nault or Karen Law
Department of Environmental Protection
Augusta, ME 04333
289-3901 or
1-800-452-1942

Dairy gravity flow manure storage. A gravity flow manure storage is a way in which farmers can reduce their energy inputs in manure handling. This system relies on gravity to move the manure from the milking barn to the storage, and/or from the storage to the spreader. In addition to energy savings, use of gravity reduces tractor wear, and especially labor time.

Initially, the manure is collected in the barn and pushed into the hopper. From here, the manure flows through a large underground pipe into a storage. Depending on the system, milk house waste water may or may not be added.

Before unloading in the spring, two gates must first be opened. The gate closest to the pit is called the safety valve, and prevents the manure from freezing in the discharge pipe. It may be either hydraulic or guillotine style and is located below the frostline. The second gate is referred to as the operating valve. It allows the farmer to control the flow of manure into the spreader. (see photo #14)

14. Gravity flow manure storage at Currier's saves time and energy

Bernard Currier
Skowhegan, ME
474-2815

Size: 110' x 70' (See photo #14)
- -cement walls
- -30" cement pipe from barn to pit
- -operating since Fall of 1980

Cost: Approximately $30,000

Burns Lilly
Oakfield, ME
757-8522

Size: 50' x 80' x 10'
- -covered storage
- -no milk house waste water added
- -operating over 1 year

Cost: Approximately $40,000
Problem: Only empties down to 6'. A gate was included in design to allow bucket loader to clean up the rest.

Charles Tebbetts, III Lisbon, ME 353-8048	Size: 100' x 90' -deepest point 11' -earthen walls, pre-cast concrete floor -30" pipe -handmade guillotine gates -utilizes milking pastor waste water -operating over 1 year Cost: approximately $35,000 Comment: "Manure has more value"
Frank Dickinson Norridgewock,ME 634-3562	Size: 52' x 74' Hopper size 6' x 4.5' -guillotine gates -operating since 1980 Cost: approximately $25,000
Clem Smith Monmouth, ME 933-2160	Size: 80' x 50' x 10' -covered storage -no milk house waste added -no need for agitation -110 cows, can hold up to 6 months -operating for 3 years Cost: approximately $40,000 Comments: "saves time, energy, no daily spreading, also easier loading spreader"
Lester Stevens Dover, ME 564-7620	Size: 210' x 122' x 12' - 16' deep -earthen walls, gravity in and out -includes milkhouse waste water -agitate using a log pulled by a tractor -storage will hold waste from 150 cows for 330 days (1,055,000 gallons) -operating since October 1980 Cost: approximately $22,000 - not including labor Comments: Very pleased. It is working well.
Frank Willoughby Albion, ME 437-5311	Size: 108' x 50' -covered storage area -milk house waste added -operating since December 1981 Costs: approximately $68,000 -projected savings $4-5,000/year
Richard Pearson Shorey Road Albion, ME 437-9236	Size: 92' x 50' -covered storage of pressure treated wood -36" concrete pipe into pit -concrete floor -milk house waste added -will probably have to agitate Cost: approximately $50,000 Comments: "He's not sold on the idea."

Gravity manure, hog farrowing barn. A hog gravity manure storage is similar in concept to the gravity manure storage used by dairy farmers. It utilizes the flow of gravity to transfer manure from the farrowing barn to the storage area located below the barn. One Maine farmer estimates a savings of 6 hours/day using a gravity system, as opposed to cleaning the barn by hand. A savings in energy would also be realized if the farmer normally cleaned the barn by machine. The two systems identified in Maine both utilize a vacuum pump to empty the liquid manure from the pit storage. This enables the farmers to cut down on the time, labor and energy spent in their operation.

Tom Dubey RFD #1 Box 228 Monmouth, ME 04259 933-2924	Type: Hog Gravity Manure Storage Size: 100' x 10' x 6' -180 day storage for 70 sows Cost: approximately $15,000
Ellis Percy Whitefield, ME 549-7070	Type: Hog Gravity Manure Storage Size: 16' x 32' -6" pipe runs from farrowing barn to storage, approximately 30 feet -slotted concrete floor with roof will house more sows directly over storage area Cost: difficult to estimate

Energy Efficient Cooling Methods

Refrigeration, an important component of storing many agricultural commodities, is typically energy intensive. Several methods have been developed that will either allow the heat removed from food to be used in other ways or to cut the cost of cooling. The next three sections will discuss three of these methods, heat exchangers, evaporative cooling and refrigeration sequencing that have been used by Maine farmers.

Heat recovery systems. Heat recovery systems are designed to utilize the heat removed from agricultural products during refrigeration. For example, a milk heat exchanger is a method of reducing water heating costs on a dairy farm. By transferring heat from the milk to water, it provides more than enough hot water to meet the dairy's needs. Depending on the type of heat exchanger, a producer cooling 3000 lbs. of milk daily, may save from 8,000-21,000 kwh/year with a payback period generally under two years.

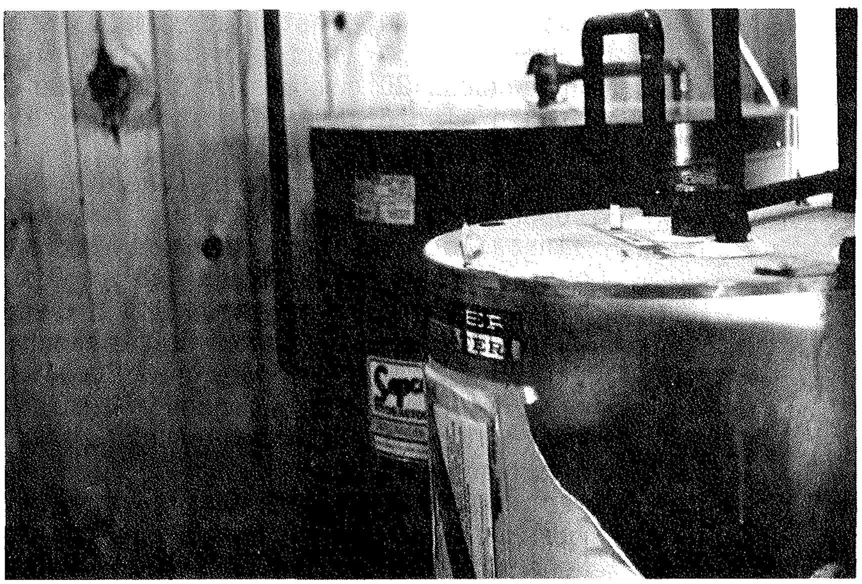
Milk heat exchangers have been around for a few years now and are becoming quite popular on dairy farms. (see photo #15). Although we have only listed eight farms below, Area Dairy Specialists believe the total number of heat exchangers is approximately 100 on Maine farms.

Apple producers are also finding applications for heat recovery systems in their operations. The heat extracted from the apples during the cooling process, may be used to heat packing facilities or meet hot water needs.

The idea of using heat exchangers in apple production is still relatively new. There are, however, at least four systems in the state of which we are aware.

Don Perkins Lower Road Charleston, ME 285-7714	Type: Milk heat exchanger (Surge) operating since 1979 Cost: approximately $1,000 including installation Projected savings: $500/year
Tim Carter Middle Intervale Farm Bethel, ME 824-2230	Type: Milk heat exchanger (Thermastore III) operating since 1980 Cost: approximately $1,400-1,500 Comments: "Relatively happy w/performance."
John Palmer Cornish, ME 625-3329	Type: Milk heat exchanger in use over 2 years Cost: approximately $1,800-$2,000 estimated payback period 1 yr
Smiling Hill Farm County Road Westbrook,ME 775-1285	Type: Milk heat exchanger (Mueller Fre-Heater) -Used in 50-55 cow operation -operating since Fall 1982 -installed when new barn was built -utilizes excess hot water in home -expected payback in 2 years
Alton Benson Gorham, ME 892-6925	Type: Milk heat exchanger -operating since 1980 Cost: $3-4,000; installed same time as new bulk tank -produces 120 gallons of 140^{o} water twice/day -saves electricity
Chris Neilsen Hill Road Clinton, ME 426-8974	Type: Milk heat exchanger (Mueller Fre-Heater) -operating since 1980 -installed same time as new bulk tank Cost: approximately $2,000 -heats water to 145^{o}F plans to use excess hot water to heat milking parlor
Ray Hall Readfield Road Mt. Vernon, ME 293-2611	Type: Milk Heat Exchanger (Delaval) -operating since 1981 Cost: approximately $1,000 Problems: "Little problem getting it started. None since"

Frank Tozier Fairfield Center, ME 453-6937	Type: Milk heat exchanger (Thermastore I) -operating device over 3 years Cost: approximately $1,000 -reduces cost of refrigeration
Maine Apple Growers Box 54 Buckfield, ME 336-2271 Contact person: Dan Thayer	Type: Heat recovery system -installed March 1982 -heat will be used to heat packing facility -estimated payback period, 5 years Cost: varies, depending upon existing equipment, size, efficiency, etc.
Gile Orchards Waterboro Road Alfred, ME 324-4393	Type: Heat recovery system for apple storage -storage capacity 40 thousand + bushels -heat utilized in packing facility -in operation since Spring 1982 Cost: approximately $9,000 Payback: estimated at 5 years
Don Ricker Ricker Hill Orchard Turner, ME 225-3455	Type: Heat Recovery System -installed in winter 1981. Fall/Winter 1982 was first season on-line -used to heat packing room Cost: approximately $4,000



15. Heat exchanger and hot water tank at Smiling Hill Farm

Evaporative cooling. In searching for a low-cost energy efficient alternative to present refrigeration, California Extension developed an Evaporative Cooling System for vegetable crops. This system provides a cool, moist, environment for a variety of vegetables, with a relatively small amount of energy. In fact, a study completed in California showed that 1 BTU of energy in an evaporative cooler, would produce 14 BTU's of cooling. Mechanical refrigeration for the same BTU of energy will only produce 3 BTU's of cooling, but is able to provide a lower air temperature than the low energy system.[1]

The system is especially well suited for cooling snap beans, cucumbers, eggplants, melons, sweet peppers, ripe tomatoes, pumpkins, winter squash, and sweet potatoes. It could potentially provide farmers with inexpensive temporary cooling for use at roadside stands and farmers markets.

The evaporative cooler is constructed primarily out of plywood and utilizes a commercially available fiber pad designed especially for evaporative cooling (see diagram #3). The device also requires a small pump which circulates water through the system keeping the fiber pad damp. A small fan draws air through the pad, providing a cool moist atmosphere for vegetable crops.

If purchased new, this device may cost between $150-$200. Evaporative coolers currently available for home use may be suitable for vegetable crops as well.

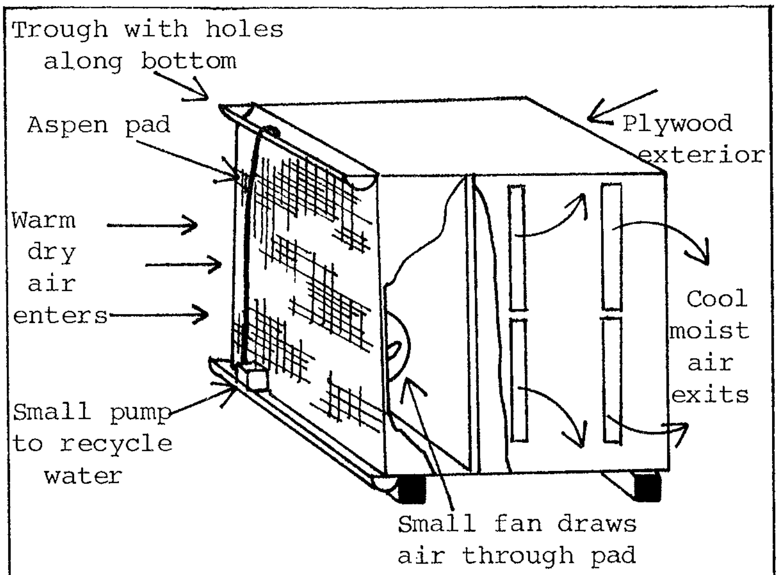


Diagram 3. Design for an evaporative vegetable cooler. (Adapted from p.20 California Agriculture, March - April, 1981.)

Mark Katz
Deerhill Farms
Weeks Mills, ME

Type: Homebuilt evaporative cooler
-cools vegetables to 40°F
Cost: under $100

[1] James F. Thompson and Robert F. Kasmire. 1981. "An Evaporative Cooler for Vegetable Crops". California Agriculture. March-April.

Refrigeration sequencing for apple storage. Substantial savings on energy expenditures may be realized in apple storage, by utilizing a technique known as refrigeration sequencing. The rate charged to apple growers for electricity is based on 80% of the growers highest demand. The demand is generally very high during September and October when apples are first brought in from the orchards. The rate for the entire year, then, is determined by a high peak that only occurs during two months. The utility, however, can establish a different, lower rate for the off-peak months (November through August) if they can be sure the peak demand during this period will remain low. Refrigeration sequencing is one way to reduce the off-season peak load for cold storage rooms.

Refrigeration sequencing requires that the cold storage rooms operate off a master time clock where one room will run long enough to keep the apples cool, before the next room is turned on. This system works well for growers whose storage is designed with separate refrigeration units for each room. The procedure for installing the time clock involves a considerable amount of electrical work. In addition, the entire system must be approved by the utility involved before a lower rate is established.

Don Ricker Ricker Hill Orchards Turner, ME 225-3455	Type: Refrigeration sequencing -in operation for two years Installation cost: approximately $1,500 Savings: approximately $6-7,000 Comments: "Works well!"
Russ Pratt Plant Manager Prince Orchards Turner, ME 225-3411	Type: Refrigeration sequencing -in operation for 2 years Installation: $1,500 two yrs ago Cost: time clock $2-300 (approx.)
Chick Orchards Monmouth, ME 933-4452	Type: Refrigeration sequencing -in operation over one year Installation costs: $1,200
Maine Apple Growers Ivan Smith Buckfield, ME 336-2271	Type: Refrigeration sequencing -in operation one year Installation cost: $3,000 Payback period: 1 year Problems: "Sometimes a room doesn't get cold enough (on for 1 hour, off for 3). Simply switch it off the time clock and let it catch up."

Energy Saving In Field Operations

A variety of energy saving ideas have been developed in the area of farm field operations. Those to be discussed in the following sections are reduced tillage and no-til practices, integrated pest management and flail mowers.

Reduced tillage/no-til. Minimum tillage is defined as the least amount of tillage required to create a suitable soil condition for seed germination, crop growth, and weed control. "It may range all the way from use of several tillage operations to elimination of all tillage operations except planting."[1] (See photo #16)

Reduced tillage techniques are being introduced to farmers as soil saving practices. In addition to reducing soil erosion, the farmer saves time, tractor wear, and energy. Most energy savings are realized in reduced gas and diesel fuel consumption due to fewer trips over the field. There is an increased need for herbicide in reduced tillage and no-til practices which will increase the indirect energy inputs. An overall comparison of conventional methods to reduced tillage and no-til shows that conventional tillage uses about 7.66 gals of diesel fuel/acre, chisel plow uses 6.95 gals/acre, disking requires 5.71 gals/acre, and no-til uses 4.4 gals/-acre.[2]

16. Planting in sod with a no-til seeder

[1] W.W. Frye and S.K. Philips. "How to Grow Crops With Less Energy". Cutting Energy Costs - 1980 Yearbook of Agriculture, U.S. Govt. Printing Office, Washington, D.C.

[2] Ibid.

Chris Neilsen Hill Road Clinton, ME 426-8974	Type: No-til grass -saves harrowing -practicing no-til 3 years
John Palmer Towles Hill Cornish, Me 625-3329	Type: No-til corn -used no-til planter for 12 years -saves time and energy in planting corn crop -sandy soil good for no-til -also has no-til alfalfa and clover -increased herbicide use to control weeds
Frank Caverly Clinton, ME 453-7506	Type: No-til Arlington Red Clover -saves plowing & harrowing -using this method 3 seasons -saves time with good results
John McLellan Ridge Road Clinton, ME	Type: No-til Grass -using no-til for 3 yrs -requires less time, saves 3 trips over the field
John Fogler Exeter, ME 379-2963	Type: Reduced tillage, w/coulter-chisel -used for Fall tilling on corn and in Spring -helps reduce erosion -can prepare more ground for planting than 2 moldboard plows -saves time on fields and fuel -Even works pretty well on sod

As of 1976 No-til was a practice being used on many farms throughout the state. The following is a list of farmers participating in the program.[3]

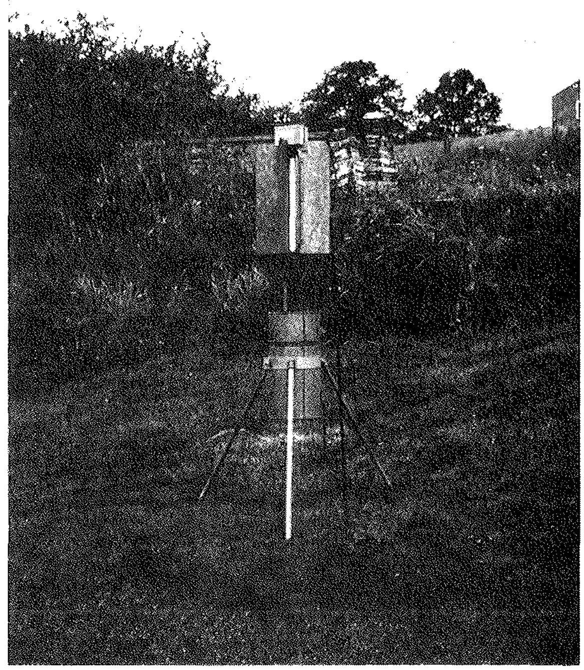
Millard James Leary	Saco
John & Bill Harris	Dayton
Dorothy & John Paquet	Biddeford
Curtis Taylor & John James	Lyman
Gerald Twitchell	Turner
Brigeen Farms	Turner
Tebbetholm Farm	Lisbon
Bill Rust	Gorham
Carl Milligan	Oxford
Kenneth Rowbottom	Norridgewock
Leonard Frolich	Norridgewock
Herman Dunlop	Skowhegan
Burleigh Crockett	Fairfield
Ashton Clark	Troy
Harold Larrabee	Thorndike
Roy Hunter	Unity

[3]Agronomy Reports, No-til Forage Seeding, Glenn K. Wildes

Scott Holmes	Waterville
Freeland Drake	Albion
Worden Hale	Albion
Dan McLaughlin	Wilton
Harland Bragg	Sidney

Integrated pest management. Integrated pest management (IPM) programs offer grower/producers a spectrum of approaches to disease, insect and weed control. It's purpose is to reduce the reliance on pesticides by utilizing pest monitoring, natural enemies, weather, and cultural practices. By monitoring their crops for pests (see photo #17), weed and disease populations, growers are better able to decide if, and when pesticide applications are necessary.

Direct energy savings result from fewer spray applications and trips across the field. Indirect energy inputs may be conserved by reducing the use of petro-chemical based pesticides. Energy savings from IPM use will vary widely from year to year, and crop to crop, so it is difficult to project potential savings for any specific situation. The experience in New Hampshire indicates that savings can be as much as $25/acre for apples, $8/acre for potatoes, and $18/acre for sweet corn.



17. Black light trap used to monitor pest populations in an IPM program

Here in Maine, Integrated Pest Management programs are underway in apples, blueberries, and potatoes. Some developmental work has been done in sweet corn and a formal IPM program will be operational in 1983. Developmental work is also under way on other vegetable crops. More specific information may be obtained from the following individuals associated with IPM programs:

James Dill	Extension Pest Management Specialist
Maples	Apple IPM
Univ. of Maine	Operational on about 5-700 acres
Orono, ME 04469	Sweet corn IPM
581-3879	Operational on about 500 acres in 1983

Terry Jones Cooperative Extension Service Presque Isle, ME 764-3361	Extension Potato Specialist Potato IPM Operational on 88 farms in northern and central Aroostook
Harold Brown Eco-Analysts Inc. P.O. Box 576 Bath, ME 04530 371-2176	Blueberry IPM Operational on about 5,000 acres in 1983 Processor's programs include another 4-500 acres

Blueberry flail mowers. Mechanical flail mowers are an alternative to burning, as a method of pruning blueberry bushes. As a rule, the blueberry bushes are pruned once every two years, during the season when they are not in production. The purpose of pruning is to cut back both bushes and weeds to ground level, without eliminating the plant entirely. The flail mower is pulled and operated by a tractor, and can prune the bushes to $\frac{1}{4}$-$\frac{1}{2}$", if the ground is level; otherwise, problems arise when the mower scrapes the ground. It is estimated that flail mowers may be effective on 20% of the blueberry fields in Maine. A savings of about $50/acre may be realized by mowing bushes instead of burning. However refinements still need to be made with the flail mower, before it can fully replace burning, as a method of weed control.

Tom Rush A. L. Stewart Cherryfield, ME 04622 546-2616	Type: Blueberry Flail Mowers -commercially available -saves approx. $50/acre -using flail mowers since 1979 -different size mowers available, able to mow 9½-10' swath or 5' swath Cost: larger size $1,400-1,500, Smaller, gas run mower, $1,000 Problems: Can't use on rough terrain due to potential plant harm, still trying to refine technology
Bill Hardy 763-3262	Type: Blueberry flail mowers -used on 200 acres -rough on stony fields -used for 1 season

Wymans
Fulton Colbeth,
Field Manager
Cherryfield, ME

Type: Blueberry flail mower
- used on 1,000 + acres in past 3 years
- one exception was summer of 1982, when mowers were used on only 200 acres
- found fields mowed also had to be burned in order to control weeds.
- mowers with 3' width did not work well on fields, too wide
- recently tried 2' improved model seems to work much better

Savings: estimated about 25 gallons of oil/acre

Production and Use of Alternate Fuels

The production and use of alternate fuels on farms is still in the experimental stages in Maine. Efforts have been made in producing fuel, alcohol and methane (natural gas) and in converting vehicles to use alternative fuels.

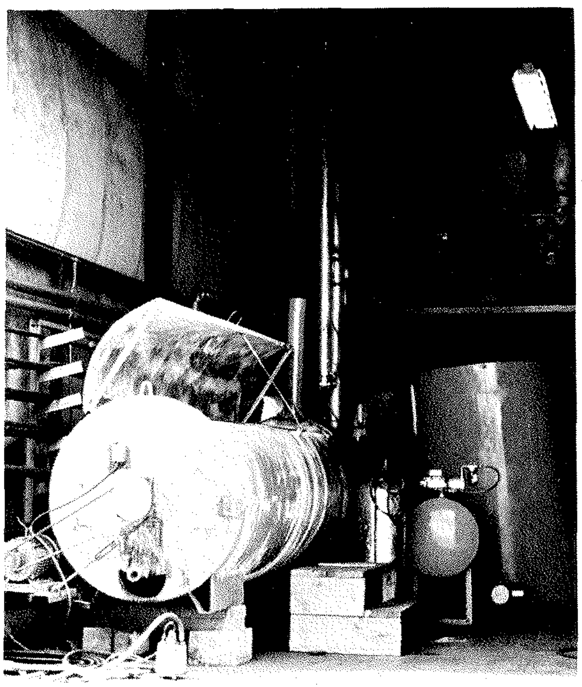
Alcohol production. There is an increasing interest in the production of alcohol fuel on farms. The technology exists for the fermentation and distillation of crops into ethanol fuel on a small scale, where farmers have a source of feedstocks, which may include corn, cull potatoes, and apples. It takes only 15-20 acres of corn to produce enough ethanol to supply the liquid fuel needs for an average size farm. However, the utilization of by-products, as well as the alcohol produced, is important to the feasibility and profitability of the process.

A farmer's primary use for the fuel is in farm vehicles and equipment. Existing gas powered engines may be easily converted to alcohol fuel, but the conversion process for diesel tractors is more difficult. Other uses for alcohol on farms may include home heating, crop drying or sale of the product.

In Maine, the feasibility of on-farm alcohol production has yet to be proven. There are a few individuals interested, and are in the experimental stages of production. The conversion of gas powered vehicles to ethanol however has been done successfully and now awaits a dependable supply of ethanol.

George Sprowl
Searsmont, ME 04973
342-5211

Type: Alcohol Fuel Production
-currently in experimental stage
Feedstocks: experimented with sawdust, cheese whey, potato waste, corn
-process involves cooking the organic material for 3-4 hours at 160°F
-saving energy in operation of the still, by running it under a vacuum, reducing the temperature at which alcohol vaporizes from 180° to 122°F
-eventually, still and cooker will utilize waste steam from sawmill boiler
Cost: $35,000
Problems: difficulty extracting sugar needed to make alcohol, from sawdust
-enzymes for sugar breakdown froze during shipment
-cheese whey had a tendency to foam while cooking



18. Sprowl Brothers' alcohol still

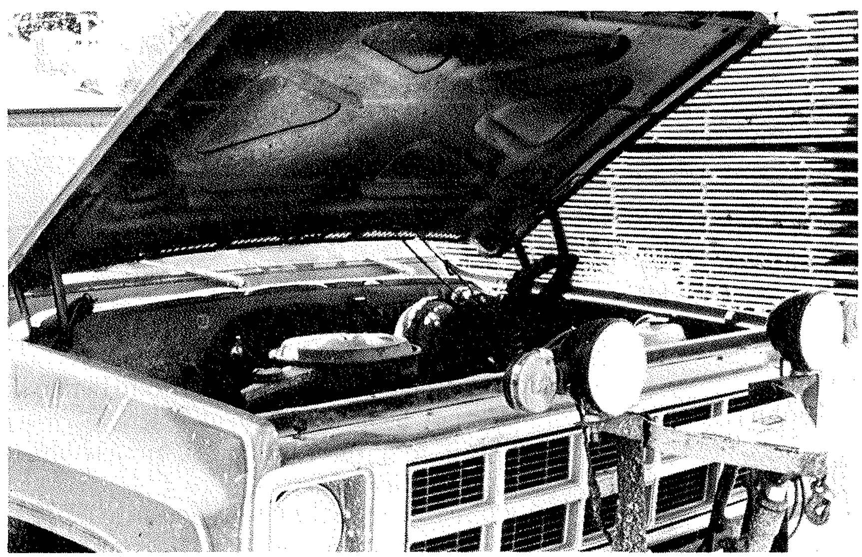
Edward Griffin
Presque Isle, ME 04769
764-0634

Type: Wood Burning Alcohol Plant
Feedstock: Cull potatoes
Objective: to produce enough alcohol to run farm equipment
- -estimated need at 7,000 gallons/year
- -project sponsored by appropriate technology grant
- -complete records will be kept regarding design, construction, quantity and quality of alcohol, cost, etc. Available to interested persons.

Vehicles Using Alternate Fuels

George Sprowl
Searsmont, ME 04973
342-5211

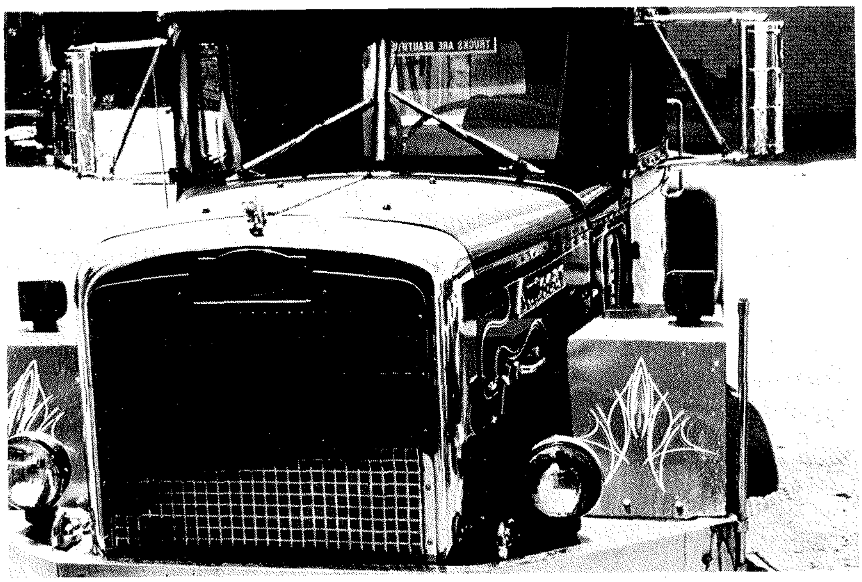
Type: 2 vehicles converted to alcohol use (see photo #19)
- -6 cylinder van
- -8 cylinder 4WD pick-up
- -carburetor and timing adjusted to accept alcohol fuel.



19. Sprowl's alcohol fueled pickup truck

Cost: varies depending on vehicle
6 cyl van: minimal cost
V-8 4WD pick-up: new (larger) carburetor $400
Problems: 4 WD pick-up ran fine but without much power, needed a larger carburetor.

Type: Customized diesel pick-up converted to soybean oil (see photo #20)
-uses contaminated soybean oil
-fuel purchased @ 80¢/gallon.
Problems: skips some when it's cold, otherwise no problem



20. Sprowl's soybean oil fueled pickup truck

Caribou Regional Vocational Technical Institute
Caribou, ME 04346
498-8111
Contact Person:
Mr. Hale

Type: Compact car using alcohol fuel
-converted Ford Pinto
-2000 cc engine now runs on alcohol instead of gas
-appropriate technology grant program
-tests conducted on engine rpms, oil pressure, temperature, etc.
-results will be tabulated and graphed

On-farm methane production. Methane (natural gas) is a colorless, odorless gas used commonly in many parts of this country as an energy source. In recent years due to the rising cost of energy, the production of methane from waste products has become more and more economically attractive. In order to produce methane, animal or plant waste products are kept in an anaerobic (oxygen-free) environment and heated to about $95^{o}F$. Under these conditions, anaerobic bacteria break down complex organic matter. Some of the products of that breakdown process are: methane (CH_4) and carbon dioxide (CO_2) with traces of other gases such as hydrogen sulfide (H_2S). The mixture of gases is often called biogas.

Biogas may be burned directly for heat and light or may be used to fuel an internal combustion engine. One of the most common uses for the gas is to run an electric generator.

Several problems, however, are associated with utilizing methane produced on the farm. One of these is that methane cannot be inexpensively compressed to any great extent. This means that it is not cost effective to store large amounts of gas for long periods of time. It also is not practical with current technology to operate motor vehicles on home-generated methane.

In addition to providing an energy source, anaerobic digestion of wastes improves pollution control and nutrient recycling. The digestion process destroys most pathogens in the manure and reduces its objectionable odor. It also maintains the nutrient content of the manure at about the same level as the raw manure but changes the form of those nutrients so that they are both more available to plants and less likely to cause pollution.

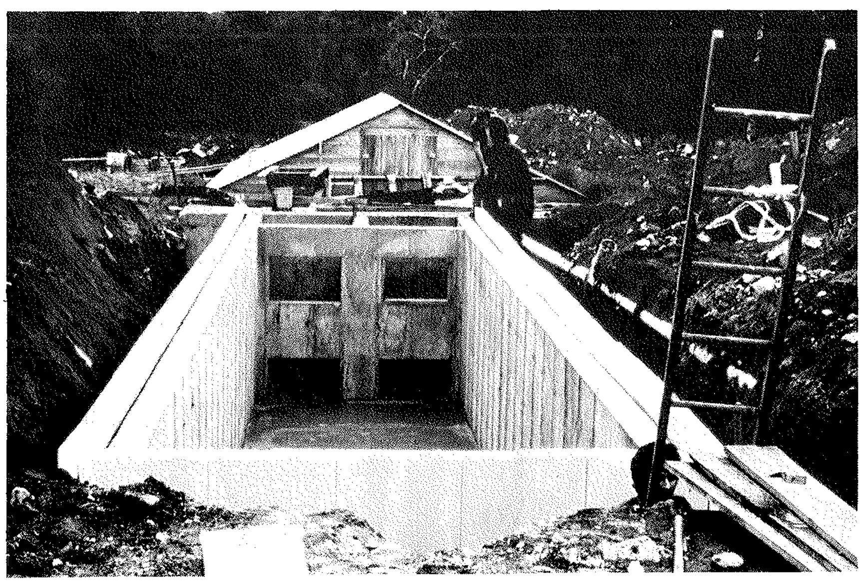
Bradford and
Martha Tait
No. Whitefield, ME
549-5123

Type: Veal calf manure methane digester
- -sized for 300 veal calves
- -40' x 10' x 8' insulated concrete tanks w/flexible gas cover.
- -plug flow design
- -gas used to heat water for heat and mixing feed
- -construction work partially done by owner

Cost: estimated to be $25,000 to $33,000

Savings: 4,000+ gallons of #2 fuel oil per year (plus energy tax credits)

Problems: highly liquid manure has caused some handling problems. A home built gate system had to be devised to divert washdown water past the digester. Wooden plank dam had to be sealed w/plastic to prevent leaking of manure from digester. Gas leaks delayed final equipment hookup

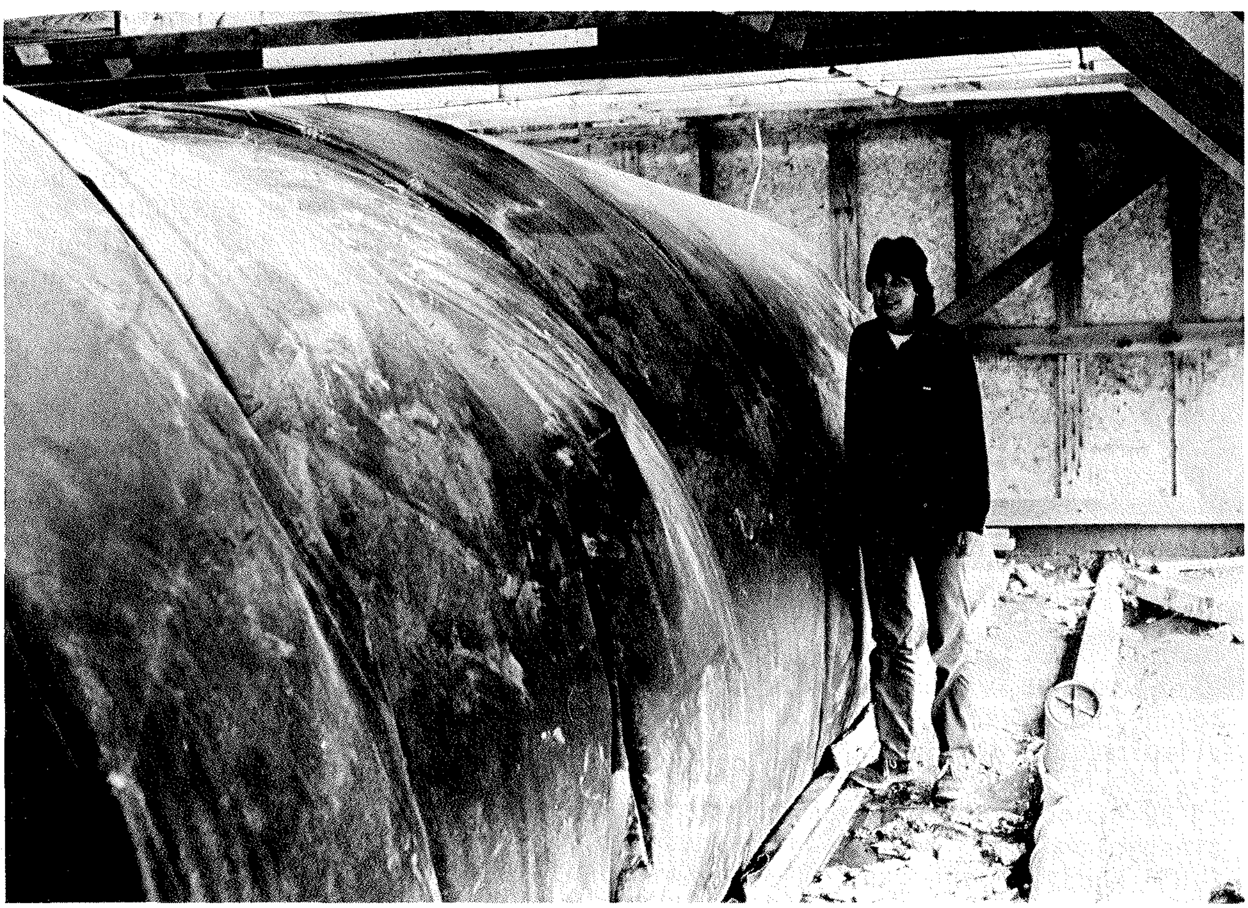


21. Tait's digester during construction

Comments: If it performs as well as it is supposed to, we can pay for it in five years.
-visits by appointment only, please

For more information contact:

Bill Seekins or Chaitanya York
Maine Dept. of Agriculture, Food and Rural Resource
Division of Resources Development
Augusta, ME 04333
(207) 289-3511



22. Tait's digester with gas bag fully inflated

Multi-Project Sites

In Maine, there are two places (one southern and one northern) where interested persons may see several energy demonstrations that have application to agriculture. Each site offers diverse energy projects utilizing various forms of renewable energy.

Northern Maine Vocational Technical Institute. The northern site, is the Energy Lab at Northern Maine Vocational Technical Institute in Presque Isle. Here students provide labor and receive instruction on how to design and build a variety of energy saving projects.

Three different wind generators are being demonstrated, the most unusual of which has been constructed out of salvaged auto parts. This particular windmill may have as many as four generators running off its drive shaft in high speed winds. The number of generators operating depends on the wind velocity.

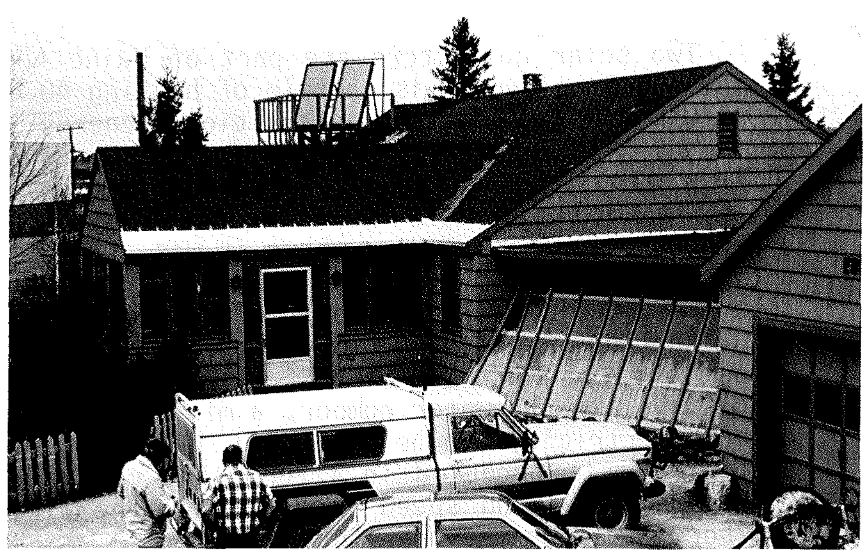
N.M.V.T.I. also has a number of solar demonstration projects (see photo #23). Two solar greenhouses have been built, one with walls constructed out of rammed earth. This material, in addition to being low cost, helps store the sun's heat. Rocks used in both greenhouses act as heat storages as well.

The sun's rays are used in an active solar hot water heating system (see photo #23) A specially designed hot water tank stores the heat in the form of hot water necessary in the lab.

N.M.V.T.I.'s alternative Energy Lab sponsors workshops, solar classes, and provides information on environmental technologies in architecture, solar greenhouses, hydroponic gardening, wind technology, and more.

For more information contact:

Burt Tompkins
N.M.V.T.I.
33 Edgemont Drive
Presque Isle, Maine 04769
769-2461



23. NMVTI's alternate energy lab

Maine Audubon Society. The Gilsland Farm Sanctuary in Falmouth, utilizes renewable energy and conservation technologies in its modern headquarters and 200 year old farmhouse. A number of the energy systems have applications to agriculture and rural living in Maine. Most systems are commercially available and offer a relatively short payback period.

Maine Audubon's solar greenhouse produces all of its own heat, as well as providing additional heat for the farmhouse. Two techniques used to reduce heat loss are: the use of window insulation at night and the lack of windows on the north wall. Thermal storage is provided by three columns filled with water (see photo #24) and an innovative phase changer storage system.

24. Maine Audubon's solar greenhouse

Two solar collectors are part of Maine Audubon's domestic hot water system. Each collector is capable of heating 40 gallons of water per day to 120-140^{o}F. This means that no additional energy is needed for heating water at the Gilsland Farm.

A water pumping windmill was used to demonstrate the wind's ability to do work until 1982 when it was dismantled. Well water was pumped underground to the building where it was stored in a 300 gallon tank in the attic. From there it was gravity fed throughout the building. It is hoped that the windmill will be repaired and back in operation in the future.

Another example of wind power is the wind-driven electic generator. This system consists of an 80 foot tower and a generator with three wooden blades. Unlike the water pumper, a minimum wind speed of 10 mph is required before electricity can be generated. No on-site storage is needed since the electricity is produced in a form that can be sold to the local utility. Due to the low wind speed at the site, the wind system is not expected to pay for itself in the near future.

Gilsland Farm has incorporated various wood heat demonstrations in their efforts to promote the use of renewable energy sources. A stick wood boiler is used in the headquarters building as a back-up to the solar space heating system. Based on a design developed by Professor Richard Hill at UMO, an induced draft is used to burn the wood at very high temperatures (up to 2000^{o}). The heat is stored in an insulated 1000 gallon water tank and distributed through the building when needed.

A wood pellet furnace is used as the central heating system in the Farmhouse Retrofit. The furnace is operated by a thermostat and pellets are automatically fed to the burner from an adjacent storage hopper. The furnace offers a convenient and efficient automatic wood heating system.

Maine Audubon has a total of fifteen energy systems in operation at Gilsland Farm. Both buildings, including our Energy Education Center, are open to the public weekdays throughout the year, and weekends from September to June. Self-guided tour brochures of both buildings are available, and staffed tours are offered by appointment.

For further information about any of these projects, contact:

Bill Hancock, Public Information Coordinator
Chris Donovan, Energy Department Director
Maine Audubon Society
118 U.S. Route One
Falmouth, Maine 04105
Tel.: 781-2330

SUMMARY AND CONCLUSIONS

This catalogue has identified over 25 different innovative ways energy is being conserved in Maine Agriculture today. A number of interesting trends have appeared in saving energy in the various commodity areas.

Innovative energy saving practices have had varying degrees of acceptance by Maine farms. In seven project areas, a number of individuals were utilizing the same (or similar) technology to save energy. These project types include: solar greenhouse designs, solar calf hutches, dairy gravity manure storages, reduced tillage techniques, sludge utilization, dairy heat exchangers, and wind power. The actual number of projects in each category varied from 10 to 100. The popularity of these ideas indicates they have become accepted as successful approaches to saving energy.

Ten different project areas were identified in which there were more than one example, but less than five in the state. These included poultry litter burners, sequenced apple refrigerators, sawdust and wood chip furnaces, blueberry flail mowers, apple storage heat exchangers, large scale composters, hog gravity manure storages, wind water pumpers, passive solar barns and vehicles utilizing alternative fuels. In these cases, the fact that there were more than one in the state was encouraging but not sufficient to show that they had become accepted practices.

Seven projects in this catalog were, as far as we know, the only ones of their types in Maine. These were an evaporative vegetable cooler, a methane digester using veal manure, a fuel alcohol production plant, a counter-slope heifer barn, a wood heated potato house with heat storage and an active solar dairy water heater. These innovations may be the models for the energy efficient operations in the decade to come.

In addition to variations in acceptance of different types of energy saving practices, there was wide variation in the number of efforts being made in different commodities. Some commodities, like the dairy and apple industries, seem to be out in front with several energy saving innovations. Dairy farms, for example, have utilized gravity manure storages, reduced tillage methods, calf hutches, a counter slope heifer barn, heat exchangers, passive solar barn designs, sludge and a solar water heater to help save energy. Apple producers have used refrigeration sequencing and heat exchangers to reduce energy costs in their storages and have tried integrated past management techniques in the orchards to reduce pesticide use.

Many energy saving ideas are demonstrated in Maine on only one or a few farms. The outlook for the adoption of these ideas varies from little potential for growth due to some limiting factor to great potential for future use.

Some project types that have been tried in Maine still need research and development. Among these activities are fuel alcohol production and the use of blueberry flail mowers. Integrated pest management programs for apples, potatoes, blueberries and sweet corn are also in the developmental stages.

Some other project types that have not been widely adopted, appear to hold promise for the future. Three, in particular, that have potential for some types of Maine farms are methane digesters using manure, evaporative coolers for vegetables and composting greenhouses. Livestock producers and especially dairy farms may be able to utilize the relatively simple methane digester technology already demonstrated on one Maine farm to produce their own fuel gas. Vegetable farmers selling at roadside stands or farmers markets, could quite easily and inexpensively build an evaporative cooler that would increase the storage life of their produce. Finally, small diversified farms that have both animals and crops should be able to put two alternative energy sources to work by building a composting solar greenhouse.

Some energy saving devices whose technology has been developed to the point where they are commercially available have not caught on in Maine for various reasons. One of these, the poultry litter burner, has been limited by problems in the poultry industry itself. These problems have resulted in discontinued use of three out of the five on farms in this state. This technology should become more widespread if the industry is revitalized. Another commercially available device, the wind electric generator has not been adopted by farms due to the payback period which is often 10 years or longer. Farmers generally require shorter paybacks on their investments.

Finally, there are a number of innovative alternative energy projects that have not found their way to Maine yet. No Air to Air or earth tube heat exchangers for warming ventilation air in livestock buildings were found on Maine farms, nor was there any farm using a heat pump in the barn to heat water or for space heating. A number of solar applicationos that have been tried elsewhere have not received much attention here as yet. Some of these are solar lambing or farrowing barns and solar grain drying. It may be that some of these unusual ways to reduce energy use will be effective in Maine but their acceptance awaits the outcome of trials by a few daring individuals.

In summary, a number of innovative ways to save energy have been found on Maine farms. Several have gained wide acceptance while others are still in the test and demonstration stage. The experiences of these pioneer farms may form the foundation on which the commonly used practices of tomorrow will be developed. It is hoped that the information presented in this catalog will help build that foundation for progress.

APPENDIX

Cooperative Extension Service Offices in Maine

Androscoggin-Sagadahoc County Extension Office
918 Sabattus Street
Lewiston, ME 04240
786-0376

Aroostook County Extension Office
23 Pleasant Street
Fort Kent, ME 04743
834-3905

Aroostook County Extension Office
Houlton Road, P.O. Box 727
Presque Isle, ME 04769
764-3361

Aroostook County Extension Office
Central Building, P.O. Box 8
Houlton, ME 04730
532-6548

Cumberland County Extension Office
96 Falmouth Street
Portland, ME 04103
780-4205

Franklin County Extension Office
78 Main Street, P.O. Box 670
Farmington, ME 04938
778-4650

Hancock County Extension Office
Christian Ridge Road
Ellsworth, ME 04605
667-8212

Kennebec County Extension Office
125 State Street
Augusta, ME 04330
622-7546

Knox-Lincoln County Extension Office
375 Main Street
Rockland, ME 04841
594-2104

Oxford County Extension Office
25 Market Square
South Paris, ME 04281
743-6329

Penobscot County Extension Office
Court House Annex
Bangor, ME 04401
942-7396

Piscataquis County Extension Office
Court House Complex
Dover-Foxcroft, ME 04426

Somerset County Extension Office
Norridgewock Avenue, P.O.Box 98
Skowhegan, ME 04976
474-9622

Waldo County Extension Office
RFD #1, Searsport Avenue
Belfast, ME 04915
338-1650

Washington County Extension Office
5 cooper Street, P.O. Box 189
Machias, ME 04654
255-3345

York County Extension Office
Court House Annex
Alfred, ME 04002
324-2814

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