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ABSTRACT

Energy education units (consisting of a general teacher's guide and nine units containing a wide variety of energy lessons, resources, learning aids, and bibliography) were developed for the Indiana Energy Education Program from existing energy education materials. The units were designed to serve as an entire curriculum, resource document, supplementary materials, or as a laboratory manual of "hands-on" activities which could be infused into existing grades 9-12 curricula. Unit V, focusing on energy and agriculture, consists of an introduction (rationale, unit objective, and general background information), one lesson, unit resources, bibliography, and teacher evaluation form. The lesson (Energy Conservation on the Farm) includes objectives, background information, seven student activities, resources, evaluation techniques, and transparency masters. (Author/JN)

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AN ENERGY CURRICULUM

for the

SENIOR HIGH GRADES

UNIT V - ENERGY AND AGRICULTURE

Division of Energy Policy
Indiana Department of Commerce
John M. Mutz, Director

Division of Curriculum
Indiana Department of Public Instruction
Harold H. Negley, Superintendent

October 1981

FOREWORD

Indiana educators have always responded to the demands placed upon them by society to resolve natural and human resource issues and problems. The task of teaching energy concepts and conservation practices to Indiana's youth is a response to energy problems facing our state and nation. It will be accomplished by many high school teachers and students getting involved in energy education.

We feel that students of all ages must be taught an energy conservation ethic. This ethic will enable each student to use Indiana's and America's energy resources more efficiently and with less waste. To help high school teachers accomplish this major goal, we are pleased to introduce a new Senior High School Energy Education Curriculum. This exciting and innovative program contains energy education activities, programs and resources for you and your students.

We encourage you and your students to get involved in the lessons presented here. We hope you will use these materials as a starting point and go far beyond by involving other classroom teachers, students, resource agencies and citizens in your community. A broad educational effort is needed to help prepare students to deal with this issue which affects us all.

Harold H. Negley
State Superintendent of
Public Instruction

John M. Mutz
Lieutenant Governor
State of Indiana

ACKNOWLEDGMENTS

The Energy Education Curriculum Project is coordinated by the Indiana Department of Public Instruction, Division of Curriculum, with the support and assistance of the Indiana Department of Commerce, Division of Energy Policy.

These materials, from the senior high grades, Energy Education Curriculum Project (EECP), were adopted from existing national energy education programs. The materials were selected by the EECP staff with assistance and direction from a Review Panel and the Energy Education Steering Committee.

George Cannon and Joe Wright, Energy Education Consultants, coordinated and supervised the preparation, evaluation and dissemination of these energy education materials. Carol Wood, Teacher Associate, assisted the EECP staff with the design and dissemination plans for the materials.

Members of the Senior High Energy Education Steering Committee are -- John A. Harrold, Director of the Division of Curriculum; Darrell Morken, Director of the Division of Traffic Safety; Gary Gesweine, Vocational Agriculture Consultant; Jerry Colglazier, Science Consultant; Joyce Konzelman, Home Economics Consultant; Jane Lowrie, Social Studies Consultant; Victor Smith, Research and Evaluation Coordinator; Gregg Steele, Industrial Arts Consultant.

Clarence Broadus, Director, and Michael Hennegan, Residential/Education Coordinator, Division of Energy Policy, offered suggestions and comments which helped to improve the materials.

The materials included in this unit of the senior high segment of the Energy Education Curriculum Project (EECP) were adopted with permission from:

- Energy Conservation: In the Home and On the Farm developed by the Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania in Cooperation with Agricultural Education Section, Bureau of Vocational Education, Department of Education, Harrisburg, Pennsylvania, and the Pennsylvania Farm Electrification Council, 1980.

This material was prepared with the support of the U.S. Department of Energy (DOE) Grant No. DE-F645-76CS 60038. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of DOE.

Unit V

Table of Contents

INTRODUCTION
(Rationale)

ENERGY EDUCATION - WHAT IT IS - Past, Present, Future

Energy education is the attempt to resolve the conflict between our present life style and the energy costs in both dollars and resources to produce and maintain that life style.

Energy education is reality education in that it deals with what exists here and now.

But, energy education is also a study of futuristics. The future that all of us must be willing to live in and accept is the one that we are creating right now by our daily decisions. We must examine the beliefs that "growth is good" and "bigger is better" and determine the impact these beliefs will have on our future.

Energy educators interested in the challenge to teach students about local, state, national and global energy resources, problems and issues should consider the following questions:

1. Can you help prepare your students to make wise and careful decisions about our remaining non-renewable energy resources?

2. Can you help prepare them to investigate and make wise decisions about research and development efforts for alternate and renewable resources, recycling programs, more efficient transportation systems, better personal consumption habits, and a personal commitment to efficient energy usage?

3. Can you explain to your classes where energy comes from, what the basic sources of energy are, how long our non-renewable energy resources will last, and the energy options among which our nation's people must choose if we are to survive?

The three questions above suggest that energy education is a challenge which encompasses all facets of living. Energy education is an opportunity for students to have impact on a long-lived problem, an opportunity to apply traditional content and skills to an important problem situation, and an opportunity for students to participate in personal and social decisions.

WHY STUDY ENERGY?

"One of the best ways to deal with a crisis is to consider it as an opportunity. From this point of view, the Energy Crisis provides almost endless possiblities for children to learn about themselves. Energy after all is what makes all things go. We need to realize that the energy crisis isn't just the newest fad. By studying the energy crisis, students can see where humanity has been, where it is now, and where it might be going. The energy crisis is another chapter in the story of mankind's continuing effort to reshape the world and the inevitable cost of doing that."[1]

To insure proper utilization of energy sources, our society must be educated about alternate life styles, energy resources, technology, consumer behavior and occupations.

The Indiana Department of Public Instruction, in cooperation with the Department of Commerce, Division of Energy Policy, has organized the Energy Education Curriculum Project (EECP) to meet the challenge of educating young people (our future adults) about energy, the energy crisis and the role they can play to help conserve America's economy and resources.

One way the Energy Education Curriculum Project staff has dealt with the task of disseminating energy information and education is through the Indiana Energy Curriculum Units. The units have been organized to help provide educators in many areas with lessons, charts, materials and "hands-on" activities to be used in the classroom.

[1] Kuhn, David J., "Teaching the Energy Lesson," in The Science Teacher, September 1978.

The Curriculum - Background Information

The Energy Education Units contained in the Senior High School materials were adopted from existing national energy education materials. A team of teachers from Indiana reviewed and evaluated energy documents from across the nation. After thoroughly reviewing the materials, only those activities or lessons which proved to be most effective in educating students were chosen for Indiana's program.

The units are designed to be used as the individual teacher wishes. The energy units could be used as an entire curriculum or as a resource document, supplement or laboratory manual of "hands-on" activities which can be infused into already existing curricula.

The Indiana Energy Education materials for grades 9-12 consist of a Teacher's Guide, nine units containing a wide variety of energy lessons, resources, learning aids and a bibliography.

Unit V

Unit V entitled "Energy and Agriculture" is composed of one lesson dealing with energy consumption and conservation in the business of agriculture. Lesson A involves activities for students to do relating to the conservation of energy on the farm.

Unit Objective

Upon completion of the unit, the student will become knowledgeable about various aspects of farm management, buildings and energy use.

Unit V

Lesson A

Note: The lesson that follows can be infused into an already existing curriculum. It is hoped that the teacher will incorporate these activities in the most beneficial manner.

LESSON TITLE: Energy Conservation On the Farm

LESSON OBJECTIVE:

The students will be able to list and support at least 10 agricultural energy conservation practices. The students will be able to demonstrate at least 10 conservation practices.

BACKGROUND INFORMATION:

The following material (some in outline form) will provide the student and the teacher with resource information concerned with energy conservation, to be used throughout the Unit. It is suggested that the student should review and study all of the Background Information prior to doing the student activities. The review and study should be done with the guidance and supervision of the teacher.

The farmer, like other homeowners, is faced with ever-increasing utility bills and predictions of higher and higher energy costs each year. Therefore, today's farmer is more concerned and more knowledgeable about how a farm uses and wastes energy. In this zealous age of consumer education and rights, farmers are learning from dozens of sources how energy is used in their daily lives. Therefore, they are impressed, favorably or unfavorably, with the features of a farm that relate to utility consumption and monthly costs. Unit V explores various points of view on farm management, buildings and energy use. Farmers are looking for the most economical way to live comfortably and continue the farm operation for both the present and future.

The following is a brief listing of conservation measures related to agriculture:

- Livestock and Housing
  - heating, cooling, lighting, water, refrigeration, food handling.
- Growing Crops
  - tillage, planting, soil fertility, pest control, irrigation, harvesting crops, forages, fruit and vegetables, drying and storing crops.
- Tractors, Trucks
  - petroleum used.

STUDENT ACTIVITIES:

1. Use the Insulation Experiment Model in Unit IV to stress the importance of proper selection and application of insulation materials.

Student Activities (continued)

2. Compare the lumen per watt (lpw) rating of lamps used as examples in the classroom to those used in the home and farm. Decide which would save energy and money for the home-farm operation.

3. Collect water lost from a leaky faucet (hot water tap) and calculate the energy and money lost.

4. Display water heater elements with mineral deposits and show how energy can be wasted.

5. Take a field trip to a precooling milk installation and an installation where heat from milk and compressors is used to heat water. Discuss and compare the two installations in regard to economic savings, energy efficiency, etc.

6. Observe electric motor demonstrations and select the most energy efficient motor required for the job.

7. Use the Background Information Sheets and Energy Terms to introduce students to farm conservation practices and terminology.

TRANSPARENCIES:

Students may also use transparencies 1-10 for help in understanding the material.

RESOURCES:

Energy Conservation: In the Home and On the Farm developed by the Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania, in cooperation with Agricultural Education Section, Bureau of Vocational Education, Department of Education, Harrisburg, Pennsylvania, and the Pennsylvania Farm Electrification Council - 1980.

Local utilities

Community farmers and farm operations

Heating and cooling companies

Construction/home builders firms

ENERGY CONSERVATION ON THE FARM
(ENERGY TERMS)

Energy terms used in Unit V:

AMCA - Air movement and condition association, established fan capacities and efficiencies.

Average heating degree days - The average of the daily high and low (degrees Fahrenheit) subtracted from a 65° standard and accumulated for a heating season.

CFM/Watt - Cubic feet of air per minute per watt of energy.

Degree days - Add together the high and low Fahrenheit temperatures of the day and divide by two. Subtract the results from 65° F. This formula is used only with heating buildings, and not for growing corn.

Dryeration - Grain removed from dryer hot without cooling. After 4-12 hours with no air flow, the grain is aerated slowly at 1/2 - 3/4 cubic foot per minute in the bin until a 2-3% moisture drop occurs.

EER - Energy Efficiency Ratio - The number of BTU's of heat that one watt of electrical energy will remove from the air in one hour.

Fluorescent - A substance which gives off light when charged by electricity.

HID - High intensity discharge (lights).

High power factor motors - Motors that use electricity more efficiently and give more output per watt.

Insulation - A material that prevents leakage of electricity, heat or sound.

Incandescent - A light which uses a filament to transfer electricity.

KW - Kilowatt - 1,000 watts

KWH - Kilowatt hour - 1,000 watts used per hour.

LPW - Lumen per watt - light output per watt of electricity.

PF - Power factor (electric motors) - the efficiency of an electric motor to carry a load with the electricity it is supplied.

R-value - The resistance of insulation to heat passing through it determines the R-value.

Solar energy - The energy received from the sun. Nuclear and geothermal energy are the only presently available energy forms not derived from the sun.

V-value - Measurement of the rate of transmission of heat through insulation and building materials.

A 10% saving in the yearly energy bill on each farm could save farmers $43,000,000 at current costs for energy. People and productivity have a direct effect on energy use. Change is required to make progress in savings. Involvement of employees and family in developing and putting energy management plans to work helps to point the way to saving energy and costs.

Remember that sizable dollar savings in energy costs can come from many, many small savings.

naturally ventilated structures. Potential savings up to 100%.

b. When warm animal housing facilities are required, consider a convertible system - closed, warm and mechanically ventilated during cold months - open and naturally ventilated during warm months.
Potential savings up to 60%.

c. *Reduce ventilation rates (cfm) to minimum levels in animal housing facilities mechanically ventilated year round and increase air circulation within the structure during hot months to compensate.
Potential savings 10-20%.

d. *Turn fans off when ventilation is not required, for example when cows are out to pasture for several hours each day.
Potential savings up to 10%.

e. *Select fans with a high cfm/watt rating.
Potential savings up to 50%.

f. *Clean fans and shutters frequently ... lubricate fans per manufacturers' recommendation... keep belts tight... check thermostats.
Potential savings 5-10%.

g. *Controls must be provided and properly set to prevent over-ventilating during cold weather months and wasting supplemental heat.
Potential savings up to 50%.

h. *Temperature-controlled, variable speed fans, two-speed fans, or motor-operated fan shutters which provide continuous but greatly reduced air flow during severe winter weather will reduce fuel consumption in heated buildings.
Potential savings 10-20%

...determine fan capacity by checking the AMCA (air moving and condition association) rating on the fan.
...determine fan efficiency by checking cfm/watt (cubic feet of air per minute per watt of energy) rating.

Examples of potential savings:

1. An enclosed, warm and mechanically ventilated 100-cow free stall barn will use approximately 12,300 kwh per year for ventilation. The annual energy cost at 5¢ per kwh could be $615. A cold, partially open, and naturally ventilated 100-cow free stall barn would eliminate the $615 expenditure for energy.

2. Selecting fans with cfm/watt rating of 17.8 vs. fans with cfm/watt rating of 14.7 for a poultry house requiring 100,000 cfm will save $517 energy cost annually with electrical costs at 5¢/kwh.

3. Reducing the level of ventilation in the above poultry house by 10% will save an additional $246.

4. Turn fans off when cows are out to pasture. A 70-cow barn ventilated with three 8,000 cfm fans will use approximately 9.436 kwh during a 7-hour period from 8 a.m. to 3 p.m. This would total 1132 kwh for the 120-day period from mid-May to mid-September. Energy savings would equal $56 at 5¢/kwh.

C. Lighting

1. How energy is consumed

   a. Indoor lighting

      1. Dairy operations
      2. Feeding operations
      3. Poultry operations
      4. House barns

   b. Outdoor lighting

      1. Security
      2. Work areas

2. Energy conservation measures

a. Lighting

Potential for energy savings

(*indicates little or no investment required)

1. *Switch to lower wattage bulbs.
Save 25-50%.

2. *Switch to incandescents to lower wattage or to lower-watt reflector bulbs.
Save 25-50%.

3. *Replace regular fluorescents with new GE Watt-Misers.
Save 12-20%.

4. *Use task lighting and reduce whole area or room lighting.
Save 15-50%.

5. *Reduce total light burning hours by turning off when not in use, leaving off some lights until needed.
Save 5-15%.

6. *Use high-intensity discharge (HID) such as mercury vapor and high-pressure sodium to allow reduction of wattage and almost always the number of lamps.
Save 15-40%.

7. *Use light dimmers where total wattage of bulbs gives more light than needed.
Save 15-40%.

<u>Energy Saving Examples</u>

Switch to Lower-Wattage Bulbs (Yearly cost if burned 8 hours daily)

Light Bulb Watts	Cents per KWH .03	.04	.05	.06	.07
25	2.20	2.90	3.65	4.35	5.10
40	3.50	4.65	5.80	6.95	8.10
75	6.55	8.75	10.90	13.10	15.25
100	8.75	11.65	14.55	17.45	20.35
150	13.10	17.50	21.80	26.15	30.50

Example = one 75-watt replacing a 100-watt saves $3.65 yearly at 5¢ per kwh ($14.55-$10.90 = $3.65).

High Pressure Sodium

Gives more light per watt and requires fewer fixtures.

Example = One 150-watt sodium lamp gives approximately as much light as... six 150-watt incandescents or two 175-watt mercury lamps.

Savings yearly at 8 hours per day at 5¢ per kwh... $101.62 under 6 incandescents or $30.96 under 3 mercury lamps.

Reduces number of fixtures needed ... 5 less than incandescents or 1 less than mercury.

Reduction of Total Burning Hours Saves Money and Energy:

One 100-watt bulb burned 8 hours daily at 5¢ per kwh costs $14.60 yr.
Each hour burning time reduced daily saves $1.82 yr.

See Transparency 5 - found at the end of Lesson A

D. Water heating

1. How energy is consumed

   a. Milk house and milking parlor
   b. Egg rooms
   c. Livestock waterers (winter)

2. Energy conservation measures

Potential for energy savings

(*Indicates little or no investment required)

a. *Preheat incoming water with heat exchanger. Potential savings up to 50%.

b. *Drain heater and remove lime deposits on a periodic basis. Potential savings up to 25%.

c. *Repair all leaking faucets. Potential savings 5-10%.

d. Insulate hot water lines which run through unheated areas. Potential savings up to 10%.

e. *Keep temperature setting at low level. Potential savings 10-20%.

f. *Use hot water prudently. Don't use to wash boots and floor areas. Potential savings up to 10%.

E. Refrigeration

1. How energy is consumed

a. Cooling milk
b. Cooling eggs
c. Meat storage
d. Cooling produce

2. Energy conservation measures

a. Potential for energy savings

(*Indicates little or no investment required)

1. A heat exchanger coupled with a refrigerant compressor will lower annual compressor operating costs. Potential savings 5-30%.

2. *Removing half of the heat from fruits or vegetables brought from the field will reduce the annual storage refrigeration costs. Potential savings up to 10%.

3. A multi-tube pre-cooler, using well water to pre-cool milk, will lower annual refrigeration costs.
Potential savings 32-40%.

4. *Keep compressor condensers and fans clean.

Assume:

80-cow herd with 15,000 lb. milk/yr. average

Select a multi-tube pre-cooler with a 2,000 lb. milk/hr. capacity

Electric costs are 5¢/kwh

A 30-ft. section of a tube cooler with water at 50°F from 2,000 lb/hr of milk. This would be equivalent to the output of a 5-hp compressor working for 1.11 hours.

On a yearly basis $521 would be saved in cooling costs and a smaller compressor could probably be used to remove the remaining heat from the milk.

The multi-tube pre-cooler in the example above would remove 50,000 BTU/hr.
- a 3 hp D/B compressor removes 28,000 BTU/hr.
- a 5 hp D/B compressor removes 45,000 BTU/hr.

Assume:

A well-insulated, 30,000 bushel capacity apple storage. Apples are stored for 9 months each year and apples are brought directly from the field into storage. 98,325 kwh electricity for refrigeration (95% efficiency) at 5¢/kwh, annual cost - $4,916.

Removing half the heat from apples brought from the field can save 10% of the annual refrigeration costs, $492 per year.

b. See Transparency 6 included in latter portion of Lesson A.

F. Manure handling

1. How energy is consumed

   a. Removal from building
   b. Storage
   c. Loading and spreading

2. Energy conservation measures

   a. Store to preserve nutrients
   b. Spread less frequently
   c. Plow down promptly
   d. Consider alternative handling procedures to conserve energy and nutrients

      1. Use resource person

G. Feed handling and processing equipment

1. How energy is consumed

   a. Grinding and mixing feed
   b. Removal from storage
   c. Distribution

2. Energy conservation measures

   a. Potential for energy savings

      (*Indicates little or no investment required)

      1. *Load motor with work as near to its rated capacity as possible. Size motor to the job. (Motor load and size are very difficult for most of us to determine. An electrician or power company representative who can determine voltage, amperes, wattage, and power factor levels should be consulted.)

      2. *Operate at capacity as much as possible (avoid overheating).

         Avoid letting motors run idle.

      3. *Start motors in sequence rather than simultaneously if there are two or more large motors.

4. *Keep motors and equipment lubricated and clean.

5. *Install electric wiring for motors which is heavy enough gauge to minimize voltage drops.

6. *Maintain proper V-belt tension.

7. Properly designed feeding system.

8. Consider custom grinding and mixing for smaller operation.

1. Resource person

II. Growing Crops

A. Tillage and planting

1. How energy is used

a. Plowing
b. Disking and harrowing
c. Cultivation
d. Minimum tillage
e. No-till

2. Energy conservation measures

(*Indicates little or no investment required)

		Save per acre
a.	*Omit plowing.	$7.80
b.	*Omit disking.	4.40
c.	*Omit harrowing.	3.60
d.	*Omit cultivating.	3.50
	Sod-seeding practice:	
e.	*Plowing avoided.	7.80 - 9.00
f.	*Disking avoided.	8.80
g.	*Harrowing avoided.	7.20

Combine some field operations (go once and accomplish two or more things).

h. *Apply liquid nitrogen and herbicides. Save up to 50%
i. *Disking and applying herbicides.
j. *Planting and applying herbicides.

Added benefits where above practices are used:

- Rock picking elimination.
- Soil compaction is reduced by fewer trips over the field.

k. See Transparencies 7, 8, 9, and 10 included in latter portion of Lesson A.

B. Soil fertility

1. How energy is consumed

a. Spreading manure
b. Spreading chemical fertilizer and lime
c. Crop residue and management

2. Energy conservation measures:

(*Indicates little or no investment required)

a. *High-analysis fertilizers mean more units of plant food per ton and reduce transportation, handling and application costs up to 20%.
Save $3 to $12 per acre a yr.

b. *Use ammoniated starters to enhance early germination and reduce replanting risk.
Save $3 to $8 per acre.

c. *Plow down all P & K when planting clear-seeded alfalfa for 3-year stands. Eliminates annual top dressing. Yields have proven to be equal or better.
Save $5 to $15 per acre over life of stand.

d. *Handle and store manure in semi-dry form (18-20% dry matter). Spread less frequently, plow down promptly, handle less weight. Nutrients, labor, energy are saved.
Save up to $26 per cow yearly.

e. *Grow forage legumes. Each ton of 16% protein dry matter produced represents nitrogen fertilizer worth.
Save $3.

C. Pest Control

1. How energy is consumed

a. Application

2. Energy conservation measures

a. Apply liquid nitrogen and herbicides.
b. Combine herbicide application with tillage and/or planting.
c. Consider aerial application rather than ground application.

D. Irrigation

1. How energy is consumed

a. Pumping
b. Equipment handling

2. Energy conservation measures

Potential for energy savings

(*Indicates little or no investment required)

a. *Diesel power instead of gasoline.
Potential savings 25-32%.

b. *Sprinkler rather than furrow irrigation.
Potential savings 10-20%.

c. *Trickle rather than furrow irrigation.
Potential savings 40-60%.

d. *Irrigation under cloudy conditions, lower temperatures, and/or at night can reduce water requirements by 25% and result in fuel savings.
Potential savings 25-40%.

e. *Maintain and tune the power unit engine.
Potential savings 6-20%.

f. *Operate electric-powered units during low-demand periods.
Potential savings 20-38%.

III. Harvesting crops

A. Corn, soybeans, and small grains

1. How energy is consumed

a. Combining
b. Picking
c. Transporting

2. Energy conservation measures

a. Size the machine to the job.
b. Use proper weed control.
c. Use efficient vehicles for transportation.
d. Consider gravity flow equipment.
e. Plan farm for efficient operation.

1. Increase field size
2. Contour
3. Strip crop

B. Forages

1. How energy is consumed

a. Chopping (silage)
b. Mowing
c. Conditioning
d. Withdrawing
e. Bailing
f. Transporting
g. Conveying to storage

2. Energy conservation measures

a. Keep knives and blades sharp.
b. Keep machines properly lubricated and adjusted.
c. Use efficient length of cut when chopping.
d. Combine steps when possible.
e. Size the machine to the use.
f. Plan farm for efficient operation.

1. Increase field size
2. Contour
3. Strip crop

C. Fruit and vegetables

1. How energy is consumed

a. Picking
b. Grading
c. Transporting
d. Processing
e. Packaging

2. Energy conservation measures

a. Use the proper size equipment.
b. Keep equipment adjusted and lubricated properly.
c. Consider bulk handling.
d. Combine steps in processing and packaging.
e. Use volume marketing.

IV. Drying and storing crops

A. Drying crops

1. How energy is consumed

a. Shelled corn, soybeans and other small grains
b. Ear corn
c. Hay

2. Energy conservation measures

Potential for energy savings

(*Indicates little or no investment required)

a. *Use early maturing varieties.

b. *Field dry to the fullest practical extent. Each point that moisture is lowered on each 100 bushels eliminates 75-100 pounds of water, saving 1 1/2 gal LP-gas equivalent, equal to approximately 3/4¢ per bushel.

c. *Buy a good moisture tester and use it.

d. *Do not overdry. Dry to needed level but no more. The fuel used to remove 10 points from 25 to 15 is equal to fuel used to remove 5 points (18 to 13).

e. *Clean grain to remove fines and reduce power needed to move air through grain.

f. *Use as little grain depth as possible and level the top.

g. *Operate dryer at optimum levels recommended by manufacturer and keep serviced properly.

h. *Use dryeration process (grain removed from dryer hot without cooling. After 4 to 12 hours with no air flow, the grain is aerated slowly at 1/2-3/4 cubic feet per minute (cfm) in the bin for a 2 to 3 point drop. May up capacity by 50% and cut fuel cost by 20-25%.

i. Use natural processes when possible for hay.

j. Consider nutrient preservation in storage.

B. Storage and handling

1. How energy is consumed

a. Conveyors
b. Ventilators and fans
c. Refrigeration
d. Humidifying
e. Dehumidifying.

2. Energy conservation measures

a. Using proper insulation where necessary.
b. Using proper ventilation where necessary.

V. Tractors and trucks

A. How energy is consumed

1. Fuel
2. Oil and lubricants
3. Tires
4. Maintenance

B. Energy conservation measures

1. Select diesel or gas.

2. Use proper size equipment for the job.

3. Size equipment to match the tractor.

4. Practice minimum tillage where practical to reduce trips over the field.

5. Follow regular maintenance and tune-up procedures on all vehicles.

6. Merge small fields into large fields to take advantage of longer rows and less turning.

7. Keep all implements lubricated and properly adjusted.

8. Use tractor weights to distribute load for minimum wheel slippage.

9. Replace faulty radiator thermostats.

10. Keep tillage tools properly aligned.

11. Avoid excessive idling and engine warm-up time.

12. Carry loads to vehicle capacity.

13. Plan and schedule trips.

14. Inflate all tires to proper pressure weekly.

ALL ENERGY REQUIRED YEARLY

(Expressed as gallons of gasoline equivalent—New York State)

1 dairy cow	7.7 gal.	1 A corn silage	15.7 gal.
1 beef animal	3.2 gal.	1 A hay (baled)	10.1 gal.
100 laying hens	6.0 gal.	1 A hay (silage)	11.8 gal.
1 horse	3.2 gal.	1 A oats	9.8 gal.
1 hog	.8 gal.	1 A potatoes	46.6 gal.
1 lamb	1.1 gal.	1 A apples	38.1 gal.
1 A corn grain	9.0 gal.	1 A cabbage	50.7 gal.

27

Where is Energy Used

U.S.D.A. projections indicate, on a BTU basis, that approximately one-third of the energy farmers buy is used in farm family living and two-thirds for farm production. Farm family living energy use includes heating, cooking, lighting and personal auto use.

The table below shows how farmers use their purchased farm production energy in New York State.

	%
Field Crops	63.5
Dairy Livestock	13.5
Vegetable Crops	10.7
Fruit Crops	6.3
Horses	2.5
Beef Livestock	1.5
Poultry	1.0
Swine and Sheep	1.0
	100.0

*Based on Cornell figures, New York State only. Northeast data unavailable.

Individual farm operations will show varying energy-use profiles.

BTU Heat Loss Per Hour, Per Square Foot at Zero Fahrenheit
Based on Outside Temperature of 0° F and Inside Temperature of 70° F

	No Insulation	Insulated 3″ of Fiberglass in Ceilings None in Walls	Insulated 6″ of Fiberglass in Ceiling, 3″ Walls
Ceilings	42	6	3
Walls	18	18	5
	Single Glass	**Storm Sash**	
Windows	180	85	
	No Storm, No Weather Stripping	**Storm or Weather** Stripping	**Storm and Weather** Stripping
Doors	350	170	90

INSULATION MATERIALS, R-VALUES, AND USES

Material	"R" per inch thickness*	Where Used
Flexible		
Cellulose fiber with vapor barrier	3.20–4.00**	unfinished attic floors open sidewalls, heating ducts crawl spaces underside of floors, rafters
Glass fiber or mineral wool	3.00–3.40**	
Loose Fill		
Glass fiber and mineral wool	2.80–3.40	finished and unfinished attic floors, finished frame walls
Cellulose	3.50–3.70	
Vermiculite, expanded	2.13	
Rigid Board		
Polystyrene, extruded	5.26	basement walls, new construction, floor slab perimeter
Expanded urethane, preformed	5.80–6.25	
Glass fiberboard	4.00	
Polystyrene, molded beads	3.57	
Foamed-in-Place		
Expanded urethane, sprayed	6.25	finished frame walls finished and unfinished attics
Urea formaldehyde	5.00***	finished frame walls

R-values illustrated are minimums recommended. Higher R-values (thicker insulation) will provide further savings particularly where season average degree days are higher

*Determined from ASHRAE Handbook 1972
**Varies according to density and fiber diameter
***From manufacturers specifications

Lighting Energy Saving Examples

Switch to Lower-Wattage Bulbs (Yearly Cost Burned 8 Hours Daily)

Light Bulb Watts	Cents Per KWH				
	03	.04	.05	.06	07
25	2.20	2.90	3.65	4.35	5 10
40	3 50	4.65	5.80	6 95	8 10
75	6 55	8 75	10 90	13 10	15 25
100	8 75	11 65	14.55	17.45	20.35
150	13 10	17 50	21 80	26 15	30 50

Example - one 75 watt replacing a 100 watt saves $3 65 yearly at 5¢ per kwh ($14 55–$10 90 $3 65)

High Pressure Sodium

Gives more light per watt and fewer fixtures are needed

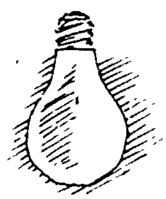
Example: One 150-watt sodium lamp gives approximately as much light as — 6—150-watt incandescents or 2—175-watt mercury lamps

Saving yearly at 8 hours per day at 5¢ per kwh — $101 62 under 6 incandescents or $ 30 96 under 2 mercury lamps

Reduces number of fixtures needed — 5 less than incandescents or 1 less than mercury

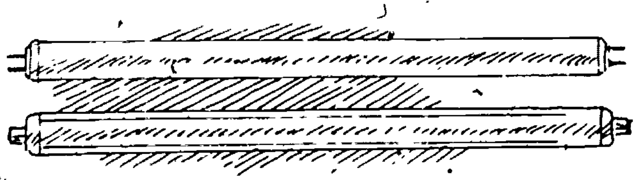
Reduction of Total Burning Hours Saves Money and Energy:

One 100-watt bulb burned 8 hours daily at 5¢ per kwh costs — $14 60 yearly
Each hour burning time reduced daily saves — $ 1 82 yearly

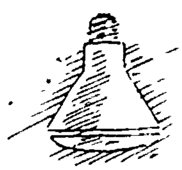


Incandescent

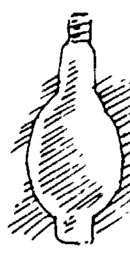
Reflector



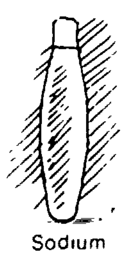
Fluorescent



Par Reflector



Mercury



Sodium

TRANSPARENCY MASTER # 6

Milk Cooling Tables

1000 lb. milk/hr. @ 90°F

	Milk Cooled to 65 F				Milk Cooled to 70°F			
	Water Flow				Water Flow			
	6 gal./min.		3 gal./min.		6 gal./min.		3 gal./min.	
Water Temp.	7 Tube	9 Tube	7 Tube	9 Tube	7 Tube	9 Tube	7 Tube	9 Tube
60	35′	25′	45′	35′	20′	15′	25′	20′
55	20′	15′	30′	20′	15′	10′	20′	15′
50	20′	15′	20′	15′	15′	10′	15′	10′
45	15′	10′	15′	10′	10′	5′	10′	10′
40	15′	10′	15′	10′	10′	5′	10′	5′

1500 lb. milk/hr. @ 90°F

	Milk Cooled to 65 F				Milk Cooled to 70°F			
	Water Flow				Water Flow			
	6 gal. min		3 gal./min.		6 gal./min.		3 gal./min.	
Water Temp	7 Tube	9 Tube	7 Tube	9 Tube	7 Tube	9 Tube	7 Tube	9 Tube
60	60′	45′	75′	60′	30′	25′	35′	30′
55	35′	30′	45′	35′	25′	20′	25′	20′
50	30′	20′	30′	25′	20′	15′	20′	15′
45	20′	20′	25′	20′	15′	10′	15′	15′
40	20′	15′	20′	15′	15′	10′	15′	10′

1750 lb. milk/hr. @ 90°F

	Milk Cooled to 65 F				Milk Cooled to 70°F			
	Water Flow				Water Flow			
	6 gal. min.		3 gal./min.		6 gal./min.		3 gal./min.	
Water Temp	7 Tube	9 Tube	7 Tube	9 Tube	7 Tube	9 Tube	7 Tube	9 Tube
60	75′	60′	—	—	40′	30′	65′	50′
55	45′	35′	90′	70′	30′	20′	40′	30′
50	35	25′	55′	40′	25′	20′	30′	25′
45	25′	20′	40′	30′	20′	15′	25′	20′
40	25′	20′	30′	25′	15′	10′	20′	15′

2000 lb. milk/hr. @ 90°F

	Milk Cooled to 65 F				Milk Cooled to 70°F			
	Water Flow				Water Flow			
	6 gal. min.		3 gal./min.		6 gal./min.		3 gal./min.	
Water Temp	7 Tube	9 Tube	7 Tube	9 Tube	7 Tube	9 Tube	7 Tube	9 Tube
60	85′	65′	—	—	45′	35′	90′	80′
55	55	45′	90	90′	35′	25′	55′	40′
50	40	30′	75	60′	25′	20′	35′	30′
45	30′	25	50′	40′	20′	15′	30′	25′
40	25	20′	35′	30′	20′	15′	25′	20′

Tables showing multi-tube pre-cooler lengths required to lower milk temperatures 20 to 25 F using well water for cooling at two different flow rates

Multi-tube Pre-cooler

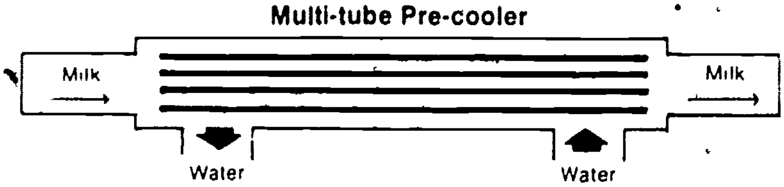


Table A 600 hrs/year Fuel Use and Cost

Test	Average Load	Annual Fuel Requirement Diesel (gal)	Annual Fuel Requirement Gas (gal)	Annual Estimated Fuel Cost (1) Diesel @ 52¢ gal	Annual Estimated Fuel Cost (1) Gas @ 63.5¢ gal
A	100%	3644	4378	$1895	$2780
B	75%	3268	3947	$1674	$2507
C	50%	2746	3269	$1428	$2076
*D	50%	1968	2537	$1024	$1611

Table B 1200 hrs/year Fuel Use and Cost

Test	Average Load	Annual Fuel Requirement Diesel (gal)	Annual Fuel Requirement Gas (gal)	Annual Estimated Fuel Cost (1) Diesel @ 52¢ gal	Annual Estimated Fuel Cost (1) Gas @ 63.5¢ gal
A	100%	7288	8756	$3790	$5560
B	75%	6536	7894	$3347	$5013
C	50%	5492	6538	$2856	$4152
*D	50%	3936	5074	$2047	$3222

*Test D was at the same HP load as Test C but Test D was a gear or two higher in the transmission and at a reduced throttle setting

(1) Tax refund for off-road use would be subtracted

Example 1. Selection of a diesel engine for the tractor shown in Test C above and working at 50% load, would reduce fuel consumption by 16% and reduce fuel costs by 31%—$1296/year saving (Table B).

Example 2. Large tractors pulling light loads can save 22.4% to 28.3% in fuel consumption by changing to a gear or two higher and throttling back the engine to maintain the same ground speed. The comparison of tests C and D above shows diesel, $809 saving/year; gasoline, $930 saving/year (Table B).

Example 3. If the tractors described in examples one and two are compared, it can be seen that the diesel tractor saves 16.7% in gallons of fuel used, and with diesel fuel selling for 52¢/gal and gasoline selling for 63.5¢/gal, the diesel model costs $3.06/hr. for fuel to operate, and the gasoline tractor costs $4.48/hr. This is a 31.7% saving in favor of the diesel model.

Table C

Operation	PTO HP-Hrs. Per Acre	Gals./Acre Diesel	Gals./Acre Gasoline
Plow 8 in. deep	24.4*	1.68	2 16
Heavy offset disc	13.8	0 95	1 22
Chisel pl[illegible]	16.0	1 10	1 41
Tandem disc (unplowed)	6 0	0.45	0 58
Tandem disc (plowed)	11 0	0 76	0 98
Cultivate row crops	6 0	0 45	0 58
Planting row crops	6 7	0.50	0.64
Grain drill	4 7	0 35	0 45

*Part of data prepared by Wendell Bowers Oklahoma State University Extension Engineer

Example 1. (See top line in Table C above) An 85.45HP diesel tractor has the potential to plow approximately 3.5 acres/hr. (85.45HP ÷ 24.4HP-hrs/acre = 3.5 acres/hr.). This value, multiplied by the gallons of fuel required per acre (1.68) for plowing, gives a value for gallons per hour (3.5 x 1.68 = 5.88 gals/hr.).

Example 2. The same model tractor, except gasoline powered, is rated at 79.73 HP and has the potential to plow approximately 3.27 acres/hr. 3.27 x 2.16 = 7.06 gals/hr.

Potential for Energy Savings in Tillage Management

▶ Indicates little or no investment required

	Save Per Acre*
▶ Omit plowing	$7.80
▶ Omit discing	4.40
▶ Omit harrowing	3.60
▶ Omit cultivating	3.50

Sod Seeding Practice

▶ Plowing avoided	7.80-9.00
▶ Discing avoided	8.80
▶ Harrowing avoided	7.20

Combine some field operations (go once and accomplish two or more things)

▶ Apply liquid nitrogen and herbicides — Save up to 50%

▶ Discing and applying herbicides

▶ Planting and applying herbicides

Approximate energy cost saving per acre as shown by standard custom cost studies.*

Added benefits where above practices are used:

- Rock picking elimination
- Soil compaction is reduced by fewer trips over the field
- Reduces work load during busy spring planting
- Some acreage can be used that is not adapted to normal crop rotations; (Ex., hilly land subject to severe erosion)

*Source—Published State College Research Figures 1976

Potential for Energy Savings in Fertility Management

▶ Indicates little or no investment required

	Save
▶ High analysis fertilizers mean more units of plant food per ton and reduce transportation, handling, and application costs up to 20%	$3 to $12 per acre yearly
▶ Use ammoniated starters to enhance early germination and reduce replanting risk	$3 to $8 per acre
▶ Plow down all P & K when planting clear-seeded alfalfa for 3-year stands. Eliminates annual top dressing. Yields have proven to be equal or better.	$5 to $15 per acre over life of stand
▶ Handle and store manure in semidry form (18-20% dry matter). Spread less frequently, plow down promptly, handle less weight. Nutrients, labor, energy are saved.	Up to $26 per cow yearly
▶ Grow forage legumes. Each ton of 16% protein dry matter produced represents nitrogen fertilizer worth	$3

Energy Costs to Dry Shelled Corn/Grain Sorghum

1 Bushel = 56 lbs. at 15.5% moisture and 47.3 lbs. of dry matter

Grain Moisture	Lbs. water to be removed from 1 bushel for 15.5%	Requires average BTUs	Fuel Cost Per Bushel: Fuel Oil 50¢ gal	Fuel Cost Per Bushel: Nat. Gas 25¢ ccf	Fuel Cost Per Bushel: LP gas 50¢ gal.
32	16.7	33,400	.117	.082	.18
31	13.5	27,000	.098	.068	.15
30	11.5	23,000	.082	.057	.125
28	9.7	19,400	.069	.048	.105
26	7.9	15,800	.055	.039	.085
24	6.2	12,400	.044	.032	.07
22	4.6	9,200	.033	.023	.05
20	3.1	6,200	.022	.016	.035
18	1.7	3,400	.012	.009	.02
16	.3	600	.002	.002	.005

Suggestion: Figure fuel cost saving by comparing in table above, loading dryer with lower moisture grain or by removing grain at a safe higher point level.

Example: 1 Bu 30% grain requires removing 11.5 pounds of water, requiring an average 23,000 BTUs, which require .25 gal. LP-Gas equivalent.

Wheat and soybean drying cost may run about 10% higher.

1 gal. LP gas = .65 gal. fuel oil
= 91.5 cu ft. natural gas

LP gas = 91,500 BTU/gal.
Fuel oil = 139,000 BTU/gal.
Natural gas = 100,000 BTU/ccf

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Here Is Your Indiana Government, 18th Edition, August 1977. Published by: Indiana State Chamber of Commerce, 201 Board of Trade Building, Indianapolis, Indiana 46204.

PLEASE TELL US WHAT YOU THINK ABOUT THE SENIOR HIGH SCHOOL ENERGY MATERIALS

Your position: ______teacher
(check) ______dept. head
______administrator
______other

Your grade level: ______________________

Subject(s) taught: ______________________

____

If possible, please answer these questions after you have taught unit lesson(s) in your class and examined the teacher's guide. If this is not possible, please answer based on your personal inspection of the unit materials.

1. What project materials are you evaluating? (Check all that apply)
   - ______Unit I
   - ______Unit II
   - ______Unit III
   - ______Unit IV
   - ______Unit V
   - ______Unit VI
   - ______Unit VII
   - ______Unit VIII
   - ______Unit IX
   - ______Teacher's Guide

2. What is the basis for this evaluation? (Check all that apply)
   - ______(1) teaching 4 or more lessons
   - ______(2) teaching 1 to 3 lessons
   - ______(3) personal inspection
   - ______(4) discussion with others who know materials

3. Have you shared these units with other educators? (Check one)
   - ______(1) No
   - ______(2) Yes, with 1-4 others
   - ______(3) Yes, with 5-10 others
   - ______(4) Yes, with more than 10

Circle the number from 1 (Definitely No) to 7 (Definitely yes) which best reflects your answer.

	DEFINITELY NO			NEUTRAL			DEFINITELY YES
4. Are these materials easy to understand and use?	1	2	3	4	5	6	7
5. Do these materials fit with the curriculum of your district?	1	2	3	4	5	6	7
6. Are you likely to make use of these materials in the future?	1	2	3	4	5	6	7
7. Are these materials appropriate for the level of your students?	1	2	3	4	5	6	7
8. Are these materials interesting to your students?	1	2	3	4	5	6	7
9. Is the reading level appropriate?	1	2	3	4	5	6	7
10. Do you think these materials will reduce energy consumption?	1	2	3	4	5	6	7

What did you like best? ______________________

What did you like least? ______________________

Suggestions/Comments (Use the back as needed): ______________________

____

RETURN TO: Energy Education Curriculum Project, Division of Curriculum, Department of Public Instruction, Room 229, State House, Indianapolis, IN 46204.