An Energy-Saving List For Dairy Production

By L. E. Stewart and R. F. Davis

Milk and meat from dairy cattle are major contributors to our food supply. Foods from dairy cattle provide major sources of protein, minerals — particularly calcium and phosphorus, and vitamin A and B complex vitamins, including Vitamin B_{12}. The quality of protein from milk and dairy products is high, and nutritional requirements can be met with smaller amounts than when animal products are not in the diet.

Hides provide an important source of fiber for a wide variety of uses.

Dairy production is an important agricultural enterprise in the United States, placing first to third in agricultural income in 16 of the 50 States. Over 10 million dairy cows produce milk for our daily use.

While significant quantities of grain are included in dairy rations, over two-thirds of the total feed used in milk production is from forages which have little or no alternative use in our economy. Much of the land on which forages are grown is not suited to more intensive cultivation. Thus dairy cattle and other ruminant livestock serve as collectors, concentrators, and converters of non-food plants to high quality human food. Byproducts of dairy production include a wide variety of medicinal products.

Energy from fossil fuels is used in varying amounts in milk production. Very small amounts of energy are required for the harvesting of forages by grazing, with more intensive use in concentrated feeding systems — particularly the feeding of high producing dairy cattle. Some energy is required indirectly by dairy production in the manufacture and construction of buildings, machinery, and equipment required for this activity.

Many functions of dairy production require direct input of energy as discussed below.

LARRY E. STEWART *is Associate Professor and Chairman, Department of Agricultural Engineering, University of Maryland. Richard F. Davis is Professor and Chairman, Department of Dairy Science.*

U.S. agriculture used 223.2 trillion Btu's of energy for operations directly relating to livestock production in 1978. This was nearly 11 percent of the total energy used in U.S. agriculture. The table lists forms and amounts.

Direct Energy Use for Livestock Production

Energy Form	Units	Quantity
Gasoline	1,000 Gallons	604,363
Diesel Fuel	1,000 Gallons	487,283
Fuel Oil	1,000 Gallons	10,218
LP Gas	1,000 Gallons	403,845
Natural Gas	Million Cubic Feet	5,141
Coal	Tons	36,522
Electricity	Million Kilowatt Hours	9,961

Milk production accounted for a significant portion of this energy. On-farm operations include feed processing and handling, waste disposal, water supply and heating, space heating, ventilation, lighting, milking and milk cooling, and vehicle use directly related to dairy production.

These operations are important steps in production of high quality milk for the consumer. Although these operations are performed on individual farms in many different ways, the following describes typical farming operations in terms of how energy is actually used in producing these important foods.

Feed Processing, Handling. Farmers must provide carefully balanced rations to dairy cows to produce the maximum amount of milk per animal. To accomplish this, grains must be mechanically reduced by grinding. Then they are thoroughly mixed with necessary protein concentrates, vitamins, minerals, and sometimes forages. Finally the mixture is conveyed to the animals in feeding areas.

Devices such as hammer or roller type mills are used to grind grains so the animals can use the feed in an efficient way. Vertical or horizontal mixers are used to insure that the feed each animal receives contains all nutrients needed for maximum production.

Auger, belt, or chain conveyors requiring little energy are frequently used to carry processed feeds from the storage area to the cattle. Trucks or tractor-drawn wagons with mechanized unloading are used on many farms to mix and distribute feed.

Dairy cows also are fed silage and hay. Silage is frequently stored in upright silos in which

mechanical unloaders are used to move the material from the silo onto conveyors or vehicles that carry feed to the cattle. Silage stored in horizontal silos (bunker or pit type) is loaded on vehicles by front-end loaders or specially designed elevators for transport to feeding areas.

Hay for dairy cattle is generally baled and moved into storage. It is transported by conveyors or vehicles for feeding.

Disposal of Waste

Farmers must pay special attention to waste handling operations to provide sanitary products, insure animal health, and prevent environmental pollution. Dairy producers must remove wastes from animal production units on a daily basis to meet regulatory and sanitation requirements.

Methods most commonly used for waste removal are either mechanical scraping or water flush systems. In mechanical scraping, a tractor mounted blade pushes wastes from the production area into a manure spreader for direct distribution, or to an approved storage tank or basin for later distribution on the land.

The water flush system involves releasing water at a controlled rate over a paved surface to wash the wastes into a lagoon or storage tank. These fluid wastes are then typically pumped through an irrigation system so that fertilizer value of the manure can be used in crop production.

Water Supply, Heating. All livestock require a continuous source of clean water for drinking. Dairy operations require larger quantities of water for animal consumption and for washing milking equipment and milking areas.

Health officials regularly inspect dairy farms to be sure milk is produced under stringent sanitary conditions. A dependable supply of clean hot water is essential to the dairy farmer in meeting the health regulations.

Most milking parlors use space heating for the comfort of milkers during winter months. Hot air furnaces, electric heaters, or radiant panels are used to help operators in the cold, wet environment that may exist in such facilities.

Ventilation and Lighting

Sometimes dairy cattle are kept in buildings designed to provide maximum production efficiency. As a result animals are often rather concentrated and ventilation is needed to control moisture and odors within the production units.

A variety of fan ventilation systems are used to remove a controlled amount of air from these

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facilities that will prevent moisture and odor buildup without removing excessive heat from the building.

Lighting is for two purposes. One is to allow animals to locate feed and water, the other so workers can observe the animals and perform tasks related to their care.

Milking, Cooling. Automatic milking systems have been developed to quickly and carefully harvest the milk crop. These systems are electrically operated and controlled.

Vacuum systems are used to withdraw milk from the cow and then convey the milk to refrigerated tanks. Again, health regulations require the milk to be quickly cooled in these tanks to insure a high quality product. All components of the milking system are automatically washed and sanitized upon completion of each milking operation.

Farm trucks and autos are used in providing many functions related to milk production. Worker transport, on-farm animal transport, and hauling of feeds and other supplies are the primary users of energy in this aspect of livestock production.

Energy Conservation

Farmers, like all U.S. citizens, are striving to reduce energy use in every possible way. Following are some of the important things dairy producers can do to cut energy use in their operations.

Savings on Feed

- Use low horsepower grinders operating for longer time periods to minimize energy consumption in feed grinding and mixing.
- In large operations, use three-phase electrical service to reduce cost of motors and improve system efficiency.
- Use conveyors and augers to replace vehicles in distributing feed.
- Maintain all equipment according to manufacturers' specifications (lubrication, alignment, etc.).
- Let cattle self-feed to eliminate mechanical equipment where possible.
- Set up gravity flow of materials where the operational situation permits.
- Use controlled grazing to provide forage for animals at appropriate times of year.

Waste Disposal. Proper maintenance of mechanical equipment is essential. The system must conserve all of the plant nutrients so they can be returned to support crop production.

Select equipment carefully to provide an efficient flow of materials through the entire system. Waste water can be recycled for flushing wastes from animal housing areas.

Tips on Water Supply, Heating

Use intermediate storage water systems. These systems employ a low horsepower pump to fill a large reservoir of water to supply needs of cattle and for sanitation.

Maintain animal waterers properly to minimize spillage and leakage.

Insulating water heaters can reduce energy use as much as 10 percent. Set thermostat settings on water heaters no higher than maximum water temperatures needed. Drain water heaters periodically to flush out lime desposits and improve heating efficiency.

Insulate hot water lines that pass through unheated areas.

In space heating, insulate walls and ceilings of heated areas. Carefully size the heating unit to match environmental conditions needed. Maintain the heating system according to manufacturers' specifications. Insulate heating ducts. Keep thermostats at lowest acceptable settings.

Note that wood stoves offer an alternative for some on-farm situations.

Use Natural Ventilation If Possible

Eliminate mechanical ventilation and use natural ventilation where possible by renovation of existing buildings and design in new construction.

When warm animal housing facilities are required, consider a convertible system which would be closed, warm and mechanically ventilated during cold months, open and naturally ventilated during warm months.

Reduce ventilation rates to minimum safe levels in heated buildings.

Turn off fans when ventilation is not required. Select fans with high cfm/watt rating. Clean fans and shutters frequently and provide proper lubrication and adjustment. Use temperature controlled, variable speed fans to optimize air flow and reduce energy use and loss.

In lighting, use lower wattage bulbs where practical. Turn off lights when not in use. Buy efficient bulbs and lamps.

Use task lighting to reduce whole area lighting needs.

Install dimmers where total wattage bulbs give more light than needed. Use photo-cells or timeclock controls on outside lights.

For milking and milk cooling, maintain vacuum pumps according to manufacturer's specification. Capture and use heat generated by vacuum pumps and milk cooling equipment. A major portion of hot water needs can be supplied from these sources. Adopt approved "clean in place" practices that permit

lower water temperature and detergent re-use by recycling.

When using vehicles, maximize loads and minimize trips. Plan schedules carefully. Follow regular maintenance programs. Buy the right size vehicle for the job. Inflate tires properly and check weekly. Avoid excessive engine idling.

Producing Energy on a Dairy Farm

Extensive research and development is underway to find ways for dairy farmers to produce energy on the farm. Systems for producing alcohol and methane are of major interest with solar, wind and biomass use also being developed and demonstrated on farms.

Alcohol Fuels. Dairy producers have special interest in alcohol fuels they might produce, since they can also use the stillage (spent grains) byproduct remaining after distillation as feed for animals.

For example, one bushel of corn can produce 2.5 gallons of alcohol and 30 gallons of stillage containing 6 to 8 percent solids or 16 to 18 pounds of grain (dry weight) from an on-farm still. For continuous production, three gallons of stillage should have a feed value approximately equal to one pound of grain plus one pound of soybean meal or similar protein supplement.

The large quantity of water involved in the stillage presents some special problems in handling and maintaining sanitary conditions. Thorough evaluation of the economic feasibility of alcohol production on each individual farm is essential.

Methane From Wastes. Production of methane gas from animal wastes has been demonstrated as technically feasible and should become an economically feasible energy source in the near future.

It is estimated that for each 1,000 pounds of body weight of dairy cattle, 44 cubic feet of methane containing 26,000 Btu's can be produced each day.

Assuming 60 percent system efficiency, 100 dairy cows (1,500 pounds each) would produce 1.6 million Btu's of energy each day, equivalent to about 12 gallons of diesel fuel each day or 4,450 gallons per year. Properly handled, enough electricity can be produced from this source to approach meeting needs of the farm unit.

Solar Energy, Use of Wind

Equipment and methods for collecting and storing solar energy for dairy production have been demonstrated in many operations throughout the United States. Solar energy is used for hot water heating, space heating for dairy production units,

and drying grain for animal feeding. Use for water heating has the advantage of continuous application and opportunity for direct storage of energy collected during periods of intense sunlight.

Wind systems have been developed to efficiently pump water or to generate electricity for use on dairy farms. Wind energy applications are very site specific. In other words, water can be pumped or electricity generated only where the wind blows in a relatively continuous fashion.

In coastal, mountainous or plains areas such conditions usually exist. In other parts of the country a dependable wind supply may not exist, and a wind system would have limited use in milk production.

Biomass Problems. Corn stover, straw and other crop residues can be collected, compacted and burned to produce energy for water or space heating and crop drying.

There is normally sufficient residue remaining on a corn field to provide more energy than needed for drying the crop. However, efficient methods for harvesting the residue have not been developed. Also, there is concern that removal of too much of the residue will reduce organic matter in the soil and also may contribute to increased soil erosion.

Additional research and development is underway and methods may be found to turn crop residues into a viable energy source.

Further Reading:

Agricultural Anaerobic Digesters, Bulletin 827, Ag. Mailing Room, 112 Agriculture Administration Building, The Pennsylvania State University, University Park, PA 16802. Free.

Energy and U.S. Agriculture: 1974 and 1978, Statistical Bulletin 632, ESCS Publications, U.S. Department of Agriculture, Room 0054-S, Washington, DC 20250. Free.

Small-Scale Fuel Alcohol Production, #001-000-04124-0, U.S. Department of Agriculture, for sale from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. $6.