ENERGY FACTS

FILE 18.85

Cooperative Extension Service
Michigan State University

Extension Bulletin E-1269 February 1979

Energy Management for Vegetable Producers[1]

Diesel fuel now accounts for 46 percent of all direct energy consumed in U.S. vegetable production and increased machinery size for tillage will demand even more. Over 40 percent of the energy used for vegetable production is gasoline. Automobiles and trucks used for harvesting, marketing and other farm operations consume 75 percent of that gasoline. Nearly 20 percent of the gasoline is used for harvest compared with 5 percent needed for tillage.

Electricity uses another 8 percent of all direct energy used on vegetable farms. Crop irrigation consumes almost 98 percent of that electricity.

Natural gas and LP gas comprise about 5.5 percent of the direct energy used for vegetable production.

But since more than 45 percent of the total energy needed on farms is for fertilizer production and delivery (Fig. 1), total energy savings on farms may depend on proper fertilizer application and efficient use.

Fertilizer Application

Energy for fertilizer can be saved in two ways: by getting greater yields from the same amount of fertilizer or by maintaining present yields with less fertilizer. There are several ways to do this:

1. *Have your soil tested.* A soil test can determine residual fertilizer levels and may indicate the need for less fertilizer than might ordinarily be used. It can also determine lime, micronutrients or other fertilizer adjustments.

2. *Calibrate distributor equipment properly.* Applying too much fertilizer is wasteful and may harm crops; too little fertilizer may result in yield reductions. Each time a distributor is used, check to make sure the proper application rate is set. The rate is influenced both by the granular characteristic of the fertilizer and by the humidity.

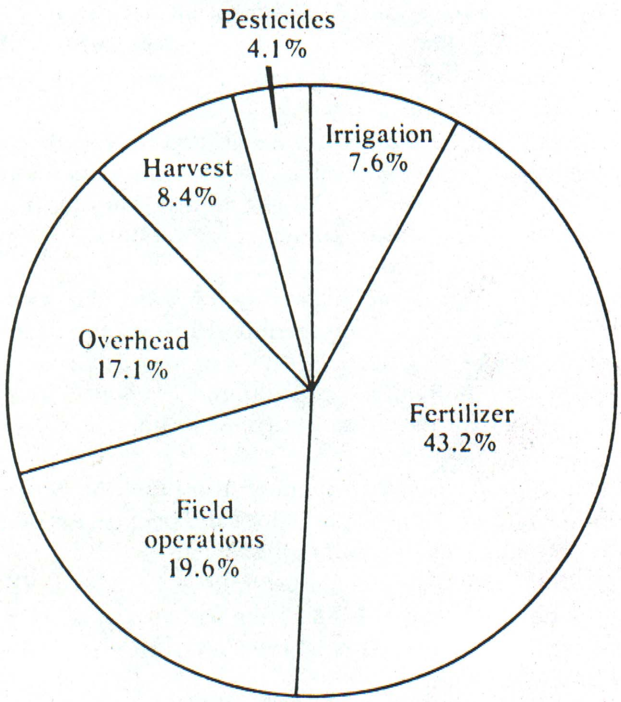

Fig. 1. Energy Use by Function, Vegetable Crops, USA, 1974.

EXAMPLE: A drill distributing fertilizer at 1,000 lb per acre with rows spaced 30 in. apart should be set to apply 5¾ lb per 100 ft of row according to standard charts. If, however, the drill was set for 6¼ per 100 ft, then about 85 lb of fertilizer per acre would be wasted. With a fertilizer cost of $150/ton, the excess fertilizer would amount to $6.38 per acre.

3. *Combine fertilizing* with another compatible operation when possible. Supplemental nitrogen can be applied through irrigation water in most overhead sprinkler systems. This practice may also be possible with furrow or trickle irrigation. Check the idea with your local county Extension office.

4. *Apply nitrogen, phosphorus and potassium together when possible.* Split fertilizer applications consume more fuel, but under some conditions they may be necessary for effective results. Split applications also lead to greater soil compaction.

5. *At planting, carefully place fertilizer* near root zones without damaging the plant with chemical burn

[1]*Adapted from "For the Vegetable Producer: A Guide to Energy Savings" (1977). Federal Energy Administration and USDA, Washington, D.C. By Claudia Myers and Bill Stout, Agricultural Engineering Department, Michigan State University, East Lansing.*

or machinery. For a given amount of fertilizer, better yields may result from band rather than broadcast applications.

6. *Develop a fertilizer program* to meet your specific needs. The Michigan Cooperative Extension Service and Agricultural Experiment Station have much to offer. The county Extension office nearest you has information about these programs and recommended fertilizer rates and procedures.

Field Operations

Seedbed preparation for vegetable growers is an involved process. Soil is plowed, disked, harrowed, rolled or dropped. After shaping, seeds or transplants are placed in the seedbed mounds. Plants are then cultivated continuously to control weeds and thus conserve soil moisture and nutrients; several herbicide and pesticide applications may also be needed. These operations account for almost 20 percent of the total energy used in vegetable production.

Although there was little difference in the total energy for field operations required to produce fresh and processing vegetables (19 percent and 22 percent, respectively), individual crop differences ranged from 34.2 percent for dry peas and beans to only 11.6 percent for potatoes.

1. *Plant seed directly* instead of transplanting, where feasible. Direct seeding of tomatoes and peppers may be feasible on light, sandy loam soils.

2. *Don't cultivate any deeper than necessary.* Deep cultivation uses more fuel and often damages plant root structure. And, to avoid repetitious cultivation, control weeds in the seeding stage.

3. *Consider increasing plant density* and using narrow row spacing. Closer row spacing helps prevent weed growth since plants cover the ground sooner and shade potential undergrowth. This practice may increase yields as well.

4. *Rotate crops.* Successive cropping encourages a buildup of weeds, diseases and insects. Rotate with crops not infected with the same diseases and insects, thus reducing insecticide and fungicide use. Alternate shallow-rooted plants with deep-rooted plants. Switch between crops supplying large quantities of organic matter and those which break it down. Use soil-improving cover crops when land is not occupied with a cash crop.

5. *Keep cultivating equipment in top condition.* Make certain that sweeps, shoes and shovels are in proper shape and adjustment for minimum draft. Don't let the equipment develop dull leading edges. When possible, hardface cultivating equipment so that cutting edges remain sharp as they wear to reduce friction.

Pest Management

Pesticides use only about 4 percent of the energy for vegetable crop production. Fresh market vegetables, harvested several times each season, require more pesticide than machine-harvested processing vegetables.

Most crop failures resulting from poor pest management can be eliminated by following an integrated pest control program. Such an approach will result in fewer chemical applications and improved crop yields.

1. *Choose a crop suited* to the specific geographical region.

2. *Select seeds or plants* that are disease-free and of the best quality.

3. *Select and apply insecticides* and fungicides carefully. The critical period for insecticides and fungicides is the minimum number of days before harvest when a particular chemical can be used; for pests it is the time they are most susceptible to the insecticide; for plants it is the time they are most susceptible to specific pests. Avoid indiscriminate spraying.

4. *Calibrate insecticide application equipment.* Make certain that the equipment is properly calibrated, spray nozzles are of proper size and are clean, and that pump and motor are working efficiently.

5. *Monitor fields and crops* frequently for pests.

6. *Plow crop residues under* soon after harvest. Crop residues can harbor insects and act as reservoirs of disease.

7. *Follow an integrated pest control program.* Following these and other cultural practices conducive to healthy plant growth should reduce the number of spray applications needed, resulting in fuel economy, improved yields and increased long-term profits.

Irrigation

Less than one-tenth of all energy used for vegetable crops is for irrigation. But this amount varies substantially between crops and can account for 60 percent or more of the total energy used. About 11 percent of energy usage on fresh vegetables is for irrigation, and for processing crops slightly more than 4 percent. However, corn and peas use 13.5 percent and 20 percent, respectively, of the total energy for irrigation.

1. *Operate irrigation pumping plants at maximum efficiency.* A good electric power pumping plant should approach 70 percent efficiency. Yet, tests on operating equipment showed efficiency varied from about 10 to 75 percent. Performance will vary with the speed and condition of the pump. Repairs or adjustments are usually justified for equipment working at less than 50 percent efficiency.

EXAMPLE: An electric motor pumping plant operating at 40% efficiency costs about 4.5 cents more per acre ft per ft of

head to run than one working at 70% efficiency (at an electrical rate of 4 cents/kwh). A grower has 160 acres of tomatoes requiring 7 in. of irrigation water per acre at a pumping head of 325 ft. The 40% efficient pump would cost $1,365 more to operate than the 70% efficient pump. That is: (4.5 cents) × (325 ft head) × (7 in.) × (ft/12 in.) × (160 acres) = $1,365.

2. *Irrigate according to plant needs.* Soil augers, evaporation pans and moisture meters can help determine when and how much water to apply. Their use will reduce the amount of water used in a season, the energy needed to pump water, and increase profits. Costs for monitoring equipment are minor compared to savings gained by not overwatering.

3. *Use drip irrigation.* Savings from the use of drip irrigation result from increased efficiency in water use and from applying water at relatively low pressure. This permits application of irrigation water at pressures as low as 10 to 20 psi, compared to 125 psi with some conventional systems.

EXAMPLE: A high pressure gun system applies irrigation water at 2 ft per acre on 160 acres of processing tomatoes. Trickle (drip) irrigation would reduce the water requirement to 1.3 ft/A. Total head for the gun system is 325 ft; for the drip system it is 85 ft. The annual savings in electricity (at 4 cents/kwh) for pumping is $5,180.

4. *Keep irrigation equipment in good repair.* Repair leaks in valves, pipes and risers. Check gaskets in the sprinkler lines for leaks which waste water and power. Inspect sprinkler nozzles; they enlarge after use and may apply water at a greater rate than needed. Enlarged nozzles also shorten the distance water is thrown, overload the pump and cause a pressure drop that increases droplet size. Clogged perforations or water screens at the water inlet may prevent water from flowing freely.

Other Cultural Practices

Some cultural practices help increase yields rather than reduce fuel consumption and conserve fuel by improving yields on less acreage.

1. *Use windbreaks.* For many crops, increased yields are possible using windbreakers to reduce wind velocity, increase temperature, decrease soil erosion and promote more rapid growth and maturity.

2. *Pollination.* Several Michigan vegetable crops require insect pollination—cucumbers, squash, pumpkin and muskmelon. And, although it is not always necessary, placement of sufficient numbers of domesticated bees in or near some crops will increase yields where there are too few wild pollinators.

Although each farm differs, further savings are possible for most vegetable growers. A work analysis can help pinpoint fuel-wasting operations. Reducing equipment operating time reduces labor costs. And non-fuel costs (tires, repairs, maintenance, etc.) also lower energy consumption.

Greenhouse Production Efficiency

Most greenhouses are not designed to conserve energy, only to grow crops when outside weather conditions are inclement. Although total fuel costs vary, the average cost for fuel is $1 per sq. ft. for the season. Thus, greenhouses with the least square footage on the ground surface will be the most efficient. But regardless of green house type, substantial fuel svings are possible under current operating conditions. To improve greenhouse efficiency:

1. *Close all possible openings* to prevent heat loss.

2. *Place reflectorized tar paper* behind heating pipes. This reflects heat into the greenhouse.

3. *Use polyethylene or fiberglass* on the inside of gable ends.

4. *Use a double layer* of polyethylene on plastic houses where possible.

5. *Use a black cloth* to shield against radiation heat loss to the atmosphere during the night. An aluminized nylon cloth pulled eave to eave could save as much as 62 percent of this heat loss.

Further energy savings are possible by strict adherence to wise management practices and a proper greenhouse maintenance. For example, to improve the efficiency of greenhouse heating and/or cooling systems:

6. *Use the proper fuel* in heating and/or cooling systems. This prevents carbon buildups which decreases heat transfer.

7. *Keep fuel oil tanks clean.* Twenty percent of service calls result from dirty fuel. Tanks should be away from dusty locations, and have watertight fittings.

8. *Remove soot from inside the furnace.* A 1/8-inch soot deposit can increase fuel consumption by 10 percent.

9. *Change fuel filters frequently.* Uniformly clean fuel delivered to the burner results in more efficient combustion.

10. *Use correct nozzle size and angle.*

11. *Clean and adjust controls.* Check gas valves, thermostats and ignition mechanisms for clean, smooth operation.

12. *Lubricate pump and motor bearings.*

13. *Drain dirty water* to steam and hot water systems. Flush steam boilers to remove scale and lime.

14. *Check combustion efficiency.* Low stack temperature signifies low oil consumption and the higher the carbon dioxide content of the stack gases, the more completely the oil is being burned.

15. *Replace burned oxygen.* Install an air intake from outside to near the heater in polyhouses and tight glass and fiberglass houses (allow one square inch of intake area for each 2,000 BTU furnace capacity).

16. *Extend the chimney* at least 8 to 12 feet above the greenhouse furnace to develop sufficient draft (seal any air leaks).

17. *Install a draft regulator* to control draft variations.

18. *Install turbulators* or baffles in boiler tubes. They slow down and direct the flow of gases so that more heat can be absorbed. It's possible that fuel consumption can be reduced by 10 to 15 percent.

19. *Operate blowers* in forced-air systems until furnace is cooled to 100° to 120°F.

20. *Repair leaky radiator valves* and replace defective ones.

21. *Clean radiator and pipes.* Dust and dirt reduce heat transfer and increase fuel consumption.

22. *Insulate distribution lines.* In unheated areas and underground, insulate pipes to reduce heat loss.

23. *Locate thermostats* at plant height, away from heat pipes and hot-air streams. Shade and aspirate thermostats for most accurate temperature control.

24. *Set fan thermostat* at least 10°F above heater thermostat to prevent simultaneous operation and possible back draft.

25. *Check for steam or water leaks.* A 1/16-inch diameter hole in a pressurized water system can add 7½ gallon per day to fuel oil use.

26. *Be sure the chimney is the proper size.* A chimney lined with soot or with too small a cross section will reduce the draft. Too large a diameter will cool the gases too quickly.

This information is for educational purposes only. Referenct to commercial products or trade names does not imply discrimination or endorsement by the Cooperative Extension Service. Cooperative Extension Service programs are open to all without regard to race, color, or national origin. Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Gordon E. Guyer, Director, Cooperative Extension Service, Michigan State University, E. Lansing, MI 48824

1P-10M-2:79-UP, Price 10 cents, Single copy free to Michigan residents.

O-11221

Michigan State University Printing