

**Organic farms** require  
30% less energy per  
bushel of corn



Field corn is the food-energy backbone of agriculture.



Solar energy drives plant growth.

## ENERGY INS AND OUTS

### ON-FARM ENERGY USE

The energy required to bring an agricultural crop to market is a key indicator of a farming system's environmental health, resiliency, and sustainability. Energy use is intimately linked to the health of soils and the internal efficiency of on-farm nutrient cycles. Energy dependence is also a sign of a farm's economic vulnerability in this era of rapidly rising energy prices. Both diesel fuel and natural gas prices are projected to rise up to 50 percent in 2006, and have already about tripled since late 1999.

Reliance on external energy is an indicator of the biological health of farming systems.

For five decades farmers have pursued higher crop yields through input and energy-intensive systems. On average across American agriculture, it takes about two kilocalories of energy

to produce one kilocalorie of food. A typical or "model" organic corn production system delivers about 5.8 kilocalories of food energy for each kilocalorie of energy input, while tomatoes return just 0.26 kilocalorie of food energy for each kilocalorie of fossil energy inputs. These and other facts on energy "ins" and "outs" are derived from data compiled by Cornell University Professor Dr. David Pimentel, author of

the Organic Center's State of Science Review "Impacts of Organic Farming on the Efficiency of Energy Use in Agriculture."

Meat, milk and other livestock products are far less energy efficient. Chickens are the most efficient animals in converting fossil energy to food energy, requiring four kilocalories for every kilocalorie of food produced, about the same as tomatoes. But pigs and dairy cattle deliver one kilocalorie of food energy for 14 kilocalories, and beef cattle are even worse at 40 kilocalories of energy inputs for every food kilocalorie.

Inefficient energy use on the farm imposes an environmental tax on Earth systems and an economic tax on farmers. It poses a threat to food security locally, regionally, and globally, and it invariably degrades air and water quality.



### ENERGY USE in ANIMAL AGRICULTURE

By weight, the amount of food that livestock produce is about **one-sixth** the amount of plant protein they consume in the form of grains and forages. On average, it takes 10 kilocalories (kcal) of fossil energy to produce one kilogram of plant-protein feed for livestock. In the case of milk production, the ratio is 14 to one.

Feeding animals a combination of grain and forage requires 40 kcal (the energy in one small peach) to produce 1 kcal from beef (a piece of meat about the size of a pea). However, the production of meat on good pasture requires one-half as much energy, because forage production requires significantly less energy than grain.

## Conventional Ag's Energy Drain

Almost every routine task on the farm consumes energy. The steel and manufacturing of farm machines and trucks requires energy, and these machines burn large quantities of liquid fuels. Barns, grain dryers, refrigeration units, and irrigation pumps use electricity. It takes energy to manufacture, transport, and apply farm chemicals. And solar energy drives plant growth.



Many line items in a farm's energy budget are about the same per unit of production on conventional and organic farms, but a few differ dramatically. Overall energy use is much greater on conventional farms largely because of their reliance on **pesticides and nitrogen fertilizer**. On a conventional corn farm, for example, these two inputs account for about 43 percent of total energy use.

Irrigation requires an ample source of water, plus large amounts of fossil energy, plus it typically reduces energy efficiency. Irrigated wheat, for example, requires more than three times the energy needed to produce the same amount of rain-fed wheat.

### Farming Systems Impact Energy Efficiency

**CORN** - It takes about one kcal of energy on a CONVENTIONAL farm to produce 4 kcals of corn food energy. Chemical inputs (pesticides and fertilizers) account for 55 percent of total energy use. Machines, and the diesel and gasoline require to run them, burn another 31 percent.

On ORGANIC farms, it takes about 30 percent less energy to produce a bushel of corn. Chemicals use far less energy. But organic farmers must still manage weeds and maintain fertile soils. They do so through a combination of cultural and biological practices that require about 25 percent more labor per hectare.

**SOYBEAN** - Soybeans are the protein backbone of American agriculture. A representative organic soybean farm returns 3.8 kcals of soybean food energy per kcal of fossil energy inputs. Conventional soybean farms are about 20 percent less efficient, returning 3.2 kcals of food energy for each kcal of energy input.

Efficiency in capturing solar energy is one reason why organic farms are, overall, more energy efficient. Plants are actively growing and converting solar energy to plant matter for two to three months more each year. Fall planted cover crops, on organic farms germinate and grow until winter arrives. As soils warm in the spring, cover crops begin growing and capturing solar energy, when nearby conventional fields lay barren. On average, organic farms collect about 1.8 times more solar energy than conventional farms.

Each year the American food system uses about **19 percent** of the nation's total fossil energy use --

**7 percent for farm production**

**7 percent for processing and packaging**

**5 percent for distribution and preparation**

**The best ways to lower the food system drain on energy resources is to consume whole foods, raised close to home. Pick foods with simple packaging, and animal products raised on forages, to the fullest extent possible. Choosing organic food will also help by reducing the two big drains on agriculture's energy efficiency -- nitrogen fertilizers and pesticides.**



Ph: (401) 647-1502  
Fx: (401) 647-1702  
46 East Killingly Road  
Foster, RI 02825

Access more information on energy use and farming systems and the State of Science Review, "**Impacts of Organic Farming on the Efficiency of Energy Use in Agriculture**" at [www.organic-center.org](http://www.organic-center.org) under "State of Science."