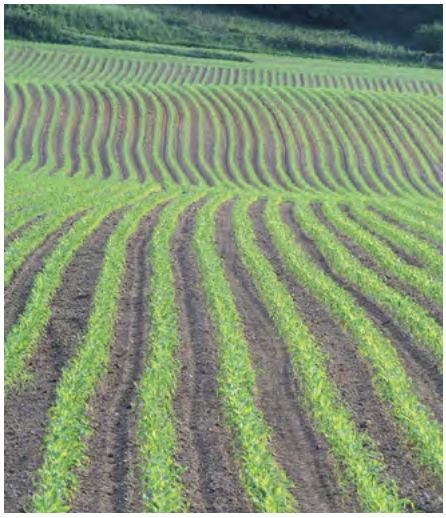
Energy consumption for row crop production



Each year, Iowa farmers plant approximately 24 million of Iowa's 31 million acres of farmland to corn and soybeans. Energy prices vary over time, but Iowa agriculture spends nearly one billion dollars annually on direct energy purchases. Due to the fact that so many Iowa farmers raise corn and soybeans, a basic understanding of energy used in row-crop corn and soybean production is helpful for managing farm energy expenses.

Annual energy consumption for corn and soybean production is in three major areas: field operations, artificial drying (typically corn only), and fertilizer/pesticides (agricultural chemicals). Agricultural chemicals are not a direct energy purchase by farmers. However, the thermal and chemical processes used in their manufacture can be significant and are often considered in farm energy budgets.

Energy is also used in other production steps which are less significant to farm budgets. Some vary with location, for example:

- Energy used for transportation from the farm to the final destination can be significant depending upon shipping distances. However, much of this energy cost is borne by off-farm grain marketers.
- Transportation energy costs for hauling from the field to farmstead bin or to the local market vary with distance.

Additionally, energy required to manufacture machinery and other larger capital equipment such as grain bins can be significant at the time, but can be paid off over several years. Solar photosynthetic (renewable) energy required to grow and dry crop, also significant, is not considered a direct cost to the farmer.

Field operations

Diesel fuel used for field operations varies with management practices. A range of 4 to 6 gallons per acre is common, particularly if one primary and one or more secondary tillage operations are used (Figure 1). Seeds must be planted, grain harvested, and weeds controlled (typically with spraying). Fuel used for these operations is typically 2 to 2.5 gallons per acre, which represents fuel consumption for a no-till system. The energy required for tilling soil can be an additional 2 gallons of fuel per acre or more.

The amount of fuel required for tillage depends on both the type and number of tillage operations (PM 709 *Fuel Required for Field Operations*). Primary tillage refers to initial tillage on untilled soil. One single primary tillage operation that covers the entire soil surface, such as chisel plowing, usually requires at least one gallon of fuel per acre when tilling at a depth of 6 to 8 inches. Fuel consumption may be two gallons per acre or more depending on tillage depth and/or the number of different soil manipulations that occur (e.g., subsoiling and disking with a combination disk-ripper). Individual secondary tillage operations often require 0.6 to 0.7 gallons of fuel per acre. However, fuel consumption may be greater for large 'combination' implements with several operations (e.g. discs, sweeps, harrow, etc.).

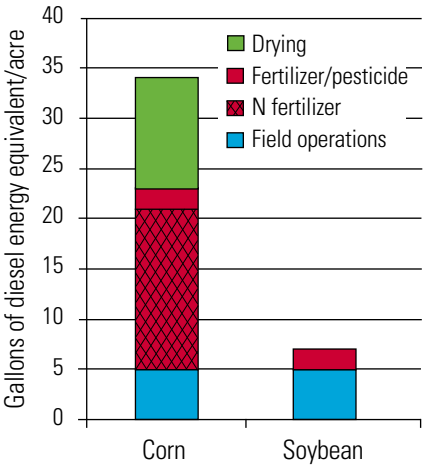


Figure 1. Relative energy requirements (gallons of equivalent diesel fuel energy) per acre for corn and soybean production. (Assumptions: 125 pounds of commercial N fertilizer applied per acre on corn; 5 percentage points of moisture removed from 175 bushel corn; full-width tillage operations for both crops).

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Drying

Soybeans typically dry to a moisture content of about 12% in the field prior to harvest and don't usually need to be dried. Corn, on the other hand, may need to be dried if it does not dry adequately in the field. The need for drying depends on the planting date, the weather during the growing season and harvest, and the adapted maturity level for the growing location.

If corn needs to be dried in the fall, the amount of moisture to be removed can vary widely, sometimes by as much as 10 percentage points or more. To remove 5 percentage points of moisture content from an acre of corn yielding 175 bushels, a conventional high-temperature dryer uses about 16 gallons of LP and 18 kWh of electricity. Fan use for electricity in a natural-air dryer used to remove the same amount of moisture would require about 280 kWh of electricity (about ⅔ of the energy used by the high- temperature dryer). Actual energy consumed by a grain dryer to remove a specific amount of moisture depends on several factors including grain depth, drying times, and heat recovery.

Fertilizers and pesticides

Even though they are not considered a 'direct' energy purchase for the farm, fossil fuels are used in the manufacture and transportation of fertilizers and pesticides. The cost of the energy to produce these inputs is incorporated into their purchase price each year. When considering the three primary fertilizer inputs—nitrogen, phosphorous, and potassium—the energy needed to create nitrogen fertilizer is by far the greatest.

Energy required to manufacture nitrogen (N) fertilizer is approximately 13 – 18 times greater[1] than phosphate or potassium on a pound-for-pound basis. When anhydrous ammonia, a more energy efficient nitrogen source, is applied to soil, it is equivalent to 15 gallons of diesel per acre at an application rate of 125 pounds/N acre. This application rate is typically used in a corn-after-soybean rotation. Similarly, an anhydrous ammonia application rate of 175 pounds N/acre is equivalent to 21 gallons of diesel per acre. This application rate is typically used for corn-after-corn.

The energy used to manufacture pesticides varies depending on the product. In general, an equivalent of one gallon of diesel energy is used to produce approximately one pound of active ingredient. Using this value, two pints of glyphosate with one pound of active ingredient applied per acre would be equivalent to approximately one gallon of diesel fuel energy per acre.

Due to the fact that adjusting the nitrogen application rate by ten pounds per acre equates to more energy consumption than the amount commonly used for phosphorous, potassium or pesticide, most fertilizer and pesticide energy consumption is attributed to nitrogen fertilization for corn. Nitrogen is not usually applied for soybean production, and only about one to two gallons per acre (diesel fuel equivalent energy) would be used for phosphorous, potassium and pesticides combined.

Summary

Diesel fuel required for field operations is a consistent energy input for both corn and soybeans. Fuel consumption can be reduced by minimizing the number and aggressiveness of tillage operations[2] along with consistent tractor maintenance and operation. For corn production, energy required for commercial nitrogen fertilizer is greater than field operations. Much of this energy is consumed as natural gas during the manufacturing of fertilizer. If corn needs to be dried significantly in the fall, the amount of energy consumed by drying can be greater than that used in field operations. However, this energy is consumed as electricity and liquid propane (LP) or natural gas.

References

[1]Sawyer, John E., and M. Hanna. 2010. *Energy conservation in corn nitrogen fertilization.* (PM 2089i). Iowa State University Extension publication.

[2]Hanna, M. and J. Harmon. 2010. *Limiting field operations. (PM 2089d).* Iowa State University Extension publication.

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