

# Re: Energy Cost of Ethanol

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- *From:* "cncut" <[cncutwiler@xxxxxxxxxxxxxx](mailto:cncutwiler@xxxxxxxxxxxxxx)>
  - *Date:* 29 Jun 2006 13:34:49 -0700
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cncut wrote:

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cncut wrote:

cncut wrote:

Greg Hansen wrote:

cncut wrote:

Greg  
Hansen  
wrote:

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Re: Energy Cost of Ethanol

of  
producing  
ethanol?  
Does  
anyone  
have  
some  
solid  
references?

Greg

Do you  
wish to start  
at—I just  
bought one  
bushel of  
shelled corn  
at  
the elevator  
for \$2 now  
let's make  
some  
ethanol—or  
here, plant  
these  
seeds and  
grow a  
bushel of  
corn— then  
we'll make  
some  
ethanol. ;-))

Tut

Starting with the seeds, of  
course. Bushels of shelled  
corn don't  
appear out of nowhere.

OK—here's some data estimates in KCALS  
for one acre of corn  
production—  
Labor 49000  
Machinery 420000

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Gas 797000  
Nitrogen 940800  
Phosphorus 47100  
Potassium 63000  
Seeds 68000  
Irrigation 34000  
Insecticides 11000  
Herbicides 11000  
Drying 120000  
Electricity 330000  
Transportation 70000

Total Inputs 2,896,800 Kilocalories per acre

For ethanol production corn need not be dried/Iowa farmers don't irrigate/electric fans unnecessary saving 484,000KCAL---bringing the total inputs to 2,412,800KCAL per acre of corn.

To be continued

Some may disagree with the 2,412,800 KCAL per acre figure---and they may be correct. The farmer for example may say---I alternate inoculated legumes (soy beans) with corn every year. This practice fixes about 100 lbs or more usable nitrogen per acre. Also, fertilizer requirements are diminished by returning everything back to the soil except the seed.

To be continued

So now we have the approx energy expended (2,412,800 KCALs) to plant and harvest one acre of corn with some variance.

How many bushels of corn can be produced on this acre?

Numbers vary---record yield is over 300 bushels per acre---average is near 150 bushels in 2005---up from 71 in 1970.

One bushel of shelled corn weighs 56 pounds---so one acre produces  $150 \times 56 = 8400$  lbs of corn---therefore the energy expended to produce one pound of corn is  $2,412,800 \text{KCAL} / 8400$  or 287KCAL.

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To be continued

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To sum to this point—it takes 287KCAL to produce one pound of corn—or it can be purchased at the elevator for  $200/56=3.57$  cents

Now, how many gallons of ethyl alcohol  $C_2H_5OH$  ( $C_2H_6O$ ) can be made from one bushel of corn?

Iowa State University (ISU) studies suggests that 2.5 gallons per bushel could be produced under reasonable conditions. Recent studies have also suggested that by treating ground corn with ultrasound, 30% more sugar could be attained by improving the break up of carb molecules in the corn. For this example though, let's stick with 2.5 gallons per bushel but remember that 2.74 gallons per bushel would be the probable limit from corn seeds only.

If one bushel of corn (56lbs) produces 2.5 gallons of ethanol—then  $56/2.5= 22.4$  lbs of corn will produce one gallon.

Before we start fermentation/distillation our energy/\$ cost for the corn necessary to produce one gallon of ethanol is/are:

$22.4 \text{ lbs corn} \times 287\text{KCAL per lb} = 6428.8 \text{ KCALs}$  (corn planted and harvested)

or

$22.4 \text{ lbs corn} \times 3.57 \text{ cent per lb} = 79.96 \text{ cents}$  (corn purchased at elevator)

To be continued

Now let's take a look at actual ethanol production process. One method that has work successfully for years ( perhaps not the best ref energy costs but should work for our calculations)

Finely grind the corn seeds and heat at 212 F in water for 30 minutes to form a gelatine (or mash). The starch in the mash is cooled then malted at 152 F (addition of ground sprouted corn—the sprouted material contains the enzyme diastase which converts the starch to sugar.) After the material cools to around 70 F the yeast is added—the holding vessel is capped and fermentation begins.

Chemically, for glucose....  $C_6H_{12}O_6$ ----->Enzyme----> $2C_2H_5OH$  ( $2C_2H_6O$ )

In 7–10 days the yeast has converted the sugars to ethanol and distillation can begin.

Energy calculations remaining:

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Grinding/crushing 20.9 lbs of corn (1.5 lb used for malting)  
Heating solution to 212F and holding for 30 minutes  
Malting (sprouting 1.5 lb of corn)  
Grinding/crushing 1.5 lb of sprouts  
Distillation of water and ethanol mixture  
Misc—manpower, movement of fluids, etc.

To be continued