

Re: Energy Cost of Ethanol

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- *From:* "cncut" <cncutwiler@xxxxxxxxxxxxxx>
 - *Date:* 29 Jun 2006 13:41:30 -0700
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cncut wrote:

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 cncut wrote:

 Greg Hansen wrote:

 cncut
 wrote:

 Greg
 Hansen
 wrote:

 Reviving
 the
 topic
 of
 Habshi's
 subject
 line,
 and
 hoping
 to
 avoid
 the
 topic
 of
 the
 content,
 what
 is

Re: Energy Cost of Ethanol

the
energy
cost
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

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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
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

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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.

To be continued

To be continued

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 $\text{C}_2\text{H}_5\text{OH}$ ($\text{C}_2\text{H}_6\text{O}$) 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%

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more sugar could be attained by improving the brake 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 lbs corn x 287KCAL per lb= 6428.8 KCALs (corn planted and harvested)

or

22.4 lbs corn x 3.57 cent per lb= 79.96 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.... $C_6H_{12}O_6 \xrightarrow{\text{Enzyme}} 2C_2H_5OH$ ($2C_2H_6O$)

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

Energy calculations remaining:

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

Correction:

$C_6H_{12}O_6 \xrightarrow{\text{Enzyme}} 2C_2H_5OH + 2CO_2$

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