The Cycle of Agriculture Energy

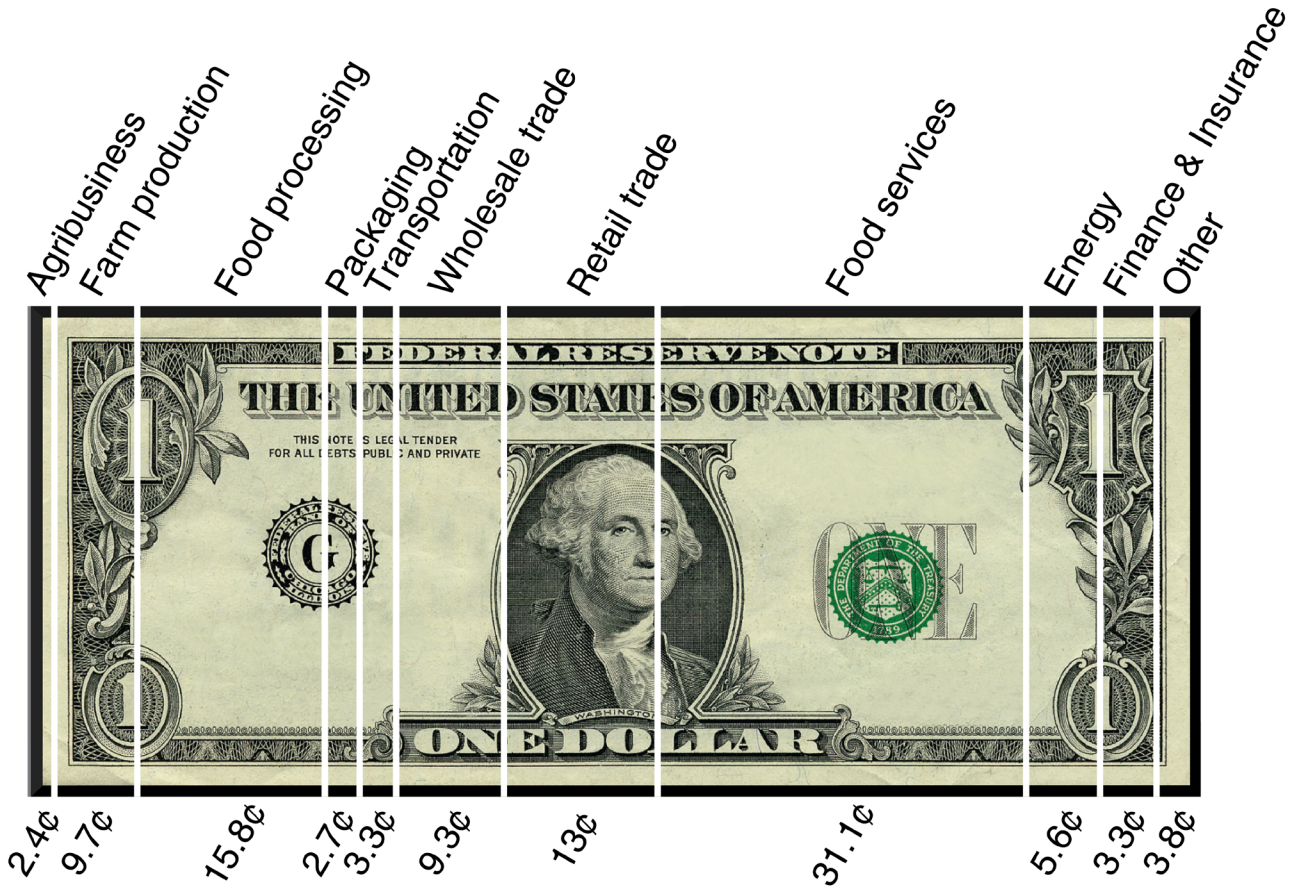
Or are you confused yet?

Jimmy Jia
jimmy@jimmyjia.com
Last Edit: April 14, 2019

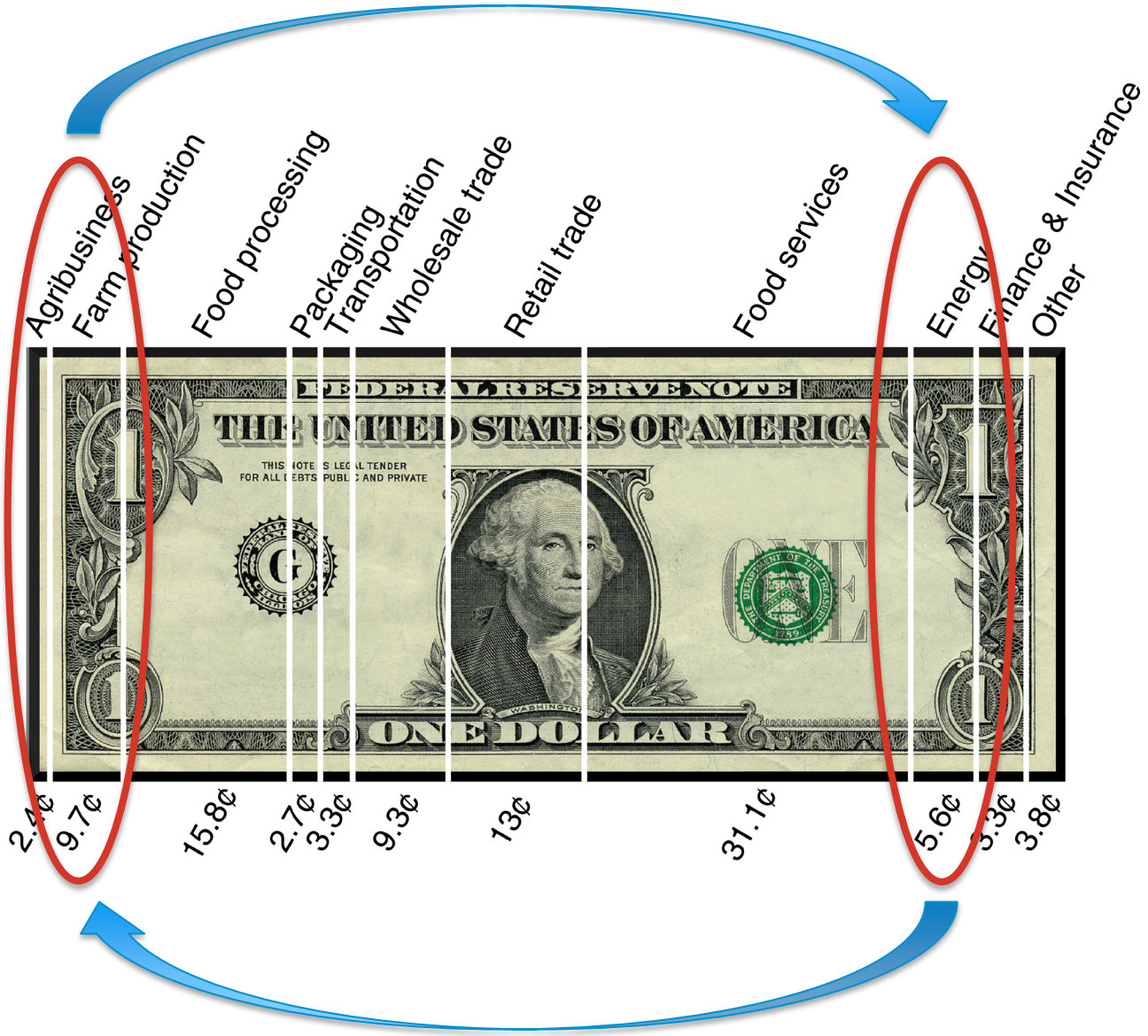
The John Gardner Memorial Lecture

Farm Bill: Food, Conservation, and Energy Act of 2008

2012 Food Dollar (nominal): Industries



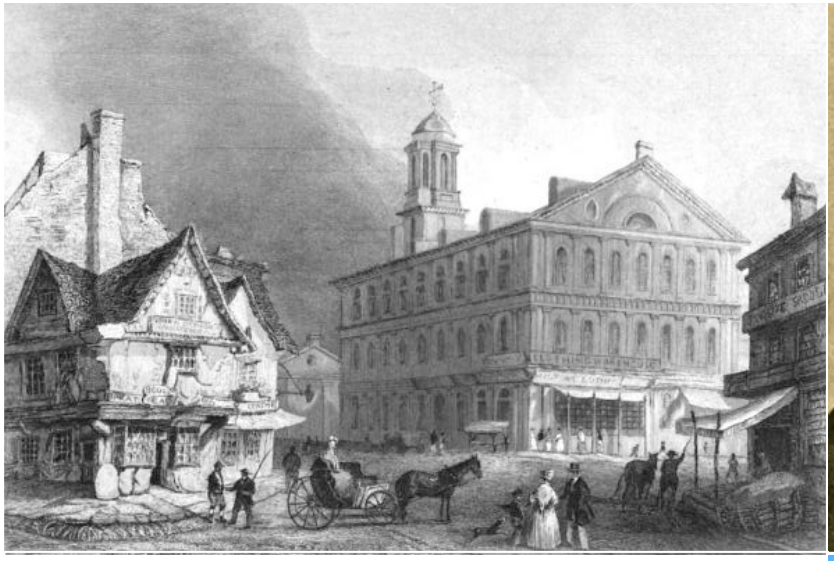
2012 Food Dollar (nominal): Industries

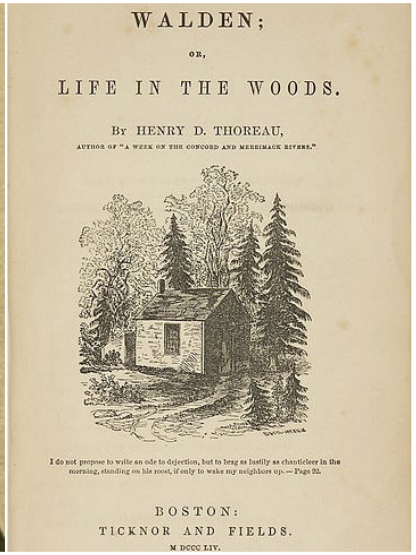


Are you ever overwhelmed by city life?

http://commons.wikimedia.org/wiki/File:Denver_Colorado_Skyline.jpg

Henry Thoreau was in 1845



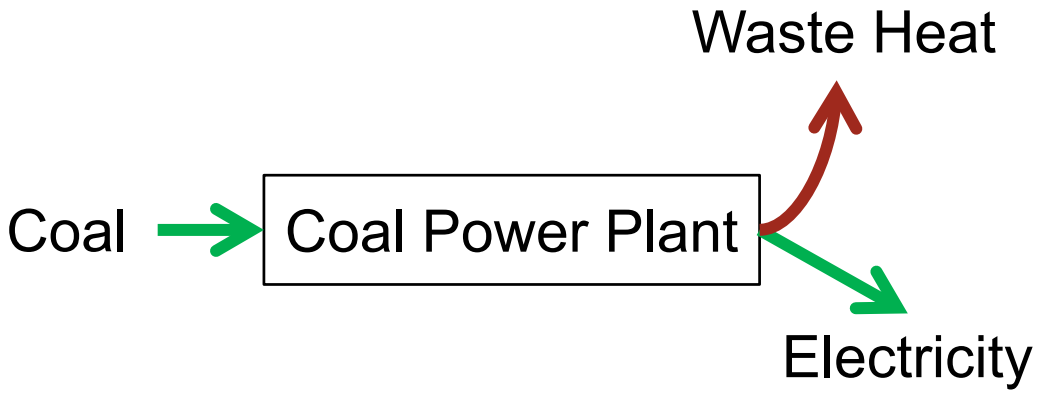


I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived.
-- Thoreau

http://en.wikipedia.org/wiki/File:Henry_David_Thoreau_-_Dunshee_ambrotpe_1861.jpg

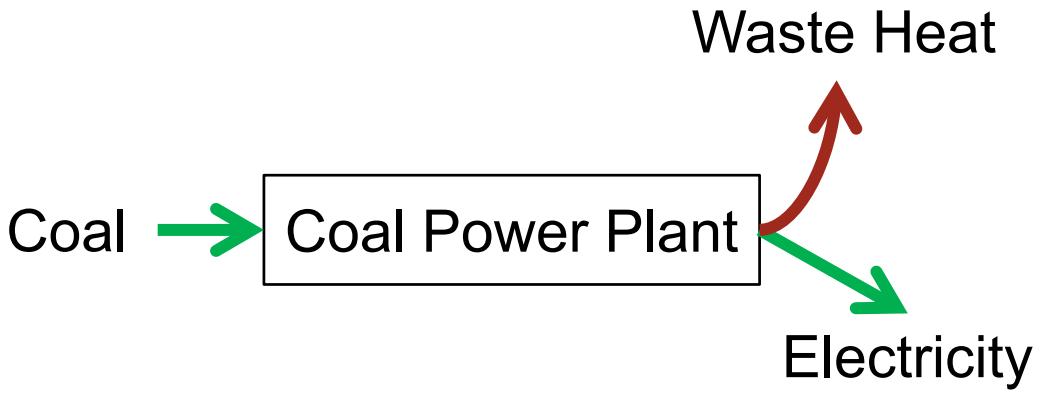
http://en.wikipedia.org/wiki/File:Walden_Thoreau.jpg

Efficiency of Systems



$$\frac{\textbf{Electricity}}{\textbf{Coal}} = \textbf{31 \%}$$

Efficiency of Systems



$$\frac{\textbf{Electricity}}{\textbf{Coal}} = \textbf{31 \%}$$

2500 Cal per day

$$\frac{\textbf{Useful Work}}{\textbf{Food}} = \textbf{20 \%}$$

So what is the energy of food?

3-4% of all energy is consumed for food and agriculture

http://commons.wikimedia.org/wiki/File:Corn_for_Sale_-_Sapanta_-_Romania.jpg

https://en.wikipedia.org/wiki/File:AngusCattle.jpg

Numbers around corn photosynthesis

7-month harvest cycle of corn

Power density of sun: 1.35 kW / m^2

Energy In:
275,000 kCal / sqft

16 Bushels per acre

0.8 kCal energy per 1 gram corn

Energy Out:
7.48 kCal / sqft

$$\frac{7.48}{275{,}000} = \textbf{0.0027 \% efficiency of a corn field}$$

Assuming 2,500 kCal diet,
a person eats 2.71 acres of corn per year

http://commons.wikimedia.org/wiki/File:South_Morgan_County_-_day_lilies_and_corn_-_P1080655.jpg

Numbers around pasture-raised cattle

Mature cow weights 1,200 – 1,400 lbs

At slaughter, a cow is 16-20 months old

Put on 2.3 lbs per day

A cow eats 20-30 lbs hay per day

Energy of hay is 0.9 Mcal / lbs

Energy In: 13,292 Mcal of hay per cow

Assume 447 kCal of food energy per 10 oz steak

Energy Out: 539 Mcal food energy per cow

$$\frac{539}{13{,}292} = \textbf{4.1 \% efficiency of a cow}$$

How much land does it take to raise a cow?

~ 3 acres per cow to pasture

A person needs to eat 1.78 cows per year

Or 0.00029 % efficiency of an acre

Assuming 2,500 kCal diet,
a person eats 5.34 acres of cows per year.

What other energy sources are there?

So far, we have only considered the energy of the sun. What other energy sources are needed for each?

Energy to farm cows

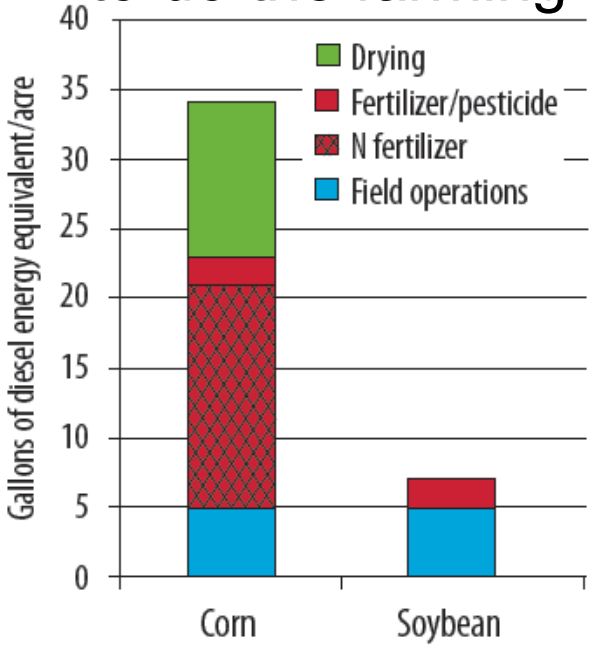
(Gallons)	Diesel	Gasoline	Liquid Petrol
Steers: from 400 to 1,200 lbs	1.8	1.3	2.15
Heavy Steers: from 700 to 1200 lbs	1.0	0.75	1.2
Heifers: from 400 to 850 lbs	1.35	1.0	1.6

Ozkan, Erdal. Estimating Farm Fuel Requirements for Crop Production and Lifestock Operations. ISU Extension Pub # Pm-587 Content reviewed: May 1995 by Jay Harmon

What other energy sources are there?

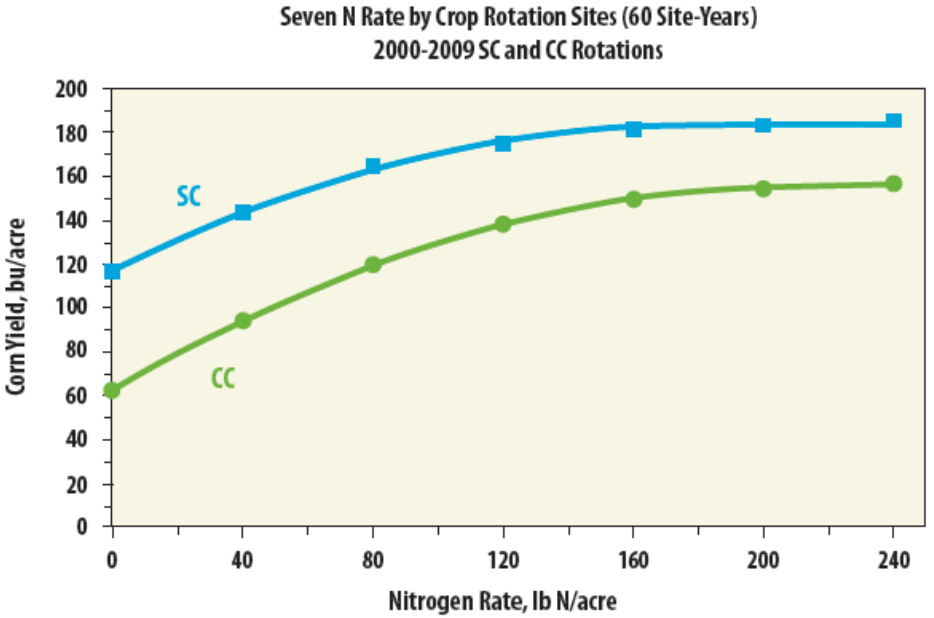
Corn is a bit more complicated….

Energy to farm corn:
34 gal diesel / acre
to do the farming



Energy to manufacture fertilizer:
20 gal diesel / acre

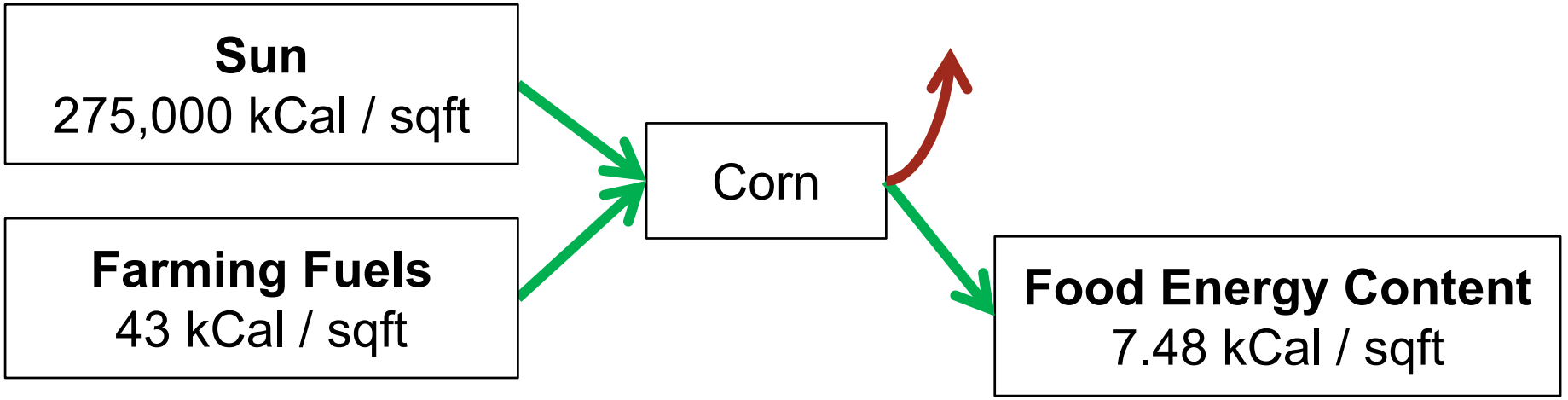
*(140 lbs N/acre) * (0.143 gal / lb N)*



Energy consumption for row crop production. Iowa State University Extension and Outreach PM 2089W June 2012

Modified numbers for corn

Approximately 54 gallons diesel per acre

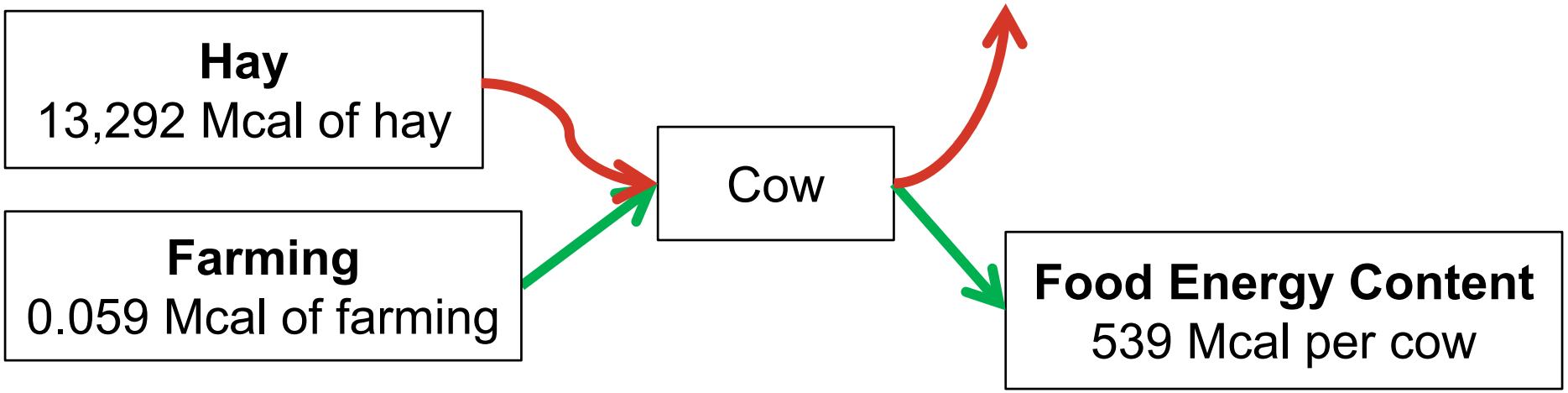


Overall efficiency is about the same
0.0027% efficiency of a corn field

17% efficiency of diesel

Energy of Farming Livestock

For a cow, it takes approximately 1.8 gal of diesel to raise cattle to maturity, or 0.6 gal per ‘acre’ of cow (Iowa)



Overall efficiency is about the same
4.1% of a cow

Over 900,000% efficiency of diesel

http://www3.abe.iastate.edu/livestock/pm587.asp

A recipe for Corned Beef with Corn

To make Corned Beef:

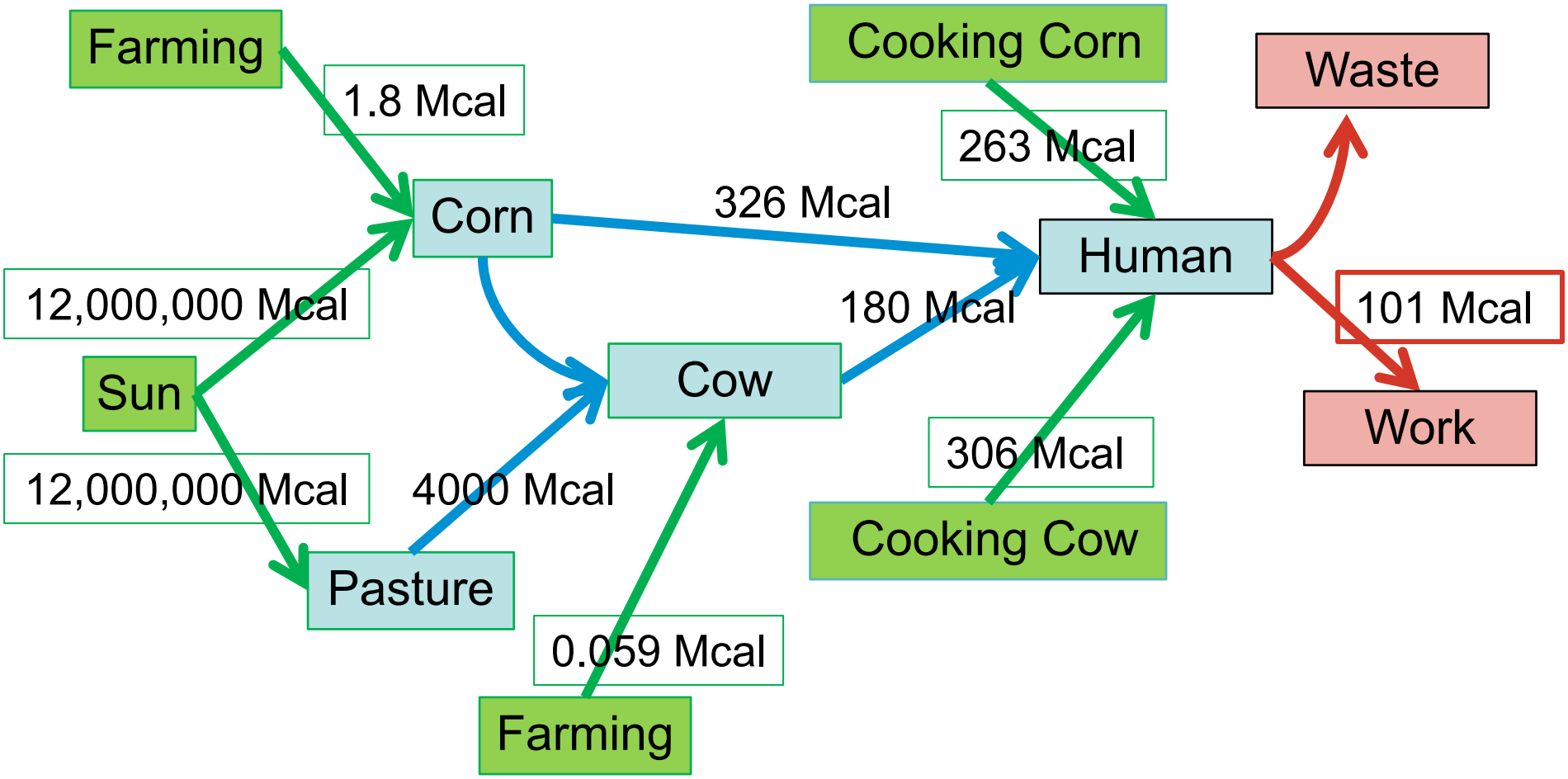
Simmer:	1.4 kWh
Cooking time:	3.5 hours
Roast:	5 lbs roast
Cow:	819 lbs
Energy:	920 Mcal / cow

To make Corn on the Cob:

Water:	1 gal
Corn:	5 ears
Energy:	263 Mcal / acre

http://www.bestbuy.com/site/Appliances-Promotions/How-much-energy-does-the-average-range/oven-use%3F-/pcmcat160300050011.c?id=pcmcat160300050011

Efficiency of Acreages
(all numbers are per acre)



0.00042 % efficient to convert all energy to work

Thoreau's Diet

I came to love my rows, my beans … What shall I learn of beans or beans of me? -- Thoreau

```
For a hoe, ..................................... $0.54
Plowing, harrowing, and furrowing, ............. 7.50 Too much.
Beans for seed, ................................ 3.12½
Potatoes   "   ................................. 1.33
Peas       "   ................................. 0.40
Turnip seed, ................................... 0.06
White line for crow fence, ..................... 0.02
Horse cultivator and boy three hours, .......... 1.00
Horse and cart to get crop, .................... 0.75
   In all, ..................................... $14.72½
```

Effects of malnutrition

Thoreau, Pulmonary Tuberculosis and Dietary Deficiency

To the Editor:

I wonder if Henry David Thoreau was responsible for his death from pulmonary tuberculosis in his prime at the age of 45?

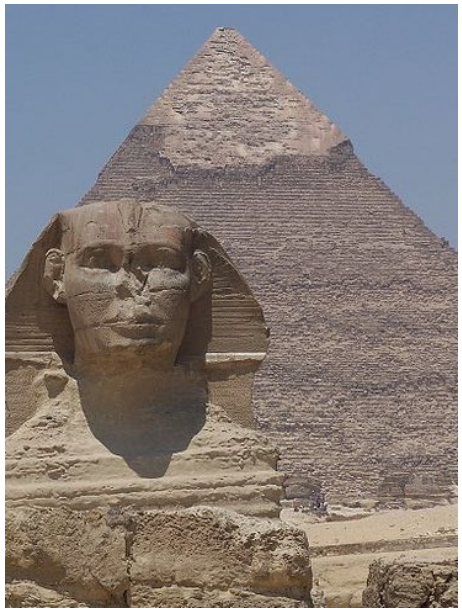
Thus, Thoreau lived on a quantitatively adequate diet from the caloric standpoint, but on a qualitatively poor diet because of the very small amount of protein-rich foods.

Benjamin P. Sandbr, M.D. CHEST, VOL. 63, NO. 5, MAY, 1973

In WWI, many soldiers developed tuberculosis after a protein-deficient diet. Perhaps Thoreau died due to malnutrition?

Using Energy to replace Hours

Pyramid of Giza



455 meters

Olive 8 in Seattle

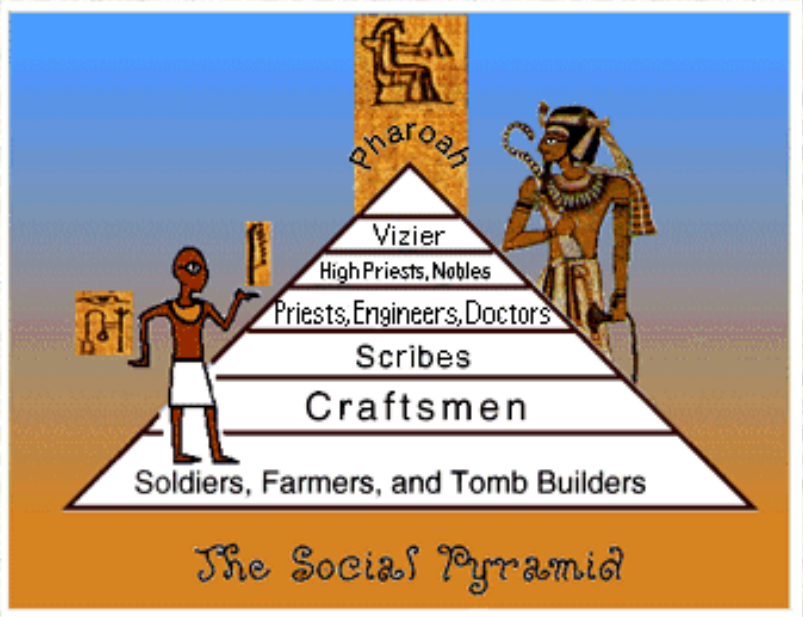
20 years
5,000 people per year
876 million man-hours

3 years
100-200 people per year
5.2 million man-hours

91 tera-calories Human Labor
3.08 e14 Joules

6 Million gallons of Diesel
8.79 e14 Joules

Comparison of Work



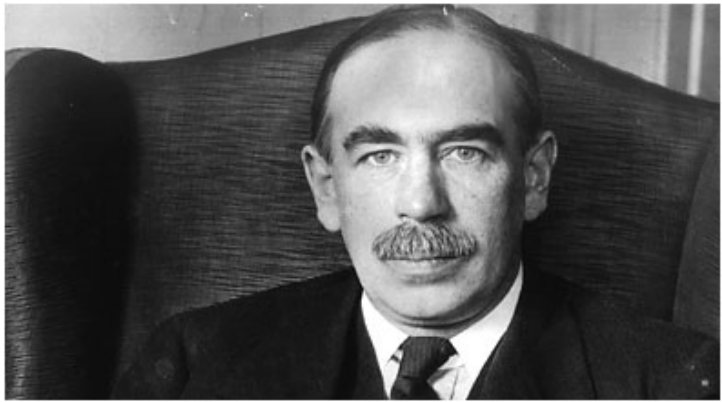
Ancient Egypt
Population: 2 million

Washington State
Population: 6 million

Keynes predicted a 15-hour work week

Technological unemployment. unemployment due to economizing the use of labor that outpaces the ability to find new uses for labor.

"Thus for the first time since his creation man will be faced with his real, his permanent problem – how to use his freedom from pressing economic cares, how to occupy the leisure, which science and compound interest will have won for him, to live wisely and agreeably and well.




TIMES SQUARE
MOTOWN
THE MUSICAL
CHRYSLER 300 MOTOWN EDITION
THE CROWD GOES WILD!
PALACE
Annie
WICK

How long shall we sit in our porticoes practising idle and musty virtues, which any work would make impertinent? As if one were to begin the day with long-suffering, and hire a man to hoe his potatoes; and in the afternoon go forth to practise Christian meekness and charity with goodness aforethought!

In Summary

- Crops have lower sunlight energy needs than animals while animals have lower energy maintenance costs than crops.
- The end-use of food is Nutrition. Nutritional content is just as important, if not more so, than energy content.
- Abundant energy has freed up time for us to create professions.
- Free time is not always a luxury.