

# Machine manufacturing and maintenance

Indirect energy input of agricultural machinery in bioenergy production

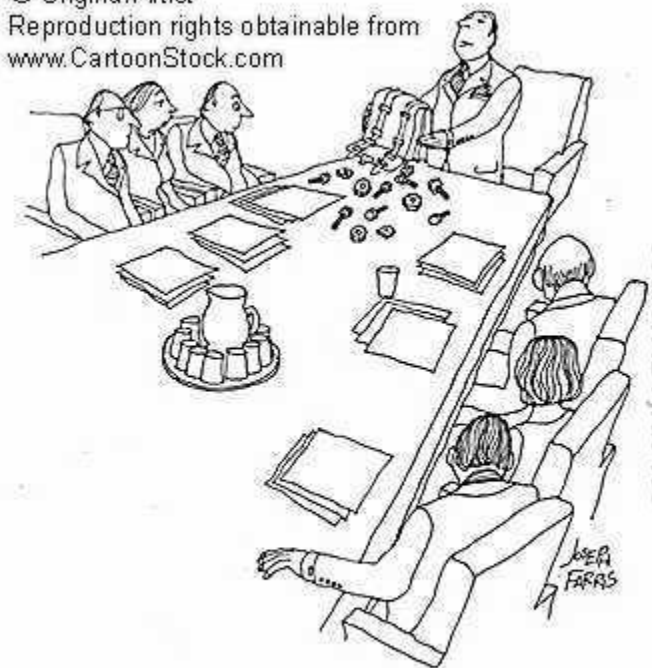
Hannu J. Mikkola, Jukka Ahokas

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# Energy analysis problem

- When tracing the energy needed in agricultural production we find ourselves to be in endless seek of energy usage
- The machines used in production have consumed energy during their manufacturing and they need besides fuel also maintenance
- The energy needed in manufacturing, transporting and maintenance should also be allocated to the agricultural production

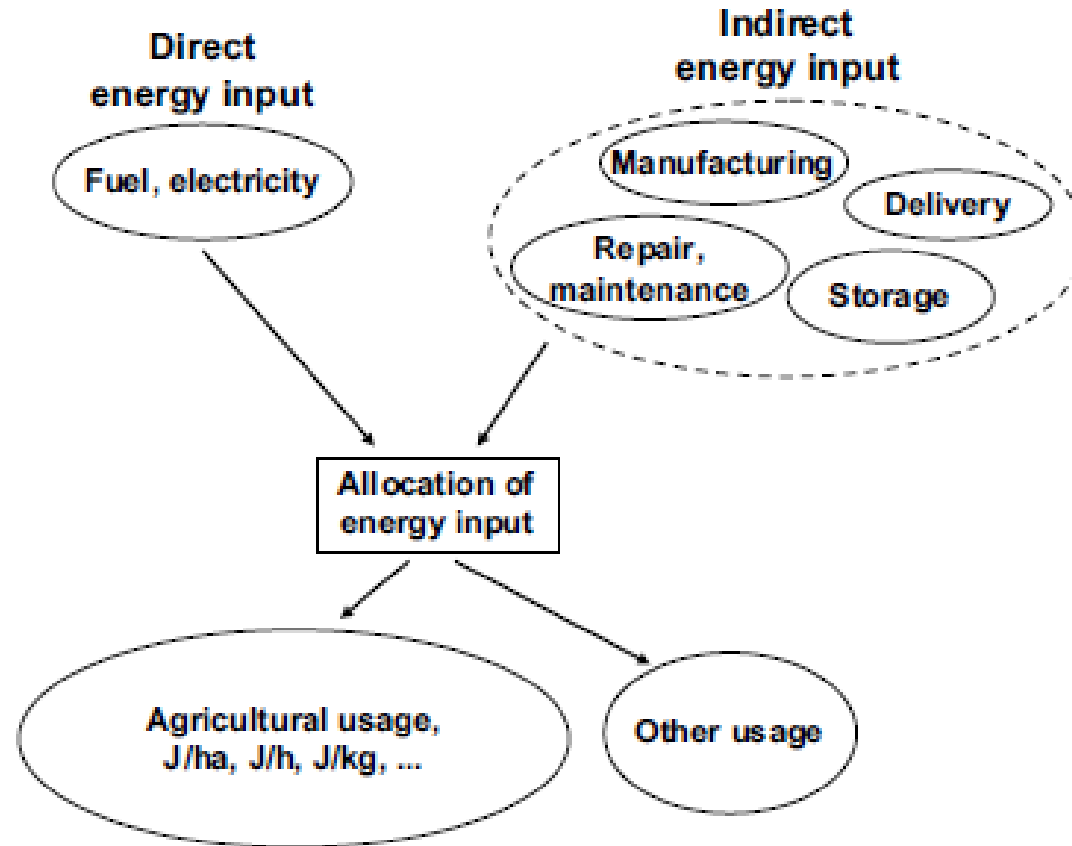
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"Ladies and gentlemen, today we're going to get down to nuts and bolts."

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# Energy analysis problem



# Manufacturing energy

- There are no precise figures for manufacturing energies
- Because machines are mainly steel structures, the figures of steel production are used
- The figures of steel manufacturing are in the range of 9 – 87 MJ/kg. Normally the consumption is around 80 MJ/kg.



# Repair and maintenance

- During the lifetimes of the machines they need repair and maintenance
- For repair spareparts are needed, their manufacturing and transporting needs energy
- Maintenance includes also change of oils, tyres, belts, batteries etc and the manufacturing and transporting of these need energy
- The maintenance work needs transportation, heated and special rooms, special equipments
- All these items should be included in the lifetime energy consumption of machinery



"The last thing I remember is something about a 'once in a lifetime' offer."

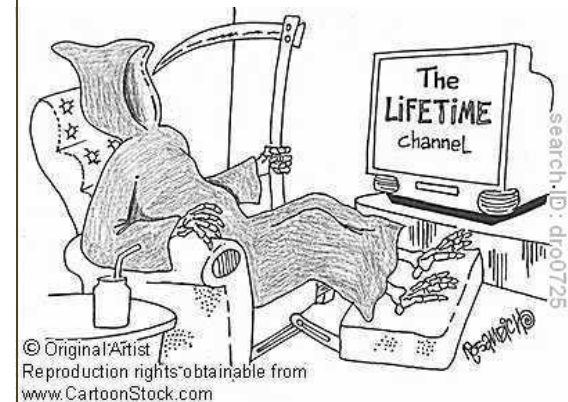
# Lifetime of machinery

- There is no exact lifetime for agricultural machinery.
- It depends on usage, level of service, and speed of technical and economical development.
- If development goes fast, machines become obsolete or uneconomical sooner than they are technically worn out.



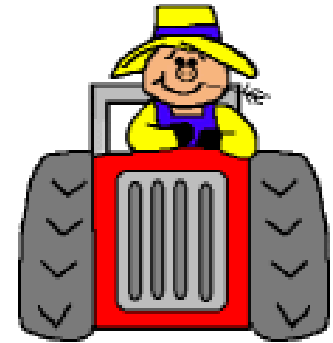
# Life-time of machinery and buildings

- ASAE D497.5 [27] gives a 12 000 h lifetime for a 2-wheel drive tractor and 16 000 h for a 4-wheel drive tractor and crawler.
- In Denmark the average annual usage was over 200 h and in Canada operating costs are calculated according to annual use values of 200, 400 and 600 h
- Schnitkey & Lattz based calculations on an annual use of 300 h in USA.
- Results from Finnish farms support the Danish results.
  - The newest tractors are used more than the average during the first 5–7 years, but after that period usage declines.
  - After 15 years the usage is only 100 h.
  - In order to achieve the estimated technical lifetime usage tractors should be running for 40–60 years, while the estimated economic lifetime is only 10–15 years.
- It would be important to know the real lifetime usage because there is a large difference depending on whether the manufacturing energy is allocated for 3000 h or 16 000 h.
- This same problem relates to implements and agricultural buildings as well.



# Tractor manufacturing and R&M energy

- Manufacturing and R&M energy can be connected to fuel consumption by estimating the life-time fuel consumption of a tractor and relating the energy consumption to this
- The energy share for tractors is normally 6 - 12 % compared to fuel consumption
- For selfpropelled machines the figure is little bit higher





# Implement manufacturing and R&M energy

- Implement manufacturing and R&M energy can be calculated as worked area basis
- The implements have a certain lifetime and with working width and speed we can calculate the lifetime worked area
- The manufacturing energy is calculated as MJ/ha

**Table 2**  
The energy needed for manufacture, repair and maintenance (R&M) of implements allocated per hectare.

Implement	Mass, <sup>a</sup> kg	Working width, m	Mass per 1 m working width	Typical working speed, km h <sup>-1</sup>	Capacity per 1 m working width, ha h <sup>-1</sup>	Lifetime, <sup>b</sup> h	Ratio of the lifetime R&M energy to manufacturing energy <sup>c</sup>	Energy for manufacturing + R&M, MJ kg <sup>-1d</sup>	Energy for manufacturing + R&M, MJ ha <sup>-1</sup>
Plough,4 furrows	936	1.60	585	7	0.7	2000	0.97	180	75.2
Chisel plough	1296	3.00	432	8	0.8	2000	0.51	140	43.2
S-tine harrow	1353	3.80	356	8	0.8	2000	0.55	143	31.8
Combined drill	1375	2.50	550	8	0.8	1500	0.55	143	65.5
Direct drill	3192	3.00	1064	10	1.0	1500	0.55	143	101.4
Roller	1824	4.00	456	6	0.6	2000	0.55	143	54.3
Field sprayer, mounted	396	12.00	33	7	0.7	1500	0.37	119	15.1

<sup>a</sup> The mass is typical for the type and size of the machine in question on the Finnish market in 2005 [39].

<sup>b</sup> [27].

<sup>c</sup> Coefficients are presented by Bowers [7], who edited Fluck's [3] original coefficients so that the mean of 14 machines is 0.55.

<sup>d</sup> Energy for manufacturing 86.7 MJ/kg [7] + energy for transportation from plant to farm 8.8 MJ/kg [4] + energy for R&M [5,7].

# Conclusion

- There are no up-to-date studies concerning the indirect energy input for agricultural machinery, i.e. manufacturing energy and the energy needed for repair and maintenance.
- There is a danger that energy analyses give too positive results if indirect energy input is underestimated.
- This same problem is associated with agricultural buildings and machinery used inside buildings.