Machine manufacturing and maintenance

Indirect energy input of agricultural machinery in bioenergy production

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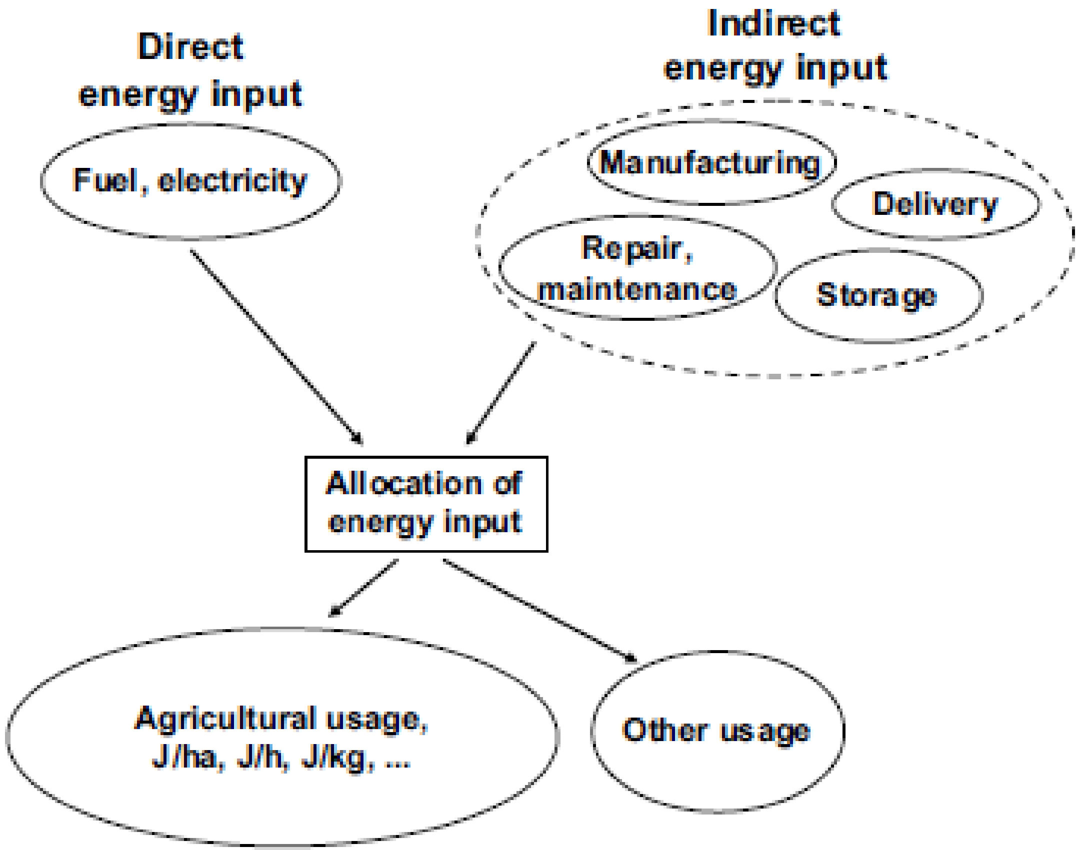
Energy analysis problem

- 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 maintanance
- The energy needed in manufacturing, transporting and maintanance should also be allocated to the agricultural production

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

Energy analysis problem



Manufacturing energy

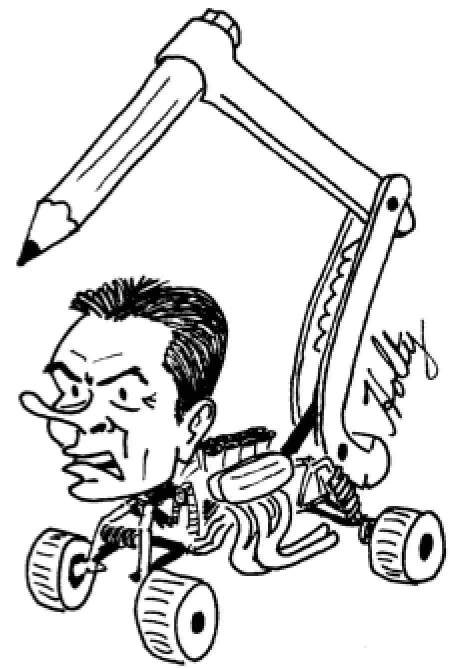
- There are no precise figures for manufacturing energies
- Because machines are mainly steel structures, the figures of steel production are used
- The figures of steel manufacturing are in the range of 9 – 87 MJ/kg. Normally the consumpition is around 80 MJ/kg.

Repair and maintanance

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

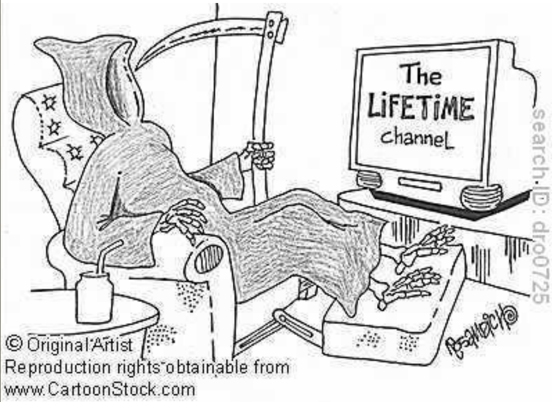
Lifetime of machinery

- 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,[a] kg	Working width, m	Mass per 1 m working width	Typical working speed, km h^{-1}	Capacity per 1 m working width, ha h^{-1}	Lifetime,[b] h	Ratio of the lifetime R&M energy to manufacturing energy[c]	Energy for manufacturing + R&M, MJ kg^{-1}[d]	Energy for manufacturing + R&M, MJ ha^{-1}
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

[a] The mass is typical for the type and size of the machine in question on the Finnish market in 2005 [39].
[b] [27].
[c] Coefficients are presented by Bowers [7], who edited Fluck's [3] original coefficients so that the mean of 14 machines is 0.55.
[d] 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.

This material has been produced in ENPOS project. ENPOS is acronym for ***Energy Positive Farm***.

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- MTT Agrifood Research Finland - Agricultural Engineering
- Estonian University of Life Sciences

Project home page is at http://enpos.weebly.com/

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