Indirect energy input of agricultural machines

Possible indirect energy items to be included in the analysis:

- Manufacturing
- Transport from the plant to a farm
- Repair and maintenance
- Discarding/Recycling

Manufacturing

- No analysis has been made especially for agricultural machines
- The most popular reference is the study of Berry & Fulton Fells 1967 from car industry
  - Energy for manufacturing 81.2 MJ/kg (or 86.7 MJ/kg)
- Later studies:
  - MacLean H, Lave L. A life-cycle model of an automobile. 1998 → 86.6 MJ/kg
  - Schweimer G, Levin M. Life cycle inventory for the Golf A4. VW environmental report 2001/2002 →74.9 – 80.8 MJ/kg

Transport from the plant to a farm

- Only one value found from the litterature:

  8.8 MJ/kg (Loewer Jr. O.J. et al. 1977)
- Energy requirement depends strongly on the transport distance and it can vary in a wide range.

Repair and maintenance (R&M)

- Kepner (1978) presented R&M costs to initial costs over the lifetime
- Fluck & Baird (1980) concluded that energy for R&M is significant compared to the energy for manufacturing
- 1985 Fluck presented two models:
  - The industry costs model (55%)
  - The lifetime repair costs model (138%)

Discarding/Recycling

- Berry & Fulton Fells (1967) took discarding into consideration in their analysis
- Mainly an ignored energy input
- Possibly an insignificant energy item if steel is recycled

Problems:

Energy for manufacturing , R&M should be allocated for the lifetime use.

What is the lifetime and the lifetime use of agricultural machines?

ASAE D497.5 → 12 000 h for a 2WD tractor.

In Denmark and Finland the annual use is some 200 h → tractors should be running 60 years to reach the technical lifetime!

Suggestion

- Energy for manufacturing, R&M should be allocated for the economical lifetime and usage e.g. 12 -15 years and 6000 – 9000 h for tractors.
- After that period tractors could be free from manufacturing energy costs.
- The same procedure could be applied for other machines.

The idea of the allocation for tractors and self propelled machines

- The lifetime fuel consumption of a tractor is estimated.
- Energy costs of manufacturing and lifetime R&M are estimated and allocated for the lifetime fuel consumption.

  → What you have to know, is the fuel consumption of the work operation.

The idea of the allocation for implements

- The lifetime capacity of an implement in ha (tons, etc.) is estimated.
- Energy costs of manufacturing and lifetime R&M are estimated and allocated for the lifetime capacity.

What should we do?

Manufacturing, repair and maintenance (R&M) energy of agricultural machines

Tractors and self propelled machines	Economic lifetime, years	Lifetime usage, h	Energy for manufacturing, MJ/kg	Energy for R&M, MJ/kg	Energy for manufacturing, R&M, MJ/l diesel fuel consumed	
2 Wheel Driven Tractor	12	9000	86,7			
Implements	Economic lifetime, years	Lifetime usage, h	Energy for manufacturing, MJ/kg	Energy for R&M, MJ/kg	Lifetime capacity	Energy for manufacturing, R&M, MJ/ha
Reversible plough	12	1200	86,7			

ENPOS Energy Positive Farm

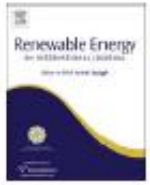
More detailed information:

Renewable Energy 35 (2010) 23–28

Contents lists available at ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene



Review

Indirect energy input of agricultural machinery in bioenergy production

Hannu J. Mikkola*, Jukka Ahokas

Department of Agrotechnology, University of Helsinki, P.O. Box 28, (Koetilantie) 3, FI-00014 Helsinki, Finland

ARTICLE INFO

Article history:
Received 22 December 2008
Accepted 7 May 2009
Available online 21 June 2009

Keywords:
Bioenergy
Energy input
Energy analysis

ABSTRACT

Sustainability of bioenergy products should be evaluated by means of an energy analysis that takes into account all relevant direct and indirect energy inputs. Direct energy input is viewed as the major energy consuming factor, and is quite easy to measure. Indirect energy input, however, has received relatively scant attention, so it is likely to be insufficiently analysed and possibly underestimated. This paper reviews the data available and suggests the type of research that would be needed to get a better understanding of the indirect energy input. The analysis addresses questions about the use of energy to produce and maintain agricultural machinery, the allocation of energy to different bioenergy products, and the real use and lifetime of machinery.

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

The project partners are
• University of Helsinki, department of Agricultural Sciences – Agrotechnology
• MTT Agrifood Research Finland - Agricultural Engineering
• Estonian University of Life Sciences

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

The project is financed by the EU Central Baltic IV A Programme 2007-2013

ENPOS Energy Positive Farm

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
INVESTING IN YOUR FUTURE

CENTRAL BALTIC
INTERREG IV A
PROGRAMME
2007–2013