Energy use and Green house gas emission in organic agriculture

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Types of energy use analyses in organic agriculture

- Comparisons of fossil energy use and efficiency in organic and conventional farming systems
  - per land unit,
  - per produced unit, farm level vs. chain based
  - green house gas emissions per produced unit
- Development of energy efficient systems
- Self-reliance in energy
- Net energy exporter : Bio-energy

Energy use in organic and conventional dairy production

Energy budget, grain production:

SANDY SOILS	ORGANIC	CONVENTIONAL
ELECTRICITY	195	246
DIESEL, MANURE	611	521
SOIL PREPARATION	1399	1568
HARVEST, TRANSPORT	577	577
DIESEL NOT ACCOUNTED FOR	1170	1208
SUM DIRECT ENERGY	3952	4120
SEEDS	459	358
FERTILIZER		3272
PESTICIDES		218
LIMING	150	150
MACHINE DEPRICIATION	1968	1936
SUM INDIRECT ENERGY	2577	5934
SUM ENERGY	6529	10054

MJ per HA

NB!: "Ancient data….": Refsgaard, Halberg og Kristensen, 1998

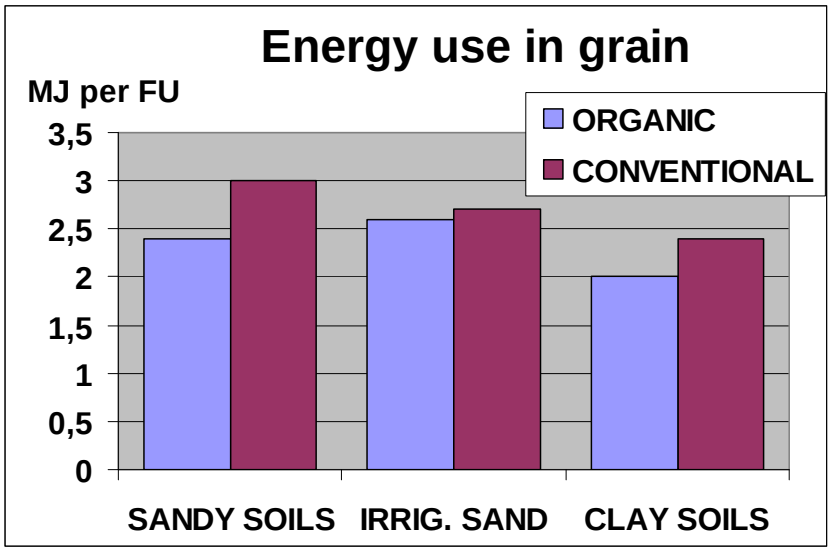
Energy use in organic and conventional production systems

Diesel use for field operations:

FIELD OPERATIONS	DIESEL USE	
PLOUGHING	20-23	L per HA
SEEDBED HARROWING	4-6	
TRADITIONAL SOWING	3	
PESTICIDE APPLICATION, 12M	1.5	
FERTILIZER APPLICATION	2	
WEED-HARROWING	2-3	
HANDLING OF MANURE	1,05	L per ton
HANDLING OF SLURRY	0,41	

Nielsen, Pick,
Norén and others

Energy use in organic and conventional production systems



Energy efficiency in organic and conventional crop production, USA, 1980

	Corn		Potatoes	
	Conventional	Organic	Conventional	Organic
Energy input (1000 kcal)	6,241	3,759	15,841	8,424
("Nitrogen-fert/manure" in %)	(27)	(7)	(17)	(7)
Yields (kg)	8,005	7,925	33,000	16,500
Yields (1000 kcal)	27,885	27,606	20,262	10,131
Output/input (1000 kcal)	4.5	7.3	1.3	1.2

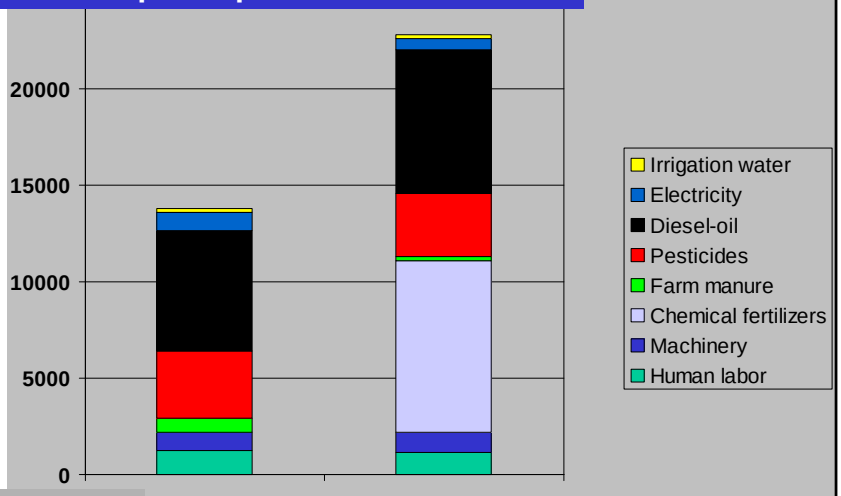
Organic crops fertilised with manure

Energy for chemical fertilizer and handling of manure included.
Human labor not included.

Alternative value of manure nutrient content not included!

NB! "Clasical data": Pimental et al., 1983

Energy consumption and energy input-output relationship in organic and conventional apricot production



Energy output/input ratio: **Organic** ***2,22*** **Conventional** ***1,45***

Erdemir Gündogmus, 2006

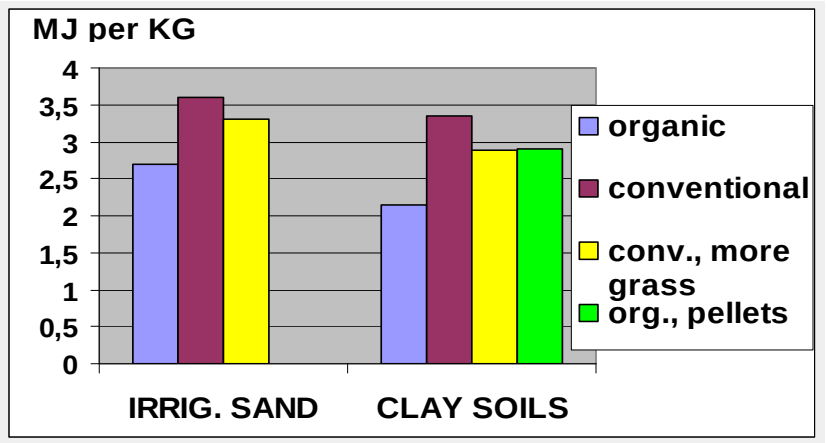
Energy efficiency in DK organic and conventional Dairy farms (clay soil)

	MJ per kg product	
	Conventional	Organic
Grass Clover Kg DM	2.0	0.7
Cereal	2.4	2.0
Milk	3.3	2.7

Refsgaard, Halberg og Kristensen, 1998

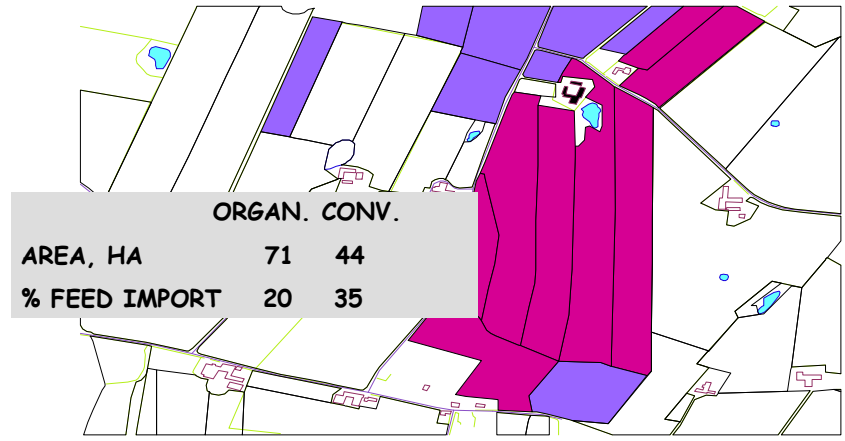
Energy use in organic and conventional production systems

Energy use, milk production:



Energy use in organic and conventional production systems

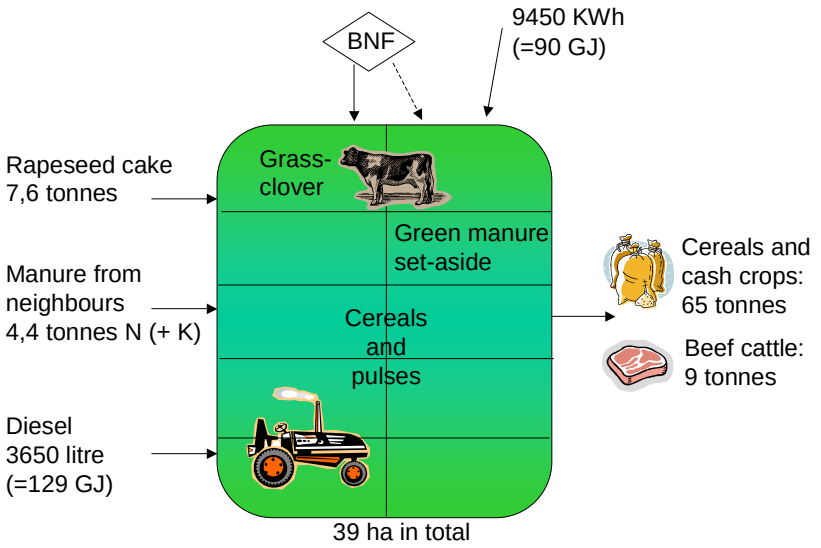
Land used for 500 t milk production:



	ORGAN.	CONV.
AREA, HA	71	44
% FEED IMPORT	20	35

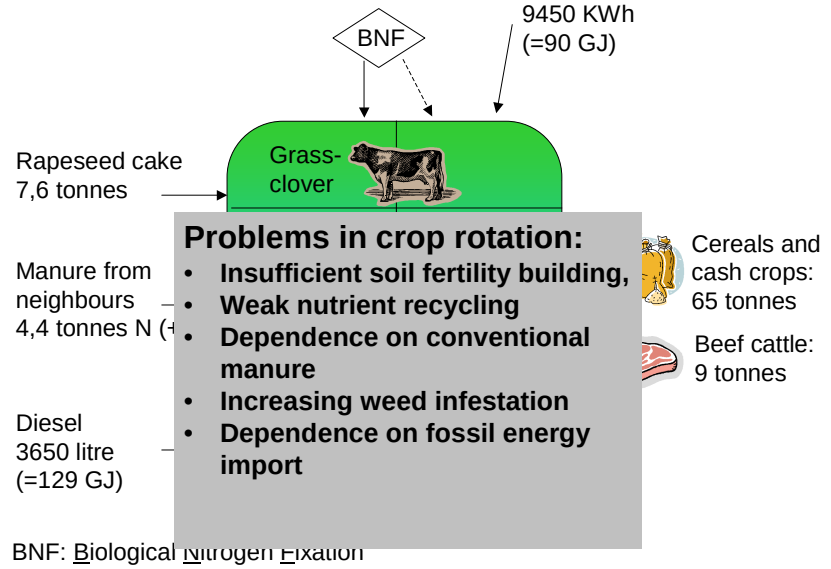
Area needed conventional farm

Extra area organic farm



BNF: Biological Nitrogen Fixation

Representative Danish organic cash crop farm



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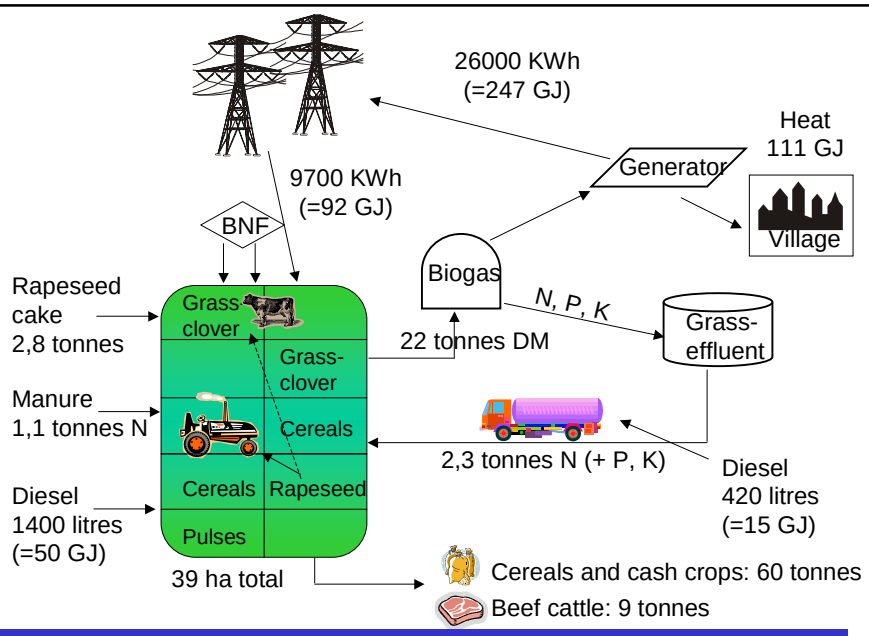


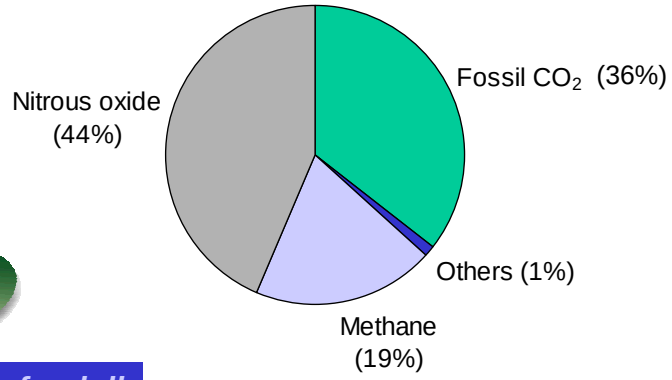
Potential for bioenergy production from grass-clover and rapeseed in the average organic cash crop farm in Denmark

Energy use and production on representative farm and simulated alternatives

Direct and indirect Energy use, GJ	**Basis**	**Rapeseed**	**Grass clover I**	**Grass clover II**
Diesel	129	50	124	124
Electricity	90	92	90	47
Rape seed cake	1	0.2	1	1
Transport of grass and effluent	0	0	15	15
Other	0	2	1	1
Sum	220	145	231	188
Replaced energy production, GJ				
Heat produced in electricity production	0	0	111	111
Electricity production	0	0	247	130
Sum			358	241
Net energy comsumption, GJ	**220**	**145**	**-127**	**-53**

Halberg, Dalgaard, Olesen, Dalgaard, 2008

The proportion of major greenhouse gases related to the production of Danish pork



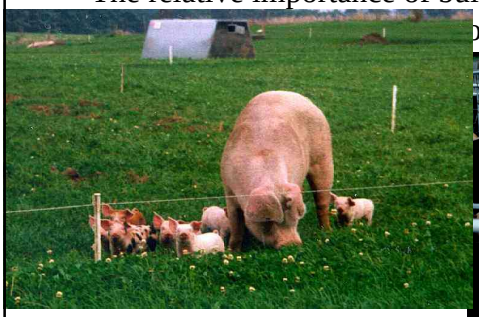
www.lcafood.dk

Calculated in CO_2 eq. according to EDIP method (Wenzel et al., 1997), with updates from IPCC 2006

Life Cycle Assessment of pork from Danish organic and conventional farms

Trade offs:

- Animal welfare and agro-ecology vs environment and GHG
- Energy use in stables (cost of construction and running costs) vs emissions of GHG from fields
- The relative importance of buildings and soil C changes for production



Three organic pig systems:
Sows are free ranging on grass-clover fields

Grass-clover part of crop rotation
Winter shelter in huts

System I: Fattening pigs are raised indoor: 1.3 m2 per pig

Deep litter straw bedding with access to outdoor run

System I: Outdoor runs with concrete sealing for growers

Most abundant organic pig system in DK

System II: All pigs free-ranged on grass-clover and supplemented outside. Huts for shelter

System III: The one unit tent system: Sows are removed and growers raised with limited access to grass-clover plots

Emissions of Ammonia, Dinitrogen Monooxide, Nitrate, Methane and Phosphate in kg year^{-1} from three modelled types of organic pig production

System Emissions	I Free range sows	II All free range	III Tent system	Estimated CV, %
Ammonia	4164	4183	3548	22
Dinitrogen monooxide (N_2O)	692	843	793	29
Nitrate	17183	29767	19785	15
Phospate	74	122	109	50
Methane	2174	506	490	50