Visions for organic bioenergy production in Denmark

Tommy Dalgaard, Uffe Jørgensen, and Inge T Kristensen

***Abstract* – There is a large potential for organic bioenergy production, which can be combined with the present food production and the provision of multiple other goods and services required by society; i.e. a cleaner aquatic environment, or nature values in cultural landscapes. This paper presents six scenarios for bioenergy production from organic farming in Denmark, with a total energy production potential of around 6.7 PJ/yr. This potential is compared to the present energy use of around 2.5 PJ/yr, and the potentials for energy savings equalling 0.1-0.5 PJ/yr.**

BIOENERGY AND ORGANIC FARMING

Koonin (2006) emphasises three important societal concerns that are addressed by a conversion to bioenergy production: Security of supply, lower greenhouse gas emissions, and support for agriculture. We argue that organic bioenergy production has the potential to deliver numerous, additional benefits to society. Therefore, the design of bioenergy production methods and policy support actions need to be based upon a diverse list of costs and benefits, and evaluated at numerous scales and for the entire production chain.

Organic farming has a defined aim "to use, as far as possible, renewable resources in production and processing systems and avoid pollution and waste" (IFOAM, 2002). Bioenergy production can be an important mean towards this aim. In addition organic farming integrated with bioenergy production can help to deliver others of the multiple goods and services required by society; i.e. a cleaner aquatic environment, or nature values in the cultural landscapes.

This paper presents six scenarios for bioenergy production from organic farming in Denmark, and compares the potential bioenergy production to the present energy use. In addition the production scenarios are compared to seven scenarios for possible energy savings in the primary organic farming sector of Denmark, and visions for the organic bioenergy production are discussed.

PRESENT ENERGY USE

The present energy use for organic farming in Denmark was estimated to 2,5 PJ (Table 1), using an existing model for direct and indirect energy use (Dalgaard et al. 2001). Most of this energy use is related to dairy farming, which together with cash crop farming dominate organic farming in Denmark (Figure 1).

Table 1. Estimated direct and indirect energy use on organic farms in Denmark 2002 (1 PJ= 10^{15} J).

	Dairy farms	Other farms
Oil (PJ)	0,3	0,3
Electricity (PJ)[a]	0,3	0,2
Net fodder import (PJ)	0,8	0,0
Housing and machinery (PJ)	0,3	0,1
Total (PJ)	1,8	0,7

[a]Indirect energy for production and distribution included.

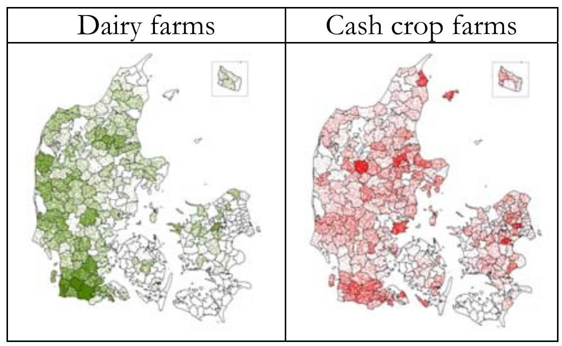

Figure 1. Geographical distribution of organic dairy farms and cash crop farms in Denmark 2002. One dot equals 2 ha.

ORGANIC ENERGY SCENARIOS

Six scenarios for organic bioenergy production are calculated:

1. Biogas energy from livestock manure.
2. Biogas energy from grass/clover production.
3. Rape oil from existing rape fields.
4. Rape oil from new rape fields.
5. Alder short rotation coppice on set-aside areas.
6. Alder short rotation coppice on permanent grasslands.

In scenario 1 it is anticipated that 60% of manures from organic cattle and 70% from other organic livestock can be collected for biogas production, and the corresponding net electricity and heat production is calculated (Dalgaard and Jørgensen, 2004). Scenario 2 shows the additional net biogas energy production, utilising potential areas for grass/clover production on all other organic farms than the dairy farms. Scenario 3 and 4 illustrate the potential energy production in the form of cold pressed rape oil produced on present rape fields and on potential, new rape fields on the non-dairy, organic farms of Denmark. Finally, Scenario 5 and 6 illustrate the potential bioenergy production in the form of alder (*Alnus* spp.) short rotation coppice for combustion (Jørgensen et al., 2005), grown on all organic set-aside areas, or on half of the organic areas with permanent grasslands, respectively.

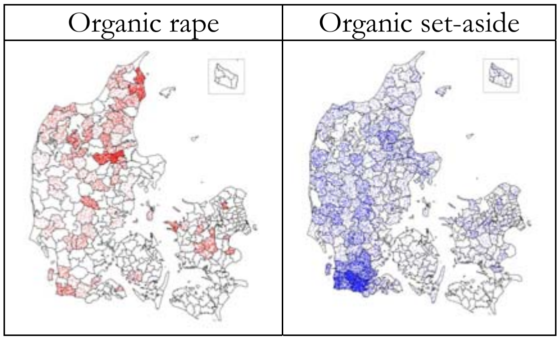

Figure 2. Organic rape production and set aside areas (incl. non-food crops) in Denmark 2002. One dot equals 1 ha.

For comparison, the following seven scenarios for potential energy savings in organic farming is defined:

A) 20% reduced oil consumption (including savings on lubricants and oil for heating).
B) 25% reduced energy for housing.
C) 25% reduced energy for machinery.
D) 25% reduced energy for dairy cow housing.
E) 25% fodder import substituted with grassing.
F) 50% area with intensive weed control (3 extra weed harrowings and 3 extra stubble cultivations on 50% of the organic area).
G) 50% of fodder import in form of grass pellets.

SCENARIO RESULTS

Table 2. Estimated net energy production in six scenarios for bioenergy production from organic farming in Denmark (Based on Jørgensen and Dalgaard, 2004).

Bioenergy production scenarios	Net energy (PJ)
1) Biogas energy from livestock manure	1,10
2) Biogas energy from grass/clover	0,73
3) Rape oil energy from existing fields	0,02
4) Rape oil from new rape fields	0,19
5) Alder coppice on set-aside areas	3,02
6) Alder coppice on permanent grasslands	1,81
Total	6,87

In practise it may be difficult to reach the bio-energy production potentials anticipated in the six scenarios. Especially the scew geographic distribution of livestock, and organic energy cash crop production sites (Figure 1, Figure 2) may limit the potentials, and imposes logistic problems for the establishment of bioenergy production plants in regions with low organic farming density. If for example organic biogas production would be limited to western part of Denmark, which has the ghigest livestock densities (Figure 1), the potential biogas production would be reduced by around 20%.

Table 3. Estimated effect of potential energy savings in organic farming in Denmark. Negative effects mean reduced energy use (A-E) and positive effects vice versa (F-G).

Scenarios for energy savings	Estimated effect (PJ)
A) Reduced oil consumption	-0,13
B) Reduced energy for housing	-0,03
C) Reduced energy for machinery	-0,06
D) Reduced energy for dairy cow housing	-0,11
E) Fodder import substituted with grassing	-0,19
F) More intensive weed control	+0,13
G) Fodder import in form of grass pellets	+0,68

VISIONS FOR ORGANIC BIOENERGY PRODUCTION

One of the major problems in modern, intensive agriculture is the lost link between livestock and land (Naylor et al., 2006). This separation in space, between different agricultural production systems, environmental problems and the consumers, is largely unaccounted for in the development of economies and agricultural practices, and mitigation actions are needed to ensure global sustainability. It is a potential danger that growth in bioenergy production will add to these problems, thereby reducing the overall benefits of conversion. In line with the studies of Jørgensen et al. (2005), the present study on organic farming and the potentials for bioenergy production, head for a solution of such problems. Organic food production, integrated with short rotation coppice, rape oil production and biogas utilisation reveal a number of win-win situations; for example: lower energy use per unit produced, water quality protection, recycling of nutrients, reduced nitrous oxide emissions and increased soil carbon storage (Jørgensen and Dalgaard, 2004). Consequently, ecologically sound bioenergy production should aim towards closed cycles of mass and optimisation of net energy yields and efficiences. This is a defined aim of organic farming, and should also be the underlying premise for the further developments and implementation of technologies for bioenergy production.

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