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Danish farming futures

Becoming independent from fossil fuels by investing fully in the new bio economy, or reintroducing wolves and the European bison, these are two visions explored in a new report about the future of Danish farming.

The Danish Ecological Council has drawn up four future agricultural scenarios for Denmark that explore four different aspects of sustainable farming. This can be seen as an attempt to visualise the difficulty of taking into account all aspects of sustainability at the same time. In the study they defined five areas for sustainability:

- biodiversity,
- aquatic environment,
- soil fertility,
- climate,
- business economy and employment

The four scenarios focus on different approaches to increase the level of sustainability within these areas.

The “green growth” scenario aims to minimise pollution and the climate impact of farming while maintaining potential for economic growth in farming. This is achieved by placing most livestock in closed barns to control emissions of ammonia and greenhouse gases, combined

with eco-friendly cultivation, planting winter crops in most grain fields to reduce nutrient leakage, and growing straw and grass for biogas production.

In the “urban and rural” scenario, the main aim is to connect urban and rural areas to drive progress in rural districts and farms, and stimulate employment and healthy economies. Local food production is promoted, a significant share of all farms is organic and land that surrounds cities is adapted for recreational purposes.

In the “biobased society” scenario, the main objective is to have farmers supply feedstock for the production of renewable energy and materials in addition to food. There are five bio-refineries in Denmark that produce bioenergy, chemicals and plastic. Denmark is independent of fossil fuels, and bioenergy is an important part of the energy supply. Fields of willow, poplar and grass provide raw materials.

In the fourth scenario “a rich nature” the

main aim is to create more biodiversity and balance in nature by 2050. Areas with the highest biodiversity potential are not used any more as regular farmland. Instead they are converted into national parks, wetlands or grazed, while agriculture is intensified in other areas to keep production levels as before. Wolf, wild boar, beaver and the European bison can be found.

Each scenario has been assigned a particular land use profile in 2030 and 2050 (table 1). For comparison there is also a business as usual scenario (BAU). In all four scenarios the share of agricultural land is lower compared to BAU. The reduced areas of agricultural land are made possible by abolishing the current export of grain and using this land for other purposes. The share of arable land is highest in the “urban rural” scenario, since low-input agriculture is introduced and it will require larger

Table 1: Area use in 2050 for the different scenarios. Note that energy crops are included in the category permanent grassland.

Area in thousand hectares	Baseline 2011	BAU	Green growth	Urban and rural	The biobased society	Rich nature
Agricultural land in total	2,659	2,351	2,286	2,286	2,286	2,191
Arable land	2,327	2,019	1,454	1,914	1,454	1,609
Permanent grasslands	332	332	632	372	632	582
Energy crops willow/ poplars	6	6	200	0	200	0
Forest	608	608	673	673	673	768
Settlements and open nature areas	1,022	1,330	1,330	1,330	1,330	1,330
Total	4,289	4,289	4,289	4,289	4,289	4,289
Total agricultural area as % of DK area	62	55	53	53	53	51
Non tilled land as % of agricultural area	13	14	36	16	36	27

Table 2: CO₂e reductions (million tonnes of CO₂e) compared to business as usual. For methane, only the changes caused by increased use of biogas are included.

Million tonnes of CO ₂ e	Green growth		Urban and rural		The biobased society		Rich nature	
	2030	2050	2030	2050	2030	2050	2030	2050
Change in carbon sequestration	0.28	0.54	0.1	0.21	0.65	0.62	0.39	0.79
Change in methane emissions	(0.26)	(0.34)	(0.01)	(0.01)	(0.17)	(0.19)	(0.01)	(0.01)
Substitution of fossil fuels	4.34	6.50	0	0	8.82	7.70	1.00	1.00

areas than conventional agriculture. The share of permanent grasslands is highest in the “green growth” and the “biobased society”, where grass is grown to provide bioenergy. The share of forest increases the most in the “rich nature” scenario.

Numbers of farm animals were related to the feed supply in each scenario. By 2050 the number of animal units is expected to be unchanged in the “rich nature” scenario, while it is 5 per cent lower in the “biobased society” scenario, 10 per cent lower in the green growth scenario and 20 per cent lower in the “urban and rural” scenario. The shares of different kinds of animals are expected to be the same as today.

It is interesting to note that numbers of animals are not expected to have a crucial impact on ammonia emissions. Instead, technical measures such as cooling and acidification of slurry, air scrubbers and direct soil incorporation of manure, in combination with keeping almost all animals indoors all year round are implemented in two of the scenarios, “green growth” and “rich nature”. Only a few sheep and cows are kept outdoors to graze

permanent grasslands. These measures are expected to reduce ammonia emissions by 80 per cent in the “rich nature” scenario and by 60 per cent in the “green growth” scenario by 2050.

The study did not model changes in greenhouse gas emissions abroad that would follow the changes in the scenarios. Nor did it model all domestic greenhouse gas emissions. For instance all scenarios will result in reduced use of mineral fertilizers and more efficient use of manure. This would probably result in lower nitrous oxide emissions, but this was found too difficult to quantify.

However, three types of greenhouse gas emissions were quantified for the different scenarios (table 2). Increased levels of carbon sequestration were achieved in all four scenarios. In the “green growth” and “biobased society” scenarios this was mainly achieved by converting arable land to energy crops and permanent grasslands. The former is assumed to increase CO₂ sequestration by 1.20 tonnes/ha/year and the latter by 1.83 tonnes/ha/year. The level of carbon sequestration is the highest in

the “rich nature” scenario, where a lot of land is afforested. This is assumed to have an increased effect on carbon sequestration of 2.17 tonnes/ha/year. Increased carbon sequestration caused by changes in land use will however decrease gradually over the years until a new equilibrium is reached.

In the case of methane emissions, only the reductions that are achieved through increased use of biogas production from manure are considered. This is assumed to have an effect of 0.14 CO₂e per tonne of processed manure.

Substitution of fossil fuels with biomass is the measure that has the largest effect on greenhouse gas emissions. In the “biobased society” scenario, emissions are expected to decrease by around 8 million tonnes of CO₂e per year. This can be compared to the total greenhouse gas emissions in Denmark that were around 50 million tonnes CO₂e in 2012.

The “biobased society” will however have the least positive effect on biodiversity and the lowest reduction in pesticides.

When it comes to employment, the authors expect that the number of people working in the agricultural sector will continue to decrease under the BAU scenario. The same trend is expected to differ in degrees in each of the four scenarios. There will be most agriculture-related jobs in the “biobased” society and fewest in the “rich nature” scenario. The loss of jobs is not however seen as a problem in the long run, as other sectors are expected to absorb the laid-off workforce.

When reading this report it is worth remembering that Denmark is in many ways quite an exceptional country in Europe. The share of agricultural land is very high (62 per cent) and there are few natural areas. The number of pigs per capita is probably one of the highest in the world. The use of advanced technology in agriculture is widespread. If this study was conducted in another country the outcomes as well as the priorities would most likely be quite different.

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The entire report “Scenarier for fremtidens landbrug i Danmark” (in Danish) can be downloaded at: <http://fremtidenslandbrug.dk/publikationer/hovedrapport-scenarier-for-fremtidens-landbrug-i-danmark/>

And for a summary in English: <http://fremtidenslandbrug.dk/future-farming/>