

# THE FUTURE OF AGRICULTURE: SCENARIOS FOR SUSTAINABLE FARMING IN DENMARK

## MAIN REPORT

### ENGLISH SUMMARY

What this study attempts to describe can be thought of as the exploration of a dream by examining the notion of sustainable agriculture. To the best of our ability, and using the best data sources available, insufficient as they may be, we have attempted to transparently and realistically lay down the scenarios of where we may be in 2030 and 2050. From these scenarios, we have worked backwards to determine what must be done today for the visions to be realized.

The Danish agriculture sector faces large challenges. The debt of the industry has increased, and environmental requirements have tightened. In the long term, climate changes, food market conditions and the ongoing reform of the EU Common Agricultural Policy will pose new challenges. How do we develop a sustainable agriculture sector in Denmark under these conditions?

This study attempts to answer just that. We used scenario analysis in which four different imaginary scenarios of possible futures are presented on equal footing. The scenarios each focus on different kinds of sustainability. They are thought up to be somewhat comple-

mentary with regards to the degree of integration of environmental considerations in production and priorities between agricultural production and other considerations for scenery, environment and society. The four selected scenarios are: **Green Growth, Urban and Rural, The Biobased Society** and **A Rich Nature**.

As such, this is not a case of futurology in the traditional sense that you use the latest tendencies to project where things are going to be with some probability in a number of years (forecasting). With an issue as complex as Danish agriculture in the perspective of nearly 35 years, such an attempt would not make sense. Instead, we start with an overall picture of the future from which we work back to the present (backcasting) to see which pre-conditions such a development would require. Thus, scenario analysis is a suitable tool to control the development of complex matters in the long term rather than a method to consider simple matters in the near future.

In order to handle the multidimensionality of agricultural development, the scenario analysis is accompanied by multiple-criteria decision analysis, a mathematically and graphically based decision support system for prioritizing between alternatives. The method allows the utility of multiple criterion functions

to be simultaneously optimized e.g. biodiversity, water and the employment rate. The individual criteria, which are often measured in different units, find a common denominator when they are standardized and given weight based on their priority.

Input for the multiple-criteria decision analysis was collected in a nationwide geographical data set including farms and cultivated land, nature, environment, soil properties, ground rent and employment. Thereby, massive processing power has provided the means to single out areas with the greatest potential for change in land use in order to best realize the respective aims of the four scenarios.

When each scenario has been devised, calculated and then geographically located, the backcasting is ready to start. Backcasting involves examining which instruments are appropriate for the present state to develop into the scenario. For that to happen, some preconditions first have to be specified. Seeing as the goal has been to adopt a holistic approach to agricultural development, we have selected global environmental and climatic parameters as preconditions, thus limiting a market-driven development. Our basis is therefore a development in which a dietary change in the west and more developed countries/populations consisting of reduced meat consumption and a relatively modest annual revenue growth rate permits globally sustainable cultivation and preservation of soil fertility.

The national preconditions have been retrieved from a business-as-usual scenario in which urbanization is expected to require about 8,000 ha p.a., the real price decrease of produce is expected to be 2 % p.a., a revenue

growth rate about 0.5 % p.a., a labour productivity increase of 5 % p.a. and a plunge in the employment rate of about 50% in 2030.

**The Green Growth** scenario mainly aims to minimize the pollution and climate impact due to farming while maintaining and improving potentials for growth in agriculture. The three sub-objectives are effective handling of nutrients, reduced emission of greenhouse gases and reduced use of pesticides.

**The Urban and Rural** scenario mainly aims to connect the urban and the rural in a development whose sub-objectives are increased focus on urban needs such as food, nature and recreation; increased processing and locally sold food and promoting an extensive, organic farming system as an alternative to setting aside land as an environmental instrument.

**The Biobased Society** scenario mainly aims to have farmers supply feedstock to the production of renewable energy and materials in addition to the food supply. The sub-objectives are high production of energy crops and raw materials for the industrial sector, effective high-tech utilization of biomass and maximizing the recirculation of nutrients.

**A Rich Nature** mainly aims to create more biological diversity and balance in nature in 2050 while maintaining potentials for growth in agriculture. The sub-objectives are increased biodiversity in the open land, increasing open nature areas, coherence and diversity in nature.

Each scenario is described first as 'the good story', briefly, eloquently and clearly with the real world as basis. Next, the instruments in play in the scenario, and the extent of their

use are described. Instruments include land restructuring, cover crops, straw utilization, slurry handling, energy restructuring and pesticide use. The selection of instruments and prioritization of criteria vary from scenario to scenario. For example, land restructuring, slurry handling and fuel consumption play a large role in the scenario of **Green Growth** in which the aquatic environment and climate concerns are highly prioritized. Afterwards, maps are used to show how the relevant changes are best located. In **Green Growth**, for example, the scenario will impact vulnerable areas near the Limfjord, South-Eastern Jutland and South Funen and islands [JF1] the most.

Across the four scenarios, the required political actions for the implementation of the instruments are described and discussed. Many things recur in several scenarios, and synergies arise in many cases. For instance, reduced pesticide use is only an explicit instrument in **Green Growth**, but reductions up to 60 % still occur in the other scenarios as a consequence of set-asides, etc.

The first political instrument to be considered is price formation and the options to influence price formation with subsidies, taxes and public acquisitions, which is especially relevant when considering expansion of the organic production area. Moreover, ecology can be promoted by supporting research and communication.

Entirely consistent with the recommendations of The Commission on Nature and Agriculture, the scenarios use targeted regulation to achieve the explicit objectives of each sce-

nario. Set-aside either for crop rotation or afforestation is the most extensive instrument employed to some degree by all scenarios. The purpose of extensification and termination of farming is the wish to reduce the introduction of nutrients to aquatic environments, carbon sequestration and fixation to organogenic land, biomass cultivation for energy production as well as set-aside of land for environmental purposes. Finally, the study discusses adjustment using nitrate retention monitoring and zonation in order to achieve optimal distribution of nutrition handling.

Extensification of agriculture in vulnerable areas by establishing the use of ecological cycles is a means applied in the Urban and Rural scenario. It is a type of organic farming in which the requirements to animal density have been tightened from the 1.4 LU per ha standard maximum for organic farming to a maximum value of 0.9 LU per ha. The instrument is thought to be used as an alternative to set-asides in vulnerable areas, mainly due to concerns for the aquatic environment. Simultaneously, it is used in peri-urban areas along with set-aside of forests and nature reserves for the sake of recreational and scenic interests and to increase access and transparency to food production.

Nature benefits in several ways. First and foremost, it benefits from the abovementioned set-aside of land, which in the scenario of A Rich Nature amounts to reserving a third of Denmark for forests, nature reserves and eco-friendly grass by 2050. Preservation of nature in the areas set aside is important and may occur either in the form of grazing or hay harvest

that can be used in biogas production. Additionally, nature will benefit substantially from reduced use of pesticides, new ways of handling slurry and initiatives to reduce ammonia emissions and leaching to the aquatic environment.

Use of cover crops, straw utilization, production of energy crops and phasing out fossil energy consumption are other means applied that contribute greatly with synergy to the vision of realizing sustainable development. In **The Biobased Society**, we go even further by refining biomass from farming to best exploit the resources. Finally, in the Urban and Rural scenario especially, regulation of the structural development of agriculture is recommended so that rural development funds can help retain some of the smaller farms that would otherwise disappear under normal structural development.

Likewise, the consequences of applying the instruments across scenarios are analysed to the extent and in the manner previously described. A complete overview of the distribution of land use in 2050 shows, in every scenario, that the land allocated for agriculture will be between 51-53% the area Denmark compared to the 55% expected in the BAU scenario and the current 62%. The fodder supply will be set back 5-30% and livestock production reduced by 0-20%.

The loss of nitrogen and phosphorus to the aquatic environment will be reduced remarkably because of set-aside of cultivated land, cover crops, buffer zones and conversion to organic farming. The targeted approach of setting aside the most vulnerable lands in **Green Growth** and **Urban and Rural** will, to

the extent previously stated, satisfy the goals of the EU Water Framework Directive. In the other scenarios, the effect will be positive as well, but we are unable to determine from the analyses whether it will fully satisfy the goals.

Pesticide use will be reduced in all scenarios partly due to improved technology, but mainly due to growth in areas with low to no pesticide use. [LBJ2] The emission of greenhouse gases will be declining, and as will carbon sequestration in soils, while substantial amounts of biofuel are anticipated in particularly **The Biobased Society** and in **Green Growth**. All four scenarios will affect nature: In **A Rich Nature** by prioritizing the creation of more continuous nature outside agricultural land, and in **Urban and Rural** with more nature inside agricultural land.

If the application of areas were to be changed, so would their operational value. And the employment rate, too. The estimated reduction in FTEs (Full Time Equivalents) from setting aside land in the four scenarios is, however, modest in comparison to the expected decrease of employment of more than 20-30,000 FTEs in the **Business As Usual** scenario.

The largest negative effect on the employment rate is due to the reduction of livestock. But this decrease of employment is overshadowed by new jobs in energy production and refineries in **The Biobased Society** and **Green Growth** - even excluding job creation due to innovation and development.

Despite little focus on energy production in **A Rich Nature**, the effect on employment is positive, primarily because the production of livestock is maintained in this scenario.

Energy production is not part of the Urban and Rural scenario. But the scenario includes new areas of business that, especially near cities, can create new jobs from direct sales, educational and communicational activities, local processing companies, etc. Yet, this project has not determined the extent of new jobs from these initiatives, and it is also unknown how more extensive livestock production will affect employment.

Finally, the financing of all initiatives are accounted for. In general, the agriculture sector needs to pay [the external costs [JF3]] that food production inflicts on society, which means that in the end, consumers will pay a higher price for food so that the farmer is able to generate appropriate earnings from his production. One way to do it is by taxing excipients and subsidies for production, sale, technology advances, etc.

The total annual support for the Danish agriculture sector is [DKK 8 billion [JF4]]. The direct agriculture support makes up 80%, the Agricultural Fund for Rural Development 16% and support for organic farming accounts for about 2%. The EU subsidies are increasingly under attack, and thus reductions are the most probable future scenario. If the direct support drops at the same rate as in 2014-2020, it will be completely phased out in 2052. We demonstrate by calculation that full financing of the three scenarios through a targeted approach only requires 14-17 % of the direct funding from the Rural Development Programme of 2013, while The Biobased Society can be realized with an amount smaller than the rural development funds of 2013.

The National Nature Fund [JF5] is a new initiative. With some support, the fund will be able to contribute substantially to ensure that vulnerable farming land is converted to valuable nature. Permanent set-aside of farming land should be practiced by acquiring the land in order to secure a lasting solution.

Several synergies between the different instruments have been indicated. That is one reason to expect environmental improvements in all scenarios. Scenic qualities and rural development and positive influence on the employment rate are other achievable benefits. Focused regulation is the requirement. A substantial increase in set-asides will be needed. Environmental regulation and economic incentives to implement new technology may lead to sustainable solutions and a strong, competitive sector. Organic farming will achieve a stronger position e.g. as an environmental policy instrument. In 2050, Danish agriculture could be competitive especially with high value and quality products, innovation, ecology and sustainability. [LBJ6]

In recent years, evidence-based administration has been requested by many e.g. in administration of nature. But if you look far into the future, like we have, not much can be scientifically determined in the traditional sense ('if a affects b ergo c'). Nonetheless, society has a clear interest in qualifying our expectations of the future even when they deal with something as complex as where we wish Danish agriculture to be in 35 years.

Complex questions require complex answers. In order to provide anything near an answer, many different qualifications, many limitations, many assumptions, considerations and

arguments are needed. The underlying knowledge is sporadic. And at that, all of it will be strongly dependent on what else happens in the world until 2050. So has the project been worth the effort with such a mixed picture? - You be the judge! [JF7]