Scotland's centre of expertise connecting climate change research and policy

A case study of agricultural nitrogen management policy in Denmark

Vera Eory, Scotland's Rural College; N.J. Huthchings, Aarhus University

March, 2017

Policy description

Agriculture is an important contributor to greenhouse gas (GHG) emissions. In Europe it is responsible for 10% of total GHG emissions[1]. Notwithstanding recent efforts policies directly targeting agricultural GHG emissions in the European Union are slow to emerge[2], particularly those targeting sectors outside of the Emission Trading Scheme[3]. However, as nitrogen pollution (mostly nitrate leaching and ammonia (NH_3) emissions has been targeted by policy since the 1970s across Europe to improve water and air quality, with synergistic effects on nitrous oxide (N_2O) emission reduction, the focus of this case study is nitrogen (N) management policies.

Denmark, as a major agricultural producer, has been suffering from significant marine, freshwater and groundwater pollution and air quality problems, still in 2013 applying 50% more nitrogen on their agricultural area on average and generating twice more nitrogen emissions than the UK[4] (see Appendix 2). A series of policies have been introduced since 1985 to manage these problems, bringing a 40% reduction in the nitrogen surplus of the country by 2010 from its peak in the 1980s[5]. Policies have been focusing on four broad farming management areas: crop fertilisation rates (including synthetic and organic nitrogen and phosphorous), livestock stocking density, manure storage and spreading technologies and buffer zones and artificial wetlands.

Although the Danish environmental legislation predates that of the EU, the policies are now closely related to the Nitrates Directive[6] (the whole Danish agricultural area is designated as Nitrate Vulnerable Zones), the Water Framework Directive[7] (WFD), the Habitat Directive[8] (HD) and the National Emission Ceilings Directive[9]. The current policy mix is a composite of regulation, market-based instruments and information provision (more details in Appendix 1).

Agricultural climate change policies can be expected to evolve in the near future in Denmark, to align the sector with the overall Danish Climate Policy Plan which aims to achieve a 40%

reduction in GHG emissions by 2020 in comparison to 1990 levels[10]. The overall policy target, also informed by a bottom-up economic analysis of Danish mitigation measures[11], is set to achieve mitigation in line with the long-term EU target of 80%-95% reduction by 2050. Though agriculture is considered in the Climate Policy Plan, there is no GHG mitigation target at the moment assigned to this sector.

Targets in the policy

Danish nitrogen policies have evolved in seven major stages since 1985 (Table 1, with further details in Appendix 1). Historically the policies were based on input targets (e.g. nitrogen application rate or stocking density), though some recent elements feature output targets (mostly related to ammonia emissions) and in the last two decades there have been some movement towards geographically targeted policies[5]. Policy targets are informed and supported by measurement and modelling based on a comprehensive soil sampling system, annual yield trials, farm and field scale statistics on nitrogen, groundwater and marine sampling system and ammonia monitoring stations.

Previous targets for reduction of nitrate leaching have been set at the national scale and the measures adopted had national scope. For example, farmers were obliged to maintain crop cover over winter on a percentage of their land, either by sowing winter crops or cover crops, and buffer zones up to 10 m width were required bordering all water courses and lakes larger than 100 m^2 [12]. The new Agriculture and Environment Package (some details of which are still under development) will target measures according to i) site-specific estimates of the proportion of nitrate leaching from the root zone that reaches specified inshore waters, and ii) the target for nitrogen loading for that specified inshore water. This means that farmers will be faced with different demands, depending on the water catchment area in which their farm is located, the nitrate reduction target for that catchment, the soil type and extent to which denitrification removes nitrogen as it drains from the land and passes through the aquatic ecosystem to the inshore waters.

Table 1 Danish agricultural nitrogen policy timeline with main targets [5, 13, 14]

Policy	Main targets
NPo Action Plan (NPo) (from 1985)	Reduction in nitrogen- and phosphorous-pollution
The First Action Plan for the Aquatic Environment (AP-I) (from 1987)	Halve nitrogen-losses and reduce phosphorous-losses by 80%
Action Plan for a Sustainable Agriculture (AP-Sust) (from 1991)	Reduce nitrogen-losses from agricultural fields by 100 kt nitrogen

Policy	Main targets
The Second Action Plan for the Aquatic Environment (AP-II) (1998-2003)	Reduce nitrate losses by 62%
Ammonia Action Plan (Ammonia AP) (from 2001)	Reduce ammonia emissions by 33%
The Third Action Plan for the Aquatic Environment (AP-III)[15] (2005-2015)	Reduce nitrogen-leaching by further 13% and reduce excess phosphorous by 50% by 2015
Green Growth Action Plan (GG AP)[16] (2010-2020)	Reduce nitrate losses by 1/3, reductions in ammonia and GHG emissions and pesticides losses, increasing biodiversity by increase organic food production
Agriculture and Environment Package (AEP) (from 2016)	Reduce nitrate leaching from about 57 to 42 kt nitrogen/y by 2021 whilst allowing farmers to apply more nitrogen than at present

Between the mid-1980s and early 2010s nitrogen use efficiency of Denmark has doubled (from 20% to 40%), nitrogen use dropped by 1/3, with similar decrease in nitrogen load to coastal waters. Ammonia emissions from agriculture and ammonia deposition got reduced by 30% and 20-25%, respectively, while N_2O emissions (though not targeted) decreased by 35%. The upward trend in groundwater and drinking water nitrate concentrations has been reversed, though the improvements in that respect are not as clear as for other effects[5]. Latest measurements show that nitrate leaching appears to have been increasing slightly over the past three years, even after correcting for variations in precipitation, although the increase is still within the margin of uncertainty of the measurements[17].

Timescale of implementation

The implementation of nitrogen policies now spans for three decades in Denmark, with seven Action Plans (APs) each spanning 3-10 years and partially building on each other. Usually the programmes followed one another and had midpoint evaluation, where additional action could have been taken if progress was insufficient. The programmes are normally negotiated across the political spectrum, with an attempt to get broad backing. That way, the programmes survive changes in governments.

The main target within the AEP is reducing the nitrate leaching to 42 kt nitrogen/y by 2021, as this has been agreed with the EU Commission in connection with the WFD. To achieve the required reduction in nitrate leaching despite the increased nitrogen quota, the government will subsidise a number of measures, primarily taking land out of agriculture (into forestry or restored wetlands) or applying end of the pipe solutions (e.g. mini wetland denitrification areas, mussel farming). These measures (still under development) would all be voluntary, although the government retained the right to impose measures if the uptake was insufficient to meet targets. However, the EU Commission intervened since it was not convinced that the measures envisaged would enable Denmark to comply with the WFD, and threatened to remove the derogation for cattle farmers (230 kg nitrogen/ha in manure, not the usual 170) and take the Danish government to the EU court. The Danish government finally made cover cropping compulsory (with financial compensation) in the most sensitive catchments.

Communication

The initial regulatory measures from the 1980s onward (mainly controlling stocking density and slurry spreading) were successful and effective because they were aligned with farmers' economic interests; the low utilisation of manure nutrients and the high synthetic nitrogen application rates were offering the potential for cheap and beneficial changes: "farmers associations from the very start supported the development, test and implementation of new low-emission technologies for manure management and for application"[5]. At that time the inter-farm variation in nitrogen efficiencies were very high, thus it's likely that the regulatory measures mostly affected the farms which had not embarked on the voluntary action route. (Nevertheless, opposition views from the farmers were also present, arguing that agriculture had no role in aquatic pollution.) Additionally to the regulations, the farms received tax subsidies for capital investments on the farm.

Over the years there was a constructive discussion between the governments and the industry concerning the best way for environmental objectives to be achieved. In general, the policy decisions considered the economic aspects of the measures, not only promoting the most cost-effective solutions but also investing in reducing the costs the farmers had to bear[5]. The pressure to increase the utilisation of nitrogen in manure and reduce nitrogen losses has encouraged the development of practical measures such as trailing hose slurry application, phase feeding of livestock (where the protein content is adjusted over the lifetime of the animal) and acidification of slurry in housing or prior to application. The pressure to reduce nitrogen pollution has been increasing in all EU countries and because Denmark was one of the pioneers in this area their support industries are now in a good position to sell their technologies into markets outside Denmark[18].

The government – industry dialogue tended to break down in the period after 2000, due to increased costs of compliance. The government attempted to revive the dialogue by establishing a Nature and Agriculture Commission, which reported in 2013[19]. Although its recommendations were generally welcomed, increased pressure on farmers, including market and financial difficulties, led to the formation of a breakaway group from the Danish farmers' association[20]. This breakaway group has an over-representation of farmers with larger farms, so the members of this group control about half the agricultural land in Denmark. This group is highly critical of all aspects of the environmental legislative system and has waged a high profile campaign in the media and through the justice system. Their activities have led the established Danish farmers' association to take a more critical stance on environmental issues.

The recent AEP was developed by the minority Liberal government, with the help of a number of other centre-right political parties. The Liberal party has its roots in the farming communities of Denmark and was keen to improve the economic situation for agriculture. At the time, agriculture was under pressure from the collapse in milk prices and the effects of the Russian embargo on the import of agricultural products from the EU. The breakaway farmers' association had close connections with the Food, Agriculture and Environment minister at the time, and made a significant input to policy formation. Aarhus University (AU) has an agreement with the government to provide independent scientific advice concerning agriculture and the environment, and was asked to assess the environmental consequences of the change in policy. The Ministry chose to present the results of this assessment in a way that AU could not support but AU was initially prevented by the confidentiality clause in its agreement from speaking publically about this matter. However, the Danish parliament initiated an investigation and the Minister was obliged to resign.

The AEP was publicised via the usual news media and the details were communicated to the farmers' organisations. In these latest policy developments the move towards more targeted regulation was generally welcomed but the increases in permissible plant available nitrogen application and the decision to transfer the cost of pollution abatement measures from the agricultural industry to the taxpayer were and are contentious.

The public is mostly supportive of moving towards sustainable agriculture: the most recent Eurobarometer survey found that Danes consider the two main priorities of farming to be protecting the environment and ensuring the welfare of animals. 61% of Danes (compared to 43% of EU-28) think that the EU should ensure a sustainable way to produce food.[21]

Context-specific factors

The initial regulatory policies were largely supported by the farmers as they were aligned with their economic incentives and were actually reinforcing a trend in voluntary action. Recently the increasingly stringent nitrogen regulations highlighted the trade-offs between nitrogen efficiency improvement and farm profitability. The balance was disturbed by increased financial and eventual political pressures for a relaxation of the quota. The relaxation of input control and introduction of end-of-pipe solutions might also result in trading off other environmental gains (notably N_2O mitigation and groundwater quality) with the new AP.

The policies since 1985 have worked for a number of reasons. The Danish governments have been working on building a consensus, both across the political spectrum and with stakeholders. On the technical side, the key factors in nitrogen pollution (livestock numbers and fertiliser use) are monitored on a farm-by-farm basis via nitrogen planning and obligatory farm-scale reports from slaughterhouses and fertiliser suppliers.

Unlike the damage caused by GHG emissions, most nitrogen pollution is highly location specific; extensive modelling and measurement capacities have enabled the consideration of this factor in the policies leading to the current development of some site specific regulations.

The different type of policies can have synergistic effects on each other. For example, the strict nitrogen quota have driven the uptake and further development of manure storage and fertiliser spreading technologies and had increased the market value of manure beyond the increasingly strict obligatory minimum rates of fertiliser substitution rates of manure[5,22]. Similarly, the stocking density and minimum land requirements prevented very high livestock concentrations, avoiding the situation occurring in the Netherlands where manure transport and market need to be strictly monitored to ensure compliance with manure spreading regulations[5].

Though the climate of Denmark and Scotland are not very different, geographical constraints led to less intensive agricultural production in Scotland than in Denmark, where a higher proportion of intensive livestock farms requires imported feed, housing and manure management (see Appendix 2). The higher intensity and the different soil structure brought about more severe nitrogen problems in Denmark, while the higher proportion of capital-intensive farming (i.e. dairy and pig production) reduced barriers in the uptake of technology intensive solutions. Overall, though policy and technological solutions used in Denmark might not be suitable to all areas and farm types in Scotland, they could be relevant particularly to more intensive agricultural areas.

Conclusions

- Water and air pollution concerns have been driving agricultural nitrogen (and phosphorous) policies in Denmark for 30 years, resulting in considerable improvements in nitrogen utilisation and synergistic effects on N_2O emissions
- Cross-party agreement and dialogue between the governments and the industry underpinned policy development for three decades, though the progress has been recently reversed due to a combination of agro-economic and political factors when external market and financial impacts gave profitability and viability increased importance, with environmental regulations (particularly the nitrogen quota) seen as a restriction

- Comprehensive data from multiple sources on livestock numbers and nitrogen use, along with wide ranging measurements of nitrogen compounds in the aquatic environment and air, provide quantitative basis for monitoring and policy development
- All nitrogen sources on farm have been targeted, including synthetic nitrogen, manure nitrogen and nitrogen in livestock feed; particularly the reducing nitrogen quotas creating a strong incentive for technological improvement in manure nitrogen utilisation
- Technological development in livestock housing and manure management achieved in Denmark ahead of most other European countries allowed the supporting industries to become provider of these solutions internationally
- Regulatory approaches worked well while efficiency savings and technology improvements could support farmers complying at a low cost (or actually generating savings)

Appendix 1: Details of the Danish policy

The main elements of the policy regarding nitrogen are the following:

- Obligatory nitrogen management planning and nitrogen application records on farms
- Field level obligatory quotas for nitrogen application (depending on soil, climate, previous and actual crop choices, and location considering marine pollution potential)
- Obligatory catch crops in areas sensitive to groundwater contamination
- Financially subsidised, voluntary uptake of nitrogen leaching reducing measures (e.g. artificial wetlands); the suite of measures is location specific
- Slurry storage and spreading regulations (obligatory slurry store covers, obligatory use of slurry injection or immediate incorporation on bare soils, use of low-emission technologies on grassland and cropped land)
- Stocking density regulations; the farmer must own or rent sufficient land to efficiently utilise the manure from their livestock (exporting manure is permitted, provided they have a written agreement with the recipient farm)
- Information provision on low nitrogen excretion livestock feeding, coupled with allowance for increased stocking rates if the farmer can prove that the nitrogen content of the feed is below the standard value for their livestock
- Wetland rehabilitation and afforestation

The history of the most important nitrogen related elements of the Action Plans is detailed in Table 2.

Table 2 Some details of the Danish agricultural nitrogen policy packages elements[5, 13, 14]

Policy	Elements
NPo Action Plan	· Max. 2 livestock unit/ha stocking density · Autumn ban on slurry spreading · Manure storage measures
The First Action Plan for the Aquatic Environment	· Minimum 9 months slurry storage capacity · Mandatory fertiliser and crop rotation plans · Minimum winter crop cover
Action Plan for a Sustainable Agriculture	· Nitrogen quota introduced (at economic optimum[23]) · Extended ban on slurry spreading · Statutory norms on plant-available nitrogen in manure
The Second Action Plan for the Aquatic Environment	· Nitrogen quota 10% below economic optimum · Max. 1.7 livestock unit/ha stocking density · Subsidies to artificial wetlands and afforestation · Minimum catch crop planting
Ammonia Action Plan	· Animal housing and manure storage subsidies · Ban on broadcast spreading of slurry · Increased minimum catch crop planting
The Third Action Plan for the Aquatic Environment	· Closely related to WFD and HD · Further increase in minimum catch crop planting · Stricter statutory norms on plant-available nitrogen in manure · Tax on mineral phosphorous in livestock feed · Further wetland areas and afforestation

Policy	Elements
Green Growth Action Plan	· Nitrogen quota 15% below economic optimum · Promotion of optimised feed practice · Further buffer zones
Agriculture and Environment Package	· Nitrogen quota at economic optimum · Subsidies for end-of-pipe nitrate leaching solutions

Appendix 2: Brief comparison of Danish and Scottish agriculture

The similarities between Scotland and Denmark are the climate (mild, damp) and population (5.4 and 5.6 m for Scotland and Denmark respectively). Scotland has a bigger land area (7.8 *vs* 4.3 m ha in Denmark) and a higher share of cultivated land (71% and 61%, respectively). In Denmark dairy cattle and pig are the dominant livestock (dairy cattle Scotland: 176 000, DK: 582 000; pigs Scotland: 318 000, DK: 12 m) while in Scotland beef cattle and sheep stocks are higher (sheep Scotland: 6.7 m, DK: 151 000; beef cows Scotland: 437 000, DK: 97 000) due to the larger proportion of rough grazing in Scotland (50% and 1.4% of agricultural area in Scotland and Denmark, respectively). Average holding sizes are slightly smaller in Denmark than in Scotland (67 ha *vs* 106 ha), the employment in the sector is 2.5% in both countries, and contribution to exports is 17% in Denmark and Scotland too (including whisky exports). Agriculture contributes to 1.6% of gross value added in Denmark and 0.6% in Scotland.[xxiv]

The severity of nitrogen related problems are different in the two countries. A comparison of the United Kingdom, Denmark and EU-15 average shows that Denmark has a substantially higher nitrogen input rate, gross nitrogen balance and nitrogen emission rate than the UK and the EU-15 average (Figure 1, Figure 2, Figure 3). Nevertheless, reductions in these rates have been higher in Denmark than in the UK and the EU-15.

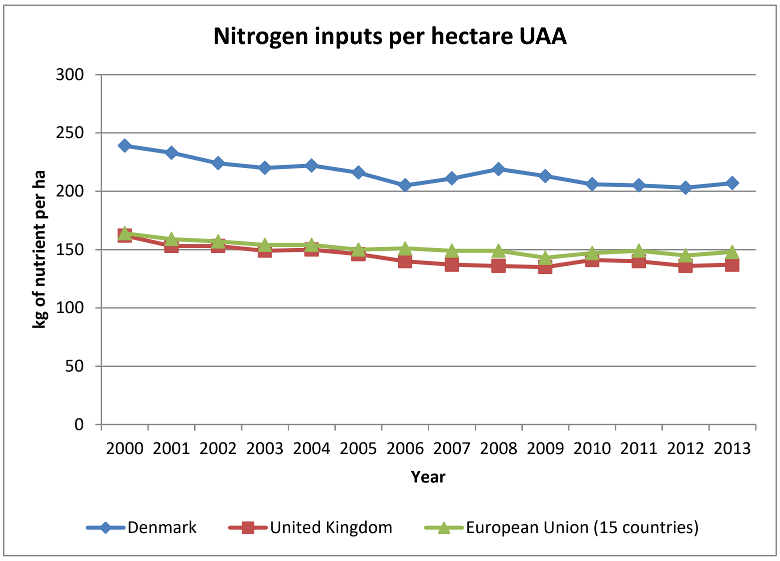

Figure 1 Nitrogen inputs per hectare in Denmark, United Kingdom and EU-15[4]

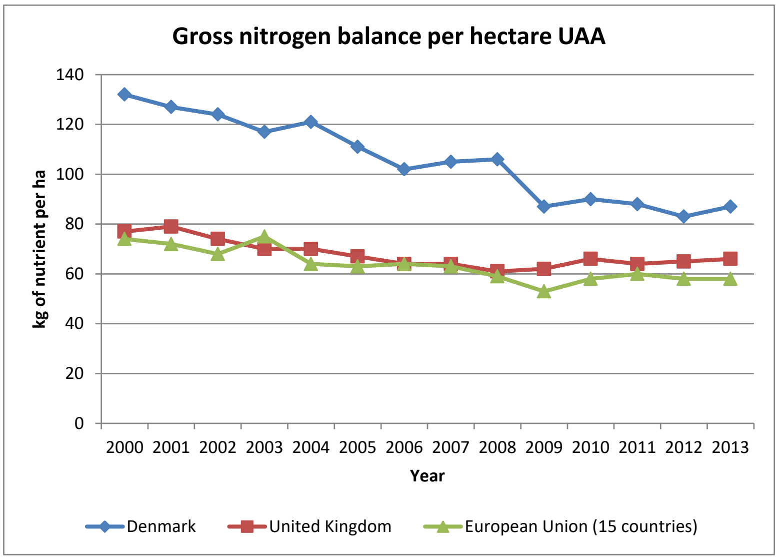

Figure 2 Gross nitrogen balance per hectare in Denmark, United Kingdom and EU-15[4]

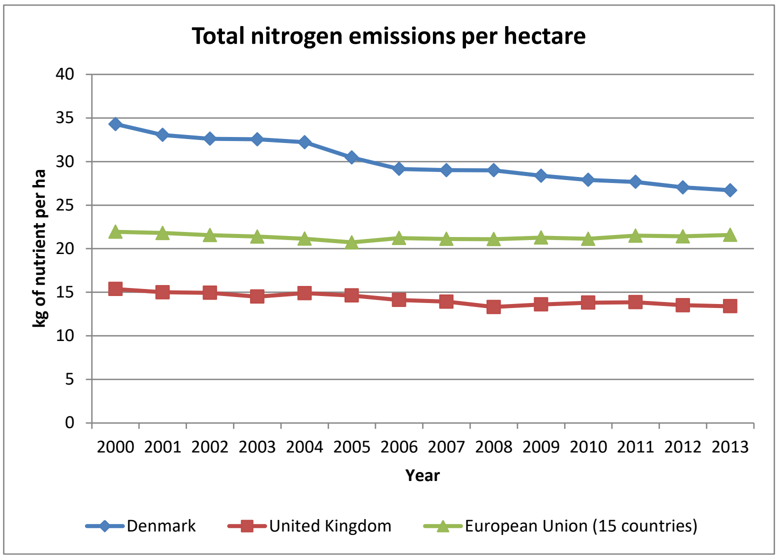

Figure 3 Total nitrogen emissions per hectare in Denmark, United Kingdom and EU-15[4]

[1] Eurostat: Greenhouse gas emissions, EU-28, 2012. URL: http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Greenhouse_gas_emissions,_EU-28,_2012.png [Accessed 10.03.17]

[2] Frelih-Larsen, A., MacLeod, M., Osterburg, B., Eory, V., Dooley, E., Katsch, S., Naumann, S., Rees, R. M., Tarsitano, D., Topp, C. F. E., Wolff, A., Metayer, N., Molnar, A., Povellato, A., Bochu, J. L., Lasorella, M. V. and Lonhitano, D. (2014) Mainstreaming climate change into rural development policy post 2013, Ecologic Institute, Berlin. URL: http://bookshop.europa.eu/en/mainstreaming-climate-change-into-rural-development-policy-post-2013-pbML0614002/ [Accessed 10.03.17];

Martinau, H., Wiltshire, J., Webb, J., Hart, K., Keenleyside, C., Baldock, D., Bell, H. and Watterson, J. (2016) Effective performance of tools for climate action policy - meta-review of Common Agricultural Policy (CAP) mainstreaming, Report No 340202/2014/688088/SER/CLIMA.A.2, URL: https://ec.europa.eu/clima/sites/clima/files/forests/lulucf/docs/cap_mainstreaming_en.pdf [Accessed 10.03.17]

[3] European Commission: 2030 climate & energy framework URL: https://ec.europa.eu/clima/policies/strategies/2030_en [Accessed 10.03.17]

[4] Eurostat (2016) Agri-environmental indicators URL: http://ec.europa.eu/eurostat/data/database [Accessed 16.03.17]

[5] Dalgaard, T., Hansen, B., Hasler, B., Hertel, O., Hutchings, N. J., Jacobsen, B. H., Jensen, L. S., Kronvang, B., Olesen, J., Schjorring, J. K., Kristensen, I. S., Graversgaard, M., Termansen, M. and Vejre, H. (2014) Policies for agricultural nitrogen management - trends, challenges and prospects for improved efficiency in Denmark. Environmental Research Letters 9, 115002. URL: http://iopscience.iop.org/article/10.1088/1748-9326/9/11/115002/meta [Accessed 10.03.17]

[6] European Commission: The Nitrates Directive. URL: http://ec.europa.eu/environment/water/water-nitrates/index_en.html [Accessed 10.03.17]

[7] European Commission: The EU Water Framework Directive - integrated river basin management for Europe. URL: http://ec.europa.eu/environment/water/water-framework/index_en.html [Accessed 10.03.17]

[8] European Commission: The Habitats Directive. URL: http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm [Accessed 10.03.17]

[9] European Environment Agency: National Emission Ceilings Directive. URL: http://www.eea.europa.eu/themes/air/national-emission-ceilings [Accessed 10.03.17]

[10] Danish Government (2013) Danish climate policy plan towards a low carbon society. URL: https://biobs.jrc.ec.europa.eu/policy/danish-climate-policy-plan-towards-low-carbon-society [Accessed 10.03.17]

[11] Danish Government (2013) Catalogue of Danish climate change mitigation measures - Reduction potentials and costs of climate change mitigation measures.URL: https://ens.dk/en/our-services/projections-and-models/climate-change-mitigation-measures [Accessed 10.03.17]

[12] Danish Environmental Protection Agency: Groundwater and surface water. URL: http://eng.mst.dk/topics/pesticides/reducing-the-impact-on-the-environment/initiatives-under-the-green-growth-action-plan/groundwater-and-surface-water/ [Accessed 10.03.17]

[13] Danish Environmental Protection Agency: Overview of APAEs and the Green Growth Agreement. URL: http://eng.mst.dk/media/mst/69160/Overview%20of%20APAEs%20and%20the%20Green%20Growth%20Agreement.pdf [Accessed 10.03.17]

[14] Kronvang, B., Andersen, H. E., Børgesen, C., Dalgaard, T., Larsen, S., Bøgestrand, J. and Blicher-Mathiasen, G. (2008) Effects of policy measures implemented in Denmark on nitrogen pollution of the aquatic environment. Environmental Science & Policy 11, 144-152. URL: http://www.sciencedirect.com/science/article/pii/S1462901107001219 [Accessed 10.03.17]

[15] Danish Government (2004) Agreement on the Action Plan for the Aquatic Environment III 2005-2015 between the Danish Government, the Danish People's Party and the Christian Democrats. URL: http://en.mfvm.dk/fileadmin/user_upload/Agreement_on_actionplan.pdf [Accessed 10.03.17]

[16] Danish Government (2009) Agreement on Green Growth URL: http://eng.mst.dk/media/mst/69152/Danish%20Agreement%20on%20Green%20Growth_300909.pdf [Accessed 10.03.17]

[17] Aarhus University (2016) Aquatic Environment and Nature 2015, National Centre for Environment and Energy Report nr 211, 60pp (In Danish)

[18] Hutchings, N. J. (2014) A nitrogen budget for Denmark; developments between 1990 and 2010, and prospects for the future. Environmental Research Letters 9, 115012. URL: iopscience.iop.org/article/10.1088/1748-9326/9/11/115012/pdf [Accessed 10.03.17]

[19] Nature and Agriculture Commission (2013) Natur og Landbrug - en ny start (Nature and Agriculture – a new start). URL: http://www.naturoglandbrug.dk/Admin/Public/DWSDownload.aspx?File=%2fFiles%2fFiler%2fNLKOM%2fSlutrapport%2f3621_NaturLandKomm_Slutrapport_1104_Links.pdf [Accessed 10.03.17] (in Danish)

[20] http://baeredygtigtlandbrug.dk/ [Accessed 10.03.17] (in Danish)

[21] European Commission (2016) Special Eurobarometer 440 Report: Europeans, Agriculture and the CAP. Report No 2015.6936, URL: http://ec.europa.eu/COMMFrontOffice/publicopinion/index.cfm/Survey/getSurveyDetail/instruments/SPECIAL/surveyKy/2087 [Accessed 10.03.17]

[22] Fertiliser substitution rate tells how much synthetic N does the manure N worth (it is less than 100%)

[23] The economic optimum N application rate for a crop depends on the variety (higher yielding varieties normally requiring more N) and on the relative price of N and grain

[xxiv] European Commission: Denmark – CAP in your country. URL: ec.europa.eu/agriculture/cap-in-your-country/pdf/dk_en.pdf [Accessed 10.03.17],

Danish Agriculture and Food Council (2014) Facts and figures – Danish agriculture and food 2014. URL: https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjc3be72cvSAhUIJMAKHVI5AI4QFggjMAA&url=http%3A%2F%2Fwww.agricultureandfood.dk%2F~%2Fmedia%2Flf%2Ftal-og-analyser%2Faarsstatistikker%2Ffakta-om-erhvervet%2F2014%2Ffacts-and-figures%2Ffacts-and-figures-2015.pdf&usg=AFQjCNGeElb0AwzWtEdHNWUHqtS0WigDPQ&cad=rja [Accessed 10.03.17],

Scottish Government: Agricultural land use in Scotland. URL: http://www.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/agritopics/LandUseAll [Accessed 10.03.17],

Scottish Government: Agriculture Facts and Figures 2016. URL: http://www.gov.scot/Publications/2016/06/5018/downloads [Accessed 10.03.17],

Scottish Government: Export Statistics Scotland 2015. URL: http://www.gov.scot/Topics/Statistics/Browse/Economy/Exports/ESSPublication [Accessed 10.03.17]