Agricultural policy objectives on productivity, climate change adaptation and mitigation

Policy assessment for the Netherlands

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This paper offers a systematic overview of policies that may cause synergies and trade-offs between agricultural policy objectives on productivity, climate change adaptation and mitigation for the Netherlands. Implementation of the climate policy is to a large extent based on voluntary agreements with the private sector, but supported by regulations, subsidies, tax incentives, emissions trade, extension services and demonstration projects. Synergies between objectives are exploited through policy different programmes including public private partnerships (PPP) at different institutional levels.

Key words: Agricultural policy, the Netherlands, productivity, climate change, adaptation, mitigation, synergies and trade-offs

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Summary

Key socio-economic and climate trends for 2050 show more frequent water shortages for agriculture as a result of climate changes, salinisation and socio-economic developments. The Ministry of Economic affairs asked for a systematic overview of policies that may cause synergies and trade-offs between agricultural policy objectives on productivity, climate change adaptation and mitigation for the Netherlands. The emission of greenhouse gases from agriculture showed a 21.5% decline between 1990 and 2014, from 32.8 million tonnes of CO_2 equivalents in 1990 to 26.3 million tonnes of CO_2 equivalents in 2014. The Dutch government approaches climate, energy and sustainability related policies as a challenge or opportunity rather than a threat to productivity. Implementation of the climate policy is to a large extent based on voluntary agreements with the private sector, but supported by regulations, subsidies, tax incentives, emissions trade, extension services and demonstration projects. Synergies between objectives are exploited through policy programmes including public private partnerships (PPP) at different institutional levels. On-the-ground initiatives for adaptation and innovation create synergies as well between innovation and adaptation/mitigation (e.g. New Cultivation Concept (NCC) in greenhouse horticulture and the Sustainable Dairy chain initiative).

The case study presents a top-down and a bottom-up approach. Within the top-down approach relevant Dutch institutions are identified and institutional coherence challenges are presented; relevant policies within and beyond the agricultural sector are identified; and policy effects in terms of generating synergies or trade-offs between the three objectives are described. Within the bottom-up approach, on-the-ground initiatives involving both synergies and trade-offs between the three objectives are identified in terms of how these initiatives can potentially inform policy design and implementation.

Reading Guide

1. This background paper offers a systematic overview of policies that may cause synergies and trade-offs between agricultural policy objectives on productivity, climate change adaptation and mitigation for the Netherlands. The case study follows the structure of the policy assessment framework as outlined by OECD in 'Synergies and Trade-offs between Agricultural Productivity, Climate Change Adaptation and Mitigation: Dutch Case Study' document (COM/TAD/CA/ENV/EPOC (2015)).

2. The case study presents a top-down and a bottom-up approach. Within the top-down approach relevant Dutch institutions are identified and institutional coherence challenges are presented; relevant policies within and beyond the agricultural sector are identified; and policy effects in terms of generating synergies or trade-offs between the three objectives are described. Within the bottom-up approach, on-the-ground initiatives involving both synergies and trade-offs between the three objectives are identified in terms of how these initiatives can potentially inform policy design and implementation.

3. This paper is structured as follows. First, key socio-economic and climate trends in Dutch agriculture are presented in Chapter 1. The second chapter, on policy goals, discusses the role of the three policy objectives within the policy making process. Chapter 3 gives an overview of the institutional coherence challenges. Chapter 4 identifies policies that potentially generate synergies and trade-offs within and across the three objectives. Finally, Chapter 5 shows examples of initiatives on the ground and presents how they could inform policy design and implementation.

1 Characteristics of Dutch agriculture

4. **The Netherlands has an open economy, with a very significant level of trade with other countries** (Ministry of Foreign Affairs, 2015). According to research carried out by the Netherlands Bureau for Economic Policy Analysis, the Netherlands earns about 33% of its income from the export of goods and services. In 2014, the value of exports amounted to 83.2% of the Netherlands' GDP. The Netherlands is located in north-western Europe and is bordered by the North Sea to the north and west, Belgium to the south and Germany to the east (see Reinhard and Folmer, 2009). The Netherlands covers 37.354 square kilometres and is partly sub-sea level. The Netherlands is densely populated with more than 16.8 million inhabitants, or 449.9 people per square kilometre of land. The country is known for its polders (sea defences and dikes) and agricultural products (bulbs, potatoes, cheese and seeds). The country has an international profile and is a member of the European Union (EU), the Organisation for Economic Co-operation and Development (OECD), has signed the Kyoto Protocol, and more recently the Paris Agreement (2015). The Netherlands is divided into 12 administrative regions, called provinces. All provinces are divided into municipalities. The country is also subdivided into water districts, of which 22 existed as of 1 September 2016. The water districts are governed by water boards, which have authority over regional and local water management.

5. **The Dutch agricultural sector is competitive compared with other countries due to its high productivity, knowledge level, the organisation and cooperation within the agro-complex, and natural and geographical conditions**
The Dutch agricultural complex includes agriculture and related trade and industry. Yields of the main arable crops, vegetables and flowers, as well as from dairy production are among the highest in the world (Wageningen UR, 2008), although productivity growth has slowed in recent decades. Depending on crops, potential explanations for slower production growth are soil quality, cost reductions, and restrictions in fertilisation. The average yield per hectare between 2009 and 2014 for potatoes, sugar beet and cereals were 45.7 tonnes/ha, 80.3 tonnes/ha, and 8.8 tonnes/ha, respectively (Statistics Netherlands, 2015). Dutch farmers use a high level of fertilisers and plant protection products (75% of the agricultural land is classified as high input per hectare, compared to an overall average of 26% in EU-28 as a whole). The Dutch agricultural sector is also vulnerable to the demands of society (environment, animal welfare, etc.) with respect to production methods and the resulting products. Furthermore, the sector operates in a prosperous and densely-populated country. This means that wage levels and cost of land are fairly high. The Dutch agricultural sector is highly competitive on international markets, exporting high-quality agricultural products (e.g. ornamental plants, dairy, meat and vegetables), and expertise on sustainable production systems. About 10% of the Dutch employment is in the agricultural-complex, i.e. agriculture including the processing industry and distribution (600,000 FTE in 2013; LEI, 2015). The complex has an added value of 48 billion euros (8.3% of GDP in 2013; LEI, 2015) and it is export driven (export value: 75 billion euros or 19% of total export value).

6. **A large part of the Netherlands was created by river and sea sediments that were deposited in the delta of four European rivers: the Rhine, Meuse, Scheldt and Ems**
Thus it can be characterised as a delta area, with more than 75% of its water coming into the Netherlands from rivers that cross national borders (Reinhard and Folmer, 2009). As a 'low country', the Netherlands is vulnerable to sea level rise and flooding. Climate change will increasingly pose a threat to the supply of fresh water. However, given the relative beneficial competitive edge of the Dutch delta compared with other agricultural areas in Europe, it will also create opportunities for the Dutch agricultural sector. In the event of excessive rainfall, the regional system drains into the main system, while the regional system can be fed by the main system in periods of drought (e.g. for irrigation purposes). In low-lying parts of the Netherlands, the water that enters the system has a variety of functions, the most important of which is maintaining the water level to prevent subsidence of peat bogs. In addition, flushing is used to guarantee good water quality. In higher areas, the water

is supplied primarily for irrigation purposes (Arnold et al., 2011). However, the impact of climate change remains uncertain (Stoorvogel, 2009).

7. **Key socio-economic and climate trends for 2050 show more frequent water shortages for agriculture as a result of climate change, salinisation and socio-economic developments** (Ministry of Infrastructure and the Environment/Ministry of Economic affairs, 2014, Polman et al., 2012 and Bruggeman et al., 2013). Water demand and supply are diverging more and more and users place higher demands on the system in case of socio-economic growth and/or rapid climate change (Ministry of Infrastructure and the Environment/Ministry of Economic Affairs, 2013). Agriculture is subject to major changes, with very diverse results at the regional level. The intensity and quantity of precipitation in the coastal region in the summer will increase compared to inland areas. The likelihood that a period of excessive rainfall coinciding with a persistent stormy period increases. This affects the probability of a flood and hampers discharging excessive water. Climate change also directly and indirectly affects the soil subsidence in peatlands and may influence agricultural production. On the other hand, elevated sandy soils are sensitive to draughts as their capacity to retain water is limited (over 60% of the is irrigated, mainly using groundwater) (Ministry of Infrastructure and the Environment/Ministry of Economic affairs, 2013).

8. **Climate change for Dutch agriculture may have positive and negative effects**
Positive effects include higher productivity for some crops, opportunities to cultivate new crops, and lower energy bills in greenhouse horticulture (see Franken et al., 2013). Higher temperatures and CO_2 concentration and a longer growing season are likely to increase further agricultural productivity. Especially the yield of sugar beet may rise sharply, but the average yield increase in potato is minimal (Schaap et al., 2014). On the other hand, loss of yield can result from too much water (flooding), too little water (droughts) and changes in the distribution, frequency and intensity of fungal diseases, insect pests and weeds. Particularly, risks of climate extremes, pests and diseases are high for potatoes and onions (Schaap et al., 2014). Schaap et al. (2014) shows argues that climate risks are relatively small in horticulture, but by the intensity of cultivation, they can still cause a lot of damage. The increase in the number of hot days can lead to lower grass yields. To a certain extent heat can also affect milk production (lower feed uptake), but this effect will not be very large. Finally, climate change may cause an increased risk of pests and diseases in animal husbandry (Schaap et al., 2014).

9. **Dutch agriculture will become more vulnerable, due to increasing risks of salinisation and drought** Farmers located in areas where salinisation is apparent during dry years, are limited in their capacity to adapt because of confined availability to use fresh sprinkle water due to salinisation of available water resources. Vulnerability differs from region to region, depending on altitude and soil type. During long periods without rainfall, freshwater can become scarce in the Netherlands. Shortages are expected to occur more often in the future. The production of intensive cultivations, such as greenhouse farming, will be further decoupled from the regional water system making those systems less dependent on climate change, but expectations are that it will not be fully decoupled. Precision farming has the potential to reduce use of resources (water, fertilisers, agro-chemicals, energy) in agriculture and to increase crop yields and quality (see research programme 'Towards Precision Agriculture 2.0). Environmental and climate impacts of agriculture will decline due to precision agriculture. Research indicates that precision soil cultivation in agriculture using GPS can considerably reduce N_2O emissions (Ministry of Infrastructure and the Environment et al., 2015).

10. **The emission of greenhouse gases from agriculture showed a 21.5% decline between 1990 and 2014**, from 32.8 million tonnes of CO_2 equivalents in 1990 to 26.3 million tonnes of CO_2 equivalents in 2014 (see Figure 1). In this period, N_2O declined with 42% and CH_4 (methane) with 16%. Decreasing N_2O and CH_4 emissions were the result of increasing efficiency and decreasing pork production resulting from an increasingly strict manure policy (Grontmij Nederland B.V., 2014). From 1990 onwards, also CH_4 emissions from dairy farming decreased due to restricting milk quota and an increase of milk production per cow (Grontmij Nederland B.V., 2014). After 2007, GHG emissions have been increasing slightly due to a growing dairy cattle sector, because milk quotas became less binding. Increased milk production per cow and feeding strategies lead to a (potentially) decrease in GHG per kg milk produced (see for instance Middelaar, 2014 on different feeding strategies). The contraction of the pig population by stricter manure policy in recent years has contributed to the

reduction of methane. Increased methane slip in the use of cogeneration has made this reduction largely undone. The greatest decline in greenhouse gas emissions has been achieved with nitrous oxide (N_2O). As a result of Dutch manure policy, nitrogen inputs to soils have fallen. Reduced and more sophisticated application of both manure and artificial fertiliser has led to a 35% reduction in N_2O emissions. Total CO_2 emissions in agriculture have decreased by 25% since 1990, mainly due to a decrease in gas consumption for stationary combustion as a result of various energy conservation measures (see National Institute for Public Health and the Environment, 2015).

11. **In greenhouse horticulture, the surface area of heated greenhouses has increased but their energy consumption has been reduced**

In greenhouse horticulture, total CO_2 emissions are below the target for 2020 and below the level for 1990 (Van der Velden and Smit, 2015). Between 2010 and 2014, total CO_2 emissions fell by 2.4 million tonnes. When the external temperature is taken into account this works out at 1.8 million tonnes. Ninety-one per cent of this recent result can be explained by area shrinkage, lower electricity sales and the growth of sustainable energy. These are fundamental factors whose influence is reflected in the downward trend in CO_2 emissions during this period. Part of the CO_2 emissions from the agricultural sector consists of emissions from cogeneration facilities (combined heat and power; CHP), which may also provide electricity to the national grid (National Institute for Public Health and the Environment, 2015). In 2014, the electricity production from CHP generators in horticulture equates to 9% of national consumption (Van der Velden and Smit, 2015).

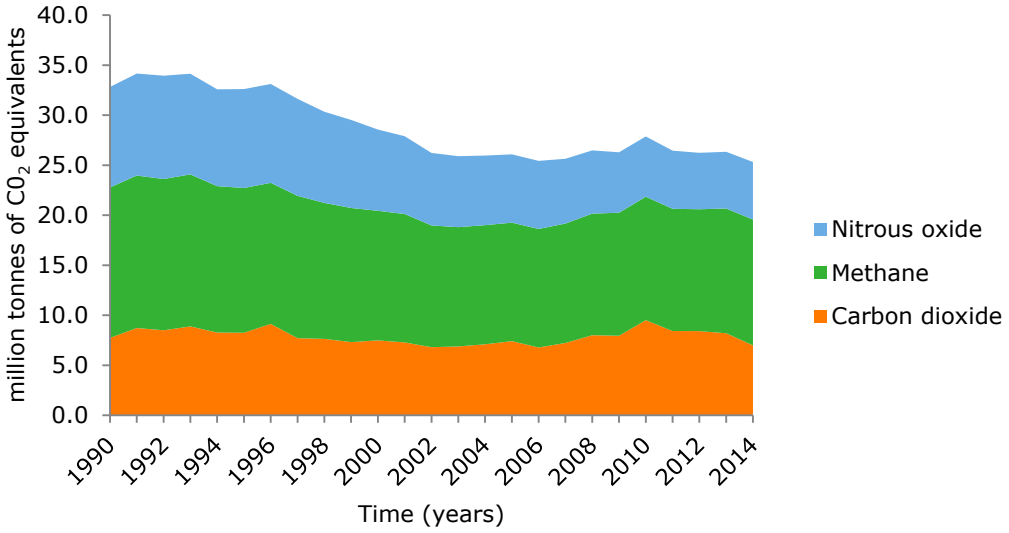

Figure 1 *GHG emissions Dutch agriculture (1990-2014)*
Source: Pollutant Release and Transfer (Register/CBS,PBL and Wageningen UR, 2016)

12. **The number of horticultural companies using sustainable energy is increasing (e.g. geothermal heat and biofuels**; Van der Velden and Smit, 2014). The greenhouse sector in the Netherlands is a major user of gas and electricity (85% of total energy use agricultural sector; SER, 2013). Energy represents 20% to 25% of production costs. Improving energy efficiency is important for the need to produce less CO_2 and other environmental issues (see Mourits et al., 2014). Greenhouse horticulture is working on a transition programme towards 2020 on energy ('Greenhouse as a Source of Energy', in Dutch: 'Kas als Energiebron'). The programme is a public-private partnership (PPP) launched in 2005, which includes the Dutch Federation of Agriculture and Horticulture (LTO Glaskracht Nederland) and the Dutch Ministry of Economic Affairs. The objective is that new greenhouses are energy neutral and economically viable.

13. **CO_2 emissions from decomposition of organic carbon in drained peat soils contribute strongly to GHGs balance of the Netherlands**

Most peat lands in The Netherlands are in agricultural use, mainly as pasture land (Hendriks et al., 2007). The agricultural use requires drainage and fertilisation of the peat soil. Due to peat oxidation the soil surface subsides and greenhouse gases (GHG) carbon dioxide (CO_2) and nitrous oxide (N_2O) are emitted to the atmosphere (see Hendriks et al., 2007). Current policies focus on water management and maintaining water levels. So far, there is only a reporting requirement for CO_2 emissions from agriculturally used peatlands (see National Institute for Public Health and the Environment, 2014 / Ministry of Infrastructure and the Environment, 2014). After 2020, it seems more likely that land use-related emissions (peatlands and forests) will be taken into account. Possibly, systems comparable to ETS will be developed for peatlands or forests to stimulate mitigation (Ministry of Infrastructure and the Environment, 2013).

2 Integration and prioritisation of policy objectives

14. **The Netherlands is party to several international climate agreements among which United Nations Framework Convention on Climate Change (1992) and the Kyoto Protocol (1997) and most recently the Paris Agreement (2015)** and thus has committed itself to stabilise 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. Under the Kyoto Protocol the Netherlands committed itself to reduce GHG-emissions by 6% by 2010 in the 1st Kyoto Commitment Period (2008-2012) as compared to 1990. This reduction target is the Dutch contribution to the overall EU commitment to the Kyoto Protocol to reduce GHG-emissions by 8% (202 million tonnes of CO_2 eq). For the 2nd Kyoto Commitment Period (2013-2020) the Netherlands committed itself to meet a 20% reduction target ceiling of 150 million tonnes of CO_2 equivalents compared to 1990, preferably within the EU-context. This target has to be realised proportionally by the sectors under the EU Emission Trading Scheme (ETS), including a limited number of large farms in greenhouse horticulture, notwithstanding the fact that these sectors have one EU-wide emission ceiling, as well as non-ETS-sectors (including primary agriculture). The Agro Covenant (Ministry of Agriculture, Nature and Food Quality, 2008) represents one of the tracks along which earlier ambitions drawn up internationally within the UN framework and laid down in 1997 in the Kyoto protocol have been transposed to the Dutch context (NL Agency/LEI Wageningen UR, 2012).[1]

15. **The Dutch government approaches climate-, energy and sustainability related policies as a challenge/opportunity rather than a threat to productivity**. As stated in the Programme 'Clean and Energy Efficient' (2007): 'The Cabinet offers ambitious plans […] as they can help the Dutch knowledge economy and energy sector to become a European, and in some areas even a global frontrunner. […] Additionally, the Cabinet is convinced that those companies and countries that are leading in addressing climate-related challenges in a responsible way can strengthen their economic position.' Economic gains are expected to be one of the major drivers for the many voluntary steps taken by the private sector. This approach resulted in a policy mix targeted at enabling the sectors to make the necessary transition by e.g. removing non-technical barriers, scaling-up/accelerating existing innovations and developing and developing and implementing a medium and long-term innovation agenda.

16. **Different multiannual agreements have been implemented for energy saving**
For the food industry the Multiannual Agreement on Energy covenant (MJA3) is relevant. The first MJA has been signed in 1989. It is voluntary covenant between Government and non-ETS-industry and aims at 30% energy-efficiency improvement from 2005 to 2020 (= 2% per year). A recent evaluation suggested that the agreed energy-efficiency improvement might be reached, but that the administrative burden is too high (Ecorys, 2013). The main policy measures geared towards energy conservation in the greenhouse horticulture ensue from the Multi-year Agreement on Energy agreed with the sector in 1993, and the Horticulture and Environment Covenant (known by the acronym Glami, from 1997) (The Netherlands Court of Audit, 2003). The successor of Glami is the Platform Sustainable Greenhouse Horticulture (PDG) in 2010. Policy includes general fiscal measures for environmental purposes, such as the scheme for accelerated depreciation of environmental investments (Vamil) launched in 1991 and the energy investment allowance (EIA, introduced in 1997). All the schemes aim to encourage investment in energy-saving technologies, with the implicit goal of achieving energy savings, which should lead to a reduction in CO_2 emissions.

[1] Covenants are a voluntary negotiated agreement between the government and sectors of industry (see Bressers et al., 2011).

17. **Implementation of the climate policy is to a large extent based on voluntary agreements with the private sector, but supported by regulations, subsidies (e.g. MEP-subsidy/Environmental Quality of Electricity Production for c-generation), tax incentives e.g. VAMIL/Voluntary Depreciation on Environmental Investment), emissions trade, extension services and demonstration projects**

In 2008, Dutch agricultural sectors signed a Public-Private Partnership with the government entitled 'Clean and Efficient Agricultural Sectors', or the 'Agro Covenant' for short (NL Agency/LEI Wageningen UR, 2012), building further on targets set in ongoing programmes like 'Greenhouse as Source of Energy', and Long-term Energy Efficiency Agreements. The Agro Covenant allows companies and sectors to secure the targets as they best see fit from their particular business perspective. The Agro Covenant is an agreement between the government and the agricultural sectors. The Public-Private Partnership sets out how the agricultural sectors can help to achieve the national targets to which the Netherlands has committed itself in the European Framework. The main targets for these sectors relate to greenhouse gas emissions, biomass and wind power (NL Agency/LEI Wageningen UR, 2012). With respect to the first, the aim is to reduce CO_2 emissions in 2020 by at least 3.5 million tonnes and those of other greenhouse gases, like methane and nitrous oxide, by 4.0 to 6.0 million tonnes of CO_2 equivalents. In 2020, 200 PJ of renewable energy from biomass per year should be produced and the total amount of wind energy on land should be 3.5 billion kWh per year, equivalent to approximately 12 PJ. The aim of the Agro Covenant is to use the competitive and innovative power of the companies concerned to achieve the targets to which the parties have agreed. Targets have been set for a range of issues within transition routes. The prime focus of policy-makers is thus not on implementing legislation and mandatory measures, but on coming to an agreement on achievable goals.

18. **The adaptation of the National Adaptation Strategy (in Dutch: 'Nationale Adaptatiestrategie'), as part of the Adaptation Programme for Spatial Planning and Climate Change was the first attempt towards a comprehensive adaptation policy**. (in Dutch: 'ARK: Adaptatieprogramma Ruimte en Klimaat, 2006-2010') For this programme several ministries worked closely with the umbrella organisations of the provincial authorities, municipal authorities and water boards. They formulated an adaptation strategy to climate-proof spatial planning in the Netherlands. The Strategy prioritised the spatial adaptation necessary to protect a safe living environment, biodiversity in a vital economy. This strategy has not been translated into the National Adaptation Agenda with concrete actions, timetable and division of responsibilities, except from some regions vulnerable to climate change within the Delta Programme (2010) for securing future fresh water supply. The Delta Programme covers also the water-related climate effects on agriculture. The complementary research programme 'Knowledge for Climate - started in 2007.

19. **In the National Adaptation Strategy a number of climate related challenges were identified that may affect the economic vitality of the agricultural sector**

Although it is recognised that the agricultural sector at that time already had taken some action, mainly in the field of water management and some innovative research e.g. on saline agriculture and floating greenhouses, the sense of urgency was low. The challenge therefore was to stimulate a climate-resilient agriculture, aimed at providing possibilities to optimise farming practices with a view to extreme weather events, pest and diseases and managing salinisation. The attempt between 2009 and 2010 to develop a more integrated climate agenda was initially stalled because the Adaptation Programme for Spatial Planning and climate changes ended.

20. **In the Energy Agreement for Sustainable Growth in 2013 ('Energieakkoord voor duurzame groei'), more than forty organisations have laid the basis for a robust, future-proof energy and climate policy (SER, 2013)**

This is an voluntary agreement - spearheaded by the Social and Economic Council of the Netherlands (SER)- on energy and climate policies, in particular (Notenboom and Boot, 2016 and OECD, 2015a) and includes agricultural sectors. The horizon of the Energy Agreement is 2020 with clear targets for energy saving, renewable energy and job creation. Organisations involved include the central, regional and local governments, employers' associations (including LTO Nederland; Dutch Federation of Agriculture and Horticulture), trade unions, environmental and other civil-society organisations and financial institutions. The decrease in gross energy consumption in agriculture (adjusted for temperature influences) in the period 2000-2013 was about 80 petajoules (Schoots and Hammingh,

2015). It is expected that energy consumption will continue to decrease, although at a lower annual percentage. Energy efficiency has improved with 2-3% per year and a decrease in energy use per unit of product of more than 50% (SER, 2013). The agricultural sector sees increased energy efficiency as an opportunity to increase the competitiveness of energy-intensive businesses, to create employment, and to achieve climate objectives in a cost-effective manner. Building on the Energy Agreement, the government put forth a 'Climate Agenda' in 2013 covering mitigation and adaptation policy with a horizon to 2030 (Ministry of Infrastructure and the Environment, 2013).

21. **The national 'Climate Agenda: Resilient, Prosperous, and Green' from 2013** outlines a government approach to climate change, focused on assembling a broadly-based coalition for climate measures and on a combined approach to climate adaptation (by designing a resilient physical environment and preparing society for the consequences of climate change) and mitigation (by reducing greenhouse gas emissions). The objective is to facilitate more knowledge sharing between authorities and knowledge institutions and to develop possibilities for synergy. One of the action lines focuses on the movement 'towards more productive and climate-friendly agriculture and horticulture'. Measures are directed towards mitigation and towards more efficient production (by using fewer inputs per unit of product). Each ministry is responsible for its own core objectives. The ministry of Economic Affairs is responsible for concrete measures and actions regarding the agricultural sector.

22. **Support within the Dutch Rural Development Programme (RDP) aims at increasing farm productivity in a sustainable way**

The Dutch RDP was formally adopted by the European Commission on 13 February 2015. The RDP outlines priorities for innovation measures for the 7-year period 2014-2020 (European Commission, 2014). In order to enhance the viability and competitiveness of the farm sector, the programme has a strong focus on stimulating innovative and sustainable investments. To foster the competitiveness of the agricultural sector, the RDP puts particular emphasis on those investments which can contribute to environmental and climate objectives. In this context, innovation is an integral part of the RDP. The programme aims to support farmers to make innovative and sustainable investments (up to 4% of all farmers, about 2 900 farms). Innovation will be facilitated via cooperation projects and by the transfer of information and knowledge between the agri-food sector, researchers and other stakeholders. Also European Innovation Partnerships (EIP) promotes innovation for productivity growth and sustainability.

23. **The three objectives - agricultural productivity, climate change adaptation and mitigation - are also determined by other policie**s

Productivity was central from the early years of the European Common Agricultural Policy (CAP). The CAP maintains a two-pillar structure: Pillar I for market measures as well as direct payments, and Pillar II covering rural development. For environmental and climate benefits permanent grassland is maintained. It is expected that Pillar I measures contribute indirectly to climate mitigation through positive side-effects. In 1984 production quota for milk were introduced to keep production within limits and wipe out milk lakes and butter mountains, in 1988 the set-aside scheme (compulsory as of 1992 for large arable farmers). The introduction of Nitrates Directive (1991), Crop Protection Directive (1991), Water Framework Directive (2000), Habitat Directive (1992) and the Directive on national emission ceilings for certain atmospheric pollutants (2001) all challenged the unrestrained agricultural production. Later, sustainability and competitiveness gained importance. In the Netherlands, a number of policies encouraged productivity through innovation stimulating measures, e.g. measure 121 ('Modernisation of agricultural holdings') of the Dutch Rural Development Plan 2007-2013 (RDP). This measure is part of axis 1 of the RDP, 'Improving the competitiveness of the agricultural and forestry sector'. Next to public initiatives, a number of (public-) private collaborations develop innovative adaptive capacity and/or mitigation measures simultaneously, with the objective to maintain agricultural productivity. Cost reductions of implementing measures through innovation are important to bring about wider usage, because many options currently involve net costs. Increasing overall sustainability and resilience, rather than increasing productivity.

24. **Supporting innovations, training, workshops and coaching of entrepreneurs in the RDP also contribute to reducing GHG emissions and use of energy, and to stimulate a transition towards renewable energy** (see Grontmij Nederland B.V. (2014) for an evaluation of environmental effects). However, these effects are not direct. Measures that focused on developing, testing and demonstrating innovations can have both a productivity effect (improving production process) and mitigation effect. For example, RDP measure 14 will foster the implementation of innovations through training, workshops and coaching of entrepreneurs and demonstration of innovations. A comparable effect could be achieved by investment measures for sustaining farms of young farmers and stimulating water related investments measures. Measures focused on collaboration are meant to improve practical knowledge and technology by frontrunners to scale up. They combine competitiveness with reducing external effects on environment, landscape and society.

25. **The realisation of the targets to which the agricultural sectors have committed themselves under the Energy Agreement, are incorporated (mostly) in already existing, revised programmes**
In the greenhouse horticulture sector for example, the renewed Multi-year Energy Transition Agreement for the period 2014-2020 reinforces the commitment in the Agro Covenant that from 2020 onwards new greenhouses will be climate-neutral. Furthermore it states that in 2020 growing concepts and techniques for existing greenhouses are available that allow production being done cost-effectively with half the amount of fossil fuel (compared to 2011) and that in 2050 the energy consumed in the greenhouse horticulture sector is completely sustainable and economically viable. Concrete targets are a maximum 6.2 million tonnes of CO_2 emissions in 2020 as well as energy savings of 11 PJ compared to 2011. Dutch greenhouse horticulture is working in the 'Greenhouse as Source of Energy'- transition programme towards 2020 on energy, which already started in 2007 and has been adjusted to several times to the increasing ambitions, can be considered as the implementation plan of the transition towards a sustainable greenhouse horticulture sector. Combined heat and power (CHP) units were first installed in the Dutch greenhouse sector in the 1980s and 1990s by flower growers who imitated CHP use in other industries (Veen and Kasmire, 2015). There has been a rapid diffusion of combined heat and power (CHP) in the Dutch greenhouse horticulture between 2003 and 2009. Dutch greenhouse horticulture is working on a transition programme towards 2020 on energy ('Greenhouse as Source of Energy'). It addressed both agricultural productivity (first objective via innovation) and mitigation (third objective; greenhouse gas emission reduction). Priorities areas following for the Greenhouse as Source of Energy programme following the Multi-year Energy Transition Agreement are the accelerated implementation of the Next Generation Growing ('Het Nieuwe Telen'), the use of geothermal energy, energy efficiency by stimulating cooperation within and outside the sector, with regional authorities as well as with energy companies in the field of (bio)energy, residual heat and alternative CO_2 sources, and stimulating innovation breakthroughs.

26. **Another example is the collaboration between dairy processors and farmers within the programme 'Sustainable Dairy Chain' (Duurzame Zuivelketen, 2016)**
Also this initiative is rooted among others in the Agro Covenant (2008) as a way to fulfil the sectoral commitments and readjusted over the years to the revised national ambitions, lastly in 2014. Development towards climate neutrality is one of the four objectives of the initiative and is to be achieved by a 20% reduction in greenhouse gases by 2020 through climate-neutral growth, 16% sustainable energy production in the dairy chain by 2020 and an energy efficiency improvement by 2% per year in the period 2005-2020. Progress in the implementation of the Sustainable Dairy Chain programme is monitored annually by an independent organisation.

27. **To support the implementation of innovative environmental/sustainable initiatives by industry and agriculture by removing obstacles, the government launched the 'Green Deals'** programme in 2011 (OECD, 2015a). The deals consist of agreements between the government and a coalition of companies, civil society organisations and local and regional government that focus mainly on removing non-financial barriers related to regulations, legislations or licensing. It is used to supplement existing instruments, such as legislation and regulation, market and financial incentives, and measures to stimulate innovation. The Green Deal approach is often used when innovations are actually put into practice, a phase during which projects often encounter barriers. The central idea is

that the government facilitates and accelerates initiatives by removing barriers. Barriers may be formed by legislation, or by a lack of market incentives, innovation and networking.

28. **An important goal for the Netherlands is the ambition of the Delta Programme to increase adaptive capacity of the Netherlands by 2050**

This programme is a national programme, in which the government, provinces, municipalities and water boards work together. The programme involves different economic sectors, from civil society organisation to citizens. Within the national government, two ministries co-ordinate: the Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs (the latter being responsible for agricultural policy). The Delta Programme deals with climate change adaptation for different economic sectors, like energy, industry and inland shipping. For agriculture, it involves developing innovative ways (adaptive capacity) to deal with future droughts to secure productive agricultural systems in the future. The fresh water investment programme includes an implementation programme for users such as agriculture, besides measures at regional and national level. Agricultural measures include stimulating self-sufficiency for farmers, increasing efficient use of water, changing drainage, and water storage.

3 Institutions and institutional coherence

3.1 Identifying institutions

29. **The Dutch have a strong civic culture that relies on a process of reaching consensus in decision making** (see 'Dutch polder approach' in OECD, 2014a). In the 13th century, people with common interests in safe water management formed co-operatives, resulting in the first water boards. Their co-operation not only involved working together, it also implied participation in governance. This type of governance has proven itself as a way of how to get big, bold, ambitious things done. However, in some cases it will slow down and paralyse decision making because of lengthy processes, and requires relentless practical co-operation to override conflicting interests, overcome differences and take action when all have been heard (OECD, 2014a). This approach is reflected in policy solutions for (synergy between) the three objectives involving large numbers of public and private institutions at different levels.

30. **The challenge for the Netherlands is to integrate all policies into the planning of spatial developments, into redevelopments, and into investments in management and maintenance** (Ministry of Infrastructure and the Environment / Ministry of Economic affairs, 2015). It requires collaboration between many actors at the local, regional levels, or in other words a functioning 'polder approach'. In this approach each party has its own role and responsibility, in mutual cooperation.

31. **The main actors in the design and definition of Dutch innovation policies for productivity, mitigation and adaptation are the Ministry of Economic Affairs and the Ministry of Education, Culture and Science**
The agricultural education system is distinct from other education institutions because it is organised under the responsibility of the Ministry of Economic Affairs. The first is responsible for promoting competitiveness, entrepreneurship and innovation; the latter is responsible for defining strategies and policies for public-sector education and research (OECD, 2014b). A number of programmes to stimulate farmers towards innovative measures for sustainable development have been set up by the Ministry of Economic Affairs. Both ministries co-ordinate the science policy agenda of the national government and contribute to the definition of international science policy at the EU level and beyond. The Ministry of Economic Affairs, being responsible for agricultural policy, funds agri-food research and green education (OECD, 2015b).

32. **There is a strong interaction and good strategic cooperation between policy makers, research institutes and private sector organisations**. Geerling-Eiff et al. (2014) show that accurate numbers of expenditures on specifically agricultural research are not available. Public and private goals within PPP can conflict, which makes conducting research difficult. There are questions as to how investments in R&D with strong public goods aspects and for long-term challenges such as climate change will be met in a system driven largely by the industry. Continuity could be difficult in responding to longer term challenges such as climate change and long-term environmental performance of agriculture.

33. **Key institutions in the Delta Programme are the Ministry of Infrastructure and the Environment (incl. the Delta Programme Commissionar), the Ministry of Economic Affairs, the Ministry of Infrastructure and the Environment, regional waterboards, provinces, municipalities and private parties**
The result is that productivity, adapation and mitigation are a shared responsibility of different institutions at different institutional levels.The Ministry of Economic Affairs is responsible for a competitive business climate, to support businesses through innovation (sustainability) and enterprise support, and clean, reliable energy. The Minister of Infrastructure and the Environment is the coordinating minister for the Delta Programma and politically responsible. The Minister of Economic Affairs, the provincies, municipalities and water boards all have shared responsibility for the Delta

Programme as a whole and its sub-programmes. The Delta Programme Commissioner is responsible for the development and implementation of the Delta Programme. In addition to the above mentioned (semi)governmental institutions, the Delta Commissioners works closely with the research world, also social organisations and the business community are closely involved in planning. The Delta Programme aims to achieve that spatial planning will become more climate-proof and water robust. Farmers will get insight into what levels of fresh water supply levels they can expect in the future.

3.2 Institutional coherence at different institutional levels

34. **The Agro Covenant implements the Kyoto Protocol by specifying emission reduction targets by sector and type of greenhouse gas (LEI Wageningen UR, 2015)**
The 2020 target for the arable farming, horticulture (excluding greenhouse horticulture) and livestock farming sectors stipulates a reduction of the emissions of methane and nitrous oxide of between 25 and 30% (4-6 million tonnes) from the levels in 1990. This target reduction was achieved in 2013, almost entirely due to the reduction of emissions of nitrous oxide. The aim is at least a reduction of the greenhouse gas emission of 3.5 million tonnes of CO_2 compared with 1990 and those of non-CO_2 greenhouse gases like methane and nitrous oxide by 4.0 to 6.0 million tonnes of CO_2 equivalents.

35. **The Agro Covenant distinguishes separate main areas of concern regarding policy measures in agriculture** (see Table 1 for an overview; Ministry of Economic Affairs, 2015 and Ministry of Infrastructure and the Environment et al., 2015):
- Greenhouse horticulture focuses on energy savings and sustainable production of the energy demand (electricity and heat), also through developing energy efficient greenhouse systems and new growing methods (the aim is improved energy efficiency by 2% annually for greenhouse horticulture);
- Objectives for other sectors are: (1) 60% less fossil energy use for cattle breeding and cultivation (ATV sector) compared to 1990; (2) improved energy efficiency by >2% annually for cattle breeding and cultivation (ATV sector); (3) improved energy efficiency by 2.2% for flower bulbs; (4) and improved energy efficiency by 2.5% for mushrooms
- Other agricultural activities (primary sectors) focus on energy saving (sustainable production of energy through, for example, the production of biomass to generate energy (at least 200 PJ renewable energy produced by biomass in 2020) and at least a doubling of the wind generation in the agricultural sectors and a capacity of 12 PJ in 2020.
- The agricultural processing industry (mainly Long-Term Agreements and innovation) is allocated to the Ministry of Economic Affairs whereas the resulting CO_2 emission reductions fall within the 'Industry' sector.

Table 1 *Objectives and results Agro Covenant*

Topic	Ambition 2020	Realised in 2012
1. Saving energy 1990-2020		
Increased energy efficiency all sectors	>2% per year	2,9% per year
2. Renewable energy production1990-2020		
– Biomass Agricultural-Industry	75-125 PJ	11,5 PJ
– Biomass forestry	32 PJ	27,4 PJ
– Biogas ATV-sectors*	48 PJ	5,5 PJ
– Production Greenhouse horticulture	Approx. 25 PJ	1,2 PJ
– Production poultry sector	2 PJ	1,3 PJ
3. Wind energy 1990-2020		
- Production ATV-sectors*	12 PJ	11,2 PJ
4. Reducing GHG emissions 1990-2020		
- CO_2 emission greenhouse horticulture	3,3 million tonnes	3,3 million tonnes
- Other GHG emissions ATV-sectors*	4-6 million tonnes	5,6 million tonnes

*ATV = Arable farming, horticulture open cultivation and livestock sector; (Source: Moerkerken et al., 2014, page 11)

36. **The agricultural sector is expected to take cost-effective measures that contribute to mitigation of greenhouse gases on a voluntary basis**. There are three categories of measures that can contribute to reducing emissions (Ministry of Economic Affairs, 2015, Ministry of Infrastructure and the Environment et al., 2015):

- Developing Best Management Practices for reducing nitrogen input on farms;
- Measures related to cattle feed to reduce CH_4 emissions. The composition of feed can affect the production of methane by the cattle's digestive systems. In general: the better the digestibility, the lower the methane emissions;
- Measures concerning manure storage to reduce emissions of CH_4. Manure fermentation is the main option for reducing methane emissions from manure.

37. **Synergies between objectives are exploited through policy programmes including public private partnerships (PPP) at different institutional levels**. Water-related effects of climate change on agriculture are covered largely by the Delta Programme (see also The Netherlands Court of Audit, 2012). If possible, freshwater measures will be implemented in an integral fashion, taking into account area development. Adaptive delta management is essential to Dutch policy measures. It implies looking ahead, using that insight to put in place effective or cost-effective measures in good time and remaining flexible to be able to act on new opportunities. Adaptive management is relevant for both government and private parties involving institutional co-operation. It is argued that sufficient fresh water is a shared responsibility that requires cohesive efforts in the water system and among the users. Governments at different institutional levels and users are to reach an agreement to limit the demand for freshwater and to reduce the susceptibility to drought and salinisation. Potential measures are underground freshwater storage, modified drainage or drip irrigation, water conservation in the soil, a more efficient use of excess precipitation making freshwater lenses more robust and researching the reuse of freshwater. Users take the initiative to pursue measures in collaboration with regional or local governments and knowledge institutes.

4 Policy initiatives and effects

4.1 Identifying economy-wide and sector-specific policies

38. **A wide range of international and national regulations, economy-wide policies and sector-specific policies create various incentives and disincentives to achieve progress across the three objectives in the agricultural sector**

The effects of a particular policy and of policy interactions will be different for the Netherlands, compared to other countries. Table 2 lists a range of policies at the international, national, local and sectoral levels that may impact the three objectives in the Netherlands (agricultural productivity, climate change adaptation and mitigation). While not an exhaustive list, the table identifies a number of relevant policies for the Netherlands. Extensive discussions of climate frameworks, agreements & coalitions are beyond the scope of this chapter.

Table 2 *Policies on agricultural productivity, climate change aptation and mitigation*

International & Regional	**Trade & economic cooperation agreements**	• WTO regulations and agreements • Bilateral, regional and multilateral trade agreements • European Agricultural Policies (e.g. Rural Development Plan (RDP), expiring dairy quota)
	Climate frameworks, agreements & coalitions	• United Nations Framework Convention on Climate Change • Kyoto Protocol (1st commitment period 2008-2012 and 2nd commitment period 2013-2020) • Global Climate Change Alliance • Global Alliance for Climate Smart Agriculture • COP 21- Intended Nationally Determined Contributions (INDC)
National	**National development plans** **National adaptation plans**	• 'Climate Agenda: Resilient, Prosperous, and Green' (2013) • Green Loans (1995, -) • Dutch enterprise policy (generic instruments) • Incentive scheme sustainable energy production (SDE+) • Tax relief for environmental friendly investments
Local	**Rural development plans**	• Rural Development Plan (RDP)
Sectoral	**Land**	• Legislation and policies outlining the allocation of national land resources: land rights, distribution, acquisition, management, use, forms of tenure
	Non Agricultural (Energy, infrastructure, water, mining, & trade)	• 'Energy Agreement for Sustainable Growth' (2013) • Water Framework Directive (WFD) • EU Action on Water Scarcity and Drought • Delta Programme • National Emission Ceilings for certain pollutants (the NEC Directive) • Top sectors policy • Energy saving subsidies: De Demonstratieregeling Energie Innovaties (DEI) en de subsidie duurzame energie (SDE).
	Agriculture	• Platform Sustainable Greenhouse Horticulture (PDG)Programme for the Reduction of other GHG (ROB, 1999) • The General Administrative Regulation for Holdings in the Greenhouse Sector (AMvB Glastuinbouw 2002) • Integrated approach on Nitrogen (PAS) • Tax concessions for diesel use in agriculture • Action Programme 'Greenhouse as Source of Energy' • Covenant for Clean and Efficient Agricultural Sectors (Agro Covenant, 2008): • Action Programme 'Greenhouse as Source of Energy' • Sustainable Dairy Chain • Long-term Agreement food sector • Long-term agreement mushroom and flower bulb sector • Green Deal Initiatives • Introduction of CO_2 offsetting system in greenhouse horticulture • Research and development (, innovation policy, innovation programme low-emission animal feed • Financial incentives energy saving (subsidy market introduction energy innovations for greenhouse horticulture (in Dutch: Marktintroductie Energie Innovaties, MEI) and subsidies for investment in energy efficiency and renawable energy 2016)

39. **Within these policies, linkages between different objectives are taken into account at different governance levels**. 'Trade & economic cooperation agreements' and 'Climate frameworks, agreements & coalitions' are international policies for the Netherlands. The Dutch enterprise policy focuses on strengthening the innovation framework, to reduce red-tape (administrative burden), to improve access to finance (financing innovative entrepreneurship) and to ensure a better match between the education system and labour market (Van der Wiel, 2015) and sustainability. The European Common Agricultural Policy (CAP), national Green Deal policies, and different innovation programmes focus on different objectives of objective 1 (namely productivity and competiveness) of Dutch agriculture. The sectoral Delta Programme is concerned with national policies regarding climate change adaptation involving governments at different levels and the civil society.

40. **The Dutch state encourages private parties to step up their research efforts, instead of carrying out research projects itself (Haas, 2013)**
Public-private co-operation and research co-ordination is the guiding principle of the Top Sector policy, which provides a strategic framework for innovation policy for 10 economic clusters chosen for support on a competitive basis by the ministry of Economic Affairs. Different forms of collaboration between public and private parties have become apparent. The valorisation of knowledge is facilitated through consortia that are project oriented). Recent examples of the two agriculture-related 'Top Sectors' (Topsectoren) are Horticulture and Propagation Materials (Tuinbouw en Uitgangsmaterialen) and Agri&Food. Central to this policy is that industry representatives are at centre of coordination instead of government. The role of the government is to bring stakeholders together. Most sector-specific subsidies disappeared. To use their resources effectively, businesses, knowledge institutions and government (triple helix) work closely together and co-ordinate their efforts within 'Top Consortia for Knowledge and Innovation (TKI)'. The TKI allowance provides public co-funding, amounting to 25% of the private funding. In order to stimulate SMEs to participate the public co-funding is 40% for the first 2,0000 euros per project ('in kind' possible for this part); It is too early to assess the impact of top sector approach (Van der Wiel, 2015).

41. **European policies and actions are set up in order to prevent and to mitigate water scarcity and drought situations, thus working towards a water-efficient and water-saving economy**
Relevant directives are the Water Framework Directive (WFD) and the EU Action on Water Scarcity and Drought. Measures within the CAP, particularly RDP-measures, are coherent within Europe. The main objective of EU water policy is to ensure access to good quality water in sufficient quantity for all Europeans, and to ensure the good status of all water bodies across Europe. Furthermore, the NEC Directive (National Emission Ceilings) set upper limits for each Member State for the total emissions in 2010 of the four pollutants responsible for acidification, eutrophication and ground-level ozone pollution (sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia), but left it largely to the Member States to decide which measures to take in order to comply (on top of Community legislation for specific source categories).

42. **In recent years, the Netherlands is integrating multiple objectives within the National 'Climate Agenda: Resilient, Prosperous, and Green'**
This Climate Agenda outlines a climate approach focused on assembling a broadly-based coalition for climate measures and on a combined approach to climate adaptation (by designing a resilient physical environment and preparing society for the consequences of climate change) and mitigation (by reducing greenhouse gas emissions). The Agenda facilitates more knowledge sharing between authorities and knowledge institutions and provides possibilities for synergy between the three objectives as the action line addresses a more productive and climate friendly agriculture and horticulture. It starts with recognising the need for food security (worldwide), without increasing the environmental burden to society. It is argued that the Dutch agricultural-complex is recognised for its low-emission (mitigation) sustainable food production and land use.

4.2 Policy effects

43. **The planning, implementation and funding of the three objectives are both addressed separately and jointly in different combinations of policies**

The impact of climate change events on agricultural-systems and on agricultural returns has been addressed in the Delta Programme. Adaptive delta management links short-term decisions to long term challenges for freshwater supply. The idea is to ensure that solutions are flexible, to work with long term adaptation tracks comprising several strategies and therewith being able to switch quickly if the situation changes. Freshwater measures will be implemented in an integral way. Other relevant impacts will be from the expiring EU milk quota system (1 April 2015), the Programmatic Approach to Nitrogen, and rural development policies. Also, the cross compliance and greening of the First Pillar of the CAP consists of a number of statutory requirements relating to environment, climate change, good agricultural condition of land, human, animal & plant health standards and animal welfare.

4.2.1 Abolishment of dairy quota

44. **With the milk quota no longer being a constraint, the Dutch dairy farmers have revised their strategy and will increase greenhouse gas emissions**

Milk production is projected to increase by 17% in the coming decade (Jongeneel and Van Berkum, 2015). The increase is related to expected market conditions (e.g. milk price), but also to other drivers and structural issues characterising the Dutch dairy sector. The Dutch dairy sector has set the objective for 2020 to reduce greenhouse gas emission with 30% with the reference of 1990 (Agro Convenant). A policy objective as set by the European Council, says that not-ETS-emissions should reduce with 30 percent with 2005 as reference. In 2013, total greenhouse gas emission from dairy farming where about 19% lower than 1990. In recent years emissions are increasing. Technical measures to reduce emissions do not compensate for the growth in dairy production. Upper limits to national phosphate production will restrict GHG emissions (Rougoor et al., 2015). Through the Sustainable Dairy Chain, dairy organisations (NZO) and Dutch Federation of Agriculture and Horticulture (LTO Nederland) work together towards a dairy sector that is future-proof and responsible. Each year, Wageningen Economic Research publishes a sector report to monitor progress in the realisation of the goals.

4.2.2 An integrated approach to Nitrogen

45. **The Netherlands has adopted an Programmatic Approach to Nitrogen (PAS, or in Dutch: Programmatische Aanpak Stikstof), aimed at reducing nitrogen deposition and the effects of the deposition in Natura 2000 sites (see Health Check, 2015)**

In March 2014, the central government and farmers' organisations reached agreement on reducing nitrogen emissions through stable/housing adaptation, low emission application of manure and a change of feed management. The PAS came into force on 1 July 2015. The PAS guarantees that Natura 2000 objectives will be met, while creating room for economic development. It uses an inter-governance approach, across all sectors and areas. The PAS includes analysis of scenarios for emission reduction, based on generic measures, an additional national package of measures for agriculture, measures at provincial/regional level and measures at the local level, such as habitat restoration measures (Whitfield & McIntosh, 2014). The objective of the PAS is to reduce point based emissions from agriculture (and other transport and industry) through on-site measures (an additional package of agricultural measures has been agreed on for the PAS). While the primary focus of the PAS is emission reduction of nitrogen, modern-day low-emission stables also tend to reduce the emission of greenhouse gases, such as methane (CH_4).

4.2.3 The Rural Development plan

46. **The Dutch RDP does not directly address EU RDP Priority 5 (promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors)**

Reasons are that national policies already cover this priority and that other measures can contribute as well (see Ministry of Economic Affairs, 2014 and Turpin et al., 2015), like measures improving

competitiveness and sustainability through innovation and 'agri-environmental and climate measures'. Measures to support knowledge sharing and dissemination also support climate adaptation, mitigation and higher input efficiency, and better farm management (see Measure 01, RDP). Investment measures are primarily meant to promote innovation in agriculture including mitigation, adaptation and input efficiency. By reinforcing sustainability of farms under 'agri-environment and climate', measures are expected also to also contribute to environment, climate and water management. Agri-environmental and climate measures in the Netherlands support production methods with favourable effects on environment (incl. water), landscape, natural resources, soil, and biodiversity (see also Turpin et al., 2015).

47. **The Dutch RDP puts particular emphasis on innovative sustainable investments, which can contribute to environmental and climate objectives**

These investments are also intended to foster competiveness of the agricultural sector. Thus, climate priorities are linked to competitiveness (including mitigation and adaptation). Mitigation includes a reduction of greenhouse gases by savings on energy use, a reduction of fossil energy by a transition towards renewable energy and production of renewable energy. Adaptation focuses on fresh water supply and salinisation. Measures are included to support sharing knowledge (including learning and extension services) for adapting production to environmental and climate requirements. A specific investment support measure is dedicated to young farmers in order to stimulate new investments when they take over the farm.

48. **The Dutch RDP includes an all-weather insurance scheme payment to support agricultural risk management**

Different weather-related (climate) risks are considered within the all-weather insurance scheme, such as gales, hail, rain, snow, frost and drought. The aim is to realise a private insurance scheme. However, a higher participation rate is necessary to allow payments to be realistic. The scheme targets 2% of farmers (about 1500 farmers). The scheme will subsidise maximum 65% of the insurance premium (Ministry of Economic Affairs, 2014). Insurance payments are possible if the damage is more than 30% of the average yearly production for the last 3 years or the average production of 3 of the last 5 years. Since 2010, the number of participants increased from 482 to 795 in 2014 (Secretary of State of Economic Affairs, 2015). The budget for 2015 is 9 million euros. Public support for the insurance scheme is continued for the coming years to stimulate participation.

49. **An all-weather insurance scheme contributes to the adaptive capacity and reducing production risks**

Climate change may have impact on agricultural risk (OECD, 2009) and income. The government considers climate change as an important reason for having an insurance instrument to deal with bad weather conditions (adaptation), resulting from climate change (Secretary of State of Economic Affairs, 2015 and Melyukhina, 2011). Broadly speaking, an insurance coverage may be beneficial for economic stability if it ensures continuity of individual farmers (production) and overall resilience of the agricultural sector after e.g. heat spells or hail storms (see Botzen et al., 2010). Botzen et al. (2010) argue that insurers could stimulate risk mitigation measures via requirements in policy regulation or by providing discounts to farmers who invest in adaptation measures (see also Meulen et al., 2011). These measures mitigate production risks (damage) from climate change (see also OECD, 2009).

4.2.4 Green loans for renewable energy and energy saving

50. **Funds for green development including renewable energy and energy saving are raised with consumer involvement**

In the framework of Green Loans, consumers can receive a tax benefit if they invest in a green fund for which they receive a lower rate than the market interest rate (see also Dreblow et al., 2013 and NL agency, 2010). The tax advantage consists of a 1.2% tax exemption on capital income and a 0.7% exemption on income tax (CE, 2013). The scheme was launched in 1995. In return, banks offer loans at lower interest rates to so-called 'green projects', using the extra liquidity generated by the consumers' investments. These 'green projects' require a positive environmental impact, whether contributing to nature, bio-agriculture, (organic) agriculture, sustainable resources, recycling,

renewable energy, energy saving, sustainable construction, sustainable mobility, or the sustainable water cycle. Examples from agriculture include organic farming and highly environmentally friendly and energy efficient horticultural greenhouses. In 2012, total investment in green funds and in green banks amounted to approximately 5 billion euros (CE, 2013). For banks, it contributes to their social corporate responsibility.

51. **The climate related social benefits of loans for green development have several dimensions**
Three main components can be distinguished (adapted from CE, 2013): environmental benefits including reduced CO_2 emissions (mitigation); the introduction of new technologies (productivity) and increased awareness among citizens and within financial institutions. The social costs are foregone profits on the capital invested in lower-value green projects when investments elsewhere would have generated higher (short-term) profits. In the period 2005-2008, relatively a large share of the budget has been invested in sustainable greenhouses, stables and aquaculture. The total amount for this category was in 2007 about 1 billion euros. The economic benefit of reducing CO_2 emissions was estimated at 28 million euros per year (CE, 2013).

52. **Green loans for green label greenhouses contribute to mitigation**
To acquire a green label, greenhouses need to fulfil a number of requirements in different areas: energy, agricultural-chemicals, nutrients, water, local effects from assimilation lightning (see also European Commission, 2008). From 2010 onwards, at least 10% of total energy use needs to be sustainable and total energy consumption needs to be 50% below a defined standard reference greenhouse. In 2015, greenhouses to acquire a green label need to fulfil version 15 of the updated requirements. Eligibility criteria have continuously sharpened. Rabobank - one of the largest banks - has loans for about 842 million euros for green label green houses. Over the years, the Rabobank has played an important role in the development of Dutch agriculture and horticulture and holds an 85% to 90% market share in the farm sector in the Netherlands.

53. **Integrally sustainable animal houses contribute to energy savings objectives (mitigation)**
Since 2007, the Ministry of Economic Affairs has an ambition on sustainable animal housing (Peet et al., 2015). This ambition addresses sustainable farming to meet environmental conditions (including ammonia and particulate matter levels) and animal welfare. Within the farmers and dairy chain programme 'Sustainable Dairy Chain', it is agreed upon that every animal house needs to be integrally sustainable from 2015 onwards. Requirements for sustainability are updated in the course of time. Integrally sustainable animal houses are defined as housing and management systems in which different aspects of sustainability are improved in an integrated way, compared to standard housing and management systems. Only housing and management systems with an approved sustainability certificate are eligible. On the basis of animal places it shows that 15.9%, 36.3%, 35.0% of respectively cattle, pigs and poultry are integrally sustainable housed (Peet et al., 2015).

4.3 Synergies and trade-offs

54. **Even more than in other sectors of the Dutch economy, mitigating climate change and increasing adaptive capacity in agriculture cannot be considered independently from other challenges as food security, food safety, animal welfare and other environmental pressures**
(fine particles, ammonia, nitrogen) and finding win-win solutions will be key (Secretary of State of Economic Affairs, 2011, page.12). Removing the tax concession for diesel used in agriculture resulted in increasing costs for agriculture. On the first of January 2013, the tax subsidy on diesel for agriculture ('red diesel') has been abolished for environmental reasons. Introduced in 1972, red diesel was an excise tax reduction for diesel used by vehicles that remained off-road. The abolishment of red diesel was expected to have positive environmental effects. The use of own machinery has become more costly, as well as the tariffs for agricultural contract work, since the cost of diesel is an important component. In the short run, a cost increase for diesel could hardly be avoided, for alternative sources of energy are hardly available. In the long run, farmers are expected to switch to energy saving

tractors and will change farmland management (reducing use of diesel), because operational farm work has become more costly (behavioural change).

55. **The Dutch climate policy (translated as GHG-emission reduction) is characterised by its close interconnectedness with energy security (through energy saving and sustainable energy sources) and sustainability objectives**
The contribution of the Dutch agricultural sector in reducing GHG-emissions within the context of the national objectives depends strongly on developments in the number of livestock, manure policy and energy production/consumption of the glass greenhouse sector and their related policies. Over the 1998-2010 period, a number of policies focused on the greenhouse horticulture sector as major consumer of energy in the agricultural sector. Implementation of the climate policy was to a large degree based on voluntary agreements with the private sector, supported by regulations, subsidies (e.g. MEP-subsidy/Environmental Quality of Electricity Production for c-generation), tax incentives e.g. VAMIL/Voluntary Depreciation on Environmental Investment), emissions trade, extension services and demonstration projects.

56. **As many climate related policies, measures and instruments serve multiple objectives (e.g. reduction of CO_2 emissions, promoting energy efficiency and the introduction of renewable energy sources)**, they not only reinforce each other (e.g. production of biogas though co-fermentation of manure), but also create benefits like improving air quality, increasing the national energy security and stimulating national innovation and technology development. The Voluntary Agreement Greenhouse Horticulture and the Environment includes in addition to energy efficiency targets objectives for the reduction of chemical pesticides, emissions of phosphor and nitrogen and waste. This integrated approach has clearly potential synergies with environmental objectives, as the reduction of CH_4 emissions observed in the period 1990-2000 due to a reduced livestock population following manure and ammonia policies (incl. poultry and pig entitlement rights) also contributes to the climate objective (Minister of Housing, Spatial Planning and the Environment, 2002, page 30). At the same time, other policies turn out to having positive impacts on the climate objectives as well. In the case of agriculture this is most evident from CAP and specific policies aimed at the reduction of manure and ammonia-emissions.

5 On-the-ground initiatives for adaptation and innovation

5.1 Introduction

57. **On-the-ground initiatives for adaptation and innovation create synergies between innovation and adaptation/mitigation**
They are diverse in their set-up, contribute in different ways to the objectives, and are implemented as a result of public, private or third parties stimulus. Different governance collaborations and initiatives are means to change farmers and practices, for the better. Three illustrative examples are presented in the remainder of this Chapter to show the relevance of on the ground initiatives developing synergies between the different objectives and objectives. The examples illustrate the interplay between policy and on the ground initiatives of farmers.

5.2 The New Cultivation Concept (NCC) in greenhouse horticulture

58. **In 2009 the programme 'Greenhouse as a Source of Energy' introduced the 'New Cultivation Concept' (NCC, 'Het Nieuwe Telen) (Buurma and Smit, 2015)**
The aim of the programme is to reduce greenhouse horticulture CO_2 emissions by 2 to 3% per year. This must be achieved through energy-saving innovations and the use of sustainable energy. The government and the greenhouse horticulture sector have a multi-year agreement which sets out the goals and ambitions for 2020 and the financial agreements to the end of 2017. The NCC is a new energy-efficient approach to controlling climate in the greenhouse horticulture sector. Promoting the NCC is one of the tracks where growers, government, research institutes, suppliers and branch organisations work closely together. Other tracks e.g. initiating and supervising research; sharing knowledge via meetings and online; developing knowledge of alternative CO_2 supply and of efficient CO_2 dosage; and developing knowledge and information network for bio-energy (Kas als Energiebron, 2016).

59. **Research showed that the New Cultivation Concept could reduce heat demand 15-30% (Ruijs et al., 2010)**
In order to accelerate the introduction of the NCCit is most beneficial to cooperate with the so-called 'crop-oriented entrepreneurs' (see Buurma et al., 2015). These entrepreneurs can be recognised by their passion for climate control, their preference for learning together with colleagues and their need for ensuring plant health. An additional argument for this approach is the fact that crop-oriented entrepreneurs are by far the largest target group in the greenhouse horticulture sector, representing approximately 50% of the population and approximately 60% of the greenhouse area. NCC course groups offered through the 'Greenhouse as a source of Energy' programme are highly valued by the participants. The guidance offered by NCC experts and the mutual discussions aim to give the participants the confidence to make the transition to NCC and to resist the criticism from colleagues and crop advisers who are less convinced of the benefits of NCC. Members of the target group of costs-oriented entrepreneurs often lacked the technical and financial means to make the transition to NCC.

5.3 The Sustainable Dairy chain initiative

60. **The dairy sector collaborates to meet climate and energy goals**
Sustainable Dairy Chain is a joint initiative of the Dutch Dairy Association involving 13 dairy companies as member (NZO) and the Dutch Federation of Agriculture and Horticulture (LTO Nederland). Dairy processing companies and dairy farmers have joined hands to make their processing chain more sustainable. Goals have been formulated in the domain of climate and energy. The goals put forward in 2011 are monitored yearly. Regarding climate and energy, the Sustainable Dairy Chain has formulated the following goals for 2020 (Duurzame Zuivelketen, 2016):

- 20% reduction of greenhouse gases from the dairy chain by 2020 compared to 1990, and climate-neutral growth compared to 2011.
- 16% sustainable energy production in the dairy chain by 2020.
- Energy efficiency in the dairy chain improves an average 2% per year in the period 2005 to 2020.

61. **Every dairy company has its own sustainability programme to help realise the goals of the Sustainable Dairy Chain**
In these sustainability programmes, new knowledge is made available, dairy farmers can compare their own performance against their peers, dairy farmers can receive financial support to address certain performance issues (innovation), and if necessary, have to take mandatory measures (Duurzame Zuivelketen, 2016). The dairy chain has a large share in the emission of greenhouse gases (30 to 40% of the total emission of the primary agricultural sector, see LEI (2015). There is also an emission ceiling for greenhouse gases, implying that a further growth of the sector can only take place if accompanied by a reduction in emissions per kg of milk.

62. **Efforts in the area of energy savings and sustainable energy (solar energy in particular) in dairy farming appear to be effective**
The percentage of dairy farms with installations for generating renewable energy (solar panels, heat recovery, heat pumps) has increased significantly compared to 2010. Consequently, the energy efficiency of the entire dairy chain improved by 5.3% in 2013 compared to 2011.

5.4 Corporate Social Responsibility (CSR) and climate change

63. Many processing companies and/or input suppliers offer extension services as part of their Corporate social responsibility (CSR) strategy on sustainable business practices, including productivity improvement, future mitigation and adaptation. The diverse extension service by companies contribute to mitigation or adaptation in different ways. They focus at different aspects of agricultural production, as examples below illustrate:

- Advice is also provided by product processing companies that focus on one commodity and provide information to their supplier farmers on how to produce the quality that they demand. One example is FrieslandCampina, one of the world's largest dairy co-operatives. About 14,132 farmers in the Netherlands, Germany and Belgium are member of this co-operative. FrieslandCampina wants to ensure that in 2020 energy usage and, therefore, emissions of greenhouse gases are on the same level as or less than they were in 2010, in other words to achieve climate neutral growth. It begins at the farm with sustainable dairy farms (see sustainable dairy farming), the purchase of sustainable (agricultural) raw materials and the reduction of energy and water consumption by the production facilities. The use of sustainable energy, preferably produced by member dairy farmers, also contributes to the achievement of the climate-neutral growth ambition.
- The FrieslandCampina FoQus planet quality programme is for all member dairy farmers, not only in the Netherlands, but also in Belgium and Germany. FoQus planet has four main themes (Milk, Cow, Production process, and Environment) that are divided into three parts: (1) basic requirements: requirements regarding hygiene, quality & safety of milk and animal health and welfare; (2) outdoor grazing: there is widespread belief that cows belong to the Dutch landscape; outdoor grazing helps FrieslandCampina to differentiate itself in the market. Full and part-time pasture grazing are rewarded with a premium; and (3) sustainable development: six indicators are developed to make

sustainability at the farm level transparent. Examples of these indicators are energy consumption, health and longevity of cows and care for the landscape. FrieslandCampina offers farmers an energy scan and energy workshops. In this way different objectives are coupled: production to mitigation. The energy scan is a questionnaire about the energy consumption on a dairy farm, possibly in combination with a comparison of the energy consumption of other member farms (about 2000 scans are performed in 2013). The comparison among members is translated into recommendations for improvements.

- Additionally, some advisory services in the Netherlands are input co-operatives of farmers. They supply inputs to farmers including advisory services, but the expertise is mainly on inputs. They essentially provide specific advice to farmers on their own products (Hermans et al., 2011). Many cooperatives have also started their own research / or innovation centres. An example of this type of advisory service is the animal feed input cooperative Agrifirm. Agrifirm Feed NL introduced five sustainability themes: mineral efficiency, animal health, climate, recycling and more sustainable raw materials. Agrifim is monitoring and wants to improve the carbon footprint of animal production, including farm level. The carbon footprint is the sum of the greenhouse gas emissions during the life cycle of the animal products (Agrifirm, 2015).

5.5 Deltaplan Agricultural Water management (DAW)

64. **Farmers and water boards co-operate on water management in agricultural areas**
For example farmers co-operate within the Deltaplan Agricultural Water management (DAW) to implement innovative measures to deal with future fresh water supply and water quality challenges in an integral way (see DAW, 2015). DAW does not only reflect devising and implementing innovative approaches, but also offers an action plan to take up challenges of water management. The objective of the DAW is to contribute to regional water management challenges in agricultural areas and to achieve an economic viable and sustainable agriculture. DAW focuses on arable farming, horticultural farming and dairy farming. Through cooperation between the agricultural sector and water boards, bottlenecks can be removed. Agricultural entrepreneurs and water boards work closely together on local water issues to improve water quality and quantity for ground water and surface water. Farmers implement measures to reduce nutrient emissions and water boards guarantee the supply of fresh water in times of droughts. For this purpose, regional co-ordinators are appointed.

65. **To support farmers, DAW has put together a gross list with water management measures which will be developed in regional pilots**
For this purpose the Ministry of Infrastructure and the Environment (I&M), Economic Affairs (EZ), association of provinces (IPO), Dutch Federation of Agriculture and Horticulture (LTO Nederland), association of drinking water companies (VEWIN) and Dutch Water Boards co-operated in a bottom-up process. Measures address water quality issues and water quantity issues. The latter address flooding, water shortages and impact of climate change. It is important to take into account regional differences in water systems and farming systems. DAW acknowledges that the regional water system and farming system are connected and that public and private responsibilities are shared at different institutional levels. A total budget of 65 million euros will become partly available from the Dutch Rural Development Plan (RDP). In total 30 projects will be developed.

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Wageningen Economic Research
MEMORANDUM
2017-045

To explore the potential of nature to improve the quality of life

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Memorandum 2017-045

The mission of Wageningen University and Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 5,000 employees and 10,000 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.