EFFECTS OF AGRI-ENVIRONMENT SCHEMES ON AGRICULTURAL INPUTS AND OUTPUTS INCLUDING BIODIVERSITY IN THE NETHERLANDS

BY

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MSc. THESIS PLANT PRODUCTION SYSTEMS

JAN. 2010-JUN. 2010

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ABSTRACT

Agriculture uses land resources and also contributes to environmental degradation through intensification and over exploitation of resources. Biodiversity loss, particularly in the Netherlands, has become a concern. The loss has been addressed amongst other measures through agri-environment schemes (AES) but its effects still remain questionable. Several studies have presented contradicting results on the impacts of AES in the Dutch agriculture. Previous studies have concluded that management agreements have had no positive effects on plants and birds diversity. The effects of management agreements for botanic contract have been investigated on entire fields or field edges and results showed no positive effects. This research has sought to investigate effects of AES on agricultural inputs and outputs and why AES has not benefited biodiversity substantially in the Netherlands based on previous research. The methodology applied were interviews, use of questionnaire, inputs-outputs analysis and literature review. Experts and farmers within the Netherlands formed the respondents for this research. Researchers who have done similar study on AES were interviewed to solicit for their knowledge on the research topic. Also, experts who are leaders and advisors of farmer cooperative and working in nature conservation organizations were consulted. The selection criterion of farmers was based on those who have accepted AES contracts basically, for botanic scheme and meadow birds' protection. Topics outlined in the questionnaire include effects of AES on inputs and outputs, effects of AES on biodiversity, effects of AES on production, effects on natural resources, economic impacts of AES, issues that hinder AES to benefit biodiversity substantially and suggestions for improvement. Results from interviews conducted show that short contract duration, low and irregular payments, inefficient monitoring, bureaucracy and agricultural intensification are issues that hinder agri-environment schemes to benefit biodiversity substantially. Extending contract durations, improving payments, reducing bureaucracy and making management prescriptions flexible are recommendations proposed to improve agri-environment schemes to enhance biodiversity.

Keywords: *Agri-Environment Schemes, Multifunctional Agriculture, Biodiversity, Botanic contract, Meadow birds, ecosystem services*

TABLE OF CONTENTS

DEDICATION

This work is dedicated to the Almighty Lord and my family. My family’s support towards my education has been very remarkable and I dedicate this work to them.

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LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AES	Agri-Environment Schemes
EU	European Union
CAP	Common Agriculture Policy
MFA	Multifunctional Agriculture
CBD	Convention on Biological Diversity
MEA	Millenium Ecosystem Assessment
LNV	Ministry of Agriculture, Nature and Food Quality
SARD	Sustainable Agriculture and Rural Development
FAB	Functional Agro-Biodiversity
PEBLDS	Pan-European Biological and Landscape Diversity Strategy
EC	European Commission
CEC	Commission of European Communities
DEFRA	Department for Environment, Food and Rural Affairs

1. INTRODUCTION

1.1 Background

The problems of overproduction within the European Union countries and the environmental impacts of agriculture have led to the introduction of agri-environment schemes that aim to reduce such impacts. The dairy sector is the most important sector of Dutch agriculture. Dutch agriculture is characterized by high productivity with high use of external inputs such as chemical fertilizers, manure, pesticides, and energy (Dutch Dairy Board, 2007). The use of these inputs increases productivity. The Netherlands is ranked the third largest net exporter of food products on the world market and it has one of the most intensive farming systems in the world (Andersson, 2000).

The focus of agriculture after World War II was on productivism (food production) with emphasis on mass food production through industrialization and mechanized agriculture. The focus was to produce and market cheap food products resulting in low value addition. There was mass food production or scale enlargement and intensification on agricultural land (Renting *et al*., 2006). Food had to be transported over longer distances (food miles) due to globalization disconnecting producers and consumers. Farm buildings had to be relocated to create more space for production. Chemical fertilizers and pesticides were used to improve yields and this led to loss of agricultural landscape and nature reserves of the countryside.

This agro-industrial paradigm or modernized agriculture had its problems seen in three folds; economic, social and environment (Ploeg and Renting, 2001). The main environmental concerns of Dutch agriculture relate to: nutrient use, emissions, pesticides, biodiversity, agro-chemicals and social issues like animal welfare, animal diseases, food safety and quality. The use of fertilizers and other pesticides to increase yield had its associated problems with gas emissions, leaching of chemicals into ground water, and destruction of biodiversity. Pesticides have residual effect on food and this poses threat to human health.

Multifunctional agriculture (MFA) has become a concept that has gained much attention by Dutch society. Multifunctional agriculture is considered as agriculture providing several functions such as tourism, employment, conserving biodiversity and other public goods and services to society beyond the primary function of food and fibre production. It is the joint production of commodities and non-commodities with its primary role of providing food for society (Verspecht *et al*., 2001). The focus of agriculture on food production alone becomes a disincentive to small scale farmers who are not able to take part in the global food market.

Most farmers are depending on agricultural activities for their source of livelihood in addition to other non-farm activities and it becomes important that other functions are incorporated into agriculture in order to meet their needs. Other needs of humans may also be partly delivered by agriculture and multifunctional agriculture seeks to provide these multiple needs that society requires. Multifunctional agriculture serves to provide a versatile countryside where food production is combined with leisure, recreation, education, care facilities, and beautiful landscapes which tend to improve the livelihood conditions of the Dutch community.

Society has expressed concerns about non-food or non-productive functions of agriculture. It is in these perspectives that multifunctional agriculture has become an important concept to address some of these problems. This concept first appeared in the Netherlands in a Dutch research for multifunctional agriculture in 1996 (Vereijken *et al*., 1997; Vereijken and Hermans, 1998).

Multifunctional agriculture, which is seen as a form of sustainable rural development integrating different functions of agriculture, has also become an important topical issue within European agriculture. The focus of multifunctional agriculture is to promote economic, social and environmental development for people. "Sustainable rural development attempts to integrate agriculture as a multifunctional set of practices that have the potential to enhance the interrelationships between farms and people, both within rural areas and between rural and urban communities" (Sonnino *et al*., 2008) Sustainable rural development is about recombination of agriculture with other forms of activities, i.e. multifunctional forms of activities that facilitate new forms of relationships between agriculture and people and between rural and urban communities. Sustainable rural development is also about creating new forms of products, services, new markets and engaging in forms of cost reduction activities to satisfy the needs of people.

The impacts or benefits of agriculture must be considered from the point of view of humans as well as of the ecology or environment. According to Acka *et al*. (2005),"economists emphasized the importance of multifunctional agriculture in maintaining and improving farmers' living standards through increased outputs and ecologists lay emphasis on conserving the natural resources". The aims of multifunctional agriculture today both focus on protecting the environment from degradation and also seeking the welfare of farmers and society at large. "Agriculture is an economic activity providing multiple benefits to society" (Acka *et al*., 2005). Some of these benefits are positive whilst others are negative. The negative effects have detrimental consequences on the environment and man such as use of pesticides with possible leaching of pesticides into groundwater, pesticides destroying micro-organisms in the soil and reducing soil quality.

All these problems have raised concerns about new practice(s) of agriculture that are more sustainable to reduce the deteriorating effect on the environment. In response to environmental problems arising from green house gas emission that have effect on biodiversity and natural ecosystems, mitigation measures has been put in place to address such impacts.

So called agri-environment schemes (AES) have been applied in many European countries including the Netherlands to reduce the loss of biodiversity and encourage sustainable farming practices. Agri-environment schemes are schemes that pay farmers to farm in an environmentally sensitive way. The European Union (EU) has integrated agri-environment schemes as one of the accompanying measures of the Common Agricultural Policy Reform since 1992. More emphasis has been placed on integrating agricultural production practices with respects to the environment and biodiversity. Payments given to farmers voluntarily participating in agri-environment schemes are established based on income forgone for production, costs incurred in applying measures specified by the agri-environment schemes and incentive elements.

Agri-environment schemes within the EU provide either a response to the pressures of farming on the environment or a means to encourage opportunities that agriculture creates for the environment. The wide variety of policy instruments ranges from voluntary to mandatory approaches (Gatto and Merlo, 1999). Voluntary approaches include advice, persuasion, education and extension whereas mandatory policies involve restrictions on inputs use to bring about improvements in environmental quality. Agri-environment schemes aim at facilitating a multifunctional agriculture and to preserve agricultural land from degradation through for instance biological diversity, soil and water health, reducing intensive farming and maintenance of landscape quality.

Farmers are given payments as economic incentive for providing ecosystem services and to encourage them to adopt sustainable practices that will preserve the environment. Societal demands or problems differ from country to country and agri-environment schemes address specific problems related to agriculture in countries. For instance, in the Netherlands the function of agriculture providing ecosystem services such as biological diversity and quality landscape in the countryside for leisure and recreation are important. In a country like France, much attention is given to social, cultural and economic functions of agriculture by sustaining rural population and employment levels (Ploeg and Renting, 2001).

In the Netherlands, most schemes are vertical schemes targeted at specific geographical areas considered as high nature value areas or problem areas with low biodiversity. Zoning is established based on the ecological value of an area. For instance, Friesland is considered as a high nature value area for meadow birds' protection and breeding. One of the most common agri-environment schemes applied in Dutch agriculture is the management agreements, which focus on enhancing biodiversity. Management agreements encourage extensified practices such as late mowing and restricting fertilizer and pesticides inputs. There are two types of management agreements: birds and botanic contracts.

AES on meadow birds' protection focus on measures that prevent birds nest destruction. Bird nests are marked to prevent trampling by grazing animals or killing of chicks during mowing. Mowing is delayed until June or July for birds to hatch their eggs. Pesticides or input use is restricted and grazing intensity is reduced. Botanical agri-environment schemes are designed to improve species richness and diversity and in the Netherlands, they are particularly applied in wet grassland, hayfields and ditch banks ((Clausman and van Wijngaarden, 1984; Westhoff and Weeda, 1984; Melman, 1991; Blomqvist *et al.*, 2003b). Management practices under botanical AES include no fertilization, extensive grazing, later first mowing dates for flowering and seed set and controlled or reduced ditch sediments or plants part (Van Strien, 1991; Melman and van Strien, 1993; LNV, 1995). Reduced productivity from restricted fertilizer use is supposed to result in improved diversity and species richness facilitated by less competitive species developing.

1.2 Problem statement

The main focus of agri-environment schemes (AES) in the Netherlands is to increase or at least stabilize biodiversity (Clausman and van Wijngaarden, 1984; Westhoff and Weeda, 1984; Melman, 1991; Blomqvist *et al.*, 2003b). The management agreements, the most common form of agri-environment scheme have been applied in Dutch agriculture since 1981 (Beintema *et al*., 1997). One type of this scheme focuses on the protection of meadow birds, black-tailed godwit and the oystercatcher which are relevant on Dutch landscape. About 50% and 30-40% respectively of these species breed in the Netherlands and the management agreements are aimed to support their populations (Hagemeijer *et al*., 1997). Farmers are required to delay mowing and grazing in order for these birds to hatch their eggs. They are also required to protect their nests from any form of damage resulting from agricultural practices. Another type of management agreement which is the botanic contract is aimed at conserving species rich vegetation in grassland. There are two types of management: preservation of existing species and development of new species. There are heavy botanic contracts and light botanic contracts. Light botanic contracts restrict fertilizer use in order to maintain or improve certain types of grassland whereas heavy botanic contract ban its use (Peerlings and Polman, 2008). Farmers are required to maintain field margins under this scheme which is also common practice under most agri-environment schemes.

The contributions of the management agreement scheme in enhancing biodiversity in Dutch agriculture have been questioned and this still remains a concern. Biological diversity (plants, birds, hover flies and bees) have been investigated for their species richness under the management agreement scheme and no positive effects were found on their diversity. Only hover flies and bees have been reported to show an increase under the management agreement scheme (Kleijn *et al*., 2001). These authors carried out a similar study to evaluate the effectiveness of the management agreement scheme on botanical diversity; no positive effects were observed on entire fields or field edges of plant species or species richness. In another study carried out to investigate the densities of black-tailed godwit (*Limosa limosa*), and redshank (*Tringa totanus*), these species were higher in the areas with management agreements, but these differences were already present before the start of the contracts. After the start of the management contracts densities of black-tailed godwit and oystercatcher (*Haematopus ostralegus*) did not increase, while those of lapwing (*Vanellus vanellus*) and redshank even declined (Breeuwer *et al*., 2009). Postponing grass mowing is generally assumed to yield positive effect in the birds' protection contract, but there was no effect of this measure on birds' densities (Terwan and Guldemond, 2001). The reasons for these negative impacts were not explained by authors and this research will seek to investigate why AES fail to benefit biodiversity on agricultural farmlands.

The impacts of agri-environment schemes in enhancing biological diversity in Dutch agriculture therefore, remain questionable based on findings of other studies and this has indicated that there is a pressing need for research to find out what hinders agri-environment schemes to benefit biodiversity substantially in Dutch agriculture and recommend suggestions for improvement.

1.3 Aim and objectives of the study

The aim of the research is to improve insight in why agri-environment schemes fail to benefit biodiversity in the Netherlands as concluded by previous studies. The effects of management agreements schemes on biodiversity (botanical diversity and birds' species) are analysed. In addition, the associated agricultural inputs and outputs of agri-environment schemes will be determined and translated into costs and benefits. Based on this, I will propose suggestions for improvement of existing AES.

The objectives of this research are:

1. To analyse the effects of agri-environment scheme on biodiversity in Dutch agriculture
2. To find out issues that hinder uptake and effectiveness of AES
3. To propose recommendations that will contribute to improving agri-environment schemes in achieving its objectives in biodiversity conservation

1.4 Research questions

In order to achieve the set objectives, the following research questions have been formulated.
The main research question is:
To what extent has biodiversity improved (birds and plants species) at farm level through agri-environmental measures, and what is the impact on other agricultural inputs and outputs?

Sub-questions

1. What are the impacts of agri-environment schemes on inputs and outputs of farming?
2. How to measure and assess biodiversity in agricultural landscapes as affected by agri-environment schemes?
3. Which networks in the Netherlands are related to agri-environment schemes and what roles are played by these networks
4. Which issues hinder AES to benefit biodiversity substantially?
5. Which recommendations can contribute to making AES benefit biodiversity substantially?

1.5 Structure of the report

The second chapter provides details on the methodology and approaches used to gather information, detailed information on literature review on main concepts and issues considered for the study. In the third chapter, literature is reviewed on biodiversity and its related issues including biodiversity and ecosystem services, threats to biodiversity loss and how to measure and assess biodiversity. The European Union agri-environmental policies on Habitat Directive, Birds Directive and Natura 2000, financial support for agri-environmental schemes (AES) and networks related to AES are all reviewed in the fourth chapter. Results obtained and insights gained from interviews and survey questions are analysed in the fifth chapter. The findings of this study and the results obtained are well discussed in the sixth chapter. Also in the sixth chapter, research results are discussed and compared to literature and suggestions for improvements are proposed based on research findings. The concluding chapter seven, gives a summary of the main findings of the research. The questionnaire and its topics and interviewees responses on the questionnaire are attached as appendix 2 and 4 respectively.

2. MATERIALS AND METHODOLOGY

The methodology of the research specifies which approaches or methods were used to gather information and data, sampling procedure and how the data were analyzed. The first part of this research was based on literature study, for the second part interviews were carried out to solicit for experts/researchers knowledge and opinions on the subject. Based on literature study and interviews, the inputs and outputs of farms with and without agri-environment schemes (AES) were determined and compared. This allowed for the assessment of the impacts of agri-environment schemes on biodiversity and associated impacts which can stimulate or constrain the effectiveness or uptake of agri-environmental schemes.

2.1 Literature review

Reports, articles, journals and other publications have been reviewed to examine the effects of management agreements scheme on biodiversity in the Dutch landscape. Secondary information from the fields of environmental and ecological sciences has been considered as literature information. The literature review was done by searching for keywords including biodiversity and its related issues and agri-environment schemes on the internet. Literature has been used to define biodiversity and how it is assessed. The methodology combines the Millennium Ecosystem Conceptual Framework to determine the threats to ecosystem services of which biodiversity are closely related. The factors leading to loss of biodiversity have been explained based on the millennium ecosystem assessment framework. Factors that impact on birds' population level and also affecting plant diversity and species richness have been highlighted. The approach is the ecosystem approach which is the integrated management of land, water and living resources that promotes conservation and sustainable use of resources in an equitable way. This approach is based on the sustainable use of natural resources, its conservation and equitable sharing of the benefits arising out of the utilization of natural resources. This approach is used in order to consider the link between biodiversity and ecosystem services.

2.2 Survey questions

Issues that contribute to the low effects of agri-environment schemes in enhancing biodiversity have been analysed based on interview results. Studies on agri-environment schemes in the Netherlands have presented contrasting results and questions were formulated based on conclusions of other studies and also consultation with supervisors. The survey questions were first pre-tested on non-target people who were students with background in environmental and natural sciences. Even though the subject of agri-environment schemes for this study was not familiar to some of the students, the focus of the pre-test was to solicit for unexpected feedback in terms of question structure during the actual survey with experts and researchers.

In order to gain insight into the subject, the survey questions were divided into five sections (appendix 2). The first section comprised the effects of AES on biodiversity; meadow birds' protection and plant diversity. The second section focused on the effects of management agreements scheme on production with section three asking questions related to AES and effects on natural resources including water quality, landscape quality and soil health (micro, meso and macro fauna). Biodiversity is closely related to ecosystem services generating economic value such as food, fibre, tourism promotion and supplementing farmer's income through payments. Questions were formulated to ascertain whether AES have contributed to these ecosystem functions. Resources are used in production to generate outputs. The inputs and outputs associated with agri-environment schemes (AES) on one hand and without AES on the other hand, were quantified and translated into costs and benefits. The fourth section of the survey captured the effects of AES and without AES on inputs and outputs of farming. The issues that hinder AES to benefit biodiversity significantly and ways of improvement constituted the final section. A set of fifteen questions were formulated and detailed information was obtained through interviews. However, the order was different for different interviewees. The questionnaire was revised separately for farmers and experts with questions that were mainly focused on farmers such as the inputs and outputs of AES on farming were put first in the questionnaire. For experts and researchers, questions including effects of AES on ecosystem services and natural resources which has less emphasis on farmers appeared first in the questionnaire and these were used for the experts and researchers.

2.3 Interviews

Experts and researchers were selected based on consultations with supervisors and literature study. These experts and researchers come from the fields of environment, economics, ecology and experts working on rural sustainable development. Interviews have been carried out to solicit for experts opinions on how they perceive the effects of agri-environment schemes on biodiversity conservation in the Netherlands in general. For farmers, the interviews was focused on their own farmers own experience with AES on their own farms and other neighbouring farms. When choosing experts, the study aimed to exclude individuals with interest or focus on political role of the agri-environment schemes and sought to select individuals or scientists who have professional expertise in environmental policy issues and biodiversity. The interview extended over a period of 7 months, from January to July with a time of one and a half hours allotted for each respondent. The interviews were recorded.

The interviews were to gain insight into why agri-environment schemes fail to benefit biodiversity substantially to propose suggestions for improvement. The experts comprised people who have done research on AES, leaders of farmer cooperatives in agri-environment schemes and experts engaged in nature conservation projects. The interviews were conducted individually and follow-up was done later for detailed information for the writing of this thesis. Names and roles of all respondents in the interviews are put in table 1 below.

Table 1: List of all respondents interviewed

Names of experts and researchers	Names of farmers
Nerus Sytema	J.A. Dekker van den Berg
Rene Klein	A.F.M. Michielsen
Henk de Vries	Herman Lenes
David Kleijn	Minne Holtrop
Jack Peerlings	Wopke Veenstra
Hein Korevaar	M. J. Smit
Louis Slangen	Alex Datema
Dirk Wascher	
Marta Perez Soba	

2.4 Input-output analysis

In this research, the inputs and outputs of agri-environment schemes (AES) and without AES were determined through interviews. These inputs and outputs were compared for AES and without AES with their associated costs. Inputs such as seeds, labour use, machinery, energy use and fertilizers are used in production to obtain a certain amount of output (Van Ittersum and Rabbinge, 1997). The output generated can be positive (yield or productivity and biodiversity) or undesirable (nutrient losses). The inputs-outputs combination is determined to explain resource use and their outputs generated. The inputs and outputs associated with AES been examined. The effects of inputs such as energy use, labour and pesticides and the outputs or production generated; grass yield, milk yield and biodiversity have been analysed based on their estimation in percentage for AES and without AES. The results are used to analyse the difference between AES and without AES in terms of input-output relation to open ways for improvement.

2.5 Description of study area

The Netherlands is administratively divided into 12 provinces (figure 1): *Drenthe*, *Flevoland*, *Friesland (Fryslan),* Gelderland, *Groningen,* Limburg, Noord-Brabant, Noord-Holland, Overijssel, Utrecht, Zeeland and Zuid-Holland. The provinces are further sub-divided into municipalities.

For this thesis, nine researchers and experts were interviewed, who considered the effects of AES in the Netherlands in general. Further, seven farmers were interviewed, who considered effects of AES on their own farms and the neighbouring area.
Table 2 below gives a summary of the places where the farms are located, their provinces and type of schemes.

Table 2. Provinces of study areas

Farms	Study areas	Provinces	Type of schemes	Type of farm
1	Delfstrahuizen	Friesland	Botanic and birds contracts	Dairy
2	Vegelinsoord	Friesland	Botanic and Birds contract	Dairy
3	Briltil	Groningen	Birds contract	Dairy
4	Boelenslaan	Friesland	Botanic contract	Dairy
5	Paterswolde	Drenthe	Botanic contract	Arable
6	Dronten	Flevoland	Botanic contract	Arable
7	Dronten	Flevoland	Botanic contract	Arable

Figure 1. Map of provinces in the Netherlands

Of the seven farmers interviewed, four had a dairy farm and three had an arable farm. Below, some of the characteristics of these farms are described.

Table 3: Biophysical characteristics of farms

Characteristics	Delfstrahuizen	Vegelinsoord	Briltil	Boelenslaan	Paterswolde	Dronten	Dronten
Total Area (ha)	110	67	55	30	46	28	34
Area under AES (ha)	10 for botanic and 73 for birds	5.5 for birds	30 for birds	3ha for botanic	7 for botanic	2 for botanic	24 for botanic
Soil type	Peat	sand	1/3 clay which is 50-80cm on sand, 2/3 clay varying form 30-70cm on top of moor	sand	sand	clay	clay
Crops	*	*	*	*	Organic farm: Wheat, potatoes, maize, hennep and vegetables	Sugarbeets, beans, wheat, potatoes and onions	Wheat, potatoes, sugarbeets and chicory
Animals	160 cows and 100 young calves	125 milk cows, 90 young stocks	100 milking cows, 30 heifers, 30 calves	35 cows	*	*	*
Water level	90cm below mowing level	80cm below field level	80cm below field level	*	5.50m-7.00m above sea level	4m below sea level	4m below sea level

The farm at Delfstrahuizen has 110ha of land with 10ha for nature (5ha rented,5ha owned) and 73ha for meadow birds protection. For the botanic management, it has different types of grasses with no fertilizers applied, only mowing is carried out. The farming system is dairy in combination with maize production as fodder for 160 cows and 100 young calves. The soil type is peat and water level is 90cm below mowing level. On the area under meadow birds protection, mowing us delayed until 15th June for birds to hatch their eggs which is one of the regulations.

The farm in Vegelinsoord is 100% dairy with 125 milk cows and 90 young stock. The dairy and botanic management are on one farm and the birds protection contract with maize field also on another farm in a different location. Only the farm with birds protection contract and maize was visited because farmer explained the botanic field was farther away. The farm has a total area of 67ha and the allocation of areas for different purposes are: 2ha for botanic management and 4.5ha used for mowing on 15th June. The birds protection contract is under an area of 5.5ha at the maize field. The purposes remaining areas were not specified, the remaining areas could be used for the maize production, occupied by ditches and also the farm structures. The land has 5.5ha sand with the rest as peat. The water level is 80cm below field level.

The farm in Briltil was under two schemes in the past six years: meadow birds protection and botanic contract. Currently, the land is used for birds protection without botanic scheme due to extension of field boarder management from 1m to 3m which takes much space according to the farmer. The total area of the farm is 55ha which is used for 100 milking cows, 30 heifers and 30 calves. Of the total area, 30ha is used for meadow birds protection. The soil in this area consist of 1/3 of clay which is about 50-80cm on top of sand, and 2/3 clay which varies from 30-70cm on top of moor. For 1/5 of the area, the water level is about 50cm below the land and 4/5 of the hectar has water level which is about 80cm below the land.

The farm at Boelenslaan has a total area of 30ha, 24ha owned and a 6ha extra managed by farmer himself. The hectares under tree, hedgerow and botanic managements are 1.5ha, 1.5ha and 3ha respectively. The farm is dairy with 35cows which is in combination with nature conservation. Payments are given for the three nature managements: tree, hedgerow and botanic. The farm is situated in a less favoured area (sandy area) so payment is received for botanic, tree and hedgerow conservation to enhance the landscape beauty of the farm. The flowers on the farm has a positive influence on insects so more insects are observed on the farm.

In Paterswolde, the farm is an organic farm with nature (botanic) management. Crops grown are wheat, potatoes, maize, hennep and vegetable production. The total area is 46ha with 7ha used for nature management but only 3ha receive compensation payment. The soil type is sand and the water level is about 5.50m-7.00m above sealevel. Although, organic farming comes under organic scheme which is not the focus of this research, it impacts positively on biodiversity through restricted fertilizer use and this enhances floral and fauna diversity on the farm.

The farm with botanic contract in Dronten is in combination with arable production with the following crops in rotation; sugarbeets, beans, wheat, potatoes and onions. This farm has two types of botanic management: functional agro-biodiversity (FAB) which is financed by the provincial government and an outer border management (PSAN) financed by national government. Different types of flowers are used for the two botanic management. Total area of farm is 28ha and the area under the two botanic contracts is 2ha. The soil type is clay and it is a small layer varying from 25 till 60 centimeters clay on sand. The farm is located 3.5meters below sealevel and the average water level is about -4.5meters which differs in the summer and winter periods and also depends on the rainfall.

The other farm in Dronten is under botanic management for tree planting combined with crop production in rotation. Crops grown are wheat, potatoes, sugarbeets and chicory (witlof). Wheats are planted 50m away from the ditch bank and for potatoes there is a 1.5m spray free zone from ditch bank. Total area of farm is 34ha with 24ha under agri-environment scheme (AES). The soil is light clay from the bottom of the sea and the ground water is 1m below the surface. The farm is located 4meters below sealevel. Payments are not received for these management but the farmer gets a certificate from the Global Common Agricultural Policy (C.A.P) for preserving and enhancing nature.

3. BIODIVERSITY

Diversity is a structural feature of ecosystem and the variability among ecosystems form part of biodiversity (Millennium Ecosystem Assessment, 2005). The article 2 of the Convention on Biological Diversity (CBD) gives a formal definition of biological diversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Biodiversity is considered at three different levels; genetic diversity, species diversity and ecosystem diversity.

Genetic Diversity- This refers to the variation of genes within species between populations of the same species and variation within a population.

Species Diversity- This refers to the variety of species. Species diversity can be measured as species richness, species abundance and taxonomic diversity (Magurran, 1988). Species richness is the number of species in a defined area and species abundance measures the relative numbers among species. Taxonomic diversity is the measure of the genetic relationships between different groups of species.

Ecosystem Diversity-Ecosystem diversity is the differences between ecosystem types and the diversity of habitats and ecological processes occurring within each ecosystem type.

The objectives of biodiversity management according to the Convention on Biological Diversity are the following:

1. Conservation of Biological Diversity
2. Sustainable use of its components
3. Fair and equitable sharing of benefits

The conservation of biological diversity involves conserving ecosystems, species and genetic diversity to provide a range of goods and services for human need. The conservation of biological diversity is aimed at protecting species or habitat from being lost.

The objective of biodiversity management in sustainable use of its resources is to provide livelihoods goods and services for future generations. The harvest of resources should be such that resources can be maintained for long term use to support lives of future generations and other organisms.

The article 4 of CBD explains that all benefits arising out of the utilization of genetic resources shall be shared in a fair and equitable manner with the provider of these genetic resources, upon mutually agreed terms. Biodiversity generate ecosystem services which benefit man and the environment so farmers are given payment through AES to ensure sustainable production of services.

3.1 How to measure and assess biodiversity as affected by aes

Modern intensive agriculture has contributed to the decline of biodiversity and assessment is made of the state of agro-biodiversity in the Netherlands (Ten Brink *et al*., 2002). Biodiversity as affected by agri-environment schemes can be measured or assessed using different indicators such as habitat, trends in birds' population sizes, land use, impact and protection status (Heath and Rayment, 2001). Indicators are a way of presenting information that can form the basis for future action and can readily be communicated to stakeholders. They are used to check whether the trends or issues of concern are occurring to indicate the success or failure of actions, and then actions can change accordingly. Indicators used in the Netherlands are based on information of Central Statistical Office (CBS) and Alterra, various organizations monitoring plant, bird, mammal, butterfly and research institutes and universities which carry out research on baseline values (Floron, 1997; Ravon, 1999; Kleunen, 2001; Kleunen en Sierdsema, 2000).

Ecosystem quality is calculated by the change in abundance of species between the current state and baseline state (Ten Brink *et al*., 2002). The EU has a list of 26 (SEBI2010) indicators for Europe (Postnote, 2008). SEBI 2010 is a process initiated in 2005 to select a set of indicators to monitor progress towards 2020 in Europe. These indicators are developed based on experts, countries and institutional partners with the European Environmental Agency, the European Centre for Nature Conservation, the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), the European Commission and the Joint Secretariat of the Pan-European Biological and Landscape Diversity Strategy (PEBLDS, 2009).

Specific indicators work best at different scales and can be developed to suit the own geographical location. For example, species extinction is more important at global or EU levels whereas protected area is important at national level. Also, causes to biodiversity loss are different for different locations so indicators are designed for specific locations when the pressures on biodiversity loss are known. The Convention on Biological Diversity (CBD) places indicators into three categories: state, pressure and response (Gregory *et al*., 2003). The state indicators measure the state of biodiversity, pressure indicators measure factors causing biodiversity loss such as nitrogen deposition and fragmentation of habitat and the response indicators track the effort to conserve biodiversity through nationally designated protected areas (Wentworth, 2008).

The first chapter of this report has well discussed the cause of biodiversity loss in the Netherlands which is attributed to intensification and table 5 below compares agricultural intensification in five European countries. Clearly, all the values are high for the Netherlands as observed from the table. The findings of this thesis through interviews have further provided the state of biodiversity on farmland. The state of biodiversity is assessed by the abundance or distribution of selected species through counting. Birds as indicators for biodiversity changes can be assessed through population trends (Gregory *et al*., 2003). In the Netherlands, the state of both plants and birds diversity are assessed through counting. Agri-environment scheme which is a response indicator to track effort to enhance biodiversity seem to have positive effects on plants diversity than birds of which the reasons are discussed further in the results section of this report. Farmers' participation, training levels and the uptake of environmental advisory service which can be considered as response indicators can be determined at the farm through surveys and administrative records.

Through monitoring, inspection or supervision and up-to date records, the uptake or participation rate of AES and compliance of measures can be determined and related to biodiversity changes as affected by AES. Scientific research and farm surveys provide data and information on nutrient balances and energy use which are restricted under AES. The reduction in input use can then be related to changes in biodiversity over time. Genetic diversity can be determined through farm surveys by breeding companies or experts when counting is done. Population trends of farmland birds through bird counts and comparing with baseline data provide a basis for monitoring changes in birds' population under AES.

3.2 Biodiversity and ecosystem services

The objective of the millennium ecosystem assessment which was initiated in 2001 was to assess the outcomes of ecosystem change on human welfare and the scientific basis for actions required to enhance the conservation and sustainable use of ecosystem and their contributions to human well-being (MEA, 2005). The assessment focused on ways human activities have changed ecosystems and how the changes may affect people and the kind of measures at local, national and global scales to improve ecosystem management for human welfare. The Millennium Assessment has involved the work of experts to contribute their findings on ecosystems and the services they produce such as forest products, climate mitigation, clean water, food and natural resources and practices to restore, conserve or enhance the sustainable use of ecosystems. Increasing demand for food due to population increases and agricultural intensification and forest activities has resulted in substantial loss in diversity. This will reduce the benefits that future generations will derive from ecosystems services unless drastic measures are taken.

- Ecosystem

An ecosystem is a dynamic complex of plants, animals and microorganisms communities and the non-living environment interacting as a functional unit.

- Ecosystem services

Ecosystem services are the benefits people derive from ecosystems, (MEA, 2005). These benefits are summarized in Table 4.

Table 4. Classification of Ecosystem Services

Provisioning functions (economic sustainability)	Food, fibre, fuel, genetic resources, clean water, biochemicals
Regulating functions (environmental sustainability)	Water purification, pollination, seed dispersal, climate regulating, disease and pests control, erosion control, carbon sequestration
Supporting functions (environmental sustainability)	Nutrient cycling, soil formation, provision of habitat, water cycling
Cultural functions (social sustainability)	Educational and inspiration, spiritual and religious value, recreation and aesthetic value, Sense of place and identity

Source: MEA (2005)

Ecosystem services are classified into provisioning, regulating, supporting and cultural services. Biodiversity and ecosystems are closely related. Biodiversity is vital for the provision of ecosystem services. Biodiversity contributes to the services produced by ecosystems which will be discussed in the next section based on the Millennium Ecosystem Framework.

3.3 Millennium ecosystem conceptual framework

Biodiversity and ecosystems have important benefits on human welfare. Land use or management, population increase and technology affect the ecosystems. The Millennium Ecosystem Conceptual Framework is adapted to explain the services provided by ecosystems and factors that affect ecosystems for human well-being (figure 2).

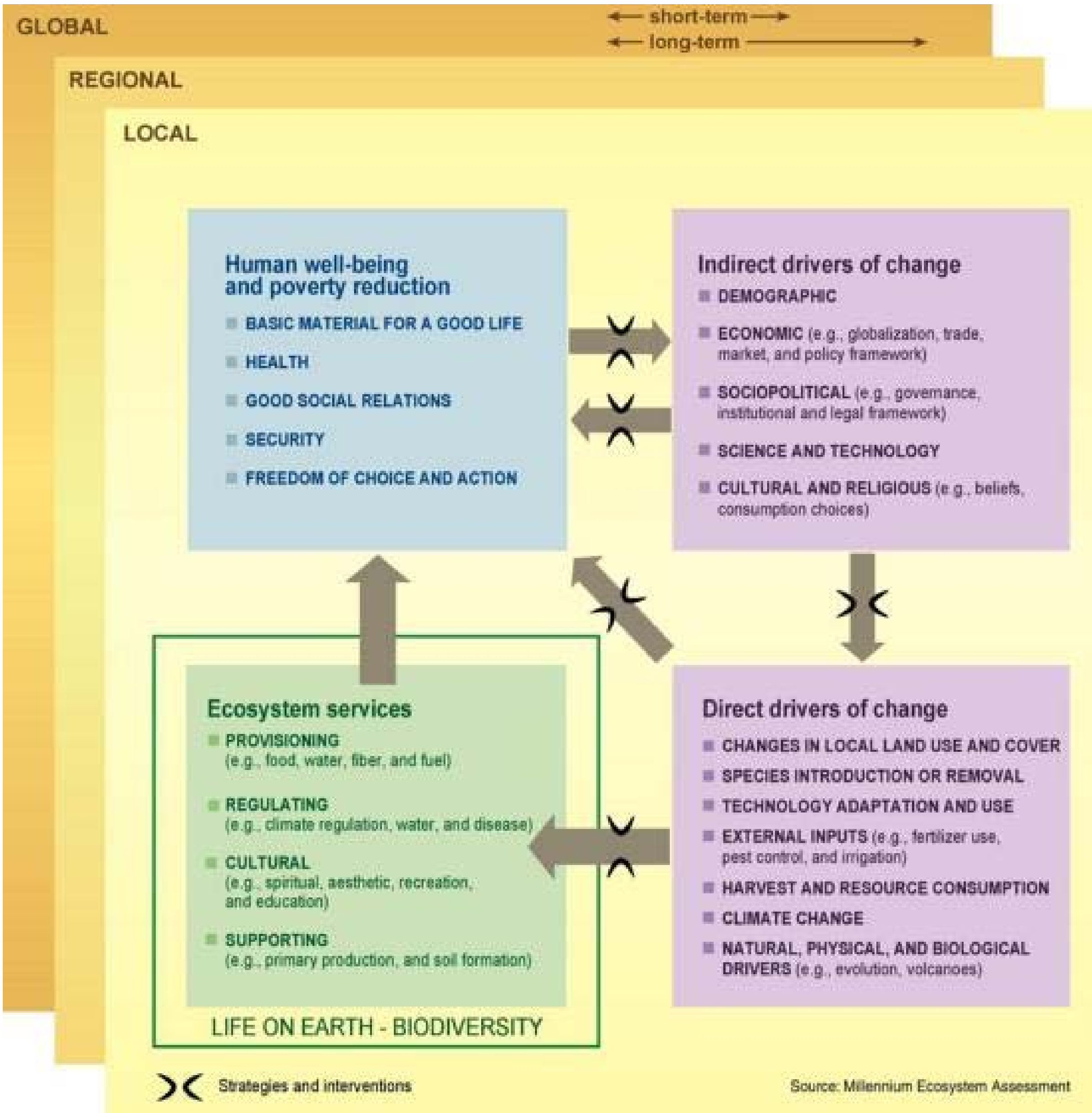

Figure 2. Millennium Ecosystem Conceptual Framework (2005)

The benefits of biodiversity in agricultural landscapes are explained in detail below based on the framework.

1. Regulating services

The regulating functions of biodiversity in agricultural landscapes are pests and disease control, pollination-seed dispersal, climate regulation through carbon sequestration and flood control (MEA, 2005). Species rich communities and improved diversity are more likely to contain highly competitive species and fewer vacant niches for resistance against pests. Improved biodiversity is essential for pest control where there is abundance of food for natural enemies or predators to attack pests.

Clearly, there is an interaction between plants, insects and birds. Plants constitute an important genetic resource producing food for living organisms, while insects and birds carry out pollination and seed dispersal that contributes to the plant genetic pool. Furthermore, they improve pest and disease control. Birds feed on pests that are harmful to crops. For instance, the ladybird is reported to eat over 100 aphids in a day and great tits feed their chicks on caterpillars protecting fruit trees (Naturopa, 1996).

Field margins are important for providing habitat for natural enemies such as beetles and ladybird to feed on aphids that attack crops. Agro-biodiversity enhancement in the form of field margin plants can be particularly essential for syrphid (hoverfly) survival and reproduction and for sustaining a viable natural enemy population (Langoya and Rijn, 2008). Many wastes or pollutants generated by humans are broken down and absorbed through biological processes. Bacteria and other life forms are involved in breakdown and assimilative processes. Chemical pesticides applied to control pests have harmful consequences on the soil and other beneficial organisms. Pests develop resurgence to pesticides after continual use. Many birds and plant species serve as natural biological control agents in controlling pests. For instance, the hoverfly feeds on aphids and marigold is useful in controlling nematodes.

Plant species that flower at different times of the season offer a continuous availability of floral resources facilitating continued presence of natural enemies as long as pest control is required in the field (Langoya and Rijn, 2008). This however also means enough food for pests. Therefore, there should be a selective approach where the species of need of conservation only attract natural enemies and are not preferred by pests. Plants furthermore influence climate by horizontal movement of air masses of varying temperature and moisture. Height, structural diversity, architecture and leaf seasonal patterns absorb heat and thus, modifying atmospheric temperature and air circulating patterns.

Temperature extremes are moderated by plants through shading effect and surface cooling by trapping warmth. Plants absorb carbon dioxide for the production of food. In this way, carbon concentration in the environment is reduced through improved biodiversity. Plants and vegetation in water catchments help to maintain hydrological cycles by regulating and stabilizing water runoff, flood and drought.

Vegetation cover prevents dry land helping to regulate ground water tables. Plants roots absorb water that may otherwise settle on the soil surface and cause flood. Water vapour is recycled by trees through the canopy's effect in promoting atmospheric turbulence. Water vapour transpired from leaves from plants is recycled and comes down as rain. Vegetation cover also protects the soil from erosion by binding soil particles and minimising the effect of water runoff.

2. Supporting services

The supporting functions of biodiversity are nutrient cycling, maintenance of soil fertility, soil and water conservation, soil formation and pollination (MEA, 2005). The functional biodiversity related to species such as improving soil fertility through nitrogen fixation improves soil health. Soil moisture, nutrient levels and soil structure are maintained through biological diversity. Soil formation is enhanced through the addition of organic matter from litter fall, root decay and regeneration.

The root system breaks up the hard pan of soils to allow for water penetration. Root systems also serve as nutrient pumps bringing nutrients from deeper depth beyond the reach of plants. Plants take up nutrients from the soil and air which serve as the basis of food for other organisms. Soil fauna break up organic materials to make nutrients more readily available for uptake. Bees, flies and birds carry out dispersal of seeds for pollination which is important for the reproduction of plants. Without pollination, the yields of most crops may reduce and many wild plant species will become extinct.

3. Provisioning function

The provisioning functions of agro-ecosystems include food, fibre, timber and clean water production. Agricultural biodiversity provides food in addition to other raw materials for clothing (cotton) and shelter (wood). Biodiversity is the raw material for all kinds of products (medicines, fruits and fish) and the gene reservoir for breeding (MEA, 2005). Human existence and other organisms depend heavily on plants. Most plants produce edible fruits and seed for human consumption. The availability of plants provides food for the completion of the life cycle of living organisms.

Pollen is primarily a source of proteins and amino acids and contains lipids, steroids and carbohydrates which are essential for birds and insects that feed on pollen (Wäckers *et al.,* 2007). Biodiversity conservation serves to provide a wide plant gene pool which augments the narrow genetic base of established crops, thus providing disease resistance, improved productivity and different environmental tolerances (Plotkin, 1988; Reid and Miller, 1989). Almost all medicinal products come from plant and animal origin. For instance aspirin is produced from willow. Wood is the raw material for making many products including paper, glue from gum, furniture and for construction.

4. Socio-cultural function

This include recreation, aesthetic or horticultural value, spiritual fulfillment and research. People spend leisure in natural scenery to observe plants and animals in their natural surroundings. Biodiversity promotes tourism which is a source of income to the farmer or local population. Wildlife habitats and natural features provide aesthetic qualities for ecological field study. Chemicals produced by animal and plant species have led to the discovery of medicinally useful substances through research. Prostaglandin E2 has been found to be important in treating stomach ulcers which was originally found in brooding frogs (Tyler, 1989). Many species, both plants and animals, have horticultural and ornamental value.

The Netherlands is one of the most densely populated and highly industrialized countries. This significantly affects the nature, the importance and the use of the countryside. Most of the Dutch population lives in the countryside and this puts pressure on rural resources, countryside for leisure and recreation. Urbanisation accompanied by growing need for recreational space is not the only factor that increases people's demand for nature space and tourist services, but also the expected increase in the ageing of the population (Ministry of Agriculture, 2000; Commission, 2003). Conserving biodiversity is also in an attempt to prevent further deterioration of nature areas and landscape to counterbalance environmental pollution and biodiversity loss. Biodiversity conservation contributes to improving the quality of life and rural cultural landscape in the Netherlands.

Conserving biodiversity is a mirror of our relationship with other living species. If humans consider species have a right to exist, they cannot cause voluntarily their extinction. Besides, biodiversity is also part of many cultures' spiritual heritage. The appreciation of nature is apparent in the art (nature photography), bird feeding and watching, ecotouring, boating and a range of other activities. Natural ecosystems provide aesthetic beauty, source of inspiration, peace and beauty, sense of place, spiritual fulfillment, recreation and aesthetic values for many human beings. Biodiversity which fulfills these functions forms an important aspect in the Dutch landscape.

3.4 Threats to biodiversity loss in the Netherlands

Biodiversity loss is simply the extinction of species. Biodiversity loss is characterised by reduction in species abundance (the number of individuals of species) and distribution of many original species and the increase in a few other as a result of human intervention. Land conversion, exploitation and pollution all lead to biodiversity loss. Biodiversity depletion can be considered from two main causes; loss of habitats (size of ecosystem surface) and loss of ecosystem quality (decreasing abundance of species (Alkemade *et al*., 2009; Reidsma *et al*., 2006). Loss of ecosystem quality in agricultural landscapes can be due to changes in landscape structure, changes in land management and external factors (Firbank *et al*., 2008).

Many unsustainable practices contribute a significant barrier to achieving basic conditions or services provided by ecosystems. Biological diversity is threatened by factors that are directly or indirectly influenced by human behaviour.
The direct causes of human induced biodiversity loss are listed below (MEA, 2005).

1. Loss of ecosystem quality
   a. Intensification; increased energy or inputs use (pollution of air, water and soil)
   b. Climate change

2. Loss of habitat: land use change
   a. Deforestation
   b. Infrastructural development/settlement expansion
   c. Habitat fragmentation

3.4.1 Intensification of agriculture

Agricultural intensification has had a damaging effect on a wide range of habitats and species. The losses related to removal of traditional field boundaries, ploughing of grassland and adoption of large scale intensive arable cropping or inappropriate use of pesticides has been significant (Baldock and Pienkowski, 1996). The Natural Capital Index (NCI) is an indicator that approximates terrestrial and aquatic biodiversity of natural ecosystems and agricultural land, respectively. The NCI for Dutch natural ecosystem has declined rapidly from about 51% in 1950 to 17% in 2000 (Netherlands Environmental Assessment Agency, 2009). Major changes in rural landscape have been due mainly to the modernization of agriculture. Agricultural intensification and infrastructural development such as construction has led to deterioration of landscape quality, pollution, lowering ground water table and loss of biodiversity of Dutch landscape.

The Netherlands is considered to be of more than average importance for migratory waterfowl, waders and meadow birds. The percentage of white fronted goose, barnacle goose and pink footed goose stopping in the Netherlands as at 2002 were 80%, 80% and 95% respectively. The current status of these birds is not known, but BirdLife international (2004a) finds that, farmland birds are particularly affected due to unfavourable conservation status attributed to climate change. It is reported that climate change now affects birds' species behavior, ranges and population dynamics. Percentage of European population of breeding birds; oystercatcher, black-tailed godwit and lapwing in the Netherlands in 2000 were 31%, 48% and 13% respectively (MNP, 2004b). A greater number of European meadow birds breed in the Netherlands. Environmental quality in Dutch agriculture has declined due to eutrophication and acidification from pesticides and this has resulted in the lowering of groundwater table which has an important influence on natural vegetation and wetlands (Netherlands Environmental Assessment Agency, 2009).

Environmental pressures are high in the Netherlands compared to countries like Germany, UK, France and Sweden. Agricultural intensity (lake phosphorus, energy transport intensity and ammonia emissions) was compared for five countries in 2003 and result is shown in Table 5.

Table 5. Agricultural intensification in five European countries

COUNTRY	LAKE PHOSPHORUS (Annual mean mg/l P	ENERGY INTENSITY TRANSPORT (Tons of oil equivalent/km^2	AMMONIA EMISSIONS (kg NH_3 per ha)
Netherlands	0.12	350	30
Germany	0.085	180	17
UK	0.05	200	12
France	0.02	100	13
Sweden	0.025	25	2.5

Source: Netherlands Environmental Assessment Agency (2009).

Reduced habitats, high environmental pressure and reduced landscape diversity has resulted in a loss of about 80% of the original biodiversity in the Netherlands (MNP, 2004a). Nature conservation has been an issue in Dutch society since early 1900 where considerable effort has yielded successes in the conservation of biodiversity at local and regional levels.

Most nature areas in the Netherlands have been converted to agriculture on a large scale. Land use has become more and more intensive where many small farms have been transformed into large farms with high inputs. Environmental pressures resulting from acidification, eutrophication, lowering groundwater table and heavy metals have been estimated to account for 60% of biodiversity loss in the Netherlands. Habitat loss, fragmentation and management are estimated to have caused a loss of about 30% (Netherlands Environmental Assessment Agency, 2006). High nature value farmland has decreased from 100% in 1950 to about 15% today caused by intensification and high nitrogen inputs. About 10% of nitrogen input on agricultural land is lost to air and about 40% to soil. Biodiversity on agricultural land in the Netherlands is still declining notwithstanding the implementation of agri-environment schemes to support for instance meadow birds and plants species population. Agricultural production for local consumption and export on Dutch land has contributed to biodiversity loss due to agricultural intensification and unsustainable methods of production (sebi indicator 23; Netherlands Environmental Assessment Agency, 2009).

3.4.2 Climate change

Climate change is the result of changes in weather patterns due to rises in the Earth's average temperature. The changes are caused by emissions from greenhouse gases from activities such as burning fossil fuel, land clearing and intensive agriculture (DEFRA, 2005). In Dutch agriculture, the main contributing factor of biodiversity loss due to climate change is a result of intensification which has led to fragmentation and less opportunities for species to move to other climate zones. Climate change affects biodiversity and leads to impact on goods and services generated by ecosystems. It puts additional pressures on ecosystems that are already stressed by overuse, degradation, fragmentation and loss of total area (DEFRA, 2005). Migratory species are especially at risk due to climate change because they require separate breeding, wintering, and migration habitats in suitable locations. Colder species rely on water to breed, any reduction or change in rainfall could reduce their reproduction.

Moreover, rising temperatures are closely linked to outbreaks of a fungal disease that contribute to the decline of populations of colder species. Warmer species need corridors so changes in climate will result in changes in habitat used for breeding, stop over rests or wintering of migrants, changes in the competitive systems among species, e.g. predators and their prey, and adaptive changes of the migratory route (DEFRA, 2005). These will lead to conservation problems such as population decrease, habitat fragmentation and poor monitoring data. Many species are uniquely adapted to specific climatic conditions whereby changes in climate can lead to their extinction. The reduction in many plants and animal populations in the Netherlands has been attributed to climate change where the environmental quality is not good enough for the conservation of species in areas designated as protected zones (Netherlands Environmental Agency, 2008).

3.4.3 Land use change

Land use change brought about by infrastructural development and agricultural expansion contributes to loss of habitat. Infrastructural development to meet the growing population and agricultural expansion to address expected increases in demand for food and fibre contribute to loss of habitat through intensification and conversion of nature land into arable and grazing fields. The issue of climate change and an attempt to mitigate environmental damage by producing renewable sources of energy also generate environmental effects. Land use change through deforestation for biomass production also poses threat to wildlife through the loss of natural habitat.

Habitat fragmentation contributes to biodiversity loss through spatial separation of habitat units from a previous state of habitat continuity (Hogan, 2009). Agricultural land conversion, urbanization and pollution cause habitat fragmentation. Fragmentation reduces ecosystem functioning by isolating populations of species into subpopulations. This affects the relationships between species where the population of some species may be high within the fragmented habitat and exert an impact on its community that may be strong and disproportionate to its abundance.

Furthermore, habitat fragmentation affects dispersal where some species could have low dispersal robustness to travel from one fragmented patch to another. Reduction in gene flow due to fragmented units could come about leading to reduced recolonisation (Kruess and Tscharntke, 2000).

3.5 Main factors impacting birds population level

Factors that have negative impacts on birds' population level (increased mortality), according to (Schekkerman, 2008; Schekkerman and Müskens, 2000; Schekkerman and Beintema, 2007) include:

1. Frequent mowing of grassland
2. Predation
3. Trampling by grazing animals
4. Loss of breeding habitats
5. Intensification on grassland
6. Loss of openness
7. Lowering of water table

8. Disturbance
9. Climate change

The decline in birds' population on intensively managed grassland is due to low survival of chicks caused by frequent mowing (early and fast) (Schekkerman, 2008; Schekkerman and Müskens, 2000; Schekkerman and Beintema, 2007). Frequent mowing destroys the nests of birds and most chicks are killed resulting in a reduction of foraging habitat of the birds (Wymenga, 1997; Kleefstra, 2007). Results of this research according to respondents interviewed have revealed that predation is the main factor impacting on birds' population level on farmland.

3.6 Main factors affecting plant diversity or species richness

Agricultural intensification is a contributor to biodiversity loss and also influences climate change through emissions causing a reduction or loss in ecosystem quality. Land use change brought about by infrastructural development, settlement expansion and habitat fragmentation contribute to habitat loss. In the Netherlands, intensification on agricultural land is the main contributor to plant species decline. Botanic contracts have been applied to restore species diversity and richness but have yielded no effect (Kleijn and Sutherland, 2003). High nutrient level is beneficial for few species whilst the less competitive ones are not able to compete for light, water and space. Pesticides use causes a reduction of weeds but also other plants. The effects of AES on plant diversity have been investigated in this research and results are discussed in later sections of this report.

4. THE EUROPEAN UNION AGRI-ENVIRONMENTAL POLICY

The European Union has integrated agri-environment schemes as one of the accompanying measures of the Common Agricultural Policy Reform since 1992. More emphasis has been placed on integrating agricultural production practices with aspects to the environment and biodiversity. Member States were required to submit a draft regulatory framework for the implementation of agri-environment aid schemes. Payments given to farmers voluntarily participating in agri-environment schemes are established based on income forgone for production, costs incurred in applying measures specified by the agri-environment schemes and incentive elements.

Agri-environment measures focus on nature and landscape protection, reduction of environmental pollution, reduction of land abandonment, and support to marginal land through the establishment of permanent grassland, protecting biodiversity and restoring landscape. In the Netherlands, AES have been designed to support biodiversity and nature friendly practices of agriculture. Schemes do not provide only environmental benefits but also social benefits. Agri-environment schemes are applied in member states based on geographical variations. Schemes can be horizontal or vertical. A horizontal scheme is accessible to a large population of farmers and is not based on any geographical zoning whereas a vertical scheme targets a geographical zone and is usually designed locally with specific objectives. The designation of agri-environment schemes in the Netherlands is done zonal or vertical for areas considered as high nature value areas such as Friesland or less favoured areas where the target species do not occur. Agri-environment schemes contribute to the objectives of the European Union nature conservation policy which covers:

- Habitat Directive
- Birds Directive
- Natura 2000

4.1 Habitat Directive

The habitat directive is focused on the conservation of natural habitat for flora and fauna species. Special Areas of Conservation (SAC's) are special areas designated by member states for conserving the natural habitat of flora and fauna species. These areas are protected sites designated under the EC habitat directive. The conservation of special areas requires that landscape features are managed to encourage the migration, dispersal and genetic exchange of species. Practices that will protect plants and animal species from becoming threatened or extinct are also encouraged.

4.2 Birds Directive

The birds' directive of the EU focuses on protecting, managing and regulating all birds' species, their eggs, nests and habitats. The directive is also aimed at reducing the exploitation of birds to prevent their extinction. Protection zones and habitats of the birds are to be maintained and destroyed habitats restored. The killing of birds' species apart from those that may be hunted, destruction of eggs or nests, disturbance, detention and selling of birds are not allowed within the European territory under the directive.

4.3 Natura 2000

The natura 2000 is an ecological network of special protected area for conserving biodiversity. Special areas of conservation have been designated by member states for conserving fauna and flora species in the territory of member states. Plants and animal species in need of particular strict protection are designated to special areas of conservation. A Special Protected Area in the Netherlands is Friesland.

4.4 Financial support for agri-environment schemes

Agri-environment schemes within the European member states are sponsored by the EU and co-funded by the national government. The aim of the Common Agricultural Policy is to provide farmers with a reasonable quality of living and consumers with quality food at affordable prices. The CAP began by subsidizing production for self sufficiency (first pillar). Over the past decades the way these aims are met have changed. Rural development and care for the environment, food safety and value for money are now all important. The CAP of today emphasizes payments to farmers to supplement farm incomes, food safety and quality and sustainable production. Payments for preserving rural landscape and biodiversity through agri-environment schemes go on to support farmers. Rural development is the second pillar of EU agricultural policy.

4.5 Networks related to AES in the Netherlands

The design and implementation of AES in the Netherlands is supported by institutions or nature conservation organizations and they work towards survey of targeted areas, species management, field margin management, creation of landscape elements, information dissemination, technical support, enforcement of measures and extension services (supervision, monitoring and inspection). The number of agri-environmental associations has increased from 90 to about 124 since 2001 with 10% of all Dutch farmers being members of AES association (Oerlemans *et al.*, 2004). Agri-environmental schemes are offered by government organizations and they liaise or partner with nature conservation organizations who aim at strengthening and preserving natural features and quality of the landscape. Nature cooperatives or organizations also contribute to sustainable and economically viable agriculture through agrotourism, biodiversity conservation and agrarian nature management.

Nature conservation organizations engage in joint projects, fundraising, consultancy and influencing policy makers. Fryske Gea in Friesland is a non-governmental organization that conserves nature. They lease land to farmer cooperatives to improve biodiversity by protecting bird nest and botanic management. The various institutions that support agri-environment schemes in the Netherlands include the national government, Nature Conservation Organisations such as Fryske Gea and farmer cooperatives. Environmental Cooperative of farmers, Ministry of Agriculture, Nature and Food Quality (LNV) are all networks related to AES (Polman, 2004). The national government designs and offers AES to address issues that are of environmental concern.

The national government also co-finances AES as a partial support to what is sponsored by the EU. Farmer cooperatives promote agri-environment schemes by giving ecological advice to other farmers, organizing courses on nature conservation and encouraging participation of non-participating members. Volunteers also play a role in nature conservation through birds count to monitor population trends e.g. meadow bird protection.

5. RESULTS

The purpose of this research was to investigate the effects of agri-environment schemes on biodiversity and the methodology applied was interviews. Nine respondents comprising experts and researchers and seven farmers were interviewed within the Netherlands. Issues that this research focused on include: effects of management agreement on biodiversity, effects of AES on inputs and outputs, effects of AES on natural resources, effects of AES on production, effects of AES on ecosystem services, issues that hinder AES to benefit biodiversity substantially and suggestions for improvement. Results from the interviews are put in the following tables (Tables 6-11).

Effects of management agreement on biodiversity were investigated and the responses of experts and farmers are represented in Table 6. Respondents who stated that AES have a positive effect on biodiversity constitute the highest percentage. This positive effect is due to the fact that measures prescribed by the scheme including reducing fertilisation, delaying mowing, protecting bird nests and maintaining floral species that all enhance biodiversity (anonymous, 2010).

Table 6. Effect of management agreements on biodiversity

	Number of respondents					
	- -	-	0	+	++	Not sure
Plant diversity				12	3	1
Black tailed godwit			1	11		4
Meadow birds			1	13		2
Lapwings			1	13		2
Oystercatcher			1	9		6
Insects and flies		1		11	1	3
Bees			1	12		3

Meaning of signs: - - = very negative, - = negative, 0 = no effect, += positive, ++ = very positive

Farmers explained that they see an increase in the numbers of plant species on their farms (anonymous, 2010). Few respondents specified that AES has a very positive impact on biodiversity (anonymous, 2010) as observed in Table 6. The positive effect for floral species under botanic contract emanates from the fact that reduced fertilization enhances plant species and this has a direct effect on natural enemies' population. Birds' numbers was explained to be enhanced as well through the provision of food and shelter (anonymous, 2010). One respondent specified not sure on the impact of management agreements on plant species but she perceived that it could be positive (anonymous, 2010). Botanic schemes on field margins were explained to attract insects and flies to pollinate field crops. Disease or pests incidence was also reported to be reduced since the flower margins provide shelter for insects to prey on pests that invade crop fields (anonymous, 2010). Farmers explained that they measure changes of biodiversity on their farm through counting of nests (anonymous, 2010). A farmer specified that in the year 2000, he had 50 bird nests and this increased to 75 nests in 2004, but currently there are 50 nests due to the increasing number of predation by foxes and storks. It was further explained that without agri-environment schemes (AES), there would be even less bird nests. Increasing biodiversity depends on how you measure it and what you want to preserve. If predators are preserved, meadow birds have less chance. Nevertheless, high biodiversity has imposed more prey available for storks and other predators (anonymous, 2010).

Respondents including farmers and experts explained that the positive impact of AES on plant diversity is proven by monitoring (anonymous, 2010). It was further explained that the contracts make farmers adopt traditional methods of farming that lead to stabilization of biodiversity (anonymous, 2010). One respondent specified that AES has negative effect on insects and flies as observed from table 4 (anonymous, 2000). Even though, reasons were not given for this very negative effect, from a point of view, it could be due to the reason that the soil is low in nutrient because of restricted fertilizer use on botanic fields and this could have a negative impact on the numbers of insects and flies.

Table 7. Effect of management agreement on natural resources

	Number of respondents					
Water quality	- -	-	0	+	++	Not sure
1. Surface water				13	3	
2. Ground water			1	10	3	2
Soil health						
1. Micro-fauna			3	8	1	4
2. Meso-fauna			3	9		4
3. Macro-fauna			4	8		4
Organic matter content			4	9	2	1
Landscape quality				14	2	

Table 7 shows the perceived effects of management agreements on natural resources. It can be observed in Table 7 that respondents who specified AES has a positive impact on natural resources constitute the highest percentage. Water quality, both surface and ground water is improved because of reduced fertilization on farms. Also, allowing a free spraying zone of about 3-6m around ditch banks improves water quality (anonymous, 2010). At Boelenslaan, where the focus is on hedgerow, botanic and tree managements, ground water quality has been measured, and results show that the nitrate concentration is 1.7 NO_3 mg/l compared to 52mg/l on sandy soils on average and a norm of 50mg/l (anonymous, 2010). Also, concentrations of other macro and micro nutrients are much lower than average (Appendix 1).

Soil microbes and organic matter contents were explained to be enhanced through agri-environment measures (anonymous, 2010). The reduction of pesticides enhances the population of soil organisms and use of surface mulch is a source of organic matter to the soil. Mulching enhances soil conditions such as nutrient levels, moisture retention and temperature regulation which all promote fauna activities. Use of mulch serves as a substitute for fertilizers, which have a tendency to destroy biodiversity and reduce water and air quality.

Landscape quality is improved because there is more biodiversity on farms (anonymous, 2010). Field margin management and birds' protection enhance the aesthetic quality of the landscape attracting other biological life such as insects and bees to pollinate. Some agri-environment schemes (AES) specifically focus on landscape quality such as the hedgerow and tree managements at Boelenslaan. For the tree management, the first cut is done at 7 years of the tree establishment, second cut at 14 years and the last cut at 21 years after which tree regrow. The aesthetic quality of the landscape was explained to be improved after adopting this practice (anonymous, 2010). Other respondents explained that traditional practices such as restricted fertilizer use for botanic management improve species diversity and richness. This facilitates biodiversity on farmland and generally contributes to landscape quality (anonymous, 2010).

The impacts of AES on other ecosystem services such as provisioning, supporting and socio-cultural functions were investigated and results are presented in Table 8.

Table 8. Effects of AES on ecosystem services

	Number of respondents					
	- -	-	0	+	+ +	Not sure
Provisioning functions		1	7	6		2
Supporting and Regulating			2	12		2
Socio-cultural			4	10	1	1

Respondents who specified that AES contributes positively to ecosystem services constitute the highest number. The positive impact of AES on provisioning functions including food, fibre and other raw materials was not attributed to man per se but crops grown on the farm constitute the main food for farm families and income generation. Rather, trees and plants bear fruits and provide nectar which serve as food for birds (anonymous, 2010). Birds that visit farms use plants as habitat for reproduction and breeding. Field margins (botanic scheme) were explained to harbour beneficial insects which prey on pests attacking crop plants. Insects are beneficial in carrying out pollination to increase plant genetic pool or diversity on the farm. It was further explained that the more biodiversity there is on the farm, the better the landscape quality and this attracts people to farms to appreciate nature (anonymous, 2010). Floral species has a regulating function in absorbing air (CO_2) and contributes to clean air production (anonymous, 2010). More biodiversity on farmland enhances the entire landscape and this has a socio-cultural benefit in promoting tourism (anonymous, 2010).

Table 9. Effect of AES on production

	Number of respondents					
	- -	-	0	+	++	Not sure
Grass productivity	1	10	3			2
Milk yield	1	6	7	1		1
Crop productivity		4	3	5		4

The effect of management agreement on production was investigated and respondents that specified no effect of AES on milk yield constitute the greatest percentage as shown in Table 9. The effect of AES was specified to be very negative on grass productivity and the reason was that if grass is cut late and it is not followed by fertilization, the grassland productivity is much lower (anonymous, 2010). A farmer further explained that grass that is cut on 15th June contains much less energy and less proteins hence, milk production is lower. The time of cutting sometimes affects quality of grass because at certain periods, birds on the farm have flown away and this may give farmers the chance to mow but because the time specified for mowing in the AES measures is not due, farmers are compelled to postpone cutting of grass (anonymous, 2010). The negative effect for grass production expressed by respondents was perceived to be because of the delayed mowing which affects the production of harvested grass. The quality is also reduced due to later cutting date coupled with no fertilization and this was explained to reduce grass yield (anonymous, 2010). Soil also has an influence on grass productivity. Farms situated at Boelenslaan and Delfstrahuizen have sand and peat soils respectively, where no high yields can be expected. Farmers farming on better soil's such as clay may have higher yields of grass and this subsequently can lead to a positive effect on milk production. Milk production was specified to be positively affected because when grass is mixed with normal roughage from intensive used pastures (up to 30% in the ration) it gives an equal milk production by higher proportion (anonymous, 2010).

Management agreements have a positive effect on crop productivity because farmers explained they still apply organic fertilizer (manure) to improve yield since their income come from the crops. Farmers ensure a balance between productivity and biodiversity conservation (anonymous, 2010).

Table 10. Effect of AES on input-output

Inputs ($ha^{-1}yr^{-1}$)	**AES relative to no AES. Range in (%)**
Labour	+5 to +10
Machines	0 to + 10
Energy (litre oil)	0 to +5
Nitrogen application (kg)	-5 to -25
Pesticides (kg a.i)	-15 to 0
Buildings	0
Irrigation water 10^6m^3	-5 to 0
Seeds	0 to +5
Cattle (LU)	-10 to 0
Outputs ($ha^{-1}yr^{-1}$)	
Milk (litres)	-25 to 0
Nitrogen loss (kg)	-25 to 0
Grass (ton fresh yield)	-5 to -10

Not all respondents who were interviewed specified the inputs and outputs for this survey because researchers and experts considered impacts of AES in the Netherlands in general instead of on actual farms, and are not experts on changes in inputs and outputs. All seven farmers were asked about their own experience on their own farm.

The effect of AES on inputs and outputs of agricultural production was investigated and results are presented in Table 10. Respondents specified that agri-environment schemes require between 5-10% more labour compared to no AES.
Farmers who have adopted botanic contracts specified that the whole management on botanic management consumes much time particularly for activities that are done manually (anonymous, 2010). The whole management prescriptions in terms of protecting birds nests, mowing of grassland, planting and maintaining floral species on field margins is time consuming (anonymous, 2010). The effect of AES on energy use was investigated and the interview revealed that AES uses 0-5% more energy relative to no AES. Mowing of grass in AES uses relatively more energy for passing over several times on grass to the desired height as perceived by farmers. Reduced fertilization specified as one measure of AES was specified to reduce nitrogen application by 5-10% and this has a positive influence on biodiversity farms. Organic fertilizer (manure) is applied on grassland as a source of nitrogen for the cows. One farmer specified that he uses 230kgN/ha on his sandy soil instead of 250kgN/ha which is specified in fertilizer regulation (anonymous, 2010). He further mentioned that formerly, there were no fishes in the waters on his field, but currently fishes are seen in the waters. The reason attributed to this positive effect is because of reduced nitrogen application on botanic fields which is perceived to reduce nitrogen loss to surface and ground water. Farmers further explained pesticide application level is reduced. Pesticides e.g. the use of herbicide was explained to be applied occasionally on the spot mainly, for docks and rumex (anonymous, 2010).
A farmer with birds' protection contract explained that, his milk yield is $1.2*10^6$ litres/year/150cows for his farm which on average gives 8,000litres/year/cow. This can be related to the Dutch average (7700litres/year/cow in 2008, FAOSTAT), hence his production is 3.9% higher than the Dutch average. This implies that the milk production for the farm is above the Dutch quota. Another farmer who has nature management, obtains a production of 260,000litres/35 cows, which is 7428litres/year/cow and this is only 3.5% lower that the Dutch average. It was explained by one farmer that grass productivity on his farm is reduced by 25% because of delayed cutting coupled with reduced fertilization (anonymous, 2010).

Table 11. Issues that hinder AES to benefit biodiversity substantially

	Number of respondents		
Issues	**Yes**	**No**	**Not sure**
Agricultural Intensification	12	2	2
Short contract duration	12	2	2
Low payment	12	2	2
Irregular payment	9	3	4
Low participation rate	6	7	3
Inefficient monitoring	9	2	5
Environmental factors	9	4	3
Few research results published on AES	9	3	4
Bureaucracy	4		
Predation	4		
The regulation makes often a very practical management not possible	3		

For issues that hinder agri-environment schemes (AES), options were provided for respondents to specify whether or not they affect AES to improve biodiversity significantly. Respondents were also given the opportunity to identify other issues based on their own knowledge or own experience on own farm. So for this question, it was focused on specifying for the options that were given in the questionnaire and allowing respondents to also identify other issues based on their own knowledge or experience on own farm.

Respondents specified that the nature of agricultural intensification in the Netherlands makes it difficult to achieve high levels of biodiversity (anonymous, 2010). A farmer added that intensification should be reduced in the Netherlands if biodiversity need to be enhanced but this will also depend on the goal of the farmer. He mentioned that if a farmer wants to get high productivity from his land, intensification could result because the farmer aims at profitability. It was also explained that intensification in the Netherlands is high to achieve very high level of biodiversity so more restrictions should be put on agricultural pressure in the Netherlands (anonymous, 2010).

The short contract duration of 6 years in the Netherlands was specified to be not long enough to benefit biodiversity significantly (anonymous, 2010). A farmer reported that apart from contracts being short, uncertainty is also an issue. It was added that from 2007-2008, she had a contract for Functional agro-biodiversity, FAB 1 and from 2009-2013, another contract for FAB 2 which is a follow-up from FAB 1. Another farmer explained that longer contract duration is better for sustainability, but there needs to be the possibility to ascertain which changes have to be made in the regulations to help improve biodiversity significantly. Other respondents specified that contract duration of 6years is not short but long enough (anonymous, 2010) to benefit biodiversity. A farmer expressed that contract duration of 6 years is not short: it's a good period and not too long but long enough to benefit floral and fauna diversity.
Bureaucracy was specified to be too much and this is not good for effective management guidelines (anonymous, 2010). One farmer added that the rules of AES involve too many criteria and paper work. A farmer with botanic management gave a similar explanation that when farmers join AES, the administrative procedures involved such as the filling of forms and paper work takes too much time. He reported that AES should rather focus on management guidelines and practical measures that will help achieve the objectives of AES.

The interviews revealed that compensation payments are low and irregular. It was explained that payments should be improved to cover large areas under scheme (anonymous, 2010). A farmer reported a similar explanation that he has 7ha on his farm and only for 3ha he receives compensation payments under botanic contract because payments are not high enough to cover large areas. Another farmer also expressed a similar reason that due to low payment, not all her field borders are planted with flowers so the botanic management is only restricted on two sides of the her farm. A farmer with both meadow birds protection and botanic contracts added that the budget is not high enough that every farmer can join AES and payments are often delayed (anonymous, 2010). Respondents explained that payments are not regular so compensation and hence, monies are not given on time (anonymous, 2010). Other interviewees specified that payment is not low: the payment compensates around the income forgone (anonymous, 2010).

Predation was observed to be the main factor that impact on birds' population level as highlighted in the literature review. Two farmers explained that the bird population on their farm has reduced which they observe through nest count (anonymous, 2010). However, specific numbers were not given. They explained most of the nests on their farm are empty without chicks due to predation. One farmer however, specified that he had 50 bird nests in the year 2000 and this increased to 75 nests in 2004, but currently the number of nests has reduced to 50 due to predation by foxes and storks.

Some interviewees specified that participation rate is not low because farmers currently have a positive attitude towards nature and many farmers are accepting AES contracts in the Netherlands (anonymous, 2010). A farmer further expressed that although participation rate is not low, accepting contracts also depends on what is already there. He observed that for birds' protection contract, there should be birds for farmers to accept the contract. On the contrary, other respondents specified that participation rate is low and it affects uptake of AES (anonymous, 2010). A farmer added that in her area, many farmers are willing to accept AES contracts but because compensation payments are not high enough and it is only given for 0.4ha for botanic management, so other farmers who are committed to agrarian conservation cannot participate in AES (anonymous, 2010). Due to the low payments, she has botanic management restricted to only two borders of her field.

Monitoring of biodiversity was found not to be efficient based on interviews but two respondents specified that monitoring of biodiversity in general is good (anonymous, 2010). They explained people who are involved in monitoring of biodiversity in the Netherlands are trained so they are experts who have the knowledge and skill to carry out counting of plants and birds. However, other respondents expressed an opposite view. Monitoring was explained to be not efficient in terms of record keeping and regularity of visits (anonymous, 2010). One farmer expressed that there is strict monitoring but the experts who do the monitoring have to better explain to farmers for them to understand what they should do. He also specified that results of the counting are often not communicated to farmers on time: visits of the experts to farms are not regular. There is therefore, some time lapse between consecutive counts so record keeping is not consistent. Also, results are mostly based on expert knowledge of official institutes and knowledge of farmers is not considered (anonymous, 2010). These inefficiencies were explained; do not contribute to making monitoring very efficient. Respondents added that the volunteers involved in the counting of biodiversity (birds) need sufficient training to make the monitoring efficient in terms of results generated (anonymous, 2010).

Environmental factors including soil, weeds and weather were explained to affect the level of biodiversity conserved (anonymous, 2010). Two respondents reported that other factors can be controlled but the weather is not under human influence. A farmer who has a botanic contract explained that in a dry period, it is difficult to grow flowers and grasses on field margins because the soil is too dry to promote seed development (anonymous, 2010). During the visit to the botanic farm on 20th April, 2010, it was observed that the area was not planted with flowers due to the dry condition so the land was bare. Mulch conserves moisture but water is needed for the initial development of plants. It was further explained that weeds are problematic since she doesn't apply pesticides because it is a regulation and herbicide is also not good for biodiversity. In contrary, another farmer who also has a botanic contract applies herbicides only on spot to control Rumex (anonymous, 2010). In this sense, it is still good to maintain floral diversity.

Soil is one factor that was identified to affect profitability of AES. At two locations, Delfstrahuizen and Boelenslaan which are both under botanic schemes with peat and sand respectively, it was observed that these soils do not give very high yields; it is difficult to grow crops there. Therefore, dairy farming dominates in these areas. Profitability is still much lower than in the clay areas. A farmer explained that in clay areas, farmers have a different mentality: they want to earn as much as possible from their land and have high yields so they are generally less committed to agrarian nature management (anonymous, 2010).

The interview revealed that more research still needs to be done and results published on the environmental effect of AES (anonymous, 2010). Two respondents expressed that AES has long been applied in the Netherlands but its effect is not high enough to commensurate the cost used in its implementation so more research and innovation need to be applied to investigate and address the issues that hinder AES and results also published (anonymous, 2010). On the contrary, a respondent observed that much research has been done on AES because knowledge and advice is shared by farmers and between farmers and organizations and also, there have been better standards for monitoring (anonymous, 2010). One farmer added that knowledge on sustainable practices is been used by farmers. He further mentioned that, more research and innovation is always needed to assess the impacts of AES on biodiversity over time. This farmer further expressed that many researchers come to his farm and neighbours farm e.g. Weeda to interact with farmers and to monitor effect of AES on biodiversity on farms (anonymous, 2010). Another farmer shared in these views that more research has been carried out on AES and confirmed it by explaining that, criteria or rules have changed but not objectives.

Respondents specified that the regulation makes often a very practical management not possible and this makes it difficult to apply certain rules on the field (anonymous, 2010). One farmer added that passing of machines over botanic fields is not allowed which is one specification in the AES regulations because it destroys biodiversity. It was explained that this regulation is difficult to implement on the field since farmers need to go into the field with machines to do farm operations such as harvesting and ploughing (anonymous, 2010).

6. DISCUSSION

This research has sought to investigate the effects of management agreements on biodiversity and to answer the research questions formulated. The study focused at farm level and findings of the research are discussed in this chapter. Based on this, recommendations are given to increase the adoption and effectiveness of AES.

6.1 Impacts of AES on biodiversity

The effects of two agri-environment schemes, botanic and birds' contracts on biodiversity were investigated and this study has presented diverse results. Few respondents specified that AES has very positive effect on biodiversity. The reason few respondents specified very positive effect is that respondents perceived much money is invested in agri-environment schemes but biodiversity is not very high to reflect the investment made. This argument is similar to the report of EC (2005a), that close to two billion euros per year was spent at this period, 1999-2003, as public funding expenditure for AES in the EU.

Most respondents however said that AES do have a positive impact on biodiversity. The positive effects for floral species under botanic scheme emanates from the reason that reduced fertilization enhances plant species and this has a direct positive effect on natural enemies' population. Birds' numbers were explained by respondents to be enhanced as well through the provision of food and shelter. This explanation by interviewees is similar to study by Wäckers *et al.* (2007), that pollen is primarily a source of proteins and amino acids and contains lipids, steroids and carbohydrates which are essential for birds and insects that feed on plants. The level of biodiversity conserved also depends on management and other environmental factors such as weather, diseases and pests. Weather changes are beyond the influence of man and if weather fluctuations are high at a given time period, it affects biodiversity. During periods of dry conditions the growth of plants species in need of conservation are slowed down and competition by weeds affect plant diversity because only few species may be less competitive for light, nutrient and space. The application of herbicides destroys or reduces plants species of conservation value. Even though, no effects were observed on plant diversity in a study by Kleijn *et al*. (2003), this research has revealed that botanic contracts seem to have positive impacts on plants diversity based on the interview results.

The impacts of management agreements on natural resources (soil quality, water quality and entire landscape) was also investigated and interview results showed that management measures specified by AES has an overall positive contribution to environmental or ecosystem functioning according to all respondents. This argument is similar to the study of Purvis *et al*. (2009) that, specific farm management practices prescribed by AES contribute to improving environmental issues including natural resources (NR), biodiversity (B) and landscape (L). Reduction of inputs use and reduced stocking density as measures specified by AES reduce pollution and this contributes to enhancing soil, water and air quality.

Agri-environment schemes through restriction of fertilizer use are to enhance biodiversity. Purvis *et al.* (2009) observed that the adoption of traditional practices such as hay making and use of local inputs (manure, local crops and animals) by farmers contribute to enhancing genetic diversity. Physical farm structure such as field margins or borders attract pollinators and this conserves natural biodiversity. The creation of footpaths also connects people to the farm to facilitate recreation. Maintaining field margins improve the quality of natural resources (soil, water and air quality) because of the reduction from pesticide use. These findings by Purvis et al. (2009) are similar to the explanation by all respondents interviewed that, practices such as maintaining floral and fauna species through reduced fertilization improve the biodiversity on farmland and this enhances the aesthetic quality of the entire landscape.

Agri-environment schemes also contribute to ecosystem services such as air purification, supporting function (soil health) and socio-cultural benefit. Vegetation on the farm including grassland and trees absorb carbon dioxide and purifies the air. The net positive effect compared to crops is not known but trees and permanent pasture can be perceived to be high in carbon stocks compared to crops because for arable crops, they are continuously harvested so there is carbon loss due to crop removal. Biodiversity on the farmland is a source of tourism which attracts visitors to the farm and this connects nature and people. This function of AES is supported by study of Sonnino *et al*. (2008), that multifunctional agriculture is a set of practices that have the potential to enhance the interrelationships between farms and people, both within rural areas and between rural and urban communities. The socio-cultural function of AES can also be supported by the findings of Groot *et al*. (2009), who examined the relationships between biodiversity and ecosystem services. They examined indicators for determining sustainable use of ecosystem services. They observed that plants and animals provide food for man and other biological life e.g. insects and birds. Botanic scheme therefore, contributes to ornamental value or resources by attracting insects and beautifying the landscape. Floral and fauna species contribute to a socio-cultural value where people appreciate natural scenery and offer recreational opportunities for tourism. This gives people a sense of cultural heritage, identity, spiritual and religious inspiration. Enhancing floral species also attract insects to feed on pests that attack crops on the field which was explained by one respondent and this observation is similar to the finding of Groot *et al*. (2009) who reported that control of pest populations is achieved through biological regulation.

6.2 Effects of AES on inputs and outputs

Scientific publications on effects of AES on inputs and outputs at farm level are very little and few compare costs at higher level for the tax payer. Not many have done this type of analysis and most studies on AES have rather focused on biodiversity issues. Dobbs and Pretty (2008) are one of the few who assessed the benefits gained by the total costs paid, based on the 10 year Environmentally Sensitive Areas Programmes in the UK. Nevertheless, AES Payments vary under different production system because costs also differ. Assessment that form the basis for the payments are however not published in scientific literature.

The effects of AES on production (milk, crop and grass) were investigated and respondents explained that the productivity of grass is lower than without schemes. This was attributed to delayed cutting and lower intensity. A later cutting date and lower fertilization means a lower feeding value of the grass. The time of cutting sometimes affects quality of grass, as at certain periods birds on the farm have flown away and this may give farmers the chance to mow, but because the time specified for mowing in the AES is not due, farmers are compelled to postpone cutting of grass (anonymous, 2010). The no effect observed by farmers for milk yield is because although delayed mowing decreases grass productivity, this is compensated by buying supplements to feed cattle.

The milk yield (litres) on a farm having a botanic contract and additional tree and hedgerow managements was specified to be 260,000L/35 cows (anonymous, 2010). This production is 7428litres/year/cow which is only 3.5% lower than the Dutch average (7700litres/year/cow in 2008, FAOSTAT). Another farm having both birds protection and botanic contracts, the milk yield for the farm is $1.2*10^6$ litres/year/150cows which on average gives 8,000litres/year/cow, hence almost 3.9% higher than the Dutch average. Clearly, the latter farmer obtains a high milk yield compared to the former. The scale of production is a factor that can influence yield because the latter farmer operates on a large area so he obtains a high milk yield compared to the former. Also, for this farmer with high milk yield, he has additional leisure activities together with the botanic and birds contracts so the higher milk yield is meant for sale to visitors who visit his farm for recreation and hence, he aims at profitability so he obtains high yield of milk. Irrigation water is reduced by 0-5% as seen in table 8 and this is because farming system under AES is not solely production but partly used for biodiversity conservation too. Cattle numbers was explained by farmers to be reduced between 0-10%. This is to reduce excessive manure production which could result in leaching or volatilization which poses a threat to wildlife. This reduction is also because of fertilizer regulations since 2006. Below is a summary of fertilizer regulations since 2006 (Korevaar *et al.,* 2006).

On dairy farms with minimum 70% grass and maximum 30% maize, the maximum allowed organic manure application in 2006 was 250kg N/ha. On sandy soils, total allowed organic plus chemical fertilizer was 300kg N/ha on grazed grassland; 355kg N/ha for mowed grassland. The application levels of N for grazed grassland and mowed grassland have been reduced to 260kg N/ha and 340kg N/ha respectively in 2009. For maize land in a sandy area the standard application in 2006 was 155kg N/ha: and in 2009 it was 150kg N/ha. For phosphate fertilizers, the standard application in 2006 was 110kg P/ha on grassland and 95kg on arable area and this reduced to 95kg P/ha and 80kg respectively in 2009. Considering these regulations, if a farmer applies the maximum allowed organic manure on his fields, and 10% becomes under AES, he needs to reduce his organic manure application with 10%. As it is not easy to get rid of organic manure, one option is to reduce the number of cows that produce manure, and this is sometimes done.

The reduction in livestock numbers and reduced fertilization limits nitrogen loss by 0-5% based on interviews. This reduction is good for high biodiversity and this facilitates the diversity of insects and other fauna species. Farmers specified that grass yield is reduced by 5-10%. The reason given by respondents was that if grass is cut later and it is not fertilized, the productivity is much lower because there is less energy and proteins and hence, milk production goes down. A farmer with botanic scheme explained that the grass yield depends on the type of soil: on clay soil the yield is higher (10,000kg FEM/ha) but he obtains the yields on sandy soil which is (7,800kg FEM/ha) without fertilizer (anonymous, 2010). This yield on his farm therefore, does not make much difference whether there is AES or no AES because sandy soil is poor compared to clay. However, it is still important to improve nutrient management on poor soils, but application should be done in split doses to reduce nutrient losses which have negative effect on biodiversity and natural resources.

6.3 Issues that hinder AES to benefit biodiversity and suggestions for improvement

6.3.1 Agricultural intensification

Although respondents indicated that AES has had positive impacts on biodiversity, it was explained that biodiversity can be much high if intensification is reduced. This was attributed to the reason that the nature of agricultural intensification in the Netherlands makes it difficult to achieve high levels of biodiversity on farmland. Uthes *et al*. (2010) observed that "Environmental effects of implementing AES were moderate and greater on high-yield than on low yield grassland". A farmer interviewed, mentioned that on his sandy soil, management is already less intensive, so easy to convert. Farmers on clay would have more difficulties as yield will reduce more (anonymous, 2010). The low environmental effect on low yield grassland as observed by Uthes and others was due to the scheme not well targeted. They mentioned that improving the efficiency of the scheme would require designing separate instruments for the two distinct objectives. However, studies by Kleijn *et al*. (2009), demonstrated that "plant species richness declined with increasing land-use intensity" and this confirms respondents' argument. The authors reported that biodiversity increase is more from changing from 75kg N/ha to 0 than 400kg N/ha to 60kg N/ha i.e. moving from extensive to very extensive than intensive to extensive.

Kleijn *et al*. (2009) also observed the most important implications of the relationships between biodiversity and land-use intensity and were that: "high biodiversity and associated ecosystem services are largely restricted to areas where land use is very extensive and species of conservation concern are concentrated in areas with low intensity farming".

The interviews conducted has revealed that because payments are not high enough to cover all costs such as labour use, more farmers engage in intensive agriculture and biodiversity loss is not halted (anonymous, 2010). This statement is supported by findings of Uthes *et al*. (2010) who reported that, "land parcels managed by extensive farms are more likely to "participate" in grassland extensification schemes due to lower on farm costs than intensive dairy farms". In giving compensation payments to farmers, all costs should be covered by the scheme so that farmers engaged in intensive production on more productive soils get enough payments that cover all costs to persuade them to participate in AES.

6.3.2. Environmental factors

Environmental factors such as weeds and drought were explained to be issues that affect floral diversity. The weather sometimes is too dry to sow and such dry condition makes it difficult to plant flowers on field margins and vegetation on the farm tend to wither. Since compensation payments are not high enough to cover irrigation, it delays planting and during such periods and the aesthetic quality of the landscape is reduced. This results in more weeds coming up competing with the few plant species on the farm (anonymous, 2010). Restricted application of fertilizer on botanic fields makes it problematic controlling weeds and hand picking is often time consuming. A farmer with botanic scheme applies herbicides on a spot to control Rumex (anonymous, 2010).

Soil is one factor that was explained to determine the profitability of agri-environment schemes. At two locations (Boelenslaan and Delfstrahuizen) where farmers farmed on sandy and peatland soils respectively, it was specified that these soils do not give very high yields making it difficult to grow crops (anonymous, 2010). Due to this, dairy farming dominates in these areas. Therefore, farmers who farm on better soils i.e. on clay are less willing to commit to agrarian or nature conservation compared to those farming on poor soils like sand.

Uthes *et al*. (2010) have reported that on sandy soils, if temporarily high amounts of N become available in the soil, there is a risk of being leached by unexpected heavy rainfall. This occurs if the total amount of N-fertilizer (particularly mineral N) applied is very high. Although, farms on sandy areas are already less intensive, participation in AES may still be more important compared to clay farming due to higher leaching risks that can be expected in sandy soils. On poor soils like sand, there is the possibility to use or apply organic manure which is important for maintaining soil fertility, but also when there are surpluses, biodiversity can be affected negatively. It is therefore important that N-fertilizer is applied in split doses to ensure that N is provided in compliance with crop growth rates.

Regulations should be based on prevailing conditions. From the interviews conducted, it was observed that environmental factors such as soil affect profitability of AES. In designing AES regulations, provision should be made for differences in soil types and make standards a bit flexible for farmlands with poor soils such as sand. For instance, cutting dates and fertilizer use should be specified in the standards but allow appropriate changes to be made if conditions such as extreme drought dictate so. Sandy soil is poor compared to clay so it’s good to improve nutrient management to ensure a balance between productivity and nature conservation.

6.3.3 Predation

From the interviews conducted, respondents who have meadow birds’ contract specified that predation is a major problem that affect birds’ population on their farms (anonymous, 2010).

Figure 3. A farm with meadow birds protection contract

Farmers explained that the more birds of conservation need are on their farms, the higher the numbers of predators. One farmer specified that in the year 2000, there were 50 bird nests and it increased to 75 nests in 2004 but currently there are 50 nests. The decrease after the initial increase was attributed to predation by foxes and storks mainly (anonymous, 2010). Conservation of storks has been very successful lately, but has a negative impact on meadow birds. Meanwhile, shooting of the predators are not allowed according to Dutch regulations and this is a major issue of concern to farmers (anonymous, 2010).

It is recommended that the objectives of AES be made clear. If biodiversity must be enhanced through AES, then all other birds should be allowed otherwise, only birds of conservation need should be protected. What is needed, more biodiversity or payments to protect birds of conservation value? If payments are given for meadow birds protection, measures should be put in place to control predation on farms. Farmers consider it a wasted effort when all bird nests are empty without chicks hence, farmers and volunteers motivation will go down if they do their work for nothing.

6.3.4. Inefficient monitoring

The monitoring of biodiversity on farmland is not very efficient and people involved in monitoring need adequate training to make it more effective. Respondents specified that monitoring is not effective due to the reasons that: monitoring is inconsistent with time (not regular), few people are involved in counting of plants species, results recorded are often not communicated to farmers and if done it is communicated late, farmers' knowledge on biodiversity record on the farm is not considered and results are only based on experts knowledge or official institutes (anonymous, 2010). Farmers specified that they protect bird nests and at the time monitoring is carried out, they know how many nests are left. Due to the fact that the experts who are engaged in the monitoring are government appointees, farmers' knowledge is given little attention, with monitoring results only based on what experts provide. This makes the system a little unreliable with the data obtained. This makes it difficult at times to compare trends of biodiversity on their farm and communicate to researchers who interview the farmers.

Strict monitoring on farmers to ascertain whether AES standards are complied with, demotivate farmers. Farmers explained that, they have a positive attitude towards nature so they receive compensation payments to preserve the environment (anonymous, 2010). This statement is similar to what Berentsen *et al.* (2007) reported that "farmers' are satisfied to some extent with the level of subsidies for nature conservation and farmers' commitment to their natural environment strongly motivates them to get involved in AES. However, the feeling of being controlled too much demotivates them".

It is recommended that more knowledge by farmers and officials is involved in monitoring. Agri-environment schemes are measures to restore or enhance biodiversity on farmland and it should involve knowledge sharing by both farmers and official or government appointees. Knowledge should not only be focused on official institute results but farmers decision and concerns should be given due consideration. Although, most farmers are in co-operatives for knowledge transfer on nature management, it is also recommended that training be organized where farmers and government personnel meet to address issues of concerns of the parties involved.

6.3.5. Few research published on AES

It was concluded from interviews that not much results have been published on the impacts of AES on biodiversity. This argument can be explained from the point of view that farmers' opinions or decisions on AES are not given much attention. One farmer explained that when monitoring is carried out, results are only based on expert knowledge without considering farmers knowledge on biodiversity on the farm, since they manage the land and also know the state of biodiversity on their farms over time. In this view, it was explained that monitoring is not efficient in terms of regularity and communication of results to farmers to ascertain reliability of data. Farmers therefore, consider that their perceptions or decisions are not taken into account so results only focus on experiments without seeking farmers' consensus (anonymous, 2010).

Good research based on efficient monitoring is recommended. As mentioned earlier, monitoring is not very efficient in terms of results not communicated to farmers always, infrequency and not involving farmers' knowledge. Farmers manage the land and AES is targeted at individual farmers on how they apply measures to enhance biodiversity. Involving farmers' knowledge in the monitoring of biodiversity to some extent will help generate good and up-to-date results of biodiversity on farmland. However, experts are required to assess plant diversity on farms.

6.3.6 The regulation makes often a very practical management not possible; measures not flexible and ineffective management guidelines

Farmers specified that measures are often non-practical and not flexible. Farmers explained that their incomes depend on the outputs from the farm so they have to adopt measures that will give them good yields to stabilize their incomes as well as conserving biodiversity. It was explained that regulation such as not disturbing biodiversity on field margins for botanic scheme interfere with farm activities as farmers are unable to move machines into the field to harvest and carry out other field operations (anonymous, 2010). A farmer concluded that for meadow birds' protection, birds are not on the field at certain periods but mowing is not allowed when the time specified in the measures is not due. Delaying mowing in such a situation affects grass productivity which tends to have a consequent negative effect on milk yield. Complying with non-practical standards specified in the scheme often leads to inability of farmers to implement flexible measures on the field (anonymous, 2010).

It is recommended that flexibility in regulations be allowed based on site characteristics such as soil and what farmers perceive it's practical to do. The result of this study has confirmed that productivity (grass) is slightly lower under AES so farmers farming on poor soils especially need to improve nutrient management. Reducing N, is however necessary to prevent nutrient loss and increase biodiversity: N application should be done in split doses to prevent undesirable loss and to also enhance biodiversity.

6.3.7. Short contract duration and uncertainty after contract duration of 6years

Contract duration of 6years for AES is not long enough to realize visible effects, respondents explained. This argument can be supported by studies of Olff and Bakker (1991) and Walker *et al*. (2004), that on intensively farmed land, restoration of species diversity may take longer periods, requiring farmers to engage in AES for several periods to observe substantial effects. Contract duration of 6 years is likely to produce good biodiversity levels if there is proper monitoring and up to date environmental data. Keeping up to date data will enable scientists and researchers to compare the changes in biodiversity over a specified time period in order to apply appropriate measures. Management measures are not designed to suit different geographical locations as explained by a respondent so there should be good targeting (anonymous, 2010). Also different farms differ in site characteristics so it will not be ideal to conclude that contract duration affects AES to benefit biodiversity substantially when the same measures are applied in all situations. It was also mentioned that contract duration of 6 years is good so that farmers who would like to stop after some time if due to an increase in area from 1m to 3m as away from ditch bank as regulation, can have the possibility to stop contract if this regulation takes more space on their land.

It is recommended to extend contract duration. Biological processes are dynamic and visible changes or effect as a result of management measures can take many years. Environmental factors also play a role in the kind of effect or results produced. In order to observe a high effect of biodiversity, contract duration must be extended and compensation payments improved to stimulate longer term commitment by farmers. Improving payments may not be the only incentive to motivate farmers for prolonged contracts periods. Attitude change of farmers and realizing that nature conservation is important for society and agriculture will help to achieve the goals of nature conservation policies. Also, measures should be maintained for longer period without many changes as this can contribute to ascertaining factors that affect biodiversity to apply appropriate measures.

6.3.8. Low payments which affect participation

From the interviews conducted, farmers explained payments are low to improve participation rates. In Dronten, a farmer mentioned that other farmers are willing to participate in agri-environment schemes but payments are not high enough to improve uptake. The low payments have also resulted to farmers participating in botanic contracts to only use a small area of their farm for conservation. Because of this, biodiversity is not high enough as will be expected on farmland since it is restricted to one or two sides of the farm instead of whole farm margin (anonymous, 2010). In a study by Primdahl *et al*. (2003), who conducted interviews with participating and non-participating farmers in agri-environment schemes, it was observed that participant farmers undertook more agri-environmental activities than might be expected to maintain or improve environmental quality than non-participants. This means that if compensation payments are improved to cover all costs and payments are also given for large areas under AES, uptake of schemes will improve and thus, farmers will adopt traditional practices on large areas for a higher biodiversity. In a study by Knickel (2000) and Knickel and Schramek (1998), they found similar indirect evidence of likely environmental benefits if uptake by farmers is high.

These explanations by authors are similar to what respondents explained that if payments are improved to cover all costs e.g. labour use and land area under AES on farms, more farmers will join agri-environment to improve the level of biodiversity conserved. However, one farmer expressed that compensation payments cover the cost so they are not low (anonymous, 2010). Two farmers added that payments should not be too high, as farmers would participate in AES for economic benefits and not because they aim for ecological benefits (anonymous, 2010). Irregular or delayed payments were explained by farmers to be a disincentive. Apart from payments being low they are also not regular and sometimes payments are delayed to the following year (anonymous, 2010). A respondent added that he has 7ha for nature management but he receives compensation payments for only 3ha and the remaining 4ha is managed with his own capital. Also, the compensation payment does not cover all costs and it was further explained that some operations on botanic fields e.g. removing unwanted plants can only be done manually and is more time consuming (anonymous, 2010). The differences in income between a typical farm involved in landscape conservation and a typical farm not involved in landscape conservation were

determined and it was observed that, farms that engaged in conservation activities already before participation in AES earned a lower income than farms not involved in conservation (Berentsen *et al.*, 2007).
This lower income the authors attributed to smaller scale, lower intensity and lower productivity. The lower income, however, was compensated by conservation subsidies. It was explained that in less favoured areas, income and intensity are also lower without AES (anonymous, 2010). If compensation payments fail to cover all costs, farmers whose income solely depends on agriculture will likely not engage in AES and this will affect the level of biodiversity conserved because of low uptake.

It is recommended to improve the amount and regularity of payments. This study has revealed that compensation payments are not high enough to cover all costs associated with AES. Compensation payments should be improved to cover all costs e.g. labour use for the extra time spent on management activities that are done manually such as removing unwanted plants on botanic fields. Budgets for AES should be improved so that farmers who are more willing to conserve nature can participate to improve uptake of schemes. In this direction, payments can cover more area/ha under AES for higher biodiversity on farmland. As mentioned earlier, the payments are not high enough to use enough land for nature management which was explained by one farmer (anonymous, 2010). If payments are improved, farmers who have already accepted contracts can have more area under botanic management to benefit floral diversity hence, biodiversity will be much higher on farms. Also, it will improve uptake for farmers in Dronten who are willing to join AES but because budget is not high enough, they cannot participate in AES.

6.3.9. Bureaucracy/paper work

Respondents explained that much attention has been focused on administrative and implementation procedures rather than measuring the impacts as affected by AES. They specified that some of the rules or regulations are not very practical and they are not flexible to implement, e.g. maintaining a certain level of plant species in an area at a given time. Lee and Bradshaw (1998), have reported that previous evaluations on AES have concentrated on administrative issues and this observation is similar to what farmers explained. The authors further explained that “participation of AES per se does not guarantee the actual delivery of environmental goods and services, and only the monitoring of the actual scheme outcomes can demonstrate their true impact”.

Summary reports from (CEC 2000; EC 2005a), have concluded that “very few scheme evaluations specifically measure environmental outcomes and following a very detailed analysis”. Oreade-Breche (2005) has stressed the need for “monitoring and evaluation procedures and tools that are less oriented towards implementation and more oriented towards impact, and adapted to the variety of issues concerned”. These findings are similar to what respondents expressed, that results required are too theoretical and too much bureaucracy involving filling of papers and lots of data (anonymous, 2010). It was added that some measures specified in the AES regulations are too theoretical and hence, difficult to implement on farms. One farmer specified that because of too much bureaucracy, the AES regulations will specify that for instance, in about 2years, 100 plants should be seen in a square metre under a botanic contract. This measure, was explained may not be achievable because other factors such as weather and soil influence plant development.

An increased flexibility of measures is recommended. Bureaucracy should be less and regulations focused more on practical measures or tools. Farmers experience in nature management should be considered. Relying on experts' knowledge only for monitoring may sometimes not generate all needed information on the state of biodiversity especially if monitoring results are communicated to farmers late and also not done on regular basis. Regulations must be made simple, based on practical measures and rules maintained for longer periods without many changes. For the same piece of land under a contract, if the land is to be used for a different purpose, the same regulations must be used over time for better nature.

7. CONCLUSIONS

Biodiversity constitutes an important aspect in the Dutch landscape and its loss has been addressed through agri-environment schemes. Several studies including that of Kleijn *et al*. (2003) have concluded that AES has had no positive effects on biodiversity in agricultural landscapes. This study has sought to examine the impacts of AES on biodiversity at farm level, and investigated issues that hinder AES to benefit biodiversity substantially. The effect of AES on inputs and outputs of agriculture was also investigated. The results of this study have shown that AES seem to have positive effects on biodiversity on farmland because plant diversity has improved and reduction of inputs use benefiting floral and fauna species have been achieved. However, there are a number of issues that hinder AES to benefit biodiversity substantially and the conceptual figure below gives a summary of such factors (figure 4).

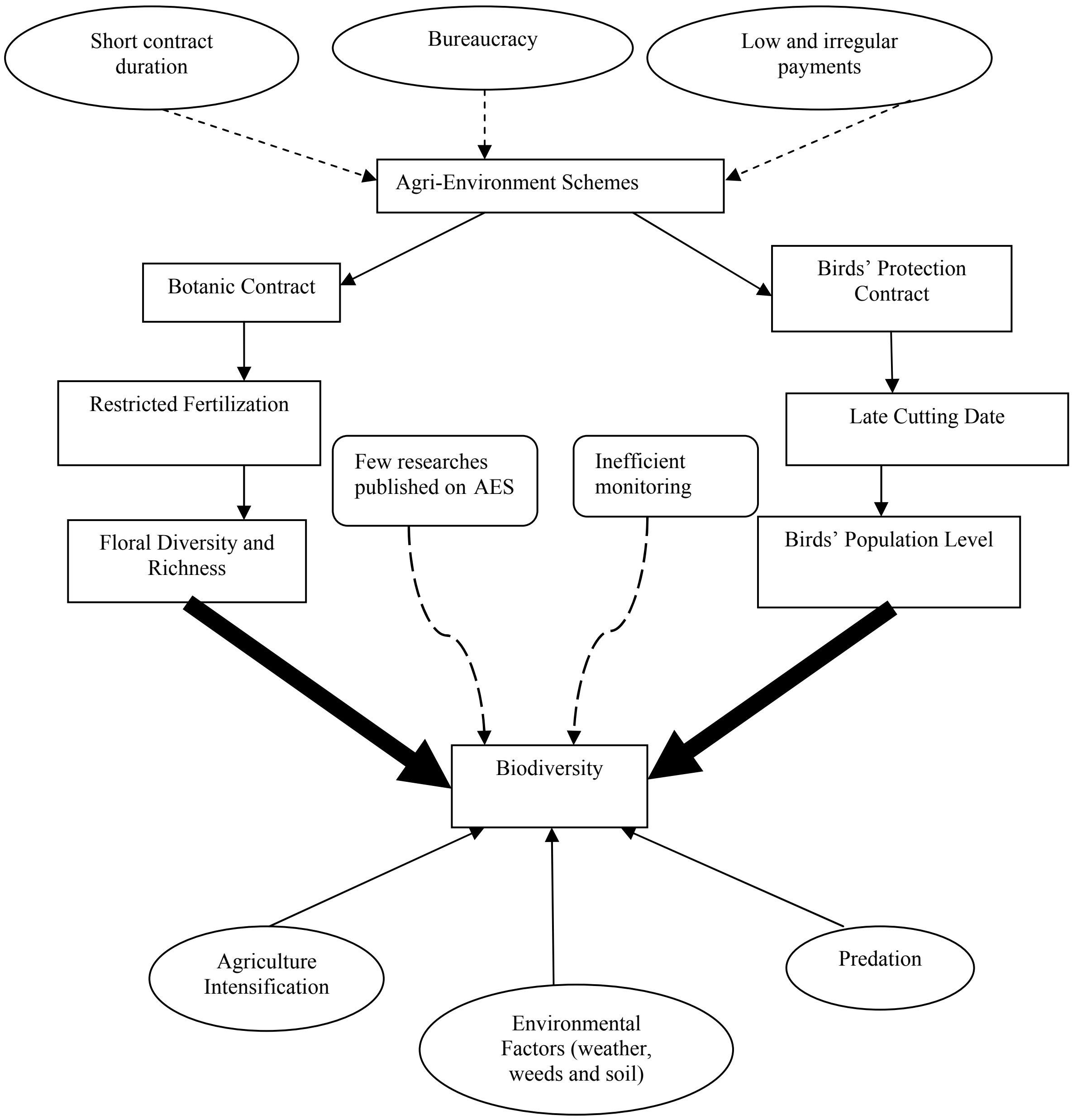

Figure 4: A CONCEPTUAL FIGURE SHOWING RELATIONSHIP BETWEEN FACTORS INFLUENCING THE IMPACTS OF AGRI-ENVIRONMENT SCHEME

The factors or issues that were identified through interviews affecting AES to improve biodiversity significantly are grouped under the following headings:

- Those that have direct impacts on biodiversity, besides AES: predation, agricultural intensification and environmental factors (soil, weather, weeds).
- Those that affect uptake of AES: short contract duration, low and irregular payments and bureaucracy.
- Those that affect knowledge on biodiversity impact: Few researches published on AES and inefficient monitoring.

Suggestions that have been proposed to help AES benefit biodiversity substantially on farmland include improving payments, flexibility of measures, good research and making objectives of AES clear. These recommendations will contribute to improving AES to benefit biodiversity substantially on Dutch farmland.

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9. APPENDICES

Appendix 1: Results of ground water sandy-summer on a botanic farm at Boelenslaan

Overview of the measured ground water quality in the summer of 2009 company number LEI 66824 and for the 263 sampled regular farms in the sandy area.

Season breakdown 2009

Measurement	Company	Average sand company	Norm	Lowest	25%	50%	75%	Highest
Nitrogen and Phosphorus compound (milligram pr litre mg/l)								
Nitrate (NO□)	1.7	52	50	<0.31	15	37	69	293
Ammonium - N	0.9	1.3	2	0.02	0.2	0.49	1.3	15
Organic - N³	2.6	1.5		0	0.89	1.4	2	10
Total - N	3.9	15		1.4	7.5	11	18	66
Ortho - P	0.02	0.13	0.1	<0.01	0.01	0.03	0.11	4.5
Total - P	<0.05	-□	3	<0.05	<0.05	<0.05	0.12	4.9
Other macro-elements (milligram per litre)								
Calcium	20	52	-	6.4	31	47	66	315
Chloride	26	44	100	7.5	20	27	37	1178
Iron	7.5	5.1	-	<0.05	1.5	3.5	7.2	43
Potassium	6.7	17	-	0.85	8.4	13	21	75
Magnesium	6	13	-	3.1	7	9.4	13	148
Sodium	15	30	-	7	13	16	20	1058
Sulphate	28	55	150	10	31	42	57	892
micro-elements (microgram per litre pg/l)								
Cadmium	0.15	0.25	0.40 (6)	<0.05	0.08	0.17	0.32	2.2
chromium	3	2	1.0 (30)	<1	1	2	3	10
Copper	14	9.5	15(75)	<0.50	3.5	8.1	14	45
Nickel	17	17	15(75)	<0.50	5.8	11	21	314
Zinc	29	41	65(800)	<4.0	15	30	56	224

Other characteristics								
DOC [4](mg/l)	48	34	-	3.6	19	30	45	118
pH[5]	5.3	5.2	-	4.3	5	5.4	5.9	7.2
EC[6](mS/m)	28	57	-	16	37	47	64	600
Gw.st.[7] (cm-mv)	138	153	-	74	116	142	174	393

By values below the detection limit is a “<” included. Values that (due to different reasons) could not be determined are indicated with “-“.

1. Norm: As shown is the national target for ground water with in bracket the intervention values. Only the Nitrate (NO_3) is the MTR value stated. In case there is no value, it is indicated with “-“ in the table.
2. To get the value of the Organic Nitrogen concentration (Organic – N), the nitrate – N is first calculated by multiplying NO_3. Then Nitrate – N en Ammonium is subtracted from the Total – N.
3. Dissolved Organic Hydrocarbon (DOC): Grounds with a higher Organic content often have a higher DOC concentration in the ground water.
4. Acidity of the ground/drain water (pH): a global division is the pH<4.5: Acid; pH 4.5 – 6.5: slightly acidic; pH 6.5-7.5: neutral and pH> 7.5 slightly alkaline.
5. Electric Conductivity (EC) of water is a measure of the amount of salt present. In fresh water is the EC mostly lower than 100 milli-Siemens per meter (mS/m).
6. Ground water level below ground on the day of sampling. The ground water level fluctuates naturally with the seasons.
7. No average calculated, excess values below the detection limit.

Appendix 2: Interview topics and key questions

QUESTIONNAIRE DESIGN

INTRODUCTION

Agriculture forms the main activity of rural communities. The rural population depends on agriculture for their source of income in addition to other off-farm and non-farm activities. Many farmers have opted to engage in multiple activities in order to sustain their livelihood conditions. Farmers have engaged in multifunctional agriculture as a means of diversifying farm activities. The non-commodity goods generated by agriculture such as wildlife habitat, biodiversity and landscape which have environmental and public benefits are not traded and farmers are given payments as economic incentives for providing these services. There have been increasing concerns about the deteriorating effect on the environment caused by agricultural activities or practices. The demand for recreational space in the Netherlands is increasing and it has become important to preserve the environment to prevent loss of biodiversity and attractive landscapes. It is in this view that policies have been applied to address environmental problems that contribute to environmental degradation. Agri-environment scheme is one such measure introduced to prevent degradation of the natural environment. The management agreements scheme (birds and botanic contracts) is one such scheme applied in Dutch agriculture to preserve biodiversity. The purpose of this questionnaire is to consider the effects of agri-environment schemes (management agreements scheme; birds and botanic contracts) on other aspects of farming, such as labour use and yield. Furthermore, I am interested in the view of farmers on the impact of biodiversity and other ecosystem services such as water quality. Lastly, I would like to know what the main factors are that hinder the uptake and effectiveness of agri-environment schemes.
I am of the view that your answers to these questions would contribute to my research findings about the impact of agri-environment schemes in conserving biodiversity in Dutch agriculture.

NAME OF FARMER/EXPERT/RESEARCHER/POLICY MAKER/ADVISOR/:

DATE:
LOCATION:
CONTACT:

***PLEASE** WRITINGS MUST BE CLEAR AND READABLE

SECTION 1

EFFECT OF AGRI-ENVIRONMENT SCHEME ON INPUTS AND OUTPUTS

1. The uptake and effectiveness of AES does not only depend on impacts on biodiversity. Changing management also influences input use and outputs of farming. Could you please indicate in the table to what extent inputs and outputs for the AES you have adopted differ in comparison to no AES?

   In the first column please indicate the relative change with AES compared to no AES (%). Where difficult to estimate, you can give a wider range. If you have more detailed information on quantities, volumes and prices, please specify these in the last four columns. Please use N/A or not sure for spaces where the specified input or output does not apply or information is not known.
   If you have adopted more than one AES, please give the information per AES.

Specification of AES:					
	AES relative to no AES	**AES**		**WITHOUT AES**	
INPUTS (ha^{-1} yr^{1})	Range in (%)	Quantity or volume	Price (€) of input or output/ha/yr	Quantity or volume	Price (€) of input or output/ha/yr
1. Labour (h)					
2. Machines					
3. Energy (litre oil)					
4. Nitrogen application (kg). Please specify for crops					
5. Pesticides (kg a.i). Please specify for crops					

6. Buildings (m^2)					
7. Irrigation water (10^6 m^3)					
8. Seeds (kg)					
9. Cattle (LU)					
10.					
11.					
OUTPUTS (ha^{-1} yr^{-1})					
1. Milk (Litres)					
2. Nitrogen loss (kg)					
3. Grass (ton fresh yield)					
4. Yield of crops (ton fresh yield).					
5. Level of biodiversity conserved					

2. Please specify other costs components related to adopting AES in € or time /ha/year:

    i.

    ii.
    iii.
    iv.

SECTION 2: EFFECTS OF AES ON PRODUCTION

3. Could you please give your perception for the quantities or range (%) on the outputs in the table above?

a. Grassland productivity?

i. No effect (0)
ii. Very negative (- -)
iii. Negative (-)
iv. Positive (+)
v. Very Positive (+ +)
vi. Not sure

Please explain

____
____
____
____

b. Milk production

i. No effect (0)
ii. Very negative (- -)
iii. Negative (-)
iv. Positive (+)
v. Very Positive (+ +)
vi. Not sure

Please explain

____
____
____
____

c. Crop productivity?

i. No effect (0)
ii. Very negative (- -)
iii. Negative (-)
iv. Positive (+)
v. Very Positive (+ +)
vi. Not sure

Please explain

____
____
____
____

SECTION 3: EFFECTS OF MANAGEMENT AGREEMENTS (BIRDS & BOTANIC CONTRACTS) ON BIODIVERSITY

4. To what extent has management agreements enhanced biodiversity at the farm level? Please specify for the type of AES at the farm.

   0 = No effect
   _ _ = Very negative
   _ = Negative
   + = Positive
   + + = Very positive

Biodiversity (%)	0	_ _	_	+	++	Not sure
1. Plants species						
2. Black tailed godwit						
3. Oystercatcher						
4. Meadow birds						
5. Lapwings						
6. Insects and flies						
7. Bees						
8.						
9.						
10.						

   Please in what sense
   ____
   ____
   ____
   ____
   ____
   ____

5. What evidence is there that the changes/effects can be attributed to changes in land management stimulated by the agri-environment scheme rather than other factors e.g. weather, climate change, emissions etc?

   a. Data on biodiversity monitored over time i. Yes ii. No

b. Weather conditions over time i. Relatively stable ii. Different

c. Diseases and Pests changes i. High ii. Low

d. Effects of soil properties (physical, chemical and biological) and organic matter content

i. Improved ii. Same ii. Reduced

e. Road construction and settlement expansion

f. Can you think of other relevant factors?____
____
____
____

Biodiversity	Evidence (Choose a, b, c (etc) from the options above or please provide other relevant factors.
1. Plant diversity	
2. Black- tailed godwits	
3. Oystercatcher	
4. Lapwings	
5. Meadow birds	
6. Insects and flies	
7. Bees	
8.	
9.	

SECTION 4: EFFECTS OF MANAGEMENT AGREEMENTS ON OTHER ECOSYSTEM SERVICES

6. Has the agri-environment scheme contributed to improving these ecosystem services? Choose from scale from very negative to very positive

   0 = No effect
   _ _ = Very negative effect
   _ = Negative effect
   \+ = Positive effect
   ++ = Very positive effect

Ecosystem service	0	- -	-	+	+ +	Not sure
1. Water quality						
a. Surface water						
b. Ground water						
2. Soil health						
a. Micro fauna						
b. Meso fauna						
c. Macro fauna						
d. Organic matter content						
3.						
4.						

Can you please explain?

___

___

___

___

7. How has management agreements contributed to landscape quality at farm level?

   vii. No effect (0)
   viii. Very negative (- -)
   ix. Negative (-)
   x. Positive (+)
   xi. Very positive (+ +)
   xii. Not sure

8. Please in what sense?

___

___

9. Can you please give a range in (%) for sub-question b above? (a) 10-20% (b) 20-30% (c) 30-40% (d) 40-50% (e) >50%

SECTION 5: ECONOMIC IMPACTS OF MANAGEMENT AGREEMENTS SCHEME

10. What have been the economic impacts of agri-environment scheme in conserving biodiversity?

Meaning of signs: 0= No effect,
- - = Very negative,
- = Negative,
+ = Positive,
++ = Very positive

a. Tourism promoted i. 0 ii. - - iii. - iv. + v. + + vi. Not sure

b. Contribution to farmers' income i. 0 ii. - - iii. - iv. + v. ++ vi. Not sure

c. Horticultural or aesthetic value i. 0 ii. - - iii. - iv. + v. ++ vi. Not sure

d. Provisioning function (food, fibre, raw materials etc) i. 0 ii. - - iii. - iv. + v. + + vi. Not sure

e. Please specify others

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____

11. Does the compensation payment cover the cost? ☐ Yes ☐ No

SECTION 5: ISSUES THAT HINDER EFFECTIVENESS OF AES AND SUGGESTIONS FOR IMPROVEMENT

12. Which issues do you think hinder AES to benefit biodiversity substantially?

a. Pressure on agricultural land (intensification) ☐ Yes ☐ No

b. Non-compliance of standards by farmers ☐ Yes ☐ No

c. Poor implementation by stakeholders e.g. Monitoring and inspection

☐ Yes ☐ No

d. Short contract duration ☐ Yes ☐ No

e. Low Payment ☐ Yes ☐ No

f. Irregular payment ☐ Yes ☐ No

g. Low participation rate ☐ Yes ☐ No

h. High cost incurred by farmers ☐ Yes ☐ No

i. Environmental factors

   i. Weather ☐ Yes ☐ No

   ii. Diseases and pests ☐ Yes ☐ No

   iii. ☐ Yes ☐ No

Please specify others____

____

____

____

13. How would you rate AES in terms of

a. Payments	b. Monitoring and Inspection	c. Level of biodiversity conserved
i. Excellent	i. Excellent	i. Excellent
ii. Good	ii. Good	ii. Good
iii. Fair	iii. Fair	iii. Fair
iv. Poor	iv. Poor	iv. Poor

b. To what extent has the objectives of agri-environment schemes in conserving biodiversity been achieved?

i. Reduction of agricultural inputs (or avoided increase) benefiting floral and fauna has been achieved.

ii. Species in need of protection have been improved by agri-environment measures

iii. Please specify others

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14. Have baseline data been used for comparison of biodiversity changes under agri-environment schemes over time in the Netherlands, which is before and after scheme implementation?

i. Yes ☐ ii. No ☐

15. a. Has enough research results been published on the environmental effects of AES?

i. ☐ Yes ☐ No

b. If yes, what has been done so far as an attempt to improve AES?

i.
ii.
iii.
iv.

16. a. How will you rate the uptake of schemes in the Netherlands?

i. 0 (ok) ii. - - (Very Low) iii. – (low) iv. + (high) v. + + (very high)

b. If high, has it reflected in improving biodiversity? ☐ Yes ☐ No

c. If low, what in your opinion can improve scheme uptake?

i.
ii.
iii.
iv.
v.

17. What in your opinion can contribute to improving agri-environment schemes to benefit biodiversity substantially in Dutch landscape?

____
____
____
____
____
____
____
____
____

18. Other comments or Remarks

____

Thank you for your contributions!!!!

Appendix 3: Information on case interviewees

Information on the sixteen interviewees

Farms	Name	Address	Role in case study
Non-applicable	Nerus Sytema	nsytema@boerennatuur.nl	Expert: Policy maker (advisor). Manager BN
Non-applicable	Rene Klein	klein@veelzijdigboerenland.nl	Expert: Policy maker at Veelzijdig Boerenland
Non-applicable	Henk de Vries	h.j.de.vries@fryskegea.nl	Expert: Advisor at Fryskea Gea
Non-applicable	David Kleijn	David.kleijn@wur.nl	Researcher: Environmental ecologist
Non-applicable	Jack Peerlings	Jack.peerlings@wur.nl	Researcher: Agricultural and environmental economist
Non-applicable	Hein Korevaar	Hein.korevaar@wur.nl	Researcher: Environmental ecologist
Non-applicable	Louis Slangen	Louis.slangen@wur.nl	Researcher: Agricultural and environmental economist
Non-applicable	Dirk Wascher	Dirk.Wascher@wur.nl	Landscape ecologist
Non-applicable	Marta Perez Soba	Marta.perezsoba@wur.nl	Researcher: Ecologist
Farm 1	Minne Holtrop,	holtrop@s-link.nl	Farmer
Farm 2	Herman Lenes	8467se1@hetnet.nl	Farmer
Farm 3	Alex Datema	a.w.datema@kpnplanet.nl	Farmer
Farm 4	Wopke Veenstra	Wb.veenstra@hetnet.nl	Farmer
Farm 5	M. J. Smit	smit@duon-advies.nl	Farmer
Farm 6	J.A. Dekker van den Berg	Dekker.vandenberg@solcon.nl	Farmer
Farm 7	A.F.M. Michielsen	michielsen@solcon.nl	Farmer