Land-ownership and Biodiversity in Agricultural Utrecht

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Appendices

Where have all the flowers gone, long time passing?
Where have all the flowers gone, long time ago?

Pete Seeger – 1955

Hey farmer, farmer, put away that D.D.T. now. Give me spots on my apples, but leave me the birds and the bees. Please!

Joni Mitchell - 1970

Picture on front and back pages by Anita Evers

Abstract

Does it matter for Biodiversity whether a farmer owns the land or merely rents it? Statistical analysis of GIS data on the agriculture and biodiversity of Utrecht shows that it does. Biodiversity is higher when land is merely rented by a farmer instead of being owned by him. Moreover: biodiversity is higher still when the rent contract is only fixed for a short period of time. This phenomenon could be explained by a tendency to invest in intensification of agriculture on owned lands thereby making them less biodiverse. The presence of a management contract correlates with a higher biodiversity, whether it be on owned or rented land, indicating that they are an effective measure in biodiversity conservation.

Summary

This study looks into the biodiversity levels on agricultural fields of Utrecht as indicated by the number of species seen in plots of 250m-250m and seeks to find whether it matters if the field is owned by the farmer or merely rented by him. Fields in ownership of nature organizations have been excluded from this study on the basis of not having agricultural production as main aim. This study also looks whether biodiversity is related to the presence of a management contract. GIS data on all fields in Utrecht were combined with GIS data on biodiversity and statistical analysis showed that the presence of a management contract correlated with a higher biodiversity as expected. It was expected to find that biodiversity would be higher on owned land than on rented land because of a higher tendency for preservation but the opposite correlation was found. Biodiversity is higher on fields that are rented than on fields that are owned by the farmer in Utrecht. Moreover: if the duration of the rent contract is short, the biodiversity is higher than with long standing rent contracts. Likely reasons for this result are (1) that governments might prioritize large land-holding organisations over small farmers in negotiations about biodiversity preservation and more importantly (2): Farmers will be more likely to invest in intensification and increased agricultural productivity in fields they own since those investments have a safer return rate than investments in rented land. Investments in intensification have been associated with a decrease of biodiversity

1. Introduction

This study focuses on agricultural land, land ownership and biodiversity in the Netherlands. Biodiversity is a term that has been consistently used in nature conservation for decades. It is presented as a goal we should strive for. The higher the biodiversity the better. Recent focus on ecosystem services has not changed this situation. While sometimes being framed as two goals between which conservationists should choose, biodiversity is also recognised as providing ecosystem services in itself: most notably conserving genetic variety we can draw from (Rands 2010). Ecosystems with a high biodiversity are also recognised to be more stable and less prone to collapsing (Farnsworth 2015, Hooper 2005). This study will therefore regard biodiversity as a positive property that should be promoted. A more in depth view of biodiversity will be presented in the theoretic framework.

The battle to protect, maintain and in some cases even increase biodiversity is fuelled by money from different sources. Out of all the organisations investing in Biodiversity in the Netherlands throughout the 20th and 21st century the Dutch state is the biggest one. In 2018 a sum of more than 100 million euro has been reserved to be spent on biodiversity in the national budget (Ministerie van Economische zaken 2018). This seems like a whole lot but in perspective of the entire budget of the Dutch state it is merely a fraction of the entire spending (0.036%). Strategies on maintaining biodiversity have been ever changing adjusting to new scientific or societal discourses. Some of the biodiversity can be found in strict reserves that try to be as close to a natural undisturbed state as possible. There is also a lot of biodiversity in half-natural landscapes that require maintenance and even biodiversity in areas that have another primary function but produce biodiversity as a side-effect.

This study is looking into that last type of landscape. Specifically agricultural land. More than half of the surface of the land in the Netherlands is still used for agricultural purposes (World Bank n.d.). increasing the biodiversity of these areas therefore has a major effect on overall biodiversity in the Netherlands. This is why agricultural land is high on the agenda for policy makers trying to promote biodiversity.

There has been much and more research trying to identify success factors determining biodiversity in agricultural lands. Knowledge on these factors is essential if one is to book any success in promoting biodiversity through policy measures. One factor that does not seem to have gotten much attention in previous research is ownership. It is not clear what the relationship (if any) is between whether the farmer owns the land or merely rents it and the biodiversity in the area. This relationship is interesting from the planning perspective since we know from previous research (Janssen-Jansen 2008) that ownership does influence land-use and might therefore also indirectly affect biodiversity.

2. Theoretical framework

This study fits in several theoretical discourses and draws on them for definitions and research design. This chapter will touch upon the definition of ownership as well as trying to define and categorize several forms of land-ownership in the province of Utrecht. This chapter will also introduce the pyramid of production, protection and consumption and finally find a working definition of biodiversity for this study.

2.1 Ownership and responsibility

Going out for a walk and looking around you there is a multitude of ways to look at the lands around you and categorize them. The most obvious one is land use. When I go westward from my home I come by a potato field, a corn field, several fields of grass where cattle and sheep graze, some wetlands that are a nature reserve and finally a forested area (by this time I usually turn around). There are numerous other categorizations to be made: The walk I described brings me in two provinces (political), I have to work my way up a steep hill (elevation). If I were to go digging I would see big differences in soils from one place to the next (soils). But the most obvious one after land-use seems to be land ownership. Land ownership seems to be surprisingly easy to see. I pass several dwellings that have a distinct and visible border with the area around them in the form of a hedge or fence. Most of the fields also have a clear border in the form of a ditch, canal or fence. And you can even spot chances of ownership at borders that are less distinct, inferring it from land-use. The road will probably be publicly owned and the potato-field probably is not.

Who owns a piece of land is an important attribute of that piece of land. The owner of the land can freely decide what he wants to do with the land if anything. Provided that he will remain within the borders set by the law of the realm. There are big differences in what ownership encompasses from country to country and from tradition to tradition. There are very free and liberal interpretations of the ownership like the one in the USA. In their interpretation of ownership the owner can do virtually whatever he wants on his land all the way to shooting anyone who trespasses. All the way on the other end of the spectrum we find a country like North Korea where private ownership of land was non-existent until 2006. By now private ownership is allowed for plots of land smaller than 85 m^2 and only for certain land-uses (Park 2016).

If we turn our attention to a less extreme example than North Korea we find that several eastern European countries deal with changing ideas about property and laws and policies to keep up with the changes. Being former socialist republics, countries like Poland, Hungary and Romania Are in a progress of change that has already lasted several decades. They drift from being a communist state to being a capitalist one. Under the communist regime the vast majority of the land was state controlled, like it is in North Korea these days. After the fall of communism it was decided that this was not a good situation and land needed to be privatized. Simply selling off the land proved to be

problematic as rich foreign investors rushed in to buy enormous plots of land and replacing the role of the old communist government effectively changing nothing for the local farmers. These foreign investors are framed to be land-grabbers and the changing hands of land into foreign hands was stamped undesirable. All of these countries react in more or less the same way. By making laws that prohibit big investors to buy or own big pieces of land in some way or other. In Romania the laws in place that prohibit the ownership of farmland if you don't work on the land yourself have recently been either suspended or adjusted in the light of Romania's admission to the European Union. Land grabbing is back on the Romanian agenda as a problem in rural areas as a result (Kuemmerle 2009 ; Dale-Harris 2014). Another example of protectionist measures related to land-ownership is found in Denmark where people who have never lived in Denmark have to ask permission from the Ministry of Justice to buy land (Justitsministeriet 2018).

The North Korean and the Romanian examples prove that the definition and interpretation of ownership is not static but is an ever changing state of affairs dealing with the cultural heritage from the past. Recent discussion in the UK supports this point of view. In 2000 a law was enacted providing people the "Right to Roam" which curtails the rights of owners by giving all people right of way on certain private lands. The name of the law refers to ancient practice in use long before the industrial revolution. (Anderson 2006).

In general we can discern two ancient traditions in Western Europe concerning land-ownership. These two traditions have competed since the early medieval times. The first finds its roots in the Roman villa system and carries the name "Manioralism". In this tradition a single person (traditionally a member of the gentry) owns a large chunk of land and contracts farmers to work parts of his land. In the early middle-ages the farmers that worked the lands were usually serfs but through the ages changed to be free tenants more often than not. Manorialism thrived under the feudalist society and nobles were known to collect tithes until well into the 20th century in countries as the UK and Canada. Other countries were more swiftly in abolishing feudalism and putting away their gentry. Most notably the French who radically broke with feudalism during the French revolution but also the Dutch that redesigned their state during the late 16th and early 17th century. Wealthy individuals and investment companies filled the void left by the nobles and became the new big landowners. (van Bavel 2001; Karagözoğlu 2017)

The second tradition is that of the family farm or Yeoman. First described in European context in old Germanic societies. This society leaves from the premise that the owner of a plot of land is also the user. A free farmer (or Yeoman) farms his own land for the sustenance of his family. The title of Yeoman was hereditary and it was hard to distinguish between them and smaller nobles in practice. A very important attribute of a Yeoman however was the fact that he worked on his own land himself with or without the help of labourers. (Coulton 1925)

We can draw parallels between these ancient traditions of land use and the present-day situation. The distinction between famers that own their own land and farmers that rent their land from someone is one that is still there today. (Hall 2013) The difference in

social status and prestige between farmers that own their land and farmers that rent it is not near as big as it was between the old serfs and the old yeomen. It is relative commonplace in comparison with the hereditary system of the old times for a farmer to sell or buy land thus changing his status. You also can't tell at first glance by looking at a farmer in which category he belongs. And yet is precisely the difference between these two groups that is of interest to this research and will be looked into.

In order to explain this difference we turn to the concept of sense of responsibility. The protection of a place and the biodiversity in the place is likely to spring from a sense of responsibility someone feels for the place. Relph has argued that such protective and responsible feeling for a place is an indication that someone has a feeling of insideness for a place. Most likely existential insideness. Someone who feels this way about a place feels a connection to that place and in fact draws identity from the place. Relph clearly states that a feeling of existential insideness can be felt for any place you love and identify with and does not necessarily have to do anything with owning the place. (Relph 1976) It is plausible however that a feeling of existential insideness towards a field develops more easily in farmers that tend to the land for a great number of years or even grew up amongst the fields. A higher degree of care and responsibility towards the land and matching higher biodiversity is therefore expected on fields that are owned by farmers or leased for longer periods of time

The notion that a sense of responsibility can drive someone to take care of the land is an intuitive one. A man named Lloyd, however, thought this concept over in the 19th century and arrived at a different conclusion: He argued that it is in the best interest of the owner of the land to take good care of it and use it in a sustainable way to ensure a continuation of merits of using the land in the future. In other words: If you take good care of the land you will be able to make money out of it in the future too. Lloyd identified commons as the other category of land use, focussing specifically on parcels of land near English villages where villagers can let their sheep graze. He reasoned that users of commons want to look after their profits same as owners but because they are not the sole user they tend to overuse and exhaust the land to ensure they make these profits before anyone else does. Nobody wants to exhaust the land but it ends up exhausted nonetheless this way. Lloyd called this the tragedy of the commons and started a way of thinking that is still widely used today in debates surrounding our modern commons like environment and fisheries. (Lloyd 1832)

Hardin over 100 years later took the thought experiment Lloyd had described and took it one step further by bringing it out of the context of English pastures and formulating the modernistic theory of the commons: He stated that if all users of a common resource act in a rational way after their own self-interest with no regard for the others, then the natural resource will be depleted. This theory has been prevalent in scientific discourse for decades afterwards. (Hardin 1968)

While it would be a stretch to say rented lands act like commons we can see some similarities here. Lloyd and Hardin have provided an explanation for why farmers that own the land might take good care of their lands (ensuring future profit). They ascertain that this will not be the case in the commons where users will make selfish decisions and

overuse the land leading to degradation and depletion. It would be reasonable to expect that some of these rules for commons also apply to land that is rented. Although the renting famer usually acts as the sole user of the land there is always the end of the lease contract that has to be taken into account and the distinct possibility that after that another tenant will take his place. Especially rent contracts that are short of duration we can expect to see choices to be made that may exhaust the land in order to maximize profits. We have to add here that it is presumed that a scenario like this will have a negative effect on biodiversity.

Some criticism on the idea that common pool resources are doomed to face depletion comes from Ostrom. Ostrom emphasizes that an individual user of a common seldom make choices in a strictly rationalist way and usually acts with a sense of responsibility towards the other users of the common. Depletion of the resources is therefore not a given at all according to Ostrom. She identifies lots of communities that share commons in a way that does not deplete them. Ostrom selected several principles that can be used to prevent this from happening in a common pool scenario. The situation seems to become more problematic when the scale increases, the number of actors grow and social cohesion disappears. Common resources such as climate, world scale fish stock or biodiversity have an immense pool of actors compared to the village commons described by Lloyd. Moreover: the users of these common resources don't know each other and have no social cohesion. This means that they will be less inclined to take each other into account and act in a way that will preserve the good of the land. (Ostrom 1990; Ostrom 2008).

It is an interesting question how these theories will manifest themselves in this case. Farmers competing over land and lease contracts do bring up images of villagers competing for the use of a village common but saying that they are not strictly speaking a common pool resource would be defendable. Furthermore: it is difficult to determine the size of the population of actors. Is it all the farmers competing for a piece of land? Is it all the farmers of Utrecht? Is it all people benefitting from the biodiversity? There are solid arguments for each of these options and picking one is therefore not within the scope of this study.

2.2 Protection, consumption and production

Changing of ownership laws and customs is far from the only dynamic aspect of land use in rural areas. Planner John Holmes made a model to gain insight and map what this change might look like. He began by identifying the driving forces in distribution of rural resources (read: land). There are three forces at work in deciding how land will be put to use according to Holmes: production, consumption and protection.

Production stands for maximization of agricultural productivity. Consumption stands for enhanced access to the area for tourists, using the land for infrastructure or construction. Protection stands for environmental, cultural and social protection of the land. (Holmes 2008)

Holmes then creates a triangle and puts each of these factors on a corner of it. As seen in Figure 1

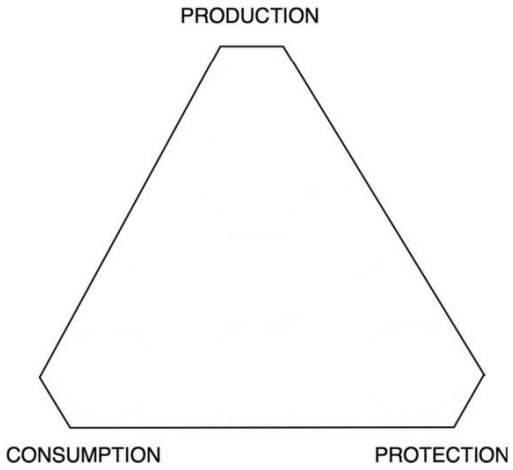


Figure 1 After: Homes 2008
this figure shows a representation of the triangle of Holms depicting Production, Consumption and Protection in the three corners

How a plot of land is used can by visualized by this triangle. Land use in different parts of the world could be used by placing them on this triangle and changes in land use could be visualized by dots floating on this schedule in a certain direction. Interpreters have later put different ways to use the land in the triangle to visualize by which force they are fuelled most. This has culminated in figure 2 by van der Sluis depicting different types of land use. (Pinto-Correia 2016 ; van der Sluis 2017)

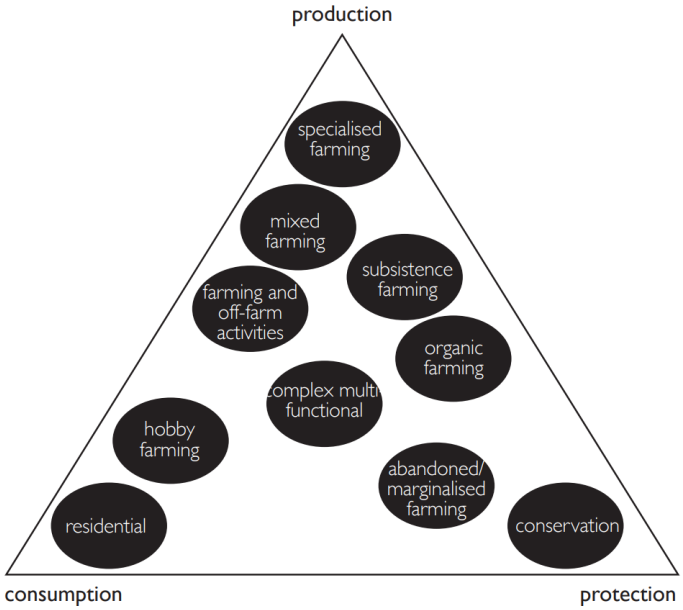


Figure 2 Van der Sluis 2017 (figure 31)
This figure shows an interpretation of the triangle of Holmes with several types of land-use specified and placed on the triangle to depict their influence on land.

The triangle of Holmes deals exclusively with land-use while this research is interested in land-ownership and biodiversity. That does not mean that the triangle is useless to us. It is to be expected that a high score on the protection axis leads to a high biodiversity. Moreover, while we are not looking at production rates in any way. We do use production is as a way to define our research topic. Lands have to have the purpose of agricultural productivity in order to be part of our study. We are not, in other words, researching the biodiversity of residential areas.

This makes the axis productivity-protection the most interesting to us. Our research could benefit from the triangle of Holmes in the sense that we could use it to visualize where owned land and rented land reside on the axis between production and protection as the presence of biodiversity would be indicative to that.

Using the triangle of Holmes in this way makes us disregard the force of consumption. This is justified by the focus of the research and there is one more argument that adds to that: van der Sluis has found that the Netherlands values production and protection quite highly while preventing consumption from taking hold. Production and protection are therefore the most important forces at work in the agriculture of the Netherlands as depicted in figure 3.

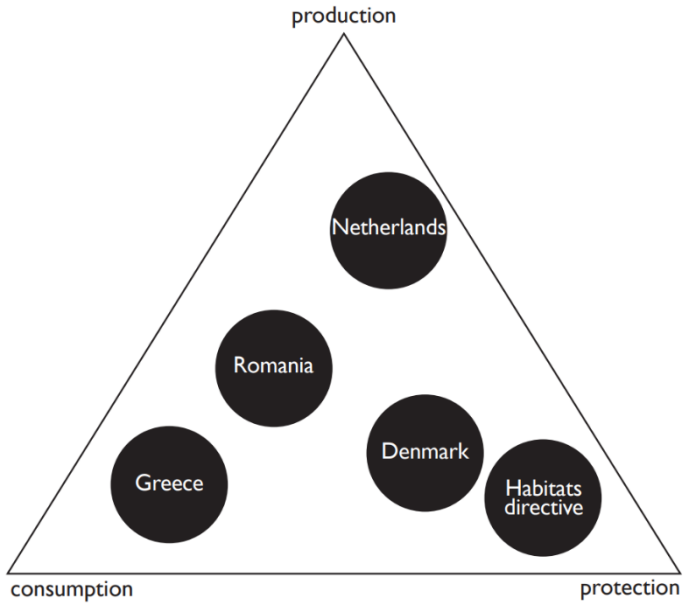


Figure 3 Van der Sluis 2017 (figure 33)
This figure shows an interpretation of the triangle of Holmes with several countries placed on it to depict the practice of land use in those countries.

In practice the tool used in this research would then only need one axis and come to look somewhat like figure 4

Figure 4
This figure shows the simplification of Holmes's triangle into a single line by disregarding the consumption axis of the triangle

2.3 Biodiversity

Biodiversity is widely recognised as a positive property that an area can hold. Numerous studies point towards the ecosystem services provided by a large biodiversity such as recreation, carbon storage (Assessment 2005), granting physical and mental health to humans (Barton 2010) and contribute to the very agricultural sector that we are looking into for this study by means of pollination and pest control (Hooper 2005). This is all in addition to granting stability in ecosystems and landscapes (Hooper 2005, Rands 2010)

The bigger a biodiversity an area can boast, the more valuable the area is considered in terms of nature. Before proceeding a working definition of Biodiversity is required to be set for the scope of this study. There is no agreement on the exact definition of Biodiversity which means that there is room for making choices in determining the working definition of Biodiversity (Meinard 2014). The definition of Biological diversity that has been coined by the convention of Biological Diversity is:

"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." (United Nations 1992)

The definition while not unchallenged seems like a very thorough definition of Biodiversity. It is however too specific for the aims of this study. We are only looking at a specific terrestrial ecosystem and will not have the possibility to register diversity within the species. The following definition has been drafted based on several sources and example studies with regard to function of the definition. (Mace 2012; Lanzerath 2014):

The variety of plant and animal life in a particular habitat.

There are many different methods of ascertaining biodiversity, different methods measure different things and lead to different outcomes (Buckland 2009). and there is no consensus on the superior way to measure it. This study will make use of a relatively simple method of estimating species richness based on species that are indicative of a high biodiversity. It is a basic method of quantifying biodiversity underlying numerous ecological models. It focusses on the multitude of species and not the relative size of their populations and uses sightings by volunteers that have been checked by experts. This method is useful because it provides a very large sample size making the chance of individual species being overlooked very small. This is an important prerequisite for estimating biodiversity as we can read in the work by Colwell. It allows us to make a reliable assessment of biodiversity in the area of Utrecht based on existing data (Colwell 1994; Gotelli 2001; Sattler 2014).

This method of estimating biodiversity is interesting for this study because there are extensive datasets in the province of Utrecht concerning the presence of species that are labelled as indicative for biodiversity. The species themselves have been selected by ecologists working for the province of Utrecht and their presence throughout the province has been recorded throughout numerous hours of field work. The use of existing datasets

to estimate biodiversity in this way is an acceptable method to most standards even though it has to be noted that it has its pitfalls. (Hill 2005; Sattler 2014)

Rare species for example could be overlooked entirely because surveyors where not expecting them or because their presence is inconspicuous. It is also not always clear whether the species or for example a taxon should be indicative of biodiversity. This method also does not recognise the density of individuals in a species as a factor. (Gotelli 2001)

2.4 Management agreements

It is possible for farmers to enter into a contract with a nature organization in which they promise to manage the land in a way that has a positive effect to nature and biodiversity. They can for example promise to not mow the grass in certain periods of the year or to restrict the use of fertilizer. In exchange the nature organization pays them a compensation for their trouble. This is a type of agri-environmental scheme that has existed in the Netherlands since the early 80's and it would seem safe to assume that fields that are under the influence of such a contract have a higher biodiversity than fields that don't.

A study from the early 2000's however strikingly enough found a minimal correlation between the presence of these contracts and biodiversity. The correlation seemed only to exist for a few species and even then only marginal (Kleijn 2001). In the same year, a study was published showing that similar practices in the UK were increasing (Peach 2001). It is difficult to compare the two because besides having a different research area, they also have a completely different research design. Kleijn pairs supposedly similar fields, one with and one without a management contract and assesses and compares their biodiversity. Whereas Peach looks on a larger scale to an area that holds a lot of research contracts and compares that to the area around it without management contracts. Peach also limits his study to one mere species.

Other studies have confirmed that management contracts and their associated management measures do have the potential of increasing biodiversity if implemented in the right way. (Douglas 2009; Perkins 2011).

The challenge might lie in the localized aspect of these types of contracts. To preserve biodiversity a combination between very local contracts such as these and measures on a bigger scale has to be made according to Gonthier (Gonthier 2014). Other factors influencing effectivity of management contracts have been suggested to be clear guidance for farmer on the implementation of these contracts, continuously checking the effectivity of these contracts and a strategic placing of these contracts. It seems that biodiversity will increase more in areas where it was already high to begin with. (Whittingham 2011).

In addition to this, we can see from the 2006 work of Donald that the absence of a higher local biodiversity does not have to mean that a agri-environmental scheme does not work. It might still help to implement corridors across farmland that species can use to cross from one nature reserve to another thus increasing genetic exchange effectively

increasing population sizes and effectively protecting biodiversity in those reserves (Donald 2006).

In any case: Weibull has a point when she states that it is not useful to keep dwelling on the research design of one study and whether organic farming is beneficial for biodiversity or whether management contracts are. It is more important to identify the mechanisms that actually increase biodiversity and to make sure to include them in subsidies and practice. (Weibull 2003).

This study cannot hope to recreate the 2001 Kleijn study to check their outcomes. It can however add to this debate by provided the results of yet another study in another area that tries to ascertain the effectivity of management contracts in protecting biodiversity. The step that Weibull suggest, to take one step further and look at what mechanisms the management contract uses to increase biodiversity is beyond the scope of this study but at least a suggestion about their effectivity will be obtained.

3. Research

A farmer that owns the land he uses will probably regard his land in a different way than a farmer who only rents his land for a short period of time. This might mean that they treat the land in a different way and affect biodiversity differently as a result. Information on how ownership of land and biodiversity are linked together will inform the efforts pursuing biodiversity and make them more effective for it.

Many policies are in place to protect and maintain biodiversity and lots of money is involved to that end. An insight into the correlation and expected causation between land-ownership and biodiversity could make strategies for conserving biodiversity more effective. This study aims to prove the existence of exactly that correlation and make an educated guess on whether this means there is also a causal link between the two factors. The hypothesis on the basis of which this study operates is that there is a higher biodiversity in agricultural lands that are owned by the farmers themselves.

This hypothesis is based on the idea that farmers that own their land make different choices concerning land-use than farmers that merely rent the land. There is an expected higher tendency towards protection of the land as opposed to farmers that merely rent their land. (Holmes 2008)

The hypothesis will be tested in the province of Utrecht where information on land-ownership and information on biodiversity will be combined and analysed.

The null hypothesis corresponding with my hypothesis is that biodiversity does not differ between fields with different ownership situations. Fields that are rented and fields that are owned will therefore have the same biodiversity.

The central question of this thesis is:

Is biodiversity of agricultural land in the province of Utrecht significantly higher when a farmer owns the land as opposed to renting it for a short or longer period of time?

3.1 Definitions

Biodiversity
For the sake of answering this question the working definition of biodiversity is set as described in the theoretical framework as:

The variety of plant and animal life in a particular habitat.

How to reliably estimate this value is also described in the theoretical framework.

Agricultural land
Agricultural land will be defined with the help of two defining requirements:

1. The aim and purpose of the land is agricultural. The user has to aim to produce value through production of agricultural products. This excludes natural or half-natural areas in which agricultural techniques are merely used as form of nature-management
2. The field has to be registered at the Netherlands Enterprise Agency (RVO) as agricultural field. This excludes small plots of vegetable gardens in back-yards, community gardens and petting zoos. Besides setting a reasonable boundary to this study this requirement also makes sense in the light of practical execution of this study as datasets of the RVO obviously only include the data known to them.

Agricultural land will furthermore be divided into several categories as makes sense in the light of the dataset provided by the RVO. Several types of rent can be distinguished within the province of Utrecht. The most prevalent among these are described below (categories according to RVO 2018). Note that the dataset includes Natural rent of which we established that we will exclude it from our study as it does not meet our definition of agricultural land. For the purposes of this we will describe these fields and leave them in the dataset under a category that we will not use in the statistical analysis.

Regular rent (Reguliere pacht)
This type of rent can be signed for 6 years (without house) or 12 years (with house). There is an option to extend the rent for another 6 years after the duration of the contract if all parties agree.

Liberated rent (Geliberaliseerde pacht)
This type of rent is more flexible than regular rent where duration and termination are considered. The duration of the rent is up to 12 years.

One-time rent (Eenmalige pacht)
This type of rent has a duration of 6 years or less and there is no option to extend the rent. The rules and legal ground of the one-time rent differ from the liberated rent in the sense that it is less flexible and that there is less room to adjust the standard agreement.

Long-term rent (Erfpacht)
Per definition longer than 40 years. Usually granted for 49 or 99 years. This is the longest type of rent possible in the Netherlands. And is usually granted in the agricultural setting to family farms since the duration is likely to span several generations. There are

some rare cases of long-term rent in the north of the Netherlands in which the contract has no ending date and will remain valid for eternity or until all parties decide to disband the contract.

Cultivation rent (Teeltpacht)
This type of rent has a duration of 1 to 2 years and there is no option to renew the contract after that.

Nature rent (Natuurpacht)
This type of rent is bound to strict rules. Usually drawn up as a contract between a nature organization and a farmer this type of rent gives the farmer the right to perform certain agricultural activities in a nature reserve in order to maintain the reserve. Examples are, mowing grasslands or grazing livestock on moorlands. There is no specific duration for this rent but the contracts tend to be short.

Rent of small surfaces (Pacht van geringe oppervlakten)
This type of rent is exclusively for rent of surfaces smaller than 1 hectare. There is no rules for a specific duration or continuation of this form of rent.

Fields with an unknown form of rent (Onbekend/gebruikscode niet opgegeven)
Several fields in the dataset

This multitude of different types of rent is interesting for this study if distinctions will be made between the different types of rent. For now the rent seems to split apart in several groups based on duration:

1. **Ownership:** situation in which the farmer owns the land
2. **Short-term rent:** everything of 12 years and less.
   including: regular rent, liberated rent, on-time rent and cultivation rent
3. **Long-term rent:** rent of 40 years of more
   only consisting of the group of long term rent
4. **Unknown duration rent:** rent with no specified duration
   only consisting of rent of small surfaces
5. **Nature rent:** rent of land in nature reserves
   only consisting of the nature rent

The fact that there is a gap in possible contract duration between 12 years and 40 years that is only filled by some contracts on very small plots of land can be conveniently used in our analysis by creating these distinct groups

3.2 Subquestions

In order to answer the main question:

Is biodiversity of agricultural land in the province of Utrecht significantly higher when a farmer owns the land as opposed to renting it for a short or longer period of time?

Several subquestions have been drawn up:

- What are the different forms of land-ownership or rent common in Utrecht, what is their spatial distribution and how do they differ?
- How do ownership and biodiversity interact?
- How do biodiversity and natural management agreements interact?

4. Methods

Several steps are necessary in order to answer the main question of this thesis. An overview of precise methods follows:

4.1 Data sources

This thesis uses of existing data. What makes this analysis new is the combination of different types of data from different sources in order to find a correlation between two phenomenon, namely: "Biodiversity" and: "Land-ownership" that have not been previously associated in this setting.

GIS data detailing ownership for all agricultural fields in the province of Utrecht have been provided by the RVO (Netherlands Enterprise Agency). These data make it possible to tell for all the agricultural fields in Utrecht whether the user is also the owner or whether the user rents the land from someone else. One can also see what kind of lease contract is in effect on the land and thus discriminate between long-term and short-term lease.

GIS data on occurrence of species indicative for high biodiversity will be provided by the province of Utrecht. This data shows us for the entire province of Utrecht how many of these indicative species occur in squares of 250m-250m.This data fits within the framework that has been selected for this study because it is based on the amount of species that has been found in the field and therefore gives an accurate spatial estimate of biodiversity as according to the working definition for this study.

Two separate GIS shape files detailing which fields have a management contract upon them has also been provided by the province of Utrecht and will be used in the analysis of the data. The reason for including two shapefiles is the fact that one of these (SNL – Subsidie Natuur en landschap) is a somewhat outdated form of management contract that has not yet been fully replaced by its successor (ANLb- Agrarisch Natuur en Landschaps beheer).

A drawback of the data is that there is no record of how many individuals of a certain type of species have been spotted in certain areas but only focusses on the richness in diversity of species. The fact that the data only gives us a one-time glance at biodiversity can also be considered a disadvantage. A dataset that is annually updated can provide insight into the development of biodiversity as ownership changes. It would be interesting to repeat this study after a few years to see whether anything has changed with the biodiversity and in which that change has been happening. It is however outside of the scope of this study.

Advantages of this dataset are the fact that the grain size is fairly small compared to the more rough data that measure 1km-1km and comprise most of the biodiversity data in our country. Moreover the dataset is a very recent publication which makes it align perfectly with the data about field ownership in terms of time.

4.2 Data analysis

Data on occurrence of indicative species can be used to assign a biodiversity score to all of the fields in Utrecht. A categorical variable depicting whether there is a contract for natural management active for the field is also be added. The data has then been exported to SPSS. A detailed description of the steps described above can be found in textbox 1.

Input:

1. **field_shapefile**:
   Polygon with all the fields data on
   a. Size of field
   b. Type of crops
   c. Type of ownership/lease

2. **Bio_shape_raster**:
   Polygon from raster with data on
   a. Number of species flora and fauna in Utrecht

3. **Management_ANLb**:
   Polygon file with data on all areas that have a contract for natural management under the ANLB (new) method. Attributes on:
   a. Type of management

4. **Management_SNL:**
   Polygon file with data on all areas that have a contract for natural management under the CBP (old) method. Attributes on:
   a. Location

Steps of analysis phase 1

1. Give every field in the field_shapefile a unique ID (field_ID)

2. Use the calculate geometry tool to find the sizes of all the fields in my field_shapefile and add them as an attribute. (field_size)

3. Intersect the fields with the biodiversity data. Into a new shape file. In the new shapefile (Intersect_field_shapefile), the majority of the fields has been cut into several pieces and each piece has info on the biodiversity within that part of the field.

4. Use the calculate geometry tool to find the sizes of all the fieldparts (fieldpart_size) in my intersect_field_shapefile

5. Use field calculator to multiply the biodiversity values with the size of the fieldparts into a new attribute (bio_times_fieldpartsize)

6. Use the dissolve tool on the intersect_shapefile. Dissolve based on the unique ID and make a sum of the attribute bio_times_fieldpartsize. Call the new shapefile: dissolve_field_shapefile

7. Use the spatial join tool to join the field_shapefile and the dissolve_field_shapefile

8. Use the field calculator to divide the attribute "bio_times_fieldpartsize" attribute by the attribute: "field_size"

9. The new attribute you found is a weighted average of the biodiversity in all the fields of Utrecht. And will be found in the field_shapefile

Steps of analysis phase 2:

1. Use the spatial join tool to join the field_shapefile and the management_ANLb shapefile

2. Use the spatial join tool to join the field_shapefile and the management_SNL shapefile

Data has been prepared by selecting those fields that we want to use in our statistical analysis. The fields are grouped according to the groups made in the previous chapter:

1. **Ownership:** situation in which the farmer owns the land
2. **Short-term rent:** everything of 12 years and less.
   including: regular rent, liberated rent, on-time rent and cultivation rent
3. **Long-term rent:** rent of 40 years of more
   only consisting of the group of long term rent
4. **Unknown duration rent:** rent with no specified duration
   only consisting of rent of small surfaces
5. **Nature rent:** rent of land in nature reserves
   only consisting of the nature rent

Fields in group 4 and 5 have been excluded from further analysis as these fields are in ownership of Nature organizations and any agricultural activities that might happen on these fields are aimed at nature conservation. Keeping the field in a half-natural state such as a heather field or an open pasture with a specific acidity level targeted to attract certain flowers and herbs. These fields are not interesting for this study since the aim of these fields is nature conservation and agricultural activities are only used as a tool towards that goal and not for production.

Field with an unknown exploitation form are also be excluded from the dataset.

The data now has values for the following attributes:

1. Ownership information (categorical) (1, 2, 3)
2. Natural management contracts (binary) (0, 1)
3. Field size (continuous)
4. Biodiversity (ordinal)

In order to be able to make full use of our data we have calculated yet another attribute by doubling the value for ownership information and adding the value of natural management contracts. Thus creating an attribute with 6 distinct values corresponding to the different groups of ownership as well as discriminating between fields that have a natural management contract and fields that don't.

5. Ownership info and natural management (categorical)

A graphic representation of the frequency distribution of biodiversity in all the fields has been made. A normal or skewed distribution is not absolutely necessary for the validity of the outcome of ordinal tests but would nonetheless affirm the outcomes of said tests.

A Kruskal-Wallis test will be used to test whether the means of biodiversity significantly differ for short term rent, long term rent and ownership. An overview of the results of the Kruskal-Wallis test will be added to the paper as well as the results of the relations between the variables using the Mann-Whitney U tests involved in making the Kruskal-Wallis test.

The Kruskal-Wallis test described above has been repeated in the same way while excluding all fields with management contracts on them. This checks whether those contracts don't influence the outcome of the first test.

A Mann-Whitney U test has been used to compare the means of biodiversity score between fields with a management contract on them and fields that do not have a management contract. The effectivity of management contracts in this area can thereby be estimated.

An linear regression test has been carried out in order to estimate correlation between field size and biodiversity. A strong correlation between those two factors might influence the validity of the other tests in some or other way.

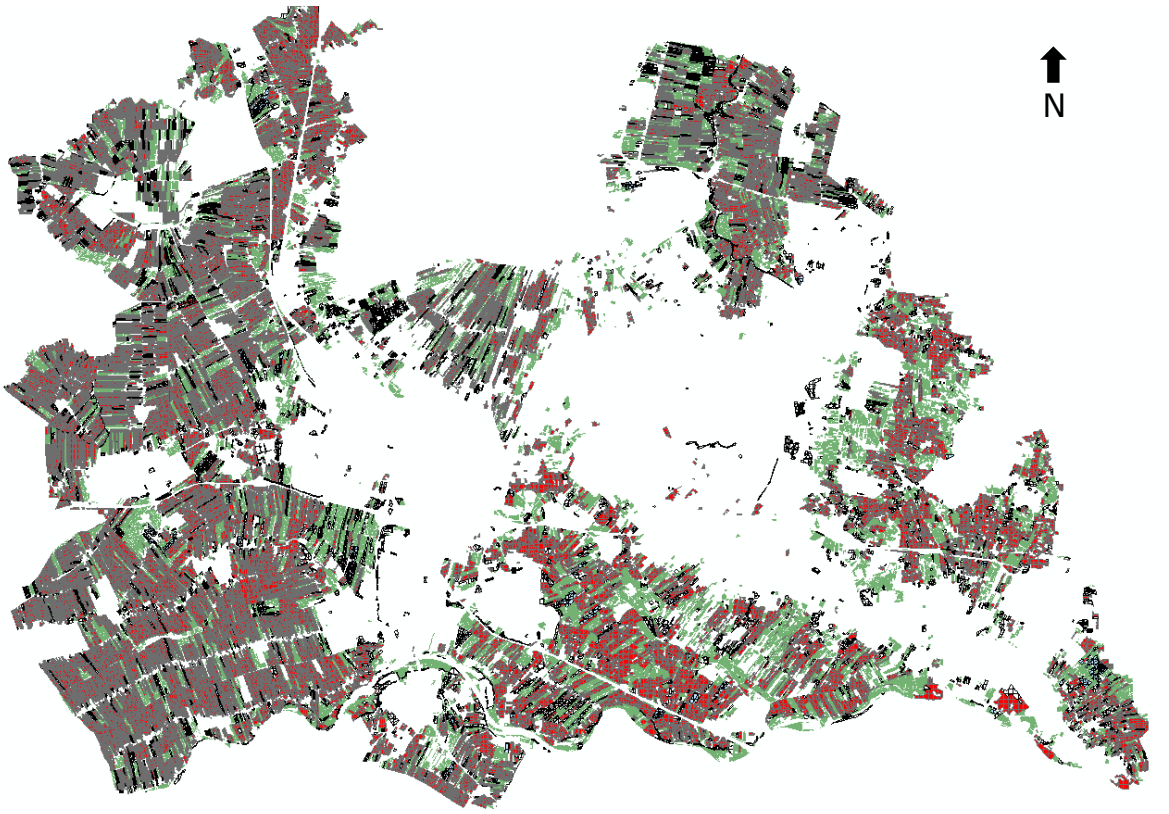
A final Kruskal-Wallis has been be carried out using the data as listed in variable 5. This enables us to see the relationship between biodiversity score of 6 variables. Each ownership situation is broken up in with management contract and without management contract. Not all Mann-Whitney U tests that come with this Kruskal-Wallis test are relevant only the tests between groups that share a characteristic provide useful information. The comparison of means between two groups with the same ownership situation but with a difference in management contract presence provide information on the effectivity of management contracts within that ownership type. Alternatively the comparison of different ownership types that all have a management contract provides insight in whether the ownership situation matters if there are also management contracts at work.

5. Results

This chapter is dedicated to providing a concise overview of the results found in this study by showing charts for all tests done and describing them. The raw dataset will be available upon request.

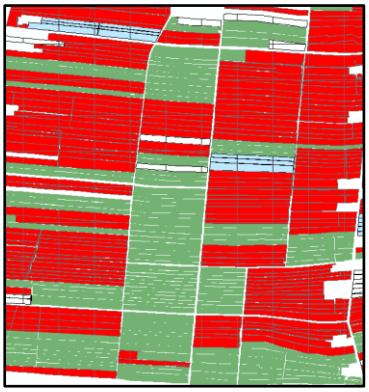
5.1 Graphical representation

The data prepared using GIS techniques can be represented visually in different ways. Map 1 shows a map of all the fields in the province of Utrecht that have been analysed.



Map 1
As we can see in this map the owned fields and rented fields are distributed fairly equally over Utrecht. There are places in which one or the other is in abundance like the area around Rhenen where independent farmers own the fields or huis ten Linschoten which rents out large part of the estate to tenant farmers

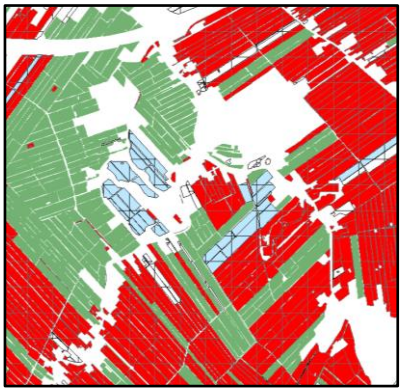
Map 2, 3 and 4 are details from map 1 above to illustrate how the fields look like from closer up. We can clearly see fields with different types of ownership situations existing side by side. The white or blank fields have been excluded from the study based on unknown ownership situation.



Map 2
This map shows a detail from an area in the north of Utrecht where peat is abundant. We can see owned and rented fields lay side by side.

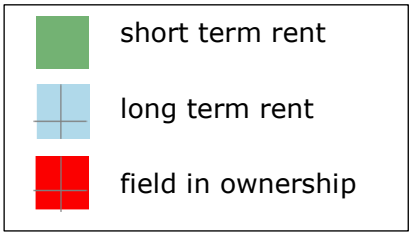
In many cases, farmers from around these parts farm both owned and rented lands

Map 3
This map shows the situation on the sand and clay soils of the area in the southeast of Utrecht. The rich riverside fields and poor hillside fields are very close to each other here. Many of the fields are owned by their farmers. Presumably finding its origin in the strong influence of the citizens from the old city of Rhenen

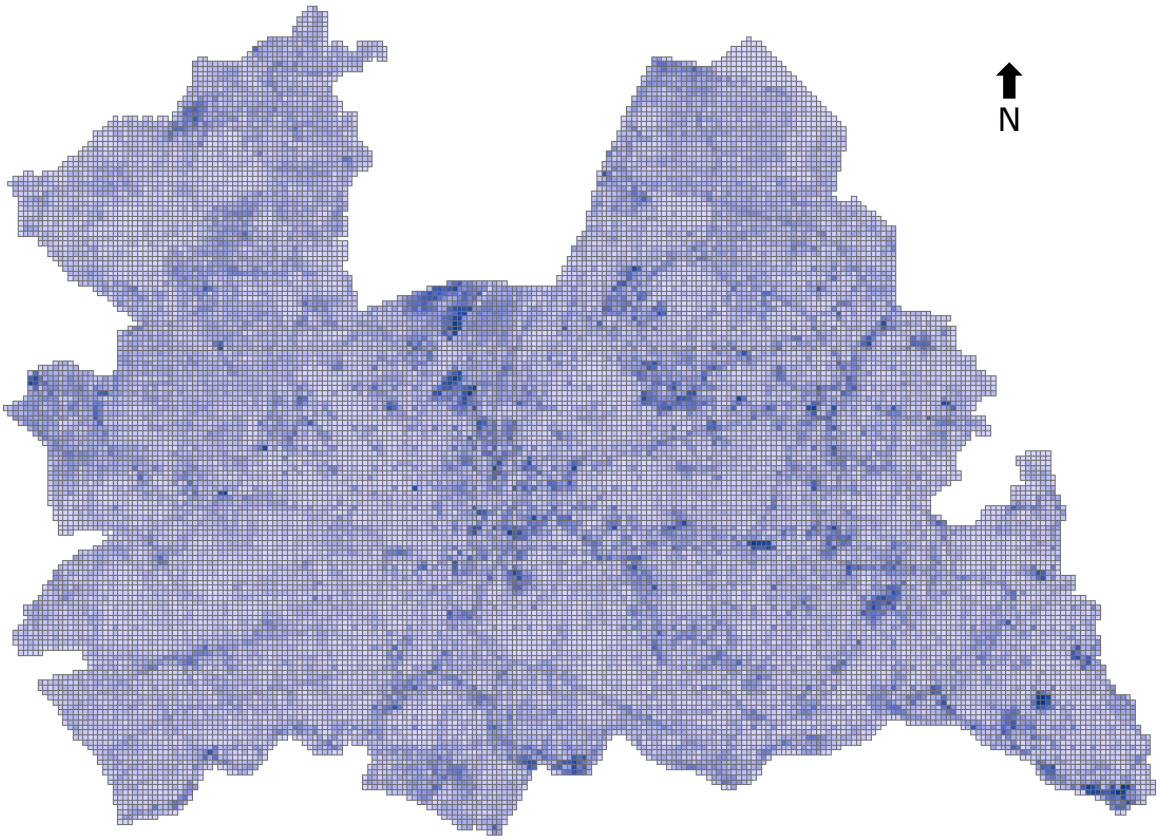


Map 4
This map clearly shows the estate huis ten Linschoten with its long time tenants close around it and the fields they rent out for a shorter period of time somewhat further from the house. The fields on the east side of the village have more independent farmers

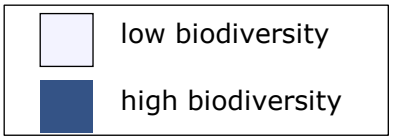
N



Map 4 shows the distribution of biodiversity across Utrecht in polygon squares of 250m-250m. We can see that biodiversity differs from region to region and that there are multiple biodiversity hotspots visible. Agricultural biodiversity seems to be highest near nature reserves. For example, In the far west of the province close to the Noordeinderplas, the central northern area near the Loosdrechtse plassen and the Molenpolder. The Kwintelooijen nature reserve on the edge of the Utrechtse heuvelrug also seems to boost biodiversity in its vicinity and there are also very biodiverse fields in the floodplains near Rhenen and also on the floodplains opposite Culemborg.



Map 5
This map shows us the distribution of biodiversity across Utrecht.
If a square is completely white it means 0 of the indicative species have been found. Darker squares show that a lot of indicative species have been found in that square. All the way up to 128 of the indicative species in the darkest squares.



5.2 Descriptive statistics

The GIS information was ultimately converted into a spreadsheet which is available upon request. Some descriptive statistics about this spreadsheet is shown in Table 1. We can see that the three groups used for the statistical analysis are not of the same size and the part of the fields that could not be used because of incomplete records at RVO is relatively large. The part of the data that could not be used for this study on the grounds of having nature instead of agricultural production as main aim is relatively small however.

	area in km2	percentage of total area		area in km2	percentage of total area
area owned fields	381.59	58.92 %	without contract	267.76	41.34 %
			with contract	113.84	17.58 %
area short term rented fields	172.74	26.67 %	without contract	138.62	21.40 %
			with contract	34.12	5.27 %
area long term rented fields	8.51	1.31 %	without contract	5.78	0.89 %
			with contract	2.74	0.42 %
unknown ownership situation	75.54	11.66 %			
managed by a nature organization	9.28	1.43 %			
Total:	**647.66**	**100 %**			

Table 1
This table shows the total area of fields of a certain ownership type and management contract situation as well as their percentage relative to the area of the complete dataset

5.3 Distribution

An analysis of the distribution of Biodiversity across all the fields showed that there was a right skewed variant of a normal distribution to be found within the data. This means that while the use of ordinal tests to find relationships is justified and even somewhat on the safe side because continuous datasets ideally demonstrates a normal distribution as well.

5.4 Biodiversity test fields with different types of ownership

The first Kruskal-Wallis test performed simply compares the means of biodiversity values for fields of the three types of ownership situations studied in this thesis (owned, short term rent, long term rent). The outcome can be described as follows:

Kruskal-Wallis H = 743,965, n = 27818 P < 0.001

As we can see in this outcome, we can assume that the ownership situation matters for the biodiversity score of a field. In other words: there is correlation. A visual representation of this test is presented in the following boxplot.

For an instruction on how to read a boxplot see appendix 1

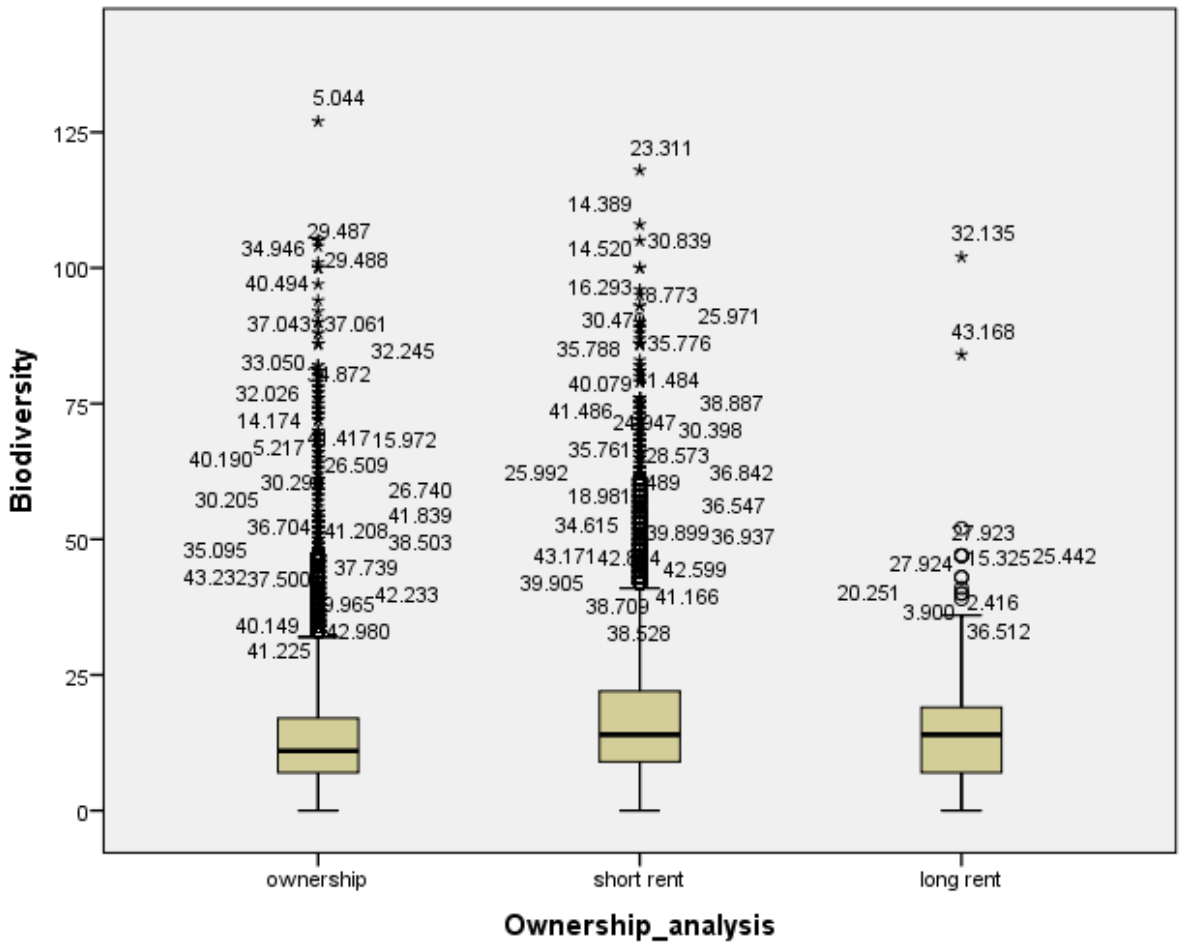


Figure 5
this figure shows the boxplot associated with testing the means of biodiversity on fields with a different ownership situation

The means for the different biodiversity scores are particularly relevant. The means found are:
Ownership: 13,20
Short rent: 17,24
Long rent: 15,01

The Posthoc analysis moreover shows us that a significant difference between means has been found between all three forms of ownership studied.

We now have to reject our null-hypothesis that claims the means for the three categories would be the same. We have to also reject our hypothesis as the correlation found is exactly the opposite of the expected correlation. Our findings indicate that biodiversity is highest on short-rented land, followed by long term rented land and lowest on owned land.

Posthoc analysis Kruskal-Wallis 1

Ownership-long rent
(Mann-Whitney U = -3.604, n1 =18174, n2 =375, P = 0.001)
So biodiversity is significantly lower in fields owned by farmers as opposed to fields that have a long term rent contract

Ownership-short rent
(Mann-Whitney U = -27.242, n1 =18174, n2 =9269, P < 0.001)
So Biodiversity is significantly lower in fields owned by farmers as opposed to fields that have a short term rent contract

Long rent-Short rent
(Mann-Whitney U = 3.032, n1=375, n2 =9269, P = 0.007)
So Biodiversity is significantly higher in fields with a short term rent contract as opposed to fields with a long term rent contract

5.5 Biodiversity test for fields with different types of ownership excluding management contract fields

The second Kruskal-Wallis test performed compares the means of biodiversity values for fields of the three types of ownership situations studied in this thesis (owned, short term rent, long term rent). The difference with the last test is that this one excludes all the fields with management contracts. The contracts could have interfered with the outcome of the last test if they influence biodiversity in any way. This test is therefore a good way to check the results of the last test performed. The outcome can be described as follows:

Kruskal-Wallis H = 743,965, n = 27818 P < 0.001

As we can see in this outcome, it confirms the results of the last test and thereby reinforces the notion that the ownership situation matters for the biodiversity score of a field. A visual representation of this test is presented in the following boxplot.

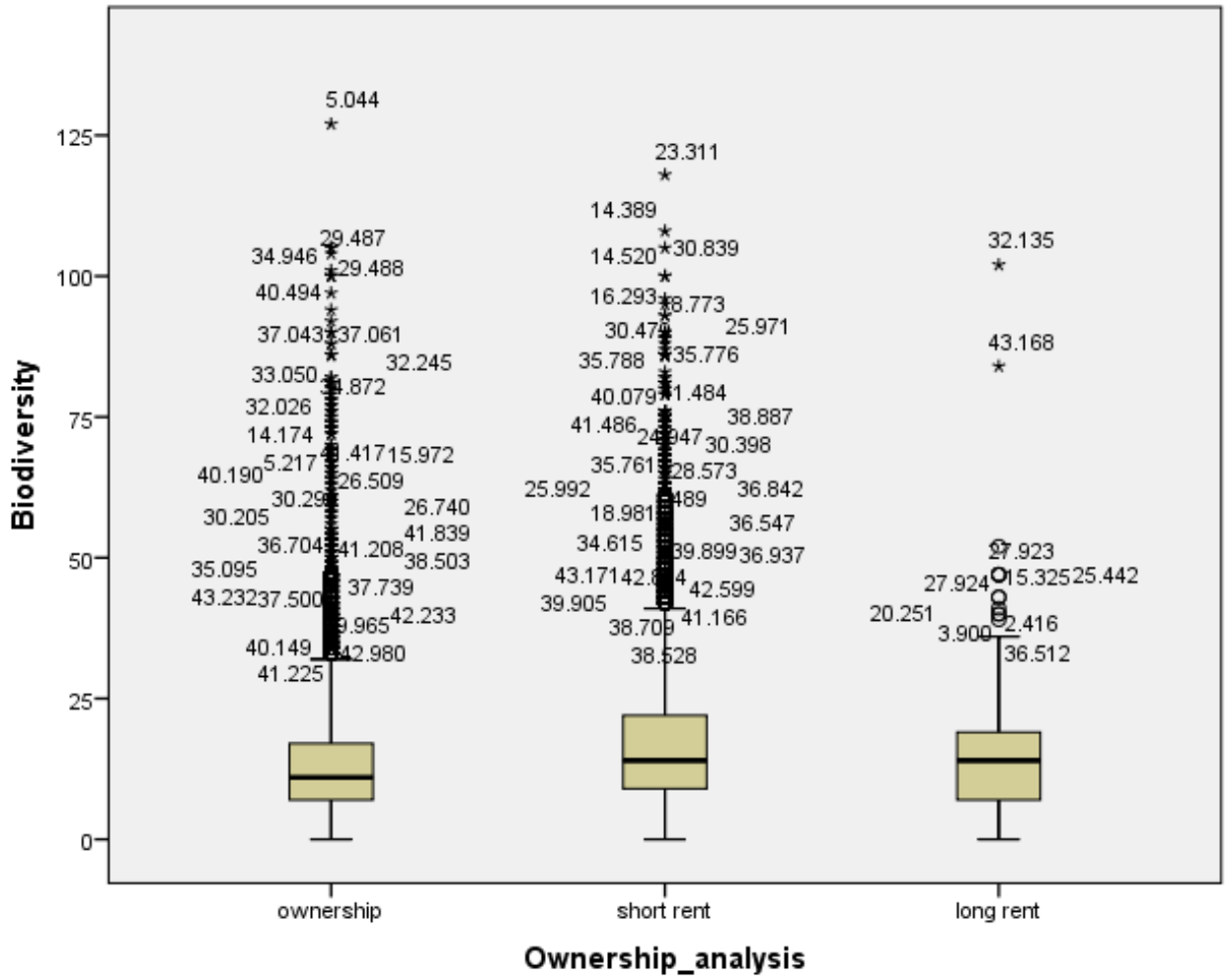


Figure 6
this figure shows the boxplot associated with testing the means of biodiversity on fields with a different ownership situation excluding fields with management contracts

The means for the different biodiversity scores are particularly relevant. The means found are:
Ownership: 13,20
Short rent: 17,24
Long rent: 15,01

The posthoc analysis of this test shows us that we have found a significant difference between the means of all biodiversity values once more. The outcome of this test affirms the outcome of the last test and shows us that this rejection of out null-hypothesis and hypothesis happen regardless of whether the management contract-fields are taken into account for the analysis

Posthoc analysis Kruskal-Wallis 2

Ownership-long rent
(Mann-Whitney U = -3.604, n1 =18174, n2 =375, P = 0.001)
So biodiversity is significantly lower in fields owned by farmers as opposed to fields that have a long term rent contract

Ownership-short rent
(Mann-Whitney U = -27.242, n1 =18174, n2 =9269, P < 0.001)
So Biodiversity is significantly lower in fields owned by farmers as opposed to fields that have a short term rent contract

Long rent-Short rent
(Mann-Whitney U = 3.032, n1=375, n2 =9269, P = 0.007)
So Biodiversity is significantly higher in fields with a short term rent contract as opposed to fields with a long term rent contract

5.6 Biodiversity score with or without a management contract

This Mann-Whitney U test compares the means of biodiversity values for fields with and fields without a management contract. The outcome of this test can be described as follows:

Mann-Whitney U = 22.684, n1 = 32.782, n2 = 10.746, P < 0.001

We can see here that biodiversity scores are significantly higher in fields with management contracts than fields without management contracts. A visual representation of this test is presented in the following boxplot.

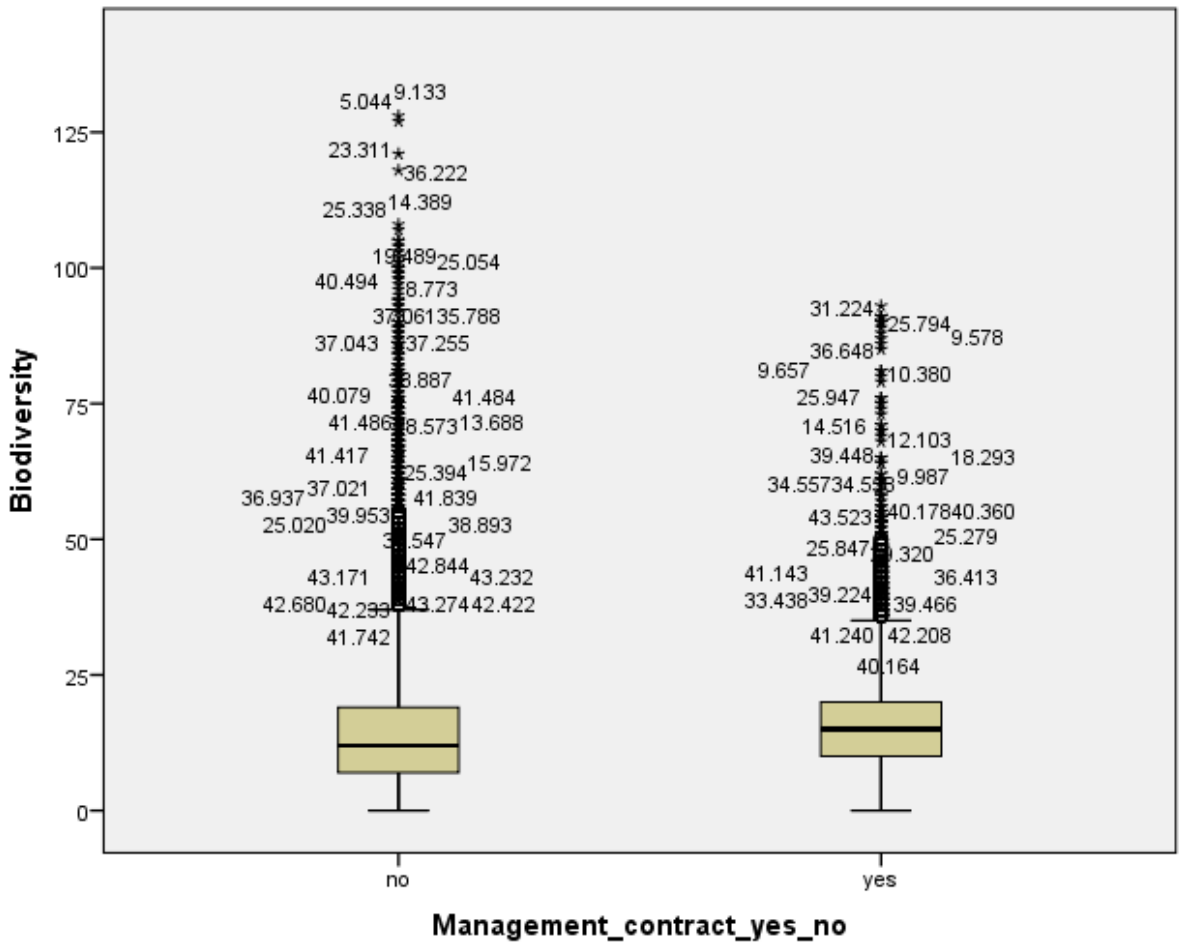


Figure 7
this figure shows the boxplot associated with testing the means of biodiversity on fields with a management contract and fields without a management contract

The means for the different biodiversity scores are particularly relevant. The means found are:
No contract: 14,57
With contract: 16,14

This test shows us that there is a correlation between whether a management contract is implemented on a field and the biodiversity score. Fields with a management contract have a higher biodiversity value than fields that don't.

5.7 Field size and biodiversity

This independent samples T-test has been carried out to ascertain whether there is a correlation between the field size and the biodiversity. In other words: the test tells us how well we can use the field size to predict biodiversity. The outcome of this test is presented in table 2.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,001[a]	,000	,000	10,769

a. Predictors: (Constant), Shape_Area

As the table shows, there is no predictive value in field size for biodiversity. In other words the two values do not correlate and it can be assumed on the basis of this test that biodiversity is not dependant on the size of the field.

Table 2
This table is the result of and independent samples T-test.
The R square and Adjusted R square tell us how well biodiversity value is predicted by the size of the fields.

5.8 Ownership groups and management contracts

The final Kruskal-Wallis test breaks the data up into 6 categories. Each type of ownership is split up in with management contracts and without management contract. The outcome of this test can be described as follows:

Kruskall-Wallis H = 1342,759, n = 37838 P < 0.001

As we can see in this outcome. Significant differences in biodiversity have been found using this test. A visual representation of this test is presented in the following boxplot.

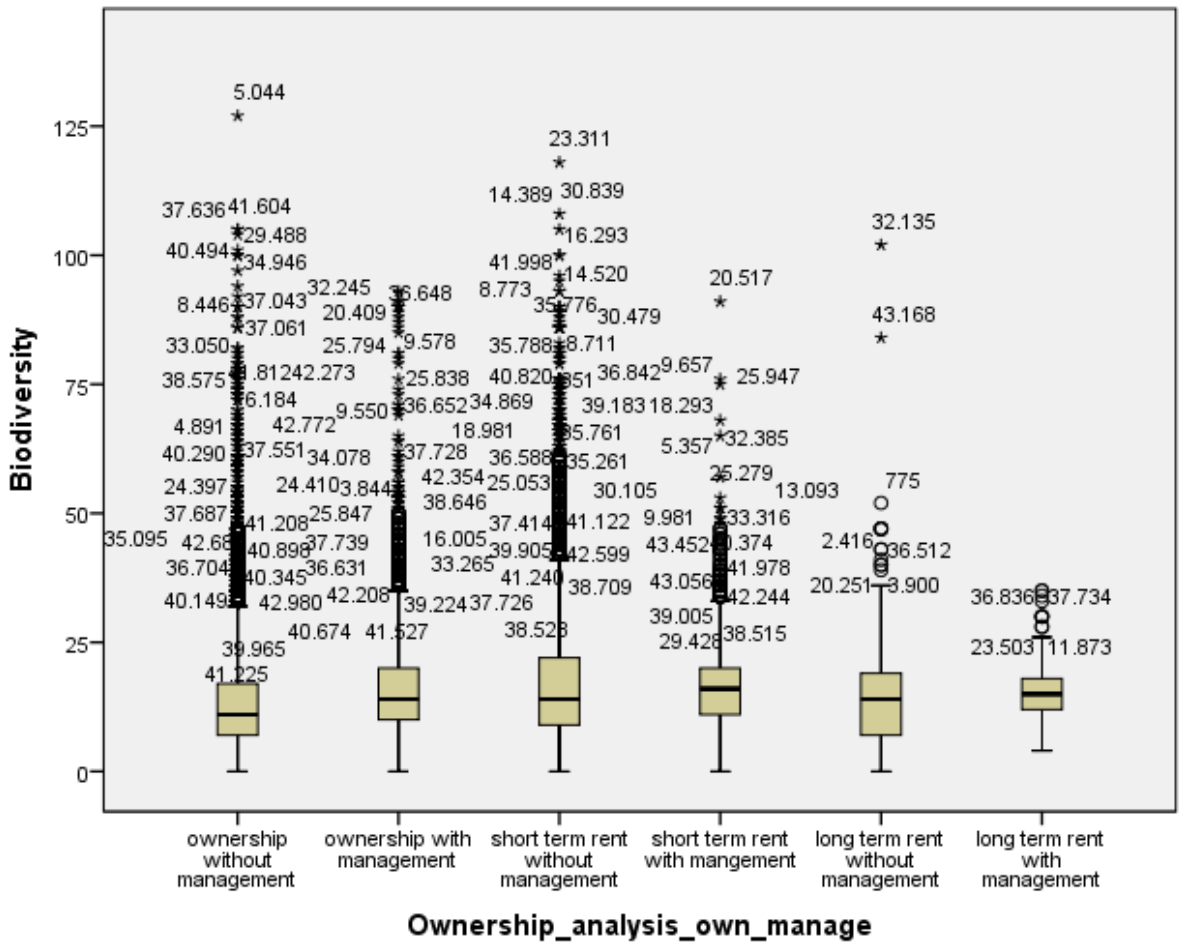


Figure 8

this figure shows the boxplot associated with testing the means of biodiversity on fields with a different ownership situation while also discriminating between fields with a management contract and fields without a management contract

The full Posthoc analysis for this test has not been included because the results between the separate groups are not relevant for the analysis. It can be noted however that a significant difference has been found between all different groups except for the difference between long term rent with a management contract and long term rent without a management contract. The means for those two groups differ still but no significance could be found, the increasingly smaller groups created by dividing the data in more categories seems to affect the analysis.

6. Discussion

The main question for this study was written nursing the hypothesis that biodiversity would be higher on land owned by a farmer. The results however indicate something differently entirely. The situation seems to be the exact opposite from the hypothesis stated and we can state on the basis of the findings in this study that the biodiversity of agricultural land in the province of Utrecht is significantly higher on rented land as opposed to land owned by the farmer. We thereby refute both our null hypothesis: "biodiversity does not differ between fields with different ownership situations" and also refute our hypothesis: "there is a higher biodiversity in agricultural lands that are owned by the farmers themselves". This does not mean however that the results of this study are worthless or even that no significance has been found. While investigating the hypothesis this study has still refuted it's null hypothesis and proved correlation between biodiversity and land-ownership. The correlation is exactly opposite as expected however. Biodiversity is highest on land that is rented out for a short time (12 years or less) a little lower on land that is rented out for a long time (40 years or more) and lowest when the farmer is the owner of the land.

This finding seems strange when the correlation was assumed to be the other way around based on the theory. We will now take a step back and check the outcomes of this study with the theory and find possible explanations for the findings.

6.1 Subquestions

With regard to the sub questions we can use the finding of our dataset to make several observations.

How do biodiversity and nature management agreements correlate?

We have found a clear correlation between nature management contracts and biodiversity. The findings of Kleijn in the early 2000's can therefore not be supported with this study. There are many possible reasons for having a different outcome from them. The research design and area of Kleijn was a different one, our research design while targeting single fields and biodiversity as a whole instead of only one species does have more in common with the research design of Peach in the sense that it did not try to pair fields but rather just looked at the effect across many fields (Kleijn 2001; Peach 2001). 17 years has gone by since the Kleijn study, it might also be that people in practice have heeded the research that has gone into management contracts and similar agri-environment schemes and improved implementation, placing and monitoring of the management contracts along the lines of recommendations done by the authors of studies referenced in 2.4 of this study. Whatever the case, we have found a positive correlation between the presence of management contracts and biodiversity of the fields.

We cannot exclude the possibility of the correlation being the result of a causal relationship. To prove causality however, a more extensive study into this topic is required. An analysis on the basis of an ecological model leaning on an extensive dataset of a wide variety of factors that could influence biodiversity (soil, hydrology, distance to

nature reserve etc.) would be recommended in order to rule out possible externally influencing factors. It has to be noted that if causality is assumed it is not even clear whether the management contracts lead to higher biodiversity or if management contracts are simply put on fields that already have a high biodiversity.

What are the different forms of land-ownership or rent common in Utrecht, what is their spatial distribution and how do they differ?

As to the different forms of land ownership that are common in Utrecht we found that they allow themselves to be divided straightforwardly into short term rent, long term rent and ownership. These three categories are a simplification of the multitude of different ownership and rent situations in Utrecht. The fact that they are so easily split in these three groups lies in the fact that virtually all rented lands are either rented out for less than 13 years or more than 40 years. There are no groups of renting contracts with a duration in between those two periods. It can be assumed that there might be a few fields rented out for a duration longer than 13 and under 40 years but those are then listed under one of the groups: "unknown duration rent, other types of rent". These two categories of fields are quite small (as can be seen in chapter 5.2) and have been excluded from analysis on the basis of the impossibility to get information about the nature of their rent contract.

The spatial distribution of these forms of ownership is not clustered in any area of the map but rather spread out across Utrecht with a single field or a couple of fields here and there.

The main difference that has been looked into in this research has obviously been the biodiversity score that turns out to differ between the three categories. Another difference that is worth paying attention to is the difference in freedom o0f actions that is inherent between the owned land category and both of the rented categories. Landowners that use their own plots of land have a far-reaching autonomy in making their own choices as how to treat the land as long as they remain within the limits of the law. Renting farmers have to consider their landlords in important decisions they make and inform or consult them.

How do ownership and biodiversity correlate?

This sub question is linked very closely to the main question. The first step into finding out how biodiversity and ownership interact is finding out whether they correlate and in which way they influence each other. Because of the unexpected findings in this study we can only hope to answer this question after a plausible explanation for the findings has been found.

6.2 Main question

Having refuted both the hypothesis and the null hypothesis the next step is to find out the reason for the unexpected findings. The theory used in the theoretical framework reinforced with other studies will be used to sketch several possible reasons for the findings.

One of the main reasons for the initial expectance to find a higher biodiversity in owned fields is the idea that farmers would look out more for land that they own. This could be because of a feeling of existential insideness, securing future profits or because of the positioning of these land in respect to the common pool resource theory. One underlying idea shaping these expectations however is that keeping biodiversity high is seen as a worthy goal. In the theoretic framework it is stated that biodiversity is beneficial for agriculture as a whole and helps to make ecosystems more resilient. With this in mind it would make sense for farmers to promote biodiversity on their own lands because that way they will be able to reap the benefits of a good harvest for years to come. Promoting biodiversity on rented lands it is being argued has a less certain return. The benefit could well pass on to a future tenant. This reasoning seems to still hold up even after the results but it is dependent on the wide spreading and acknowledgement of these feedbacks. It may well be that many farmers do not know or acknowledge the beneficial potential of biodiversity or in fact acknowledge the existence of such a feedback as described above but assign an inferior importance to it while prioritising elsewhere.

When looked at it this way the fact that owned land provides for the safest return of investments might even compromise biodiversity in those lands. The main aim of the lands studied in this thesis is agricultural production. Land in nature reserves that only uses agricultural techniques in order to heighten the ecological value has been excluded from the research. Reasoning along these lines we can assume that farmers invest in their lands to increase their harvests, profits and agricultural production. Since we have seen that the return of investments is safest on their own lands it might be deducted that a relatively larger part of these investments is done on their own lands. It seems reasonable to assume that the returns of investments decline when land is rented for a shorter period of time. In other words: it is relatively safe to invest in land that you've rented for more than 40 years compared to lands that are only yours for 6 years or so. Moreover: as seen on the last page farmers have a bigger freedom making decisions about investing on their own land. Big investments on rented land will probably have to be negotiated with the land-owner adding an extra hurdle for doing them.

We can see over and over again in the literature that big investments aiming to increase productivity often negatively impact ecological values such as preserving the soil, variety in the landscape and biodiversity (Gebhardt 1985; Tilman 2002; Reidsma 2006; Henle 2008 Tsiafouli 2014). A lot of research these days is dedicated to taking away this tension between intensifying agricultural activities and preserving ecosystems and biodiversity (Scherr 2008 ; Duru 2015 ; Altieri 2018). There are some studies that conclude that increased productivity does not have a disadvantageous effect on ecology and biodiversity (Margraff 2003). A large study by Grace goes as far as to claim to even have found a positive correlation between biodiversity and productivity in grasslands

across the globe (Grace 2016). The vast majority of researchers does still recognize that intensification measures to increase productivity lower biodiversity. It is not hard to imagine how big investments like: killing off grassland to sow new high yielding grasses, lowering ground water levels by installing a new drainage system or even scaling up by making fields bigger would impact biodiversity in a negative way. This could well be one of the main reasons for why biodiversity is lower on fields that are owned by farmers rather than merely rented for a short or longer period of time.

Another thing to consider is that it's not always the private party such as the famer that pays for the preservation of biodiversity. While many private parties pay a lot of money for the preservation of biodiversity (Ferraro 2002) the bulk of investments in biodiversity however is done by governments. This is no surprise if you take into account what Hodge has said about biodiversity preservation in his 2016: "governance of the countryside". He argues that the majority of biodiversity boons benefit the public at large and only a rare few are of direct benefit to the landholder and provide him with return for his conservation efforts. This rings with the idea of the link that has been made in this paper with the common pool resource problem and the situation of individual landholders. Hodge goes one step further however: he recognises that the main effort towards biodiversity preservation is done by the government since the benefits of biodiversity preservation apply to the public and not the landholder. The government uses many instruments to influence landholders to take biodiversity preservation into account more. Hodge also states that the influencing of landholders will become increasingly more complex and expensive when the areas are held by more landholders that all have their own agenda (Hodge 2016 page 181-197). Many of the organizations that rent out land own a lot of land and rent it out to several tenants, striking deals biodiversity preservation might therefore have a greater return value than striking deals with individual farmers for the government and thus a higher priority. This could partly explain why biodiversity is higher on rented land than on owned land.

6.3 Production over protection

Looking back at the Holms triangle of production, protection and consumption we can conclude on the basis of our findings that the axis deemed most relevant for this study, the axis: production-protection would show the different forms of land ownership like presented in figure 9. This is assuming a high biodiversity is a signifier of a focus on protection instead of production.

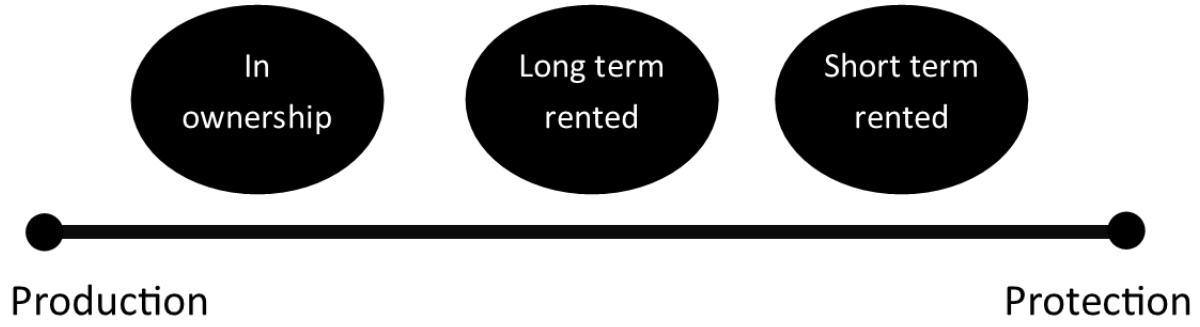


Figure 9
This figure shows where the three situations of land ownership would fit on figure 4, the simplified triangle of Holmes depicting only production and protection on an axis.

The differentiation of ownership categories on this axis does not necessarily have to mean there is a bigger focus on protection on rented lands however. It probable considering the findings in this chapter that there are more investments toward higher production on owned land as compared to rented land. This means that the focus on production is higher on owned land than on rented land. This would mean that rented automatically drifts more towards the middle of this axis than owned land would.

6.4 Limitations of this study and recommendations for future research

The unexpected results of this study ask for further research to be done into this topic. The nature and scope of this study has led to several restrictions and left us with many questions. The simple repetition of this study for other provinces or in different countries with comparable ownership situations could check whether the tendency found in Utrecht is a general one and not a local phenomenon.

It would also be useful to see whether a combined study can be done which uses the research strategy of Kleijn (Kleijn 2001) on the one hand and then uses the framework for this study on the other hand. If conducted at the same time in the same area it would show how much of the differences in findings between Kleijn and this study are due to research strategy and how much has to be attributed to other factors.

A repetition in time would also be very valuable since that could take into account changes of ownership situation. You could look into all fields that have changed from one type of ownership into another one and see whether biodiversity has gone up or down for those fields. This method would be helpful because it lets you zoom in on single fields and changes that are happening over times. This also opens up opportunities of adding qualitative methods to the study by interviewing (former) owners of these lands and asking after their motivations.

Furthermore, the data lends itself to be included into an ecological model with many variables. An analysis with a model like this could take into account so many factors that an estimate could be made about whether the correlation found in this study is also signalling of a causal relation. A qualitative counterpart of this study on the basis of questionnaires or interviews inquiring after the reasons farmers make choices, priorities they have and hurdles they experience in accommodating for biodiversity preservation could also greatly help in finding whether the correlation shown in this research is indeed a sign of causality.

This study has only distinguished agricultural land based on ownership situation and has not been able to provide an overview of different forms of land-use. It is to be expected that Biodiversity differs for various types of land-use. A corn field will influence the biodiversity in a different way entirely than a grassland. There could also be a correlation between ownership situation and land-use. If this is the case: part of the results from this study could be explained by ownership influencing what kind of crops the farmers grows which in turn influences biodiversity. This study would benefit from a look into this connection. To be able to provide more and more precise recommendations. There has also been no room in this study to distinguish between organic farms and regular farms. It is expected that whether or not a farm is organic influences biodiversity and therefore recommended to take this into account in further studies.

This study was conducted on the basis of existing datasets dedicated to estimating biodiversity that cannot be assumed to be faultless and all encompassing. While being confident in the findings presented in this study it has to be noted that a repetition of this study including another method of estimating biodiversity on the basis of different datasets would help a lot in checking the reliability of the findings.

6.5 Recommendations for policymakers

This study shows several things that branches of the government, nature organizations and other actors looking after the preservation of biodiversity could use to their advantage. One of the most obvious conclusions is that the current use of management contracts in Utrecht seems to be beneficial to biodiversity in the sense that management contracts correlate with a higher local biodiversity. It is therefore recommended to persevere in the way these management contracts are used today.

The findings concerning the land-ownership indicate a higher biodiversity on farms that are rented by the farmer. Whatever the reason for this finding the most straightforward way to interpret these results into a recommendation is to advice a government to promote organizations, associations, companies or foundations acquiring land and renting it out to farmers. After all: biodiversity tends to be higher on rented lands so when there are more rented lands and less lands owned by farmers that could increase biodiversity.

The realisation that intensification might be the driving factor behind biodiversity loss and disparity of intensification between ownership situations one of the main reasons for finding different biodiversity levels would lead to the recommendation of discouraging intensification. The promotion of innovative ways to improve yields that have no adverse effects on biodiversity is another viable option. And last but not least: rules about compensation for intensification: intensifying agriculture on one field could be balanced out by increasing biodiversity on another field. Since management contracts do better on fields that had a good biodiversity score to begin with this could be very worthwhile.

7. Conclusion

Biodiversity matters on the grand scale of human affair in general and agriculture in particular. The agricultural sector, in turn, has a big impact on biodiversity as well. The ownership situation of a field matters in that regard. Is the farmer also the owner of the field? Is the farmer merely renting the land? And is that rent fixed for a short period of time or for a long time? This affects biodiversity though not in the way fist expected on the basis of studying the theory. It was expected that farmers take greater care of land they own and invest more in the preservation of biodiversity on these lands as opposed to lands they merely rent. We therefore expected to find a greater biodiversity on owned lands as opposed to rented lands. The correlation proved to be the other way around however. What could be reasons for these findings?

The part about investing more into owned lands seems to have been accurate but farmers don't seem to necessarily invest more in biodiversity but mainly into productivity. This would explain the correlation found in this research. Biodiversity is highest on lands rented for a short period of time. Slightly lower on lands rented for an extended period of time and lowest on lands that are owned by farmers. An unexpected and interesting discovery that can nonetheless be explained through the lens of previous research. A safer and better return of costs of an investment on your own land, more autonomy in choosing to invest and the prioritisation of big landholders for government conservation programmes could all contribute to this situation. The tension between productivity and conservation, Intensification and ecological farming seems to lie at the heart of this issue.

The presence of management contracts seem to correlate with a higher biodiversity so they could help to solve the issue of biodiversity decline. Other viable options are discouraging intensification of farmland or applying innovative measures that have a positive effect on both productivity and biodiversity.

Because, at the end of the line: All farmers alike, be it landowners or tenants, they will all benefit from a stable ecosystem reinforced by a high biodiversity in the long run.

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Appendices

Note:

The spreadsheet with the data used for the statistical analysis will be provided upon request.

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Master thesis - LUP-80436 - 36 ECTS

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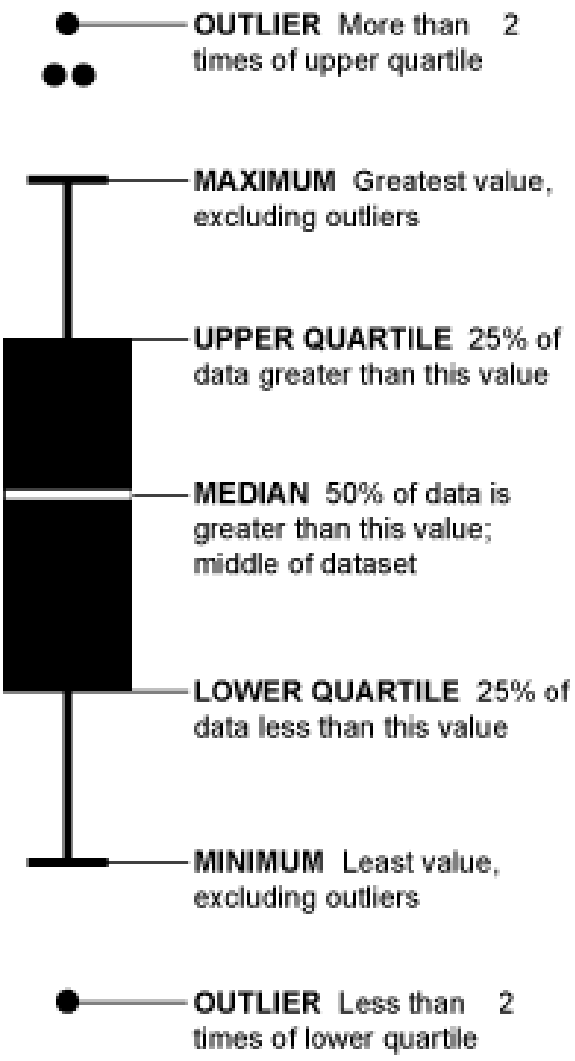
Appendix 1 Reading Boxplots

This is a helpful image on how to read boxplots. The height covered by the actual box contains 50 percent of all findings with the stripe in the middle being the median or middle value.

The lower bound of the box is called the lower quartile or Q1. The upper bound of the box is called the upper quartile or Q3. The difference between the two (Q3-Q1) is called the interquartile range or IQ.

The lines attached to the box are constructed using the IQ. The lower line ends at Q1-1.5 IQ. All values in that range are considered within the boxplot. All values below that are outlying values. The upper line is constructed in a similar manner. The upper line ends at Q3+1.5 IQ. All values above that are considered outlying values.

Outlying values are not uncommon in large datasets like the ones used in this study. The location and distribution of outlying values can indicate skewedness of distribution. The outlying values for this study have all been found above the upper bound indicating right-skewedness.



Appendix 2 Distribution data

this graphical representation shows the distribution of biodiversity across fields in Utrecht. The stem shows the amount of species found on a particular field and the leaf is a graphical representation of the amount of fields found with that biodiversity score. The frequency on the far right shows the exact number of fields for that biodiversity score.

We can ascertain from this graphical representation that there is a distinct right-skewedness to the dataset and a long tail.

```
Frequency    Stem &  Leaf

  283.00        0 .  000000000000000
  578.00        1 .  000000000000000000000000000000
  854.00             000000000000000000000000000000000000000000000
 1087.00             000000000000000000000000000000000000000000000000000000000
 1253.00        4 .  000000000000000000000000000000000000000000000000000000000000000000
 1449.00        5 .  0000000000000000000000000000000000000000000000000000000000000000000000000000
 1625.00        6 .  00000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1766.00        7 .  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1823.00        8 .  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1815.00        9 .  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1855.00       10 .  00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1808.00       11 .  00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1733.00       12 .  0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1791.00       13 .  0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1733.00       14 .  0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1672.00       15 .  0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1576.00       16 .  00000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1498.00       17 .  0000000000000000000000000000000000000000000000000000000000000000000000000000000
 1311.00       18 .  000000000000000000000000000000000000000000000000000000000000000000000
 1178.00       19 .  00000000000000000000000000000000000000000000000000000000000000
 1040.00       20 .  0000000000000000000000000000000000000000000000000000000
  985.00       21 .  0000000000000000000000000000000000000000000000000000
  749.00       22 .  000000000000000000000000000000000000000
  657.00       23 .  00000000000000000000000000000000000
  586.00       24 .  0000000000000000000000000000000
  499.00       25 .  00000000000000000000000000
  483.00       26 .  0000000000000000000000000
  445.00       27 .  00000000000000000000000
  396.00       28 .  000000000000000000000
  357.00       29 .  0000000000000000000
  305.00       30 .  0000000000000000
  253.00       31 .  0000000000000
  230.00       32 .  000000000000
  220.00       33 .  000000000000
  197.00       34 .  0000000000
  152.00       35 .  00000000
 1596.00 Extremes    (>=36.0)

Stem width:         1
Each leaf:       19 case(s)
```