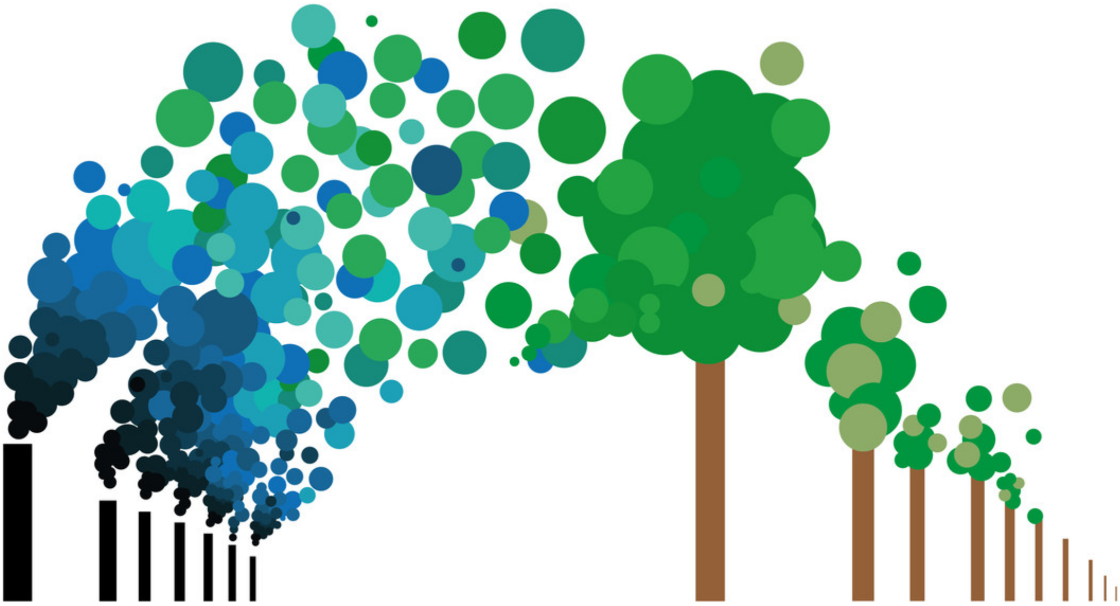
Compensating for our emissions: Agroecological carbon farming as a voluntary offset method

A potential multi-beneficial solution that sequesters carbon while increasing biodiversity?



(Illustration from Fadi Nadrous; obtained from Trouw, 14 feb 2020).

Master Thesis

Submitted by:	Daan van de Kamp
Master Student:	Sustainable Development: International Development
Supervisor:	Dr. Kei Otsuki
Second reader:	Dr. Murtah Shannon

Abstract

This master thesis examines the interconnection between the concepts of agroecological carbon farming and the voluntary carbon offset market. It is aimed at answering the question to what extent agroecological carbon farming is suitable to be adopted as a voluntary offset method. The research is characterized by a case study on the Dutch VCM and an extensive literature study on agroecological carbon farming. Voluntary offsetting is increasing in popularity and numbers while projects take place in the Global South. Especially offset methods that use storytelling to point out positive side-effects next to the sequestration are increasing in popularity. Popular methods used for offsetting are REDD+ and the distribution of cleaner cooking stoves. These project categories are failing in delivering credible, permanent and additional offsets and do not positively affect the carbon cycle. Moreover, the Dutch voluntary offset market in its current form fails for the greater part to deliver reliable offsetting due to inconsistent carbon calculators, inconsistent pricing and failing projects and methodologies. This research examined an alternative method that is not yet used as a voluntary offset method. The results showed that agroecological carbon farming is a promising offset method in the sense that it has many positive ecological and socio-economic side-effects. The set of agricultural practices is aimed at enhancing the quality of the soil which makes it a high-potential sequestration strategy. Ecosystem services can be derived from agroecological carbon farms and farmers can be rewarded for their sequestration work. To become a certified method, there is a need for standardized monitoring tools for agricultural practices. Measuring and monitoring carbon as well as the long implementation time for perennial cropping systems remain major obstacles for agroecological carbon farming to become successfully implemented as an offset method. Nonetheless, the research shows that sequestration does not only have to come from forestry; sustainable ecological agricultural practices also have a high sequestration potential while contributing to biodiversity and local farmers in the global south.

Keywords: Agroecology, carbon farming, carbon sequestration, voluntary carbon offsetting, biodiversity, carbon cycle

Table of Contents

List of figures and tables

List of Abbreviations

AGB	Above Ground Biomass
BGB	Below Ground Biomass
CC	Climate Change
CCB	Climate, Community Biodiversity Standard
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CFI	Carbon Farming Initiative
CORSIA	Carbon Offsetting and Reduction Scheme International Aviation
CSA	Climate-Smart Agriculture
EU-ETS	European Union-European Trading Scheme
FCS	Forest Stewardship Council
GMO	Genetically Modified Organisms
INDC	Intended Nation Determined Contributions
IPCC	Intergovernmental Panel for Climate Change

MTCO2	Metric Tons of Carbon Dioxide
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDG	Sustainable Development Goals
SHAMBA	Smallholder Agriculture Monitoring Baseline Assessment
VER	Verified Emission Reduction
VCM	Voluntary Carbon Market
VCS	Verified Carbon Standard
VVB	Validation and Verification Body
UN	United Nations
UNFCC	United Nations Framework Convention on Climate Change

1 Introduction:

1.1 Putting a price on climate change

The increased public concern about climate change and desire to come up with a market-driven solution has created a rapidly increasing and complex market for carbon trading. Companies, individuals and nation states can compensate their CO_2 emissions via 'carbon offsetting' schemes in countries in the Global South (Ritchie, et al., 2020; Lang et al., 2019). The carbon offsetting retailers claim that individuals can compensate for their CO_2 emissions by paying an extra small fee on top of a booked flight or filled tank. KLM claims that a person can make its intercontinental completely carbon neutral for less than four euro (KLM, 2020).

Restoring carbon into the soil and out of the atmosphere while increasing biodiversity and generating income is a potential win-win situation. However, the principle of carbon offsetting is considered controversial. There is currently a polarised scientific debate on the offsetting of carbon emissions (Lang et al., 2019, Missler, 2020). The focus of literature used to be on the values and principles of carbon offsetting and, until recently, not on empirical studies on the different offset markets and their offset methods (Lovell & Livermann, 2010).

Extensive research performed by the European Council tested offset projects in countries in the Global South and found that only 2% of the projects researched, restored the climate damage that was promised (Öko-Institut, 2017). Projects did not capture enough carbon, wrong carbon calculations were made, and projects were overall poorly designed.

Nonetheless, the offsetting markets are growing and so is the number of international flights (Came et al., 2015). While current carbon offsetting methods are failing but simultaneously are increasing in popularity, there is a scientific need to investigate other alternative offset methods that were not yet extensively adopted and researched.

1.2 Societal and Scientific Relevance

The carbon offsetting economy can be divided into two markets. Firstly, there is the compliance market that evolved through the Kyoto protocol and allows nation-states to invest in emission reduction projects (UNFCCC, 2014). The Clean Development Mechanism (CDM) was defined in the Kyoto protocol and stands at the basis of the compliance carbon offsetting market. Emission reduction projects in countries in the global south produced transferable certified emission reduction credits (CER) that were equivalent to one ton of CO_2 (Lo & Cong, 2016). The main idea behind the CDM was that it mitigated climate change while enhancing sustainable development in countries in the Global South (United Nations, 2018). This so-called, 'compliance offset market' is certified by the Executive Board of the UN climate regime (UN, 1998). Extensive assessments have been published regarding this compliance market and its projects that failed on most occasions (Öko-Institut, 2017; Missler, 2020; Parool; 2020). For example, a commonly used offsetting method is the planting of monocultures of forestry under the REDD+ method (Gibbs et al., 2007). This method is widely contested alongside other existing CDM offset programs (Öko-Institut, 2017).

Secondly, parallel to this market, another more informal and unstructured market evolved. This is the Voluntary Carbon Market (VCM). The VCM is including non-state activities and is a private sector mechanism within climate governance that has evolved outside of the UN climate change regime but is still indirectly attached to it (Lang et al., 2019).

The compliance market and CDM are widely criticized (Öko-Institut, 2017; Missler, 2020). The VCM however, is portrayed to be a more innovative and flexible market system that includes smaller projects of different types that are unsuitable for the CDM (Lang et al., 2019; Lovell et al., 2010).

One practice that bears the potential of actually mitigating climate change while it enhances sustainable development is '*carbon farming*'. Carbon farming refers to agricultural practices that sequester carbon. This can be done by using alternative *agroecological* production systems while maintaining high yields (Toensmeier, 2016). Agroecology is a set of farming practices aimed at sustainably managing and increasing the health and diversity of an agricultural ecosystem (Altieri, 2009). With industrial agriculture as a leading cause of climate change, it is relevant to investigate the relationship between climate change mitigation and agricultural intensification (GRAIN, 2010). The IPCC reported in their report on Climate Change and Land Use that land use is both a source (unsustainable agriculture) and a sink (sequestration of carbon) and that land use can play a key role in contributing to reducing the predicted negative effects of climate change on people and biodiversity (IPCC, 2019). Furthermore, the report states that certain practices can contribute to both climate change adaptation as mitigation by sequestering carbon while increasing food security.

1.3 Problem definition and knowledge gap

The carbon sequestration potential of crops has been largely ignored in the literature (Toensmeier, 2016). There are at present no clear scientific studies on the effectiveness of agroecological carbon farming as a possible VCM method in the Global South, even though this principle has a high potential and numerous other benefits. A common misunderstanding is that there is no diversity in offset techniques and critics have over generalized the voluntary offset market, due to on the one hand, failed afforestation projects, and on the other hand, the failure of the CDM (SinksWatch, 2007, Lovell and Liverman, 2010, Missler, 2020).

There is a knowledge gap regarding agroecological carbon farming as a potential voluntary offset method. Research must be done in order to find out how and if agroecological carbon farming can be made suitable as a voluntary offset method. Carbon farming and the voluntary offset market and their relation to each other need further understanding and investigation. This thesis aims to contribute to the polarized debate on carbon offsetting, by analyzing an alternative method with a high potential that is not yet widely used in the voluntary market. The problem that needs to be addressed is presented in the following research question:

To what extent is agroecological carbon farming suitable as a voluntary carbon offset method?

This research aims to investigate to what extend agroecological carbon farming could function as a CO_2 offset method. In doing so, the voluntary carbon offset market with its different segments will be described and existing projects will be critically grouped and assessed. Retailers in the offset industry will be interviewed and agroecological carbon farming and its ability to capture carbon, as well as its societal, ecological and economic benefits will be extensively studied. Is this alternative offset method overlooked in a growing but heavily criticized and deceitful carbon market?

2: Theoretical framework

2.1 The planetary Carbon Cycle & Terrestrial Carbon Pool

Over the last 110 years the global mean surface temperature on earth has increased (IPCC, 2018). Next to the scientific consensus that the global mean surface temperature is rising, there is also a consensus that human activity is the main cause (Bolsen, 2018; IPCC, 2013). Human activities as land management practices in relation to the burning of fossil fuels are the principal drivers of global climate change (Anderegg et al.; 2010, IPCC, 2013; IPCC, 2018). Global temperatures are rising, and this greatly affects the system earth in ecological, societal, and economic terms (Toensmeier, 2016).

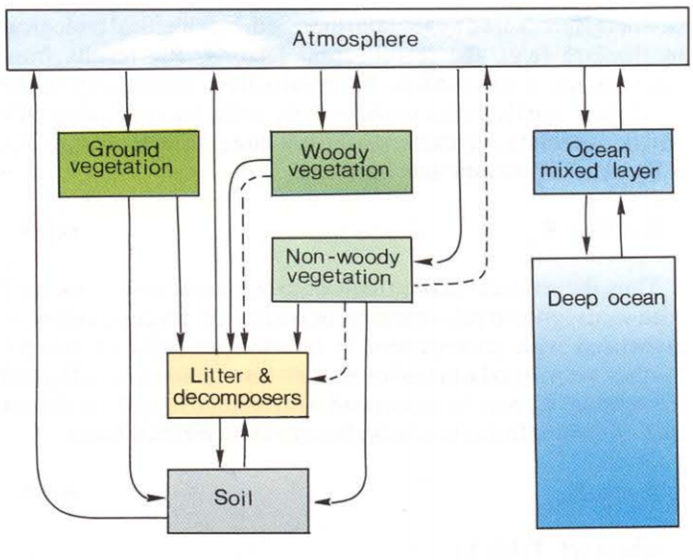
Scholars state that the greatest driver for climate change is the disturbance of the atmospheric amounts of greenhouse gasses (Solomon et al., 2009). Agriculture and the burning of fossil fuels have increased the amount of greenhouse gases in the atmosphere (IPCC, 2013). This has resulted in an increase in the amount of trapped thermal radiation which has resulted in a planet that is heating up. Research shows that these gasses and the greenhouse effect are essential parts of planetary cycles. However, the atmosphere at present contains far too many of them, resulting in relatively rapid climate change (IPCC, 2018; IPCC, 2013).

The Planetary Carbon Cycle

Mitigating the disturbance of the atmospheric amounts of carbon dioxide can roughly be done in two ways. Firstly, by halting the emission of carbon dioxide into the atmosphere. And secondly, by sequestering a fraction of carbon into the soil where it belongs (Nilsson, S., & Schopfhauser, W. 1995). At the basis of carbon sequestration stands the theory of the planetary carbon cycle.

Biogeochemical processes are transferring energy and materials into different parts of the earth's system and the atmosphere. One of these materials that are transferred and moving back and forth is carbon. This process is going on for billions of years and is called the planetary carbon cycle (Lal., 2010). The cycle is displayed in a simplified manner in figure 1.

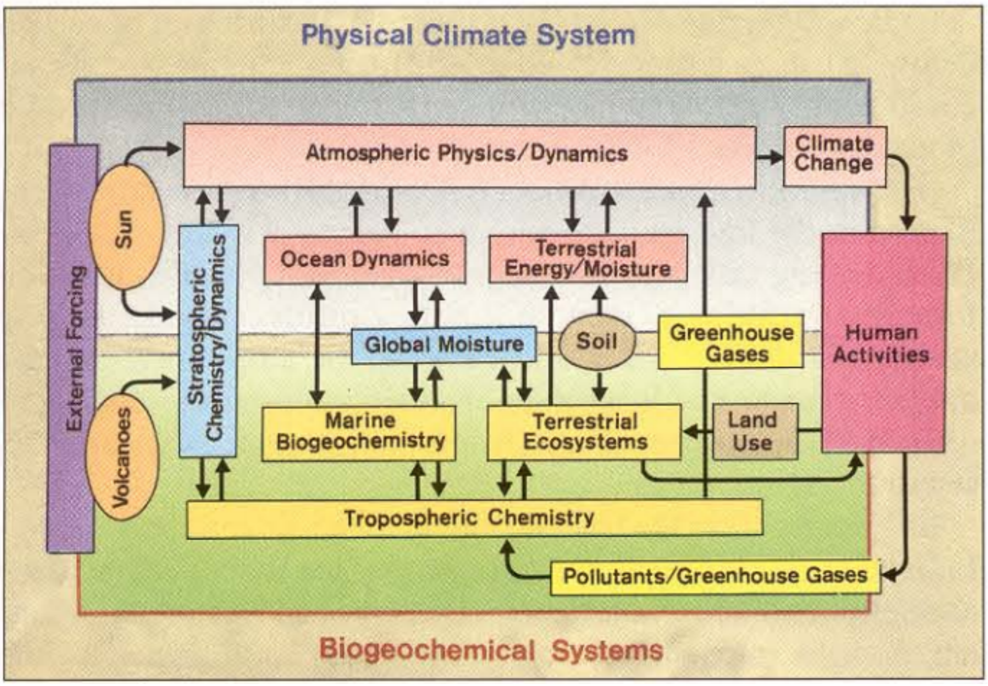
The figure shows how the atmosphere exchanges carbon with oceans and terrestrial components and how the different components interact in this carbon cycle. At present human activities are interfering in this natural cycle. Human action or anthropogenic CO_2 emissions come from two sources. Firstly, the burning of fossil fuel stocks. Secondly, the depleting of biomass, or vegetation and soil that is stored in carbon stocks (Becken & Mackey, 2017).



(Figure 1, Planetary Carbon Cycle, source: Moore & Braswell, 1994).

The earth's atmosphere's carbon dioxide budget is critical for the maintaining of ecosystems and the regulation of the climate on earth. Fluxes of carbon between the earth's surface and the atmosphere influence the earth's climate. On the long-term, volcanic emissions of CO_2 have influenced the climate. In the last century the burning of fossil fuels affected the climate (Hayes & Walbauer, 2006). Furthermore, the melting of permafrost means that CO_2 is released from the earth's surface into the atmosphere whereas other natural and biochemical processes are releasing and absorbing CO_2 from and towards the atmosphere (Moore & Braswell, 1994).

There are many trade-offs between the physical climate system and the biogeochemical system as can be seen in figure 2. Human activities such as agriculture and land-use change affect the soil, ecosystems, and amount of greenhouse gasses in the atmosphere. Carbon is transferred, stored, and emitted through different biogeochemical processes that affect the physical climate system.



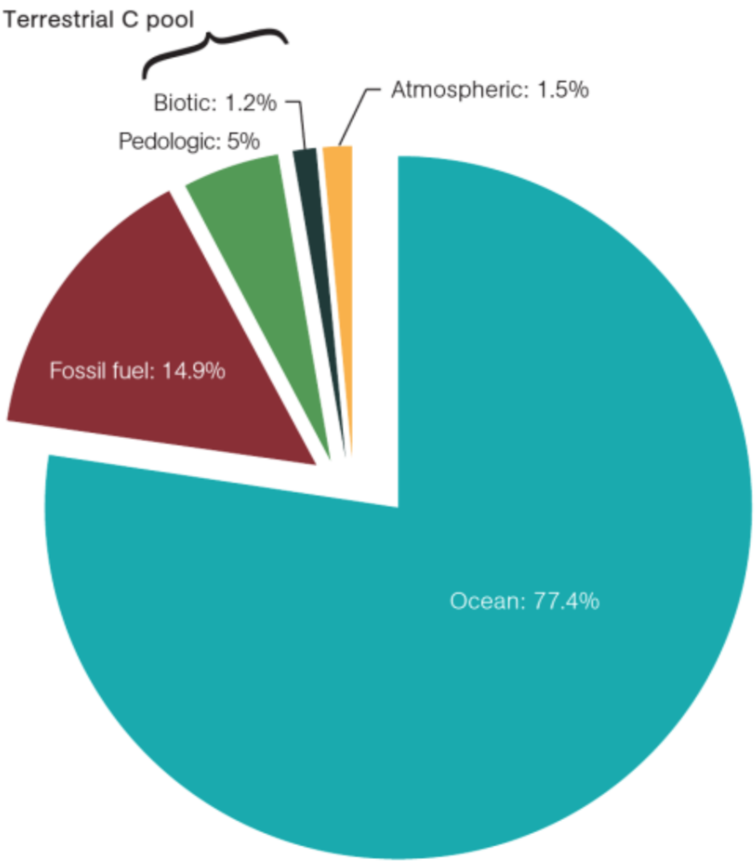
(Figure 2 the Physical Climate System and the Biogeochemical system, Moore & Brasswell, 1994)

<u>The Terrestrial Carbon Pool</u>

The planetary carbon cycle indicates that not all carbon is stored in fossil fuels. The planet has five great pools of carbon as are displayed in figure 3. The ocean is the largest carbon pool and is growing each year resulting in ocean acidification (IPCC, 2018). The fossil carbon pool is currently shrinking due to human activity in the form of burning an estimated 8 billion tons of carbon annually (Toensmeier, 2016).

During this research, the main focus will lay on the terrestrial pool which is declining rapidly due to deforestation, desertification, and land-use change. When analyzing the carbon pools, it is stated that burning fossil fuels in combination with agricultural practices has transferred carbon from the fossil and terrestrial pools, into the atmospheric pool (Gilbertsen & Reyes, 2009). Deforestation and land degradation are outstripping the capacity of the terrestrial pool to absorb atmospheric concentrations while increasing the atmospheric pool itself (Becken & Mackey, 2017).

However, by carbon sequestration, it is possible to transfer carbon from the atmospheric pool, back into the terrestrial pool (Lal et al., 2010).



(Figure 3, Carbon Pools from: Toensmeier, 2016)

Carbon sequestration happens through photosynthesis which means that plants convert sunlight, water, and CO_2 into carbohydrates. CO_2 can be removed from the atmosphere and be stored into the terrestrial pool of carbon that consists out of soil and plants (Toensmeier, 2016; Lal, 2010; Nilson & Schopfhauser, 1994; Schaschenski, 2009). This terrestrial pool, however, has lost 320 billion tons of carbon in the last 10.000 years due to land-use change and has therefore lost much of its ability to capture carbon dioxide (Lal, 2010). Carbon sequestration is proven to bear the ability to shift or restore the balance in the planetary carbon cycle in theory (Toensmeier, 2016; Lal, 2010).

2.2 Carbon Offsetting

The origins of carbon offsetting can be traced back to the 1980s when the carbon pool and carbon cycle theories were used to generate funding for forest conservation and afforestation projects (Hamilton et al., 2007). Since then, aviation companies, fossil fuel companies, banks and individuals can now compensate for their carbon emissions in different ways. There is much discussion in the literature regarding the principles, techniques, and ethics behind the compensation of emitted carbon which is considered as *carbon offsetting* (Lovell & Livermann, 2010). In the literature, different definitions try to cover the broad principle of the compensating or 'neutralizing' for carbon emissions. The United Nations describes carbon offsetting as climate action that enables companies and individuals to compensate for their emissions by supporting projects that reduce emissions elsewhere (United Nations, 2020).

Bumpus & Liverman (2010) describe carbon offsetting as follows;

"*Carbon offsetting allows carbon to be reduced in the global atmosphere by compensating for excess emissions in one location through carbon reductions in another*".

However, carbon offsetting can also be involved in reducing emissions that "*would not have occurred in the absence of the project" (*Becken & Mackay, 2017).
There is a complex mix of different offsetting methods and techniques with different rules and legislation (Öko-Institut 2017; Hamrick et al., 2015). POST (2007) states that a carbon offset is a novel and complex product.

2.2.1 A failed CDM and Compliance Offset market

The compliance carbon offset market operates under strict international regulations. Therefore, some scholars also name it the regulatory market (Lovell et al., 2009). This market is mainly used by nation states (POST, 2007). At the centre of the compliance carbon market is the Clean Development Mechanism (CDM) (United Nations, 2020). The CDM was designed during the Kyoto protocol in 1997 and was designed to mitigate climate change while encouraging implementation of sustainable development (Lovell & Livermann, 2010). CDM schemes have created the largest multi-country, multi-sector carbon emission trading-scheme in the world (Gossling et al., 2010). This designed system works in a way that certified carbon credits, or Certified Emission Reductions (CERs), can be traded internationally (Lovell & Livermann, 2010, Richard et al., 2019). Each certified credit is an equivalent of 1 ton CO_2 emitted and comes from certified carbon offset suppliers and retailers that are all approved by the CDM Executive Board (Taiyib, 2006, Gossling et al., 2010). This board supervises the CDM and is amongst others responsible for the registration, certification and procedures and standards of offsetting projects.

This type of carbon offsetting allows countries to comply with their targeted emission reductions through the trading of CERs internationally, rather than through domestic reductions (Lovell & Livermann, 2010). Industrial countries can therefore meet their greenhouse gas emission targets trough emission reduction or carbon sequestration projects in developing countries (Lovell, 2008). These countries in the global south often have no international emission targets themselves (UNFCCC, 2016). The underlying idea behind this market-based approach was that it provided cost-optimal solutions to the problem of climate change (Hickman, 2016, Backstrand & Lovbrand, 2006).

The Kyoto protocol and the CDM are widely criticized (Gilbertsen & Reyes, 2010, Lovell & Livermann, 2010). In the past, there has been a slippery nature of the estimation of the amount of carbon emissions, and the amount of emissions prevented (Gilbertsen & Reyes, 2010,). Furthermore, scholars call the European Trading Scheme and the CDM a consistent failure because many projects seemed inefficient and socially unjust (Gilbertsen & Reyes, 2010, Toensmeier, 2016). The efficiency of the CDM projects has been investigated and the results indicated that carbon offsetting schemes under the CDM were failing dramatically (Öko-Institut, 2017).

The largest investigation on carbon offsetting was initiated by the European Council in 2017 and showed that 85% of the CDM projects that were covered in the investigation, were unlikely to deliver r*eal, 'measurable and additional emission reductions'* (Cames et al., 2016). The researchers even stated that if the carbon credits would be used, it could lead to an actual increase in greenhouse-gas emissions. Only 2% of the CDM projects had a high likelihood of ensuring that emission reductions are additional and are not over-estimated (Öko-Institut , 2017).

Main problems that were associated within CDM projects are land grabbing, socially unjust programs, non-community-based programs, programs that were not additional and overestimation or double counting of emission reductions (Gilbertsen & Reyes, 2009, Öko-Institut, 2017). It can be concluded that the compliance market and the CDM are widely viewed as a complete failure. The compliance carbon market has failed to do what it intended; to successfully mitigate climate change while promoting sustainable development and reduce the absolute amount of carbon dioxide from the atmosphere (Becken & Mackay, 2017).

Main reasons for its failure had amongst others to do with a shift in portfolio towards projects with a higher questionable additionality, a simplification in rules by the CDM Executive board and the not excluding of 'bad' projects (Öko-Institut , 2017). Moreover, a more fundamental reason that is mentioned by scholars is the fact that the CDM created CERs that were internationally tradable. Inflation occurred, meaning that one ton of CO_2 at a certain point was only worth 0.2$, and scholars state that the CDM did not de-carbonise the world, instead it was re-carbonised (Gilbertson & Reyes, 2009). Trading carbon credits or emission rights does not tackle climate change, instead it has shifted the problem to another location (Toensmeier, 2016; Gilbertson and Reyes, 2009). Furthermore, CERs are not traceable to a certain project, meaning that carbon traders are not actually aware of what they are selling.

With the Paris Agreement the end of the CDM is near. It will be adjusted into a new international carbon trading system. Article 6 refers to the "Sustainable Development Mechanism' (SDM). The only one-page UN article 6 mentioned that this time, it will actually promote environmental integrity (UNFCC, 2016). However, this article 6 on carbon trading, is the last unsolved piece of the Paris Agreement. At the COP25 in Madrid an agreement was not reached. The next chance is at Glasgow November 2020 (Evans & Gabattis, 2019).

2.2.2 Limited Knowledge on the Voluntary Carbon Market

Next to the compliance market, there is a smaller more informal offsetting market were individuals, companies and other entities can offset their own carbon emissions. Where the compliance market has one, uniform price for a CER, the VCM has a wide ranging of pricing of one ton CO_2 (Hamrick & Gallant, 2017).

The credibility of the VCM market has been questioned and contested by scholars and journalists, from the early stages in VCM and at present (Lang et al., 2019, Trouw, 2020, Becken & Mackey, 2017). The language behind carbon offsetting is often misunderstood and stakeholders have not always indicated whether they avoided, reduced, or sequestered emissions of carbon dioxide from the atmosphere (Ecobusiness, 2016).

Due to the complexity behind carbon offsetting, there exists widespread skepticism and uncertainty about compensating under the VCM by the public (Becken & Bobes, 2016). Also, the 'believe in climate change', environmental attitudes and the willingness to take action enhance this skepticism (Blasch & Ohndorf, 2015). In order to gain more understanding of carbon offset methods, it is important to provide more insight in existing offset techniques (Becken & Mackay, 2017).

The VCM has developed independently from the compliance market and is not strictly regulated or administered by the CDM board (Bumpus and Livermann, 2008). Compared to the compliance market, the VCM is much more informal, uses inconsistent carbon calculators and the projects are smaller. However, they are also described as more attractive due to their poverty-alleviation side benefits, lower transaction costs, a greater sustainable development focus, their use of 'storytelling' and a wider range of methods and techniques (Lovell and Liverman, 2010, HoC Environmental Audit Committee 2007, Lang et., 2019). The location sites of VCM offset projects lie often in countries not aligned to the Kyoto protocol (Hamrick, 2017). The Paris Agreement will also very likely affect the development of VCM and actors within the VCM are facing uncertainty adjusting to the coming new rules and legislation (Lang et al.,2019).

There is much less to be found regarding successes or failures within the VCM. Main problems of the CDM such as land grabbing, social injustice, non-community based, as well as the entire trading system and indirect compensation mechanisms, are not yet all directly relatable to the parallel VCM. However, news articles and the public confuse and misuse the report of the European Council (2017) that is fully about the compliance market, in their assessment of the voluntary market (Trouw, 2020, Parool, 2020). Many aspects of the CDM have little to do with the VCM. Especially the roles of nation states, the ethics behind the principle of the CDM and the entire compliance market itself. There is much less to be found regarding successes or failures within the VCM.

The voluntary market has its own standards and aspects that are not yet widely assessed in the literature. At the start of the VCM, the CDM was used as example. As both markets evolved, they moved further away from each other and the carbon trading aspect of the compliance market is not to be found in the VCM (Hamrick & Gallant, 2017). VCM its small-scale, eco-friendly, more socially just projects seem to differ in most aspects from the CDM projects. Between 2005 and 2015, 4.5 billion USD has been spent in the VCM (Hamrick, 2016). Therefore, it is relevant that, in order to find out whether there is still hope for carbon offsetting, this market with its different techniques should be researched more extensively.

2.2.3 Certification of the Voluntary Offset Market

As described earlier, the certification of projects within the compliance market is under the jurisdiction of the CDM Executive Board (UNFCCC, 2014). All projects under the CDM result in so called Certified Emission Reductions (CER) that are internationally tradable and are equivalent to one ton of CO_2 (Öko-Institut , 2017).

Within the VCM, this certification works entirely different. There is not one central body that is responsible for certification. Instead, different offset suppliers have different standards and certification (WWF, 2008). Therefore, the pricing for one ton of CO_2 offsetted can vary from less then 1 USD to as high as 50 USD in 2015 (Hamrick, 2017). This has to do with the difference in project scale, location and certification.

In the VCM, when a project developer is ready to market carbon offset units, he or she is responsible to find buyers, do marketing, advertising retailing and much more. This is also a reason for the high difference in pricing (Zheng et al., 2019).

The media as well as WWF and scholars state that the differences in certification and setting standards are far from perfect (WWF, 2008, Parool, 2020, Lang et al.,2019). Yet, it is stated that the certifiers that have the widest support of offset suppliers, environmental NGOs and projects developers are most trustworthy. A respected voluntary offset standard must firstly, ensure that the offsets are real, additional and permanent. Secondly, the offsets must be monitored, verified and certified. And thirdly, the offsets must be validated and registered in order to clarify ownership (WWF, 2008, Gold Standard, 2020). Voluntary quality marks Gold Standard and the VCS originally used the CDM Executive Board project approval processes and simplified them. 15 years later these standards have developed independently from the UN (Hamrick et al., 2015).

Standards of the VCM state that buyers engage in the VCM due to interest of the storyline or narrative behind their bought carbon offsets. Remember that the highly criticized CDM holds no track of what project was linked with which CER. Co-benefits of 'charismatic' projects that do more than just sequestering carbon by also taking care of biodiversity protection or local employment are emerging and standards are even intending to, next to promoting, certifying these co-benefits (Hamrick et al., 2015).

The "one-size-fits-all' approach of the CDM was one of its shortcomings. The abundance of certified standards could be a potential shortcoming of the VCM.

2.2.4 Carbon Sequestration and Green Grabbing

One method to remove carbon dioxide from the atmosphere is by storing it in trees, soil and plants; the terrestrial carbon pool. This natural part of the carbon cycle bears the opportunity to function as a tool for carbon offsetting. One of the most well-known offsetting methods that uses this sequestration method is the planting of monocultures of trees in countries in the global south. Both the CDM and the VCM have used this method and it has become more popular over the years (Öko-Institut , 2017, Hamrick et al., 2015). This method has proven to be inefficient in many cases and can be accompanied by negative social and ecological impacts (Lindenmayer et al., 2012; Pittock et al., 2013).

For example, Franco and Borras (2019) indicate that these climate change policies can trigger land grabbing and are having negative spillover effects. They state that a change from traditional local land use to an industrial monoculture, dramatically changes the social relations, control of land and water and existing value chains (Virchow et al., 2014).

Indirect outcomes are in many cases unforeseen by climate change policy makers and project developers. REDD+ projects (reducing emissions from deforestation and degradation) are a common used example of what can go wrong with (indirect) land use change because these projects proved to push villagers outside of their livelihoods, pollute the environment, decrease biodiversity and disturb value chains and social relations (Franco & Branca, 2019). Furthermore, the opportunity for co-benefits gets lost using this technique. Co-benefits such as food production, an increase in biodiversity, better soil quality and economic benefits for local communities are for a great part neglected (Bradshaw et al., 2013).

Another method that also sequesters carbon is not by planting trees, but instead, by planting crops. Different techniques such as 'Climate Smart Agriculture' (CSA) claim to increase productivity, increase resilience and reduce emissions. However, even though this method is proved to be sequestering carbon, it also proved to have social and environmental ills (Richard and Lyons, 2016). Community forests were being cut, and small-scale agriculture had to move in order to create space for reforestation projects or mono-cropping agriculture that makes use of pesticides (Scheidel & Work, 2015).

It seems that both VCM as CDM carbon sequestration projects in the Global South, are in many cases intertwined with land grabbing and social injustice.

2.3: Agroecological Carbon Farming

Agroecology has been promoted as a land-use practice that can have positive effects for local communities due to its side-benefits and is yet not linked to these issues (IPCC, 2019; Altieri, 2009). It has the potential to further address the problems of land grabbing and social injustice.

2.3.1 Sequestration through Agroecological Carbon Farming

Studies have shown that agroecological farms can have a higher yield, higher soil fertility, and sequester more carbon per hectare than industrial farms (Reij, 2013). Agroecological carbon farming in theory has an immense potential to restore the carbon balance in the terrestrial pool while simultaneously rewarding farmers in the Global South for their carbon sequestration work.

Thus, another method that can sequester carbon is carbon farming.
Most simply defined, carbon farming is a term used to describe land-use or farming practices that sequester carbon (Evans et al., 2015). For this research, agroecology is combined with the definition of carbon farming which means that industrial carbon farming is not considered.
Agroecological carbon farming differs in this way from CSA that does not solely include agroecological characteristics. In the literature carbon farming is already linked to carbon offsetting although also here the debate on carbon offsetting has found its way into the theories and therefore some scholars exclude carbon offsetting in their definition of carbon farming. (Toensmeier, 2016; Nath et al., 2015). Lal (2016) describes carbon farming as; "*a system of increasing carbon in terrestrial ecosystems for adaptation and mitigation of climate change, to enhance ecosystem goods and services, and trade carbon credits for economic gains*" (Lal, 2016).

Carbon farming thus involves practices that enhance the amount of carbon dioxide that is removed from the atmosphere and is converted into material and soil organic matter (Smith et al., 2014). Altieri (2009) describes agroecology as "*the application of ecological concepts and principles to the design and management of sustainable agricultural ecosystems*". Instead of an industrial approach on agriculture, including fertilizers, mechanization and GMO's, agroecological carbon farming uses sustainable practices such as conservation tillage, integrated pest management, live-stock integration, water harvesting and nutrient management.

The concepts of agroecology and carbon farming have not yet been extensively linked together by scholars. Moreover, clear studies on the offset potential of both concepts combined is lacking as well.

2.3.2 Socio-economic and ecological benefits of Carbon Farming

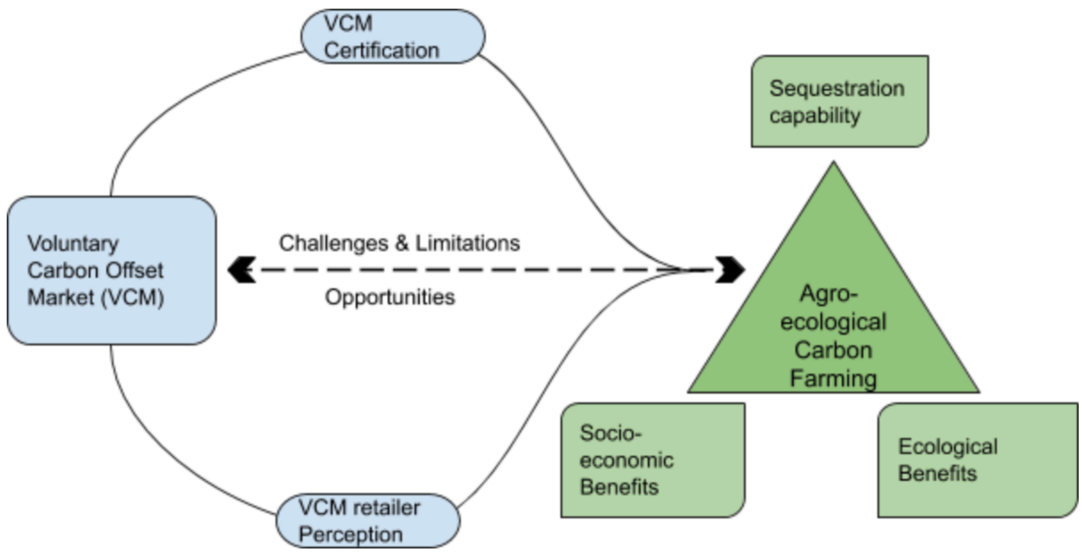
Although yield and biodiversity, as well as ecosystem services and the sequestration capability are considered important, so are social implications and economics of carbon farming based on agroecology. Especially since, as earlier described, climate change policies have many negatives for local development. REDD+ projects as well as CSA failed in many occasions regarding both (Richard and Lyons, 2016).

A more fertile soil and a more resilient farm also have their influence on food production and the ability to store water. Nutrient loss can be prevented as well as erosion (Harvey et al., 2014). Moreover, crop diversification and other agroecological practices make a farm and its farmers less vulnerable than monoculture-practicing farmers in that same area (Altieri, 2013). Multiple examples of hurricanes in Central America indicated that diversified farms only suffered 50% losses against 90% to 100% for monoculture farms (Toensmeier, 2016). Moreover, diversified farms recovered more quickly than their monoculture neighbors (Altieri, 2013). Agroecological carbon farming can help to buffer against an increasingly unpredictable climate by adopting multiple strategies that will be investigated during this research (Branca, et al.,2011).

Alongside food production, income can also be generated via carbon farming in at least two ways. Firstly, the selling of food and secondly, by being financially compensated for the sequestering of carbon.

In conclusion, agroecological carbon farming has potentially many benefits that will be examined during this research and does differ from REDD+ and CSA in many ways. However, exact knowledge of the social implications that might occur when implemented is needed to make sure whether or not carbon farming becomes just the new CSA or REDD+.

2.4 :Conceptual Framework



(Figure 4, Conceptual Research framework; authors own)

Figure 4 displays the conceptual framework that guides the research. The center of this research consists of, on the one hand, the Dutch voluntary carbon offset market and on the other hand, agroecological carbon farming. The dotted line indicates that there is not yet a clear link between both concepts and the goal of this research is to try to see how both concepts could be linked together, including the main challenges and opportunities that come with this interlinkage.

The concepts of retailer perception and certification information are aimed to provide a further understanding of the boundaries and challenges and limitations of agroecological carbon farming to function as a voluntary offset method.

Agroecological carbon farming itself also needs extensive characterization. The three main concepts that will create this characterization are firstly, the capability of agroecological carbon farms to sequester carbon. Secondly, the agroecological practices and their ecological benefits. And lastly, the socio-economic benefits that might come along with carbon farming. If each concept is examined, the main challenges and limitations for agroecological carbon farming to function as voluntary offset method can be pointed out.

3 Research Design & Methodology

3.1 Research question and subquestions

The central research question is:

To what extend is agroecological carbon farming suitable as a voluntary carbon offset method?

Subquestion 1 (SQ1)
What voluntary carbon offset techniques are currently in use within the Dutch market and how do they function?

The goal of this question is to localize the existing techniques that are used in the Dutch voluntary carbon offsetting market. To group them and make a short assessment of the most used methods.

Subquestion 2 (SQ2)
What is agroecological carbon farming and how does it differ from offsetting techniques that are currently in use?

The goal of this sub question is to present an extensive description of the carbon sequester practices and cropping systems within agroecological carbon farming and it's possible (side)-benefits.
This result will be compared with the existing methods from SQ1.

Subquestion 3 (SQ3)
How do Dutch retailers that are involved in offsetting programs, view agroecological Carbon Farming as a voluntary offset method?

The goal of this question is to examine the perception of actors that are already involved in the offset market and to find out if there is awareness and support base for this method. Furthermore, the aim is to identify possible challenges and limitations seen by this these actors regarding future implementation of agroecological carbon farming as a voluntary offset method.

Subquestion 4 (SQ4)
What steps need to be taken for Carbon Farming to be used as a certified offsetting technique?

The goal of this research question is to identify the steps that need to be taken in order for carbon farming to function as an official certified voluntary compensation method in terms of a basic outline and to present a basic framework in which the main steps are identified.

Subquestion 5 (SQ5)
What are the main challenges and opportunities for agroecological carbon farming to function as a certified voluntary compensation method?

This question helps to focus on the research objective and summarizes the main challenges and opportunities that were detected during this research. It is the last step that helps answering the research question.

3.2 Research Framework

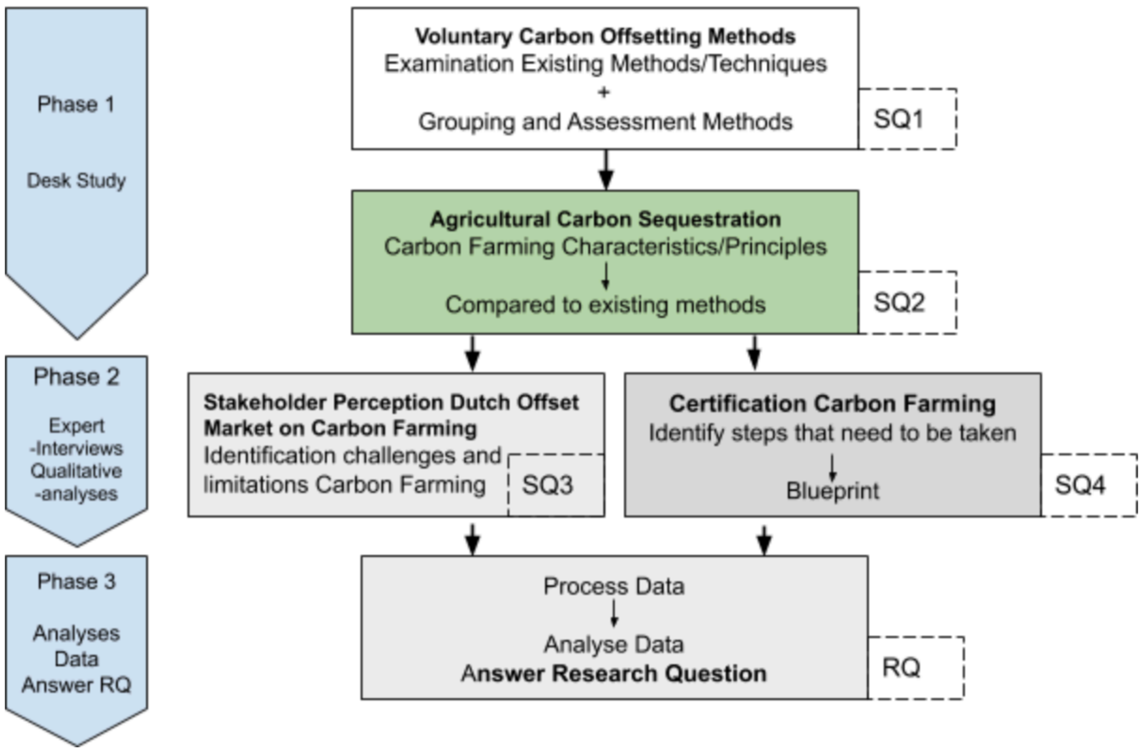
The research framework is presented in figure 5. It consists of three phases.

In the first phase, the global voluntary offset market will be investigated and grouped in offset project categories. Then, there will be zoomed in on the Dutch VCM and there will be looked into the offered project categories. The most used project categories will be briefly assessed. Afterwards, a case study will be done. A fictive flight Amsterdam-Auckland will be used to investigate how this service can be offsetted by the different offset retailers in the Netherlands. This will create an understanding of the practices that are currently in use and their possible shortcomings.

Afterwards, Agroecological carbon farming will be extensively examined. During this stage exact understanding of the ecological, agricultural, and socio-economic characteristics of the principles of agroecological carbon farming are needed to provide a clear description and gain a full understanding of the concept of agroecological carbon farming.

During the second phase, the research will focus on the perceptions of retailers within the voluntary carbon offset market in the Netherlands. Stakeholders/experts will be interviewed and asked about their perception of agroecological carbon farming as an offset method. The goal is to investigate the developments in the VCM, awareness, and support base for agroecological carbon farming as an offset method and detect possible challenges and opportunities. Furthermore, the certification procedure will be researched in the form of an extensive investigation of methodologies used by the major voluntary offset projects in countries in the global south. What standards are there and what is needed to become a certified offset project? A blueprint or framework of the main steps that need to be taken in order for a carbon farming project to be certified will be presented.

The last phase consists of the processing and analysis of the obtained data.
Afterward, the research question will be answered.



(Figure 5: research framework: authors own)

3.3 Methodology

3.3.1 Data collection & research methods

In order to answer the sub-questions, several qualitative research methods will be used. Qualitative research methods are regarded as appropriate methods to gain in-depth understanding of practices and expert interpretation, which is needed to gain a full understanding of agroecological carbon farming as a voluntary offset method (Scheyvens, 2014). Agroecological carbon farming in relation to carbon offsetting covers a wide spectrum of the sustainable development field. Offsetting includes climate mitigation, corporate sustainability, and development in the global south. Carbon farming includes the more ecological and environmental side, as well as the social and agricultural side. This research is a combination of disciplines and can be considered interdisciplinary. However, the methods used will be mainly qualitative. Quantitative data will also come in the form of economic costs/budget, the amount of carbon captured through sequestration, and the number of different crops used. Also, quantitative data will serve as a means to compare and analyze data surrounding the pricing of offsets and emissions and sequestration rates.

Desk research (Phase 1):
In order to answer SQ1 & SQ2, a desk study will be conducted. Sources include scientific studies, policy documents, CSR's, quality newspapers, two in-depth interviews, and online information on companies and foundations involved in carbon offsetting.

For SQ1 to be answered, a grouping and assessment of the existing voluntary offset market principles will be produced. Firstly, the existing methods/techniques of offset techniques will be grouped. This grouping will be done on basis of the grouping of the compliance market projects, conducted by Gosling et al. (2007). Next, it is complemented and adjusted by the author. Additional grouping categories have been added during the desk study. The grouping is based on table 1.

Offsett Project Type		Scale & Costs	Time	Location	
F.	Forestry				
R.	Renewables		<2 years	Global South	yes,no
EE.	Energy Efficiency		>2 years, <5 years	Kyoto member	yes, no
CCX.	Retired credits		>5 years, <15 years	Country project	..
O.	Other		>15 years		

(Table 1, grouping of voluntary offset methods/techniques. Source Gosling et al.,2007)

The grouped projects were selected through those projects that currently are in use in the voluntary offset market. Only projects in the Global South were taken into account. In addition, an assessment was made for the project categories that are currently in use in the Netherlands. The points that are considered are presented in table 1. These points were selected from various articles that assessed CDM projects within the compliance offset market and from the research conducted by the Öko-Institut (2017) & Eijgelaar, (2011).

Credibility
Mitigation-Potential (CO_2)
Sustainability Benefits

Counting Method
Main Limitations

(Table 2, *Points of consideration for each voluntary carbon offset method/technique)*

For the Dutch VCM, the case study will focus on the following elements for each selected offset retailer.:

Project Category & Project Location(s)	AMS-AKL (single) Ton CO_2 & Price in Euro's (Price for each ton CO_2)	Aligned VCM Standards

(Table 3:Case study Amsterdam-Auckland single flight)

This means that at each retailer, this flight is booked, the emissions for the service were calculated and the price will be noted. On top of that, the price for each ton of offsetted carbon will be calculated and basic information on the retailers will be filled in.

The main patterns within Dutch voluntary offsetting have been detected and analyzed. These patterns were distinguished and followed into the thee three most relevant retailers and their projects. These were critically analyzed.

a) KLM's CO2zero service with their Tropical Mix projects
b) Shell's offset service with their REDD+ project in Kalimantan Indonesia
c) Treesforall set of different reforestation projects in Indonesia and Uganda

These retailers were chosen on basis of their differences to each other and because during the market analyses these three were to be estimated to have the largest market share and/or were the most popular ones.

For SQ2, an extensive literature study was done on the characteristics of agroecological carbon farming. The capability of carbon to be captured by agroecological practices was examined. The cropping systems that were best to use, the livestock systems as well as the social, ecological, and financial benefits that were accompanied by it. The literature used consisted of academic papers and books. Also quality newspapers were used. This literature study in relationship to the study on the Dutch VCM formed the center of this research.

In-depth & semi-structured interviews (Phase 2):

During phase 1, two in-depth interviews were conducted with:

- I:M. Tollenaar, Foreign project manager of Treesforall, Most experienced offset retailer in the Netherlands.
- II:B. Klein Lankhorst: soil and organic fertilizer expert and director of Bodemliefde: focusses on sustainable agricultural land use.

During phase 2, the retailers in the Dutch VCM had been identified and were interviewed.
In this phase six more semi-structered interviews were conducted with:

Name and Retailer	Function
Cozijnsen: Greenseat	Carbon Expert
Treesforall: Tollenaar	Manager: Foreign Projects
ClimateNeutralGroup	Carbon specialist
KLMCO2zero	X

Shell	X
FairClimateFund: Van der Geest	Manager Director
Justdiggit: Van het Hof	Marketing, Involved with study on offsetting
Anonymous retailer	Business director
Gold Standard*: R Duchesneau	Certification manager land use and value chain

(Table 4: Interview respondents phase 2 * Gold Standard's Duchesneau only replied through email to questions)

KLM and SHELL did not give consent for an interview. Shell was simply not available. With KLM there was contact regarding the interview, and after exchanging requested files and research goals, they finally pulled back and said they couldn't be of any help.
A topic list was prepared for the interviews, consisting of questions related to awareness, support-base, and limitations regarding agroecological carbon farming as an offset method. The room for expert input was left in the interviews. The questionnaires were derived from the knowledge obtained during phase 1. The questionnaires consisted of open questions. The interviews were conducted online through Zoom and Microsoft teams. Interview guides were adjusted on the field of expertise of the respondent. In some cases, as with Greenseat and Justdiggit, it was first not clear who within the foundation would be the person interviewed, which resulted in an aware diversion of the topic list. There was always room for other information and new information created new insights which resulted in new questions during some interviews. The questionnaires can be found in Appendix II and were in Dutch. Respondents were asked for their consent. Two of them would only participate in the name of his company and his own were not mentioned in this research. The other respondents all gave consent.

3.3.2 Geographical Scope

During this research, the voluntary offset market of Dutch suppliers was investigated.
A list of the current voluntary offset market suppliers is displayed in appendix I.
The Dutch VCM projects take place on different continents in the Global South. One supplier, for example, has projects in Mexico, Uganda, and Myanmar. The different projects were grouped as presented in table 1. The goal was to picture the currently available suppliers in the Netherlands and group their worldwide projects.

For agroecological carbon farming itself there was looked upon carbon farming in the Global South. VCM projects take place all over the world.
Dutch agroecological carbon farming was not the aimed scope since all VCM projects examined take place in the Global South for reasons that will be explained during this research.

The goal was to describe and assess if agroecological carbon farming initiatives can have a place within the Dutch VCM. The Dutch VCM operates outside of Europe.

The research took place from the Netherlands. All retailers apart from Gold Standard (which is located in Geneva) are also located in the Netherlands

3.3.3 Data collection & Sampling

Data was collected during the months of April to August. The first phase was devoted to the desk study. Followed by a series of semi-structured and in-depth qualitative interviews The sampling method used was snowball sampling.

A list of NGOs, companies, and foundations had been derived and can be found in table 4. If respondents were not able to answer all questions, there was asked for contacts that might be able to do so. Using this sampling method, the characteristics of the Dutch voluntary offset method were investigated.

The interviews were preferably done face to face. This was because of COVID-19 not possible. A recording device was used in consultation with the respondents. A notebook was also carried at all times to quickly process and store information and thoughts while interviewing. The statements from the interviews were backed up by data coming from literature and media research.

3.3.4 Data analysis

For the desk study during phase 1, existing literature and policy documents were researched extensively and presented in (1) a clear extensive description of the characteristics of agroecological carbon Farming and (2) a clear indication of the current state of the Dutch VCM.

For the interviews, the transcripts were analyzed in order to answer SQ4 and SQ5. For this qualitative data, a thematic content analyses was executed.

Each interview was also used to obtain new insights and meanings and was compared with data that was already obtained.

3.3.5 Ethics

A researcher should always ensure that the entire research from the obtaining, processing and analysing of data is done in an ethical manner from beginning to end.

Because carbon compensation in the Netherlands had been badly reviewed in the last few months by multiple Dutch quality newspapers and on television, understanding and patience was in place if actors were not willing to talk. However, fairness and critical questions that might unease the conversation were not always avoided. The identity of the researcher and goal of the study were always made clear to the respondents. Furthermore, all respondents were made clear that they were free in the choice not to participate.

3.3.6 Limitations

Because of the COVID-19 outbreak, a field research on a carbon farm was not possible. Research on agroecological carbon farming and the sustainability impacts for local farmers and their value chains would have been most interesting. This research could function as a starting point for further research on actual implementation of agroecological offsetting projects. Also, it was not possible to arrange face-to-face interviews. Zoom and Microsoft Teams formed a solution but nothing beats real face to face contact. Because of the outbreak, the flight industry is showing non-anticipated trends that will likely affect the carbon markets. It is not exactly clear what the long-term effects on the aviation sector will be. This research followed the original trends that indicate that the flight sector will grow substantially at least until 2050 (Sikander, A., 2019). Still, it is not sure how this sector, which is responsible for many voluntary offsets, will develop in the (near) future.

Lastly, the carbon offsetting legislation is changing in the compliance market and possibly the voluntary market. This is due to article 6 of the Paris Agreement.

4. Result I: The State of the Voluntary Offset Market

4.1 Grouping the global voluntary carbon market

The VCM is valued over $500 million a year and is growing globally (Vidal J., 2019; Hamrick et al., 2018). Project developers make use of different methods to produce voluntary carbon offsets. Gossling et al. (2007) grouped the compliance market into four categories. Forestry, renewables, energy-efficiency, and retired credits. The VCM has evolved and offers a wider variety of project types at present. These project types are divided into eight main project categories as listed below in table 5. Agriculture (1) has only a market share of less than 1.0% and is not taken into account by various certified offset standards.

Table 6 presents the number and percentage of projects that took place globally from 2008 till 2015 for each category and the number and percentage of the offsetted volume in metric tons of carbon dioxide.

Table 7 present each category (apart from agriculture) in their market volume, the average price, and market value. Lastly, map 1 indicates where voluntary offset projects take place globally.

Project Category	Explanation Summary	Examples project type
1: Agriculture	Modifying agricultural practices to reduce emissions: Sustainable agricultural land management.	-Fertiliser-n20 -No-till agriculture -Grassland management -Rice-cultivation-management
2: Chemical Processes and Industrial Manufacturing	Modifying industrial processes to emit fewer GHG's	-Ozone-depleting-substances -Coal mine methane -Carbon Capture/Storage
3: Energy Efficiency and Fuel Switching	Improve energy-efficiency or/ad switching to cleaner fuel sources	-Fuel Switching -Waste heat recovery -Community Efficiency
4: Forestry and Land Use	Managing forests, soil, grasslands, and other land types to avoid releasing carbon and/or increasing the amount of carbon the land absorbs.	-Afforestation -REDD+-avoid deforestation -REDD+-unplanned deforest. -Agro-Forestry -Soil Carbon -Urban Forestry
5: Household Devices	Distributing cleaner-burning stoves or water purification devices to reduce or eliminate the need to burn wood (or other inefficient types of energy)	-Clean Cookstoves -Water Purification devices -Other household devices
6: Renewable Energy	Installing solar, wind, and other forms of renewable energy production.	-Geothermal -Biomass -Solar -Wind
7: Transportation	Increasing access to public and/or alternative transportation	-Transportation-private -Transportation-public

	(like bicycling) and reducing emissions from private transportation like cars and trucks.	
8: Waste Disposal	Reducing methane emissions from landfills or wastewater, often by collecting converting it to usable fuel.	-Landfill-methane -Waste-water-methane

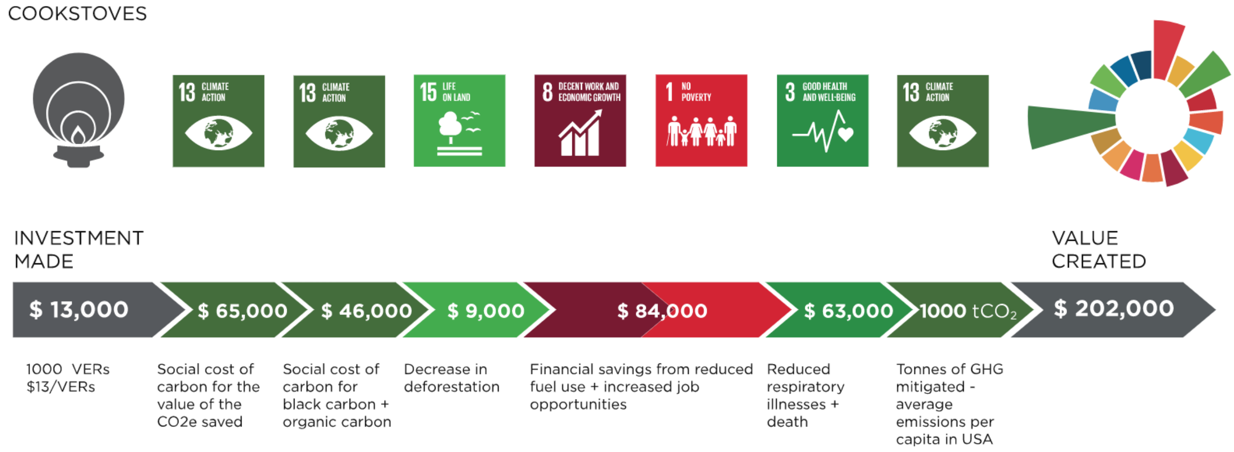
(Table 5: Project categories VCM:Ecosystem Marketplace, 2018; Hamrick et al., 2018; Author, 2020).

The VCM has introduced projects with a broader range of SDG's. VCM projects have started to address a broad range of Sustainable Development Goals. Examples are Forestry and Land Use (4) and Household Devices (5). Numerous reports indicate an increasing demand for offset projects that, next to offsetting carbon, hold numerous co-benefits such as supporting the local economy or help to sustain biodiversity. A large stakeholder survey indicated that co-benefits are becoming increasingly important for buyers and suppliers and are one of the main reasons to get, or to not get involved in certain projects (Donofrio et al., 2019).

Several standards are trying to incorporate co-benefits in their requirements by linking project-types to the Sustainable Development Goals (image 1). These standards are 'quality marks' aimed at guaranteeing that an offset project actually takes place and is responsible for the presented amount of prevented emissions. A project developer can present an offset project to a standard that uses its own methodologies to calculate and double-check the estimated emission is compensated for. A project that is enlisted at a respected quality mark has on paper a better chance to actually offset the certain amount of carbon.

Gold Standard and VCS (also known as VERRA) are the most widely used and respected quality marks that are currently in place globally. (Gold Standard, 2020; VCS.org, 2020). Gold Standard operates in both the voluntary market (verified emission reduction known as VER) and the compliance market (certified emission reduction known as CER). The most used, respected well-known quality mark in the Netherlands is the Gold Standard. This organization was established by NGOs and the WWF in 2003 and claims to ensure that their projects feature the 'highest possible levels of environmental integrity'. The organization calls itself best practice and states they focus on the Sustainable Development Goals (Gold Standard, 2020). As described earlier, nearly all examined Dutch retailers used Gold Standard as a certifier making it the most important and logical choice for offsetting. The quality mark is located in Geneva and is the high-status signboard for project retailers to offer their projects to the voluntary market.

Standards have not yet found a way to actually measure the exact size of co-benefits using a universal set of metrics. These co-benefits are also proven to help create a "narrative" or "story-line" which is a much-wanted asset for for-profit companies in reaching their broader corporate environmental strategy (Forest-Trends, 2019). More "charismatic" projects have seen a dramatic increase in demand and consumers are willing to pay extra for these wanted offsets (Hamrick et al., 2018). It can be concluded that "charismatic'' project categories such as 4 and 5 that associate natural climate solutions with strong social components have a commercial advantage over other offset project categories.



(Image 1: Gold-Standard their link of project category 5 with SDG's, Gold-Standard, 2019).

The example presented by Gold Standard in figure 1 shows how a project type, in this case, 'cookstoves' within category 5 Household Devices, is linked to the Sustainable Development Goals. Number 13, climate action is checked because fewer tons of greenhouse gasses are emitted due to the cleaner cookstoves. Goal 15 life on land is checked because less fuel is needed, leading to less deforestation and other goals (1 and 8) are tapped as well. The image also shows that there is little modesty in linking the SDGs to the project looking for example at the far-fetched no-poverty goal due to savings on fuel. The added value arrow that shows the value created polishes this image that is a powerful tool in presenting offsetting and its positive externalities. It can be easily adopted by larger companies in their corporate sustainability reports. Methodologies can be found on their website although the calculations behind this image regarding the added value are only 'based on funding of 10.000 VER's' (Gold Standard.org, 2019). During SQ4 more information behind quality marks, certification and the methodology will be presented and more critically analyzed.

Project Category	**Number of projects** (2005-2018)	**Volume offsetts in MtCO2e** (2005-2018)
1: Agriculture	87 (4.3% of total)	6.7 (1,5%)
2: Chemical Processes and Industrial Manufacturing	72 (3.6% of total)	63.5 (14,5%)
3: Energy Efficiency and Fuel Switching	633 (31,4% of total)	127.9 (29,2%)
4: Forestry and Land Use	170 (8,4% of total)	95.3 (21,8%)
5: Household Devices	161 (8.0% of total)	23.4 (5,3%)
6: Renewable Energy	611 (30,3% of total)	61.9 (14,2%)
7: Transportation	43 (2,1% of total)	1.1 (0.2%)
8: Waste Disposal	238 (11,8% of total)	57.5 (13,1%)

(Table 6:Project-Category, Market Share project categories between 2005-2018, Forest-Trends, 2018)

Multi-national and large for-profit companies have the bulk of the VCM market.

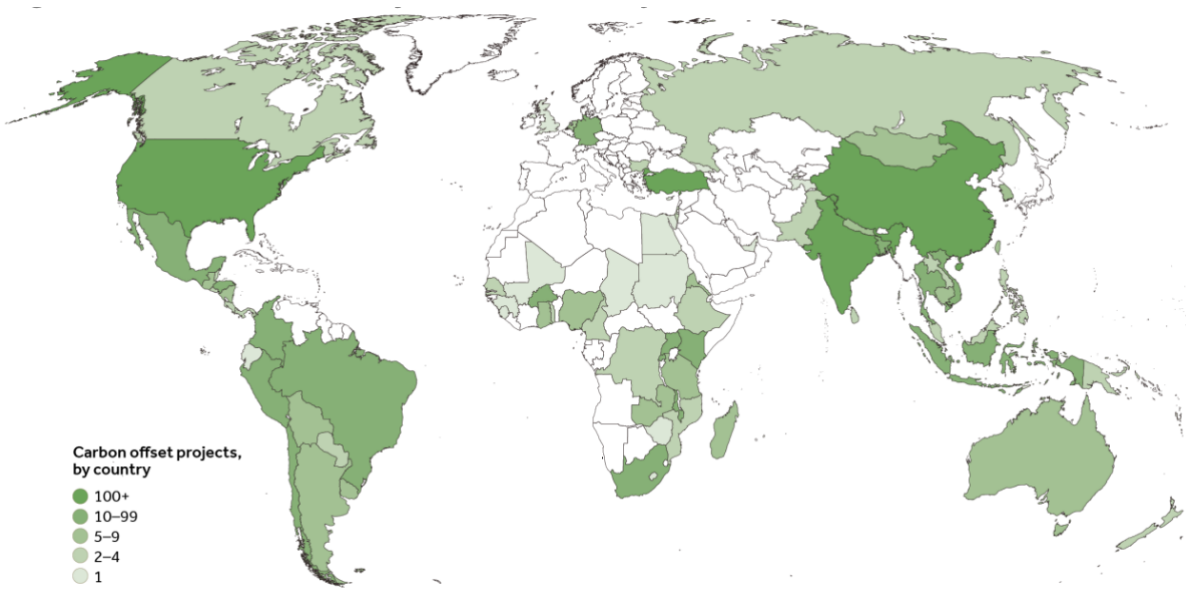
Royal Shell and BP for example, have adopted voluntary offsets in their corporate sustainability strategies (Donofrio, 2019). The VCM has grown since 2005 and with over 600 projects in Energy Efficiency and Fuel Switching, category 3 has had the largest share in number of projects followed by 6: Renewable Energy (30,3% of total). However, when looking at the volume of offsets, category 6 holds only 14,2 % of the total amount. This could implicate that the project-types within category 6, have not been efficient in offsetting carbon or, it could implicate that projects were of a less significant scale.
The category that seems most efficient regarding offsetted MTCO2e per project is category 4, Forestry and Land-Use. With only 170 projects, 21,8% of the total offsets were produced.

2018	VOLUME $MtCO_2e$	AVERAGE PRICE	VALUE
FORESTRY AND LAND USE	50.7	$3.2	$171.9M
RENEWABLE ENERGY	23.8	$1.7	$40.9M
WASTE DISPOSAL	4.5	$2.2	$10.0M
HOUSEHOLD DEVICES	6.1	$4.8	$29.5M
CHEMICAL PROCESSES/ INDUSTRIAL MANUFACTURING	2.5	$3.1	$7.9M
ENERGY EFFICIENCY/ FUEL SWITCHING	2.8	$2.8	$7.8M
TRANSPORTATION	0.3	$1.7	$0.5M

(Table 7, 2018 market volume mtCO2e for each project category, source; Donofrio et al., 2019).

In 2018, Forestry and Land-Use (4) was the global leader category in voluntary offsets in both transactions and issuances Forestry and Land-Use overtook Renewable Energy in 2017 and improved with 264% in the time period 2016-2018 (Donofrio, et al., 2019). Especially REDD+ orientated projects caused this improvement. REDD+ projects increased with 187%, making it by far the project-type-leader in voluntary offsetting.

Another fast-increasing project category is (5) Household Devices. The project-type that distributes clean-burning cookstoves its transaction volume has increased 113% in time period 2016-2018 with a market value of $24.8 million.
As with Forestry and Land-Use (4), the demand of buyers for social co-benefits is pointed out as a reason for the success of the distribution of 'clean-burning' cooking stoves (ibid).



(Map 1: Locations of Voluntary Carbon Offset Projects 2008-2018, by Hamrick et al., 2018)

More than half (51%) of all voluntary offsets are produced in Asia. 18% is produced in North America, 12% in Africa and 11% in both Latin America as Europe.
When looking at offsetted MtCO2, Asia leads (39%) followed by North America (26%). Africa remains third with 13% (Hamrick et al., 2018). A main reason for the high amount of voluntary offset projects in North America, is the fact that the United States was not aligned with Kyoto, creating an early demand for a voluntary market, parallel to the regulatory CDM. An early withdrawal from the Paris Agreement further enhanced the demand for voluntary carbon offsets in the United States (Donofrio et al., 2019). China was firstly not member of the 1997 climate group but an associate after which they did ratify in 1998 (Liang et al., 2007).
One might argue if it wouldn't be an option to start offset projects closer to home in , for example, the Netherlands. This has to do with the (international) carbon trading schemes. The Netherlands is aligned with the European Trading Scheme, making it illegal to externally produce offsets and sell them within the same boarders because otherwise you would count these avoided emissions twice. All carbon that is sequestered in the Netherlands is part of the Dutch Intended Nation Determined Contributions (INDC). This principle is called double counting and is a serious concern within offsetting economies (Oko institute, 2017).

4.2 Voluntary offsetting in the Netherlands, a case study

Carbon offsetting is increasing in popularity in the Netherlands. Especially the offsetting of energy-use, flights, and other forms of transportation are widely used by individuals, companies and the Dutch government (Missler, 2020). If an individual in the Netherlands wants to offset emissions, several patterns can be detected and distinguished.

Large multi-nationals Shell and KLM offer their own carbon offsetting services where an individual can voluntarily pay a small additional fee on top of a fueled tank or booked flight (KLM, 2020). Both companies claim to directly invest donations in pre-selected certified offsetting projects outside of Europe. Most airlines have this option available for consumers.

A second option is the offsetting through a (certified) Dutch retailer. TreesForAll for example includes an online carbon calculator that calculates the needed offset for a specific flight. Climate Stewards goes even further in offering a wide spectrum of consumed products or services that can be emission-wise calculated and offsetted. Retailers offer a limited assortment in (certified) offsetting projects. Mostly in a few different areas (TreesForAll.nl; ClimateStewards.nl; FairClimateFund.nl).

Lastly, there is the choice to not make use of companies or retailers. Instead, an individual or company can consult directly at certified standards and self-select a wide offer of offsetting projects in a wide range of countries. Prices differ between projects since some are more expensive due to project type or location (GoldStandard.org,2020; VCS.org, 2020).

What all three patterns have in common is that the offsetting consists roughly of three phases. Firstly, the carbon emissions for a consumed service are estimated with the help of a carbon calculator. For this research, the example of a booked single flight Amsterdam-Auckland will be used as a case study.
After the calculation, the amount of carbon of this specific action or service will be presented. Secondly, by certain retailers, a choice can be made where, and what kind of project category and project type is selected. Lastly, the total amount for the offsetting costs is presented and an individual can proceed to his or her payment.

Since carbon offsetting is becoming more popular in the Netherlands, the options and range are increasing. Online fashion shopping companies as Zalando have included voluntary emission offsetting in their services. An ordered box of shoes can be voluntarily compensated for $0,25 by simply adding this option right before payment (Zalando.com, 2020).
It doesn't matter where you live, or the amount of products you order, the price is always the same. The company claims it works together with Gold Standard but there is no further information. Neither is there a choice in offsetting category for consumers. This development shows that voluntary carbon offsetting has found its way from multi megaton-carbon amounts coming from fuel, energy and aviation, to small uniform payments for everyday services.

Energy providers in the Netherlands also offer a wide range of “carbon neutral” or offset products. Eneco for example invests in Gold Standard certified projects (Eneco, 2020). Essent does the same whereas Vattenfall offers energy contracts to households that include the purchase of CER’s (Vattenfall.nl, 2020). Offsetting through energy suppliers differ from ordinary voluntary offsetting since individuals sign an energy-contract in which the energy provider might offer ‘clean’ or compensated energy. One might state that this is not directly voluntary offsetting since it is included in an energy contract. Moreover, CER’s are sold and obtained within the compliance carbon market

In voluntary offsetting choice for an individual can be determined in the following patterns:

a) The consumer has only the choice to do, or to not do offsetting: Zalando
b) On top of a), consumer can also see where his offset goes to: KLM
c) On top of a) and b) a consumer can also choose from a pre-selected handful of projects: Treesforall
d) The consumer chooses his own wanted amount of offsetted emissions, and from a broad range of projects directly via an official certifier: GoldStandard

There are major developments on the way for voluntary offsetting in aviation. Currently, most airlines offer the choice to individuals to offset their flight. KLM for example sends you a WhatsApp message with a payment request for offsetting, after the purchase of your flight ticket. However, a worldwide carbon reduction scheme, solely designed for aviation is on its way and planned to be piloted in 2022. This scheme is CORSIA which stands for Carbon Offsetting and Reduction Scheme International Aviation. Aviation will be legally obligated to offset all amounts above the set average of 2019-2020 amounts of their emissions. In other words, all growth, worldwide in aviation must be offsetted. With the outbreak of COVID-19 it is not clear how much the aviation sector will grow and on 26 June 2020 a ‘kamerbrief’ was sent to the Dutch ministry of infrastructure asking about developments surrounding CORSIA and the COVID outbreak. There is a lot of uncertainty about CORSIA and the reduction scheme and there is not yet certainty what exactly will happen. It might affect the voluntary offset market in the (near) future. CORSIA will very likely mean an increase in the total of offsetting projects. However, CORSIA is officially not planned to take part in the VCM. Instead, it is a regulatory market principle.

An overview of the largest players in the Dutch VCM is presented below.
The available project categories and locations, the aligned standards, and the amount of carbon and pricing for a specific selected service (A single flight from Amsterdam to Auckland New-Zealand) help to provide insight in this growing market.

(Table 8: Overview VCM in the Netherlands; Example used; Single flight Amsterdam-Auckland 2020, authors own)

Name	Explanation Summary	Project Category & Project Location(s)	AMS-AKL (single) Ton CO2 & Price in Euro's (Price for each ton CO2)	Aligned VCM Standards
CO2zero by KLM	Offsetting service by KLM since 2008. Outsource to certified standards	4: Forestry L.U. 5: Household D. (Panama)	1.49 ton Co2 **€12,96** (€8,70=1 ton)	Gold Standard
GreenSeat	Part of Climate Neutral Group. Offers consumers to compensate all types of transport.	5: Household D. 6: Renewables (India, Africa→ country unknown)	2.09 ton Co2 **€17,24** (€8,24=1 ton)	VCS Gold Standard
TreesForAll	First offsetting initiative in the Netherlands(1999). Extensive carbon calculator. Focus on reforestation.	4 Forestry L.U. (Bolivia, Uganda, Philippines, Netherlands)	2.67 ton Co2 **€33,34** (€12,48= 1 ton)	VCS Gold Standard
FlyGreen	Search Engine that compares flights and offers compensation.	5: Household D. 6: Renewables (India, Tsjaad)	5.44 ton co2 **€78,93** **(**€14,51=1 ton)	VCS
FairClimateFund	Aims at individual and corporate. Also includes compensation for events (Festivals)	4: Forestry L.U. 5: Household D (India, Ethiopia)	2,76 ton co2 **€63,53** €23,02 = 1 ton co2	Gold Standard FCS
Gold Standard*	Most well known and respected VCM Official Certified Standard.	*All project categories and worldwide	**ranging from €9,08 to €25,43 euro for each ton of co2*	Gold Standard
Shell	Consumer can pay an extra fee to offset the bought fuel. Shell claims to compensate the	4: Forestry L.U. (Peru, Indonesia)	**€0.01 for each liter Petrol/Diesel/LPG*	VCS CCB

	emissions of the production and distribution of the fuel.	

Table 8: Dutch VCM suppliers and retailers, 2020, (*Gold Standard is not Dutch but operates worldwide).

When looking at the example of the offsetting of AMS-AKL it immediately becomes clear that the different retailers are extremely inconsistent in pricing and calculating emissions. Estimated emissions for AMS-AKL range from 1.49 ton co2 to 5.44 ton co2. The price in euros ranges from €12,96 to €78,93. The difference in pricing between KLM and Flygreen is over 500%. The price to offset 1 ton of co2 ranges from €8,24 at Greenseat, to €23,02 at Fairclimatefund.

While it is possible to choose between two types of projects, the price can remain the same. At Gold Standard an individual can choose project types that have a price range from €9 to €25. As can be seen in table 5, different retailers offer their services in different ways. The earlier distinguished patterns can be traced back while the majority of the offset retailers their scope is on the transportation sector and especially aviation. A variety of carbon calculators are to be found on almost all websites of the offset retailers and these calculators are capable of more than only weighing transport related emissions.

The most appeared project category is Forestry and Land Use (4). Followed by Household Devices (5). Renewables (6) is also offered as an offset category although it is underrepresented regarding the global market value (table 4). What is also noticeable, is the fact that at most retailers' websites, an individual can choose between two project categories.

On the question where these large inconsistencies in pricing come from, Treesforall foreign project manager explains there are different factors involved. Firstly, she explains that in order to create an offset you need a number. This is the amount of avoided or sequestered carbon. With this number a story (offset) is quantified and from there on it can be sold. However, not all of these numbers tell the entire story she continuous. Cheaper credits often mean that projects are of a larger scale and are cost-effective. Most of the times this means large scale REDD+ projects (Interview I)

Apart from inconsistent pricing and carbon calculations, it seems that certain projects are more expensive than others. When looking at Gold Standard, one can see that projects in category 6 (renewables) are less costly. Most projects cost around $10 . Category 5; Household Devices, are more expensive and cost around $15. Forestry and Land Use (4) projects are most expensive and cost over $20 (GoldStandard, 2020). With Forestry and Land Use as most popular project category regarding the global VCM market share, it is also the most expensive.

The most popular standard is the Gold Standard followed by the VCS. Most retailers outsource their sold offsets to one of these standards. This could be a reason why pricing differs between Gold Standard and for example, FairClimateFund.
Another reason given for the large inconsistencies in carbon calculations lies within what is measured and is considered climate damage. KLM for example, claims one can fly 'carbon neutral'. Fairclimatefund, goes further and claims an individual can fly 'climate neutral'. The difference between both, is that KLM only takes co2 in consideration while 'climate neutral' considers all GHG emissions. Atmospfair explains that different flight heights influence the damage of emissions. Greenseat explains that they include a so called 'detour factor' in their carbon calculator because a flight follows certain areal pathways. Other retailers calculate all emissions and add a factor x2 and offer offsets for all negative climate effects. To summarize, different retailers measure with different sizes and there is a discussion going on between them. It can be concluded that all these inconsistencies and contra information between retailers are both overwhelming and confusing for an individual that wants to offset his or her emissions.

4.3 Reviewing the leading project categories

The project categories that are most in use globally, are also the ones that are offered to individuals within the Dutch VCM (table 8). These project categories with their most used method will therefore be reviewed in the following section.

4.3.1 Forestry and Land Use (Category 4)

Forestry and Land Use is made up almost entirely out of REDD+ and other similar forms of afforestation (Forest-Trends, 2019). REDD+ and some of its negative societal and environmental impacts have already been discussed in the theoretical framework. The question remains whether or not it is the right tool for sequestering carbon.

The most important actors for deforestation are beef production, soya beans, and palm oil (Boucher et al., 2011). Carbon offsets both CDM and VCM are only accountable for $0.22 billion in funding to counter deforestation. When compared to 'export of drivers' ($134, 38 billion) and 'public funding' ($7,23 billion) it can be concluded that carbon offsetting only had a minuscule role in preventing and countering deforestation (Boucher, 2015). However, with the VCM growing, and REDD+ growing in popularity, and outdated numbers, the role of offsetting might have increased.
There is a scientific discussion going on regarding the sequestration capability of trees. Location, species, environment, and many more factors influence the amount of carbon that is stored in trees (Toensmeier, 2016). One large tree captures an estimated 7,3 kg of carbon. However, other sources indicate that sequestration capability ranges from 2kg to 20kg (Porcelijn, 2017). If a tree burns or dies and decomposes, this carbon is released back from the terrestrial pool into the atmospheric pool. This means that sequestration through reforestation falls or stands by the fact whether or not the forestry is permanent. However, with a growing population, more pressure on land, and local tensions as described in the theoretical framework, it is very hard to say whether or not a forest is still there 60 years from now. One can even state that it is simply not possible to absolutely guarantee the planting and conserving of forestry in the global south for more than half a century from now.

Then, there is the statement that carbon can be offsetted trough the conserving or protecting of existing forestry. This means, that by protecting forestry that was already there, or avoiding deforestation, carbon credits can be sold. The idea is that because this forestry is protected from destruction, an x amount of carbon is sequestered. The amount of carbon that is claimed to be saved by doing so, is almost impossible to substantiate officially. How can you calculate the amount of carbon that is saved from "possible'' destruction? And just as difficult: how do you prove that this certain hectare of forestry is actually under direct threat? And even then, if locals are blocked from a certain strip of forestry, why won't they just go to another forest nearby to harvest trunks? The point here is that you can easily criticize the idea that emissions are compensated by something that was already there. Is this really compensation and thus offsetting? In most cases there is no actual mitigation effect.

The most used method that estimates carbon savings by protecting forestry by certified offset retailers is to assume calculation based on the average deforestation rate of this certain area (Missler, 2020). However, these are mere estimations and there are many variables and also context that is not considered. An example of this comes from the International Forestry Review that looked at a certain project in Congo where a certified project prevented deforestation at a 'great' scale'. It turned out that the deforestation rate of a nearby densely populated forest was used to scale 'his' forest that was not so much under threat. The 2011 project had been overvalued and therefore over rewarded to great extend (Trouw, 2020).

Ecological, social, and hydrological problems encountered with REDD+ aside, one cannot say that mitigation effects can be guaranteed. There are simply too many uncertainties, inconsistencies, and errors. Especially with the protection of forests which could be a good thing, but is not suitable as a carbon offsetting method. Amounts of sequestered carbon trough category 4 are purely based on speculation and therefore pricing and offsetting are as well. The effects are not perfectly measurable and it can't be said that they are permanent.

4.3.2: Household Devices (Category 5)

Cleaner cook stoves aim to improve livelihoods by replacing traditional wood and charcoal fires by clean-burning more efficient and modern LPG cookstoves (Gold-Standard, 2019). This should result in less emissions and reduced smoke which in turn has a positive effect on healthcare. More positive effects that Gold-Standard claims these projects have are; 93% of women have more time for their family, 78% of husbands are involved in cooking activities, slowed down deforestation, less costs, reduced gender inequality and cleaner kitchens. A lot of SDGs are linked with providing a device to a family which makes them charismatic and wanted.

In 2012 a study was published regarding families in India that had received certified cookstoves and were extensively followed for four years. This study showed that the certain group only used the received stoves in the right manner for less than 1 year. In the years following, the stoves broke, families returned to traditional fuel, and the stoves were not large enough for expanding families. The study concluded that there was no significant benefit for health and no significant emission reduction due to the limited long-run impacts (Hanna et al., 2016). The main reason given apart from breaking was a lack of local knowledge on maintenance, incentives to stick to the modern cookstove. Gold-Standard their own reports show that projects in Mali, Ghana and Kenya had more success due to longer usage. However, even in their report Gold Standard states they overestimated the long-term use of cookstoves (Homolova, 2019). Lambe et al. (2015) also claim that for a cookstove to be truly beneficial, it must completely 'replace' a traditional charcoal or wood stove. In India for example, were the bulk of projects take place, traditional stoves cannot be completely replaced because a 'three-stone fire or chulha' is culturally embedded and therefore unlikely to be permanently dismantled (Lambe & Atteridge, 2012). Improved stoves are used next to traditional stoves which is called 'stove-stacking' and may lead to even higher levels of pollution and emissions (Ruiz-Mercado et al., 2015). This problem is encountered worldwide.

The Oko institute extensively researched CDM projects, including 65 cookstoves projects. Their report concluded that cookstoves are over credited due to parallel usage of traditional cookstoves and overestimated emission reductions due to uncertainties in fuel consumption. They valued this method as 'low' in terms of environmental integrity (Oko-institute, 2017).

Long term performance of stoves in real-use settings remain uncharacterized (Ventrella & MacCarthy, 2019). Gold Standard also concludes that more research is needed to improve understanding of the true impact of cookstoves (Gold-Standard, 2019). Many encountered problems can be traced back to practical dysfunctionalities. Right implementation is considered the main problem for failing adaptation of cookstoves for several decades (Brakema et al., 2020).

When looking at the different selectable cookstoves projects available at Gold-Standard, there are 16 projects, from solar to LPG stoves in several countries in different continents that all cost the same 15$ for each ton CO2.

How can you assure or guarantee that a cook-stove will actually be used and therefore aid in mitigating carbon emissions? It turns out that we can't. The effects are not trackable. When adding all the other limitations regarding performance, failing implementation, stove-stacking it can be concluded that there are no measurable, verifiable and permanent mitigation effects.

4.4 Mitigating Climate Change by KLM, Shell and TreesForAll

Three of the most used offsetting providers in the Netherlands are examined in this section

4.4.1. KLM

KLM founded its own carbon offsetting scheme in 2008, called CO2ZERO. They claim, that with only a little extra fee, a flight can be turned completely carbon neutral (KLM, 2020).

Their calculations are based on the type of plane, the distance, and the historical loading of the specific flight. Methodology and verification were done by KPMG which is a respected auditing and advisory firm. When looking at their verification document, it becomes clear that many variables for calculating fuel and emissions are based on assumptions and averages (KPMG/KLM, 2019). A factor of x 3.15 is added based on EU-ETS regulations. Furthermore, KPMG states that it considers that KLM efficiency is benchmarked as 'best in class', and hence the estimation might be undervalued. They also state that "not all data was currently available and that there was no other objective". As can be seen in table 8 the estimated carbon emission for AMS-AKL is the very lowest at KLM. Flight height is not considered, and only fuel related carbon emissions are taken into account. Indirect emissions such as the production and distribution of kerosene are not considered. IPCC Scientist de Coninck, states that an airplane also emits nitrogen dioxide and produces condense and clouds at high altitude, which multiples the climate damage by factor 2.

If an individual wants to compensate, the fee goes to "CO2OL Tropical Mix" reforestation project. 7.5 million trees have been planted and 150 locals have been provided a job related to this project. The project is Gold Standard.

The costs and calculated emissions of KLM's CO2ZERO are far too low to actually mitigate the climate damage that is done by booking a flight. Only direct fuel emissions are considered and the methodology of KPMG is not fully accountable. Without further investigation at the specifics of the project type, it already becomes clear that the price and calculated climate damage does not comply with the actual damage done and the needed offset. Claiming that an individual can fly without harm and completely "carbon neutral" after using CO2ZERO can be considered false and misleading.

4.4.2 SHELL

Royal Dutch Shell started to offer the possibility of offsetting fuel in 2019. Individuals are offered to pay an extra amount of 0.01 euro for each liter either petrol, diesel, or LPG. The same price for each type of fuel. Shell claims that this 0.01 euro is enough to ensure that each tanked liter is fully offsetted (Shell, 2020). One liter of petrol is estimated to emit 2.7 kg of co2.

An estimated 80% of the amount of Co2 comes from the exhaust pipe and 20% is emitted during production and distribution (Reijn, 2019). When an individual decides to offset at Shell, he or she pays for the 80%, and Shell claims to offset the other 20%. The most important question is whether or not the 0.01 euro per liter is enough to actually fully offset 1 liter of petrol.

If an individual pays 0.01 euro for each liter of fuel, this individual pays 4,60 for each ton emitted co2 (Reijn, 2019). Shell provides calculations for emissions verified by MilieuCentraal. Shell invests in VCS certified REDD+ projects (Category 4, Forestry and Land use).

4,60 for 1 ton co2 is much lower than the average 15.00 for 1 ton co2 an individual pays at Gold Standard. However, Forest Trends explains that large scale REDD+ projects can be cheaper. The planted forest of Shell on Kalimantan is as large as the province of Utrecht. Shell has no exact figures or statistics regarding the exact amount of funding and captured carbon. De Volkskrant tried to investigate the Peru and Indonesia projects. The administrators of the Shell projects did not provide financial information. Shell ensures that the largest part of the funding of these projects comes from the offsets (Reijn, 2019).

Indonesian journalist Hanifan and his team investigated the "Shell forest" after NASA satellite images showed burning spots in September 2019. The project administrators confirmed that over 2000 hectares of forest had been burned (Missler, 2020). A part of the forest is claimed by the local Dayak community. Wooden signs with tribe-names that indicate claimed territory can be found throughout the forest. Parts have been burned in order to provide space for agriculture, inhabitants were not informed about the boundaries of the Shell project, there is a lack of supervision and local farmers are trained to be a firefighter (Trouw, 2019). There is an ongoing conflict going on between local communities and the project developers and administrators. In 2014 Dayak leaders were promised five hectares of land to grow crops which was officially documented. Currently, Dayak leaders use them to claim areas inside the protected forest. Local families were offered hundred million roepia to help 'assist' and protect the forest. Many villages however, refused because the offered payment was to low (Dupont-Nivet, 2019). A palm oil plantation is located next to the forest putting extra pressure on the Shell forest and the local political situation is untenable. Farmers and tribes could be legally dislocated. The Indonesian Ministry of Forestry affairs however, is afraid that the situation escalates and has focused on a peaceful way that is so far unsuccessful.

It can be concluded that even though Shell's calculated carbon as well as the pricing for the offsetting is theoretically plausible, the situation at this certain REDD+ project of Shell is even worse than described in the theoretical framework. Shell's climate forest is failing and unsustainable. It is therefore very unlikely that it actually mitigates the promised climate damage that is done. This is without asking the critical question of whether or not 'protecting' a forest, which is the case with Shell, is the same as 'planting' a forest.

4.4.3: Treesforall

Treesforall is a Dutch foundation that is fully devoted to planting and recovering forestry worldwide. The foundation claims that all projects guarantee the amount of sequestered co2. Treesforall claims that planting forestry (category 4), is the most high-quality way of offsetting, due to benefits to climate, nature, humanity and environment (Treesforall.nl, 2020). Treesforall guarantees that all trees are planted within a year from the donation.

What makes them different from earlier mentioned retailers, is the fact that they operate on a much smaller scale in terms of projects (Interview 1). The foreign project manager of Treesforall states that large multinationals such as KLM want large-scale projects so they have cost-effective and cheap credits. In interview I she states: *"We cannot and do not want to operate at such a scale. That is a different corner in emission reductions. We are consciously not involved with REDD+" (Tollenaar, M., 2020).*

Treesforall is only involved in projects that do active ecological reforestation or invest in areas that are degrading very fast. The manager of foreign projects explains that it is of key essence that economic value is added to forestry. With the protection of forestry, land can't be used for agriculture and other economic practices, and exactly this creates a huge tension on land that creates risks because it gets in the way of local economic development. If you are not able to give this forestry other value, farmers or governments will intervene eventually. And exactly this makes it nearly impossible to guarantee that forestry will be preserved permanently. The foundation are focusing on projects that redesign and refurnish the land from scratch so that it becomes economically profitable for local development (Interview I*, 2020).*

Examples are agroforestry, sustainable low-impact logging, local training, bee-keeping, and more. Knowledge regarding the local political context is also of major importance and a list is used to measure risks. Tollenaar states that large-scale projects often go hand in hand with large scale risks. They operate at multiple smaller scale projects to reduce risks.

The forests that are planted by Treesforall are monitored for at least 30-50 years. Treesforall claims to focus on the monitoring and managing of forestry on the long term. They pay attention to local forestry legislation and involvement of local communities. Also they have local partners such as the Uganda Wildlife Authority that should have the means to actually monitor on the long term.

The foundation presents several links to factsheets with the estimated sequestration capabilities of certain forestry projects (Boosten & Briel 2020). The foundation declares in honesty that presenting exact amounts of offsetted co2 is hard to deliver and that they work with secure measured and checked estimations (Treesforall.nl ,2020). They outsource the used methodology provided by Gold Standard or VCS. The foundation also declares in honesty that they cannot fully guarantee that forestry will still be there in 30 years. They do have it contractual covered but cannot rule out factors as local regime-change, pressure on land and climate change.

Treesforall does things differently from the other offsetting retailers. They already have incorporated several ecological mechanisms in their offsetting such as agroforestry and bee-keeping that are distantly related to agroecological carbon farming. Also they only focus on actual reforestation and pay much attention to adding economic value for local development. It remains unclear whether or not the example of AMS-AKL is fully mitigated at Teesforall. Treesforall proves that not all offsetting is bad and must serve as an example for other larger offsetting retailers. Best practice in the Netherlands is so far set by Treesforall.

4.5 Conclusion and answering sub-question 1

The outcome of the calculated amount of carbon by retailers and standards is never 100% accurate. And most often not even close. Therefore, projects should estimate and calculate frugal. Lambert Schneider from Oko institute states that they don't. Developers and retailers often simply overestimate the offsetted carbon and have a financial incentive to do so. The more certificates and offsetts they collect, the more they can sell to KLM or GreenSeat (Kill, J., 2019). Moreover, the project categories in which the Dutch VCM markets operate are erroneous. The extra fee paid by an individual to spend one of these projects cannot provide the guaranteed mitigation effect in the high majority of cases. Agriculture is almost nowhere to be found.

Global Voluntary Carbon Offset Market

- The VCM is growing. Charismatic projects that have a clear link to multiple SDGs are increasing in popularity and have a commercial advantage.
- Large Multinationals and for-profit companies have the bulk of the VCM market
- Over half of the voluntary offsets are produced in Asia
- Voluntary Offsetting can be divided into eight project categories. Agriculture has a negligible market share.
- Category 4, Forestry and Land Use is increasing exponentially in popularity. REDD+ is project-leader in current VCM
- Category 5, household devices follow up with improved cookstoves as project leader

Reviewing Sequestration Methods

- Category 4 Forestry and Land Use is unsuccessful in providing real, measurable, permanent and verifiable offsetts
  Especially the "protecting of forestry" is unable to prove real carbon sequestration and is not expected to be successful in the future.
- Category 5 Clean cookstoves in unsuccessful in providing real, measurable, permanent and verifiable offsets. The main problem is the right implementation of the stoves and the capability to track its use.

VCM in the Netherlands

- Voluntary Offsetting is already widely used in the Netherlands from offsetting aviation to everyday services such as online shopping.
- 3 patterns in Dutch offsetting can be distinguished and options and range are further increasing
- The Dutch VCM offers:
  -Inconsistent carbon calculators
  -Inconsistent pricing, up to 500% difference between retailers for the same service.
  -inconsistency in what is considered 'climate damage'.
- Retailers all use different methodologies, some are incomplete.
- Unclear what exactly an individual pays for.
- Overwhelming, confusing, and misleading information for the consumer.

Mitigation Effects Dutch VCM retailers

- The extra paid fee at KLM's CO2ZERO service certainly does not mitigate the climate damage that is done.
- The extra paid fee at Shell has a very low probability to mitigate the climate damage that is done due to a failing local project and an ill-sequestration method (4).
- Treesforall has a decent case and their vision should be taken as example in Dutch VCM. They focus on creating added value to forestry and land use for the long term. They are not yet considering agriculture or carbon farming. Also are slowly discovering more truly ecological options for afforestation. Mitigation can not be guaranteed in all cases.

(SQ1): What voluntary carbon offset techniques are currently in use within the Dutch market and how do they function?

REDD+ and the distribution of clean cookstoves are the most used offsetting techniques that are currently in use within the Dutch VCM. If an individual wish to choose another technique he or she can cut the middle-man and go directly to Gold Standard or another officially certified retailer. However, the most common retailers (Shell, KLM, Treesforall red.) do not offer the wider variety of techniques. The currently available methods fail in providing real, measurable, permanent and trackable offsets.
The extra fee that is paid, does not guarantee to mitigate the climate damage that is done. Side benefits are sometimes present, and many projects are linked to different SDG's but real additional sustainability benefits are lean. Especially with category 4 however, many indirect social and ecological negatives are also present. After analyzing different project types and retailers offering different offsets using different methodologies in different locations, it must be concluded that the current Dutch VCM is failing to provide a real quantifiable permanent voluntary offset. Too much is based on assumptions, averages, and wrong estimations. There are too many limitations, context specific problems, and uncertainties with projects locally. The main problem with sequestration is for projects to be permanent. It seems it is not possible with these current techniques in place to provide a real offset for a certain service at a certain price. The problem is that many retailers claim they can while they are not clearly informing on how and the evidence is against them. The exception is the experienced Treesforall, which is further than others in the Dutch VCM in terms of ecology, vision and additionality.
Carbon offsetting in the Netherlands in its current state fails for the larger part to do what it intends: to compensate for the damage that is done and to restore part of the balance of the planetary carbon cycle. It is in its current state not much better than the failed CDM and there is yet a lot of work to do to make it even partly successful.

5. Results: II: Agroecological Carbon Farming

5.1 Introduction to agroecological carbon farming

The sequestration potential of crops has been largely ignored in the literature and agriculture is almost nowhere to be found in the voluntary carbon market. Farming practices are often described as causes for climate change and seldom mentioned as potential climate solutions. Carbon farming as described in the theoretical framework implies most simply defined: *all land-use or farming practices that sequester carbon* (Evans et al., 2015). For this research, agroecological farming practices are added to this definition. Industrial or conventional carbon farming is therefore not considered carbon farming in this research. It turns out that specific agroecological farming practices are capable and necessary to successfully sequester high amounts of carbon.

Next to the capability of sequestering carbon and with that, offsetting CO2, carbon farming can be thus made agroecological. Unsustainable farming practices have degraded the soil and led to water scarcity, desertification, erosion, fertility loss, and loss of biodiversity (Eswaran,Lal & Reich, 2001).
Agroecology is based on the principle that interconnections and inputs and outputs of an agricultural site, are understood as an ecosystem (Gliessman,2015). It incorporates ecological and social components and, if adopted properly, should function as a managed working ecosystem. Agroecological carbon farming differs from regular carbon farming in the sense that agroecological carbon farming includes practices that are aimed at "*the application of ecological concepts and principles to the design and management of sustainable agricultural ecosystems"* as described by Altieri (2009). Regular carbon farming can therefore exist of all farming or land-use practices as long as carbon is stored into the soil. Agroecological carbon farming goes further into incorporating certain practices and principles that help further enhancing the agroecosystem potential.

In order to find out whether or not agroecological carbon farming can be made suitable for offsetting, it is important to present a clear and extensive description of what agroecological carbon farming exactly is. In this section agroecological carbon farming will be explained. The sequestration capability, the agroecological principles and the socio-economic and ecological benefits will be described followed by its limitations.

The IPCC already quantified mitigation potential for several sequestration techniques in 2014 (IPCC, 2014). The report looked into the potential global mitigation impact, the easiness of adaptation by farmers and the time to implement. Different farming techniques have a different annual sequestration rate per hectare. As mentioned earlier, agroforestry practices and cropping methods are also given only little attention in the 2014 IPCC report.
In the 2019 report on climate change and land, agroecology and especially agroforestry are repeatedly described as ecosystem based adaptation and mitigation practices that sequester carbon while also being beneficial for in terms of providing services to people and improve natural conditions locally as well (IPCC, 2019). It turns out that specific agroecological (cropping) practices have an underestimated potential in sequestering carbon per hectare per year. One of the conclusions of the report can be read below:

> *Farming systems such as agroforestry, perennial pasture phases and use of perennial grains, can substantially reduce erosion and nutrient leaching while building soil carbon (high confidence). The global sequestration potential of cover crops would be about 0.44 ± 0.11 GtCO2 yr–1 if applied to 25% of global cropland (high confidence). The application of certain biochars can sequester carbon (high confidence). ,and improve soil conditions in some soil types/climates (medium confidence).* (IPCC, 2019)

(Citation from IPCC's 2019 report on Land Use and Climate Change, IPCC, 2019)

5.2 Sequestration Capability of (Agroecological) Carbon Farming

In order to provide an indication on how much carbon is sequestered the rating of Toensmeier (2016) will be used, (table 9).

Sequestration rate	Tons CO2 ratio per hectare/per year
“very-low”	<0-0.5
“low”	0,5-1
“medium”	1-5
“High”	5-10
“very high”	10-20
“extremely high”	>20

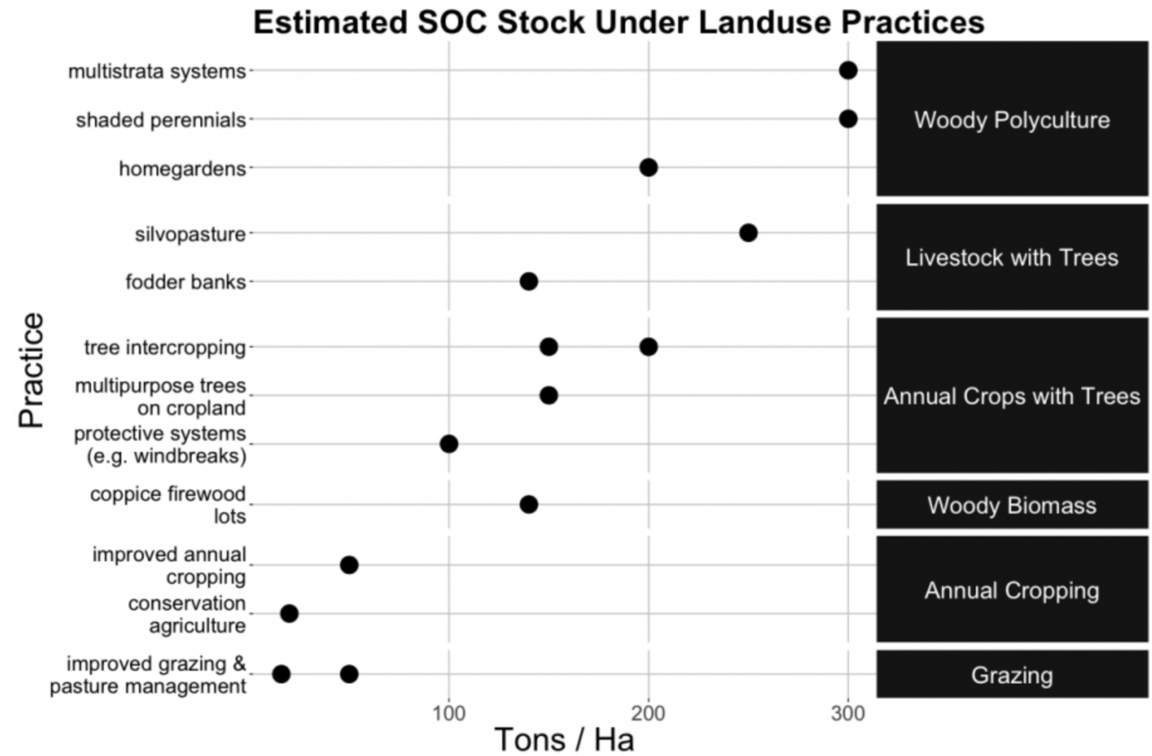
(Table 9 :Sequestration rates for carbon farming systems per hectare per year. Source: Toensmeier, 2016).

5.2.1 The carbon sequestration of annual cropping systems.

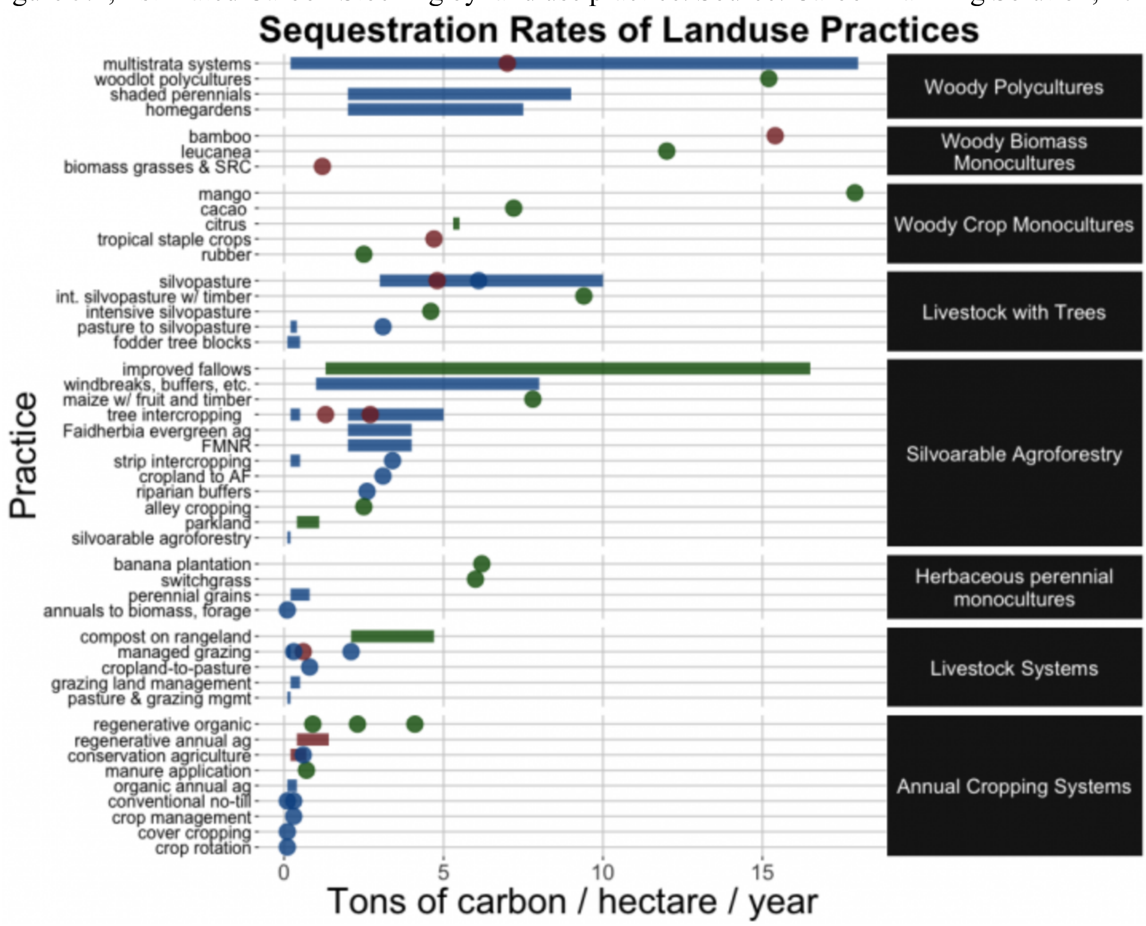
Conventional cropping systems (non-agroecological) sequester carbon too.
The cropping method that is responsible for most of the human food and feed for livestock worldwide, is **annual cropping** (Toensmeier, 2016). This method sequesters carbon although the rates range from very low to medium per hectare (Table 9 and figure 5.2).

Before explaining the differences between types of cropping it is important to understand that apart from sequestering carbon through photosynthesis and food security, the accumulation ability of the soil related to this practice is at least as important. This last- mentioned variable is exactly where annual cropping scores are very low. Whereas other cropping methods store vast amounts of carbon below ground, annual cropping systems only accumulate little to even negative amounts of carbon (figure 5.2). Even Though practices such as crop rotation or polyculture can improve the sequestration capability, it remains lower than other cropping techniques. In other words, this globally most used cropping method is not very functional to be used to increase the terrestrial carbon stock.

The main reason for this is quite obvious. Annual crops complete their life cycle in one year. From seeding to growing to the harvesting phase which means that the carbon sink only has a few seasons to develop and less photosynthesized carbon ends up below ground. Furthermore, the above-ground biomass is not stored because it is harvested and/or it dies at the end of the annual cycle (Interview II, B. Klein Lankhorst, 2020). The mean residence time (the time-length that sequestered carbon remains in the soil) with annual cropping is very low. Annual cropping is therefore not considered agroecological and not suitable for agroecological carbon farming. Annual cropping in general has a low potential in terms of sequestering carbon.



(Figure 5.1, Estimated Carbon Stocking by land use practice. Source: Carbon Farming Solution; 2020).



(Figure 5.2: Sequestration capability of land use practices. source: Toensmeier, 2020).

5.2.2 The carbon sequestration potential and characteristics of agroecological polyculture perennial cropping systems

Where annual cropping fails in storing vast amounts of carbon, **perennial cropping** has proven to do the opposite. It has the ability to sequester extremely high ratios of carbon under the right circumstances (figure 5.2). Moreover. The lifetime accumulation of soil organic carbon is also the very highest at perennials (figure 1). Both annual carbon sequestration and lifetime storage are very positive. Perennial crops are those that live at least for five years and the longer they live the more carbon they can sequester (Toensmeier, 2016). In other words, perennials are "non-destructively harvested" which means that they do not die after being harvested.

The lifespan of perennials can easily be up to 40 years and for nut trees and some nut pines up to 1000 years (Lal, R., 2014). This greatly increases the potential to function as carbon stock since the mean residence time in above-ground biomass as well as in trunks and roots depends on the lifespan of a plant. When a perennial plant is harvested, it does not die and leaves and fruits and roots for example will grow back while carbon in trunks and branches will remain stored. The previously described annual crops release their carbon back into the atmosphere when harvested (ibid).

Especially woody perennials such as fruits, nuts, and olives have high sequestration rates. Specific species of bamboo have extremely high rates and woody crops such as cacao and safao have high to very high rates (Toensmeier, 2016).

Perennials can be found in monocultures and in polycultures. Polycultures are proven to sequester more carbon than monocultures (figure 2).

Director of "Bodumliefde" B. Klein Lankhorst is a soil expert and works on organic fertilizers and was interviewed for this research (Interview II). Bodemliefde is a consultancy bureau that works on multiple projects for land-use and improvement on soil-fertility in Ghana and the Netherlands. He also emphasizes the power of perennials.

> *"Over the centuries we converted perennials into annuals for our own convenience. The paradox is that perennials are actually easier to work with if you have patience. Why would you want to seed, till and harvest every year? With annuals you are degrading your soil. With perennials you only chop the head off and the plant remains. Now you keep storing carbon into the soil which improves the soil quality which in turn improves your food system. Instead of degrading the soil you make it better. If carbon gets stored in your soil you are doing something good. Working with nature works much better than working against it"* (Klein Lankhorst, 2020).

As with a regular ecosystem, an agricultural system can be made diverse. Mono-cropping of soy or corn is an example of a non-diverse mono-cultural system. Diverse populations make interactions between species possible and exactly this is one of the key factors for a healthy agricultural system(Toensmeier, 2016; Gliessman, 2015). Polycultures are systems in which at least two or more crops are grown in the same area at the same time. Vertical and horizontal lines of cropping increase the number of crops that can be grown in that same area. Moreover, a polyculture's total system is capable of achieving higher yields per hectare than monocultures (Gliessman, 1990). In the literature, there is a consensus that higher plant diversity increases the agroecosystem 's multifunctionality. The structural complexity of an agricultural system provides a greater variety and number of resources it can give (Yahya et al., 2017).

Polycultures can be designed by farmers in many manageable ways, from crop rotation to multistrata systems or silvo-pasture systems that will be explained during this chapter. What is of key importance is diversification of plant and tree species. The richness of species is a multi-beneficial solution for many ecological problems and, as earlier described, such a system is better capable of sequestering carbon which is the initial goal of carbon farming.

Perennial polycultural cropping systems are suitable for agroecology and therefore for agroecological carbon farming. Polyculture perennial cropping systems have a high potential in terms of sequestering carbon.

5.2.3 The carbon sequestration potential and characteristics of multistrata agroforestry

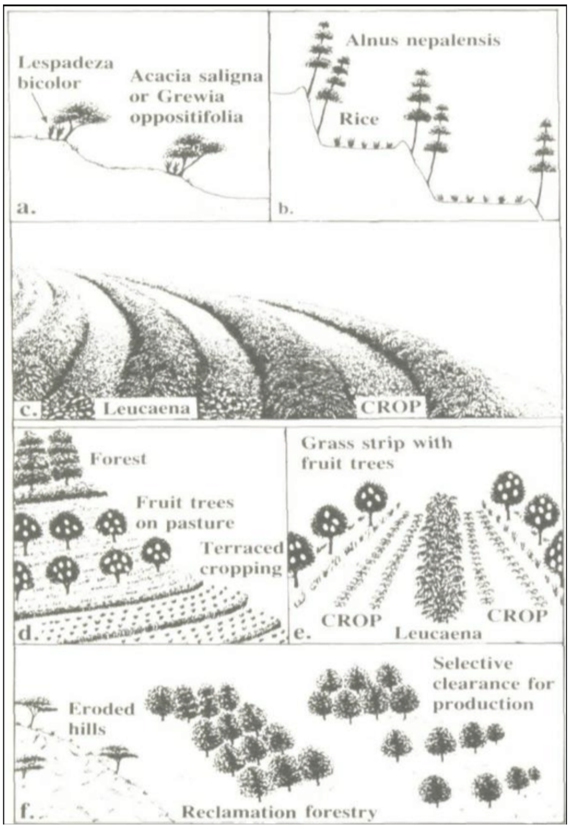
The most successful agroecological carbon farming practice in terms of sequestration potential is the multistrata agroforestry. Multistrata agroforestry includes polycultures of perennial crops, species of trees in pastures. Livestock can also be integrated. The World Agroforestry Centre describes agroforestry as: *a dynamic ecological natural resource management system, that integrates crops and trees on an agricultural site which diversifies and improves production for increased social, economic, and environmental benefits for its land users on all levels (*Nair et al., 2010*).* Randomly selecting trees and crops is not enough to create a successful multistrata agroforestry. Instead, it is about the intentional, intensive and interactive integration of different crops and trees (Nair et al., 2011). Goals of multistrata agroforestry include the reduction of erosion, achieving a more sustainable crop production all year round, fixing nitrogen and building up biomass (Toensmeier, 2016).

Regular agroforestry can firstly include the integration of trees with annual crops. Secondly, it can include trees with livestock. This might cause confusion. For example, a livestock farmer grows some trees on its pasture, this can already be regarded as agroforestry. And lastly, it can include a mix of solely perennial trees and crops with integrated livestock. This last one is known as multistrata agroforestry. And this last practice is considered agroecological.

Figure 5.4 shows multiple examples of the possible integration methods of agroforestry. Images 5.3 and 5.5 provide field examples of agroforestry. Under and overstory rows of trees and cropping systems provide a broad range of combinations that can serve a broad range of needs.

Apart from the sequestration of carbon, multistratata agroforestry systems provide food, timber, shade for crops fuel, and many more ecosystem services. Integrated pest management is maximized in such a system since habitats are provided for predators and insects.

(Image 5.3, Agroferstry example; Van Noordwijk via theconservation.com



(Figure 5.4; Various scheme of agroforestry in Dieng, Pradana et al., 2015)

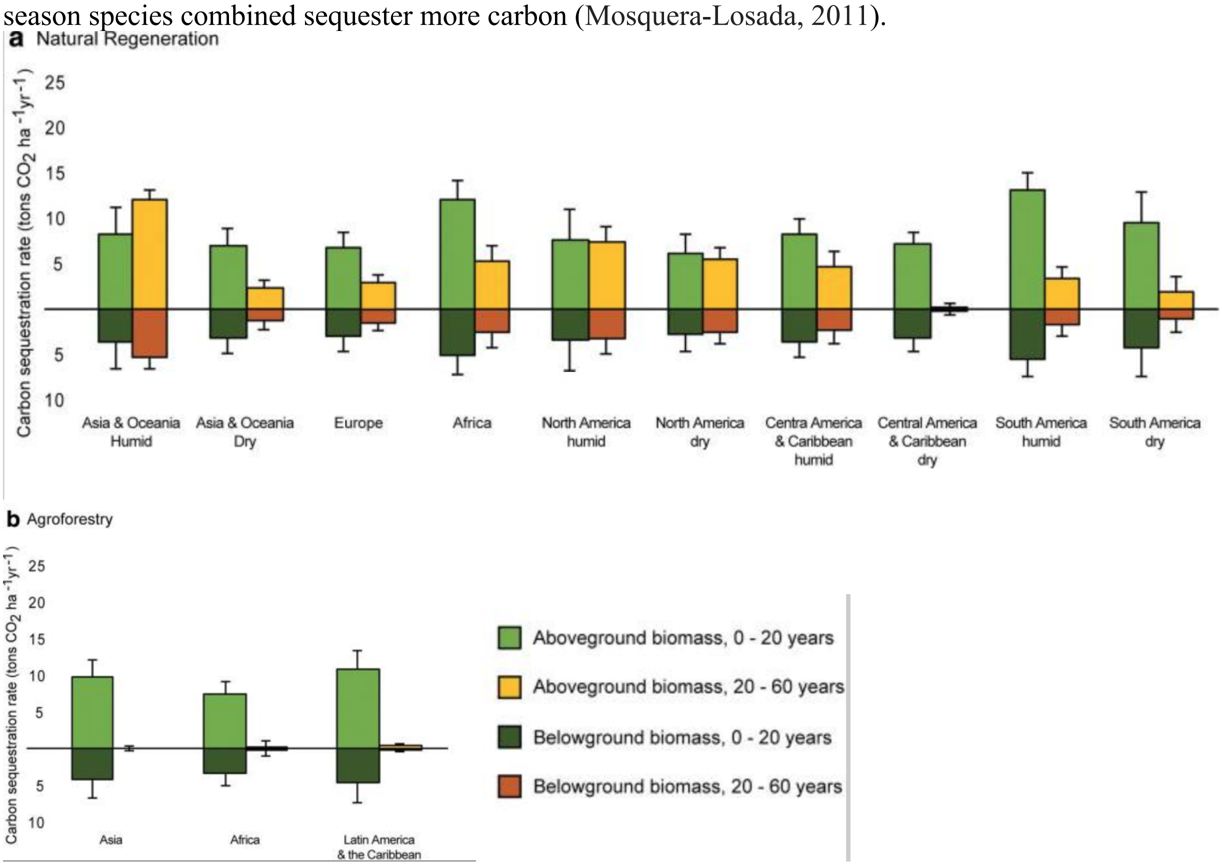

(Image 5.5 of multistrata agroforestry. Source F.S. Diniz, 2017).

Wooden multistrata perennial agroforestry systems represent the single highest sequestration capability of all food production systems (figure 5.2). Such a system hosts multiple perennials from lower hanging fruit trees to larger overstory wooden timber trees and smaller perennial crops close to the ground such as cacao. Multiple layers of photosynthesizing mixed species of perennials sequester carbon simultaneously in the same area and have numerous other benefits that will be described further during this chapter (Udawatta & Jose, 2011).
Perennial crops in addition to trees in the form of a multistrata agroforestry are best suited for agroecological carbon farming when looking at sequestration potential due to the life-span of the species, the mean residence time, the storing of soil organic carbon below ground, the higher density,

the higher diversity and the sequestration capability (Lou et al., 2010; Toensmeier, 2016). Multistrata agroforestry is considered agroecology and is suitable for agroecological carbon farming. It has a very high potential in terms of sequestering carbon

5.2.4 Location and Sequestration

Apart from agricultural practices, crop choices, and strategies, the rates of carbon that can be sequestered also depend on location. Climate and soil type are the two main location-dependent variables that affect sequestration rates (Nair et al., 2010). There are differences in the division in the composition of carbon stocks below and above ground. In the tropics, for example, the largest part of carbon biomass is stocked above ground in trunks. In temperate climate systems, it is the opposite with soil organic matter and root systems storing carbon belowground (ibid).
In the tropics, however, trees do grow faster than in temperate areas but also here things are more complicated since fast-growing trees only sequester more carbon in the first decade and slow growing trees have a higher sequestration potential which makes them more suitable for long-term sequestration(Nair et al., 2010. There are also studies done that show that certain cool-season and warm-season species combined sequester more carbon (Mosquera-Losada, 2011).



(Figure5.6: Carbon sequestration rates per area for a) natural regeneration and b) agroforestry, source: Villa & Bernal, 2018)

5.2.5 Sequestration capability of forestry

Agroecological carbon farming is proven more than suitable to sequester Co2. The question remains where it stands compared to a planted monoculture tree project or a preserved forest. In general terms, agroecological multistrata agroforestry systems sequester less carbon than a natural forest. However, long-term agroforestry could also sequester equal amounts to even more carbon than preserved forestry (Nair et al., 2010). One of the reasons is active participation in management. Another study in the

Philippines showed that multistrata agroforestry's can even outcompete natural forests sequestration rates (Brakas & Aune, 2011).
Toensmeier (2016) indicates that multistrata agroforestry's can sequester up to 18.5 tons co2 per hectare per year (figure 5.2). Monocultures of pine take up to 22 tons per hectare per year and eucalyptus almost double that amount (Villa & Bernal., 2018).
When analyzing figure 5.6, it shows that sequestration rates of agroforestry are comparable to natural regeneration. What exact type of agroforestry is used is unclear but based on the high sequestration amount it is presumably multistrata agroforestry. Measuring exact sequestration amounts is proven to be very difficult. Furthermore, there is a great variety of techniques and methodologies used by researchers to measure and present sequestration rates. Examples are the depth of measuring in the soil, the division between above and below ground, albedo effect, other emissions as methane, and nitrogen and on top of that context specific circumstances (Toensmeier, 2016)

Still, the sequestration capability of agroecological carbon farming practices with multistrata agroforestry in particular proves to be real competitors to traditional sequestration methods in terms of sequestration rates. Natural or planted forestry should therefore not be removed for agroforestry systems since it would mean a net loss for the carbon cycle. If agroforestry is planted on farmland, degraded land, and areas where there are not many trees it is a net win for sequestration and the carbon cycle.

5.3 Agroecological practices: strategies for increased sequestration

Possible Strategies for increased sequestration carbon and adaptation to CC

Issue	**Sequestration Strategies**
Water	Rainwater harvesting, drip irrigation. arid-land crops,
Soil	No-till, mulching, rotation crops, perennial cropping, silvopasture, managed grazing
Crop Production	Nitrogen fixation, diversification, **agroecology**, agroforestry
Livestock	Managed grazing, agroforestry, silvopasture, fodder banks

(Table 10: Possible strategies for increased sequestration source; Lipper et al., 2014)

There are strategies to further enhance the sequestration potential of agricultural practices as can be seen in table 10. Agroecological multi-strata agroforestry, for example, combines perennial cropping and no-till (soil) with agroecology and diversification (crop production), agroforestry (livestock), and possibly more. Certain agricultural practices and strategies do not only affect biodiversity, soil quality, resilience, and yield. They also affect the amount of carbon that is sequestered (IPCC, 2019). Moreover, specific species can be selected that sequester more carbon than others and can be harvested without doing harming the soil (Toensmeier, 2016). Not only crops but also trees can resprout. A pine tree will die after cutting in contrast to certain bamboo that will restore themselves after cutting making them ideal for timber use.

5.4 Agroecological systems and principles

Traditional annual mono-cropping is not suitable for carbon sequestration whereas alternative agroecological systems have proven to be (figure 5.2). Unsustainable farming practices have caused emissions and degradation of the soil (Eswaran, Lal & Reich, 2001).

Next to physical systems such as polycultures of perennial crops and multistrata agroforestry, there are complementary agroecological practices and principles that will be described during this section. In the part that follows, the benefits that come along with these approaches will be examined.

5.4.1 The use of synthetic fertilization & Integrated pest management

Agroecology does not make use of artificial fertilizers and is aimed at not using pesticides. One of the main reasons for this, described in the literature and described by Klein Lankhorst (Interview II), is the fact that it, nonetheless that it increases individual crop performance in the short term, it decreases the soil on the long term (Interview II Klein Lankhorst).

> *"Fertilizers simply lead to manmade changes in ecosystems. Especially the soil is affected in almost the worst possible way because a complex natural system is disturbed and downgraded by chemicals"* (Klein Lankhorst, 2020)

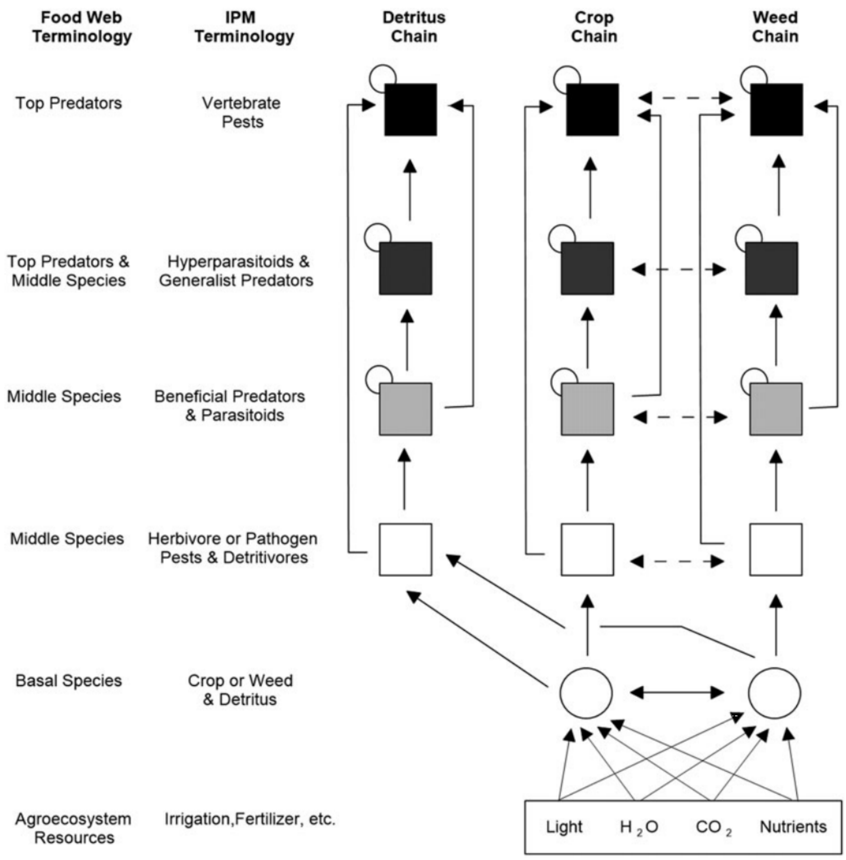
Indeed, scholars also point this out to be a major problem since energy and nutrient cycling are changed by the use of fertilizers which leads to a disruption within the functioning of an ecosystem (Yadav et al., 1998)
Fertilizers turn out to have a tremendous effect on biodiversity loss globally, and statistical analyses proved that the amount of inorganic fertilizer used per hectare of farmland, causes a significant increase in biodiversity loss (Mozumder & Berrens, 2007).

Already in the '90s studies were conducted to figure out if fertilizers had a positive effect on yields. Pimentel (1997) compared an annual mono-cropping system of corn that used fertilizers, to a crop switching non pesticide system. The last-mentioned system had 15.7% more yield and 36% less costs. There are alternatives for artificial fertilizers that do not poison the soil. Livestock could be used in a managed way and be fed the crop residues after which their manure can be used as fertilizer if necessary (Van Noordwijk et al., 2014). Chemical runoffs and the destabilization of the soil are other factors that come along with the use of fertilizers and this negatively influences the development of soil organic matter. A higher complexity and diversity in the soil are reached if no fertilizers are used (Harvey et al., 2014). This complexity is needed to sequester carbon and reach the full potential of the soil.

Apart from the dangers for the soil (where carbon must be stored) fertilizers also have a negative long term effect on plants. This is described by Klein Lankhorst:

> *You may increase single crop yield, you also decrease your food quality. Plants that have been fed with fertilizer fail to symbiosis with the soil meaning they don't reach out for the precious nutrients that can be found in a healthy soil. Because of this it will become receptive to pests because it's immune system will be affected. The plant is fully grown in a matter of time but lacks magnesium or kobalt. They never got this from the soil because it's full"(*Interview II).

The trade-offs between crops and the soil are disturbed which causes negative externalities.
Short term high intensive annual single crop yield is arguably suitable for fertilizing. Sequestering carbon through the long term process of soil organic matter certainly is not. The use of synthetic fertilization is not agroecological and negatively influences the sequestration potential.



(Figure 5.7: Integrated Pest Management of ago-ecosystem. source: Bottrel et al., 2018)

Pesticides in turn also affect agricultural systems (Toensmeier, 2016). Agroecological practices exclude the use of pesticides. Instead, it adopts a practice that is called 'integrated pest management'. This only works with polycultures since higher crop diversity increases the protection of the agricultural system (Ewel, 1986). A diverse system attracts diverse insects and other species and functions as habitat for animals, plants, fungi, and bacteria. These organisms interact and if managed right, make the use of pesticides not necessary due to the presence of natural enemies in the agroecosystem (Bottrell et al., 2018)

Figure 3 presents an indication of how such a system interacts in terms of an agro-food web. Beneficial predators and prey all have a role to play in this food system. Insectivorous species as bats, frogs, and birds are top predators and spiders that feed on insect pests fulfill an important role (Bottrel, 2018)

Knowledge and proper management of organisms and their biology and provided services, especially at the start, is needed to develop a system that is in no need for pesticides. Procedures as crop rotation also reduce the risk of crop loss due to pests (Croft, 1990). Furthermore, there is a wide variety of plants that contain natural pesticides (Toensmeier, 2016). Natural enemies are exploited and that natural agents are being used instead of pesticides in agroecology (Bottrel et al., 2018; Toensmeier, 2016).

If not, there will be manipulations in the agroecosystem which will affect the food web(figure 5.7). The use of fertilizers and pesticides cause shifts in statuses of pests, crops, and predators. It disrupts population dynamics which affects the chains in the food web which has a negative result on biodiversity. A healthy diverse agroecological system is better at sequestering carbon and creating reservoirs for useful organisms that aid in controlling pests.

5.4.2 Conservation Tillage

Ideally, agroecological carbon farming systems should not be tilled. No-tillage is of key importance since the soil must be held intact. Digging, shoveling, and plowing or turning over the soil is harmful to the sequestering of carbon underground (Toensmeier, 2016). No-till and non-destructive harvesting of perennials result in plants that can yield for multiple years and keep the soil and the carbon within, in place. This is also known as 'conservation tillage'. Tillage is even more harmful in the tropics as Kleihorst describes:

> *"In the tropics around 90% of the biomass is above-ground and here in the Netherlands, it is around 50/50. This means that if you slash and burn in the tropics and start planting annual crops followed by tillage, the 10% underground biomass will be depleted very fast. You almost completely destroy the carbon stock. This is happening on a large scale currently. The soil will last for maybe a decade and then we move production and deplete a new part of the Amazon" (Kleinhorst, 2020).*

Also, Tollenaar speaks of the shallow soil in the tropics and the problems that occur there (Interview I). Many farmers in the tropics deplete the soil at a rapid pace. Soil degradation is a main problem in many regions and can result in desertification, deforestation, salinization and a decrease in water holding capacity (Goudie, 2015). Moreover, studies showed that losses of carbon in the surface-soil were up to 50% after cultivation for over 30 years (Lovell et al., 2009). Earlier studies already proved the injurious results for the soil after ploughing (Greenland & Lal, 1978) such as soil crusting, water runoff and improved flooding risks.
A healthy fertile soil stands at the basis of carbon sequestration and tillage is its enemy. Soil erosion is enhanced by tillage and extremely harmful for soil productivity and the sequestration capability of an agro-ecosystem (Goudie, 2015; Toensmeier, 2016).

There are multiple techniques for conservation tillage that implicate the management of the agro-system without interfering with the soil in a harmful way. Techniques are aimed at controlling weeds and promoting nutrient cycling to overcome soil carbon loss (Puerta et al., 2018). Leaving up to 30% of crop residues on the surface is a technique, as well as ridge chisel and managed grazing of livestock. These practices prove to do better after two years than conventional tillage looking at soil stability (Bottinelli et al., 2017).

Why do farmers still plough then one might argue? Tillage creates a perfect bed for starting seeds and it results in averting weeds to grow. This implicates that the annual crops can easily grow without competition (interview II; Goudie, 2015). The benefits that occur with conservation tillage for the soil and above-ground biomass occur after several years making the transition for conventional large-scale farmers a risky one because if a farmer stops tilling it should also change other aspects within its establishment. Still, in the United States almost 40% of farmers adopted conservation agriculture leading to a higher yield and the short-term yield losses were compensated by a reduction in fuel costs up to 30% (Boersma, 2016). Next to this comes the fact that polycultures of perennial cropping can be used for agroecological carbon farming making conventional tillage even less significant.

5.4.3 Livestock integration systems

Livestock and their feed are responsible for immense amounts of carbon, methane, and nitrogen emissions. One might consider the meat industry as one of having the largest impacts on climate change. However, livestock can be integrated into an agroecological system being beneficial to the soil, diversity, sequestration, and economy (Toensmeier, 2016).

Managed grazing means that the intensity, location, and timing of grazing are controlled. Rotational grazing is an example that can lead to gains in soil organic matter (Flannery, 2009). The IPCC noted that managed grazed lands have better sequestration rates than overgrazed or ungrazed lands (IPCC, 2014). The 2019 report adds that crop fertility management is improved by the correct use of manure (IPCC, 2019). Furthermore, the IPCC reviews crop-livestock integration as having a high potential carbon impact because it is easy to adopt globally. Still, the sequestration rates of managed grazing per hectare are low but the easiness and total hectares of grazed lands are high, making it a high potential adaptation method(Gutteridge, 1994).

Silvopasture systems integrate pasture with trees and are widely adoptable. The trees provide shade and food for the livestock and this system sequesters up to three times as much carbon as a normal pasture (Henderson et al., 2015).

Feeding annuals to livestock is unwanted since it is an inefficient way of using land and depletes the soil. Instead, perennials or even insects should be fed to create a net carbon win(Toensmeier, 2016). Bees and other insects as silkworms can also be integrated as ‘livestock’ in an agroecosystem providing important provisional and supporting ecosystem services (Van Huis, 2013). Furthermore, livestock is able to process and covert plants humans cannot consume, into livestock products (Interview II).

A positive carbon outcome of managed grazing is extremely context-specific. Grazing in clay soils lead to a net loss of soil carbon whereas grazing in humid climates results in a net win of soil carbon (McSherry & Ritchie, 2013). If livestock is not managed right, the maintenance of ground cover cannot be guaranteed, resulting in negative effects for the soil and it’s sequestration capability (IPCC, 2019).

More ecological principles that fit within the concept of agroecology and that enhance the sequestration potential of an agro-system such as water harvesting practices and nutrient management. With the previously described components the main characteristics are described and show that these practices are indeed more suitable for sequestering carbon than conventional farming practices.

In the next section the other benefits that come along with agroecological carbon farming, as well as the main barriers will be described.

5.5 Ecological benefits agroecological carbon farming

The forming of soil organic matter has many more functions than the sole sequestration of carbon. Humans live and depend on the soil and so does biodiversity. Fertility and erodibility depend on the soil’s structure (Goudie, 2015). “*Your soil stands at the basis of everything. If you have a healthy carbon rich soil, the rest will follow on itself. Your crops are more resilient, they grow better, the ground holds more water and is also capable of preventing floods”* (Klein Lankhorst, 2020). Conventional agricultural practices such as tillage trampling, fertilizing, and other (mechanical) practices change the soil’s chemical and compaction (Batey, 2009). This negatively influences the root penetration capability; it limits oxygen and the exchange of carbon dioxide between the soil and atmosphere. Moreover, the water holding capacity, the moisture status, water infiltration and runoff of the soil are negatively affected. And most importantly, it enhances the process of soil erosion which is the number one enemy of carbon sequestration (Nawaz et al., 2013). The soil is the core of carbon sequestration and must be held intact and farming is much easier on healthy soil. This is why only agroecological carbon farming is a true suitable agricultural practice for storing carbon. Because you cannot have a net carbon win if you are degrading the land it’s soil (White, 2014).

Soil erosion is the number one reason for land degradation and leads to a great loss of arable land which holds the potential to sequester carbon (Myers, 1988). The prime reason worldwide for soil erosion is agriculture (Goudie 2015). Agroecological carbon farming is aimed to do exactly the opposite. Instead of decreasing it enhances the quality of the soil. The earlier described practices are aimed at holding the soil intact and increasing
soil fertility. Furthermore, soils that are richer in carbon are better capable of holding moisture resulting in a higher resilience against drought while also being better at combating floods (IPCC,2014). High carbon soils are less exposed to erosion and have smaller amounts of nutrient leaking which enhances the state and fertility of an agro-ecosystem (Harvey et al., 2014).

> *Land degradation in agriculture systems can be addressed through sustainable land management, with an ecological and socioeconomic focus, with co-benefits for climate change adaptation. Management options that reduce vulnerability to soil erosion and nutrient loss include growing green manure crops and cover crops, crop residue retention, reduced/zero tillage, and maintenance of ground cover through improved grazing management* (very high confidence). (IPCC, 2019)

Climate change is putting higher pressures on water and its hydrological cycle is becoming more unpredictable (Goudie, 2015). Agroecological carbon farming increases soil organic matter and sequesters carbon, enhances the soil’s water-holding capacity so that rainwater is captured and the runoff is decreased and so is erosion (Palombi & Sessa, 2013). Furthermore, a carbon rich soil is also increasingly resistant against droughts. Resulting in a smaller chance of vegetation loss and therefore the loss of yield (Toensmeier, 2016). Next to water holding capacity, the water cycling in an agroecosystem is also strengthened (Pimentel et al., 2012)

Diverse more complex systems such as perennial polycultures or multistrata agroforestry are better at holding onto water and function as a habitat for many plants, insects, predators, fungi, and bacteria. They form corridors for wildlife and increase biodiversity (Constant, 2010). Biodiversity in its turn, brings pollinators and beneficial species that function as pest controllers (Toensmeier, 2016). An example is given by Klein Lankhorst who described one of his projects; "*With a higher diversity you have less physical and financial risks, let's say there is a mildew, it doesn't migrate to all apple trees because a row of pear trees is located in between. The same counts for mites and other insects. A disease or pest doesn't spread exponentially"* (Interview II). Different flowers of fruit trees draw other insects in the agro-system that feed on pests and serve as food for other predators. The system as a whole is becoming self-sufficient. Kleinhorst also tells that when you start using pesticides a farmer won't use it once because what you exterminate will be replaced by something else.
Agroforestry polycultures have few pest problems (Ewel, 1986)

Agroecological farms that have a rich carbon-filled soil are more resilient to pests, storms, droughts and floods and therefore to climate change (ibid; Toensmeier, 2016). They also have a positive effect on plant growth since the complexity of the soil is higher than with conventional farming which affects nutrient cycling which in turn affects the capability of capturing and transferring nutrients by the different plant species (Harvey et al., 2014). Deep root systems of trees in agroforestry for example, are capable of transferring nutrients from the deep soil and make them available for crops. Crops alone would not be able to take these nutrients in (Nair, 1993).

Perennial cropping systems are better at preventing salinity than annual cropping systems since their (deeper) root systems are better capable of holding mass and water and prevent nutrient leaching (Pimentel et al., 2012).

Land degradation overall is prevented by agroecological farming. Acidification, crusting and fertility depletion are results of tilling, pesticides and fertilizing. Agroecological practices have the capability to restore degraded lands by improving the health of the soil instead of degrading it (Eswaran et al., 2001). Beneficial life in the soil is created and existing life is multiplied which positively affects life above the soil and enhances the overall resilience of an agro-ecosystem (Zomer et al., 2016).

The 2019 report of the IPCC on climate change and land also acknowledge the benefits of agroecological practices:

> *Farming systems such as agroforestry, perennial pasture phases and use of perennial grains, can substantially reduce erosion and nutrient leaching while building soil carbon (high confidence). The global sequestration potential of cover crops would be about 0.44 ± 0.11 GtCO2 yr–1 if applied to 25% of global cropland (high confidence). The application of certain biochars can sequester carbon (high confidence).* (IPCC, p.31, 2019).

Desertification and deforestation are also prevented by carbon farming and lastly and maybe most importantly: agroecological carbon farming can be used as both an adaptation and mitigation method for climate change (IPCC, 2019). This method of reversing the degradation of (agricultural) soil proves to be molded in capturing and storing carbon.
This is why only agroecological carbon farming is a suitable set of agricultural practices for storing carbon. Because there cannot be a net carbon when degrading the land its soil (White, 2014).

5.6 Socio-economic benefits of Agroecological Carbon Farming

The health and state of an agroecosystem also affect the socio-economic position of its farmers. For example, a carbon-rich soil enhances the crop-growth which affects the yield. An increased yield leads to more products to sell or consume. Other socio-economic impacts of carbon farming are beneficial as well.

First of all, a farm provides products. Perennials give fruits and vegetables, nuts, and herbs and other foods for humans. On top of that, a farm provides possible feed for livestock and livestock itself can provide food, fiber, and functions to fulfil in the agroecosystem. Perennials as trees or bamboo can provide timber to use as building material. If rightly used, the carbon inside building materials will be trapped and not exposed to the atmosphere. There are many more services provided by plants and trees on agroecological carbon farms ranging from diverse building materials to solvents to medicine. Provisioning services can be obtained by farmers without harming the agroecosystem (Toensmeier, 2016). A diverse multistrata agroforestry has countless possibilities in providing products to farmers while mitigating climate change (IPCC, 2019).

Land degradation in agriculture systems can be addressed through sustainable land management, with an ecological and socioeconomic focus, with co-benefits for climate change adaptation. Management options that reduce vulnerability to soil erosion and nutrient loss include growing green manure crops and cover crops, crop residue retention, reduced/zero tillage, and maintenance of ground cover through improved grazing management (very high confidence). (IPCC, 2019)

An agroecological system improves fertility and productivity which increases the resilience of a farm. With climate change putting more pressure on agricultural systems, a diverse farm that is better at absorbing climate shocks, holding onto water or releasing it, is most welcome. Especially since an increasing amount of arable land is under direct threat because of climate change, agroecological carbon farming can help farmers to adapt to this development. Moreover, a diverse system delivers a wider range of products and services. This implicates that farmers are less dependent on a single product that needs to be harvested at a certain location at a certain time. A farmer is less vulnerable for high income loss. The more complex agroecosystem has many more second or third options than a conventional annual monoculture. Multistrata agroforestry also helps to improve the productivity of the agro-system on the long term by building up soil carbon. These direct and indirect services can lead up to a possible increased income for farmers due to sales and greater self-sufficiency. (Toensmeier, 2016).

Agroecological carbon farming has different positive effects on food security. The earlier mentioned improved production that was a result of the improved soil and yield aside, there is also more seasonal complimentary availability. Polyculture crop systems provide backup in case of crop failure and provide a higher variety of nutrients and selling options (Mbow et al., 2014). Farmer to farmer networks and production consumption cycles can help local farmers to develop value chains.

Agroecological carbon farming requires fewer inputs, and can potentially be more cost effective than conventional farming. (Kiptot & Frenzel, 2012) This however, only occurs when an agroecological system is fully operable and remains context specific. Still, agroecological practices can save money and time. First of all, money is saved on fertilizers and pesticides that are not needed if integrated pest management practice is successful. Machinery and diesel are normally needed for tillage but in an agroecological carbon farming there can be no tilling. The least fuel is needed in a multistrata agroforestry (Cox et al., 2013). Agricultural emissions can be dramatically decreased in an agroecological system since chemical fertilizers have an energy consuming lifecycle, tillage and it's machinery use amounts of fuel and annual cropping monocultures depend on heavy intense inputs that are capable of processing and harvesting great amounts of crops in a short amount of time (Toensmeier, 2016). The rich soil on a carbon farm needs less to no irrigation since such a system is better capable of managing its own hydrology. Less water is needed (Palombi & Sessa, 2013)

The diversity of the perennials on an agroecological carbon farm is the main reason for the less intense labor and cost inputs of its farmers. Many perennials do not provide products for the first few years. With annual cropping monocultures, within a year a farmer can harvest and there is much certainty on the amounts. With a multistrata agroforestry it can easily take up to seven years before it starts providing products, with some species such as mango even up to 15 years (Mbow et al., 2014; Interview II). However, when an agroforestry starts to provide, it can yield more per hectare and needs less intensive labor. The diversity of the perennials on an operational agroecological carbon farm means that labor is divided more equally throughout the year. With annual monocropping there is the ploughing, seeding, watering exterminating and a few weeks of intense harvesting every year.

Agroecological carbon farms don't need that. The implementation phase tough is likely to be hard work, but the agroecosystem remains largely intact. (Kleinhorst, Interview II).

Agroecological carbon farming has a longer preamble than a conventional farm. The long term benefits seem to be worth the investment. Multistrata agroforestry's have higher long term productivity. Examples of cost-effective perennials are mango's, almonds, coconuts, olives, cashews, walnuts and avocados (Toensmeier, 2016). Next to income from products, farmers could be compensated financially for their sequestration work.

5.7: Barriers for agroecological Carbon Farming

At least as important as the potential benefits of carbon farming, are the challenges and limitations that are surrounded by it. And there are many of those present.

First of all, Carbon farming is limited by the implementation time. As mentioned earlier, perennial cropping systems take years before they bear crops. When comparing this to offsetting methods such as afforestation this may not sound like a problem per se, because forestry's take even more time to develop (Interview I). However, the ecological and socio-economic benefits surrounding carbon farming take years before they kick in. This is a complex problem that needs solving on different levels.

Firstly, there is a problem surrounding farmers. Especially small-scale farmers in the global south are already often in financially stressed situations (Toensmeier, 2016, Interview II). Farmers might have multiple (financial) disincentives to adopt the agroecological practices. Even if it is attractive to start agroecological carbon farming for the long term, incentives in the form of compensation and investments have to be created the years before agroecological carbon farming starts to be beneficial. The IPCC also states that "the example of agroforestry and restoration of high carbon and degraded soils provide multiple ecosystem services and functions, but take more time to deliver (IPCC, 2019). Offsetting might be part of the solution if a large share of the funding is paid to farmers during the years before perennials start to produce, and when they start to bear crops, farmers receive less income for their sequestration work and more from the selling of their products. Agroecological carbon farming takes time and time is something investors, certifiers and farmers might not have. It is expected that this would be one of the main challenges surrounding agroecological carbon farming. On the other hand, planting a forest also takes time while not having long term added value.

Secondly, land use and culturally embedded agricultural practices that are also region and-climate specific will make it impossible for agroecological carbon farming to be implemented as one manageable uniform offset method. Differences in regional climate influence the soil type and therefore the sequestration potential as well as the usable crops, agricultural practices, and implementation time (Nair et al., 2014). The variables in soil type and in yield may also affect the sequestration potential per hectare meaning that a consistent amount of offsetted carbon is very difficult to present. Moreover, the IPCC states that successful implementation of soil carbon management depends on socio-cultural as well as physical ecological conditions (IPCC, 2019). Barriers to carbon farming are therefore linked to environmental and cultural context on the regional level.

Klein Lankhorst and Tollenaar (Interview I & Interview II) both repeatedly stated that local cultural embedded habits and practices are always present and can be very hard to change. In the case of agroecological carbon farming this is a big deal since the agroecological practices are aimed at increasing the soil instead of depleting it. The agroecological practices enhance the sequestration potential and are diametrically opposed to local long used practices as slash and burn, livestock unmanaged grazing and ploughing. In other words, farmers have to be able to adopt the right practices and simultaneously have to be assured that these practices actually work. Since it may take years before the farm starts producing, it is likely tempting for a farmer to trust in his or her own previously used methods that seemed successful in the past.

Because many offsetting techniques need land, carbon farming needs arable land, and the pressure on land is increasing in many countries in the global south, it is very likely that carbon farming projects might create tension. Treesforall project manager Tollenaar explains that these tensions create risks and that a larger project often means that the risks also increase. The Shell case provided an example of what could happen if there is no added value or if land used for offsetting is getting in the way of local economic development. Knowhow of the local cultural and economic context is needed as well as eyes on the ground and reliable stable local partners (Interview I). Still, starting a farming project that seems to be doing nothing for years will raise eyebrows and may create tension. However, Tollenaar also stated that the forestry projects were mostly under pressure by agriculture (Interview I). Agroecological carbon farming is of course agriculture and is able to add value.

Agroecological farming projects are more complicated than conventional farms or monocultural offsetting techniques such as afforestation. As described earlier it's complexity is its success but for investors, certifiers, farmers, scientists and consumers this complexity might also be a reason for distrust in an already widely distrusted and controversial voluntary offsetting economy. The complexity makes it also harder for scientists to model for example agroforestry systems (Luedeling et al. 2014; IPCC, 2019). The time-lag between adoption and realization of the benefits of carbon farming will likely put extra pressure on projects. Furthermore, there is also a knowledge gap in the monitoring of carbon and measuring the sequestration potential. Researchers use different methods making it already difficult to choose the sequestration potential of a monocultural forest. With agroforestry this problem is even more present. Without even being able to actually present numbers for each practice, soil type or climate for a monoculture of trees. It will be very difficult to be truly convincing to certifiers and the public. Another question that remains is whether it is really possible to give the sequestration capability an exact number or that it instead, would be better to speak of an estimation.

Financing will also be difficult since agriculture is currently negligible in the voluntary offsetting economy and the fact that agroforestry for example is by some counted as forestry and not as agriculture. The projects that are counted as agriculture are large-scale projects such as biogas or sustainable fertilizers (Ecosystem-Marketplace, 2018). Small farmer initiatives have a history of financial and organizational problems regarding obtaining access to carbon markets (Toensmeier, 2016).

5.8 :Concluding summary and answering subquestion 2

Sequestration potential

- Multistrata agroforestry is best suited for carbon farming due to its sequestration potential, due to the life-span of the species, the mean residence time, the storing of soil organic carbon below ground, the higher density, the higher diversity and the sequestration capability
- Forestry should never be cleared for multistrata agroforestry because this would result in carbon loss, instead multistrata agroforestry should be implemented on (degraded) agricultural land. This would mean a net win for the carbon cycle.
- Carbon farming practices should always be aimed at increasing soil quality and quantity since a healthy soil is the single most important factor for successful carbon sequestration. There cannot be a net carbon win if the soil is depleted. Therefore principles of agroecology need to be integrated
- Agroecological practices such as no-till, no fertilizing, integrated pest management and perennial polycultures are essential for the successful sequestration of carbon. Instead of conventional agricultural practices that degrade the soil, agroecological practices are aimed at enhancing the soil which increases the sequestration potential.

Benefits that are accompanied

- Agroecological carbon farming has many socio-economic and environmental benefits next to mitigating climate change and this is repeatedly acknowledged by the IPCC 2019 report on land and climate change.
- Agroecological practices can provide economic, ecological, and social stability through diversification of species and products.
- An agroecological carbon farm is more resistant to droughts, floods, pests and failed harvest than conventional farming making a carbon farm and it's farmers more resilient.

- Agroecological carbon farming increases biodiversity, soil fertility, nutrient cycling, water storage capacity and more, while simultaneously sequestering carbon and providing provisioning ecosystem services to farmers in the global south.
- Next to income from products coming from the farm, farmers could be compensated financially for their carbon sequestration work.

Barriers

- The socio-cultural and economical local and regional context will very likely form barriers for the implementation of carbon farming
- A carbon farm with perennial crops will not bear fruit for several years. Implementation time is long and is likely to cause tensions. The ecological and socio-economic benefits surrounding carbon farming take years before they kick in.
- The complexity of a carbon farm project in relation to the time-lag of implementation could create distrust by investors and certifiers and make modelling, predicting and examining more difficult than monocultural offsetting.

Subquestion 2 (SQ2)

What is agroecological Carbon Farming and how does it differ from offsetting techniques that are currently in use?

Agroecological carbon farming is a set of agroecological agricultural practices that is aimed at removing carbon dioxide from the atmosphere and storing it into the terrestrial carbon pool in the form of material and soil organic matter. Certain agroecological practices are different from conventional agricultural practices and are essential to be adopted since they are fully devoted to enhancing the soil instead of degrading it, which results in an increased sequestration capability per hectare. Agroecological carbon farming holds numerous socio-economic and ecological benefits making it a high potential offsetting method since charismatic projects that include positive externalities are increasingly in demand. Agroecological carbon farming is capable of reaching sequestration amounts that can compete with offsetting practices that are currently in use. Adding value to land is a main problem that occurs in the most used offsetting method that is focused on protecting or planted forestry. Agroecological carbon farming can overcome this problem because of the number of ecosystem services that can be derived from these agroecosystems and farmers can be rewarded for their sequestration work. This makes agroecological carbon farming fundamentally different from planting or protecting forestry or handing out cooking stoves. There are more positive side effects present compared with other offsetting methods that are currently in place. However, implementation time forms a barrier problem and successful carbon farms are defined by their complexity. The long preamble can also be interpreted as a logical side-effect for a sustainable investment. Agroecological carbon farming is able to sequester high amounts of carbon, it embraces ecological concepts and principles resulting in a well-designed sustainable agricultural system that can be beneficial to farmers and the environment. With the IPCC also acknowledging the positive externalities of agro-ecological agricultural land use with very high confidence, enough evidence is collected to state that carbon farming truly has the potential to become a more sustainable alternative for the terrestrial and non-terrestrial offsetting methods surrounding project categories Forestry and Land Use and Household Devices that have multiple negative externalities or do not guarantee mitigation. There is too little attention for agriculture in the voluntary offset market which represents a failure in focus.

(The IPCC on sustainable land use and adaptation and mitigation, source, Climate Change and Land, IPCC, 2019)

> *Most of the response options assessed contribute positively to sustainable development and other societal goals (high confidence). Many response options can be applied without competing for land and have the potential to provide multiple co-benefits (high confidence). A further set of response options has the potential to reduce demand for land, thereby enhancing the potential for other response options to deliver across each of climate change adaptation and mitigation, combating desertification and land degradation, and enhancing food security (high confidence). (Figure SPM.3) {4.8, 6.2, 6.3.6, 6.4.3}*
> *(IPCC, 2019*

6. Results: III: Retailer perception on Agroecological Carbon Farming as voluntary offset method

Now that agroecological carbon farming has been described, the opinion of those that are responsible for the selling and selecting of offset projects were asked about their opinion and expertise on the matter.

Voluntary offsetting has received much publicity in 2019 and 2020 in the Netherlands. Newspapers Trouw and Parool have published headliners: “Offsetting is misleading and based on guessing” and “Flying Neutral? I don’t think so” (Trouw, 2020; Parool, 2020). Moreover, a prime Dutch public television show called RamBam negatively analyzed carbon offsetting and called it a scam in march 2020 (NPO3.nl,2020). These publications have definitely not remained unseen by those involved in the Dutch VCM. The project manager of Treesforall understands part of the critique but does say the media made a mistake in generalizing offsetting (Interview I). She also says that, since then, the foundation gets a lot of questions regarding the trustworthiness of not only their foundation, but offsetting as a whole. That people are becoming more aware and critical she sees as a positive development..

Within the Dutch VCM six retailers were interviewed and shared their visions on developments within the VCM and the role carbon farming possibly can play in the near future. One of these foundations wished to remain anonymous and will therefore not be mentioned by its official name.

Retailer and name	Function	Interview number
Treesforall: Tollenaar	Manager Foreign Projects	Interview I
Bodemliefde: Lankhorst	Director	Interview II
Anonymous retailer: A.	Business Director	Interview III
Greanseat: Cozijnsen	Carbon Expert	Interview IV
Climate Neutral Group:	Carbon Specialist	Interview V
Justdiggit: Van t Hof	Marketing, Involved with study on offsetting	Interview VI
Fair Climate Fund: van der Geest	Managing Director	Interview VII
Gold Standard: R Duchesneau	Certification manager land use and value chain	No interview, only email contact

(table 6.1: Respondents interviews. Retailers their function and interview number: authors own)

6.1:Opinions on the Development of the (Dutch) VCM

As described earlier, there are major developments on the way regarding the development of the carbon offsetting markets including the Paris Agreement (P.A.) and CORSIA. When asked how these developments might influence the future of voluntary offsetting for their ‘businesses’ the reactions were for the larger part careful and optimistic. The foreign project manager of Treesforall replied that the foundation does not worry about the P.A. and states that the compliance market is failing and should therefore be changed. She also sees opportunities in case the European Trading Scheme is made available for the VCM. CORSIA is seen as a positive development in the way that offsetting becomes legally obliged for airlines but does bring uncertainty. There is no contact between Treesforall and airlines because Treesforall does not wish to partner with ‘greenwashing ‘companies. KLM unfortunately did not consent to providing any information on CORSIA or offsetting.

On the questions regarding the developments of the successful growing market-share of forestry and REDD+ projects, different reasons were given. Treesforall claims that the last major IPCC reports mentioned the urge to mitigate climate change through reforestation and that NGO’s and governments followed quickly in setting priorities and making commitments. Retailer (A.) stated that climate change is becoming an increasingly hot topic and that information and transparency regarding forestry offset projects are easier to come by. Also reforestation is the easiest offsetting category to explain to the public he explains. People understand that a “tree is good for nature and is able to clean the air”. Because offsetting is for a large deal marketing, forestry projects are most suitable because most people easily link trees to fighting climate change. For companies, these projects are the easiest to communicate externally even though they are quite hard to be additional and are also widely criticised (A.,Interview III). FairClimateFund also states that trees are marketing-wise very suitable for offsetting since they provide a strong visualisation for carbon sequestration. For the public this seems more concrete than handing out cookstoves(Interview VII). ClimateNeutralGroup points out the positive co-benefits of forestry projects as a reason for its success. After explaining that forestry projects are associated with negative externalities, the statement is ‘justified’ by the link of forestry projects to the SDG’s (Interview V).

The role of the SDG’s in selecting offsetting projects by Dutch retailers seems to have an even more profound role than expected. (A.) tells that they are increasingly taking the SDG’s into account with selecting projects. Moreover, he explains the SDG’s form a great marketing tool since they have gained understanding by an increasing number of people. He continues stating that people are willing to pay extra for offsets that are incorporating more SDG’s (Interview III). Tangibility is mentioned by multiple retailers as a powerful tool used to promote offsets and the SDG’s help projects to become more tangible for consumers. The days that offsetting was solely about sequestering or compensating emissions are over they explained. Co-benefits are becoming increasingly important. N. of FairClimateFund states that they see a clear trend in the willingness of consumers to pay more for ‘charismatic’ projects but state that tick boxing multiple SDG’s is not enough to truly make projects decent. They add a ‘fair trade’ quality mark to their offsets and make sure that those responsible for the actual sequestration or reduction of emissions get rewarded instead of, in the case of cookstoves, the producers, project developers and the distributors of the household devices. She adds that she thinks it is a shame that offsetting retailers think the Gold Standard alone is enough. She hopes for more retailers and project developers to add Fairtrade to their products in the near future (Interview VII). Greenseat carbon specialist Cozijnsen states that they always look at the SDG’s because Gold Standard does the same thing. He adds that the SDG’s are becoming more widely known with the broader audience (Interview IV). Justdiggit’ employee S. explains that their foundation was not yet aligned with any quality mark, but was already approached increasingly often by companies that wish to offset their carbon via their projects. Justdiggit came to the conclusion that business wise, offsetting is becoming increasingly popular and desired by many companies and major (Dutch) brands (Interview VI)

> *The SDG’s are becoming more widely known with the broader audience. Because of this they will pay more since the impact of projects is better visible and they understand it is not only about climate change (Cozijnsen, 2020)*

6.2: Awareness of (agroecological) Carbon Farming as Offset Method.

As described in the section on the Dutch VCM, there are currently no agricultural projects promoted by Dutch VCM retailers. When going directly to Gold Standard their global offered projects, again agriculture is absent and agroforestry projects of any kind are also not present. On the question to what extent they were informed on carbon farming as an offset method, Treesforall replied that they never were involved in projects that had something to do with agriculture (Interview I). They were starting an agroforestry project but this was with a different purpose and in the Netherlands. (A.) was aware of an agroforestry project in Zambia in which they were involved (Interview III). Gold Standard replied that they did involve in agroforestry projects and were certifying projects that were focussed on agriculture. Greenseat’s Cozijnsen states he is enthusiastic about carbon farming. He is currently working on a standard for sequestering agriculture in the Netherlands. For voluntary offsetting he thinks carbon farming is very suitable as an offset method.

After asking why agriculture is so little represented in the Dutch VCM, answers were divergent. Treesforall’s Tollenaar stated they she was not sure why agriculture was nowhere to be found in the

VCM, but that they think it's because of the limited sequestration capability farms have. Because crops are taken, vegetation is rotated and there is not much permanent vegetation in place to sequester carbon she answered. Treesforall says they don't have any experience with agriculture as offsetting but think that it's much harder to sequester carbon than with trees and also much harder to prove (Interview I). FairClimateFund thinks that the limited number of projects has to do with the slow process of sequestration and the difficulty to measure and monitor the sequestration rates. She says that the sequestration potential of agriculture is immense (which is also acknowledged by the IPCC, 2019), but that the costs of monitoring currently are too high to compete with (cheaper) offsets that are currently offered within the VCM. The foundation is currently involved with developing a project in India that is focussed on soil carbon (Interview VII). Cozijnsen explains that it is mainly for political reasons that carbon sequestration through agriculture gets so little attention. NGO's focus on adaptation instead of mitigation and don't want large-scale farmers to get carbon credits, he states (Interview IV).

Retailers are for the largest part aware of the potential of agriculture and also come with some semi-examples of agricultural projects that are under development. Accurate examples of agroecological carbon farming as an offset method is not yet given or known and reasons given for the absence of agriculture are different although marketing-wise (agroecological) carbon farming seems currently harder to sell. Also, additionality and especially measuring and monitoring are seen as more difficult than offset practices that are currently in place.

6.3 Perception of Dutch VCM on agroecological carbon farming as offset method

So, what do the Dutch retailers think about agroecological carbon farming as an offset method? After explaining agroecological carbon farming to them, questions popped up surrounding feasibility and their opinions on implementing it as a certified offset method from which they could derive carbon credits. Treesforall states that they think that carbon farming can be certified since agroforestry projects have been certified in the past in voluntary offsetting. With solid communication with the local farmers and stakeholders, it must be possible to create a certified functioning agroecological carbon farm that produces credits. A long breath is needed though she adds. FairClimateFund thinks that carbon farming is very interesting and might be suitable as a certified offset method but repeatedly mentions the negative cost-benefit situation that she thinks exists. Also, she adds that you need to have the resources to be able to devote yourself to such a project because it will take a lot of time before carbon will be sequestered (Interview VII)

'Complexity' is mentioned multiple times by retailers. FairClimateFund states that there had been projects in the past with the involvement of agriculture but that it was too difficult. The collection of data and the low revenues were the main reasons why it did not work out. (A). also thinks that actually proving that carbon is sequestered on an agroecological carbon farm is the number one problem of this offset method.

> "*A solid methodology and proven additionality are of the highest importance if you want to speak of reliable carbon offsetting. With carbon farming I expect this is very hard to do because if a farm is already operating there is no additionality. And I think it's difficult to measure sequestered carbon on a farm*" (Anonymous manager of carbon offset retailer, 2020).

Cozijnsen adds that additionality is hard to prove and hard to measure but sees this as a manageable problem. (A). thinks that carbon farming can be made suitable for offsetting provided that there is successful abidance. The involvement of local stakeholders and local communities was considered essential in successful offsetting projects that involve land use. He points to forestry projects that went bad due to non-holistic approaches from the past and points to afforestation projects.

The retailers were thereafter asked to what extend they would consider agroecological carbon farming projects offsets. FairClimateFund replied that they mainly focus on household devices since their main goal is to help those most vulnerable to climate change in developing countries. They think other methods are better at achieving that goal. Treesforall is solely focussing on afforestation projects but are trying agroforestry projects in the Netherlands and might be interested in the future. Greenseat and ClimateNeutralGroup are saying that agroecological carbon farming seems 'very suitable' as an offset method and say that they would be glad and are ready to implement projects. Cozijnsen is working on standards for in the Netherlands and sees regular carbon farming as a high potential offset method. (A). would be willing to adopt agroecological carbon farming projects as long as they are certified by Gold Standard. *"If these projects can be certified this proves that they are additional. I then don't see any reason to not use this method in the future*". He finally adds that the price for each credit can't be much higher than those currently on the market because he thinks consumers won't buy them otherwise.

6.4: Concluding summary and answering SQ3

How do retailers that are involved in offsetting programs, view agroecological carbon farming as a carbon offset method?

Retailers are for the most part aware of the sequestration potential of agriculture and also come with some semi-examples of involvement in agricultural offsetting projects that are under development such as soil carbon and agroforestry. Real examples of agroecological carbon farming as an offset method are not yet known by them. Given reasons for the absence of agriculture in the VCM are differentiating although marketing-wise agroecological carbon farming seems currently harder to sell. Also, additionality and especially measuring and monitoring are seen as reasons for agroecological carbon farming being more difficult to successfully implement than offset practices that are currently in place. The role of the SDG's and certification of Gold Standard are pointed out as the basic requirements for the retailers to adopt carbon farming projects. The main concern for projects to become certified is additionality. Also, pricing is seen as a potential obstacle by at least three of the interviewed retailers. They don't think that these credits can be sold for the same price as different project categories because of the high costs and long implementation time. Still, other retailers such as ClimateNeutralGroup and Greenseat seem very positive about agroecological carbon farming and think there are political reasons why it is not yet more widely adopted.

The mitigation potential of carbon farming is acknowledged by all project retailers, but not all of them see it as a suitable offset method. What also becomes clear is that the retailers within the Dutch VCM are focused on projects that are certified by Gold Standard. If a project is Gold Standard, affordable, and meets criteria of the SDGs they see it as a good project. Except FairClimateFund who thinks more that that is needed in order to become a decent project, and Justdiggit who decided not yet to interfere with offsetting. Becoming certified can therefore be seen as a top priority for agroecological carbon farming. There is a support base for this method by most of the interviewed retailers although it's complexity might form a barrier since retailers expect it harder to explain to the public than cookstoves or afforestation projects.

It seems that if a carbon farming project can be certified and costs can remain within limits, some of the Dutch retailers are eager to adopt these projects. Explaining the benefits and linking them to the SDGs is expected to help and sell offsets more successfully. Still, the largest problem of the voluntary offset market has been the accurate measuring and monitoring of carbon rates. Agroecological carbon farming will probably only increase the difficulty of doing this, instead of making it easier. This makes it seem as a very complex voluntary offset method.

7 Results IV: Certification of voluntary carbon offset projects.

In order for agroecological carbon farming to become used as a voluntary offset method, certification is a necessary step. This chapter will present a basic outline of the procedure and the importance of certification and quality marks.

7.1 Certification and quality marks of the VCM

Within the VCM numerous official certifiers label offsetting projects and make certain that: a) projects offset carbon, b) local organizations are involved, c) projects are transparently adding to sustainable development.

The most used, respected well-known quality mark in the Netherlands is the previously described Gold Standard. There is a run on Gold Standard certified projects since it is the most well-respected quality mark. Retailers in the Dutch VCM prefer this quality mark above others because of its status. Tollenaar explained that they can assure their forestry projects are additional because they are Gold Standard (Interview I). A. tells that he takes Gold Standard and their link to the SDG's very seriously and sees it as an example for offsetting (Interview III). What is notable from several interviews, is that the retailers themselves are not exactly aware of how much carbon is sequestered and how this is measured. They outsource this to Gold Standard and assume if it is certified, the offsets are real, permanent and additional. It is also very likely that the value of reliable quality marks is high since the carbon markets and carbon offsetting has had a tumult history and are experiencing critical publicity. Consumers are becoming more aware and critical (Interview I), meaning that in order to sell offsets, they need to be certified at the best available quality mark. It is clear that (Dutch) retailers and possibly consumers think this is Gold Standard and put much trust in this Suisse foundation. Brand reputation seems a decisive factor.

There are also others. The Verified Carbon Standard (VCS) says it is the most widely used voluntary offset program with over 1600 projects worldwide. Gold Standard has done 1700, making it a contester in terms of number of projects. The VCS uses mechanisms and methodologies of the highly criticised CDM (verra.org, 2020). FCS and CCB are other less used quality marks. The use of quality marks can be considered highly necessary since carbon offsetting is not new to miscalculations, over-exaggerated carbon offsetting calculations, and many other shortcomings that are already described in earlier sections (Oko Institut, 2017; Trouw, 2020).

An independent external quality mark should keep an eye out and ensure a consumer her or his donation is truly responsible for the promised covering up of the certain amount of carbon emissions. However, the independency of quality marks is questionable since project developers calculate their own carbon and the quality mark only supervises (Trouw, 2020). This could create an incentive for quality marks to be less critical on carbon calculators since the standards receive more funding if more carbon is 'successfully' offsetted. In other words, a quality mark and/or project developer benefits from overestimating the sequestered or prevented carbon. More carbon means more offsetts to sell to KLM for example. A large-scale investigation by Trouw in 2020 proved that the company that decides how much carbon is acknowledged, it's externality and independence is questionable since this company, SustainCert, is established by Gold Standard in 2018 and the current CEO is former director of Gold Standard (Trouw, 2020). Gold Standard is also the majority shareholder of SustainCert.

Also, with certification it seems that voluntary offsetting has its shortcomings. Still, for agroecological carbon farming to become used as an offset method, certification is needed because the voluntary carbon market remains a market that consists of consumers and companies that offer offsetting. It is not a compulsory market.

7.2:Certifying agroecological Carbon Farming at Gold Standard

For this part the steps are identified that need to be taken in order for carbon farming to become certified at Gold Standard. Table 7.1 consists of a summary of the most important action points coming from

Gold Standard documents regarding the certification procedure. If all seven steps are completed successfully, an agroecological carbon farming project is a certified voluntary offset program and can therefore actively be sold to offset retailers or individuals that want to compensate for a certain action or service.

A retailer can select or fund certified projects and sell carbon credits throughout these projects. For example, FairClimateFund is responsible for the promoting and funding of projects that had been designed by (local) partners and sell carbon credits derived from them. A project developer can also function as a retailer if they have both designed the project and also promote and sell the credits.

GOLD STANDARD CERTIFICATION PROCEDURE (Summarized by author)

1. Project planning and stakeholder consultation.
    - a basic project design needs to be created
    - estimate and indicate climate and sustainable development impacts
    - assessment Gold Standard safeguards
    - make a summary of the above
    - pay a fee of ($3500)
2. Preliminary review by SustainCert
    - They need a Stakeholder Consultation Report
    - They need a Project Design Document (this is step 1 + monitoring plan)
    - Submit Gold Standard GS4GG* letter
    - Sign terms and conditions
    - pay review ($900) fee
3. Third Party Validation
    - Complete Project Design Doc.
    - Contract and Pay VVB*
4. Project design review by SustainCert
    - Submit final Validation report
    - Submit VVB and Project Design doc.
    - Pay design review fee ($1000)
    - Approval results in GOLD STANDARD CERTIFIED status
5. Project Monitoring (*monitoring is needed as long as the project produces credits*)
    - projects must continuously engage with stakeholders
    - submit annual reports of verification
    - prepare monitoring report
6. Third Party Validation
    - Validate and assess monitoring
7. Performance review by SustainCert
    - submit VVB final verification report
    - submit VVb final monitoring report
    - pay ($1000) performance review fee → GOLD STANDARD CERT.

* GS4GG= *Gold Standard for the Global Goals; naming for the standard used by Gold Standard*
* VVB= *Validation and Verification bodies: Exams and training needed in order to become vvb member. Provided by Gold Standard*

(Table 7.1: Process to be certified by Gold Standard; source: Gold Standard.com 2020, adjusted and summarized by author)

Foreign offset project manager Tollenaar explained that having strong ties with local reliable partners and local authorities are of key importance for long-term sequestration programs (Interview I). The stakeholders as described at phase 1, consist of employees of Gold Standard, the project developers, possible funders, and local partners.

Apart from project costs, additional fees to become certified are also needed. As can be seen in table 7.1, at least $6400 is needed to become a certified project. These costs are for the project developer, or for a third party that wishes to account for funding. The review fees can vary per project type, whereas the fees used in table 7.1 are used for the most common project type. There is also the annual fee of

$1000 and for each credit, an additional fee is also demanded. Furthermore, there are numerous smaller and more additional (annual) fees that need to be paid including a fee for each sold credit. Without the actual costs for the project, certification will already cost a significant amount to a project developer.

The main goal for a Gold Standard certified project is to 'quantify, certify and maximize' the climate impact and to check as many SDG's as possible. In the project design there are multiple rules and principles that need to be followed in order to become certified. The first principle is that there is a proven **contribution to climate security and sustainable development.** Again, as seen before, the Sustainable Development Goals indicator list forms the centre of the methodology surrounding this first principle.

Article 4.1.2 of the principles and requirements of certification states that contribution to at least SDG 13 and two others must be demonstrated (Gold Standard, 2019). With agroecological carbon farming contributing to as many as 9 SDG's including SDG 13 this won't form a barrier (Appendix II). A clear link with the SDG's is required and keeps returning in the principle and requirement list. The link with agroecological carbon farming and the SDG's will be presented further during this chapter.

Additionality was considered one of the main problems with the CDM (Oko institut, 2017). To become certified, a **baseline scenario** must be designed in which the scenario is described where the project is absent. This baseline scenario represents business as usual. This for example with agroecological carbon farming could be degraded agricultural land. This baseline scenario is followed up by a **project scenario** wherein the scenario is described with a fully operational project. A fully operational multistrata agroforestry for example. The amount of net emissions and removals in terms of tons co2 per hectare per year (mtco2) is used as a unit of measurement. The difference between both scenarios is aimed to show additionality. Finding the right impact quantification methodologies for smaller projects can be hard though and especially for a complicated land use practice such as agroecological carbon farming (Gold Standard, 2019).

After the right stakeholders have been found, inclusivity with stakeholders needs to be proven to become certified. Concerns of (expert) stakeholders and engagement in consultation of the project design are stated essential by the standard. Local affected and interested stakeholders such as NGOs and local and national authorities that are active in the country where the project takes place, need to be identified and informed. There must be stakeholder/ experts consultations during the certification procedure and throughout the lifespan of the project.

The most important aspect of the certification procedure is the demonstration of real outcomes. This means delivering proof that the project a) is contributing to the SDG's and b) is offsetting carbon. In order to verify, parameters need to be identified and selected for both the positive SDG impacts and the variables that, in the case of agroecological carbon farming, measure soil organic carbon and carbon in above and below ground vegetation. Gold Standard provides templates and methodologies for monitoring as well as tools for reporting and measuring additionality. However, here things become more complicated.

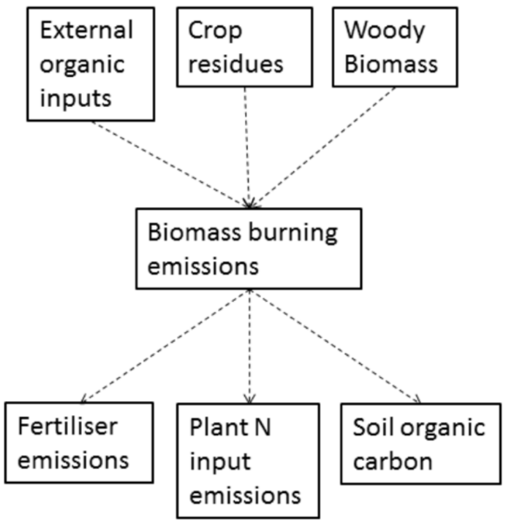
Certifiers or quality marks are verified by 'independent' accreditation bodies. These bodies differ for each certifier.

7.3 Measuring offsetting with agroecological carbon farming

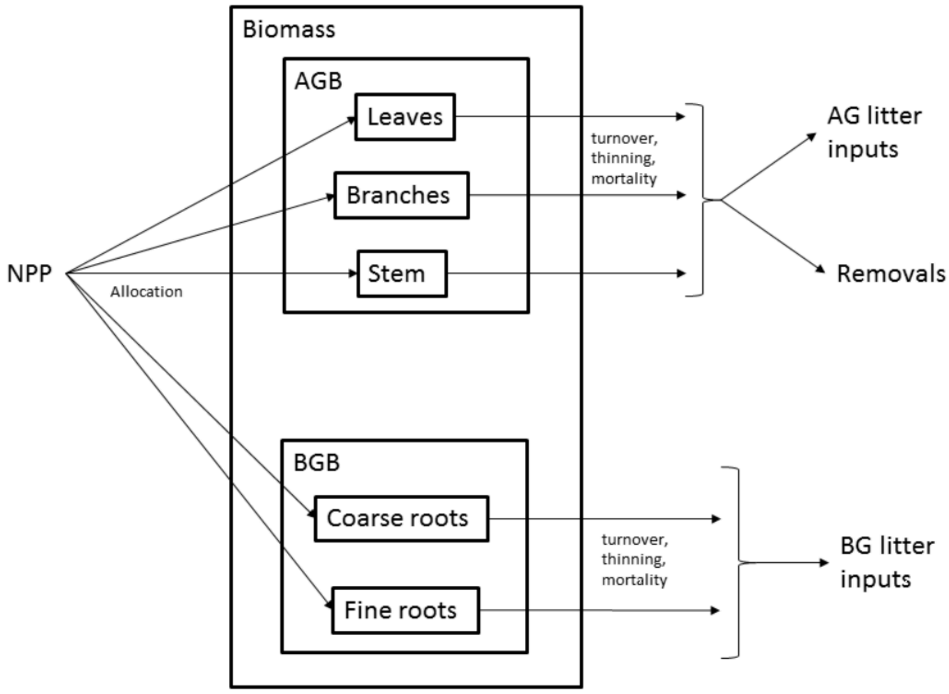
Another option in terms of certification is the less well-known Scottish Plan VIVO. Treesforall's foreign project developer mentioned this certifier that is relevant in the sense that it is a body that focuses solely on community-based land use and forestry programs including REDD+ but also agroforestry and improved grazing projects (Plan Vivo, 2020).

Agroforestry (non-agroecological) is distantly related to agroecological carbon farming and Plan Vivo has certified a project in Indonesia where fruit trees and medicinal plants are used to sequester carbon while providing products to local farmers. Their methodology and certification procedure is shorter and less complicated than Gold Standard's but shows many similarities. It is also costly and follows similar steps such as the baseline/project scenario, the monitoring and validation phase. Most importantly, it also presents a clearer, more understandable indication of how to measure a credible and quantifiable estimation of emission removal, or carbon sequestration. Plan Vivo introduces the

Smallholder Agriculture Monitoring and Baseline Assessment (SHAMBA) methodology that is designed by the University of Edinburgh in support of the European Union, the Agriculture and Food Security research program and the International Fund for Agricultural Development. The peer-reviewed SHAMBA is aimed at estimating emissions and removals resulting from changes in land use practices such as agriculture. The methodology includes Climate Smart Agricultural practices (CSA) which, as described in the theoretical framework, are distantly related to agroecological practices. Both do include different forms of agroforestry and also includes variables as fertilizing. The model states itself as capable to calculate both (changes in) carbon in soil-organic matter, woody above ground biomass, crops and underground biomass on a hectare basis (Woollen et al., 2014.).
The model can be used for the baseline scenario and the project scenario.
Figure 7.1 shows the variables used for this model and figure 7.2 shows a graphical representation of the biomass model. Figure 7.3 shows the more complicated model that can be used for the measuring soil organic carbon. The biomass model in figure 7.2 estimates the changes in the woody biomass carbon pools. The NPP stands for the net primary productivity and is the biomass that flows into the pool. Biomass also flows out of the pools in the form of outflux litter due to, for example, the decay of vegetation.



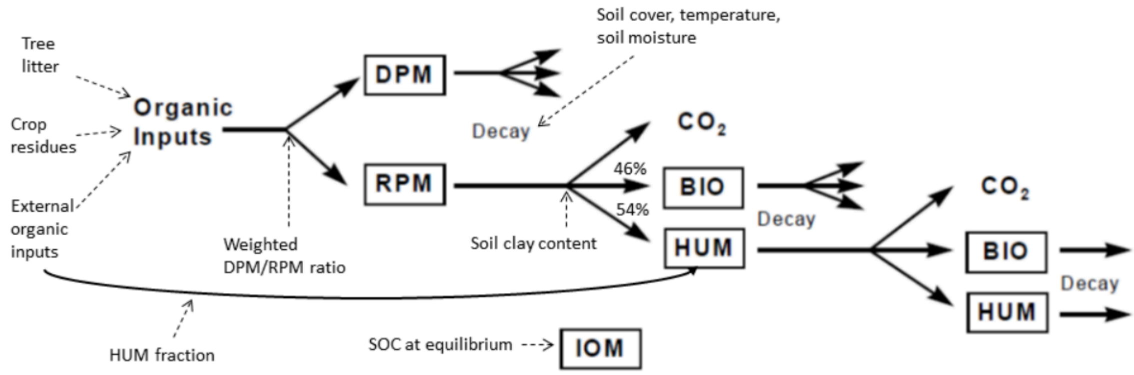
(Figure 7.1: Each modelled component of SHAMBA and the information between them. source; Woollen et al., 2014.).



(Figure 7.2, graphical representation of the biomass model of SHAMBA. AGB = Above-ground biomass and BGB= beneath ground biomass. source: Woollen et al., 2014.)

The measuring of biomass in terms of growth rate, biomass loss, density, tree and crop species, tree mortality, soil type, and climate and location shows that these models are extremely difficult to understand and to use. For every in and outflux, numerous non-basic calculations are needed to be executed and estimating the amount of sequestered carbon is the single most difficult factor within offsetting (Toensmeier, 2016). This model is presented as a model that is 'easier to adopt' but is already hard to interpret. The presented figures are merely an indication of how the model works and only form the tip of the iceberg. More tools, objects and data are needed for implementation of this model.

Figure 7.3 shows the adjusted version of the RothC carbon model whose base was designed by Coleman and Jenkinson in 1999. RothC is the most widely used model to calculate soil carbon globally (Woollen et al., 2014) This adjusted version is implemented in Python and in SHAMBA it is able to run a yearly time step of the topsoil which can be used to estimate the soil organic matter levels and changes for baseline and project scenarios (Woollen et al., n.d.) There is an extensive user manual available online for this model.



DPM: Decomposable plant material
PRM: Resistant plant material
BIO: Microbial Biomass
HUM: Humified organic matter
IOM: Inert organic matter

(figure 7.3: Shows the modelling of the soil organic carbon RothC; source Woollen et al., 2014)

Modelling and calculating the amount of sequestered carbon is proven difficult for both natural forestry and especially agroecological carbon farming and scientists are still finding new ways and differences in methodology. Monitoring carbon is already difficult without even incorporating all different agroecological practices. Still, the fact that certifiers such as Gold Standard state they can estimate sequestration amounts of forestry and Plan Vivo ads SHAMBA with agricultural variables, shows that just as certificates are given to forestry per sequestered carbon per hectare, certificates per hectare for multistrata agroforestry should be possible as well in theory. Measuring and monitoring amounts of carbon were described by Dutch retailers as a main problem and obstacle for agro-ecological carbon farming as an offset method. These methodologies and models can definitely aid with the certification process regarding measuring and monitoring.

What is needed but still missing, is a standardized sequestration rate for each agroecological practice, each soil type and each climate. The methodology presented by Plan Vivo does provide the start to work with and with additional research on carbon sequestration agroecological carbon farming should be able to become verifiable. Still, it must be stated that as described in the sections surrounding REDD+, estimating sequestration amounts for the planting and protection of forestry are already inconsistent and their reliability is highly questionable.

What makes agroecological carbon farming more difficult to monitor than for example natural forestry, are the use of agricultural practices that change the biomass more frequently and in a greater variety than when monitoring a natural or planted forest (Toensmeier, 2016).

7.4 Learn from Carbon Farms in action

Apart from becoming certified, it is also important to firstly look and investigate examples of carbon farming that are currently in action. Even Though investments in agroforestry worldwide are growing (Hanes, 2020) and it is in some ways already used for carbon sequestration (Interview III)., the problem with agroforestry is that it is a term that is widely interpretable. For example, most large chocolate companies claim they are integrating agroforestry. However, agroforestry by them means that a few trees are integrated at their cocoa plantations (Bos & Sporn, 2013; Hanes, 2020). Agroecological carbon farming can be agroforestry but not all agroforestry is agroecological carbon farming. Real presentable best-practice agroecological carbon farms need to be found and examined. There have been cases in which agroforestry has been certified as offset method (Interview III). These procedures can serve as a starting point to certify the agroecological multistrata agroforestry which is considered agroecological carbon farming

The Australian government ran a large-scale nationwide carbon project since 2011 called the Carbon Farming Initiative (CFI). It is a voluntary scheme where farmers and land managers in Australia could earn carbon credits for sequestering carbon on their land. Thereafter, farmers could sell these credits to businesses or individuals that wanted to offset their emissions (Verschuuren, 2017). Although this CFI differs from carbon farming as described in this research, it is the largest project that involved farmers, carbon sequestration and sold offsets. CFI did not adopt agroecology and is not implemented in the global south though. Still, lessons definitely could be learned from this large-scale project. A start-up called Indigo AG in Boston is already investing in carbon farming in the United States in a similar way as the CFI but then non-governmental based. For each ton of captured Co2 by a farmer, Indigo pays an amount of $15 using venture capital (Reily, 2019). To put this in contrast, $15 is similar to the amount an individual pays to Gold Standard to offset a ton of Co2 for a REDD+ project (GoldStandard, 2020).

Farmers in the global south form the key for successful implementation. Work and partnerships with farmers are essential to learning more about the (implementation) of agroecological carbon farming practices. International agencies such as the World Agroforestry Centre and other NGOs and farming and land use foundations could be consulted on possibilities for agroecological carbon farming. The connection between carbon farmers and voluntary carbon markets is an essential one. Moreover, since agroecological carbon farms have a long implementation time, there is a need for a financial support mechanism for project developers to support the farmers during the time their perennials have not yet started bearing fruits and are sequestering carbon.

Are there then absolutely no carbon farming projects that can be considered VCM? There is one methodology that has two agroforestry farming projects aligned. It is called SALM and is used by certifier VERRA known as the Verified Carbon Standard (VCS). The methodology is former CDM and is in many terms similar to the VIVO methodology but does not pay much attention to agroecology. Some agroecological practices such as no-till are involved and the farmers promote 'climate-safe' agriculture. It does prove that carbon farming in the form of semi-agroecological agroforestry as a voluntary offset method is certified by one of the largest quality marks in terms of sold credits. It also raises questions why only two projects in Kenya are adopted. If it is possible to certify an agroforestry project and present it as an agricultural carbon project, why is the uptake of agricultural projects so limited? Nevertheless, these two Kenyan projects are the closest lead to an official certified agroecological carbon farming project in the voluntary carbon offset market in the Global South and should be investigated thoroughly.

7.5 Perceptions on certification procedure

The foundation Justdiggit is no offsetting retailer but is focussing on re-greening land by inspiring farmers in Kenya and Tanzania to adopt certain (agricultural) techniques (Justdiggit.org). The foundation works together with local farmers and is encouraging them to bring back vegetation. The foundation was also interviewed (Interview VII) and one of their employees had extensively studied whether or not Justdiggit should involve voluntary carbon offsetting in their projects. She explained that the foundation repeatedly was approached by companies that wanted to offset their emissions via their foundation. Because of this, the foundation started researching possibilities surrounding the generating of carbon credits out of their current projects. They discovered the options surrounding certifying at Gold Standard and explained that it was a costly procedure. Also, they hired an external company called SouthPole (Southpole.com) that offered to help them with the certification procedure. The major problems they encountered were:

- Because their project was already on its way and because the land was owned by the local farmers; in order to certify they needed all farmers that owned land to sign a contract. This would mean a tremendous operation since they worked with a large amount of communities and thus farmers.
- Credibility was also a major concern. Because the project was already on the way, it seemed inappropriate to suddenly return to tell them their sequestered carbon would become certified and sold. The build-up trust over the years between the project developers and local farmers would have likely suffered if they would proceed. Not

only because it was not clear if and how farmers would be remunerated for their sequestration work.

Therefore, Justdiggit decided not to engage into certifying and using their projects for offsetting as can be read below:

> "It would be much easier to certify a project that would be designed from scratch. We would have needed to almost entirely reshape our projects to become legally obliged to sell carbon credits throughout our projects. Even Though from business development perspective it is seen as highly attractive, our main goal is not to sell carbon credits" (Employee S. Van het Hof Justdiggit, 2020)

She added that even with a new project it was unlikely that they would try to become certified because the Gold Standard procedure was difficult to realise. For now, they therefore were not planning to get Gold Standard certified. However, they are discovering other ways to offer offsets to companies. The verified carbon credits (VERs) are a more simplistic way of producing credits that needs less juridical actions.

7.6 Carbon Farming and the Sustainable Development Goals

All previously defined ecological and socio-economic benefits of chapter five on agroecological carbon farming have been examined as well as the indicators list of the Sustainable Development Goals by the United Nations and put in table 7.4 in the Appendix III. The definition of the specific goals can also be found in the Appendix. Even Though there has been critique on the goals and indicators, it is widely used by carbon offsetting certifiers and retailers for funding and certifying. The link to the SDGs is a step that needs to be taken in order to estimate sustainable development impacts. Agroecological carbon farming proves to be a potential multi-beneficial strategy that, next to mitigating climate change, has many demonstrable direct links to at least over half of the Sustainable Development Goals. Considering the increasingly importance of side benefits and the SDG's for offsetting retailers, agroecological carbon farming has more potential than assumed by these same retailers Agroecological carbon farming can be directly linked to 9 out of the 17 SDG's. This is more than with any other project category so far (Gold Standard, 2020).

(7.7 Answering sub-question 4: Basic steps that are needed for agroecological Carbon Farming to become certified

What steps need to be taken for Carbon Farming to be used as a certified offsetting method?

In order to create a successful reliable, additional and operational carbon farming voluntary offset project many actors are involved. As described earlier, receiving certification or turning a project into a credit producing offset, is a huge task. JustDiggit for example used external companies to look into the Gold Standard procedures (Interview VII). Treesforall also is not aware of methodologies itself, but leaves this to Gold Standard. However, in order to provide an indication of what would be needed, the basic outline is presented below. The steps are based on the Gold Standard procedure, the Plan VIVO procedure and the interviews with Teesforall (Interview I) and Justdiggit (Interview II).

1. Research phase
   -Investigate the SALM Kenyan VERRA projects
   -Investigate VIVO and SHAMBA methodology
   -Set three potential locations and investigate local/cultural context
   -Investigate physical context (climate, soil type, suitable species and agroecological practices)
2. Clear and Extensive link agro-ecological carbon farming with SDG's
   -Important for funding
   -Important for certifying

-demonstrate multifunctionality
-demonstrate sequestration potential
-See Appendix II

3. Make first basic project design
    - Example can be found via Gold Standard
4. Make extensive risk assessment
5. Find expert-stakeholders
6. Find funding
7. Find reliable local partners that can ensure long term monitoring
8. Obtain social license
9. Lay contact with farmers and make educational plan/ design toolset agroecological practices
10. Select VCM certifier and follow official certifying procedure
    - Gold Standard step 1-7 as described in table 1
11. After certification
    - Promote credits
    - monitor carbon farm
    - Ensure agro-ecological practices
12. After implementation
    - Create incentives for farmers to overcome long implementation time
    - When system starts to bear fruit: help designing farmer to farmer value chains
    - use Payment for Ecosystem Service (PES)

8 Discussion

8.1: Limitations of carbon offsetting as an adaptation and mitigation strategy

Carbon offsetting has had a history of controversy and is criticized by the media, by the scientific world, and by fellow students (Missler, 2020; Oko Institut, 2017; Lang et al., 2019). The failure of the CDM could have been a warning for the evolving VCM but as the first chapter indicated, the VCM in its current state is far from solid. The inconsistent pricing as well as the calculating of emissions make it difficult to not raise suspicion and distrust this market principle by ordinary consumers. On top of that come the case studies that indicated that there are many factors that are simply not solid enough to provide certainty to a consumer that emissions are truly compensated. Two of the largest retailers in the Netherlands; Shell and KLM have highly questionable offsetting mechanisms. On the one hand it is theoretically possible to sequester carbon and therefore to compensate emissions. On the other hand, the inconsistencies within the VCM as defined in chapter 4, clearly indicate that the interaction between both sides, the calculated emissions and the actual offsetted emissions, cannot yet be guaranteed. One might argue that the entire principle of offsetting is therefore not suitable as a mitigation and adaptation strategy. The principle of paying a small amount of money to compensate for your emissions does not seem to work properly at the moment. Yet, doing nothing to compensate for our emissions might seem worse. However, as described before, some project categories do not even positively affect the carbon cycle and have negative externalities as well.

This also raises another question; is this practice of offsetting not merely a decoy for multinationals, the aviation sector, and individuals to carry on with business as usual? Is CORSIA not simply providing a means for the aviation industry to keep growing or for individuals to keep polluting? Does offsetting not merely shift away attention from the real problem which is the pace on which the natural carbon cycle is imbalanced by the burning of fossil fuels? With the bad shape of the current VCM and the predicted (before COVID-19) exponential growth of the aviation industry, the future will be both interesting and concerning. Offsetting will increase but the most used current practices are faltering. The VCM market will need to improve fast, otherwise, it is very likely a similar scenario will unfold as with the CDM. On top of this, there should be social research done to consumers on their choices in using offsetting. Why? Because if it turns out consumers, in general, will fly more, use more, and consume more because they are aware that offsetting is an option, offsetting will very likely create even more emissions and a larger disturbance in the carbon cycle. Not in the least because the price for offsetting carbon remains (too) low.

Offsetting will increase whether we like it or not, and therefore it is of the utter most importance that methodologies, strategies and techniques will be examined and improved in the very near future.

8.2: Contribution and connections to the used theories

CDM has been researched extensively. The more informal and upcoming VCM has not yet been researched extensively and neither is the sequestration potential and its suitability for offsetting of agroecological practices. Where afforestation projects and specifically REDD+ have been criticized in past scientific research as an offset method, there might be room for a different approach to offsetting via the terrestrial pool. This research provided insight in the capability of agroecological practices to help restore balance in the carbon cycle. It showed among others how agroecological practices can help to restore the soil fertility and thereby the sequestration capability. A set of agroecological practices and strategies were presented combined with their socio-economic and environmental benefits and their effect on sequestering carbon. This research contributes to the theory that agroecological agricultural practices (agroecological carbon farming) are also suitable as land-use practice to sequester high amounts of carbon. The sequestration potential of agroecological carbon farming is immense and underrepresented in scientific literature with respect to offsetting. This research explains the potential agroecological practices and principles such as perennial cropping and no-tillage for carbon sequestration, climate mitigation and adaptation. Moreover, it goes further into detail on the microlevel whereas the IPCC report of 2019 on Climate Change and Land only provided the sequestration potential of certain agricultural practices on a macro-level.

This research also contributed to the scientific debate on carbon offsetting within the VCM. The generalization that occurred in the scientific literature of the different offset methods is countered by analysing and grouping all the different methods that exist within the VCM. On top of that, their development over the years was presented and the currently most used project categories were reviewed. Furthermore, this research focussed on the Dutch VCM and the case-studies on three types of retailers as well as the patterns within Dutch VCM. This research provided insight into the Dutch VCM in a practical and understandable manner. Scientific papers lacked a combined insight in how offsets were created, by whom they were sold and how they could be purchased. This research provided examples of all of them combined. The research also provided insight in how projects could be certified, making a link from the practical procedure to the scientific methodologies needed for monitoring and measuring soil carbon. This research is a collection of different aspects within voluntary offsetting and their combination might be used as a good start to further examine voluntary offsetting methods in the Netherlands and for further examination of the design of agroecological carbon farming as a sellable voluntary offset method.

The credibility of the global market was already contested and this study has confirmed that these problems are also surrounding the Dutch voluntary offset market. The inconsistencies in calculated carbon and pricing, as well as inconsistent use of methodologies proved that the Dutch VCM market is not very different. This research also showed that with developments that are underway such as CORSIA, and with the manner in which offsetting has found its way to everyday services such as buying a pair of shoes or signing an energy contract, offsetting is becoming more common in Dutch society. Critically analysing the offsetting markets and their methods is therefore not only socially relevant for those involved in the projects in the Global South but also here in the Netherlands.

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8.3: Main limitations of this research

One of the limitations of this research was that it combined many aspects surrounding carbon offsetting as well as aspects surrounding agroecological carbon farming. Because these two complex and extensive themes were researched together, attention had to be divided. Nevertheless, this created enough understanding about both themes to link them together, which in the end was the main research goal. Still, to go fully in-depth on agroecological carbon farming, actual carbon farms should have been visited or at least examined. Due to COVID-19, fieldwork on (agroecological) carbon farms in the Global South were not possible. The political and local context and especially the role that farmers could play on an agroecological carbon farm are essential in truly understanding this land use practice. This also became clear in the case studies and in two in-depth interviews. The local cultural context kept coming back during this research and should have had a more profound role in examining the functionality of agroecological carbon farming. There was, however, no opportunity to further investigate the role of farmers and the value chains surrounding an agroecological carbon farm. This means that some questions regarding the successful functioning of an agroecological carbon farm with respect to food production and income for farmers remain unanswered. In this research it is only assumed that farmers can obtain income from perennial crops and trees and for their sequestration work. The exact further role on their food supply is not researched.

Attention on offsetting as a whole also suffered in a sense that not all project categories could be reviewed. The choice to further examine the categories of forestry and household devices was made on basis of the demand in the Dutch voluntary offset market and their global market share (concluding the vast majority of offset projects) and is therefore defendable.

To summarize, because this research was aimed at examining a relatively unknown potential offset method and looking to what extent it is suitable for offsetting, some seemingly important relevant factors did not make it into the research. Still, this was a deliberate choice since there was the urge to link the concepts of agroecological carbon farming and voluntary offsetting together.

Then there also is the controversy surrounding carbon offsetting. This research did not go in-depth into the question of how offsetting as a whole is working or mitigating climate change. Although it examined and critically assessed certain facets of the market and looked at an alternative for current failing methods, it did not critically look into the question whether carbon offsetting is an effective political or market-based solution for the emission and climate-based problems we are facing. Instead, the research tried to not derive too much from this question to prevent bias. On the other hand, one might argue that this question does matter for this research since, during the case studies, the question was raised whether analysed methods and techniques could possibly mitigate climate change. There could be argued that only a statement could be made regarding this, if at first, the basic principle of offsetting as a whole is critically analysed. As earlier described in the discussion, controversy surrounding this theme is not unknown to the researcher. There are many authors and researchers that are certain that offsetting is not a solution but instead part of the problem surrounding the combating of climate change. This research neither agree nor disagrees with this statement. It merely looked critical at practices that were currently in place and questioned if the proposed alternative could function and is potentially any better than the ones currently in place.

Methodologically there is room for improvement since data on the functioning of agroecological carbon farms is coming from extensive literature study added by a limited number of interviews. The division between theoretical data and data from interviews and/or case studies on agroecological carbon farms could have been more balanced. Now it becomes clear that agroecological practices have potential in terms of sequestering carbon and positive externalities, but all examples come from the literature. Logs and perceptions of farmers could be added to provide physical examples of these theoretically explained strategies and principles. The results of this research are sufficient to answer all research questions. However, data coming directly from Gold Standard would have improved the section on certification and would have provided data on their view on agroecological carbon farming and their perception on the reasons why agriculture is so badly represented in the VCM. Gold Standard did not have time for an interview although they did reply that they were currently working on certifying agricultural projects.

8.4: Recommendations for future research

-Research on agroecological farms on location in different regions and climates:
Unfortunately, fieldwork was not possible during this research, but researchers should learn from operating carbon farms, agroecological or not, and from agroforestry which have already been in place for several years. Because of the long implementation time of agroecological carbon farms, knowledge on farms that are already further under development could be of value in detecting sequestration levels and possible problems and their causes. The World Agroforestry Centre is already in place and a similar research centre should be able to investigate carbon farms in all agricultural climates for as many soil types as possible. This information is not only relevant for offsetting but for mitigation through agricultural sequestration as a whole. As the IPCC acknowledged in their 2019 report, certain agroecological practices have a great potential since they can be easily adopted and cover large amounts of land (IPCC,2019).

-Development of multifunctional, easy to use, standardized carbon monitoring tools:
Measuring and calculating the amount of carbon that is stored above ground and below ground and the time this takes seems still very difficult in the scientific world. There are still great varieties in how somebody measures soil carbon. Some take samples at 10 centimetres below ground, others do this at 30 centimetres (Toensmeier, 2016). There are also great varieties in sequestration potential of different crops, soil types, agroecological practices and climate. There is only little to be found on standardized sets of data on sequestration rates of carbon farming. There is enough to be found on sequestration rates of forestry's in different climates and soil types. Certification and therefore using carbon farming as an alternative for current offset project methods are dependent on monitoring carbon in above and belowground biomass. Currently, there are some methodologies but as with REDD+, they should

improve. Not only because of certification and credibility but also for promoting agroecological carbon farming as an offset method. Without clear reliable and standardized information about tools and methodologies to measure sequestration rates for different agroecological practices in different climates and soil types, it will become difficult to become attractive as an offset method. Especially since other methods are already controversial, agroecological carbon farming as an offset method should make sure it does a better job.

-Further research on understanding the economic effects and tradeoffs surrounding agroecological carbon farming:
Next to the theoretically proved externalities, there needs to be a clearer understanding of the value chains that go paired by agroecological carbon farming. Apart from offsetting retailers and project developers, it is also of great importance to gain an understanding in how farmers in the Global South can benefit optimally from carbon offsetting trading schemes.

-More research on emissions within the aviation sector:
Just as it is important to truly calculate the sequestered amount of carbon, it is important to come up with uniform datasets wherein emissions of flights can be presented. Of all researched retailers for the case study Amsterdam-Auckland, not one emission rate was the same. They differed extremely. With CORSIA on the way, and aviation as one of the most important reasons for voluntary offsetting, research on the exact amount of emissions coming from a plane should be conducted. Currently, Dutch retailers all use self-selected carbon calculators that all differ, meaning that at least all but one presents the wrong number. If in the first stage of offsetting (the carbon calculator) things already don't work out, how can you convince an individual or researcher that offsetting works, and emissions are really mitigated? Different flight heights, detour factors, and considered emissions make it impossible to form a uniform indication of the actual emissions of a flight. For now, it seems that if an individual wants to offset, he or she could best pick the highest number to be closest to actual compensation. This of course, is no integer way of presenting offsetting. Especially not considering that the company that has the best papers of calculating the actual emissions (KLM) values it the lowest of all retailers. This is seriously concerning and proves there is still a lot of work to do regarding CORSIA.

8.5 Main Challenges and Opportunities for agroecological carbon farming to become a voluntary offset method: answering subquestion 5

Sub-Question 5: *What are the most important detected challenges and opportunities for agroecological carbon farming to be used successfully as a voluntary offset method?*

Challenges

- The long implementation time of agroecological carbon farming is a main challenge to overcome. As retailers also stated; project developers and retailers need a long breath. Besides, so do financially stressed farmers. What will happen in the first years before an agroecological carbon farming starts sequestering carbon and starts bearing fruits needs to be solved first before an agroecological carbon farming project is initiated. This implementation time will very likely put pressure on the land. The multiple ecosystem services take even more time to deliver.
- Agriculture might be less "attractive to sell" than the popular 'planting of trees' as an offset method. Afforestation is the most popular one the retailers stated. They explained that nearly everyone knows that trees are cleaning the air and it sounds a lot more logical than planting crops and adopting certain farming practices. Furthermore, agriculture is seen as a reason for climate change. Sequestration through agroecological carbon farming is less tangible and understandable than the planting of trees and might therefore be harder to promote, fund, and sell.
- Additionality is seen as a problem by retailers within offsetting. They often state that because a farm might already be there, additionality is under threat. Additionality is needed to become

a credible offset project (Oko Institut, 2017). You must make a difference in offsetting carbon instead of counting something as offsetting that was already (partly) there.
- Measuring and monitoring agroecological farming could be more difficult to measure in terms of sequestration rates than afforestation projects. The lack of tools for monitoring and measuring sequestration rates of agroecological practices in all agricultural climates will likely cause difficulties in presenting credible numbers to certifiers and the public.
- Certification is expensive and complex, in relation to that, there is the time-lag between adaptation and realisation. This might not create the most wanted investment as an offset method.
- As described in the literature and by examples coming from the case studies and retailers that were interviewed, the socio-cultural and economic local and regional context must be fully understood to assure long-term stability that is needed to capture and hold onto that carbon.
- Most retailers within the Dutch market fully trust on Gold Standard, meaning that if agroecological carbon farming will not survive the certification procedure, it is very unlikely it will be adopted. This again shows the importance of certifying for agroecological carbon farming as an offset method.

Opportunities
- Carbon farming implementation might be more expensive than REDD+ but charismatic projects are worth more and farms in a later stadium can provide services that are worth more than merely logging.
- Carbon Farming can be linked to many of the SDGs. This link to multifunctionality is most important in certifying as well as in promoting a 'charismatic' offset method which is increasing in popularity.
- The growing Voluntary Offset Market can create new opportunities for VCM projects.
- It is uncertain how carbon markets will evolve in the near future, considering the Paris Agreement that jammed on carbon trading schemes and CORSIA that is currently in progress. These developments might produce new insights and attention for and within the VCM and agroecological carbon farming might be able to benefit from this. Also, since CORSIA's 'first phase' will be in 2024-2027 and itss second phase will be in 2027 till 2035 there will be time enough for agroecological carbon farming to be tested, researched, and being operational in theory.
- The IPCC acknowledged the need to store carbon into the terrestrial pool and also mentioned agroecological practices as managed grazing and agroforestry as means that can positively affect the sequestration rates. Furthermore, the report mentioned the high potential such measures have since they are in many cases easy to adopt globally. This amount of attention and recognition might increase the amount of funding and research done into these practices resulting in more data and information on agroecological carbon farming.
- The VCM's most used project categories are widely criticized and have proven to not always be successful in mitigation. One of the main problems as described in the theoretical framework is the fact that there often is no added value (for local communities). Especially with REDD+ projects, locals see them often as an obstacle for their own economic development and researchers proved they are often right (source). Agroecological carbon farming, if implemented right, has the potential to solve this major problem by the ecosystem services it can provide. Agroecological carbon farming has the potential to overcome the problem of lacking added value.
- Retailers within the Dutch VCM are willing to adopt agroecological carbon farming projects as long as they are certified and credits are not far more expensive than other credits on the market. Two retailers are already encouraging agroecological carbon farming projects to become adopted.
- The co-benefits of agroecological carbon farming are numerous and outcompete other project categories in number. More importantly, they enhance the soil and prove to truly increase biodiversity instead of decreasing it. Making it a potential multifunctional mitigating solution. If rightly explained, implemented and promoted, it could be a real gain for the current VCM.

There are currently no contesters in terms of ,next to sequestering carbon, bringing that many side-benefits.

9: Conclusion

This thesis investigated the not yet extensively researched and a so far overlooked agricultural project method for voluntary carbon offsetting. This research was aimed at answering the question to what extent agroecological carbon farming is suitable to be adopted as a voluntary offset method by Dutch offset retailers. The research was characterized by the aim to interconnect the concepts of the voluntary offset market and agroecological carbon farming. There is a societal and scientific need to shine a light on methods that are used in carbon offsetting and by filling the knowledge gap surrounding agroecological carbon farming and it's capability and potential to be adopted in the voluntary carbon market. The findings were derived from extensive literature research on agroecological carbon farming, a case study on used offset methods and the Dutch VCM, interviews with voluntary offset retailers and the examination of the certification procedures of quality marks. The findings aid in exploring the possibilities and potential of this underexposed project method and serves as a combined work that examined multiple practical and theoretical facets of offsetting as a mitigation strategy.

The research showed that the voluntary offset market is growing and not capable of contributing to restoring the balance in the carbon cycle. It is in urgent need of improvement on multiple levels. The most used project categories in the Dutch VCM fail to provide real offsets and the available retailers and their projects that have a strong link to environmental integrity are spread thin. The products that are sold to consumers within the Dutch voluntary offset market fail to a great extent to actually provide what was promised: compensation for emissions. Agricultural strategies are seldom used in voluntary offsetting. Literature study provided insight that agroecological carbon farming bears the potential to function as an alternative and additional offset method. The set of sustainable agricultural management practices and principles is capable of sequestering high amounts of carbon from the atmosphere and storing it into the terrestrial pool while contributing to a broad range of sustainable development. It has the potential to overcome problems that occur with other voluntary offsetting project methods since agroecological carbon farming has many more positive ecological and socio-economic externalities. It can add value to land for local farmers in the Global South because it provides multiple ecosystem services whereas other project categories fail to do so. Moreover, the potential of agroecological carbon farming as an offset method is enhanced by the growing demand on offset projects that tell a palpable story and have positive co-benefits for people and the planet. Again, agroecological carbon farming is better suited to provide this story and these benefits than other methods currently in place, making it in theory an attractive method in a growing and rapidly developing voluntary offset market. The benefits that are accompanied by carbon farming are plenty and real. Agroecological carbon farming in the form of a functioning multistrata agroforestry greatly affects the soil-fertility, biodiversity, the amount of soil carbon and sequestered carbon and creates a more resilient self-functioning agroecosystem. Agroecological carbon farming has the capacity to function as an adaptation and mitigation strategy for climate change.

Some challenges will cause major obstacles in becoming a certified offset method. Most importantly, the exact sequestration amounts of certain agroecological practices are difficult to prove. However, the examined project methods as well as certifiers and retailers, are all currently struggling to present clear indications and explanations on the amount of emissions and the amount of offsetted carbon. It will very likely take many more years of research before retailers and project developers can present a verifiable, and constant exact number of carbon that is emitted and offsetted, by a service or action. That agroecological carbon farming might be even more complicated to measure and monitor than REDD+ remains a major concern. Measuring and monitoring amounts of sequestered carbon and additionality are the most important factors that need solving in order to create reliable offsetting.

Certifying agroecological carbon farming is also proven to be more difficult than with other project categories in place, but with the presented methodologies this can very likely be solved. The certification itself is a (time) costly and complex process that also involves many factors and agents that could not all be examined during this research.

Retailers indicate that the demand in offsets has risen in the last few years and will increase further. However, there is currently an abundance of flaws within voluntary offsetting, ranging from credibility to green grabbing to sustainability. The urge to investigate and look critically at the strategies and methods used in this market is high. And so is the urge to start to think of other innovative ways within the practice of voluntary offsetting. This research is relevant since it contributed to both. Retailers already indicated that they see the potential of agroecological carbon farming but do think it might be expensive and harder to sell than offset projects of another kind. In order to present the potential and multifunctionality of agroecological carbon farming to a greater extent to consumers, examples of well functional agroecological carbon farms need to be found, researched, and promoted.

Hence, further research is needed into agroecological carbon farming and the effects on the economic position of local farmers as well as ways in which they could be compensated for their sequestration work. Furthermore, this research might have overgeneralized certain aspects surrounding offsetting. Regional and sociocultural context is proven to be important in the sense that soil types, climates, species and local communities differ which makes a one size fits all conclusion for agroecological carbon farming as a voluntary offset method somewhat short-sighted. More research on effects on local farmers, their food systems and value chains are needed to truly understand agroecological carbon farming and so are uniform standardized carbon monitoring tools for agroecological practices.

This thesis showed that agroecological carbon farming can be moulded into a functioning, certified offset method that can provide ecologically sound carbon credits that can be sold to the voluntary market. Even though many aspects needs solving first, and both main concepts need further refining, agroecological carbon farming has a promising hand in becoming a fairer and more eco-friendly soil enhancing alternative method for some of its failing competitors in the (Dutch) voluntary offset market.

Dealing with climate change requires action within different disciplines and on several fronts. Offsetting is not a solution to our climate problems. Sequestration through sustainable agriculture might be.

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APPENDIX I : Questionnaire I

(Questionnaire 1: interview Tollenaar)
Questionnaire Tollenaar (Interview I)

Vragenlijst gericht aan Treesforall,

Masterscriptie: Carbon Farming as Voluntary Carbon Offsetting Method

Daan van de Kamp
Deze informatie wordt alleen voor studiedoeleinden gebruikt.

(1) De vrijwillige CO2 compensatie-markt

-Hoe denken jullie over huidige ontwikkelingen binnen de vrijwillige CO2 compensatie markt?

-Hoe zien jullie de toekomst voor jullie met oog op het Parijs akkoord? (Zijn er grote gevolgen voor jullie en/of de vrijwillige co2 markt in zijn algemeenheid?
-Hoe denken jullie over CORSIA? (carbon offsetting and reduction scheme for aviation)

Ik heb alle methoden gecategoriseerd en het blijkt dat met name (Forestry and Land Use) snel aan het groeien is in populariteit wereldwijd binnen de vrijwillige compensatie markt.
-Hoe komt het denken jullie dat compensatie-projecten gericht op planten en herstel/behoud van bossen groeit in populariteit ?
-Wat maakt bosbouw vinden jullie, het meest geschikte compensatiemiddel en waarom?

-Wat vinden jullie van compensatie methoden als bijvoorbeeld het uitdelen van kookstellen of het investeren in renewables?

Er zijn veel aanbieders die bepaalde diensten claimen te compenseren. Ik nam bijvoorbeeld een vlucht AKL-AMS als voorbeeld en bij alle aanbieders verschilde de CO2, de prijs en CO2/per ton in euro.
-Wat denkt u dat we hieraan kunnen doen? Zou er een universele carbon calculator kunnen komen of iets in

(2) De Projecten Lokaal
In de wetenschappelijke literatuur blijkt het helaas nog vaak het geval te zijn dat bosbouw projecten lokaal hinder ondervinden. Er worden nu en dan problemen aan de kaak gesteld met REDD+ zoals brandstichting en of lokale politieke/economische en sociale conflicten.

-Hoe voorkomen jullie problemen met de lokale bevolking? Hebben jullie dat in het verleden wel eens gehad? Hoe lossen jullie dit op en hoe monitoren jullie dit?
-Maken jullie gebruik van een bepaald framework/stappenplan bij het implementeren van een bos-project in het buitenland? Zo ja, hoe gebruiken jullie deze?

-Hoe garanderen jullie dat het bos er na 20-50 jaar nog staat? Wat is er denken jullie, belangrijk en voor nodig om langdurige projecten te waarborgen?

(3) Technisch
Hier en daar lees ik over het voorkomen van boskap en het aanplanten van boskap of het beschermen van bestaande bossen.

-Hoe zien jullie het verschil in voorkomen boskap/aanplanten van nieuw bos? Hoe werkt dit CO2 verhoudingsgewijs en dus met uitgerekende CO2 winst?
De studies lopen uiteen m.b.t. de CO2 opvang capaciteit van bossen, hoe berekenen jullie?
Hoe lang duurt het ongeveer voordat de CO2 is opgenomen?
Zijn jullie VCS of Gold Standard gecertificeerd? Hoe denken jullie over de verschillende certificaten die gepaard gaan met CO2 compensatie?

(4) Carbon Farming
Agro-ecologische carbon farming is een manier van landbouw waarbij simpel gezegd gewassen op dusdanige manier worden verbouwd dat deze meer CO2 opnemen. Het doel van carbon farming is om de koolstofcirkel weer in balans te brengen, hetzelfde principe gaat op met het aanplanten van bomen, alleen carbon farming richt zich dus op landbouw. Echter, geen industriële landbouw maar landbouw gericht op het verbeteren van ecosystemen, diensten, en een toename van de biodiversiteit. De manier waarop dit gebeurd is door middel van agro-ecology: "the application of ecological concepts and principles to the design and management of sustainable agricultural ecosystems".

Samengevat: geen pesticiden, monoculturen, gmo's etc. Maar in plaat daarvan laat je de natuur het op slimme wijze zelf oplossen. Klinkt misschien te mooi om waar te zijn maar wanneer zoon ecosysteem-boerderij op gang komt is de opbrengst hoger, de grond vruchtbaarder, gewassen weerbaarder, water wordt beter vastgehouden en er wordt meer CO2 opgenomen door versterkte capaciteit van wortel-sytemen en planten.

-Zijn jullie op de hoogte van compensatie projecten rond voedselbossen of soortgelijke?

Agricultuur is haast nergens terug te vinden als officiële gecertificeerde compensatie methode. Op Gold Standard staat zo nu en dan iets maar het marktaandeel is verwaarloosbaar.
-Hoe komt dit denken jullie?
-Wat weten jullie over Carbon Farming? Hadden jullie er hiervoor al over gehoord?
-Op wat voor manier zijn jullie bezig met biodiversiteit in jullie aanplant beleid? -Hoe realiseren jullie dit?
-Hoe haalbaar is het om van Carbon Farming een compensatie methode te ontwikkelen denken jullie?

APPENDIX II : Questionnaire II

Questionaire B. Klein Lankhorst (Interview II)

Interview II met Professor B. Klein Lankhorst: Directeur Bodum Liefde

Interview kan in zowel Nederlands als Engels. Vragen staan in het Engels i.v.m. nationaliteit 1e en 2e beoordelaar.

Carbon offsetting= CO2 compensatie
Global South= Ontwikkelingslanden

Vragenlijst:
Currently, Carbon offsetting is increasing rapidly in popularity. The Voluntary offset market is valued over $500 million annually. The most popular used method is REDD+(reforestation and countering deforestation)

1. **What is your view on the use of afforestation as an offsetting method for sequestering carbon? (KLM and Shell their afforestation projects for example)**

How do you think the planetary carbon cycle could be restored best, in the context of carbon sequestration through offsetting in the Global South?
2. Why do you think agro-ecology or permaculture isn't widely used in agricultural practices in the Global South?

3. **Why is the sequestration potential of crops largely ignored in academic literature as well as in offsetting projects?**
SEQUESTRATION CAPABIliTY

1. **To maximize carbon sequestration, perennial cropping is often mentioned. Why is perennial cropping so important/special?**
2. **How do you think it would be possible to measure the amount of sequestered carbon annually, on a carbon farm in the Global South?**

Je moet weten waar je in de wereld bent (Tropen gaat veel sneller). je moet ehte aantal bomen hebben per hectare. Eens in de 5 jaar de hoogte, stamomtrek en boomsoort.

AGRO-ECOLOGICAL CHARACTERISTICS

Studies have shown that agro ecological farms can have a higher yield, a higher soil fertility and sequester more carbon than industrial farms.

1. **What is your opinion on the role of agro-ecological farming in countries in the global south in relation to industrial farming?**

It can take many years for such an agro-ecological carbon farm to develop.

2. What is your opinion on this issue? Do you think local farmers and project developers have that amount of time?
3. What is in your opinion, the potential of a switch from industrial farming to agro-ecological farming practices in the Global South?

SOCIO-ECONOMIC BENEFITS

Let's say that Carbon Farming will be adopted on a large scale.

1. **How easy are these practices to adopt by local farmers?**
2. **How do you think that farmers could be remunerated for their sequestration work?**

3. Is the input needed by farmers, lower or higher compared to traditional/conventional agriculture? (in terms of labour, materials, water and other resources)

4. Many positives are mentioned, from increased fertility, more resilience, higher yield etc. Are you aware of any negatives? If yes, what are they?

BIODIVERSITY BENEFITS

1. **What are in your opinion the most important reasons for an agro-ecological farm becoming more self-sufficient and more resilient than a conventional farm?**
2. **What are the main problems with the soil you have encountered in your fieldwork and why can permaculture/carbon farming help?**
   How important is improvement of soil for local farmers in the Global South?

3. What are your own experiences with benefits for biodiversity thanks to agro-ecological farming practices?

Carbon Farming as Offsetting Method

1. **Where do you think finance for carbon farming should come from?**

2. People might be uninterested to change their diet/ change their traditional agricultural practices. How do you think local farmers can be best persuaded to do so?

3. What is your opinion on the use of carbon farming as a voluntary carbon offsetting mechanism for the aviation industry?

4. What would be a way to demonstrate the multifunctionality and potential of carbon farming to the world?

5. What are the main challenges you face doing reforestation/agricultural work in the global south?

APPENDIX III: Benefits A.C.F. and the Sustainable Development Goals

Agroecological Carbon Farming linked to the Sustainable Development Goals

(Defined benefits Carbon Farming and their links to the specific Sustainable Development Goals)

Benefits Carbon Farming	Sustainable Development Goals
-Sequestering carbon by agriculture	**-2.4** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality **-2.5** Maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed **-11b** substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels **-13.1** Strengthen resilience and adaptive capacity to climaterelated hazards and natural disasters in all countries **-13.b** Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities **-15.a** Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems
-Generate income local farmers	**-1.1** 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day **-1.5** By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters **-2.3** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

-Increase soil fertility	**-2.4** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality **-15.3** By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradationneutral world
-Prevent soil erosion	**-15.3** ibid
-Prevent desertification	**-15.3** ibid
-Obstruct land degradation	**-15.3** ibid
-Increase biodiversity	**-15.5** Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
-Enhance nutrient cycling	x
-Habitat for organisms	**-15.5** ibid
-Increase water quality and quantity	**-6.3** By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally **-6.4** By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
-Increase productivity agro-system	**-2.4** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality **-8.2** Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors
-Increase resilience agro-system	**-1.5** By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters **-11.b** substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion,

	resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels **-13.1** Strengthen resilience and adaptive capacity to climaterelated hazards and natural disasters in all countries
-Prevent acidification	**-3.9** By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination **-15.3** By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradationneutral world **-12.4** By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
-Prevent salanity	**-15.3** By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradationneutral world
-Restore degraded land	**-15.2** By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally **-15.3** By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradationneutral world
-Prevent nutrient leaching	**-15.3** ibid
-Recharges groundwater	**-6.4** By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
-Increase sustainably net primary production	**-2.3** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment **-2.4** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality
-Improve food security	**-2.3** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers,

	pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment
-Less costs for fertilizers	x
-Less costs for pesticides	x
-Sequestration rewards farmers	**-1** Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions
-Fewer fuel inputs	x
-Fewer long term labour input	**-8.4** Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead
-Increase overall vegetation	**-15.5** Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
-Increase economic resilience farmers	**-1.5** By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters **-2.4** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality
-Fewer water inputs	**-6.4** By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
-Increased drought resistance	**-2.4** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality
-Provide provisioning ecosystem services (Products)	**2.3** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

-Reduce pressure on natural forestry	**15.5** Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
-Mitigate climate change	**13.b** Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities
	All goals that are directly related: **1**: End poverty in all its forms everywhere **2**: End hunger, achieve food security and improved nutrition and promote sustainable agriculture **3**: Ensure healthy lives and promote well-being for all at all ages **6**:Ensure availability and sustainable management of water and sanitation for all **8**:Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all **11**:Make cities and human settlements inclusive, safe, resilient and sustainable **12**:Ensure sustainable consumption and production patterns **13**: Take urgent action to combat climate change and its impacts **15**:. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

APPENDIX IV Questionnaire III

Questionnaire semi-structured interviews

Vragenlijst Carbon Farming als CO2 compensatie methode.
Research Master: Sustainable Development : Universiteit Utrecht

Daan van de Kamp: daanvdkamp@gmail.com tel 0623373115

Deze vragenlijst en gegeven antwoorden worden alleen gebruikt voor studiedoeleinden

Deze vragenlijst bestaat uit 10 open vragen. Er zijn geen foute antwoorden. Indien u geen antwoord wilt of kunt geven op een vraag kan deze desnoods worden overgeslagen. De vragen hebben betrekking op CO2 compensatieprojecten in the Global South oftewel ontwikkelingslanden.

(1) Hoe komt het denkt u dat compensatie-projecten gericht op het planten en herstel/behoud van bos wereldwijd groeit aan populariteit?

Er is een groeiende vraag naar CO2 compensatie projecten met positieve sociaal-economische en ecologische bij-effecten en consumenten zijn bereid om meer te betalen voor desbetreffende projecten.

(2) In hoeverre heeft dit betrekking voor u bij het selecteren van methoden/technieken en compensatie projecten?

(3) In hoeverre gebruikt u de Sustainable Development Goals in het selecteren en presenteren van de door jullie aangeboden compensatie projecten?

(4) Wat vinden jullie het belangrijkste bij het selecteren van compensatieprojecten?

Agricultuur is haast nergens terug te vinden als officiële gecertificeerde compensatie methode. Op Gold Standard (de grootste gecertificeerde project aanbieder) staat zo nu en dan iets maar het marktaandeel in de CO2 compensatie economie is verwaarloosbaar.

(5) Hoe komt dit denkt u?

Carbon Farming heeft net als het aanplanten van bos als doel om CO2 vanuit de atmosfeer op te slaan in vegetatie en de bodem. In plaats van alleen bos kan er een mix van bomen en (eetbare) gewassen gebruikt worden. Met meerdere agro-ecologische methoden ontstaat er ,indien juist geïmplementeerd, een grote verscheidenheid aan functionele biodiversiteit die naast het opnemen van CO2 talloze wetenschappelijk bewezen positieve bijeffecten tot gevolg heeft voor mens en natuur. Carbon farming kent waarde toe aan land, levert ecologisch verantwoorde producten op en inkomen aan lokale boeren en verbetert de bodemkwaliteit. Boeren kunnen daarnaast worden beloond voor hun compensatie-werk.*

**agro-ecologisch = ecologische concepten en principes gericht op duurzaam design en management van agro-ecosystemen.*

(6) Had u ooit al eerder gehoord van het principe carbon farming? Zo ja, waar en wanneer?

(7) In hoeverre lijkt deze manier van co2 compensatie uw geschikt als methode en/of gewenst als co2 compensatieproject?

(8) Wat zijn denkt u op het eerste gezicht mogelijke limitaties aan het gebruik van carbon farming als CO2 compensatie methode?

(9) **Zijn jullie op de hoogte van compensatie projecten rond voedselbossen of soortgelijke? Zo ja, in hoeverre heeft u ooit overwogen deze te implementeren?**

(10) **In hoeverre zou uw (organisatie) in de toekomst openstaan voor het adopteren van carbon farming als aangeboden compensatie project?**

-Heeft u nog verdere vragen of opmerkingen?

Hartelijk dank voor het invullen van deze vragenlijst. Als u op de hoogte wilt blijven of in contact wilt komen kunt u mailen of telefonisch contact opnemen via

daanvdkamp@gmail.com 0623373115