CHALMERS
UNIVERSITY OF TECHNOLOGY

# Biodiversity in cotton farming in western Turkey

## A qualitative case study on Nudie Jeans' impacts on biodiversity

Master's thesis in Industrial Ecology

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Cover: Cotton field in spring in Torbalí, Turkey. Photograph taken by the authors.

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# Abstract

The concept of biodiversity relates to richness and variability of species and ecosystems, and is linked to health and resilience of natural systems. Agriculture, and specifically cotton farming, has large impacts on the environment and causes a rapid decline in biodiversity globally. The Swedish jeans company Nudie Jeans (NJ) wants to identify the impacts on biodiversity from their cotton production in Turkey. The aim of this study is therefore to map the impacts of NJ's organic cotton production in western Turkey, and to provide suggestions on how NJ can decrease the identified negative impacts and take action to enhance biodiversity.

The study was purely qualitative and used the backcasting tool as a guiding framework to assess the impacts and suggest actions. A field study on site in western Turkey was performed, where most of the needed data was gathered through interviews and observations from the area in which two cotton fields producing cotton for NJ are situated.

The impacts on biodiversity in the area around the studied fields are large in general, with pollution from industries and intensive agriculture as a dominating factor. However, the direct impacts from the farms that produce for NJ are relatively small in comparison, as several mitigating measures are taken already. Several gaps were identified that describe how the present system differs from a desired state regarding impacts on biodiversity. Based on the gaps, three actions were identified that cover the three areas of education, economy, and collaborative work.

The results indicate that exact monitoring and inventory of species is needed to conclude exact impacts on biodiversity over time in the cotton production, but the general engagement in finding their impacts that NJ show is already said to be important for the area. Moreover, it can be concluded that sourcing NJ's cotton from somewhere else likely would not ease the overall burden on biodiversity in the area, as the impacts could instead increase if another actor uses the land instead.

Keywords: biodiversity impacts, cotton production, agriculture, corporate responsibility, backcasting, field study

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Hanna Comstedt & Alina Ridderstad, Gothenburg, June 2022

# List of Abbreviations

| | |
|---|---|
| Bt | *Bacillus thuringiensis* |
| CBD | Convention of Biological Diversity |
| ES | Ecosystem Services |
| GDPR | General Data Protection Regulation |
| GMO | Genetically Modified Organism |
| GOTS | Global Organic Textile Standard |
| IPBES | Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services |
| IUCN | International Union for Conservation of Nature |
| KBA | Key Biodiversity Area |
| KPI | Key Performance Indicator |
| LP | Leverage point |
| MEA | Millennium Ecosystem Assessment |
| NCP | Nature's Contributions to People |
| NGO | Non-Governmental Organisation |
| NJ | Nudie Jeans |
| UN | United Nations |
| UNSDGs | United Nations Sustainable Development Goals |
| WWF | World Wildlife Foundation |

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# 1
# Introduction

## 1.1 Background

The concept of biodiversity concerns the variety of living organisms on Earth and the ecological complexes they contribute to (Convention on Biological Diversity [CBD], (2006)). It is fundamental for well-functioning ecosystems, and ecosystems and their contributions are, in turn, prerequisites for human life and well-being. However, the increasing supply of food, energy, and materials for human use threatens nature's future capacity of such and numerous other contributions (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], (2019)). IPBES furthermore describes how changes to natural systems, and thereby human-induced biodiversity loss, occur at an unprecedented rate, undermining the fundament on which humanity is dependent.

Agriculture is one of the major causes of biodiversity loss (Erisman et al., 2016). For instance, it causes conversion of natural ecosystems into managed fields, and pollution through use of agrochemicals and fossil fuels. The ongoing replacement of traditional, small-scale farming by intensively managed, large-scale production aggravates the situation further, as such systems support only very low levels of biodiversity (Dudley & Alexander, 2017). Globally, cotton is one of the most commonly grown crops, and its fibres are used extensively for both apparel and furnishing fabrics and in industrial applications (Weigmann, n.d.). Yet, cotton cultivation causes severe impacts on nature, not least due to the extensive use of chemicals and water. As an example, cotton requires the largest amounts of insecticides of all major crops (Weigmann, n.d.). However, an increasing trend of organic cotton production has been observed (Textile Exchange, 2021). Organic cultivation aims at integration of ecological processes to create self-regulating systems with low input of synthetic resources (Textile Exchange, 2016).

Nudie Jeans (henceforth referred to as NJ) is a Swedish values-based denim brand that works extensively with sustainability. The company wants to be a role model in the apparel industry, and criticises the fast fashion norm (Nudie Jeans, 2021). In line with this, they have increased their ambitions regarding biodiversity related issues in recent years. Yet, as a denim brand, NJ is dependent on the continued use of cotton, despite the material's harmful effects on nature. However, only organic cotton is used, of which the majority is supplied by the Turkish company Agrona, which also has a pronounced sustainability profile. As a part of NJ's biodiversity work, the company wants to enhance their understanding of the local impact on biodiversity in the cotton production area in Turkey, and how it can be mitigated.

## 1.2 Aim and research questions

The aim of the study is twofold. Firstly, the aim is to holistically map the impacts of the cotton production on biodiversity in the area where the majority of NJ's organic cotton is produced. Secondly, the study aims at providing suggestions for how NJ can decrease identified negative impacts, and take action to contribute to enhanced biodiversity. The study is further specified through the following three research questions concerning the cotton production area in Turkey:

- What would be a sustainable situation regarding biodiversity?
- What is the current state of NJ's impact on biodiversity?
- What are suitable actions that NJ can take to mitigate potential impacts on biodiversity from the cotton farming?

## 1.3 Delimitations

The study concerns the cotton production step of the supply chain, and, more specifically, the cotton production in western Turkey. This geographic delimitation also applies to the stakeholder interactions, which focus on local actors, apart from the consideration of NJ's perspective, which is done through communication with their Environmental Manager at the Swedish headquarter. Furthermore, no economic or technical judgement of the proposed solutions are made. Lastly, two of the major drivers of biodiversity loss, direct exploitation and invasive alien species, are not considered, since they were found not to be of importance in an earlier study (Wickman, 2021).

## 1.4 Report structure

The report is structured as follows. Chapter 2 gives a more elaborate presentation of the biodiversity concept, including drivers of biodiversity loss and effects of agriculture, and cotton production and its environmental impacts. Thereafter, chapter 3 describes the applied backcasting framework and the methods used within the different steps of the procedure. Next, the studied case of NJ's cotton production in Turkey is described in chapter 4. The results for each backcasting step are presented and analysed in chapter 5, and these as well as the applied methods are discussed in chapter 6. Lastly, the conclusion of the study is presented in chapter 7.

# 2

# State of the art

This chapter presents relevant concepts and information that the following chapters build on. First, biodiversity, drivers of biodiversity loss, and impacts on biodiversity from agriculture are described. Next, cotton production and its effects on nature, especially through use of chemicals and water, as well as organic cotton production are elaborated on.

## 2.1 Biodiversity

The development of natural systems for billions of years has resulted in the conditions seen today, which are crucial to all living beings. The variability within the existing natural environment is the fruit of development and adaptation (CBD, 2000). According to CBD (2006), the term biological diversity (biodiversity) describes "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Further specifications of the three types of biodiversity have also been made (CBD, 2000). The first type concerns genetic differences between individuals of the same species, for instance among crops in a field. The second regards the diversity of the many types of existing species, whose number has been predicted to about 8.7 million (Mora et al., 2011). The final form of biodiversity is that between ecosystems, such as the ecosystems in desserts, forests, or mountains.

Nature provides quality of life to humans through its supply of goods and services (CBD, 2000). These qualities can be communicated through the concept of Ecosystem Services (ES), as done by the Millennium Ecosystem Assessment (MEA, 2005). MEA divides goods and services from nature into the four categories provisioning, regulating, cultural, and supporting, depending on the way in which they contribute to the needs of humans (MEA, 2005). IPBES (2019) presents an alternative way of categorising the provided goods and services through the concept of Nature's Contributions to People (NCP). This concept categorises 18 different contributions into the three main areas of regulation of environmental processes; materials and assistance; and non-material contributions. The introduction of an alternative terminology through NCPs was aimed at adapting the ecological descriptions towards better policy treatment through inclusion of more perspectives (Díaz et al., 2018). The distribution of these goods and services are, however, not equal over the globe, and the "health" of the ecosystems further regulates nature's ability to provide the different goods and services. This study will further on use the more established concept of ES, like most of the literature that it is based on.

### 2.1.1 Biodiversity loss

Global trends in the health of ecosystems, and thus biodiversity, have been declining rapidly recently (IPBES, 2019). A common indicator of biodiversity loss is the increasing extinction rate of species. IPBES (2019) suggests that the number of species currently being threatened means that one million species in total will face extinction. Furthermore, the extinction rate on average for all species is expected to increase in the future to become ten times the extinction rate at the beginning of this millennium (MEA, 2005).

The effects on biodiversity are caused by human alterations of nature, to such extent that for example 59 % of the world's river systems had been anthropogenically fragmented in 2014, and tropical forests are being seriously diminished (IPBES, 2019). Identified direct drivers of this loss of biodiversity are, according to IPBES, land or sea use change (loss or fragmentation of habitats), direct exploitation, climate change, pollution, and invasive species. Moreover, identified indirect drivers of biodiversity loss are linked to values and behaviour regarding for example sociocultural aspects and demographic movements, economic and technological aspects, conflicts, and global epidemics (IPBES, 2019).

As described by IPBES (2019), the consequences of decreased levels of biodiversity are severe due to the close link between ecosystems, ES, and human well-being; the possibility to meet the human needs will decrease as the loss of biodiversity affects nature's goods and services. The effects of decreased health of ecosystems and species are thus destructive for humanity as well, apart from the more direct negative ecological effects. Moreover, the development of the state of the majority of the services has been seen to decline.

### 2.1.2 Biodiversity in agriculture

Agriculture constitutes one of the major drivers of biodiversity loss (Erisman et al., 2016). Dudley and Alexander (2017) describe how it impacts species in a number of complex ways, including conversion of natural ecosystems into managed farmland; intensified management in already since long farmed areas; and emission of pollutants such as agrochemicals and greenhouse gases. They furthermore point out that traditional agricultural practices and small-scale production generally allow for maintenance of higher biodiversity levels, but that they are being replaced by more intensive methods applied in large-scale, monocultural systems. The authors also describe how land sparing and protected areas have been prioritised over action against unsustainable farming measures. However, research that shows the significant magnitude of the offsite effects of intensive farming (Matson & Vitousek, 2006), and questions the notion that intensification leads to reduced agricultural area, calls for change (Byerlee et al., 2014).

As described by Tscharntke et al. (2021), increased diversity in farming systems is fundamental to the restoration of biodiversity and the ES it provides. At farm level, this can be achieved by measures such as increased crop diversification (more heterogeneous crop patterns and longer crop rotations), cover crops that are ploughed into the soil, and agroforestry, i.e. combination of crops and trees (Tscharntke et al., 2021). Moreover, incorporation of so-called landscape elements, such as ditches, hedges, field margins, and ponds, supports local flora and fauna (Erisman et al., 2016). According to M. Balfour, especially native plants play a vital role by providing habitats and food for other native species (personal communication, March 16, 2022). There are also several possible measures for prevention of soil and water quality degradation, for instance filter strips around field edges that trap runoff containing sediment and pollutants, reduced tillage, and to leave residues on the field surface (Tuppad et al., 2010).

However, for biodiversity enhancing practices at farm level to be effective, it is crucial to also consider the landscape perspective (M. Balfour, personal communication, March 16, 2022). The biodiversity in a field or on a farm is dependent on the population and species pool in the area that surrounds it. Therefore, only a limited number of species is anticipated locally, regardless of field or farm management, if the landscape has a simplified structure and thereby cannot support any larger species pool (Tscharntke et al., 2021). Hence, not only the quality of individual landscape elements is important, but also the level of connectivity between different elements (Erisman et al., 2016). In addition to preventing fragmentation, complex landscapes also sustain a more varied set of resources and microclimates, which supports biotic heterogenization and population dynamics (Tscharntke et al., 2021). Yet, high land prices make it economically difficult to allocate land to such seminatural habitats (Grass et al., 2021). Tscharntke et al. (2021) describe how this has led to increased interest in the practice of decreasing the field size to enhance the diversity of the landscape crop mosaic, which also is advantageous for biodiversity. Another significant aspect regarding habitat connectivity, according to M. Balfour, is that fences may severely hinder species' migration (personal communication, March 16, 2022). Moreover, she stressed the importance of biodiversity monitoring for assessment of what species are present in the area, and how they are affected by agricultural activities.

## 2.2 Cotton production and its environmental impacts

Cotton is one of the leading agricultural crops globally, and cotton fibres are used in numerous kinds of fabrics for apparel and furnishing as well as industrial applications (Weigmann, n.d.). Cultivation of cotton comprises 2.4 % of total arable land globally, and while this figure has remained largely unchanged for the last 80 years, yields have increased threefold in the same period of time. This was made possible by measures such as use of pesticides and fertilisers, increased irrigation, and genetic modification of seeds (Grose, 2009). However, yield, as well as fibre quality, are heavily affected by climatic conditions, and thus vary between different regions (Weigmann, n.d.). Likewise, cotton production impacts the environment differently depending on local or regional aspects such as climate, pest incidence, and capital accessibility, but the use of chemicals and water are the most prominent issues. Solutions to both these problems demand insight into the regional conditions, and hence no universal solution is available (Grose, 2009).

### 2.2.1 Chemical use

Several different kinds of chemicals are used in cotton cultivation, such as pesticides and defoliants, which remove the leaves prior to harvest (Grose, 2009). Hence, it contributes substantially to pollution, one of the direct drivers of biodiversity loss according to IPBES (2019). Since cotton is targeted by several hundred insect species, the need for pest control is substantial. This can be achieved by various means, such as carefully selected and timed agricultural practices, selective breeding, or cultivation of genetically modified species, but use of chemical insecticides is considered the most efficient measure (Weigmann, n.d.). Hence, the use is extensive, and 16 % of the global insecticide consumption is linked to cotton cultivation (Pesticide Action Network UK, 2018). In addition to environmental problems such as pollution of water and air and biodiversity loss (Clay, 2004), this has also caused development of resistance which in turn results in even more frequent application of even stronger chemicals (Grose, 2009). The resistance problem applies to herbicides and fungicides as well, and despite efforts to develop chemicals that are more precise and less persistent, cotton pesticides remain among the most toxic agricultural chemicals (Grose, 2009).

### 2.2.2 Water use

Water use is the other often cited environmental issue in the context of cotton cultivation, and the crop is often described as "thirsty". Production of 1 kg of cotton fibre, which is the approximate amount required for one pair of jeans (Grose, 2009), consumes 7,000-29,000 litres of water (Clay, 2004). Additionally, as described by Grose (2009), cotton cultivation contributes to several other water-related problems. Irrigation leads to decreased levels in natural water bodies, and fertiliser and pesticide runoff that reaches freshwater causes pollution. Moreover, water management has a high influence on soil quality, especially regarding salinisation. In some areas, the negative impacts can be reduced through rainfed agriculture, and Grose (2009) also describes how decreased water availability and increased costs have incentivised the development of highly effective watering systems. This has resulted in cotton only requiring moderate amounts of water in some production systems in e.g. Israel and California, the author continues.

### 2.2.3 Organic cotton production

The production of organic cotton has been increasing globally for several years, with India, China, Kyrgyzstan, and Turkey being the largest producers (Textile Exchange, 2021). To be classified as organic, cotton must be grown, processed, and certified in accordance with national or international organic standards. For a final product to be considered organic, the cotton also has to be handled separately from conventional ditto and be possible to trace throughout the supply chain (Textile Exchange, 2016). The aim of organic cultivation is to achieve self-regulating agro-ecosystems where ecological processes are integrated, and farm-derived resources are used instead of synthetic inputs (Textile Exchange, 2016). This demands knowledge about the local ecology, and the ability to adapt the production to beneficially complement the natural system (Guerena and Sullivan, 2003). Good soil health is also a prerequisite for successful organic production. Well-chosen crop rotations, cultivation of adapted species, and mixed cropping systems are some examples of used methods. Moreover, native species are commonly used as border crops, which improves soil fertility, enhances biodiversity, and may contribute to restoration of habitats (Textile Exchange, 2016). Hence, organic production can entail benefits for the wider system, and although an initial yield gap might arise, it has been seen that yields increase over time and as management is enhanced (Forster et al., 2013).

An important objective of organic production is to reduce toxicity by reduced chemical use (Grose, 2009). Therefore, synthetic fertilisers and chemicals such as pesticides, plant growth regulators, and defoliants are prohibited, with a few select exceptions (Wakelyn and Chaudhry, 2009). Natural fertilisers such as manure and compost are allowed, but regarding defoliants, natural alternatives are scarce and other methods for leaf removal, for instance thermal defoliation, must be used (Textile Exchange, 2016). Synthetic pesticides can be replaced by bio- or mineral-based variants, but pest control can also be achieved by e.g. crop rotation, trap crops, monitoring, and hand removal (Textile Exchange, 2016). Moreover, use of the soil bacterium *Bacillus thuringiensis* (Bt), which produces proteins that act as natural insecticides, is approved. It is, however, not allowed to use cotton seeds that have been genetically modified to contain foreign genes, such as the ones that code for the Bt proteins (Wakelyn and Chaudhry, 2009). This ban on genetically engineered varieties and the restricted use of chemicals together work in favour of indigenous species and biodiversity (Textile Exchange, 2016).

As previously described, the extensive use of chemicals and unsustainable water management are the two most prominent environmental issues related to conventional cotton production. However, unlike chemical use, water management is not directly addressed in organic production standards (Kooistra and Termorshuizen, 2006). Despite this, benefits with organic systems have been reported, for instance by farmers in Israel where water use has decreased by 30 %, possibly due to enhanced soil structure and water retention (Grose, 2009). Moreover, the majority of the organic cotton cultivations are rain-fed, which generates substantially lower environmental impact in general than irrigated systems (Kooistra and Termorshuizen, 2006).

# 3

# Methods

In this chapter, the methods applied in the study are described. The study was purely qualitative, and it was structured according to the so-called backcasting method, which provided an overall framework and guided the work. The backcasting approach consists of a series of steps, and it is possible to apply one or several other methods within each step. Further information about backcasting and an overview of the methods used in this study are provided in section 3.1, and in sections 3.2-3.5, more elaborated descriptions of each of the backcasting steps are given.

## 3.1 Overview of methods

As described by Holmberg and Robért (2000), backcasting differs significantly from the commonly employed method of forecasting, in which the past or present is merely extrapolated into the future. In the backcasting approach, one instead starts from a vision of a future desired state and then identifies the steps necessary to reach it, thus likely avoiding transferring current problems into the future. When applied to sustainability issues, this means defining the requirements that describe a sustainable situation, followed by identification of measures to attain those requirements (Holmberg & Robért, 2000). There are several variants of backcasting (Quist, 2007), but this study used the version based on Holmberg (1998). As illustrated in figure 3.1, it consists of four different steps: definition of the desired future state, mapping of the current situation, identification of leverage points (LPs), and formulation of actions. Each step is given a colour in figure 3.1, and these are used throughout the report to indicate the different steps. Step 1 is green, step 2 is blue, step 3 is purple, and step 4 is grey.

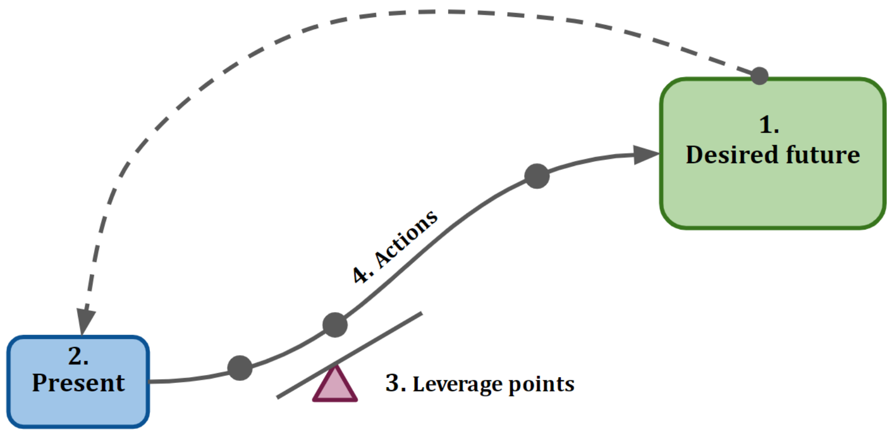


***Figure 3.1:*** *A schematic illustration of the connections between the four steps in the applied backcasting method. The desired future state formulated in step 1 is connected to the present state by actions identified in step 4. These are based on leverage points from step 3, which bridge the gaps identified in step 2. Adapted from Holmén (2020).*

General descriptions of the four stages, and the methods used for them in this study, are presented below. An overview of the process is also provided in the flowchart in figure 3.2.

The first step entails the definition of principles for a sustainable future (Holmberg, 1998). These act as a framework for the subsequent steps, and should be adapted to the context of the organisation in question (Alänge & Holmberg, 2014). Moreover, Holmberg and Robért (2000) stress that the aim is not to formulate principles that describe the desired future state in detail, but to identify guiding principles that can frame several potential futures. This allows for flexibility in the strategies developed later in the backcasting process. In this study, the principles were based on theoretical frameworks on sustainability and biodiversity, and NJ's perspective was taken into account by considering their needs and ambitions as expressed in documents, such as their sustainability report, and in an interview with Environmental Manager Eliina Brinkberg.

In the second step, the present state is described in relation to the sustainability principles by analysing current activities and competences (Holmberg, 1998). Thereby, gaps and challenges that need to be addressed are identified (Holmén, 2020). This was done through a field study on site in the farming area, consisting of visits to two cotton fields as well as interviews with farmers, a representative from NJ's cotton supplier Agrona, and several experts within agriculture and sustainability. The field study was complemented by a literature study, to verify and further develop the gathered data. The collective information was analysed to render a mapping of the current state, which was compared to the sustainability principles to identify gaps.

The third step comprises the envisaging of future options, using the principles from step 1 and the inventory from step 2 as a base (Holmberg, 1998). The aim is to find measures with the potential to bridge the identified gaps, so-called leverage points (LPs) (Holmén, 2020). These LPs are places in the studied system where a small adjustment can cause large changes for the whole (Meadows, 1997). In this study, LPs were identified by review of the gaps and construction of groups of gaps that could be addressed by a common LP.

In the fourth and last step, strategies for moving from the present to the desired sustainable state are formulated (Holmberg, 1998). This is achieved by experimenting with the leverage points from the previous step (Holmén, 2020) and developing a plan with suitable goals and activities that support the transition (Alänge & Holmberg, 2014). This was done by review of the LPs combined with literature research. Information about what kind of suggestions that NJ finds most rewarding, retrieved from a second interview with Eliina Brinkberg, was also considered.

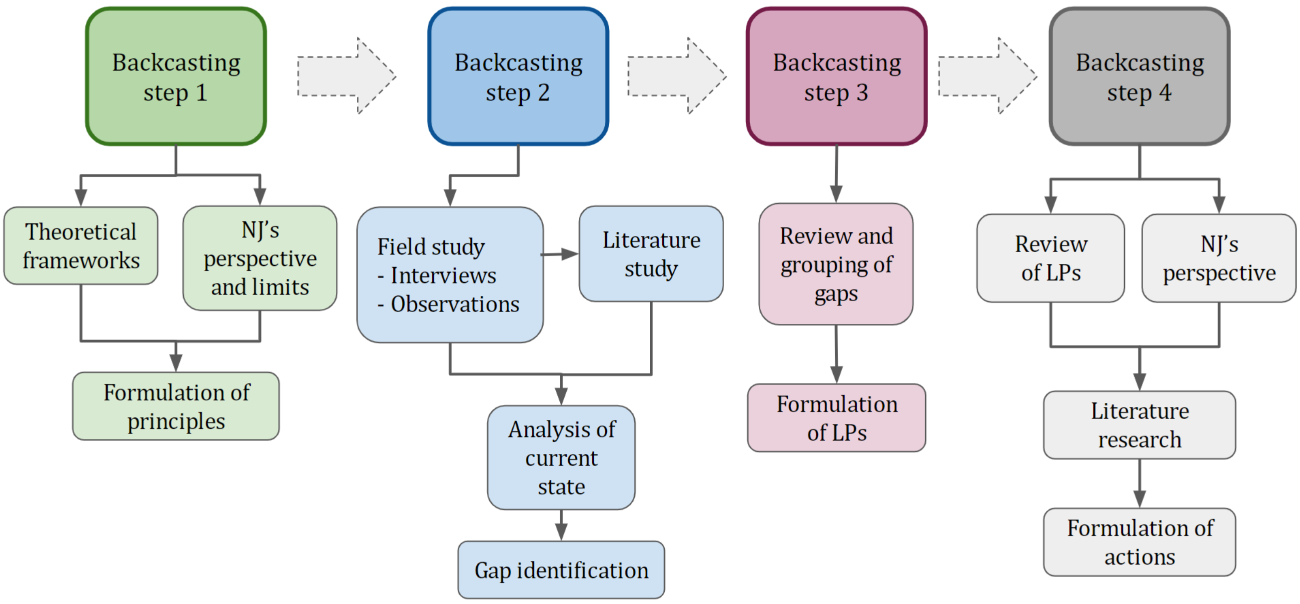


***Figure 3.2:*** *A schematic figure showing the methods used in the four steps of the backcasting framework, illustrating the chronological methodology of step 1 to 4 from left to right.*

## 3.2 Backcasting step 1: Desired future state

In the first step, principles that describe a desired, sustainable, future state regarding NJ's impact on biodiversity in the area were defined. The definitions of the principles were based on both ecological aspects from commonly used sustainability targets, and on NJ's sustainability ambitions and business model. Ethical reasoning around acceptable levels of anthropogenic interventions in nature also played a fundamental role. It was considered important that the ethical reasoning around the guiding principles was done in coherence with NJ's views and priorities, to be able to achieve end-results in line with the company's worldview.

The search on the desired ecological setting was done by the authors by considering theoretical frameworks on sustainability in general and ecology in particular. The used frameworks were the Global Assessment Report on Biodiversity and Ecosystem Services (IPBES, 2019), the United Nations Sustainable Development Goals (UNSDGs) (United Nations, n.d.-h), the Aichi targets (CBD, n.d.), and the Sustainability Lighthouse model (Holmberg & Larsson, 2018). From these, aspects to be considered in the principles were extracted and put together thematically by the authors into nine preliminary areas. These covered all three dimensions of sustainability, i.e., ecological, social, and economic aspects. The nine preliminary areas were then formulated into principles by the authors. The principles describe how to produce cotton sustainably in relation to natural systems and human needs. More specifically, they were formulated in relation to the question "What would be a sustainable situation regarding biodiversity in cotton production in Turkey?".

The assessment of NJ's desired position in the matter was done firstly by the authors studying the company's sustainability report and other published documents, extracting NJ's ethical reasoning and limits for allowed anthropogenic intervention in nature. This was used by the authors as a starting point in a semi-structured discussion with Eliina Brinkberg, Environmental Manager at NJ. The aim of this discussion was to verify the authors' understanding of NJ's ethical standpoint and frames of reference, and to discuss the nine preliminary guiding principles. The final formulation of the desired future state was done by the authors. This stage consisted of summarising the findings from the theoretical frameworks and NJ's reasoning and priorities. The company's input on the desired future state was implemented into the principles by the authors. Moreover, the number of principles was narrowed down to seven, to create clarity in the complete description of the desired state. The summarised results constituted a final collection of seven non-overlapping principles that together describe the desired state regarding biodiversity in the area.

## 3.3 Backcasting step 2: Current state and gaps

In the second step, the current situation regarding biodiversity in the studied area was mapped, and gaps between this and the desired state were identified. A field study on site in the production area, consisting of interviews and observations, was combined with a literature study to collect data regarding how the production is performed, its effects on nature and biodiversity, and the context in which it takes place. Regarding the context, examples of relevant aspects were other human activity in the area (e.g. industries, roads etc), the natural ecosystems surrounding the cotton fields, and the level of biodiversity knowledge and awareness among especially the farmers. The data collection was performed inductively, i.e., data was gathered and then used in a subsequent formulation of concepts (Yin, 2016), and both methodological and data triangulation were strived for. Methodological triangulation (i.e. implementation of more than one method for study of an issue (Bekhet & Zauszniewski, 2012)) was achieved by the combination of interviews, observations, and a literature study. This approach also facilitated data triangulation, which is described by Yin (2016) as seeking convergence between data from at least three independent sources, preferably of different kinds such as verbal accounts, observations, and written documents. Below, the field and literature studies as well as the data analysis and gap identification procedures are further described.

### 3.3.1 Field study

As mentioned above, the on-site field study consisted of interviews and observations. First, a basic pilot study was performed. The purpose was to prepare for the actual field study by gathering information about the cotton production area, how biodiversity is affected by agriculture in general, and what agricultural measures that can be implemented to increase biodiversity. This was done through informal literature research and discussions with two biologists. The information was then used to formulate relevant questions to ask in the interviews, and to prepare for the assessments of the fields. During the field study, handwritten or digital notes, depending on what was most convenient, were taken to record the findings from both parts. These were, as Yin (2016) recommends, continuously refined and summarised, to evaluate the adequacy of the data. This also enabled recursivity, a cyclical process of repeatedly analysing collected data to e.g. identify new areas of interest (Leech & Onwuegbuzie, 2008). In this section, the methodologies used for the interviews and observations are described.

**Sampling of interviewees**
Interviewees were identified by a combination of purposive (aiming at large variety in information and perspectives) and snowball sampling (finding additional interviewees based on information from interviews) (Yin, 2016). NJ brought the authors into contact with the Sales and Marketing Manager at the cotton supply company, Agrona. In addition to participating in interviews himself, he also arranged meetings with cotton farmers that produce for NJ. An initial search for experts and organisations working within biodiversity and related topics was also made. Relevant actors were approached via email and given information about the study and how they could contribute. However, they either did not respond or declined to participate due to workload issues etc. Instead, NJ's network provided valuable initial contacts. The project was introduced to an expert working for the organisation Textile Exchange, who brought in other relevant actors. Moreover, a Turkish soil scientist was introduced via another of NJ's contacts. He made a great effort in inviting a number of scientists and other experts within the fields of agriculture, ecosystem services, and biodiversity to a digital meeting, which resulted in several individual follow-up interviews. When deemed relevant, the interviewees were also asked for other actors to contact, yet this approach only resulted in one additional interview. A summary of all interviewees and clarifications of their roles are provided in table 3.1. Since it was not possible to derive the answers in the interviews with the farmers to a specific individual, due to the format of these interviews (see further below), they are referred to jointly in the remainder of the report.

*Table 3.1: Presentation of the interviewees and their roles*

| Interviewee | Role |
|---|---|
| Representative from Agrona | Sales and Marketing Manager at Agrona, member of the board of directors |
| Farmers | Cotton farmers producing for NJ |
| Soil scientist | Professor at Adnan Menderes University, Faculty of Agriculture (soil specialist) |
| Agricultural researcher | Researcher within agricultural economy and environmental policy at the Turkish Ministry of Agriculture and Forestry |
| Biodiversity specialist | Biologist working in wildlife conservation and sustainable development, Biodiversity Specialist at Textile Exchange |
| Environmental consultant | Consultant working in environmental economy and nature conservation |
| Cotton researcher | Cotton researcher at Nazilli Cotton Research Institute |
| Representative from WWF Turkey | Freshwater Specialist at WWF Turkey |

**Interview procedure**

The interviews were semi-structured with mostly open-ended questions and allowing for follow-up questions. As proposed by Adams (2010), they evolved around the main topic, but were permitted to take unexpected directions if relevant information was revealed. Therefore, no strict questionnaires were used, but a research protocol was prepared and used to guide each interview. As Adams (2010) suggests, the protocol described the line of inquiry but did not state all specific questions to be posed. The protocol was adjusted prior to each interview according to the knowledge the interviewee was assumed to have, and the relevance of the topics was then reassessed during the interview. Hence, prepared questions were sometimes excluded in the interviews while new ones were added. An example protocol is presented in appendix A. When possible, the interviews were held in person, but some were conducted digitally using Zoom or Microsoft Teams. Not least, this was the case for the interviews that were performed after the authors' visit in Turkey due to the limited time frame of the visit. Moreover, some interviewees were contacted again via email for clarifications or further information after the interview. In some instances, interviewees also provided written documents in addition to the information conveyed during the interview.

To comply with the European Union's General Data Protection Regulation (GDPR) (European Commission, n.d.), a consent form was created that described how personal data was to be handled and informed the interviewees of their right to withdraw from the project, receive further information etc. The document was also translated into Turkish by a person proficient in both English and Turkish, to enable all participants to make informed decisions on whether they wanted to take part. When interviews were held digitally, oral consent was given instead. Some interviews were recorded, either as an audio recording on a mobile phone or by using the recording function in Zoom, again with the interviewees' permission. Recordings were not made if, for instance, the soundscape was too noisy or the meeting was an introduction rather than a formal interview. However, in all interviews regardless of whether a recording was made, one interviewer was responsible for taking notes while the other led the inquiry.

In general, the interviews were made with one participant at a time, but the interviews with the cotton farmers deviated from this format. In the first session, two farmers who had formed a business partnership were the official interviewees, yet several other persons, mostly neighbouring farmers, were present in the room and contributed to the discussions. As the farmers were not proficient in English, the representative from Agrona acted as translator. As he related the authors' questions to the interviewees, a discussion between several of the assembled persons often followed, especially if a question was broad and/or speculative. The representative then summarised the answers and reflections in English, sometimes adding information about the context to explain the interviewees' reasoning. Hence, a long discussion was sometimes condensed into a few sentences, or a short answer was elaborated on and clarified. Moreover, two other students performing a separate project for NJ on social aspects were present as well. Their questions were of limited relevance for this study, but some useful information was gathered from the provided answers. The second farmer interview session was performed in a similar way, although a single farmer was officially interviewed and only two additional persons were present.

**Direct and indirect observations**
Direct observations of the farming practices and the state of biodiversity in the production area were mainly done during the visits to two different fields used for production for NJ. Since the field study was conducted in March, no cotton was grown at the time, but observations of how the fields were used, how they related to surrounding natural and managed areas, and features of the wider landscape were made. The first field could only be studied from a distance, since it was separated from the road by a canal, and no English-speaking person was present to make explanations or answer questions. Another field visit was therefore requested, during which the field could be directly accessed and both the farmer who owned the field and the representative from Agrona were present. Hence, additional questions could be asked to better understand the observations and relate them to the information provided in interviews. All observations from the visits were recorded as written notes, voice memos, photographs, and/or video recordings. Pictures of observed plants were later used for species typing via the application iNaturalist. A storing

and spinning facility and a ginning facility were also visited. Although these activities were not assessed in this study, some useful information was extracted from the conversations held during the visits. Moreover, direct ocular assessments during site visits were complemented by some indirect observations of the overall system function, described by Yin (2016) as being observant and listening between the lines. For instance, the way in which people acted and their understanding of and interest in different topics were noted. Indirect observations could thus be made during both site visits and interviews.

### 3.3.2 Literature study

The literature study was performed after the field study with the purpose of verifying and developing the data collected during interviews and field visits, and assessing whether the different aspects of the cotton production have positive or negative impact on biodiversity. Verification was especially important when information was perceived as controversial, or the interviewee could be considered as partial or expressed opinions rather than facts. Occasionally, contradictory information was given by different interviewees, which also demanded additional data collection from other sources. Development of field study data was necessary e.g. when a topic was mentioned only briefly in an interview and its relevance needed to be assessed, or if it was considered especially relevant and further information would be useful. Regarding assessment of the biodiversity impact from different production aspects, references were used in the cases where it was not immediately obvious whether a feature is beneficial for biodiversity or not. For all three parts of the literature study, initial search words were identified from the field study data. Then, the citation pearl growing strategy was applied, i.e., new, possibly more specific, search words were identified in the documents found in the first round, and these were subsequently used in a new search round (University of Oulu, n.d.).

### 3.3.3 Analysis

The analysis procedure used for the field study data was based on the stepwise but iterative analysis method described by Yin (2016), and the information from the literature study was included in the last step. The steps, and descriptions of how they were performed in this context, are presented below.

In the first step, the gathered data is compiled into what Yin (2016) describes as a data base. This was done based on person and chronology, i.e., all information received from each interviewee was gathered in chronological order (if the person was contacted more than once) in a single document. The information and impressions from the field visits were also reviewed and formally ordered.

The second step is a disassembling process in which the data is coded, to methodically start bringing the data to a slightly higher conceptual level (Yin, 2016). For this, the compiled data was colour coded: individual sentences or longer arguments were assigned different colours representing various topics. These were formed in an inductive way by constructing new topics, and relating them to a colour, continuously during the disassembling process. In total, 40 different topics were identified.

In the third step, the data is reassembled and brought to an even higher conceptual level, to identify themes and theoretical concepts (Yin, 2016). This was achieved by assembling all sentences or arguments assigned to the same colour, and summarising the topic that it represented. Based on these summaries, patterns and connections between the topics were sought for. The patterns and connections were then, in turn, used to group the topics and form ten broader areas.

The fourth step is interpretation of the data to arrive at a description of the current state (Yin, 2016). When creating this narrative, the field study data for each of the areas formed in the previous step was combined with the information from the literature study. From the ensuing description of the current situation, positive and negative aspects for biodiversity were identified for the ten areas.

### 3.3.4 Gap identification

As the final part of the second backcasting step, gaps were identified by comparison of the description of the current state to the sustainability principles formulated in step 1. All positive and negative aspects for the ten areas were reviewed and linked to one or several principles (see appendix B). For each principle, these summarised findings were compared to the sustainable situation described by the principle, and gaps were formulated based on the discovered discrepancies. Any number of gaps could theoretically have been formulated, but considering the scope of the study, it was limited to one or two per principle depending on the amount of collected data. In total, nine gaps were identified.

## 3.4 Backcasting step 3: Leverage points

In the third step of the backcasting process, LPs for moving from the current to the desired state, i.e. to overcome the previously identified gaps, were identified. The identification was done by first reviewing the treated data and the final gaps in a broad brain-storming process on possible areas of intervention. This was done by the authors in a process where the gaps were grouped based on whether they were judged to concern the same areas of intervention. Following this was a phase of narrowing down the number of groups to a manageable amount within the scope of the study. For each group, one LP formulated as a question about how to bridge the specific gaps was identified. These were to be answered in the next step, where actions were identified. The selection of groups and subsequent LPs was done by the authors based on the LPs' judged potential to be used to formulate concrete actions. In total, three LPs were created, covering seven of the nine gaps. Since the selection was done to focus on feasibility and potential for actions, the authors did not strive to cover all gaps but rather to include the most important ones. The included groups of gaps were considered to have the largest potential to result in concrete actions that are well adapted to NJ's operations.

## 3.5 Backcasting step 4: Actions

The fourth and last step entailed the development of the LPs into concrete suggestions for how NJ can act to decrease the negative impacts on and support biodiversity in the area. The LPs were reviewed in a new brainstorming process to formulate actions, and the focus was especially on gathered suggestions from interviewees. These were deemed to have particular potential to achieve changes in the system, since the initiatives already are established in the area. NJ's perspective was included in this step through a semi-structured conversation with Environmental Manager Eliina Brinkberg about possible actions. The results from this were incorporated into the procedure of creating actions to make sure that the actions would be practical for NJ's business and working procedures. Moreover, literature research was done around the subjects of the LPs to create the final formulation of the actions. For each LP, the authors suggested an action that was judged to have the potential to bridge the gaps addressed by the LP and to be feasible for NJ.

# 4

# Case description

This chapter presents the case that was studied. First, a general description of the cotton production area is provided, followed by descriptions of the two fields that were visited during the field study. Thereafter, NJ is presented and its cotton supply chain, with focus on Agrona, and local collaborations are described.

## 4.1 The area

The area in which most of NJ's organic cotton is grown is located on the west coast of Turkey close to the Aegean sea, which is part of the Mediterranean basin (Britannica Academic, n.d.). The area in focus can be seen in figure 4.1. The region close to the sea is referred to as the Aegean region and a categorising factor is the overarching similarities in climate. The region belongs to the Mediterranean forest biome, which is characterised by hot, dry summers and cold, wet winters (WWF, n.d.).


*Figure 4.1:* *Map of Turkey, with the studied area indicated by a red circle. Retrieved from Google, https://www.google.se/maps, 2022.*

The area is considered to be ecologically unique, as it is part of an ecological hotspot. The hotspot contains highly distinctive flora and fauna and is especially diverse (Critical Ecosystem Partnership Fund, 2017). One of several factors determining the diversity is the many types of soils in the area. Some soils are, for instance, high in lime and thus supply large amounts of alkaline substances which support certain plant growth, while other soils have lower levels of alkaline substances and support other plants, as described by Critical Ecosystem Partnership Fund (2017). Moreover, the organisation mentions that the unique area has developed a relatively high level of endemic species, which are restricted to this geographical area. Among these are plants, birds, and larger mammals that all are dependent on the special conditions in the area (WWF, n.d.). Moreover, another indicator of the region's special conditions is the relatively high concentration of so-called Key Biodiversity Areas (KBAs), which are areas with large amounts of species of high diversity (Critical Ecosystem Partnership Fund, 2017). However, the hotspot is considered to be in critical conservation condition and most larger mammals are endangered, according to WWF (n.d.). WWF also highlights that the factors that pose threats to the ecosystems are for example frequent fires, continued agricultural practices, and extension of urban areas. The ecosystems in the region have developed alongside humans historically according to Critical Ecosystem Partnership Fund (2017), and equilibrium has been reached in the landscape including human interactions dominating in the landscapes. This balance between humans and ecosystems is, however, intricate and in a precious state since it is challenged by the human need for ES. The dependence on habitats and resources in the area is high, particularly on freshwater in the otherwise water-stressed landscape, where reservoirs are important as well as filtrating capacities of geological materials and vegetation (Critical Ecosystem Partnership Fund, 2017).

The two fields that were studied are located close to Izmir, the third largest city in Turkey. Moreover, the studied area, and the Mediterranean area in general, is characterised by intensive agriculture, according to the agricultural researcher. It is also very common that agricultural areas are surrounded by heavy industries. More specifically, the fields are located in two different plains separated by mountains, but the areas and their environmental problems are very similar according to the environmental consultant. The following sections describe the visited fields' similarities and differences in more detail.

### 4.1.1 The fields

The first field that was visited was located close to a town called Söke in the Aydin province. The field has recently been included in NJ's production. In figure 4.2, field 1 and its surroundings are presented from a satellite perspective, with field 1 marked with an x. As can be seen, the field is one among many others in a large area of agricultural land that is referred to as the Söke Plain. The Söke Plain has a total area of 400 km$^2$ and stretches from the coast of the Aegean Sea and inland (Küçüksümbül et al., 2021), and the Söke area consists of 98 % agricultural land according to the representative from WWF Turkey. The production is mostly focused on cotton, but maize, sunflowers, olives, figs, and chestnuts are also produced, according to the soil scientist and the representative from Agrona. The latter elaborated that the Söke area together with an area close to the Syrian border are the most important cotton producing areas in the country. However, not all cotton production in Söke is organic, according to the interviewed cotton researcher.

The plain is very flat, and with its higher mountains or hills along the sides, it constitutes a large valley. The soil scientist explained that the large Menderes River, which is 560 km long and reaches the sea in the Söke area, runs through the plain. Along the river, several sensitive habitats of many endangered species, such as the European eel, are located and since it is a wetland there are many endangered bird species, according to the representative from WWF Turkey.

***Figure 4.2:*** *A satellite picture of field 1 (marked by an x) from a landscape perspective. Retrieved from https://parselsorgu.tkgm.gov.tr/, 2022.*

The second field that was visited had been used for production for NJ since last season, according to the representative from Agrona. He described the field's size of 10 ha as average in comparison to other fields producing for Agrona, but small for a cotton field in general. The field was located in another agricultural area north of the Söke plain, close to the town Torbalí in the Izmir province. Like field 1, the second field was located in a larger area of agricultural production, as can be seen in figure 4.3 where a satellite photo of field 2 is shown. This area is located in another water basin and centred around a river called Küçük Menderes River, as explained by the environmental consultant. Characteristic for the Torbalí area is, according to the representative from Agrona, the very fertile soil, which explains the intensive agricultural practices.

***Figure 4.3:*** *A satellite picture of field 2 (marked by an x) from a landscape perspective. Retrieved from https://parselsorgu.tkgm.gov.tr/, 2022.*

## 4.2 The company Nudie Jeans

Nudie Jeans is a Swedish denim brand founded in 2001, with the aim to create a brand built on values where environmental aspects and human rights are taken into account throughout all operations (Erixon, 2019). In line with this, the company's vision is to become the most sustainable actor in the sector, and its business model challenges the norm of fast fashion (Nudie Jeans, 2021). For instance, customers are offered free repairs and the possibility to hand in old jeans, which are sold second-hand or recycled, and receive a discount on a new pair (Nudie Jeans, n.d.-a, n.d.-d). The largest environmental impact occurs in the raw material and fabric production, over which NJ does not have direct influence since these steps of the supply chain are performed by external actors (Nudie Jeans, 2021). Hence, the company selects suppliers carefully and values long-term relationships (Nudie Jeans, n.d.-c), and audits are performed regularly (Nudie Jeans, 2021). Moreover, all cotton, which comprises approximately 94 % of NJ's total fibre use, is organically sourced, mainly from Turkey (Nudie Jeans, 2021). The company's Turkish cotton supply chain and partnerships with external organisations are described further in sections 4.2.1-4.2.3.

Despite being at the forefront regarding sustainability work, NJ has paid relatively little attention to its impact on biodiversity. The issue has, however, been studied in previous Master's theses. Phan (2021) concluded that NJ, although not working extensively with biodiversity impact mitigation, shows an interest in engaging more directly and increase the company's knowledge within the field. This interest was deemed to result from NJ's own risk awareness, as well as the rising attention within the fashion industry as a whole about the need for mitigation of biodiversity loss. Wickman (2021) studied the impact on biodiversity from NJ's fibre production, arriving at the conclusion that overexploitation and invasive species are less important drivers than land use, pollution, and climate change in this specific context.

### 4.2.1 Actors within NJ's supply chain

This section describes NJ's supply chain for organic cotton in Turkey based on information from internal company documents (Nudie Jeans, 2017, 2022), or received from Eliina Brinkberg at NJ or the representative from Agrona. The cotton is produced by individual farmers owning their land. After harvest, the untreated cotton is transported to a ginning facility for separation of the cotton fibres from leaves and seeds. For traceability reasons, each farmer only delivers to a single ginner. The cleaned cotton is compressed and packaged in bales, which are bought by NJ's cotton supplier, Agrona. The cotton is stored in Agrona's warehouses until it enters the spinning process, in which the fibres are spun into threads. These are sold to NJ's fabric suppliers, where the weaving, dyeing, and finishing processes take place. This marks the end of the Turkish supply chain, as the fabric is then sold to manufacturers in other countries, who perform the sewing and further processing of the fabric into finished garments.

The supply chain is illustrated in figure 4.4. This study focuses primarily on the first part of the supply chain, i.e., the farmers and their activities, since the largest effects on biodiversity occur here. Some regard is also given to Agrona in general, but the ginners' and fabric suppliers' operations have not been studied.

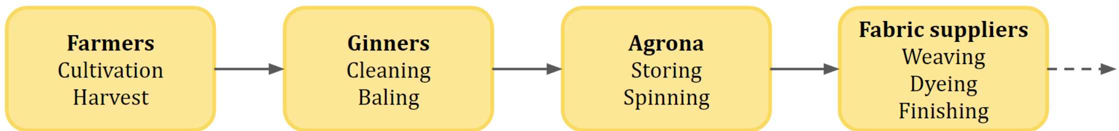


***Figure 4.4:*** *Illustration of the actors in NJ's Turkish cotton supply chain, with the arrows connecting them representing transportation. The dashed arrow farthest to the right indicates that the cotton leaves the Turkish part of the supply chain.*

### 4.2.2 Agrona

The following information about the cotton supplier Agrona is retrieved from the company's Sales and Marketing Manager and its Quality Manual (Agrona, 2020). Agrona is owned by the local family business Uçak Tekstil, which also owns another cotton supply company, Egecot. Agrona has been active in the cotton industry for more than 40 years, and now has both national and international companies among their customers. The company strives for long-term customer relations, and works actively with supply chain traceability and transparency. According to the vision and mission statements in the Quality Manual, Agrona aims for sustainability throughout the production, addressing all three dimensions of sustainability (social, economic, and ecological). For instance, the importance of a decent living standard for the farmers is underlined, and the company applies forecasting each season, meaning that the customers inform Agrona about their needs before the cotton is sown, and pay the farmers in advance. Moreover, a project for transition to organic production was initiated ten years ago, and since five years, all farms producing for Agrona are organically certified. This is motivated by the company's claimed purpose of making a positive contribution to the health of humans, animals, and the environment.

### 4.2.3 Collaborations

As an essential part of their sustainability work, NJ engages in several industry collaborations concerning environmental as well as social aspects in all of the company's operations (Nudie Jeans, n.d.-e). With regard to environmental issues in the Turkish organic cotton supply chain, the two most important partnerships are those with Textile Exchange and Control Union Certifications (Nudie Jeans, 2022). Textile Exchange is a non-profit organisation aiming at achieving a more sustainable textile industry globally. This is done by inspiring and empowering actors to implement sustainable practices, to minimise the industry's destructive impacts and maximise its advantageous contributions (Nudie Jeans, n.d.-b). Control Union Certifications is the organisation responsible for certifying NJ's organic cotton according to the Global Organic Textile Standard (GOTS), which is an internationally renowned certification for organic textiles (Control Union Certifications, n.d.). It contributes to the assurance that the production complies with the 17 UNSDGs by putting strict requirements on the production through the entire supply chain (GOTS, n.d.-b). Examples of demands put on the cotton supply chain include presentation of evidence that the cultivation is performed according to an organic production standard, assurance that organic and conventional fibres are kept separate to prevent contamination, and demonstration of proper transportation documentation (GOTS, n.d.-a, n.d.-c).

# 5
# Results and analysis

This chapter presents the results and analysis of each step in the backcasting process. First, the sustainability principles for a desired future state are accounted for. Then, a description of the current situation based on the field and literature studies is provided, as well as found gaps between the current state and what is considered sustainable. Next, the leverage points that were identified as possible ways to bridge the gaps are described. Lastly, suggested actions for NJ to take are presented.

## 5.1 Backcasting step 1: Desired future state

In the first step of the backcasting procedure, the following seven sustainability principles were formulated:

- Sustainable agricultural management
- Sustainable production and consumption, and efficient resource use
- Sufficient financial support for biodiversity
- Extensive knowledge and widespread awareness of biodiversity values
- Well-functioning collaborations and transparent communication
- Well-functioning ecosystems and habitats
- Minimised biodiversity loss caused by human activity

In sections 5.1.1-5.1.7, each principle is described further, and the references that their different components are based on are presented in tables 5.1-5.7.

### 5.1.1 Sustainable agricultural management

The first principle relates to the agricultural measures used in the cotton cultivation, and their impact on the surrounding environment. Sustainable is a relative term, but to be considered sustainable according to CBD, UN, and IPBES, the agricultural management should safeguard biodiversity and protect terrestrial and aquatic ecosystems and the services they provide. Further land and soil degradation should be prevented and already degraded areas should be restored, and water resources should be used in an efficient way. Moreover, pollution of air, soil, and water caused by agricultural chemicals and excess nutrients should be decreased to levels that do not harm the function of ecosystems and biodiversity. For references, see table 5.1.

***Table 5.1:*** *Presentation of the components of the first principle, Sustainable agricultural management.*

| **Principle 1** | |
|---|---|
| **Component** | **References** |
| Sustainable management of areas used for e.g. agriculture to safeguard biodiversity | CBD (n.d.) |
| Sustainable use of terrestrial and inland freshwater ecosystems and their services | United Nations (n.d.-c) |
| Restoration measures targeting land and soil degradation | United Nations (n.d.-c) |
| Water use-efficiency, protection of water-related ecosystems and their services | CBD (n.d.) and United Nations (n.d.-f) |
| Chemical and nutrient pollution of air, soil, and water decreased to levels that do not harm natural systems | CBD (n.d.), IPBES (2019), and United Nations (n.d.-a, n.d.-b, n.d.-e, n.d.-f) |

### 5.1.2 Sustainable production and consumption, and efficient resource use

The second principle concerns taking responsibility for the effects of production and consumption, and using resources efficiently and modestly. Again, the view on sustainability is adopted from CBD, UN, and IPBES. The impacts of resource use should not exceed ecological limits, and the economic growth related to production should be decoupled from ecological degradation. Moreover, consumers should be well-informed about the link between lifestyle choices and impact on nature. Decoupling and consumer involvement were highlighted by Eliina Brinkberg at NJ as topics that the company already works extensively with. For references, see table 5.2.

***Table 5.2:*** *Presentation of the components of the second principle, Sustainable production and consumption, and efficient resource use.*

| **Principle 2** | |
|---|---|
| **Component** | **References** |
| Efficient and modest resource use to not exceed ecological limits | CBD (n.d.) and United Nations (n.d.-a) |
| Economic growth decoupled from ecological degradation | IPBES (2019) and United Nations (n.d.-g) |
| Well-informed consumers | United Nations (n.d.-a) |

### 5.1.3 Sufficient financial support for biodiversity

The third principle addresses the need to allocate adequate financial resources to initiatives beneficial for biodiversity to incentivise them, while harmful activities are disincentivised and phased out. It is connected to the other principles, indicating a degree of overlap, but since financial capital has a prominent role in today's economy, and its management has significant long-term effects, it was kept as a separate principle. Thus, its importance is underlined and oversight of it in later backcasting stages is avoided. For references, see table 5.3.

***Table 5.3:*** *Presentation of the components of the third principle, Sufficient financial support for biodiversity.*

| **Principle 3** | |
|---|---|
| **Component** | **References** |
| Allocation of financial resources to biodiversity initiatives | CBD (n.d.), IPBES (2019), and United Nations (n.d.-d) |
| Financial management has short- and long-term effects | Holmberg and Larsson (2018) |

### 5.1.4 Extensive knowledge and widespread awareness of biodiversity values

The fourth principle relates to the level of knowledge and awareness regarding biodiversity among all different actors. Specifically, knowledge about biodiversity values, the state of ecosystems (via monitoring), and the consequences of biodiversity loss is required. This knowledge should be complemented by considerable awareness of sustainability in general and biodiversity in particular. Thus, the actors would have good understanding of both the need for action, and how to intervene. For references, see table 5.4.

***Table 5.4:*** *Presentation of the components of the fourth principle, Extensive knowledge and widespread awareness of biodiversity values.*

| **Principle 4** | |
|---|---|
| **Component** | **References** |
| Knowledge about biodiversity values, ecosystem health, and consequences of biodiversity loss | CBD (n.d.) and United Nations (n.d.-a, n.d.-c) |
| Awareness of sustainability and biodiversity values | SDG12, SDG13, Aichi |

### 5.1.5 Well-functioning collaborations and transparent communication

The fifth principle concerns the need for cooperative management of information and knowledge about biodiversity, and transparent reporting on biodiversity impacts of actions. Thus, all actors would have access to relevant information and be able to make educated choices. Other central aspects are stakeholder interaction and partnerships, to enable coordinated efforts. For references, see table 5.5.

***Table 5.5:*** *Presentation of the components of the fifth principle, Well-functioning collaborations and transparent communication.*

| **Principle 5** | |
|---|---|
| **Component** | **References** |
| Transparent reporting | United Nations (n.d.-a) |
| Stakeholder interaction and partnerships | United Nations (n.d.-c, n.d.-d) |

### 5.1.6 Well-functioning ecosystems and habitats

The sixth principle acknowledges the fundamental role of healthy ecosystems and adequate habitats for biodiversity conservation, and the fact that land use change is a direct driver of biodiversity loss. Therefore, restoration of ecosystems and their resilience and reduction of habitat degradation and fragmentation are vital. However, as Eliina Brinkberg at NJ desribed, the company is dependent on the cotton supply to continue its business, so the fields cannot be completely restored to their original, natural state. Hence, "well-functioning" was chosen, rather than e.g. "fully restored". For references, see table 5.6

***Table 5.6:*** *Presentation of the components of the sixth principle, Well-functioning ecosystems and habitats*

| Principle 6 | |
|---|---|
| **Component** | **References** |
| Ecosystems and habitats are prerequisites for biodiversity, and land use change is a direct driver of its loss | IPBES (2019) |
| Restoration of ecosystems, reduced habitat degradation and fragmentation | CBD (n.d.) and United Nations (n.d.-c) |

### 5.1.7 Minimised biodiversity loss caused by human activity

The seventh principle directly addresses biodiversity. Biodiversity loss occurs naturally, but human impacts on natural systems should not be the cause of biodiversity loss and species extinction. Moreover, genetic erosion should be minimised, to maintain genetic diversity. Yet, NJ's business perspective must be considered, and the impacts of the cotton production on nature and biodiversity cannot be completely eliminated. The company also intends to limit its commitment to the direct, local effects of the production, according to Environmental Manager Eliina Brinkberg. Therefore, the principle concerns minimising, and not halting, biodiversity loss. For references, see table 5.7.

***Table 5.7:*** *Presentation of the components of the seventh principle, Minimised biodiversity loss caused by human activity.*

| Principle 7 | |
|---|---|
| **Component** | **References** |
| Reduced human impact on nature and biodiversity | United Nations (n.d.-c) |
| Prevention of species extinction | CBD (n.d.) |
| Maintained genetic diversity | CBD (n.d.) |

## 5.2 Backcasting step 2: Current state and gaps

In this section, the mapping of the current situation regarding impacts on biodiversity in the cotton farming is presented. The results are based on interviews, observations, and literature, and have been divided into ten different areas. First, the results from the field visits are given in sections 5.2.1 and 5.2.2 as descriptions of the observations made on site. Thereafter, presentations of the results for each of the remaining areas of analysed data are provided in sections 5.2.3-5.2.10. All ten areas have been assigned a colour for communicative purposes and to guide the reader. These colours are shown in 5.1.

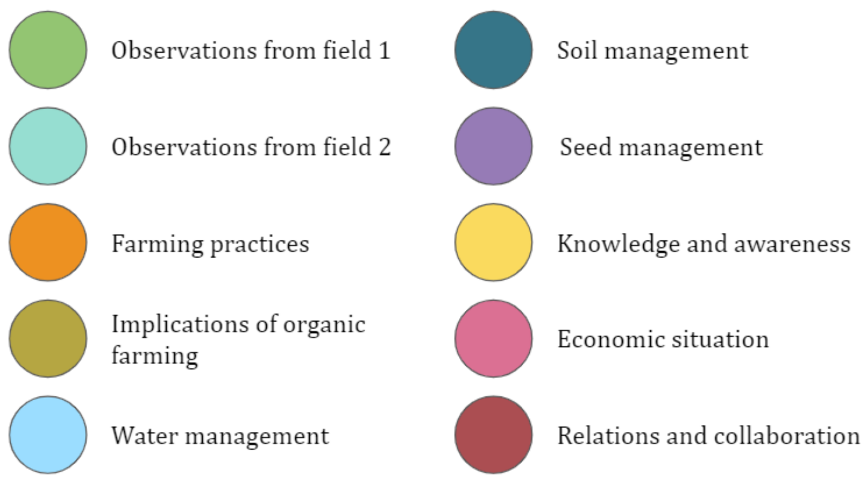


***Figure 5.1:*** *Presentation of the colours assigned to the ten areas of the mapping.*

For each section, the extracted results of positive and negative impacts on biodiversity are given in a table. The same aspect can be found in several tables or sections, if they are judged to contribute to more than one area's impacts. The references used for the valuation behind the categorisation of each of the aspects as positive or negative are given as footnotes in the tables. Moreover, each bold part of the text in sections 5.2.3-5.2.10 refers to an aspect in each section's table so that it is easy to follow the extracted aspects in the text.

### 5.2.1 Observations from field 1

The direct observations from the visit to field 1 are given in this section, related to the positive and negative aspects of the field's impacts on biodiversity given in table 5.8.

***Table 5.8:*** *Positive and negative aspects for biodiversity concerning the observations from field 1.*

| **Observations from field 1** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| On a landscape level, hills/mountains with natural or semi-natural ecosystems surround the plain [1] | Observed natural vegetation close to the field is relatively limited [3] |
| On a landscape level, some trees and other natural vegetation intermixed between the fields and roads, to a larger extent than around field 2 [1] | Relatively large field among very many other monocultural fields, a large plain on a landscape level [2, 3] |
| No fences [2] | The field area is enclosed by smaller and larger roads, potentially limiting animal migration [2, 3] |
| Small filter strip with naturally growing plants between the field and the canal [1] | Few larger areas with natural vegetation among the fields [1] |
| Some natural vegetation on a somewhat broader strip separating the field from the adjacent one [1] | Heavy industries in the area [4] |
| Grass cultivated in the field and presumably cotton residues left between seasons [1] | |
| Some natural vegetation close by the field, and some diversity among plant species [4] | |

[1] Tscharntke et al. (2021), [2] The interviewed biodiversity specialist, [3] Erisman et al. (2016), [4] IPBES (2019)

The direct surrounding of field 1, located in the Söke plain, can be seen in figure 5.2. The landscape around field 1 was rather homogeneous and **few larger trees** were observed. Around the field were **many other monocultural fields covering a large area**.

***Figure 5.2:*** *Field 1 from a satellite perspective, showing the surrounding fields. Field 1 is marked with an x.*

The **ecosystems on the surrounding hills were natural or semi-natural**, with olive tree plantations, and the ecosystems here contained more trees and vegetation than the wide agricultural area beneath, as can be seen in the background of figure 5.3. The area had **a lot of industries, such as some kind of larger mining industry** that was observed on the hillside. Through the landscape, different smaller streams of the large Menderes River, that supplies the valley with water, were running. The field area was furthermore **enclosed by one larger, straight road and a few smaller roads**.

Regarding the direct surroundings of the field, there were five other fields of different sizes in direct relation to the field, and on the left side, it bordered on a water canal, see figure 5.2. **No fences were observed on any of the sides of the field**. The canal had some parts that were newly dug, and some older parts that seemed untouched. The water in the canal was used for irrigation in many of the fields in the area, and it was observed to be clear and without any growth of plants or visible algae. On the sides of the older part of the canal, there was some naturally growing reed and weeds, while on the newly dug part, there was only clay and no observed growth. Some kind of grass or small natural plants grew on one of the adjacent fields, and on the field on the other side of the canal, wheat was cultivated. Between the field and all surroundings, there seemed to be **a small strip of natural vegetation on all sides**. When bordering on other fields, the size of the strip of natural plants varied, where some vegetation was larger with some bushes and other strips had smaller plants, but the strips were in general estimated to be between 50 and 100 cm broad. An example of a field strip can be seen in figure 5.4.

***Figure 5.3:*** *A picture of field 1's surrounding hills on the left and flat agricultural land to the right, with the newly dug water canal in the centre. In the picture, field 1 can be seen on the right side of the canal, and on the left side of the canal is another field with winter wheat.*

The growth in field 1 seemed at the time of the visit to consist of **cotton residues from the previous season, and some kind of grass grew in between the rows**. This can be seen in figure 5.4. It was unclear whether or not the grass between the cotton rows was intentionally cultivated or had appeared naturally. Due to the observations of field 1 being made from a distance, limited details were observed about the actual field area itself.

***Figure 5.4:*** *A picture showing field 1 to the left, and another field to the right. In between them is a field strip with some kind of naturally growing plants.*

By the field, **observations of a number of plants were made**. Near the road from which the observations were made, many specimens of *Silybum Marianum*, a small common weed called *Plantago Major*, flowering *Hieracium*, some kind of clover, and some sort of *Taraxacum* were growing, as well as a few kinds of grasses. An example of observed plant species can be seen in figure 5.5. The diversity on the field was not possible to evaluate due to the distance from the viewing point. A few smaller, dry bushes were seen on the field strips between the land, see figure 5.4. These were possibly annual but nevertheless dry and left untreated, presumably from last season's farming.

***Figure 5.5:*** *A picture taken close by field 1 showing Silybum Marianum, a thistel of which many specimens were observed.*

### 5.2.2 Observations from field 2

The gathered data from the visit to field 2 is presented here. In table 5.9, the positive and negative aspects of the impacts on biodiversity are given.

***Table 5.9:*** *Positive and negative aspects for biodiversity concerning the observations from field 2.*

| **Observations from field 2** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| On a landscape level, hills/mountains with natural or semi-natural ecosystems surround the plain [1] | Relatively large field among very many other monocultural fields, a large plain on a landscape level [2, 3] |
| On a landscape level, occasional trees and other natural vegetation among the fields [1] | The field area is enclosed by smaller roads, potentially limiting animal migration [2, 3] |
| Three of four sides not fenced in [2] | Few larger areas with natural vegetation among the fields [1] |
| More extensive vegetation on the strips around the field compared to field 1 [4] | There was a fence on the left side of the field, limiting animal movement [2] |
| Field separated from the irrigation canal by filter strip with natural vegetation [5] | |
| Grass cultivated in the field off season, the majority to be ploughed into the soil for soil health purposes [1] | |
| Some natural vegetation close by the field, some diversity among plant species [4] | |

[1] Tscharntke et al. (2021), [2] The interviewed biodiversity specialist, [3] Erisman et al. (2016), [4] IPBES (2019), [5] Tuppad et al. (2010)

The same kind of landscape formation as in the Söke area was found in Torbalí, with flat, rather homogeneous, farmland enclosed by **hills or mountains with semi-natural vegetation on the sides**. The landscape, like the one around field 1, consisted of **many monocultural and large fields**. Field 2 was located slightly further from the hills and thus further away from more natural vegetation, and also closer to a smaller town centre. In the case of field 2, there were **many roads of different sizes that cut the farmland into fragments**, and only **a few, small patches of natural growth were observed in the landscape**. A handful of **larger trees** were observed in the field area. The surroundings can be seen in the satellite picture in figure 5.6, where the field is marked with an x.

***Figure 5.6:*** *A satellite picture of field 2 from a landscape perspective, showing the closest area around the field. Field 2 is marked with an x.*

To the left of the field was a chicken farm that was **separated from the field by a fence**. On the right side was a cattle farm with several open booths for animal keeping, and between field 2 and the farm was an open manure storing facility. A picture showing field 2 and both of the neighbouring farms can be seen in figure 5.7. A relatively **large road bordered on the field** on the shorter side, and on the other side of that road was another field. From the point of view from which the field was observed, it was difficult to note what surrounded the field on the side opposite to the road, but **a few trees** were noted far away, and these marked the end of the field according to the representative from Agrona.

***Figure 5.7:*** *A picture showing field 2 and its surrounding. The chicken farm is to the left in the picture, and the cattle farm is to the right. As can be seen, field 2 is separated from the cattle farm by a natural field strip of weeds and reed. The hills surrounding the farmlands can be seen in the background.*

Around the field were small **strips of naturally growing plants of different kinds**. The size of the strips varied between the different sides, from smaller on the side bordering on the chicken farm to larger, approximately 1 meter wide, of naturally growing plants and weeds on the side bordering on the cattle farm. On the side that bordered on the road was a **filter strip and a small, elevated barrier that rose higher than the field right in front of a ditch**. The ditch was observed to carry irrigation water to the fields and the water was, as opposed to the canal by field 1, very muddy and a lot of algal growth was observed in and around the water. The ditch furthermore had **some larger, presumably annual, plant residues, reed and weeds** that partly covered the water stream or grew right beside it. Figure 5.8 shows the ditch and the water.

(a) (b)

***Figure 5.8:*** *Two pictures showing the irrigation ditch beside field 2.* ***(a)*** *The ditch with its growth of reed and smaller bushes.* ***(b)*** *The water and growing algae in the ditch.*

***Figure 5.9:*** *A picture showing a soil sample from field 2, which was judged to be very clayey.*

Regarding the field area in particular, it was more closely observed than field 1. In the field, **some kind of grass, presumably of the *Poa* genus, was growing**, with a few observed larger weed specimens intermixed with the grass. The grass was observed to grow densely on the field at the time of the visit in between last season and the coming one. The grass covered almost all of the soil except some parts close to the road and on the left side. Moreover, the soil in the field was observed to be very clayey and rather wet at the visit, which can be seen in figure 5.9. **Lastly, some plant species were observed around**

**and on field 2**, for example *Sylbium Marianum*, some type of *Euphorbia* and some *Utricaceae*. Also, a few types of flowers were observed, such as *Taraxacum*, *Capsella Bursa-pastoris*, *Raphanus raphanistrum*, some kind of *Lamium*, *Brassica nigra*, and *Senecio vulgaris*.

### 5.2.3 Farming practices

The applied practices related to fertilisation, pest control, crops, and the interaction between managed and natural systems are described below. Some are mandatory according to the organic standards, while others are voluntary. Moreover, some production- and biodiversity-related aspects of Agrona are presented. Unless otherwise stated, the information was retrieved during interviews with the cotton farmers and the representative from Agrona. The summarised positive and negative implications for biodiversity are presented in table 5.10.

***Table 5.10:*** *Positive and negative aspects for biodiversity concerning farming practices.*

| **Farming practices** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Performs organic farming [1] | Harvests field margin plants [4] |
| Uses manure and dried weeds as fertilisers, very limited and controlled use of synthetic fertilisers [1] | Does not have intercrops between cotton rows [4] |
| Uses biological pest control, very limited and controlled use of synthetic pesticides [1] | Large, monocultural fields and machinery used in marketing [5] |
| Practices crop rotation every three years [2, 3] | Intensive and increasing human activity in the area [4] |
| Grows alfalfa in between seasons [2, 3] | Does not monitor biodiversity |
| Has field margins with native plants [4] | |
| Plants trees around the fields [4] | |
| Leaves small maize corns in the fields for birds | |
| Invests in tree planting [4] | |
| Seeks to understand water and carbon footprint through an LCA study | |

[1] IPBES (2019), [2] Tibbett et al. (2020), [3] Thiele-Bruhn et al. (2012), [4] Tscharntke et al. (2021), [5] Dudley and Alexander (2017)

The use of synthetic fertilisers and chemicals such as pesticides is not allowed in **organic farming** (see section 2.2.3), which drastically decreases the productions' contribution to pollution, a major driver of biodiversity loss (IPBES, 2019). The fertilisation need is instead largely covered by **application of manure**. Most farmers also keep animals and are thus self-sufficient, and others can turn to Agrona for manure supply. Moreover, **weeds from the cotton fields are dried and ploughed into the soil** to add further nutrients. If these natural methods are not sufficient, the farmers buy **approved commercial fertilisers from certified companies**. To avoid damage by harmful insects without using synthetic insecticides, the farmers rely mostly on **biological pest control**. For instance, the lacewing *Chrysoperla carnea*, a well-known natural enemy to aphids (Turquet et al., 2009), is used. One farmer explained that the pesticide use used to be too heavy for naturally occurring beneficial insects to live in the fields, which caused extensive damage on the production in the first year of organic farming. Yet, the damages have decreased with increased knowledge and restored insect populations, and consciously applied and naturally occurring beneficial species together provide sufficient pest control. Occasionally, synthetic pesticides are needed, but the farmers **must receive a license** to be eligible for pesticide application, and the task cannot be delegated to employees. Each **application must also be approved** by the government.

Other applied measures include **three-year crop rotation** and **cultivation of alfalfa or other grass in between seasons**, which is ploughed into the soil or harvested as animal feed. Both improve soil quality and hence also soil biodiversity (Tibbett et al., 2020), which is fundamental for the stability of ecosystems and their functions, and thus affects the potential for other kinds of biodiversity as well (Thiele-Bruhn et al., 2012). Practices that increase the diversity of the farming system and provide habitats, thereby benefitting biodiversity (Tscharntke et al., 2021), are also implemented. As observed during the field visits, there are **field margins with natural vegetation**, and the representative from Agrona described a local tradition of **planting trees around a field** when a child is born. If the child later gets married, the trees are harvested and the profit for the timber is given to him or her. In general, the farmers considered themselves to be interested in sustainability and to take nature into account in their farming. For instance, one of them also produce maize and use to **leave small corns in the field** to support the relatively poor bird population in Torbalí. Yet, there are negative aspects as well regarding farm system diversity and habitats, such as **harvesting of the field margin plants** (to be used as feed) and the **absence of intercrops** grown intermixed with the cotton. The farmers seemed unfamiliar with the latter practice, and considered it incompatible with the obligation to report what kind of crop each field is used for, which does not allow for mixes. Moreover, an Agrona marketing video shown in the interview featured **extensive, monocultural cotton fields and large machinery**, indicating limited ability to support biodiversity (Dudley & Alexander, 2017). Such lack of landscape perspective is a crucial aspect, according to the interviewed biodiversity specialist, not least considering the **intensive and further increasing human activity** in the area.

The abovementioned positive aspects of the production support Agrona's image as a conscious, sustainability focused company, and the company representative also mentioned projects such as Agrona contributing to the **establishment of a forest**, and an ongoing **lifecycle assessment (LCA) of the company's carbon and water footprint**. Moreover, the marketing video contained claims to care for nature, but **no monitoring of the production's biodiversity impacts** is performed. Overall, there are several positive traits, especially compared to other production in the area, but further improvements are possible and a systemic view is needed. A will to better understand and decrease negative impacts on nature was detected, and the company representative showed great interest in regenerative agriculture. This is a holistic approach aimed to enhance soil, water, and vegetation quality, and thereby the ES provided (El-Sayed & Cloutier, 2022). There is no clear-cut definition, but examples of measures are integrated animal and crop farming, use of perennials, multi-cropping systems, and minimised tillage (Schreefel et al., 2020). According to the representative from Agrona, biodiversity is not considered enough in organic production, which makes regenerative farming preferable, and he also reported an interest for the concept among customers. Implementation is impeded by some current rules, e.g. the ban on intercrops, but the company representative believed that legal changes might be possible and seemed relatively hopeful for the future. Furthermore, Textile Exchange has launched a research initiative for regenerative production aimed to guide textile and fashion industry actors by improving their understanding of relevant tools, programs etc and providing concrete plans for increased involvement and handling of the intricate actor network in the production system (Textile Exchange, 2021).

### 5.2.4 Implications of organic farming

The following section elaborates on the possibilities of and overall system behind transitioning to organic farming. All data in the section is gathered from the representative from Agrona, if nothing else is indicated. The extracted positive and negative aspects of the impacts on biodiversity of organic farming can be seen in table 5.11.

***Table 5.11:*** *Positive and negative aspect for biodiversity concerning the implications of organic farming.*

| **Implications of organic farming** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Organic certification enables new economic opportunities which increase the possibility for farmers to keep their land, and the incentive to care for the surrounding environment is upheld | The positive effects on species populations as a consequence of the transition to organic are questionable |
| Farmers perceive an increase in observed species since the transition to organic farming | Farmers seem to have a simplified view of biodiversity system complexity, as they fail to make connections from landscape perspective |

The first aspect that has positive impact on biodiversity relates to the organic transition's effects on the farmers' situation. It takes four years to transition the farming to organic production, during which the cultivation is considered conventional from the start during the first year, and from the second year, it is referred to as transitional, on the path towards an organic certification. The transition to organic cultivation **opens up new economic opportunities for the farmers, who can sell the certified cotton for higher prices**. The economic benefits of adopting organic production are also visible through the subsidies given to the farmers, and the lower expenses related to for example fertilisers, as synthetic ditto are not permitted (see section 2.2.3). Further investigation showed that the governmental support includes both subsidies and other economic possibilities, such as loans to the farmers who transition to organic farming (Republic of Türkiye Ministry of Agriculture and Forestry, n.d.). This gives the farmers the possibility to invest in new machines and equipment for the workers, but it also **enables the farmers to keep their farmland**. Selling the land is an option that can generate more economic stability for the individual farmers, who generally are in an economically difficult situation. Yet, selling the land to a buyer such as a larger company is reported by the representative from Agrona to be unfavourable for the environment, as the **farmers who own the land and live close to the fields would have a larger incentive to care for the land, its natural surroundings and the environment**. Moreover, the farmers see selling the land as a last escape; they generally want to keep on farming the land, as has been done in their family for a long time.

The cotton farmers **see a link between the transition to organic production and a regrowth of species and an increased number of observed species**, which is the second positive aspect in table 5.11. The farmers said that the organic transition, and particularly the lower use of pesticides, has lead to an increased number of e.g. birds, soil bacteria, boars, coyotes, and ladybugs. This information of increase in species was retrieved from both the farmers and the company representative. The increase in observed species was reported to have occurred both on the farmlands and further away, for instance in the close by Büyük Menderes National Park. It can also be noted that the extent of the changes done in farming practise varies between the two visited fields. In field 2, the practices were already almost organic and the farmers claim not to have made any larger changes when transitioning.

It is, however, **questionable whether the species increase that was observed by the farmers can be linked to the transition to organic farming**, according to the interviewed agricultural researcher and environmental consultant. The changes in nature as a consequence of organic farming are unlikely to occur this fast, but the recovery time of natural systems varies between areas according to the agricultural researcher, and thus there is a possibility for local quick recovery time around the fields. On the whole, the link seems overrated, and the observed changes are probably linked to more events than these farmers transitioning to organic farming, she continued. Moreover, she pointed out that different units in nature affect each other, and it is important to address nature as a system. To verify that the changes are linked to the transition, continuous monitoring is needed, according to the environmental consultant. Finally, it can be said that the farmers seem to have **a simplified view of biodiversity related systems**. This is the second negative aspect in table 5.11, and stems from the understanding of the farmers' perspective on their part in the surrounding. They fail to fully understand the complexity of the interaction between managed agricultural systems and natural systems. Their direct answers about increased species in the area as a consequence of them transitioning to organic production appears naïve considering the input from experts regarding system complexity and the large number of activities in the area.

### 5.2.5 Water management

This section describes the agricultural water use in the area in general and specifically in Agrona's production. Water management was brought up as a major issue by all interviewed experts with insight into local conditions (see also e.g. Sütgibi (2008), Küçüksümbül et al. (2021), and Bakaç and Kumru (2010)), and pollution, salinisation, and resource allocation are some important water-related issues. The identified positive and negative aspects for biodiversity of Agrona's water management are presented in table 5.12.

***Table 5.12:*** *Positive and negative aspects for biodiversity concerning water management.*

| **Water management** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Performs organic farming [1] | Has potentially deficient insight into drainage issues [2, 3] |
| Takes irrigation water from rainfed dams, not the Menderes River or groundwater [1, 2, 3] | |
| Makes analyses of the irrigation water, which show good results [1] | |
| Uses drip irrigation, not sprinkler systems or flooding [2, 3] | |

[1] IPBES (2019), [2] Tibbett et al. (2020), [3] Thiele-Bruhn et al. (2012)

The first three positive traits concern pollution, a direct driver of biodiversity loss (IPBES, 2019) and a major local problem. Considerable amounts of insufficiently treated wastewater are discharged into the Menderes River (Yeşilırmak, 2010). Examples of sources mentioned by interviewees and in literature are leather processing (Bakaç & Kumru, 2010; Sütgibi, 2008), textile production (Sütgibi, 2008), and geothermal energy production (Küçüksümbül et al., 2021). The interviewed representative from WWF Turkey described how the difficulties to control the sources make it difficult to control the emissions as well. Moreover, the soil scientist and the agricultural researcher highlighted agriculture as an important source (see further in Bakaç and Kumru (2010) and Sütgibi (2008)), and particularly the extensive use of agricultural inputs. For instance, pesticides contribute to elevated concentrations of heavy metals, which affect both managed and natural systems. But since Agrona's farmers **perform organic farming**, no or very small amounts of synthetic chemicals are used. Moreover, many farmers use river water for irrigation (Küçüksümbül et al., 2021; Sütgibi, 2008), transferring pollutants to the soil as well. According to the company representative, **Agrona's irrigation water is instead taken from rainfed dams**, led to the fields via canals, and applied by a drip system. Thus, spreading of pollutants from the river to the soil is avoided. The dams are owned and operated by the government, and the authorities determine how large quantities that can be used depending on the crop grown in a certain field. Both the company representative and the representative from WWF Turkey explained that irrigation was performed twice instead of thrice last season due to drought. The harvest was not negatively affected, and the custom will be kept. Moreover, the company representative claimed that the water use is substantially lower than in GMO cotton production, yet this has not been possible to verify. As recommended by the soil scientist, Agrona also **make chemical and microbial analyses of irrigation water samples**, and all results in the latest report are within acceptable ranges (Agrona, 2022).

Furthermore, both **irrigation with rainwater (and not groundwater)** and the use of **drip irrigation** help avoiding salinisation. This benefits soil biodiversity, and thereby, as previously described, biodiversity in general. As described by Sütgibi (2008), the area's location near the coast makes the freshwater-seawater balance naturally sensitive, and the use of groundwater for irrigation has led to leakage of seawater into the groundwater. The ensuing salinity problems were also brought up by the soil scientist, who pointed out that drip irrigation is preferable to sprinkler systems or flooding of fields (which drives salinisation due to the high evaporation rate).

Overall, Agrona's water management is performed relatively well from a biodiversity perspective, especially compared to the general situation in the area. The only identified negative aspect is a **potential lack of understanding of the importance of drainage**, which also is related to soil quality and hence biodiversity. The representative from Agrona claimed in an interview that all fields had drainage systems, but this statement was withdrawn during a later field visit. Hence, it is unclear how many, if any, of the fields that are drained. According to the soil scientist, drainage systems are important yet often malfunctioning, but the agricultural researcher nuanced the issue by explaining that the need for drainage systems depends on local conditions such as soil structure. However, flat topography and high soil salt concentration indicate that drainage is likely needed (Sands, 2018), and both conditions apply to the area. According to the agricultural researcher, construction of drainage systems can but must not be expensive, depending on the techniques used.

Lastly, the representative from WWF Turkey, who is a freshwater specialist, mentioned the difficulties of allocating water to the many actors in the area, and Yeşilırmak (2010) describes how farmers unlawfully divert water from the Menderes River during the summer. The WWF Turkey representative also pointed out the area's ecological importance and the impacts of urban water use on natural ecosystems, indicating another allocation problem between anthropogenic and natural systems.

### 5.2.6 Soil management

It became clear during the field study that soil is another important point of analysis when assessing the impacts on biodiversity from the farming, as the aspects of soil health was brought up by many of the interviewed actors. The extracted positive and negative aspects of biodiversity impacts from soil management are presented in table 5.13.

***Table 5.13:*** *Positive and negative impacts on biodiversity concerning soil management.*

| Soil management | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Soil health seems to be prioritised and understood comparatively well [1] | Does not leave cotton residues on farmland for increased soil organic matter [2] |
| Performs organic farming [1] | |
| Irrigation water from rainfed dams, instead of using polluted river water [1] | |
| High soil fertility in the areas, without adding fertilisers | |
| Adds bacteria and fungi to the soil for increased soil health purposes, instead of synthetic pesticides and fertilisers [2] | |
| Grows alfalfa in between seasons for nitrogen fixation [2] | |
| Uses last season's weeds as fertiliser, instead of synthetic inputs [2] | |
| Practices crop rotation every three years [2] | |

[1] IPBES (2019), [2] FAO et al. (2020)

The first positive aspect in table 5.13 is that **soil health seems to be prioritised higher by the farmers and Agrona compared to other actors in the system** of cotton farming in the area. This is gathered from the collected understanding of the farmers' view on soil. Prioritising soil health, and thus biodiversity, can be said to be a prerequisite for enhancing it (IPBES, 2019). The next two aspects of positive impacts on biodiversity relate to efforts taken that clearly do not contribute to surrounding problems of soil health. As previously stated, the area where the cotton fields are located is heavily polluted. The pollution affects the soil health extensively, and the issue is not given sufficient attention, according to the soil scientist and the agricultural researcher. This is in line with literature, which highlights soil and water as key components for managing the basin's agriculture sustainably (Küçüksümbül et al., 2021). Regarding effects from agriculture, pesticides reach the soil through careless use in the fields and polluted irrigation water from the Menderes River. These transmission routes for the substances affect both the agricultural land and the natural surroundings, as the pollution may spread to natural water and soil systems, according to the soil scientist. She also highlighted that the pollution in the Söke area is an old but also still ongoing problem, due to industrial emissions and careless farming. It can, however, be noted that some literature, mentioning the contamination of metals in water in the area, concludes that the high levels of metals may not necessarily derive from only anthropogenic sources, but could be results from bringing up metals from below ground. The area contains geologically high levels of metallic substances (Küçüksümbül et al., 2021). According to the soil scientist, there are some general soil issues in the area. Firstly, exaggerated salinity is a problem (as described in section 5.2.5). Salinity is naturally high in the area, but it is increased by irrigation with saline water which leads to accumulation of salt in the soil (Koç, 2010), as mentioned in section 5.2.5. Increased salinity levels is bad since it can lead to reductions in crop quality and productivity (Sayeed Ahktar Mohd, 2019). Another mentioned problem is excess metals, especially boron which is brought up with subsurface water in geothermal energy production (Koç, 2010). In contrast to these severe pollution problems causing diminishing soil health status, Agrona is implementing measures that mitigate the addition and spreading of pollutants. The fact that Agrona is **performing organic farming** means for instance that synthetic fertilisers are not used, and they are furthermore using **irrigation with water from dams and not the Menderes River** which is good from a pollution perspective.

Following in table 5.13 are four measures that are examples of ways in which soil health is enhanced. It can, however, firstly be stated that the **soil fertility is naturally high** in the area of field 2 near Torbalí, according to the farmers themselves and the representative from Agrona. The following was said by the farmers, and translated by the company representative:

> "The town names here are all related with cotton. For example, next town's name is *Cotton giver* [in Turkish], another is *Cotton taker* [in Turkish]. [...] If we do not apply manure or another [fertiliser], the cotton comes up automatically"

From this, it can be extracted that the soil is very fertile in the area and has been for a long time, enabling cotton production and providing a reason to name the towns accordingly, and the soil is furthermore important to and valued by the farmers. The transition to organic production meant lower use of fertilisers, but the same good yield, which indicates a good soil health and that the fertility is independent of the previously high input of fertilisers. The farmers in Söke, where field 1 is located, did not mention any soil problems, nor any extremely fertile qualities of the soil, but highlighted efforts made since shifting to organic. One way that soil health is enhanced in the organic production, is that the farmers **add bacteria and fungi**. The names of the organisms were provided by the farmers on site, and verified against the knowledge of the soil scientist. The fungi *Glomus intraradices* or *Rhizophagus irregularis* is applied to the soil during tillage according to the soil scientist. Another fungi, *Trichoderma harzianum*, is applied as a biological fungicide control, as it suppresses various soilborne diseases (AGRIOS, 2005). The bacteria are added to the soil and, according to the soil scientist, multiply in the soil under organic conditions. *Azotobacter chroococcum* is used to fixate nitrogen and works effectively as plant inoculant (Wani S. A et al., 2013). The bacterium *Azotobacter vinelandii* is also a plant inoculant, enhancing plant growth through for example nitrogen fixation and metabolisation of heavy metals (Sumbul et al., 2020). Finally, the purpose of applying the bacterium *Methylobacter symbioense* was not possible to verify and thus its actual purpose and use is unclear.

Other measures that are taken to enhance soil health, as described in section 5.2.3, according to the representative from Agrona, that **weeds are harvested and dried, and then applied as fertiliser** and that the farmers perform **crop rotations every third year** to avoid accumulation of pathogens. Lastly, usage of **seasonal intercrops such as alfalfa** increases nitrogen in the soil. The only extracted negative aspect for biodiversity in table 5.13 is that cotton residues are not left on the farmland, which would have contributed to increased organic matter in the soil and hence enhanced biodiversity (FAO et al., 2020).

### 5.2.7 Seed management

The gathered data concerning cotton seeds and the cotton seed system in Turkey comes primarily from the interviewed cotton researcher at Nazilli Cotton Research Institute, who shared her knowledge about practices in the seed breeding industry. The extracted negative aspects of impacts on biodiversity are gathered and presented in table 5.14.

***Table 5.14:*** *Positive and negative impacts on biodiversity concerning seed management.*

| **Seed management** [1] | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| | Always uses the same type of seeds in each field, even though different kinds could be used theoretically |
| | The seeds produce phenotypically similar plants |
| | Lack of biodiversity perspective in breeding |

[1] All aspects are evaluated against IPBES (2019)

As can be seen in the table, there are no identified actions that have positive impacts on biodiversity, but three that are identified to have negative impacts. All three are related to the cotton plants' lack of genetic diversity, which is one of the three general types of biodiversity (IPBES, 2019). At Agrona, most of seeds that are used are from the previous season. According to the contact at the company, up to 70-95 % of the seeds needed in a season come from previous season's cotton plants, and the rest is provided to the farmers through Agrona themselves by a seed company called ProGen. In general, a variety that has been found to give good yield will be used by the farmers year after year, according to the representative from Agrona. Within a certain field,**only a single type of seed is used**, resulting in **phenotypically similar plants** of the same height and size. However, the cotton researcher considered it theoretically possible to mix different kinds of seeds in a field, but both she and the company representative regarded it as difficult to implement in practice, since the seed type regulates the cotton quality and the farmers strive for evenness in quality.

Regarding the breeding of seeds, the seed researcher described that the process to obtain approval and necessary certifications of a newly bred cotton seed type was long and rather cumbersome. All new seed types have to go through a verification process steered by a national registration institute in Ankara, involving cultivation trials during two seasons in different regions and compilation of a report describing the results. Moreover, cotton breeding is done with the primary focus of increasing the yield and quality of the cotton fibre, including adaptation of the plant to climate change effects. From the cotton researcher's report, the conclusion can be drawn that **the breeding process lacks a perspective on biodiversity**, which is stated as a negative aspect in table 5.14. When asked about whether the research considers biodiversity aspects, only answers about the importance of high yields and good fibre quality were given. The seed system in Turkey is furthermore generally quite tightly regulated, for example through the strict regulations regarding Turkey being a non-GMO (Genetically Modified Organism) country. This was confirmed by both the representative from Agrona, and the agricultural researcher, who both mentioned the GMO standard as an important aspect concerning seeds. There is, furthermore, a ban on using old seeds that have been passed down through the generations among the farmers, if the seed type lacks mandatory official certifications, as the agricultural researcher elaborated. According to the company representative, trading with seeds has to be officially approved, in order to comply with different standards and ensure traceability of the seeds. This data was not deemed positive, nor negative for the sake of biodiversity impacts.

### 5.2.8 Knowledge and awareness

In addition to practices used in the cotton production, different actors' knowledge and awareness regarding sustainability and biodiversity were investigated; see table 5.15 for a summary of identified positive and negative aspects. Efforts to counteract biodiversity loss and support for conservation initiatives are dependent on people's knowledge about biodiversity and their awareness of the implications of its loss (Lindemann-Matthies & Bose, 2008). Similarly, IPBES (2019) calls for a new view of interactions between humans and nature, to achieve the transformative change needed for sustainable development and improved biodiversity.

***Table 5.15:*** *Positive and negative impacts on biodiversity concerning knowledge and awareness.*

| **Knowledge and awareness** [1] | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| General political and public awareness for sustainability and biodiversity | Lack of concrete action for sustainable development |
| Demand-driven transformation of the system towards sustainability | Agricultural research focuses on improving production |
| Increased demand for natural fibres and organic cotton | Agrona's sister company has limited understanding of local strategy need |
| Well-founded sustainability work at Agrona | Farmers do not talk about local flora |
| Customers show interest in biodiversity | Agrona and farmers do not talk about all types of biodiversity, only species diversity |
| Agrona shows understanding of the need for a concrete, local biodiversity strategy | Farmers have limited knowledge about possible agricultural measures for enhanced biodiversity |
| High self-reported biodiversity awareness and knowledge among farmers | |
| Farmers make a connection between impacts on surrounding nature and impacts on themselves | |
| Farmers seem knowledgeable about local fauna | |

[1] All aspects are related to the importance of knowledge and awareness described by Lindemann-Matthies and Bose (2008) and IPBES (2019)

The interviewed agricultural researcher described the **general public and political environmental awareness in Turkey as increasing**, yet also pointed out that **few concrete actions are taken**, which results in a further deteriorating situation. Also in her own field of research, the **focus is almost exclusively on improving products**, and effects of agriculture on nature are seldom regarded. Others share this notion, e.g. Öktem and Canel (2016) who state that despite increasing awareness among especially young people, environmental issues such as severe pollution and lacking support to research do not receive sufficient attention. However, several interviewees had noted a change in the mindset and interest among the brands that source cotton from the area, which affects local actors and their operations. The environmental consultant termed it "**demand-driven transformation**", and described how the want for non-polluting cotton makes even large, international companies show interest in more sustainable production despite the extensive effort it requires considering the complexity of the system. Two examples are H&M and IKEA, who both operate in the area and at least claim to strive for more sustainable cotton products (H&M, n.d.; IKEA, n.d.). Textile Exchange has observed similar trends, and their latest statistics for organic cotton show both increased global production and unprecedented demand (Textile Exchange, 2021). The representative from Agrona also reported an **increased demand for natural fibres in general and particularly organic cotton** in recent years. He attributed the change partly to the COVID-19 pandemic, which, according to him, has enhanced people's understanding of nature's value. Yet, he discerned more extensive engagement in e.g. northern Europe than other parts of the world, and perceived smaller niche companies like NJ as forerunners, while large fast fashion companies try to catch up. The interviews gave the impression that **Agrona's own sustainability work is genuine**, and that the representative himself is devoted to it. He was, for example, a driving force in Agrona's transformation into a value-based company with the core values traceability, sustainability, and renewability.

The company representative described the biodiversity awareness in the area as increasing, especially among farmers who depend on agriculture, which in turn depends on biodiversity. Agrona has also noted a **rapidly growing interest in biodiversity among customers**. They enquire about the applied farming practices and whether targets for biodiversity have been set, which the representative linked to the necessity of sustainability reporting. However, the environmental consultant called NJ's commitment to biodiversity "remarkable", which indicates that biodiversity awareness varies between companies and may not be very deep overall. Regarding Agrona's biodiversity work, the marketing video mentioned in section 5.2.3 included phrases such as "sensitivity towards nature" and "protecting nature". More practically, the representative addressed the **need for a biodiversity action plan with local focus and concrete measures**. Agrona's sister company, Egecot, already has an action plan which covers a relatively comprehensive selection of topics, e.g. soil and water systems, species, and habitats. It includes several ambitious initiatives and points of verification for audits, yet some border on unrealistic and methodological formulations are often vague. Moreover, it lacks collaborative aspects and landscape perspective, indicating **limited understanding of the requirements put on a local biodiversity strategy**.

When translating questions about biodiversity during the interviews with the farmers, the company representative explained that "biodiversity" contains a broad range of aspects in Turkish and that he had to clarify the meaning in the context of this study. He described it to the farmers as species richness or similar. They considered their **knowledge and awareness of biodiversity to be extensive**, and mentioned that they even had biodiversity lessons in school. They live close to the fields and feel a strong connection to the cotton production, and they pointed out that **by impacting surrounding nature, their farming also affects themselves and their health**. When asked about observed species and temporal changes, the farmers mentioned some mammals, several birds, and a few insects, indicating **knowledge about the local fauna**. However, **no plants were referred to**, and their **conception of biodiversity seemed to be dominated by species diversity**. Yet, these aspects may be influenced by the description of the biodiversity concept and the translation of the questions. When asked about what they would do to increase biodiversity in their fields, the farmers had difficulties answering. In one interview, no spontaneous answer was given, but the company representative said that they might be implementing measures without reflecting over their positive implications for biodiversity. In the next interview, the question caused confusion and the farmer pointed out that the production already is organic, implicitly saying that this was enough. This indicates a general understanding of the link between production, nature, and people, but **limited knowledge about agricultural measures expressively targeting increased biodiversity**.

### 5.2.9 Economic situation

The topics of the long tradition of cotton production in the area and the difficult economic situation in Turkey were continuously brought up during the interviews. Especially the latter has significant implications for the farmers' operations and possibilities to prioritise increased biodiversity. The issues are elaborated on below, and biodiversity-related positive and negative aspects are summarised in table 5.16.

***Table 5.16:*** *Positive and negative impacts on biodiversity concerning economic situation.*

| Economic situation | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| The farmers want to do more for biodiversity | Expected increase in cotton production, leading to increased landscape homogeneity [1] |
| Forecasting and advance payments improve the economic situation | Insufficient governmental support for agriculture |
| Organic production gives economic benefits which enable environmental work | The farmers are economically restrained, and cannot afford to prioritise biodiversity |
| | General trend of anthropocentric prioritising in society |
| | Lack of governmental economic incentives for sustainable production |

[1] Tscharntke et al. (2021)

The interviewed environmental consultant explained that cotton production is deeply rooted in tradition in the area since several decades and closely linked to people's personal living. This strong connection was clearly expressed during the interview in Torbalí, where, as described in section 5.2.6, the farmers are very proud of the soil fertility and many towns have cotton-related names. The agricultural researcher described how this may make some farmers resist change, e.g. not wanting to adopt new and better adapted seeds, but such tendencies were not observed among the farmers interviewed in this study. Several interviewees underlined the cotton production's importance for the local economy (see also e.g. Yeşilırmak (2010)). For instance, the environmental consultant described the cotton market as stable and reliable. According to the representative from Agrona, the production dropped in 2020 in favour of food production due to feared food scarcity in the beginning of the COVID-19 pandemic, but it has now recovered and he even predicted that yet **more farmers will take up cotton farming**. This may have negative impact on biodiversity, since the landscape homogeneity would increase further (Tscharntke et al., 2021).

Despite the relative security of cotton production, the farmers are significantly affected by the economic situation in Turkey. The Turkish Lira was considerably depreciated in 2018 (Kantur & Özcan, 2021). That trend continued during the pandemic, and has, combined with dependence on imported commodities, further increased the already high inflation (Macchiarelli et al., 2021). Kantur and Özcan (2021) also describe how unemployment has increased and that many households face reduced income. The interviewed farmers explained that farming becomes increasingly difficult economically, which many others also report, and farmers and experts alike criticise the **insufficient governmental support for agriculture** (Büyük, 2021). The agricultural researcher also broached this issue, calling for rural development. According to the farmers, some have been forced to turn to animal farming (which is considered more profitable), or sell their land and relocate to the city. As described in the previous section, the farmers are relatively knowledgeable and aware about biodiversity. They expressed a **will to enhance biodiversity in their fields**, but are **economically restrained and cannot prioritise biodiversity over production efficiency**. They explained that if they did, their neighbours would laugh at them or assume they had won the lottery. The interviewed experts showed understanding for these circumstances, for instance the representative from WWF Turkey, who mentioned the need for behavioural change among farmers, but also acknowledged people's dependence on cotton farming and the need for collaborative measures.

This issue of prioritisation between economy and nature is related to the previously described **general trend of increased environmental awareness, but lack of concrete action**. As all companies, Agrona faces the trade-off between economy and environmental impact, and although the marketing video shown in the interview contained claims to care for nature, it was concluded with "We love nature, but more importantly, we love future generations". However, efforts are made to facilitate ecological *and* economic sustainability. **Forecasting and advance payments** mean that selling prices and incomes are fixed in the beginning of the season, improving the farmers' economic security, and the transition to **organic production** has led to increased revenues, additional subsidies, and decreased expenses for synthetic inputs (see also section 5.2.4). Yet, the farmers called for even stronger support to enable them to keep their land and extend their sustainability and biodiversity work, and the environmental consultant agreed that **the government should create more economic incentives for shifting to sustainable production**.

### 5.2.10 Relations and collaboration

Stakeholder interactions and how or when to collaborate seem to be important for the actors in the production system and the interviewees of the extended system, as many actors mentioned the current or needed level of collaborative work. Seven interviewees called for collaboration or expressed positive perception of working together to achieve sustainable systemic change within cotton production. This is the first positive aspect for biodiversity in table 5.17, since working together is a prerequisite for working together for biodiversity. All positive and negative aspects regarding collaboration, relations, and impact on biodiversity are noted in table 5.17.

***Table 5.17:*** *Positive and negative impacts on biodiversity concerning the relations and collaboration between actors.*

| **Relations and collaboration** [1] | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Generally good understanding of the importance of and positive attitude towards collaboration among Agrona, farmers, and actors of the extended system | Lack of policy coordination between adjoining areas |
| Recent change in structure of national administrative work, forestry and agriculture are joined in a single Ministry | Insufficient platforms for collaborations in the area to enable resource allocation and transition of the system |
| Well-functioning relationship between farmers and Agrona (both structured and informal) | |
| Collaboration between industries, currently focusing on biodiversity | |
| Well-functioning relationships between farmers, as they help each other and live in the same villages | |

[1] All aspects are related to the importance of well-functioning collaboration as described by IPBES (2019)

Generally, the identification stems from the fact that since the problem of biodiversity is an overarching one, covering many actors and many connected natural systems, the collaborative work needs to be well-functioning to enable common work for biodiversity. This is central according to IPBES (2019) among others. Thus, on the positive side in table 5.17, there are aspects of actor relations that point towards a well functioning exchange of knowledge, that has the potential to concern biodiversity specifically. Aspects on the negative side show evidence of the opposite. One important movement for increased collaboration mentioned by an expert concerns policy coordination. **Recent changes in policy work have brought two previously separated ministries together** into a single Ministry of Forestry and Agriculture, which the agricultural researcher considered beneficial for collaboration. Focusing on Agrona's relations to other actors, the company has **a good relationship with the farmers** according to the representative, with both mandatory, structured knowledge sharing (trainings and check-ups on procedures), but also small-scale, more personal, communication. Agrona is family-owned and the farmers trust their good and stable reputation. An example of this is the continuous work throughout the organic transition where no farmers have left Agrona's organisation during the ten years of the project. The representative furthermore explained that Agrona has connections to other industries as well and take part of their perspective on biodiversity through **Agrona's engagement in the Aegean export association that currently focuses on sustainability to a large extent** (Aegean Exporters Association, n.d.). The representative described almost all of the company's connections to other companies and actors (customers, farmers, ginners, universities etc) as good and fruitful with communication in both directions.

**The relation between farmers can also be described as well-functioning**. They are, according to themselves, communicating and helping each other to a large extent since they are living in the same villages, for instance planning future production together. This well-functioning relation was confirmed by observing the farmers interact during the interviews and tours on site. The farmers are, moreover, linked to each other through the use of the same ginning facilities.

There are, however, some examples of collaborations presently not functioning satisfactorily, for example **difficulties regarding policy interactions locally between different areas** (specifically Söke and Torbalí), and some EU regulations implemented by the government do not seem to be adjusted to the farmers' work, according to the agricultural researcher and the environmental consultant. This is the first noted negative aspect in table 5.17. The basin furthermore contains many actors of many types that need to collaborate to allocate the resources that they share, as stated by the WWF Turkey representative. There is thus **a need for common platforms to transition the system**, she elaborated.

To sum up the relations between actors, it can be said that there are many positive attributes to the collaborative work but also some extensive negative ones. There is potential for positive impacts on biodiversity through common work, but there are underlying hinders and a need for more collaborative work in the matter.

### 5.2.11 Gap identification

Through comparison between the described current state and the seven sustainability principles defined in section 5.1, nine gaps labelled A-I were identified. This is illustrated in figure 5.10, where the connections between the principles and gaps are made clear. The figure also shows a schematic flow of the remaining steps, i.e. formulation of leverage points (LPs) based on the gaps, and identification of actions for the LPs.

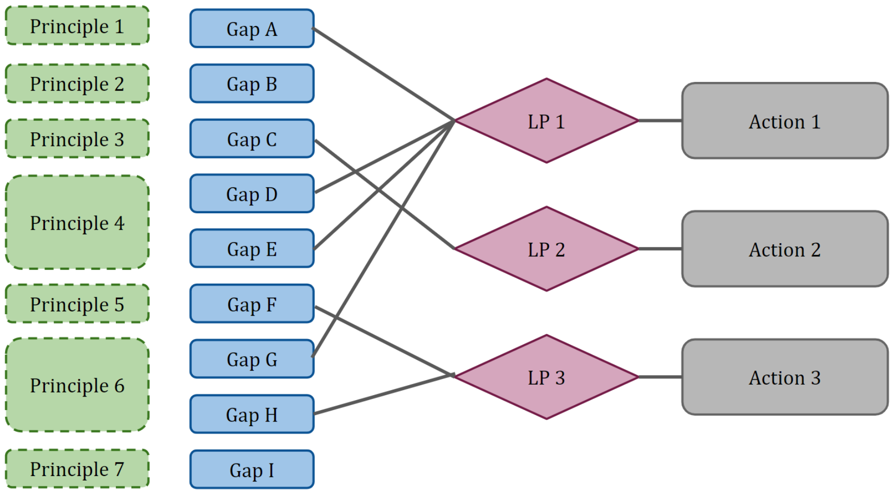


***Figure 5.10:*** *A schematic figure illustrating the identified gaps' connection to the principles, and the flow of connecting gaps to LPs and LPs to actions.*

The gaps are presented in table 5.18. The left column describes the traits of the current state that were compared to the sustainability principles in the right column, and the resulting identified gaps are presented in the middle column. Together, the gaps relate to all principles and they are judged to cover the mapped system relatively well, yet it should be noted that this is only a selection of the many gaps possible to consider. The features of the current state in the left column were identified by connecting the positive and negative aspects of the current situation presented in tables 5.8-5.17 to one or several principles. The results of this process are presented in tables B.1-B.7 in appendix B.

Gap A relates to principle 1 about sustainable agricultural management, which is assessed to be rather well met regarding soil and water management and decreased pollution, but fewer measures explicitly aimed to safeguarding of biodiversity are implemented. Thus, there is a **lack of measures specifically targeting biodiversity conservation**.

Gap B concerns principle 2 about sustainable production and consumption and efficient resource use. Currently, actions are taken to decrease negative effects of the cotton production, and investigative measures such as water analyses and an LCA are performed to understand the impacts on nature in general. However,

**biodiversity monitoring is not performed**, although it is important in order to enable Agrona and the farmers to take responsibility for effects on biodiversity in particular.

Gap C covers the discrepancy between principle 3 about sufficient financial support for biodiversity, and the farmers' severely restrained economic situation. This means that **the farmers cannot prioritise biodiversity over production**, although they are aware of its importance.

Gaps D and E both relate to principle 4, addressing biodiversity knowledge and awareness. Gap D concerns the farmers' **limited theoretical knowledge about biodiversity**, for instance about landscape effects and different kinds of biodiversity. Gap E instead focuses on their **limited knowledge about agricultural measures for improved biodiversity**, due to which the farmers appear to not know what to do, beyond organic farming, to enhance biodiversity in their fields.

Gap F connects the observed conflicting interests and insufficient cooperation for biodiversity with principle 5 about well-functioning collaborations and transparent communication, highlighting the **lack of common platforms for collaboration on biodiversity aspects**.

Gaps G and H both concern principle 6 about well-functioning ecosystems and habitats. Gap G relates to the fact that although actions are taken that benefit e.g. soil and water quality and hence biodiversity, **current measures have limited effects on habitat maintenance and restoration** specifically. Gap H complements this, as the intensive human activity, landscape homogeneity, and habitat degradation and fragmentation of the larger system are considered, which indicate that **the surrounding landscape is locked into a state of low potential to provide habitats and support biodiversity**.

Lastly, gap I links principle 7 regarding minimised anthropogenically caused biodiversity loss to the strong connection the farmers make between organic production and increased biodiversity. Such changes depend on numerous other factors as well, and monitoring is needed to determine causes and effects, implying that **the farmers are over-reliant on perceived positive effects of organic production in their biodiversity work**.

***Table 5.18:*** *Presentation of identified gaps between the current situation and the sustainability principles.*

| Current situation | Gap | Principle |
|---|---|---|
| Few measures for primarily safeguarding biodiversity, actions often done for the purpose of soil fertility etc rather than biodiversity itself | A. Lack of measures specifically targeting biodiversity conservation | 1. Sustainable agricultural management |
| Perform water analyses and an LCA of water and carbon footprint to understand the impact and enable mitigation, but biodiversity impacts are not assessed | B. Biodiversity monitoring is not performed | 2. Sustainable production and consumption and efficient resource use |
| National economic difficulties and lack of governmental support for agriculture | C. The farmers cannot prioritise biodiversity over production | 3. Sufficient financial support for biodiversity |
| Farmers have simplified views of landscape effects, only talk about one type of biodiversity, and do not show knowledge of local flora | D. Limited theoretical knowledge about biodiversity | 4. Extensive knowledge and widespread awareness of biodiversity values |
| Farmers do not know which farming practices to implement to further enhance biodiversity | E. Limited knowledge about agricultural measures for improved biodiversity | 4. Extensive knowledge and widespread awareness of biodiversity values |
| There is awareness about the importance of collaboration in general, but the many conflicting interests lead to insufficient cooperation for biodiversity | F. Lack of common platforms for collaboration on biodiversity aspects | 5. Well-functioning collaborations and transparent communication |

Continued on next page

**Table 5.18 – continued from previous page**

| Current situation | Gap | Principle |
|---|---|---|
| Some actions beneficial for biodiversity are taken, like soil health enhancement and water management, but insufficient attention is paid to habitat issues | G. Current measures have limited effects on habitat maintenance and restoration | 6. Well-functioning ecosystems and habitats |
| The human activity is intensive and the landscape consists of large, monocultural fields with little natural vegetation, resulting in degraded and fragmented habitats | H. The surrounding landscape is locked into a state of low potential to provide habitats and support biodiversity | 6. Well-functioning ecosystems and habitats |
| Farmers make a strong connection between organic production and biodiversity increase, but the increase may not be due to their transition since it depends on many factors and monitoring is needed | I. The farmers are over-reliant on perceived positive effects of organic production in their biodiversity work | 7. Minimised biodiversity loss caused by human activity |

## 5.3 Backcasting step 3: Leverage points

Based on some of the identified gaps, the following three LPs that may facilitate the transition from the current to the desired state were formulated:

**LP 1: How could the farmers' knowledge about biodiversity be increased, so that the impact of their production on biodiversity may be limited?**
The first LP bridges the gaps A, D, E, and G, as illustrated in figure 5.10. The mapping of the current state shows that there is an awareness among the farmers regarding biodiversity, but as expressed by gaps D and E, there are deficiencies in their knowledge about both biodiversity in general and possible agricultural measures for biodiversity enhancement. Additionally, few measures are implemented explicitly for biodiversity conservation (gap A), and especially habitat issues are not sufficiently attended to (gap G). Therefore, it is important to improve the farmers' understanding of the fundamentals of biodiversity, and also the effects of agricul-

ture. The more general knowledge may firstly facilitate the farmers' understanding for why certain measures are beneficial or unfavourable for biodiversity, and secondly, together with the more agriculture-specific knowledge, it might enable the farmers to generalise in new situations, prioritise between efforts, and take own initiatives for biodiversity conservation. Taken together, this would empower the farmers to efficiently limit their different negative impacts on biodiversity.

**LP 2: How could the farmers' economic situation be improved, so that they may act on their awareness and prioritise biodiversity?**
The second LP bridges gap C, as illustrated in figure 5.10. This LP also relates to the biodiversity awareness observed among the farmers, but focuses on the economic aspect as described in gap C, and thus complements LP1. The mapping clearly shows that the economic situation is a major barrier to prioritisation of biodiversity, and that improving it is a prerequisite for extended biodiversity work. This indicates that economic efforts are likely to have high leverage potential, especially if they are combined with training activities so that the farmers receive both the necessary knowledge about what to do, and the financial means to apply it.

**LP 3: How could collaboration between actors be facilitated, so that measures for enhanced biodiversity can be taken on a landscape level?**
The last LP bridges gaps F and H, as illustrated in figure 5.10. As expressed in gap H, the landscape in which the fields are located is largely homogeneous and monocultural, which implies that biodiversity efforts implemented at field level are likely to have limited effects on the whole, and that cooperative measures are necessary. Yet, current platforms are not sufficient for facilitation of collaboration on biodiversity aspects (gap F). Therefore, it is vital to bring stakeholders together and enable coordinated biodiversity work that is planned and executed at landscape level.

## 5.4 Backcasting step 4: Actions

In this section, suggestions for possible actions that NJ can take are presented for each of the three identified LPs. The suggested actions are linked one to one against the formulated leverage points, as can be seen in figure 5.10 above.

**Action 1: Provide support to biodiversity education**
Regarding LP 1, NJ could support trainings for the farmers within biodiversity and agricultural practices for enhanced biodiversity. From previous experience of supply chain actor education, NJ has concluded that collaboration with external organisations is the most efficient way to coordinate initiatives and ensure high quality of the trainings, according to Environmental Manager Eliina Brinkberg. One option is to educate the farmers about regenerative agriculture, which both NJ and Agrona have shown interest in. WWF Turkey is a potential external partner, since the organisation carries out a local pilot project where regenerative measures are implemented in cotton farming. The interviewed WWF Turkey representative explained that measurements and laboratory analyses of e.g. soil samples are performed to mon-

itor the impact of the practices. No results have yet been published, as long-term effects are to be investigated through comparisons between seasons, but observations, experiences, and recommendations will be shared eventually. As described by Başak (2020a), the organisation will develop a Regenerative Agricultural Practices Guideline for cotton farmers and cooperatives, with enhanced on- and off-farm biodiversity as one objective, and trainings based on the Guideline will be held. NJ could support this initiative by informing Agrona about it, and urge the company and the farmers to engage. Additionally, NJ could work directly with WWF regarding for instance financial support and sharing of knowledge and experiences related to e.g. sustainable production, certification, and cotton supply chain activities.

Another possibility is the regenagri initiative (regenagri, n.d.). It was launched in 2020 by Control Union, the organisation responsible for the organic certification of Agrona's cotton, to guide farms and organisations in their transition to regenerative production. The initiative is meant to foster continuous improvement, and the members are provided a complete framework for measuring and communicating progress. They are also offered advisory support, with trainings in regenerative measures and additional assistance regarding e.g. strategy development, improvement areas, and formulation of key performance indicators (KPIs). A digital hub also provides tools for review and reporting of implemented practices, and facilitates progress tracking and comparison against KPIs. Moreover, if audits prove that the production complies with the regenagri standard criteria, farms can be certified as regenerative. Similarly, other supply chain companies can apply for certification, to be eligible to assert that their products are produced in regenerative agriculture. Thus far, several cotton producers and fabric suppliers, but no apparel companies, have joined the initiative and obtained certification. NJ could therefore encourage Agrona and the farmers to join as well, and also investigate their own possibilities to become certified.

**Action 2: Provide new economic support to the farmers**
One action that addresses LP 2 regarding bridging the economic gap that was found, is to organise measures that offer economic support for the farmers. According to the gathered data, the economic support does not necessarily have to be specifically for biodiversity, but a general increase in welfare and stability for the farmers could enable higher prioritisation of biodiversity and less focus on maximising production. Giving economic support to the farmers could thus be a measure that would solve the gap of implementing biodiversity perspectives even more. Moreover, NJ prefers to give economic support outside of their existing supply chain to guarantee that the economic benefits are not lost as the money is transferred between actors, but reach the targeted actors and purpose, according to Eliina Brinkberg at NJ. Therefore, the company favours collaborations with external organisations over additional payments to suppliers. One organisation that enables economic sustainability for farmers within organic cotton that NJ already has engaged in, is the organisation Chetna Coalition (Nudie Jeans, 2021). The organisation supports farmers through economic funding, but also through education and training. However, it is currently operating in India only. This action therefore suggests that NJ should investigate the

opportunities to engage with a similar organisation in the Turkish cotton production area to enhance the economic stability.

**Action 3: Collaborate with WWF**
The identified action related to LP 3 about actors' collaboration concerns engaging with WWF Turkey. The organisation holds knowledge about the local environmental conditions and problems, yet also about what is needed of the many actors in the area to solve the issues. Below, two WWF projects identified during the interviews that could be effective solutions for NJ to engage in are presented.

One relevant project is the Büyük Menderes Water Stewardship Strategy, which the interviewed environmental consultant has been working with, and the following information is retrieved from a report she prepared for WWF Turkey (Başak, 2020a). The project includes a number of approaches and actions, requiring multi-stakeholder collaborations, to enable environmentally, socially, and economically sustainable water use in the area. An important part of the initiative is the so-called WWF Water Stewardship Ladder, which is used to guide private sector actors. In implementing the ladder tool, a business actor commits to the development of sustainable water management by engaging in cooperative action with other businesses, communities, non-governmental organisations (NGOs), and governments. The long-term aim of the Strategy is firstly to enhance the water quality, with special focus on severely polluted hotspots. Secondly, an agreement for the entire basin should be made between the government, companies, and organisations representing the civil society. Lastly, the aim is to promote protection and restoration of freshwater habitats and species. When asked about the possibilities for NJ to participate in the project, the representative at WWF Turkey seemed very positive. The suggested action could thus be for NJ to invest in the project, and initiate communication with Agrona regarding it, as it supports the type of broad collaborations that would bridge the identified gap.

Another project conducted by WWF Turkey is the development of a road map for restoration of the Bafa Lake and the Büyük Menderes Delta's wetland systems, which are highly important both ecologically and socially. The environmental consultant that was interviewed has been involved in this initiative as well, and the following description is based on another of her reports (Başak, 2020b). One of the affected species is the European eel, which has a strong conservational value from a biodiversity perspective, and is fundamental for local fishery. Therefore, it is considered a suitable flagship species to build WWF's work in the wetlands around. The species is critically endangered according to the International Union for Conservation of Nature (IUCN), and the main threats to this species in the studied area are the water quality and quantity issues. To address this, WWF calls for collaboration and intends to create a platform for conservation of the species, engaging multiple stakeholders. According to the representative at WWF Turkey, this, too, would be a possible way for NJ to contribute to biodiversity enhancement in the area. However, it is not primarily financial support that is needed, but rather efforts to create attention and spur collective action.

# 6

# Discussion

This chapter begins with a discussion of the study's results and their credibility, structured according to the four backcasting steps. Thereafter, the applied methods and their suitability and implications are discussed. Lastly, some suggestions for further research are provided.

## 6.1 Discussion of results

### 6.1.1 Backcasting step 1: Desired future state

The identified sustainability principles are well adapted to the context, and fulfilled their purpose of facilitating the gap identification well. Yet, their formulation was highly influenced by the choice of frameworks and actors to include and the perspectives and ethical reasoning they represent, as is always the case in backcasting processes. The main references used were the UNSDGs and the Aichi targets, and the authors processed the information and considered the impact from NJ. Hence, inclusion of other or additional references and/or actors might have resulted in slightly different principles. For instance, both the UNSDGs and NJ represent a rather anthropocentric view, while other frameworks and stakeholders may have a more ecocentric view that only accepts very limited human impact on nature. To even more accurately capture different perspectives on the system, more actors should therefore have been included.

The principles are judged to be comprehensive and to cover the studied system satisfactorily. They are based on broad frameworks that aim to address issues holistically, and also match the collected data well. The principles have a slightly broader focus than only biodiversity, and include some more general sustainability aspects. This proved useful, as it facilitated the connection between cotton production, biodiversity impacts, and NJ's operations. Moreover, the principles are based on globally applicable frameworks, which affected the formulation of the desired state. Some degree of local anchoring, e.g. by including Agrona or the farmers in the formulation process, might have provided even more locally relevant gaps and actions.

The principles are largely unambiguous and non-overlapping, and only a few of the identified positive or negative aspects were assigned to more than one or two principles in the gap identification. Yet, it would have been possible to formulate somewhat fewer but broader principles, as some of them bore some resemblance (primarily principles 1 and 2, and 6 and 7). This would perhaps have made the desired state more graspable, provided that the principle formulations were made concise and clear, but the current number of seven principles is still considered acceptable.

### 6.1.2 Backcasting step 2: Current state and gaps

The first part of the aim, to holistically map the impacts of the cotton production on biodiversity in the area, was achieved in step 2 of the backcasting procedure. A broad mapping was made, and although some parts are not very profound, it is considered to cover most of the essential aspects of the system. Some key findings were that the human activity and its impacts on biodiversity are high in the area in general, and that water and soil issues are especially problematic. However, Agrona's production is managed relatively well from a biodiversity perspective, including water and soil management, partly due to the organic certification, and the farmers express awareness about biodiversity and have a positive attitude towards increasing it. Yet, their financial situation prevents them from prioritising biodiversity, and many issues cannot be solved by individual actors but demand multi-stakeholder collaborations and landscape perspective.

The interviews together constituted a major source of information, and the interviewees complemented each other relatively well regarding areas of knowledge. However, they were relatively few, and hence, the results may not paint the full picture. Not least, the interviewed farmers represent a large group of farmers connected to Agrona, and some aspects of their answers may not be representative for all farmers. Moreover, not all actors' perspectives could be covered considering the complex actor network in the area and difficulties in establishing contacts. For instance, it would have been beneficial to include more NGOs than WWF Turkey.

Not all interviewees were closely familiar with the biodiversity term, and answers to questions about biodiversity were sometimes more about sustainability in general. Occasionally, this made it difficult to assess the answers, especially if it was not clear whether the interviewee referred to biodiversity or general sustainability. Linguistic barriers may also have contributed. Some interviewees were not accustomed to using English, which impeded communication in general and particularly that regarding understanding and valuation of biodiversity. In the farmer interviews, the sales and marketing manager at Agrona acted as translator, which was not ideal considering his position as manager at Agrona. The farmers may not have felt able to talk freely, and Agronas' representative could have left out or altered parts of their answers. The authors want to underline that no such tendencies were observed, but to ensure reliability, an external translator would still have been preferrable. Moreover, the sales and marketing manager at Agrona may not have been sufficiently knowledgeable about biodiversity and agriculture to convey all nuances of the questions and answers. Linguistic limitations potentially affected the level of detail as well, i.e., certain aspects may have been lost in translation. The filtering of answers through the representative at Agrona also meant that only summaries of discussions, rather than entire lines of reasoning, were noted and that the farmers' answers might have been coloured by his attitude. Despite these issues, an advantage of the representative from Agronas' presence was that he has good understanding of the Turkish culture and knows the farmers, but as Sales and Marketing Manager, he also meets with international customers regularly. This meant that he could explain the questions and answers, and thus ease the communication between interviewers and interviewees in more ways than only linguistically.

The field visits also generated important data. Yet, only two fields were studied, and these may not have been fully representative for all NJ's fields. Furthermore, the authors have limited experience of biodiversity assessment, and may have overlooked some important aspects. Moreover, the visits were made in March, i.e., not during the cotton cultivation season. It could have been beneficial to assess the fields later in the year, as it might have enabled further verification of the information given in interviews, but it was still possible to assess how the fields were used (e.g., presence of field margins and filter strips) and features of the surrounding landscape. The literature study also contributed to the verification, although it only provided more general information about the area and not NJ's fields specifically.

Several different gaps could have been formulated based on the mapping, leading to many different LPs and hence actions. Since the research question related to the mapping is quite broad, it was regarded as reasonable to provide relatively many gaps, but the number was limited to nine (one or two per principle) to be manageable considering the scope of the study. The gaps are deemed to be concrete, and to jointly cover the deficiencies of the system quite well, thus providing a comprehensive view of the areas of improvement.

### 6.1.3 Backcasting step 3: Leverage points

As described in section 3.4, the chosen LPs do not cover all gaps. The selection of gaps to address in the LPs and the subsequent LP formulation was based on their potential to lead to concrete actions with high feasibility in NJ's context. Again, the scope of the study was considered when deciding what would be a reasonable number of LPs. Although the three identified LPs do not span all issues identified in the mapping, they are deemed to provide a good indication of three different areas that are crucial to address to improve the current situation. The first LP concerns the farmers' knowledge and actions, thus focusing on the field level; the second highlights the economic situation and the farmers' possibilities to prioritise biodiversity; and the third regards stakeholder collaboration and coordination, i.e., landscape level aspects. Together, these quite diverse areas span several important dimensions of the system. The final LP formulations for the areas were intentionally made in rather broad terms. This was beneficial, as it opened up for many potential actions. The choice to formulate them as questions also contributed positively to the final backcasting step, as it supported creativity and openness in the brainstorming process.

### 6.1.4 Backcasting step 4: Actions

As for the gaps and LPs, the number of suggested actions was decided based on the scope of the study. Hence, the three presented actions are not considered a comprehensive set, but reasonable examples. As explained in section 3.5, the selection of gaps was made according to their potential to bridge the gap(s) addressed by their respective LPs, and their feasibility considering NJ's sphere of influence and room for action. Since the description of the current state showed that several measures already have been taken in Agrona's production, which is managed quite well from a biodiversity perspective compared to the general situation in the area, few quick fixes and low hanging fruits were available. Instead, broader and more systemic actions were suggested. This is considered beneficial, since the mapping also indicated that the farmers are locked into a system with limited potential to support biodiversity, and that landscape level interventions are needed.

Actions 1 (support to biodiversity education) and 3 (stakeholder collaborations organised by WWF Turkey) are considered more concrete than action 2 (economic support to the farmers), and thereby easier to evaluate. However, all three are assessed to have the potential to bridge the gap(s) they are associated with, and to be implementable for NJ. Regarding action 1, Agrona already arranges trainings with the farmers, meaning that there is infrastructure for knowledge sharing in place that could facilitate sessions within the framework of WWF's regenerative project and/or the regenagri initiative. Hence, the action appears to be feasible, and it is also in line with NJ's preference of collaborating with external organisations. Action 2 is less detailed and points out a direction rather than gives specific instructions, since no organisation of the kind that is called for was identified in the study. Hence, it demands a larger effort of NJ, but the economic situation stood out as a major issue to address, which indicates that this action could have important positive effects. Lastly, concerning action 3, the representative at WWF Turkey seemed positive about NJ participating in both the Water Stewardship project and the eel project, and since this action also fits with NJ's will to cooperate with external actors, it is judged to be feasible.

## 6.2 Discussion of methodological choices

### 6.2.1 To use or not to use backcasting

Early in the process of initiating this study, the choice was made to use backcasting. This has shaped all methodology and guided all succeeding methodological steps. It is consequently considered suitable to analyse how it impacted and possibly limited the results of the study.

Backcasting was implemented in the study as a guiding structure, a framework with room for methodological choices within the steps. The method can, however, be more or less of a strict procedure of steps to follow. Thus, the shape of a backcasting study may vary. In general, the idea to include the many perspectives of the studied system to achieve results that are suitable for the included perspectives are at the core of achieving a good result that may be implemented well and that can achieve transformation. The scope of this study was, however, limited, and choices were made throughout the method that narrowed down the study and the perspectives for manageability reasons. For instance, only nine gaps, three LPs, and three actions were identified. Similarly, the involvement of NJ in the process of the study was limited to two occasions, and the data sampling phase can be considered as relatively short, although broad. In all the mentioned choices, more perspectives and aspects could have been considered which could have enabled solutions better suited to more actors or aspects of the system.

Backcasting did, nevertheless, provide structure for the authors and supported the results and collection of data through set directions. The method is well in line with the aim of this study, as it gives both a mapping and concrete actions as results. It is thus perceived to be well suited to this type of assessment. However, the same sort of results could possibly have been reached without backcasting. Backcasting is time consuming in relation to the given aim of achieving a mapping of the cotton farming's impacts and to propose actions. Not doing a backcasting study might have given room for a more extensive and deeper mapping of the system and impacts, as no formulation of principles and LPs would have been necessary. This might have enabled a more true or nuanced description of the system.

Yet, backcasting has provided results that are well adapted to both the system and to NJ's business. Backcasting in general is considered to be a powerful tool that both is well grounded in the current situation of the issue, but also very clearly points out the future. This was true for this study as well, as the proposed final actions seem to fit both the system on site in Turkey and NJ's ambitions for their future. Finally, the method can be concluded to be very pedagogically structured, as it clearly communicates very complex problems, such as the one studied here, through a timeline. Moreover, it is believed that the backcasting as a method provided more than direct results, but also initiated a learning process for the included actors. NJ has through the involvement in the first backcasting step been urged to reflect over what they desire and should strive for regarding biodiversity work within their business. Moreover, it is believed that by interacting with Agrona and the farmers, they learn about their process's relation to biodiversity and how they could help the transition. This is yet another reason for the backcasting to include more actors of the system.

### 6.2.2 Qualitative research

Regarding the qualitative character of this study, some remarks are to be made about the strengths and weaknesses of the choices made. The different parts of the qualitative data collection can be considered to strengthen each other rather well. Data from the interviews with for example the farmers or the soil scientist was possible to verify through observations on the fields and by assessing literature on the topic. This became important for triangulation purposes and increased the validity of gathered information. Moreover, the data that was not possible to observe on site at the fields, such as practices after harvest, given that the field study was carried out in early spring before the cotton was planted, could be collected during interviews and from literature. Likewise, the crop rotation demanded by the certification was not possible to observe due to the need to observe the practices during several years, but this data could also be gathered from interviews and literature instead. Thus, the different types of data gathering methods complemented each other as well.

In spite of the central role of triangulating data through literature, the study did not carry out any extensive literature study. The depth to which the literature was assessed varied and the search process did not uphold a rigid structure. Since the purpose was triangulation of found data, the search words were extracted from what had been gathered on site, and the search was done when deemed useful. The limited extent of the literature study and the irregular character of its execution were due to the limited scope of the study overall. The role of the literature study was, however, judged to be sufficient and well adapted to the study's purpose. A more extensive and well-structured literature study might have been useful and could have rooted the observations and interviews even more in previous research. But the scope of this study focuses mostly on NJ and Agrona, for which a limited amount of literature exists due to research often being done in more general terms.

A finalising comment on the qualitative research, regards the authors' objectivity in the matter. Throughout the process, the authors have made efforts not to let their own agenda or preferences affect the analysis or the data gathering. Yet, due to little experience in the field of qualitative research, it has been difficult to tell whether opinions and frames of reference have affected the outcome. The study is, however, on the whole judged not to mirror the opinions of the authors, but the system that they studied. The support of structured analysis procedures and iteration have been helpful to avoid subjectivity through the study.

## 6.3 Suggested future research

The limitations of the study opes up for suggestions on how to continue the research. Some alternatives for how to take the results further are given in this section.

The study's qualitative character puts results that quantifies biodiversity impacts out of reach. It is thus reasonable that the proposed actions are systemic measures rather than exact changes of practise. However, for NJ to continue the pursuit of identifying their production's impact on biodiversity, direct results on changes in number and richness of species must be searched for. Thus, a suitable way to move forward from this study's results is to do an inventory of species over time. The need for monitoring is, furthermore, a result of this study, as called for by many actors. When specific and quantifiable impacts on biodiversity are found, the analysis of which impacts that are possible to mitigate should be done for NJ to be able to act accordingly.

To compensate for unavoidable impacts might also be a viable method to act on the identified impacts. However, the issue is morally difficult, and it is very important that a damaging activity is not allowed to continue because the responsible part claims to make amends for it somewhere else. The risk of compensating is that something damaging is done without endeavouring to decrease the harm while paying for something beneficial, according to the interviewed biodiversity specialist.

Moreover, the study has clearly shown that the environmental impacts in the Söke plain and the area around Torbalí are much larger than that of NJ's producer and its farmers. Another suggestion to move forward in the issue is consequently to perform an assessment on biodiversity impacts that includes more actors. This aspect of collaboration to achieve systemic transitions is in line with the suggested actions in this study.

# 7

# Conclusion

To conclude, the backcasting framework provided satisfactory support, and made it possible to answer all research questions. It was found that NJ's perception of a desirable future state regarding biodiversity in the area is largely in line with global targets, although some business aspects limit their level of ambition. In short, agriculture and other production should be performed sustainably, financial means should be made available, and actors should be knowledgeable and aware, and communicate and collaborate. Moreover, ecosystems and habitats should be protected, and effects of human activity that cause biodiversity loss should be minimised. Regarding the mapping of the current situation, it showed that impacts on biodiversity due to agriculture and other human activity are quite large in the area in general. For instance, the landscape is rather homogeneous, and water and soil pollution is a major problem. However, several mitigating measures are already implemented at field level in Agrona's production, and the farmers are willing to increase the efforts further.

Since the production is already managed relatively well from a biodiversity perspective, the three actions that were suggested for impact mitigation are systemic rather than directly production oriented. Two important barriers to enhanced biodiversity are limited knowledge among the farmers about biodiversity, and their difficult economic situation. To handle these obstacles, cooperation with external organisations is needed. Moreover, facilitation of multi-stakeholder collaboration is necessary to address the problems in the area, since they must be considered from a landscape perspective and demand coordinated efforts. Hence, all actors share the responsibility to take initiative and create networks.

Further assessment of biodiversity impacts through inventory and monitoring is needed, but NJ's engagement in biodiversity issues is already commended by several interviewed experts and the company has an important role to play. Lastly, it can therefore be concluded that although the situation regarding biodiversity is problematic in the area, relocation is likely not the best option for NJ. This would entail a substantial risk of another, less conscious actor taking NJ's place, and NJ's own impacts would be moved elsewhere. Hence, it is more constructive to remain in the area and continue to make a difference by raising awareness about biodiversity and spur further action.

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# A

# Example of interview protocol

## Interview with Agricultural researcher at the Turkish Ministry of Agriculture and Forestry, 16 March

Could you briefly describe the work you do at BATEM?

What issues related to cotton cultivation are most important (largest effects etc) and/or urgent to address (already reached critical levels, will take most time to change etc)?

To what extent and in what ways is biodiversity addressed within research on cotton cultivation?

What does the link between research and practice look like? Do you interact a lot with e.g. farmers, ginners, and/or cotton supply companies to exchange knowledge etc?

Are there any measures taken of prioritising biodiversity in agriculture today in Turkey? Such as intercropping, border crops or usage of agroforestry?

Have you heard of Agrona? In that case, what is your view of them as a company? Genuinely engaged in sustainability/biodiversity?

Söke vs Torbalí

- Were told that all fields were in the Söke area, turned out there are fields in the Torbalí area as well
- Is what we have learned about Söke applicable to Torbalí as well? Soil pollution, Menderes River, old agricultural area etc
- If not, what are the most important aspects to look into for Torbaí?

Changes observed since shifting to organic

- More ladybugs, bees, birds, boars and hence coyotes, both locally near the fields and in the Büyük Menderes National Park
- How fast do this kind of changes normally occur? How can one tell whether it is actually due to the changes in farming practices?

Regenerative production

- The sales and marketing manager at Agrona talked about it quite a lot, next step after organic
- What is your view/experience of this?
- Is it common in cotton production (here or elsewhere)?
- What are the benefits?
- What are the disadvantages?
- Do you think that it will become more common in the near/far future?

Water

- According to Agrona, it is not mandatory by law to take samples, but they do it for their own sake, will get example report
- What should they be testing for, in your opinion?
- The fields do not have drainage systems, what are the most important implications of this?
- Is it common to have drainage systems in cotton cultivation?
- How much money and work would it require to create drainage systems?

Seeds

- According to the sales and marketing manager at Agrona, the farmers only purchase very small amounts of new seeds, use 70-90 % leftovers from last year. Does this sound reasonable? What is a common ratio new/reused?
- Always buy genetically identical seeds since the genes affect the quality of the cotton, is this correct?
- Are there many high-quality seeds to choose from (so they could increase genetic biodiversity without decreasing the quality)?
- Would it be possible to have a seed swapping system? Not allowed to give away seeds, but selling is ok (Representative at Agrona)

How would you describe the political and public interest in/awareness regarding biodiversity, its values, and the effects of its loss?

# B

# Tables for gap identification

The categorisation of positive and negative aspects of impacts on biodiversity for each of the principles are given in tables. The aspects are colour coded according to which of the ten areas of analysed data in section 5.2 they originated from. The colour code can be seen in figure B.1.

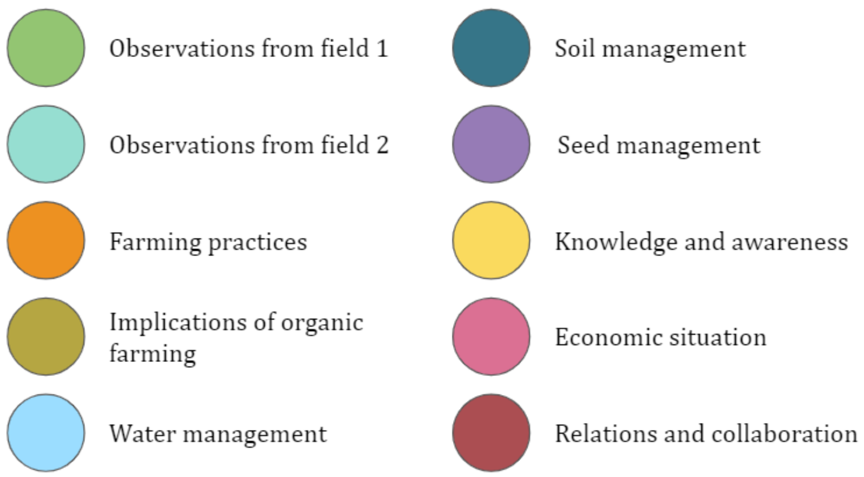


***Figure B.1:*** *A figure showing the assigned colours to each of the ten areas of analysed data.*

***Table B.1:*** *Comparison of mapping results to principle 1, Sustainable agricultural management.*

| **Principle 1: Sustainable agricultural management** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Grass cultivated in the field and presumably cotton residues left between seasons | The irrigation canal contained unclean and small amount of water |
| Clean water in irrigation canal | Do not have intercrops between cotton rows |

Continued on next page

**Table B.1 – continued from previous page**

| Positive aspects | Negative aspects |
|---|---|
| Grass cultivated in the field off season, the majority to be ploughed into the soil for soil health purposes | Do not leave cotton residues on farmland for increased soil organic matter |
| Performs organic farming | Always use the same type of seeds in each field, even though different kinds could be used theoretically |
| Uses manure and dried weeds as fertilisers, very limited and controlled use of synthetic fertilisers | The seeds produce phenotypically similar plants |
| Uses biological pest control, very limited and controlled use of synthetic pesticides | |
| Grows alfalfa in between seasons | |
| Practices crop rotation every three years | |
| Performs organic farming | |
| Takes irrigation water from rainfed dams, not the Menderes River or groundwater | |
| Makes analyses of the irrigation water, which show good results | |
| Uses drip irrigation, not sprinkler systems or flooding | |
| Performs organic farming | |
| Irrigation water from rainfed dams, instead of using polluted river water | |
| Adds bacteria and fungi to the soil for increased soil health purposes, instead of synthetic pesticides and fertilisers | |
| Grows alfalfa in between seasons for nitrogen fixation | |
| Uses last season's weeds as fertiliser, instead of synthetic inputs | |
| Practices crop rotation every three years | |

***Table B.2:*** *Comparison of mapping results to principle 2, Sustainable production and consumption and efficient resource use.*

| **Principle 2: Sustainable production and consumption and efficient resource use** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Small filter strip with naturally growing plants between the field and the canal | Does not monitor biodiversity |
| Field separated from the irrigation canal by filter strip with natural vegetation | Lack of governmental economic incentives for sustainable production |
| Performs organic farming | |
| Uses manure and dried weeds as fertilisers, very limited and controlled use of synthetic fertilisers | |
| Uses biological pest control, very limited and controlled use of synthetic pesticides | |
| Seeks to understand water and carbon footprint through an LCA study | |
| Organic certification enables new economic opportunities which increase the possibility for farmers to keep their land, and the incentive to care for the surrounding environment is upheld | |
| Performs organic farming | |
| Takes irrigation water from rainfed dams, not the Menderes River or groundwater | |
| Makes analyses of the irrigation water, which show good results | |
| Uses drip irrigation, not sprinkler systems or flooding | |
| Performs organic farming | |
| Irrigation water from rainfed dams, instead of using polluted river water | |
| Adds bacteria and fungi to the soil for increased soil health purposes, instead of synthetic pesticides and fertilisers | |
| Uses last season's weeds as fertiliser, instead of synthetic inputs | |
| Demand-driven transformation of the system towards sustainability | |
| Increased demand for natural fibres and organic cotton | |

Continued on next page

**Table B.2 – continued from previous page**

| Positive aspects | Negative aspects |
|---|---|
| Customers show interest in biodiversity | |
| Well-founded sustainability work at Agrona | |
| Organic production gives economic benefits which enable environmental work | |
| Forecasting and advance payments improve the economic situation | |

***Table B.3:*** *Comparison of mapping results to principle 3, Sufficient financial support for biodiversity.*

| **Principle 3: Sufficient financial support for biodiversity** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Invests in tree planting | The farmers are economically restrained, and cannot afford to prioritise biodiversity |
| Organic certification enables new economic opportunities which increase the possibility for farmers to keep their land, and the incentive to care for the surrounding environment is upheld | Insufficient governmental support for agriculture |
| Organic production gives economic benefits which enable environmental work | Lack of governmental economic incentives for sustainable production |
| Forecasting and advance payments improve the economic situation | |

***Table B.4:*** *Comparison of mapping results to principle 4, Extensive knowledge and widespread awareness of biodiversity values.*

| **Principle 4: Extensive knowledge and widespread awareness of biodiversity values** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Seeks to understand water and carbon footprint through an LCA study | Does not monitor biodiversity |

Continued on next page

**Table B.4 – continued from previous page**

| Positive aspects | Negative aspects |
|---|---|
| Soil health seems to be prioritised and understood comparatively well | Farmers seem to have a simplified view of biodiversity system complexity, as they fail to make connections from landscape perspective |
| General political and public awareness for sustainability and biodiversity | Has potentially deficient insight into drainage issues |
| Demand-driven transformation of the system towards sustainability | Lack of biodiversity perspective in breeding |
| Increased demand for natural fibres and organic cotton | Lack of concrete action for sustainable development |
| Customers show interest in biodiversity | Agricultural research focuses on improving production |
| Well-founded sustainability work at Agrona | Agrona's sister company has limited understanding of local strategy need |
| Agrona shows understanding of the need for a concrete, local biodiversity strategy | Farmers do not talk about local flora |
| High self-reported biodiversity awareness and knowledge among farmers | Agrona and farmers do not talk about all types of biodiversity, only species diversity |
| Farmers make a connection between impacts on surrounding nature and impacts on themselves | Farmers have limited knowledge about possible agricultural measures for enhanced biodiversity |
| Farmers seem knowledgeable about local fauna | General trend of anthropocentric prioritising in society |
| The farmers want to do more for biodiversity | |
| Collaboration between industries, currently focusing on biodiversity | |

***Table B.5:*** *Comparison of mapping results to principle 5, Well-functioning collaborations, and transparent communication.*

| **Principle 5:Well-functioning collaborations, and transparent communication** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Generally good understanding of the importance of and positive attitude towards collaboration among Agrona, farmers, and actors of the extended system | Lack of policy coordination between adjoining areas |

Continued on next page

**Table B.5 – continued from previous page**

| Positive aspects | Negative aspects |
|---|---|
| Recent change in structure of national administrative work, forestry and agriculture are joined in a single Ministry | Insufficient platforms for collaborations in the area to enable resource allocation and transition of the system |
| Well-functioning relationship between farmers and Agrona (both structured and informal) | |
| Collaboration between industries, currently focusing on biodiversity | |
| Well-functioning relationships between farmers, as they help each other and live in the same villages | |

***Table B.6:*** *Comparison of mapping results to principle 6, Well-functioning ecosystems and habitats.*

| Principle 6: Well-functioning ecosystems and habitats | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Grass cultivated in the field and presumably cotton residues left between seasons | Observed natural vegetation close to the field is relatively limited |
| No fences | Relatively large field among very many other monocultural fields, a large plain on a landscape level |
| Some natural vegetation close by the field, and some diversity among plant species | The field area is enclosed by smaller and larger roads, potentially limiting animal migration |
| Small filter strip with naturally growing plants between the field and the canal | Few larger areas with natural vegetation among the fields |
| Some natural vegetation on a somewhat broader strip separating the field from the adjacent one | Relatively large field among very many other monocultural fields, a large plain on a landscape level |
| On a landscape level, some trees and other natural vegetation intermixed between the fields and roads, to a larger extent than around field 2 | Few larger areas with natural vegetation among the fields |
| On a landscape level, hills/mountains with natural or semi-natural ecosystems surround the plain | The field area is enclosed by smaller roads, potentially limiting animal migration |

Continued on next page

**Table B.6 – continued from previous page**

| Positive aspects | Negative aspects |
|---|---|
| Grass cultivated in the field off season, the majority to be ploughed into the soil for soil health purposes | There was a fence on the left side of the field, limiting animal movement |
| Some natural vegetation close by the field, some diversity among plant species | Harvest field margin plants |
| Field separated from the irrigation canal by filter strip with natural vegetation | Large, monocultural fields and machinery used in marketing |
| Three of four sides not fenced in | Intensive and increasing human activity in the area |
| More extensive vegetation on the strips around the field compared to field 1 | Expected increase in cotton production, leading to increased landscape homogeneity |
| On a landscape level, occasional trees and other natural vegetation among the fields | |
| On a landscape level, hills/mountains with natural or semi-natural ecosystems surround the plain | |
| Uses manure and dried weeds as fertilisers, very limited and controlled use of synthetic fertilisers | |
| Has field margins with native plants | |
| Plants trees around the fields | |
| Grows alfalfa in between seasons | |
| Practices crop rotation every three years | |
| Invests in tree planting | |
| Organic certification enables new economic opportunities which increase the possibility for farmers to keep their land, and the incentive to care for the surrounding environment is upheld | |
| Takes irrigation water from rainfed dams, not the Menderes River or groundwater | |
| Irrigation water from rainfed dams, instead of using polluted river water | |
| High soil fertility in the areas, without adding fertilisers | |

Continued on next page

**Table B.6 – continued from previous page**

| Positive aspects | Negative aspects |
|---|---|
| Adds bacteria and fungi to the soil for increased soil health purposes, instead of synthetic pesticides and fertilisers | |
| Grows alfalfa in between seasons for nitrogen fixation | |
| Uses last season's weeds as fertiliser, instead of synthetic inputs | |
| Practices crop rotation every three years | |
| Organic production gives economic benefits which enable environmental work | |

***Table B.7:*** *Comparison of mapping results to principle 7, Minimised biodiversity loss caused by human activity.*

| **Principle 7: Minimised biodiversity loss caused by human activity.** | |
|---|---|
| **Positive aspects** | **Negative aspects** |
| Some natural vegetation close by the field, and some diversity among plant species | Intensive and increasing human activity in the area |
| Some natural vegetation close by the field, some diversity among plant species | Does not monitor biodiversity |
| Performs organic farming | The positive effects on species populations as a consequence of the transition to organic are questionable |
| Uses biological pest control, very limited and controlled use of synthetic pesticides | Always uses the same type of seeds in each field, even though different kinds could be used theoretically |
| Leaves small maize corns in the fields for birds | The seeds produce phenotypically similar plants |
| Farmers perceive an increase in observed species since the transition to organic farming | |
| Performs organic farming | |
| Performs organic farming | |

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