Mapuche Sustainable Farming: what we can learn from the biggest indigenous group of Chile

Mapuche Communities Protest Against Land Seizure in Wallmapu (Protests.media, 2020).

Lotte van der Grinten
Student nr. 2991311
BSc Global Sustainability Science
Supervisor: Kees Klein Goldewijk
Second reader: Ádám Tóth
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Utrecht University

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Summary

Anthropogenic land use changes have contributed to global climate change over the years. Using indigenous traditional farming practices might be a possibility to be able to keep feeding the growing world population, while maintaining the natural environment. This research aims to find the effects of traditional farming practices by the Mapuche, the biggest indigenous society of Chile, on the local environment. This is done based on a literature review. The Mapuche make use of seed exchange networks, small polyculture orchards, intercropping, crop rotation, irrigation and natural fertilizers. Overall, these practices beneficial effects on biodiversity, resilience and on the soil. This is partly due to the fact that the agricultural purpose is subsistence and no commercial motives are present. The incorporation of these practices into the Dutch highly industrialized agricultural sector is explored. The aim of the research is to investigate whether aspects of the indigenous practices can be used to steer the Western agriculture towards a more sustainable system. This research is written from a Western perspective without including the Mapuche community in the process, this makes the research is limited.

Introduction

In the past 300 years, land use has changed significantly. The global surface area containing croplands has increased by almost a sixfold. Originally undisturbed forests, grasslands, steppe and savannas have been cleared for agricultural purposes and the global amount of pasture has increased at a high rate. This has led to the current situation, in which globally more or less 40% of the ice-free land is used for agriculture or settlements. Anthropogenic land cover changes are of great influence on ecosystem processes. These changes lead to greenhouse gas emissions and have contributed over the years to the accumulation of carbon dioxide in the atmosphere (Klein Goldewijk, 2017; IPCC, 2019). Western agricultural practices nowadays are often linked to the export of agricultural products. It is argued that agricultural exports lead to economic growth, however this industrial agriculture comes with a variety of environmental and social problems, such as biodiversity loss (Altieri, 2009; Aguayo et al., 2009).

In order to be able to keep feeding the growing world population in the future while maintaining the natural environment, societies will have to explore new alternatives for our food system, because we are facing serious challenges such as climate change and environmental degradation (Pautasso et al., 2013; Alam et al., 2014). Incorporating indigenous traditional farming may be a part of the solution. Previous research has shown that traditional farming practices are often more nature-friendly than modern agricultural practices. It has been shown that indigenous managed lands have higher biodiversity rates than non-indigenous owned lands (Schuster et al., 2019; Nolte et al., 2013). Using indigenous traditional farming methods, agroecosystems have emerged that conserve agrobiodiversity and safeguard genetic diversity and local ecological knowledge (Altieri, 2004). Most agroecologists acknowledge that traditional farming practices have potential to bring solutions to the uncertainties facing humanity in the era of global climate change (Altieri & Toledo, 2011). Research shows that some indigenous communities use traditional practices

that are more effective in controlling wild fires and avoiding deforestation than practices used in non-indigenous owned areas (Nolte et al., 2013; Yibarbuk et al., 2001). To explore the possibilities of traditional farming methods, this research aims to investigate the traditional farming methods of a specific indigenous group. A focus will be put on the biggest indigenous society of Chile, the Mapuche. This will be done according to the following research question:

"How do indigenous traditional farming methods of the Mapuche affect the local environment?"

The name Mapuche is derived from two words in Mapudungun, the language spoken by the Mapuche. The word 'mapu', which means land and the word 'che', which means people, so they literally call themselves people of the land (Ñanculef Huaiquinao, 2016). The interaction between the population and the land is mostly based on the understanding that nature and land use is sacred (Peña-Cortés et al., 2020). They are the biggest indigenous group in both Chile and Argentina and among the most numerous and diverse indigenous societies of Latin America (INDEC 2024; INE, 2017. Because of the size of the population and the close connection to the land, the Mapuche are an interesting group to look into regarding land use and agriculture.

The Mapuche is the only indigenous community that was not defeated by the Spanish invasion. Still, the Mapuche have a long history of fighting oppression and discrimination by the Spanish, the Chilean and the Argentinean (Bañales-Seguel et al., 2020). The interference of the Chilean government with the Mapuche, resulted in land expropriations from the Mapuche population (Peña-Cortés et al., 2020). The Mapuche have experienced a lot of land loss. They are people of the land, but not much of their ancestral land (shown in figure 1) is left:

"I was a good person of my land, but the wingka [someone white, reference to the Spanish colonizers] took my land away from me…" - Kolüngür a Nawelpi, 1901, in Canío y Pozo, 2013: 440 (Marimán Quemenado, 2023).

The establishment of a border at the Bío bío river in 1656, seemed to put an end to the invasion of Mapuche territory, until the Chilean state created the province of Arauco in 1886, which meant that the lands south from the river Bíobío were no longer controlled by the Mapuche. From that moment on, land could be bought or sold with only the authorization of a local state authority. Chile's burgeoning agricultural export aimed to benefit from the acquisition of the fertile lands owned by the Mapuche (Crow, 2013). Up until today, the Mapuche are still fighting for their lands and experience high rates of poverty, illiteracy and discrimination (Andrade, 2019; Carruthers & Rodriguez, 2009). Nowadays, 17,6% of all individual farmers in Chile are part of the Mapuche, while the area of their land only represents 2,2% of the total farming area (ODEPA, 2019).

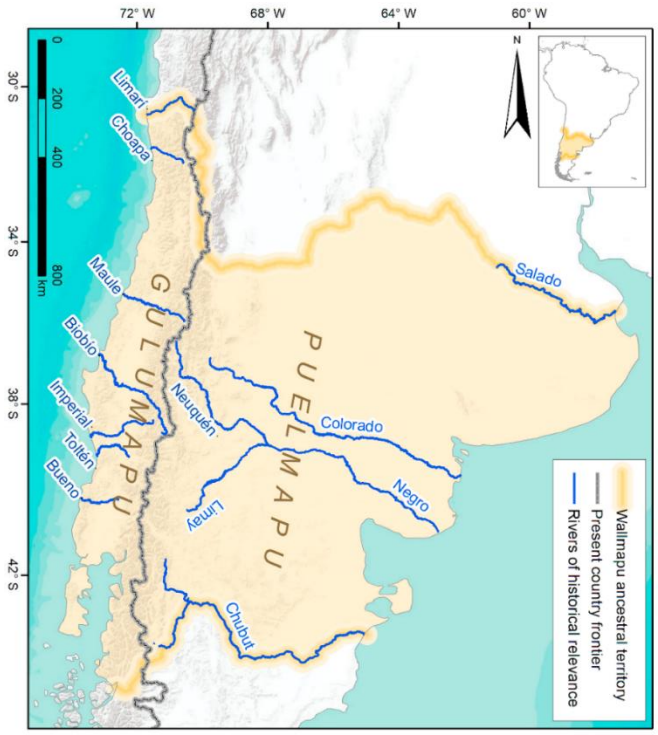

Figure 1. The ancestral territory of the Mapuche, denominated the Wallmapu. Consisting of the Puelmapu, land east of the Andes and the Gulumapu, land west of the Andes (Bañales-Seguel et al., 2020).

There has been a rise in social movements in recognition of indigenous cultures, ways of living and knowledge systems. The rapid increase and activation of Mapuche intellectuals who contribute with their authentic perspective to the debate and the struggle for self-determination is an example of this movement (Melin Pehuen et al., 2016; Ñanculef Huaiquinao, 2016; Marimán Quemenado, 2012; Enrique & Ruth, 2019). Research on the farming practices used by the Mapuche, cannot be done in a vacuum, the social and cultural perspectives need to be taken into account since these are so closely linked and integrated with their land use.

After investigating the land use practices of this group, the possibilities for incorporating aspects from the indigenous traditional farming techniques into modern industrialized agriculture will be considered. A case of highly industrialized modern agriculture is found in the Netherlands. The Dutch agricultural sector is the most productive and efficient of the Euopean Union, which makes it an interesting case for this research (van Grinsven et al., 2019). The aim of the research is to offer insight into the possible incorporation of these aspects to contribute to achieving ecological, economic, and social sustainability within food systems. In the discussion of the research the following sub question will be answered: to what extent is it feasible to incorporate aspect of Mapuche indigenous farming into the Dutch agricultural system?

1. Theoretical frameworks

1.1 Agroecology

To investigate the indigenous traditional farming methods of the Mapuche and their effects on the local environment, the concept of agroecology is used. This word derived from the words ecology and agronomy. Agroecology is closely related to the protection of natural resources and gives insight into a way towards sustainable agriculture (Wezel et al., 2009). The term has been through a lot of changes over time and is used in different ways. Wezel et al. (2009) describe that the term is used to refer to either a scientific discipline, an agricultural practice or a social or political movement. Since the term was first coined in scientific papers in 1928 and 1930, the word has increasingly been used in scientific papers and the definition and use of the term have changed over time. It became defined as "a way to protect natural resources, with guidelines to design and manage sustainable agroecosystems" (Wezel et al., 2009). Conway (1987) developed the concept further and identified four main properties of agroecosystems. These are: sustainability, productivity, stability and equity. Agroecology started contributing more and more to the concept of sustainability within agriculture. Francis et al. (2003) defined agroecology as "an integrative study of the ecology of the entire food systems, encompassing ecological, economic and social dimensions, or more simply the ecology of food systems".

The properties defined by Conway (1987) combined with the dimensions outlined by Francis et al. (2003) will form the different perspectives from which this research will be done. The main focus of the research will be on how agricultural practices by the Mapuche are sustainable in a sense that the natural environment is not degrading due to agricultural practices and whether the practices are stable and thus can be used for a long time period. Additionally, the productivity of these practices will be addressed to see whether these practices are profitable and can feed the growing global population, observed from an economic dimension.

Finally and inevitably, the social dimension will be incorporated in the research. As will be explained below, cultural development is closely related to agricultural practices, as well as political debates about land ownership.

1.2 Agrobiodiversity

According to Spirito et al. (2022), the term agrobiodiversity is considered as "the variety of animals, plants and microorganisms used directly or indirectly in agricultural systems". It is crucial for good nutrition, productivity and stability of farming systems and it is closely linked to its functional biodiversity. Qualset et al. (1995) say that agrobiodiversity is key to agricultural activity and they refer to it as the "variety and variability of living organisms that contribute to food and agriculture in the broadest sense, and the knowledge associated with them". In the face of a globally changing world, the management and conservation of agrobiodiversity is a key factor in achieving food security for the growing world population. However, land use intensification, structural changes in the agricultural sector, climate change, invasive species and urbanization are among the threats that endanger agrobiodiversity (Pautasso et al., 2013).

1.3 Cultural ecology

The term cultural ecology was coined by Steward (1955) as a methodological approach to investigate changes that result from adaptation of a culture to its environment. The method is focused on the relationships between humans and nature. Here, *ecology* refers to the physical and biological world, while *cultural* refers to the interrelationship between society and nature within the evolutionary process. This interrelationship is visualized in figure 2. The approach views society and environment as two separate spheres, it has however the capability to include the ecological environment among factors affecting cultural change. It recognizes the relevance of natural systems influencing human evolution. Until the end of the twentieth century, economic growth overshadowed the environmental relevance. Due to new concerns about the balance between society and nature, cultural ecology deepened studies on ecological factors and adaptive behavior (Piccardi & Canepa, 2021).

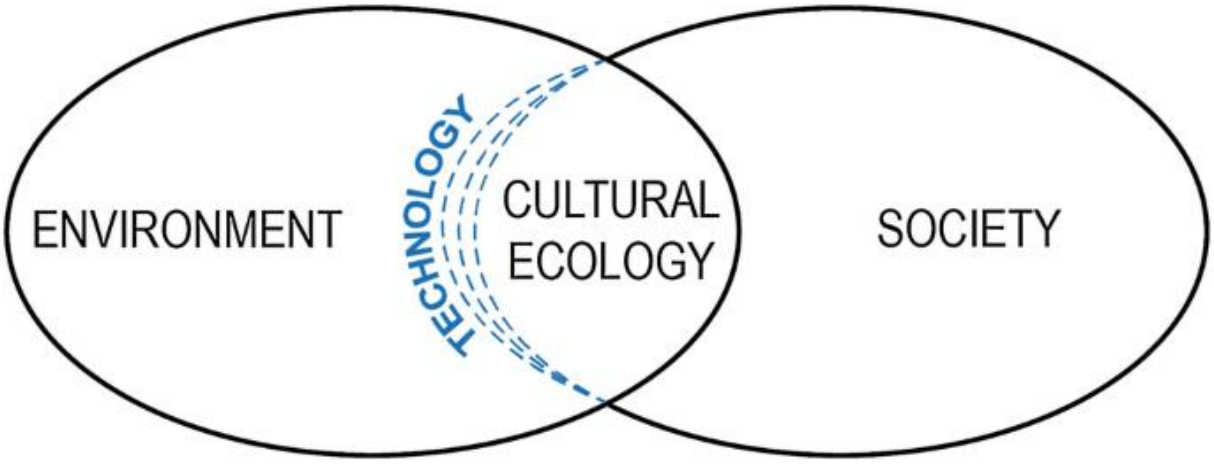

Figure 2. Conceptual framework of cultural ecology (Piccardi & Canepa, 2021).

1.4 Sustainability

The word sustainability is used in a lot of different contexts nowadays. The term is used in all kinds of settings, which can cause the meaning of the word to become undefined. Goodland (1996) made a distinction between economic, social and environmental sustainability. He states that environmental sustainability (ES) originated because of social concerns and

is needed by humans. Goodland writes that "ES seeks to improve human welfare by protecting the sources of natural raw materials used for human needs. (…) to prevent harm to humans." This can be interpreted as quite a human-centered view, since the only purpose of environmental sustainability seems to be the wellbeing of humanity. According to Goodland (1996), natural capital needs to be maintained, as a provider of sources and as a sink for waste. He continues that social sustainability cannot be obtained without having environmental sustainability. In this research, the focus will mostly be on environmental sustainability, however this is closely linked to economic and social sustainability. So all three kinds of sustainability will be treated regarding indigenous traditional farming. According to Costanza and Patten (1995), the definition of sustainability is quite straightforward. They define a sustainable system as one that survives and persists. In the context of sustainable agriculture, this also applies, since we are looking for an agricultural system that can persist over time.

1.5 Traditional farming and knowledge

Traditional farming is a way of farming based on indigenous knowledge, traditional tools, natural resources, organic fertilizers and cultural beliefs of the farmer (Hamadani et al., 2021). The knowledge has been passed on generation on generation. Traditional farming evolved over the years as a sustainable system in equilibrium with its surrounding ecosystems (Alam et al., 2014). The inputs used within traditional farming are mostly organic in nature and produced on the farm itself. This type of farming involves sustainable interaction between plants, animals, soil, water, and food, leading to retained soil fertility, pest control, and mixed crop production. Indigenous farming practices are gaining attention for being in tune with the environment and being less resource intensive (Alam et al., 2014).

Traditional farming is based on traditional knowledge, which has been defined as "the local knowledge of a cultural group or a society, in contrast to the global, universal knowledge generated by universities, research

institutes and private institutions. Traditional knowledge is holistic, encompassing many fields of scientific knowledge, such as climate, hydrology, soils, plants and animals" (Pulido & Bocco, 2003).

1.6 Overview concepts

Figure 3 provides an overview of all concepts used in this research and the different perspectives from which the research topic is addressed. As can be seen, the environmental field plays a central role and has shared concepts with the socio-cultural field. There is an economical aspect to sustainability and this perspective is related to the topic, but is not elaborately discussed in this research.

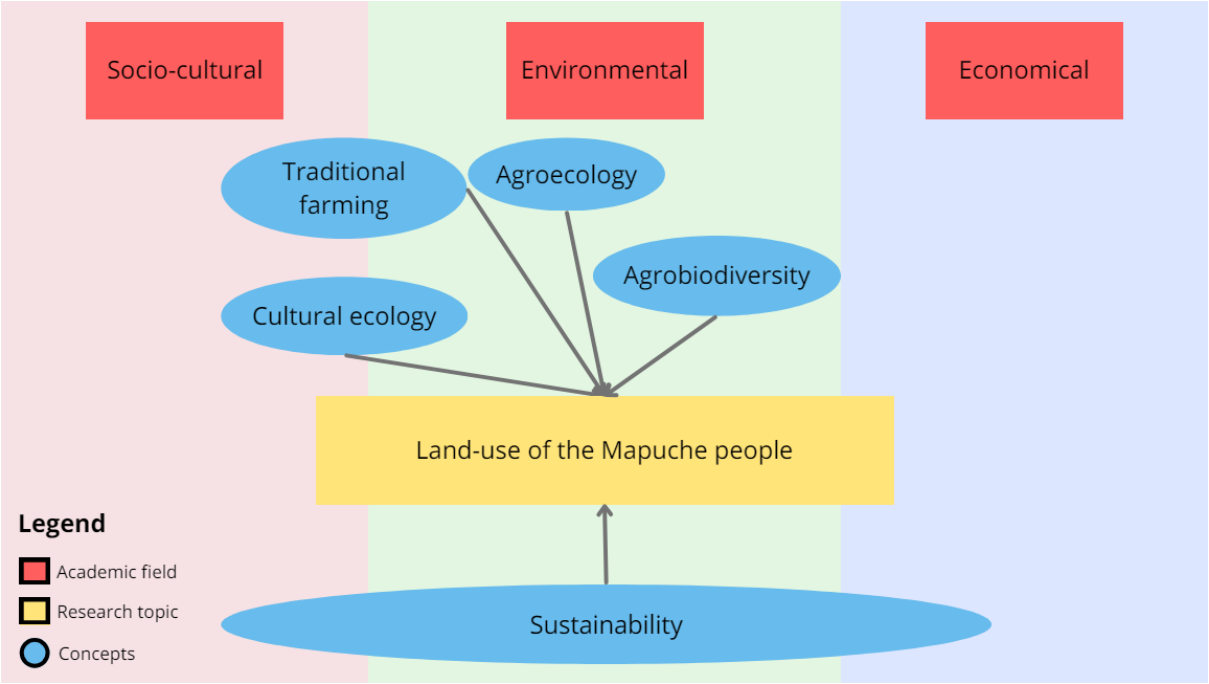

Figure 3. Overview of the concepts and perspectives related to the research. The concepts in blue and the different perspectives in red. In yellow the research topic. The arrows indicate the relationship of the concepts to the research topic

2. Methods

In order to investigate the indigenous traditional farming methods, the relationship between the Mapuche and land use will be researched. Since it is not feasible to do field work in the region within the given time, the research is a literature review. A mixture is used of quantitative and qualitative data given in existing literature.

2.1 Data collection

Literature is found through Google Scholar and Worldcat, using different search terms as well in English as in Spanish. Use is also made of sources provided by the University of Chile, obtained while following the course about indigenous societies in the country during an exchange. To find literature on the topic, multiple search terms are used. Combining the following terms in different combinations led to the collection of nine relevant articles on different agricultural practices by the Mapuche: "Mapuche", "Indigenous societies", "Chile", "traditional farming", "indigenous farming", "farming practices, "land use", "sustainable", "Araucanía", "agroecology", "agroecosystems".

Additionally, literature is found through snowballing, the process of finding more literature on the same topic by using references made in a paper. Use is made of three case studies on Mapuche farmers. A case study can give more in depth and detailed insights about the topic, so it will become more specific. Gerring defines a case study as an intensive study of a unit with an aim to generalize across a larger set of units (Gerring, 2004). So in this case, the intense study of a specific family and/or farm is used to generalize across the whole Mapuche population. The literature is analyzed by filtering out the most relevant articles, in which land use practices are described. These relevant articles are found by reading the abstract and scanning the source to see if it contains useful information for the research. To organize the data, a table was made, which is adjusted in the document as the appendix.

Due to a lack of explicit literature on the environmental effects of practices by Mapuche in Southern Chile, literature on the same practices used in other regions is used to draw conclusions. After defining the practices used by Mapuche, more in depth information is found on these practices. The assumption is made that the effects they have on the environment in different parts of the world are similar to the effects they will have on the local environment in Southern Chile. This assumption is made because literature on these practices is often also based on small scale agricultural areas and the effects are locally visible.

2.2 Region

Since most literature on the Mapuche is written about the Mapuche in Chile and less on Mapuche in Argentinean territory, the focus of this research is on the areas in the first named country. The size of the indigenous group is larger in Chile than in Argentina and more information can be found on this population. 1.800.000 people in Chile identify as Mapuche, which corresponds to more or less 10% of the population (INE, 2017). In Argentina the Mapuche population is as big as 150.000 people, which corresponds to less than 0,5% of the Argentinean population (INDEC, 2024). In present day Chile, Mapuche people are mostly living in the southern parts of the country. In the region of Araucanía, 33% of the population identifies as Mapuche, which is the highest percentage of all regions (INE, 2017). In this research the focus will thus be on the Araucanía region, which is shown in figure 2.

Figure 4. Southern America showing the Araucanía region (Google Maps). One third of the population in this region identifies as Mapuche, the highest percentage of all regions (INE, 2017).

2.3 Types of data

The research consists of a lot of reading of scientific articles and papers, since it is a literature review. This literature contains different types of data. Most sources are found to provide qualitative data. There are however also some sources providing quantitative data, such as information from the 'Oficina de Estudios y políticas Agrarias'. Overall data from ministries of the Chilean government contain mostly quantitative data on agricultural practices of Mapuche farmers. This includes figures on which crops they produce and in what quantities. The case studies provide more qualitative data, with in depth information on how families use their land and on their beliefs. Additionally, there is a lot of offer from social sciences about the Mapuche culture, which includes their relationship to nature.

2.4 Relevance

After finding information on the agricultural practices of the Mapuche, research is done on the effects of these practices on the environment. About some of these practices a lot is already known, such as crop rotation, while some practices may not have been researched as much. The applicability of these practices in modern agriculture will be analyzed. What are the pros and cons of incorporating these practices in larger scale agricultural practices in the Western world? Is it feasible for Dutch farmers to include these practices in their agricultural production? The relevance of the research will mostly be shown in the discussion, where these questions will be discussed and answered.

2.5 Ethical issues

The Mapuche is a highly marginalised group in Chile, which struggles with a lot of discrimination and faces challenges such as illiteracy and poverty. Up until today, the tensions between the Chilean state and the Mapuche are high, especially in the southern parts of the country. This makes it a delicate topic which should be handled with care. Making assumptions might contribute to the stereotyping of the indigenous group, which could be harmful. As researcher that is not of Mapuche descent, the topic will be handled with as much care and nuances as possible and the realisation that information is missing from out the community itself is present. For this research the time and resources were not available to do more in depth and community based research. In the future the community itself should definitely be included.

3. Literature on agricultural practices

The literature review resulted in the findings of multiple practices used by the Mapuche. Some of them are named often in different papers, others are pointed out occasionally. An overview of all practices found in the literature can be found in the appendix. Table 1 shows a summary of the different practices found and the presence of those in the literature. This is a simplified view. In some sources practices are not explicitly described which makes it difficult to place them within a category of practices. Most sources mention the special relationship between people and nature and the spiritual value it has. This is however hard to quantify, so it is not included in table 1, but spiritual care is an encompassing aspect in all land use practices by the Mapuche.

Table 1. Summary of the occurrence of practices found in the literature.

Practice	**Mentioned in number of sources**
Trafkintu/Seed exchange	4
Tukun/small polycultural orchards	4
Crop rotation and intercropping	4
Irrigation	4
Natural fertilizers	2

3.1 Beginning of the Mapuche agriculture

The Mapuche have a long history of domestication of plants as part of their agricultural practices. Early archeological evidence suggests that the Mapuche were involved in the process of selecting edible plants as early as 10.500 B.C., relating to the cultivation of the potato (Chehuaicura et al.,

2010). The presence of by Mapuche domesticated and acclimated species, has its evidence based in chronicles written by Spanish conquerors, such as the chronicle by Pedro de Valdivia in 1551 in which he writes the Spanish king that the region of the Araucanía was prosperous and abundant in everything the 'indios' sowed, such as maize, potato, quinoa, pepper and beans. In 1558, Geronimo de Vivar wrote "The natives have maize, beans, and potatoes, and a herb similar to oats, which is good sustenance for them. They are very skilled farmers and cultivate the land very well" (Torrejón & Cisternas, 2002).

Their agriculture has been influenced by external factors, such as the presence of the Inca and the Spanish. Over time they have adopted several cultivated species from foreign cultures. These landraces, such as old wheat landraces, chili peppers and quinoa, have adopted to the local conditions over time, such as water scarcity and low soil fertility (Spirito et al., 2022) The arrival of the Spanish brought a lot of changes to the Americas. One of the first characteristics of the Spanish invasion of America was the introduction of vegetables species and animals, unknown in the pre-Columbian production systems and biodiversity. Intensive cultivation and the raising of cattle, horses, sheep and goats structured the new system that was based on the Hispanic-Mediterranean agricultural model. The introduction of the horse was of great influence for the ability to move around (Chehuaicura et al., 2010)

There is still a difference between land use by the Mapuche and land use by non-Mapuche in Chile, so the new system did not eradicate the Mapuche farming system in totality, but it did add some new aspects.

Originally, the Mapuche sowed in very small portions. "a small basket of peas and maize, a basket of wheat, barley, and beans, about two baskets of potatoes, a plate of beans and flax, and that sums up all their planting" (Ibarra et al., 2019). A variety of species is traditionally cultivated by the Mapuche. According to chronicles from conquerers like Pedro de Valdivia and Geronimo de Vivar, this cultivation existed of maize, beans and

potatoes. Additionally, they grew llamas and domesticated camels for wool, meat and other primary materials for transport (Zavala et al., 2020). Since the Mapuche population and their ancestral lands were widely spread, the practices used also spread over a large area. Practices by the Mapuche in the Araucanía spread through the Andes mountain range and influenced the farming practices by the Pehuenches, a sub group of the Mapuche, in the pampas in Argentine (Mandrini, 1988). From this information, the conclusion can be drawn that the farming practices used in the Araucanía region are most dominant. Nowadays, Mapuche farmers still cultivate on small plots to cultivate vegetables, cereal crops and root vegetables (ODEPA, 2019).

Spirito et al. (2022) found in a case study in southern Chile, that Mapuche farms present the highest agrobiodiversity in comparison to foreign or Chilean owned farms in the same region. This agrobiodiversity can be explained by a mix of choices made over time by the Mapuche. In this case study, they conclude that agrobiodiversity increases with higher proportions of Mapuche small-farmers. The high rates in agrobiodiversity on these farms can be explained by different indigenous practices, such as the practice of seed exchange networks.

3.2 Trafkintu

In Mapudungun, this exchange of seeds is called *trafkintu*. It entails the exchange of propagules and seeds, which allows for the exchange of species and a variety of plants across generations. Biological and cultural factors are closely related to this process and it also influences the local economy (Pautasso et al., 2013; Ibarra et al., 2019). For thousands of years, women collected, exchanged and adapted seeds to thrive in semi-controlled spaces. *Trafkintu* can take place in domestic settings as well as in publicly organized events (Ibarra et al., 2019). At public events it is organized by so-called seed keepers, which are usually women who facilitate the exchange between unknown individuals. These seed keepers maintain a great variety of seeds and knowledge which is associated with the adaptation to specific

soil and climatic conditions of a territory. They can be seen as the guardians of the seeds, they protect and take care of them. This makes the seed keepers individuals of great importance to the rest of the community when it comes to advice and provision of propagules (Ibarra et al., 2019).

In a case study done by Egert Laporte and Godoy Gallardo (2008), it is emphasized that *trafkintu* took place because of a lack of money. As one of the family members in the case study says "He who did not have any money, needed to do *trafkintu*, because the other also had the wheat he did not like, so he needed to do *trafkintu* with the other which he did like… before this happened more often, because there was little money. In contrast with now, if one wants anything you go to the store. I'm going to get groceries!" ~ Filomena Namuncura, 2006.

From this quote, one can conclude that the practice of *trafkintu* is less common now than it was before the arrival of money. This can be seen as an example of the originally traditional practices by Mapuche, which might be disappearing due to the integration of the Mapuche into the capitalist Chilean society.

Seed exchange is not only a traditional practice within the Mapuche community, it is a common practice in many other regions and cultures as well. Farmers create their own varieties through exchange using local germplasm and traditional practices (Emperaire and Peroni, 2007; Jackson et al., 2007; Ellen and Platten, 2011; Leclerc and Coppens d'Eeckenbrugge, 2012). This seed exchange typically takes place between farmers and their neighbors, relatives, and even distant strangers, this causes crop genetic diversity to be moved across farming units (Chambers & Brush, 2010; Coomes, 2010). Seed exchange networks are of importance for the conservation of agricultural and cultural diversity and identity (Heckler and Zent, 2008; Bezançon et al., 2009). Additionally they are relevant for coping with environmental and economic shocks (Sperling and McGuire, 2010; Cavatassi et al., 2011). Although the shift towards a small number of productive crops has in part made it possible to meet growing

food demands, it is now known that sustainable agriculture cannot be achieved without the conservation of agrobiodiversity (Mercer & Perales, 2010; Carvalheiro et al., 2011; Vigouroux et al., 2011). Agrobiodiversity can be crucial for an ecosystem and whether it will be stressed or resilient when experiencing a biotic or abiotic disturbance. A diversity in organisms is required for an ecosystem to function properly and to provide ecosystem services (Altieri et al., 2015). Biodiversity enhances the functioning of an agroecosystem, because different species perform different functions and therefore have different niches (Vandermeer et al., 1998). High biodiversity rates act as a buffer to environmental changes, because it enhances the compensation capacity. If one species fails, others can take over the role and thus compensate (Altieri et al., 2015). Additionally, species-divers systems produce biomass at a much higher rate than in monocultures, almost twice as much (Brooker et al., 2015). In conclusion, *trafkintu* increases agrobiodiversity, which in its place increases resilience and ecosystem services.

3.3 Tukun

Tukun refers to the Mapuche garden, small polyculture orchards that merge with the surrounding vegetation, featuring crops like peas, maize, wheat, barley, beans, quinoa , potatoes, and flax. The design of *tukun* is related to the moon and its cycle (Ibarra et al., 2019). This is one of the ways in which *tukun* embodies the Mapuche worldview. This is reflected in the layout, arrangement, and variety of plants, the use of the lunar calendar for planting and transplanting, the orientation of crops and the oral transmission of knowledge and language. The Mapuche gardens were traditionally set within a biodiverse environment, with extensive forest canopies spread across the *Nag Mapu*, the physical space on which man and nature live in Mapudungun. These forests contained small food-producing areas that blended harmoniously with the natural surroundings. This *tukun* was in coexistence with nature, an example of which is the fact that the

forest itself functioned as a fence that protected the *tukun* (Chehuaicura et al., 2010).

A study by Manosalva Torres (2017) identifies two types of Mapuche gardens based on their characteristics and practices. One with high biodiversity rates, which aligns with the concept of *tukun* and one with lower rates of biodiversity, which shows more signs of the influence of modernization and conventional agricultural practices, such as the use of agrochemicals and specific cultivation techniques. Both gardens are typically located near a home, but the first one is characterized by high diversity of plant species, including different vegetables, aromatic plants, medicinal herbs and fruit trees. In these highly biodiverse gardens, the arrangement of the plants follow a logic of protection; the larger plants provide protection for the smaller ones. This type of gardens reflects the traditional approach to horticulture, in line with the concept of *tukun.* Just like the effects of the seed exchange networks, does the use of small polyculture orchards have a positive effect on biodiversity rates and play a role in the cultural and social context. Besides the effect the polyculture has on biodiversity, the fact that the cultivation is done on a small scale also has beneficial effects on the local environment. It causes the farm to be in harmony with the local environment and the farmers to be independent and self-sufficient (Altieri, 2004).

Literature about the current farming practices of the Mapuche, do not use the term *tukun* but they rather speak about the Mapuche *huerta*, which translates into Mapuche garden. This garden plays a core role in the daily life of the Mapuche people, because it is a place which allows for connection to the land and crops (Manosalva Torres, 2017). Chehuaicura et al. (2010) investigated what criteria are followed for incorporating vegetable species in the gardens. These criteria were found to be: social, value of use, sentimental value, symbolical ceremonial value, inheritance and conservation. No commercial motives were found for the incorporation of species. This is in line with the perception in which plants are not seen as

object, but rather as an entirety (Morales Painemal, 2008). Furthermore, this research found which practices are used by Mapuche traditional specialists. These practices are organized in different categories, as can be seen in table 2.

Table 2. Care and management types for the establishment of vegetable species by traditional specialists (Chehuaicura et al., 2010).

Categories	Practice examples
Regulation of growth	Trim and guide the plants, so they adapt to the planting area.
Management of genetics	Manual pollination.
Survival of the plant	Irrigation. (This is however not possible in all areas due to water scarcity).
Adaptation to the climate and/or soil	Place the plants or seeds in the freezer where the curator controls the variables and slowly adapts the specie to the circumstances of the soil in which it will be placed. Or place them under present trees in the garden with almost perfect conditions.
Resistance of the plant	Select and incorporate resistant species, which can handle the local environmental conditions, such as water scarcity, plagues and soil erosion.
Nutritional care	Do not water the plant with the amount necessary, equip them with the incorporation of organic material from the soil.
Spiritual care	Speak and pray with the plants. Orient them towards the *Puel Mapu* (the exit of the sun). The 'jealous plants' such as cinnamon and pumpkin are highly sensitive, they capture the bad energies, so these need to be protected.
Replicate natural ecosystems	Creation of different ecological spaces through micro habitats in the *tukun*s, imitating the characteristics of the original ecosystem. With the aim for adaptation and domestication of wild plants.
Rewilding	Rewilding of cultivated species such as quinoa, raspberry, maize and beans to increase resistance towards water stress and other effects of global climate change.
Insert crops	Does not happen often since there is no extensive cultivation in the *huerta*.

Of the 40 species investigated in the research, 237 different reasons were found for the use of the plants. These are categorized in medicinal use, organic use, symbolical value, culinary and decorative use. The different ways of incorporating species were found to be through the exchange of plants and seeds, inheritance, gathering and gifts. Same as for the incorporation of species, also for the use of species no commercial motive was found. The incorporation, care and use of species are all considered along an ecological and cultural matrix in which conservation of biodiversity plays a key role (Chehuaicura et al., 2010).

According to the Office of Agrarian Studies and Policies (ODEPA), the Mapuche community use their land for subsistent scale production, with small plots to cultivate vegetables, cereal crops and root vegetables. They maintain an ancestral link to their land through harvesting wild pine nuts in Araucanía forests and through the shepherding in communal groups of herds of goats, llamas and alpacas (ODEPA, 2019). In table 3, an overview is given of the quantities of these practices. As can be seen, wheat is the crop which is cultivated in the largest quantity. In line with other literature, the Mapuche also cultivate potato, beans, quinoa, wheat and different kinds of vegetables and fruits and they maintain large areas of native forest (Egert Laporte & Godoy Gallardo, 2008; Ibarra et al., 2019; Inostroza Córdova, 2016; Zavala et al., 2021).

Table 3. Information on Mapuche farms (ODEPA, 2019).

Variables	Mapuche
Número de explotaciones [2] / *Number of farms [2]*	48.518
Productores hombres / *Male farmers*	32.817
Productores mujeres / *Female farmers*	14.834
Superficie de las explotaciones (ha) / *Area of farm holdings*	794.685,60
Superficie utilizada en las explotaciones (ha) / *Total areas under active production in farmholdings (ha)*	451.424,90
Cultivos anuales y permanentes (ha) / *Annual and perennial crops (ha)*	60.284,00
Trigo (ha) / *Wheat (ha)*	21.277,40
Avena (ha) / *Oats (ha)*	7.994,10
Papa (ha) / *Potatoes (ha)*	8.105,10
Lupino (ha) / *Lupine (ha)*	6.587,60
Hortalizas, flores y semilleros (ha) / *Vegetables, flower and seedbeds (ha)*	4.714,20
Plantaciones frutales [3] (ha) / *Fruit plantations [3] (ha)*	1.215,80
Forrajeras permanentes y de rotación (ha) / *Permanent pastures or pastures in rotation (ha)*	11.571,50
Praderas mejoradas (ha) / *Improved pastures (ha)*	31.841,80
Praderas naturales (ha) / *Natural pastures (ha)*	287.435,60
Bosque nativo (ha) / *Native forest (ha)*	227.417,90
Matorrales (ha) / *Scrubland (ha)*	65.001,50
Plantaciones forestales (ha) / *Forestry plantations (ha)*	47.112,80
Bovino (cabezas) / *Cattle (head)*	248.128
Vacas lecheras [4] (cabezas) / *Dairy cows [4] (head)*	11.836
Ovino (cabezas) / *Sheep (head)*	231.582
Caprino (cabezas) / *Goats (head)*	35.394
Porcino (cabezas) / *Pigs (head)*	152.078
Camélidos (cabezas) / *Camelids (head)*	472

3.4 Crop rotation and intercropping

Egert Laporte & Godoy Gallardo (2008) and Inostroza Córdova (2016) note that other practices used by the Mapuche include crop rotation and intercropping. Egert Laporte & Godoy Gallardo (2008) define crop rotation as "a technique where different crops are planted in succession on the same land to prevent soil depletion and maintain soil health". This technique gives the soil the time to replenish its nutrients in the soil. It also decreases the susceptibility for pests and diseases (Inostroza Córdova, 2016). Besides crop rotation on a temporal scale, diversity of crops on a spatial scale is also incorporated, this is called intercropping (Chehuaicura et al., 2010;

Inostroza Córdova, 2016). This is the practice of planting different crops together in the same field. This method promotes biodiversity and improves soil structure (Inostroza Córdova, 2016). Intercropping leads to increased and stable yield, it reduces the susceptibility of plants to diseases and pests. Because different crops can complement each other in resource acquisition, intercropping enhances resource efficiency. And lastly, it increases soil quality. Different plant species in close proximity can enhance nutrient cycling, soil structure and organic matter (Brooker et al., 2015).

3.5 Natural fertilizers and irrigation

Additionally, organic methods are used, such as the use of natural fertilizers. These entail animal manure and compost to enrich the soil (Inostroza Córdova, 2016; Egert Laporte & Godoy Gallardo, 2008). The use of natural fertilizers enriches the soil with nutrients without extracting the soil (Egert Laporte & Godoy Gallardo, 2008).

As described by Chehuaicura et al. (2010), in order to take care of the plant and with the aim of survival of the plant, irrigation is used. The main sources of water are water wells and the river (Oyarce et al., 1989). Irrigation is carried out during the early hours of the morning or in the afternoon when the sun is less intense to ensure proper hydration for the plants (Manosalva Torres, 2017). The water management practices of the Mapuche include the construction of canals, ditches and reservoirs to capture and distribute water for crop cultivation (Inostroza Córdova, 2016).

4. Results

Many of the land use practices that have been used by the Mapuche people, are related to biodiversity. As Spirito et al. (2022) found in their case study, the biodiversity rates are higher on Mapuche owned farms than on Chilean and foreign owned farms. The latter were mostly dominated by monocultures. Many of the practices used by Mapuche result in an increase of the variety of plant species. The use of seed exchange, the small polyculture orchards, crop rotation, inter cropping, the introduction of foreign species and the use of natural fertilizers have shown to be beneficial for biodiversity (Inostroza Córdova, 2016; Spirito et al., 2022; Egert Laporte & Godoy Gallardo, 2008; Ibarra et al., 2019). Some information has been found on the effects on the soil quality, but explicit research results are missing. Table 4 provides an overview of the used practices found in the literature and their effects on the local environment. Since the literature did not provide information on the effects on irrigation on the local environment, this practice is not included in the table.

Table 4. An overview of all practiced found in the literature and their effect on the local environment.

Practice	**Effect on local environment**
Trafkintu (Seed exchange)	• Enhances biodiversity • Increases resilience and reduces risk pf pests and diseases
Tukun (polyculture orchards)	• Enhances biodiversity • Improves soil structure.
Crop rotation	• Gives time for the soil to replenish nutrients in the soil • Increases resilience and reduces risk of pests and diseases. • Enhances biodiversity
Intercropping	• Increases resilience towards pests and diseases. • Enhances soil structure and quality. • Enhances biodiversity
Natural fertilizers	• Enrichment of the soil with nutrients without depleting the soil.
Spiritual care	• Respect and value for the plants. Tangible effects cannot be found.

5. Discussion

The agricultural practices by the Mapuche are in strong contrast with the industrial agricultural systems in the Western world. Over recent decades agricultural production systems have evolved in Northwestern Europe that are characterized by a high degree of specialization, which can be seen in the presence of monocultures, narrow crop rotation and high external input of chemical fertilizers (Oomen et al., 1998). The Netherlands is an example of a Western country where highly intensive agriculture dominates the landscape. A quarter of the country's surface consists of grasslands for dairy production. The Dutch agricultural sector is per unit of land the most efficient and productive sector of the European Union (EU) (van Grinsven et al., 2019). It has four times the average livestock density of the EU and is the EU's fourth milk producer in volume. This high production has detrimental effects for biodiversity (Vermunt et al., 2022; van Grinsven et al., 2019). Intensive agriculture is found to be negatively related to soil biodiversity (Tsiafouli et al., 2015). The emissions of ammonia, surpluses of nitrogen and phosphorus and the use of pesticides per hectare of agricultural land in the Netherlands are among the highest in the EU. Agriculture counts for 14% of the national emission of greenhouse. To meet the Paris Climate Agreement, the Dutch agricultural sector needs to decrease GHG emissions by 3.5 Mton in 2030 (van Grinsven et al., 2019). This research aims to present opportunities for the Dutch highly industrialized agricultural sector to steer towards a more sustainable way of farming, inspired by the indigenous practices of the Mapuche community.

The practice of *trafkintu* or seed exchange, has increasingly received attention of NGOs and grass-root associations of farmers, with the aim of preserving agrobiodiversity (in Europe: Arche Noah, Kokopelli, Pro Specie Rara, Red de Semillas, Réseau Semences Paysannes, Rete Semi Rurali) (Pautasso et al., 2013). This is done through, for example, the organization of local markets for biodiversity as a meeting point for members of the of the seed exchange network ('¿Qué es la Red de Semillas?', n.d.). It would

probably be difficult to incorporate this in the Dutch system, since this practice is also closely related to cultural traditions and is of social value for the community as well. It can however function as an inspiration for Dutch farmers to explore ways in which they can conserve and increase biodiversity by working together with other farmers and exchange knowledge and crops.

Another core aspect of the agricultural lifestyle of the Mapuche was found to be the use of the *tukun*, the small polyculture orchards. Whether this would be applicable in the Dutch agricultural system is questionable, since the aim of agriculture is very different. The Mapuche agricultural practice is mostly based on subsistence, while the Dutch aim is mostly to export the yield for economic success. The assumption is made that it will not be achievable to incorporate this on a large scale in Dutch agriculture, since it will be very labor intense and difficult to meet demands for large scale export. Because the perspective on nature differ due to the large cultural differences, it seems nearly impossible to copy-paste practices into the Dutch agricultural system. However, there is a need for conservation of biodiversity and through the concept of agroecology, agrobiodiversity enhancing practices could be incorporated, such as crop rotation and intercropping. So even though it is unlikely that Mapuche practices will be incorporated on a large scale in the Dutch agricultural sector, some of these practices can be studied more elaborately and function as a source of inspiration for incorporating more sustainable ways of agriculture.

As stated within the method section, in future research the Mapuche community should be included in research. Because of the limited time and resources of this research, it was not feasible to do an in depth study on Mapuche farms and on the population. This research is done from out the perspective of the Western world and misses information and knowledge from the community itself. It is important to clearly state this when doing research, since it is a very one-sided view. Additionally, many indigenous communities such as the Mapuche, are marginalized and face discrimination

and oppression. For future research in this field, it is of great importance to collaborate with the community that has a central role in the research. Not including them contributes to the exclusion of the group in the academic community and increases a 'they versus us' way of thinking. This being stated, the research is most probably lacking relevant information which cannot be obtained through literature research. Literature research is limited to written sources, while the oral transmission of knowledge plays a big role within the Mapuche community.

This literature research can function as background information for fieldwork to obtain more information on land use by the Mapuche. More information on the practicalities of sustainable land use by the Mapuche can give more insights on how this would or would not be applicable in other agricultural systems across the world. The concept of agroecology and agrobiodiversity are -without using these terms- widely incorporated in the Mapuche agricultural practices and should have a central role in the approach to a more sustainable future of farming in the Netherlands and the rest of the Western world.

6. Conclusion

In the search for an answer to the question: "How do indigenous traditional farming methods of the Mapuche affect the local environment?", it is found that overall, land-use practices used by the Mapuche affect biodiversity, soil quality and structure and resilience. This literature review found that the practices often contribute to the conservation of biodiversity, which in its turn positively affects the natural environment since it is vital for ecosystem services. In line with earlier research on indigenous practices expressed in the introduction, indigenous traditional farming methods by the Mapuche positively affect the local natural environment with. The way in which this is mostly obtained is through the conservation of biodiversity. Even though the Mapuche and the Dutch agricultural system are worlds apart, there might be a possibility for lessons to be learned from the Mapuche. In the search for a more sustainable way of farming in these times of climate crises, the Dutch can take an example from the practices that enhance agrobiodiversity. This is a field that can definitely be further explored.

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Appendix

Source	Important take aways	Statement	Concepts
Schuster, R., Germain, R. R., Bennett, J. R., Reo, N. J., & Arcese, P. (2019). Vertebrate biodiversity on indigenous-managed lands in Australia, Brazil, and Canada equals that in protected areas. *Environmental Science & Policy*, *101*, 1-6. https://doi.org/10.1016/j.envsci.2019.07.002	Indigenous-managed lands represent one avenue by which national targets can be met. Both Indigenous lands and conventional protected lands have high biodiversity. Indigenous-managed lands have equal-or-higher biodiversity than protected areas. Partnerships with Indigenous communities can ameliorate shortfalls in habitat. protection for biodiversity conservation.	Indigenous communities have a more sustainable way of treating nature.	
Yibarbuk, D., Whitehead, P. J., Russell-Smith, J., Jackson, D., Godjuwa, C., Fisher, A., Cooke, P., Choquenot, D., & Bowman, D. M. J. S. (2001). Fire ecology and Aboriginal land management in central Arnhem Land, northern Australia: A tradition of ecosystem management. *Journal of Biogeography*, *28*(3), 325-343. https://doi.org/10.1046/j.1365-2699.2001.00555.x	Traditional fire management practices from the Aboriginals lead to less wild fires. The solution for controlling wild fires would lie in the collaboration with Aboriginal communities. The biodiversity is higher in the Aboriginal managed land, more different species including threatened species.	Indigenous communities have a more sustainable way of treating nature.	
Nolte, C., Agrawal, A., Silvius, K. M., & Soares-Filho, B. S. (2013). Governance regime and location influence avoided deforestation success of protected areas in the Brazilian Amazon. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(13), 4956-4961.	Indigenous communities can help balance deforestation pressures. Indigenous lands were effective at avoiding deforestation at locations with high deforestation pressures.	Indigenous communities have a more sustainable way of treating nature.	
Ceddia, M. G., Gunter, U., & Corriveau-Bourque, A. (2015). Land tenure and agricultural expansion in Latin America: The role of Indigenous Peoples' and local communities' forest rights. *Global Environmental Change*,	Agricultural intensification does not necessarily lead to land-sparing. Extending the area owned or managed by Indigenous Peoples promotes land-sparing.		Land-sparing Jevons paradox = agricultural intensification leads to

35, 316-322. https://doi.org/10.1016/j.gloenvcha.2015.09.010	Extending the area owned by privates or by the government promotes Jevons paradox. Jevons paradox is more likely when agriculture is export-oriented. Jevons paradox more present when agriculture is used for export.		an expansion of agricultural area.
Peña-Cortés, F., Escalona, M., Soria-Lara, J. A., Pincheira-Ulbrich, J., Salinas-Silva, C., & Alarcón, F. (2020). Translating sociocultural transformations into historical maps on land use changes: the case of Lafkenmapu (Araucanía, Chile). *Journal of Maps*, *16*(1), 163–171. https://doi.org/10.1080/17445647.2020.1793817	"no attention has been paid to exploring the effects of these cultural changes on land use. Bridging this gap can be valuable to facilitate a better integration of native and occidental views of land-use planning in the present. Moreover, it can provide a conceptual and geographical basis for policy-making processes that reinforce the social inclusiveness of native cultures." "The interaction between the Mapuche population and land uses was mainly based on their understanding of nature and land use as sacred. Agricultural practices were focused mainly on subsistence." Formation of chilean nation-state. "This originated substantial socio-cultural transformations, based on implementing extensive agricultural practices (e.g. wheat bowl), building of railway lines, using intensively of mobile sawmills called 'Locomóviles' (e.g. around Budi Lake), burning of forest to open up new areas of farmland (e.g. by the 'El Budi' colonial company), consolidating the urban system, and dividing administratively the region." → post-colonial period (1886-1934) Agrarian reform to modernise agricultural practices in 1960s. During the State consolidation period (1934–1973), forestry grew. And extensive agricultural model in the area. Neoliberal economic model after the golpe. "Resulting in: (i) derogation of the 1960s agrarian reform; (ii) land expropriations from the Mapuche		

	population in favour of the private sector; (iii) the development of new human settlement." "In 1994, a national programme to regulate the use of the coast was approved, recognising the ancestral use of this area by the native population, and granting them access to the coast and water bodies." Pre-hispanic era: "The large expanses covered with forest, described in contemporary chronicles, presented an abundance of native vegetation, impenetrable forests and the inhabitants of the 'seashore' or 'Lafkenmapu' who were known as 'coastal Indians'." The first relevant land use changes took place during after the settlement law and foreign colonisation law (1874-1896) due to the need for productive agricultural lands to feed the immigrants in the area. "That led to burn large areas of the Araucanía coast, generating new agricultural places (25,200 ha)"		
Wezel, A., Bellon, S., Doré, T., Francis, C., Vallod, D., & David, C. (2009). Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development*, *29*(4), 503-515. https://doi.org/10.1051/agro/2009004	Different meanings of the word agroecology. A scientific discipline → plot/field approach, agroecosystem ecology, ecology of the food system. Movement → environmentalism, rural development, sustainable agriculture Practice → technique. Four concepts: - Productivity - Equity - Stability - Sustainability 'the integrative study of the ecology of the entire food systems, encompassing ecological, economic and social dimensions, or more simply the ecology of food systems' (Francis et al., 2003).		

Labeyrie, V., Thomas, M., Muthamia, Z. K., & Leclerc, C. (2016). Seed exchange networks, ethnicity, and sorghum diversity. *Proceedings of the National Academy of Sciences*, *113*(1), 98-103. https://doi.org/10.1073/pnas.1513238112	Analysis of the social processes involved in crop diversity dynamics and human cultural diversity in central Africa, highlighting the role of homophily (preferential interaction among members of the same social group) as a key factor in determining seed exchangne networks.		

Sources explicitly describing how agriculture was/is done by Mapuche:

Source	Content	Argicultural practices
Inostroza Córdova, L. I. (2016). Agricultura familiar y comerciantes mapuche en el mercado regional de Nueva Imperial, sur de Chile, 1870-1930. América Latina en la historia económica, 23(3), 80-114. https://doi.org/10.18232/alhe.v23i3.681	Family agricultura based on plowing and triguero. Exploitation of indigenous of indigenous lands after the occupation of Auracania in 1882-1930. Land use in two camps of agriculture and livestock. Cereals, legumes and sheep for wool. Technology of bulls plowing land incorporated by the Spanish. Agricultural activity and livestock complementary character for the Mapuche. The Mapuche land use has been a fundamental aspect of their traditional agricultural system. These traditional practices include: - Crop rotation - Use of natural fertilizers, like compost and animal manure - Land conservation practices, such as terraces, infiltration ditches and living hedgerows (barreras vivas) To protect from erosion and maintain humidity in the soil and protect it from degradation. - Selection of a variety of adapted crops to the local land and climate. Sustainable and respectful practices to the environment, which have been passed on generation to generation and has shown to be effective in maintaining the productivity of the soil over a long period of time.	Based on plowing and wheat. Agriculture and livestock complementary to each other. Cereals, legumes and sheep for wool. Crop rotation. Natural fertilizers like compost and animal manure. Terraces. Infiltration ditches. Living hedgerows. 1. **Milpa Agriculture**: The Mapuche practiced a form of slash-and-burn agriculture known as milpa, where they cleared small plots of land by cutting and burning vegetation. This method allowed them to cultivate a variety of crops such as maize, beans, squash, and potatoes in rotation, maintaining soil fertility and biodiversity. 2. **Terracing**: In hilly or mountainous areas, the Mapuche constructed terraces to create flat surfaces for cultivation. Terracing helped prevent soil erosion, retain moisture, and maximize arable land for agricultural production. 3. **Crop Rotation**: Mapuche farmers practiced crop rotation to maintain soil health and fertility. By rotating different crops in the same field

	Casas indiginas named 'rucas'. Where an nuclear family lives: parents and single kids or brothers/sisters and parents that serve as caretakers. Trigo and arveja only for domestic alimentation and local market. Reap in fanegas of 82 kilos. Potatoes, beans, corn, lentils, garlic, onion, seasonal vegetables. Animals like horses, bulls and sheep relevant for livestock and productive labour. Livestock is used for: - Domestic consumption: milk, meat, butter and cheese for the daily consumption obtained through sheep, bulls and horses - Commercial purposes: products on the local market for extra income for the family - Agricultural work: as workforces for plowing and transport To gain economical resources to invest in the agricultural practices. For development of the Mapuche families.	seasonally, they could replenish nutrients in the soil and reduce the risk of pests and diseases. 4. **Seed Saving**: Mapuche communities preserved traditional seed varieties through seed saving practices. This ensured the conservation of local plant genetic diversity and the adaptation of crops to specific environmental conditions. 5. **Water Management**: Mapuche farmers developed irrigation systems to manage water resources for agriculture, especially in areas with limited rainfall. They constructed canals, ditches, and reservoirs to capture and distribute water for crop cultivation. 6. **Intercropping**: The Mapuche practiced intercropping, planting different crops together in the same field. This method promoted biodiversity, improved soil structure, and provided a more sustainable use of land resources.
Oficina de Estudios y políticas Agrarias (ODEPA) (2019). Panorama de la agricultura chilena. *Oficina de Estudios y Políticas Agrarias (ODEPA) del Ministerio de Agricultura del Gobierno de Chile. Recuperado de* *Page 47-51*	53,064 individual farmers from indigenous Chilean groups, with an area of 1,155,770.8 hectares*. This represents 17.6% of the total number of farmers in Chile, although the area of their farms only represents 2.2% of the total. Small size of indigenous farms. 40.9% of indigenous holdings are less than 5 hectares in size, and 84% are less than 20 hectares. Mapuche farms are concentrated between the basin of the Bío Bío river to the north and the Isla Grande (Greater Island) of Chiloe to the south. Relationship with their land that is not only commercial. Ancestral link to their land, subsistent scale production, with small plots used to cultivate vegetables, cereal	Indigenous famers are on small scale. Mapuche farmers (with 48,518 holdings covering almost 795,000 hectares)

	crops and root vegetables; by the harvesting of wild pine nuts in araucaria (native Chilean pine) forests; and through the shepherding in communal groups of herds of goats, llamas and alpacas. However, the land area managed by indigenous farmers, the location of their holdings, the technology they use and the production yields they achieve, bear testament to farming communities that have managed to develop a successful, marketoriented agricultural model, fully adapted to changes in this sector of the economy in recent years.	are the biggest group. **Variables** / **Mapuche** Número de explotaciones [2] / *Number of farms [2]* — 48.518 Productores hombres / *Male farmers* — 32.817 Productores mujeres / *Female farmers* — 14.834 Superficie de las explotaciones (ha) / *Area of farm holdings* — 794.685,60 Superficie utilizada en las explotaciones (ha) / *Total areas under active production in farmholdings (ha)* — 451.424,90 Cultivos anuales y permanentes (ha) / *Annual and perennial crops (ha)* — 60.284,00 Trigo (ha) / *Wheat (ha)* — 21.277,40 Avena (ha) / *Oats (ha)* — 7.994,10 Papa (ha) / *Potatoes (ha)* — 8.105,10 Lupino (ha) / *Lupine (ha)* — 6.587,60 Hortalizas, flores y semilleros (ha) / *Vegetables, flower and seedbeds (ha)* — 4.714,20 Plantaciones frutales [3] (ha) / *Fruit plantations [3] (ha)* — 1.215,80 Forrajeras permanentes y de rotación (ha) / *Permanent pastures or pastures in rotation (ha)* — 11.571,50 Praderas mejoradas (ha) / *Improved pastures (ha)* — 31.841,80 Praderas naturales (ha) / *Natural pastures (ha)* — 287.435,60 Bosque nativo (ha) / *Native forest (ha)* — 227.417,90 Matorrales (ha) / *Scrubland (ha)* — 65.001,50 Plantaciones forestales (ha) / *Forestry plantations (ha)* — 47.112,80 Bovino (cabezas) / *Cattle (head)* — 248.128 Vacas lecheras [4] (cabezas) / *Dairy cows [4] (head)* — 11.836 Ovino (cabezas) / *Sheep (head)* — 231.582 Caprino (cabezas) / *Goats (head)* — 35.394 Porcino (cabezas) / *Pigs (head)* — 152.078 Camélidos (cabezas) / *Camelids (head)* — 472

Mandrini, R. (1986). La agricultura indígena en la región pampeana y sus adyacencias (siglos XVIII y XIX). *Anuario del IEHS*, *1*(1986), 11-43.	The article discusses the development of agriculture among the Mapuche people in Chile. It mentions that by the late 18th and early 19th centuries, the Mapuche had achieved a true agriculture system, which was linked to other economic and sociopolitical changes. This development of agriculture was part of a historical process and was achieved through various transformations. Furthermore, it is noted that the Mapuche in Chile were knowledgeable about agriculture, and by the early 19th century, they had transitioned from horticulture to a more advanced form of agriculture. This agricultural knowledge was well-established among the Mapuche even during the time of the Spanish conquest, and their practices were influenced by interactions with the Inca and later the Spanish. Overall, the article highlights the significant progress made by the Mapuche in developing a sophisticated agricultural system by the late 18th and early 19th centuries, showcasing	Horticulture to more advanced agriculture.

	their adaptation and advancement in agricultural practices over time During the 19th century, farming was present in the mountain range. The pehuenche practiced a simple horticulture and were influences by the Araucanians. During the second half of this century, the Chilean Mapuche also started cultivating on Argentinean grasslands due to political upheavals in Chile. Because of conflict in Argentina, refugees and political exiles moved into indigenous territories which influenced the social dynamics.	
Spirito, F., Vieli, L., & Montalba, R. (2022). Advancing towards an understanding of the relationship between culture and agrobiodiversity. A case study in Mapuche territory, southern Chile. *NJAS: Impact in Agricultural and Life Sciences*, *94*(1), 1-23. https://doi.org/10.1080/27685241.2022.2083987	Hypothesis: positive correlation between agrobiodiversity and cultural diversity. → negative correlation, since Mapuche farms presented the highest agrobiodiversity and were dominant in most focal landscapes, Chilean and foreign-owned farms were mostly dominated by monocultures. Agrobiodiversity crucial for good nutrition, productivity and stability of farming systems is closely linked to its functional biodiversity. Relationship between ethnic groups and their environment is mediated by culture. Opportunity to reduce biodiversity loss by understanding interaction nature-culture to create the main ecological processes driving landscape changes. Currenty urbanization and migration to urban areas are the major drivers changing the biocultural diversity. → cultural severance. loss in traditional-ethnic knowledge → Biodiversity loss → decrease landscape quality. Higher linguistic (as a proxy of cultural) diversity ~ higher biodiversity. Explained from the ethnoecological perstective: distinct enthnic groups perceive and appropriate nature through their beliefs and knowledge, manifested in agricultural practices for high biodiversity rates.	Agriculture supplementary to hunting and gathering. Incorporation of foreign species, which lead to higher agrobiodiversity. They have generated a horticulture and on average there are 51 cultivated plant species on Mapuche farms. Seed exchange networks.

	Other explanation: isolation between cultural groups as main mechanism behind culture and biodiversity correlation. Araucanía, incorporated by the Chilean State in 1883. Ancestral Mapuche land, highest proportion of Mapuche rural population. Because of the colonization processes, a lot of different cultures in Araucanía. In less than 20 years, non-Mapcue burned down more than 500.000 ha of native forest and converted it to agricultural lands (Hanríques Jaramillo, 2013). → unproductive agricultural lands → exotic species. Poor productivity capacity and water scarcity. Results: Agrobiodiversity index is higher for Mapuche, compared to Chilean and Foreign. Mostly higher than Chilean. Not that much higher than Foreign. The Mapuche's ontology and cosmology attached to biodiversity. Agriculture was not the central way of life, but supplementary to huntering and gathering. Their agrobiodiversity can be explained by a mix of planned choices. E. g. wheat cultivation as a response to the global demand. They also adopted several cultivated species from foreign cultures. These landraces have adopted to the local conditions, such as water scarcity and low soil fertility (old wheat landraces, quinoa, chilli peppers). The Mapuche have generated a horticulture. On average 51 cultivated plant species on Mapuche farms. Chilean agriculture strongly influenced by the Green Revolution, especially during the dictatorship. Agribusiness companies were favoured in this time. Non-Mapuche farmers adopted conventional agricultural practices to a much higher extent than Mapuche. Agrobiodiversity loss due to: i) fewer farmers ii) less land used for cultivation iii) less crop variety cultivated	

	Agrobiodiversity increases with higher proportions of Mapuche small-farmers. Explanation could be **seed exchange networks**. Mapuche farmers are not homogeneous along their agricultural practices. Not always like a homogeneous mass. Concepts: Agrobiodiversity, considered as the variety of animals, plants and microorganisms used directly or indirectly in agricultural systems. The concept of biocultural diversity embraces the dynamic, place-based and complex relationship arising from links and feedbacks between biological diversity (genetic, populations, species, ecosystems) and human cultural diversity (covering from individual ideas to entire cultures, including linguistic diversity).	
González García, F., & Contreras Fernández, D. E. (2013). *Diversidad vegetal: De los mapuches a la enseñanza formal chilena*. https://digibug.ugr.es/handle/10481/30196	this paper summarizes the contributions of a doctoral thesis on the botany knowledge of students of Mapuche descent. Social problems of the Mapuche people are described, especially those related to education and environment. By examining the botanic taxonomy in Mapuche language, the importance of vegetable diversity to the Mapuche people and their traditions and vision of the cosmos was revealed. Mapuche students at middle schools were shown to have much more knowledge of vegetable biology than college students at the beginning of their studies in forest engineering and agronomy. Formal education may use this situation to its advance, in search of intercultural scientific education and the protection of threatened ecosystems.	
Zavala, J. M., Dillehay, T. D., Stewart, D. M., Payàs, G., & Medianero, F. J. (2021). Los mapuche de Concepción y la frontera inca: Revisión de fuentes tempranas y nuevos datos. *Revista de Historia*, *2*(28), Article 28, 146-150. https://doi.org/10.29393/RH28-30MCJF50030	The cronistas described a combative character and a complex military system of the inhabitants between rio itata and the imperial. They also described an agriculture and livestock and high demographic of these southern Mapuche. Jerónimo de Vivar described how they used sheep or ram necks or sea lion leather for armor. Valdivia went on an exploring trip to the south in 1550. Once installed in Concepción, he was surprised by the richness and	Situated in the Andes region, during the year 1550, the Mapuche cultivated corn, beans, potatoes and grew

	abundance in the territory populated by a sedentary society of warriors, llama herders and cultivators of corn. Next to corn he saw beans and potatoes. Quite a developed agriculture economy in the space in the andes. Cultivation of corn, beans and potatoes and the growing of llamas. Domestic camels for wool, meat and other primary materials and for transport. The Spanish came in search of gold. According to Valdivia, the indigenous people wore gold and silver in accessories.	llamas. Domestic camels for wool, meat and other primary materials and for transport.
Egert Laporte, M., & Godoy Gallardo, M. (2008). Semillas, cultivos y recolección al interior de una familia mapuche huilliche en Lumaco, Lanco, Región de los Ríos, Chile. *Revista Austral de Ciencias Sociales*, *14*, 51-70. https://doi.org/10.4206/rev.austral.cienc.soc.2008.n14-03	Case study of a family Mapuche Huilliche in Lumaco, Lanco, Chile. They are an extended family, like many Mapuche. The process of land loss, which started with the Conquista, stands out in the family life of Mapuche. With the colonies of Chileans and foreigners that acquire ground based on fraudulent means, combined with criminal actions. A reduction of land has caused young Mapuche to move to the big cities during the 20th century. The Chilean society is more and more infiltration the indigenous communities. Because of the factors combined, cultural traditions are abandoned fromout the Mapuche. A model of agriculture and livestock of subsistence, based on family work. The children learn not only technological necessities, but also relations and actitudes, morals and behavior. Knowledge linked to native and introduced vegetables and the genetical process of these resources is passed on within the family since everybody, including children, contribute to the work. During the 20th century, new agricultural developments took place, such as the use of a windmill for wheat. Nowadays the main economical activities in Lanco are traditionl agriculture, services, non-traditional agriculture (raspberries, asparagus, cranberries), milk production, meat and the forest sector. During the most time of the 20th century, the men were dedicated to selling wood from the native forests. The typical agricultural spaces are the 'gard' and the 'chacra'. Huerta: a closed space, relatively small, close to the house, in a high and flat space.	organic methods: application of animal manure and compost to enrich the soil with nutrients. Crop rotation, a technique where different crops are planted in succession on the same land to prevent soil depletion and maintain soil health. The Mapuche Huilliche family in Lumaco grows a variety of crops, both traditional and introduced species. Crops including: wheat, maize, kinwa (quinoa), trigo castaño (a type

	Chacra: bigger terrain, more extensive cultivation, like potatoes, wheat and other cereals, located in lower terrains in the meadow. Both spaces are destined for family consumption. The mom worked at the Huerta, the father went out for work, selling wood. The Huerta is central to life, as a place of daily work. In the old day, the children helped sowing, but nowadays they go to school extensively. All three generations have actively participated in agricultural labour and taking care of the animals at a family level. The agricultural practices are part of the childrens daily life. The collection of crops is developed in an ancestral way by the Mapuche huilliche families. Closely related to the seasons and time consuming, loss of native forest also has an influence. The prehispanic Mapuche had a divers diet based on the combination of provided resources through agriculture, gathering, hunting and fishing. The exchange between natural resources has been well developed, traditionally done by women. The first cronistas wrote about clear lands, filled with huertas which gave room for the integration of cereals and fruit trees to the Mapuche and colonial economy. After the war and diseases brought by the colonizers, the land has lost this. However, some vegetable species had already been culturally assimilated. Over time, some foreign species replaced the native species. Sucha as wheat replaced corn and quinoa. However, , the cultivation of certain varieties continued to exist due to the cultivation in huertas and chacras. Some cultivated species declined also due to the exchange. For example a kind of wheat, called the brown wheat. Most lost species were darker of colour, which were replaced for species of lighter colour, favoured by the buyer	of wheat with darker coloration), trigo trébol (another type of wheat), arvejas (peas), and papas (potatoes). These crops have been historically significant in the community, with certain varieties being dominant in the past but experiencing a decline in cultivation in more recent times. The cultivation of these crops reflects the family's connection to their land and traditional agricultural practices. Trafkintu: exchange of seeds. Analogue to a situation of pre vent, in scarcity of money.

	Bueno, las partes de las semillas que se perdieron, como te mencionaba, el trigo y las papas, yo creo que eso se perdió a través de las mismas personas que no les gustaron y dijeron "sabe, que para el otro año no voy a sembrar más esta semilla, porque la comida me queda demasiado oscura. Que el trigo es muy duro para hacerlo harina, así que voy a preferir otro trigo, que sea blando para hacer mote. Que lo lleve al molino y me lo reciban" (Alfredo Maripán 2006) Trafkintu: exchange of seeds. Analogue to a situation of pre vent, in scarcity of money. Es que el que no tenía plata tenía que hacer trafkintu, porque el otro tenía igual el trigo que no le gustó, entonces tenía que hacer trafkintu con el otro que le gustó... antes ocurría más eso, porque antes había poca plata. En cambio ahora, si uno quiere algo va a la tienda ¡Me voy de compras!" (Filomena Namuncura 2006). The loss of seeds of some crops (due to commercial preferences) can be associated with the loss of cultural traditional elements connected to a particular adaptation to the environment. The loss of native forest combines with the lack of time available, made gathering more and more difficult. The traditional exchange , like the trafkintu and la minga are in disuse, because of the use of money. "The changes in the way of living, expressed in the transition from the old Ruka, or houses that retained many of its characteristic elements, highlighting the 'sobrado', have also affected the modes of storing provisions and seeds. The traditional storage model proves to be more efficient in terms of climate adaptation, as it proposed the comprehensive use of the calorific source represented by the hearth, avoiding the deterioration of food and seeds due to humidity." The lack of time due to school and work away from home nowadays, negatively effects the process transmission of cultural elements of the Mapuche Huilliche culture.	Huerta: a closed space, relatively small, close to the house, in a high and flat space. Chacra: bigger terrain, more extensive cultivation, like potatoes, wheat and other cereals, located in lower terrains in the meadow. Both spaces are destined for family consumption. The collection of crops is developed in an ancestral way by the Mapuche huilliche families. Closely related to the seasons and time consuming, loss of native forest also has an influence

Ibarra, J., Caviedes, J., Barreau Daly, A., & Pessa, N. (2019). Huertas familiares y comunitarias: Cultivando soberanía alimentaria.	Page 22: Agroecology: transdisciplinar: it combines knowledge and practices of farmers, indigenous societies and ecologists to form a base to design sustainable, divers and resilient agricultural systems. Page 52: strawberry, potato and quinoa are three species that present centre of origin in chile and have become part of the global diet. 5 macro ecotypes and within these 203 ecotypes in Chile. These were originally protected by women. Cultivated from the north of Colombia to the South of Chile. Called by the Mapuche 'kinwa' or 'dawe', which translates to plant similar to corn which feeds the wisdom of the people. It has been used for medicinal purposes. When the Spanish arrived, two types of germplasm: the kinwa ih the central-south area of the country and the quinoa in the altiplano. The Mapuche domesticated the kinwa in the south. the planting of quinoa crops in the south is carried out in October along with crops of potatoes (Solanum tuberosum), corn (Zea mays), and beans (Phaseolus vulgaris), locating the quinoa seed at shallow depths, with the function of providing shade to the potato during periods of high summer heat. Strawberry has been used for more than thousand years by the Mapuche together with corn, quinoa, beans, peppers, oca and madi. Strawberry has been used in drinks, sweets and traditional medicines. The Mapuche has contributed to the botanical selection of the white strawberry. The potatoe is also one of the core species in traditional farming. Page 56: The area of Bío Bío and La Araucanía where the Mapuche originally stayed, permitted the Mapuche to develop a diverse economy based on gathering, hunting, fishing and agriculture. Before the Spanish, agriculture was done on plain areas without forest vegetation and humid zones calles vegas. Main cultivated: corn (Z. mays), quinoa (C. quinoa), potatoes (S. tuberosum), el madi (M. sativa) and a variety of	Exchange of seeds: For the Mapuche people, the "trafkintu" or exchange of propagules, not mediated by money, allows the exchange of species and varieties of plants across generations, influencing both biocultural transfer and local economy. This transfer of propagules can take place both privately in domestic settings and at public events organized by "seed keepers" or other organizations. Seed keepers are usually women who facilitate exchanges between unknown individuals and who, in turn,

	grains (e.g. bromus mango). The polyculture were simi;ar to natural systems in terms of nutrient cycles in the soil, no animals were used. With the arrival of the Spanish in the 16th century, new cultivations were introduces like grapes (vitis vinifera), wheat (triticum aestivum) and livestock. The invasion and colonization of the Araucanía by the Chilean state during the 19th century increased cultural erosion that started with the Spanish invasion and decreased the original territory from 33 million hectares to 400 thousand ha nowadays. Because a lot of territory was taken away by the Chilean state (and given to foreign colonisers) the Mapuche were left with unfirrtile land which explains the subsistence agroculture with low levels of commercialization. However, there are still some cultural practices that persist that have contributed to the maintenance of the diverse Mapuche agriculture. The **exchange of seeds** makes up a big part of this. Another concept originated from the Mapuche is the 'tukun'. A link between agroecology and etnoecology to develop sustainable agriculture in an ecological and social sense (Altieri) → methode? The management of ecosystems related with biocultural memory of indigenous societies, associated with the conservation of knowledge and the incorporation of new elements and technology, permit to develop new practices over time. The Mapuche have a spritiual relationship with the natural external. Landscapes. Soils, subsoils, water, plants and animals are all equal to the humanbeing, part of the mapu (land). This culture is shaped through these historical relationships between human and nature. This relationship is still present in todays Mapuche farmers and even in the Mapuche who moved to the city. The farmers gardens are polycultures and posess high levels of biodiversity. A lot of the native cultivos and variaties have been protected by farmers and indigenous societies by conserving propagules and seeds over generations. This can contribute to the diversity and alimentation sovereignty at a	maintain a great diversity of seeds and knowledge associated with the adaptation of different varieties to the specific soil and climatic conditions of a territory. This is why seed keepers are individuals of great importance to the rest of the community in terms of advice and provision of propagules. "Tukun" corresponds to small polyculture orchards that blend in with the surrounding vegetation. Tukun feature crops such as peas (Pisum sativum), corn (Zea mays), wheat (Triticum aestivum),

	local and national level, consolidating a cultural and patrimonial identity in the country.	barley (Hordeum vulgare), beans (Phaseolus vulgaris), quinoa (Chenopodium quinoa), potatoes (Solanum tuberosum), and flax (Linum usitatissimum). The design of tukun in terms of transplant dates and spatial orientation is related to the moon and its cycle
Torres, H. M. (2017). Conocimientos y construcciones sobre la naturaleza en la huerta mapuche: Estudio de caso con horticultoras y horticultores mapuche de la zona norte de Tirúa. *Revista Sustentabilidad (es)*, *8*(16), 3-45.	1. **Relationship with the Land**: The Mapuche horticulturists have a close relationship with the land, intensified by indigenous circumstances and land recovery processes. This connection allows for cultural resistance and identity construction. 2. **Symbolic Constructions**: The horticulturists have a vast array of knowledge and practices related to their vegetable gardens. They construct symbolic meanings based on their relationship with nature, influencing their interactions with the environment. 3. **Influence of External Factors**: The horticulturists' practices are influenced by both local knowledge and external factors such as acculturation, modernization, and interactions with new social actors. This blend of influences shapes their horticultural development.	

	4. **Divergence from Western Perceptions**: The Mapuche horticulturists' view of the land differs significantly from Western scientific, technical, and religious perspectives. Their relationship with plant varieties in their gardens reflects a strong attachment, particularly among the women who predominantly work in these spaces. 5. **Value of Indigenous Knowledge**: The study emphasizes the importance of valuing Mapuche horticultural knowledge to bridge the gap between Western science and local indigenous knowledge. Integrating these diverse knowledge systems can offer solutions to various challenges when combined with scientific disciplines. The practices used by Mapuche horticulturists in their vegetable gardens include: 1. **Aporca and Desmalezamiento**: Aporca refers to the practice of hilling soil around the base of plants to protect them and promote growth. Desmalezamiento involves weeding using a small hoe called "cabrita" to maintain the garden beds. 2. **Riego (Irrigation)**: Irrigation is carried out during the early hours of the morning or in the afternoon when the sun is less intense to ensure proper hydration for the plants. 3. **Control de Plagas (Pest Control)**: Constant pest control is essential in the vegetable gardens, with horticulturists using techniques and preparations based on locally available elements to manage pests effectively.	

	4. **Cuidados y Manejos (Care and Management)**: The horticulturists demonstrate a high level of care and management towards the plants, showcasing a mutual dependence between the plants and the horticulturists. This care includes nurturing the plants and protecting them from harm. Two types of gardens/huertas: 1. **Garden with High Species Diversity**: This type of garden is characterized by a high diversity of plant species, including vegetables, aromatic plants, medicinal herbs, and fruit trees. The garden is typically located near the home, has access to water for irrigation, and is enclosed with fencing to protect the plants from animals. The arrangement of plant species in this garden follows a logic of protection, with larger plants providing shelter for smaller ones. This type of garden reflects a traditional approach to horticulture with a focus on biodiversity and sustainability 13. 2. **Garden with Low Species Diversity**: In contrast, the second type of garden has lower species diversity, with fewer plant varieties cultivated. This garden is smaller in size, often enclosed with basic fencing made of mesh, wires, and stakes. While it may still be located near the home and have access to water, it exhibits a more limited range of plant species compared to the first type of garden. This type of garden may show influences of modernization and conventional agriculture practices, including the use of agrochemicals and specific cultivation techniques 13.	

Source	Content	Practice
Pautasso, M., Aistara, G., Barnaud, A., Caillon, S., Clouvel, P., Coomes, O. T., Delêtre, M., Demeulenaere, E., De Santis, P., Döring, T., Eloy, L., Emperaire, L., Garine, E., Goldringer, I., Jarvis, D., Joly, H. I., Leclerc, C., Louafi, S., Martin, P., ... Tramontini, S. (2013). Seed exchange networks for agrobiodiversity conservation. A review. *Agronomy for Sustainable Development*, *33*(1), 151-175. https://doi.org/10.1007/s13593-012-0089-6	Conserving and managing agrobiodiversity is key to achieve food security for a growing world population in the face of global change (Thrupp 2000; Cavatassi et al. 2011; Chappell and LaValle 2011). It is however under threat in many regions (Lotti 2010; Shen et al. 2010; Engels et al. 2011), an example is the disappearance of landraces, traditional, locally adapted crop varieties with historical origins and cultural significance (Lehmann 1981; Camacho-Villa et al. 2005; Negri 2007; Angioi et al. 2011). Threats include land use intensification, climate change, structural changes in the agricultural sector, invasive species and urbanization. This leads to a reduction in diversity at genetic and varietal level as well as species and landscape level, affecting crop and communities and associated ecosystem services (Biesmeijer et al. 2006; Chambers et al. 2007; Flynn et al. 2009). Agrobiodiversity leads to socio-ecological resilience to disturbances and unforeseen events)Folke 2006; Dulloo et al. 2010; Narloch et al. 2011). Multi-species cropping systems can enhance soil fertility, reduce losses to pathogens and pests, and help farmers adapt to changing environmental, socio-cultural and market conditions (Bellon 1996; Malezieux et al. 2009; Mercer and Perales 2010; Bellon et al. 2011; Ratnadass et al. 2012). Better nutrition due to diversity of crops and varieties, this contributes to food security, human well-being, and sustainability (Flora 2010; Nesbitt et al. 2010; Frison et al. 2011). Biodiversity also had psychological/health benefits and may increase tolerance to cultural differences (Ulrich 1984; Fuller et al. 2007; van den Berg et al. 2010; Dean et al. 2011; Bratman et al. 2012; Dallimer et al. 2012). Seed exchange networks are of importance for conservation of agriucultural/cultural diversity and identity (Heckler and Zent 2008; Bezançon et al. 2009), for coping with environmental and economic shocks (Sperling and	

	McGuire 2010a; Cavatassi et al. 2011) and for understanding the effects on biodiversity of the adoption of genetically modified crops (Stone 2010). Due to the reduction in number of famers in developed countries, crop varieties have disappeared in the last decades. In developing countries, farmers often use exchange and create their own varieties, using local germplasm and traditional practices (Emperaire and Peroni 2007; Jackson et al. 2007; Ellen and Platten 2011; Leclerc and Coppens d'Eeckenbrugge 2012). Cultivated varieties originate from the domestication of wild crop relatives a process continuing to this day and involving both farmers and professional breeders (Döring et al. 2011). A useful assumption is that farmers are members of a society with rights, expectations, contacts, and traditions. Farmers are typically actively exchanging seed material with neighbours, relatives, and even distant strangers, thereby moving crop genetic diversity across farming units (Emperaire et al. 1998; Chambers and Brush 2010; Coomes 2010). Seed circulation is a social process, based on trust, and influences by socio-cultural norms and practices (Sirabanchongkran et al. 2004; Delêtre et al. 2011; Vigouroux et al. 2011; Leclerc and Coppens d'Eeckenbrugge 2012). Seed transactions tend to follow unwritten rules. The aim in many agrarian communities is use rather than conservation, there is however a growing consensus that use and conservation are interdependent. Increasingly, NGOs and grass-root associations of farmers organize seed exchanges as planned activities with the explicit aim of preserving agrobiodiversity (in Europe: Arche Noah, Kokopelli, Pro Specie Rara, Red de Semillas, Réseau Semences Paysannes, Rete Semi Rurali) (Hammer et al. 2003; Bardsley and Thomas 2004; Arndorfer et al. 2009; Thomas et al. 2012). Seed exchange is fundamental to agrobiodiversity conservation, but also relevant to other phenomena like plant	

	diseases transmitted by seed to the cultural significance of seeds, from social organization to the transmission of knowledge, from geographical and landscape genetics to the sustainability of rural economies (Stukenbrock and McDonald 2008; Carvalho 2011; Guei et al. 2011; Wu et al. 2011). Difficult to separate the biological from cultural factors related to seed exchange, they interact both in cause and effect. Although often referred to as "informal", local seed networks follow social norms and rules, and can thus be considered as being entirely "formal" in their local contexts. Recent decades have seen progressive loss of local varieties and widespread adoption of the mono-cultural production (Dawson et al. 2011). Although this shift towards a handful of productive crops made it possible to partly meet growing food needs, it is now recognized by many that sustainable agriculture cannot be achieved without the conservation of agrobiodiversity (Mercer and Perales 2010; Carvalheiro et al. 2011; Ebert 2011; Vigouroux et al. 2011). Local seed exchange networks are essential to agrobiodiversity conservation, because they permit access to seed and the maintenance of landraces in agro-ecosystems throughout the world, despite the trend towards more uniform seed material flowing through formal, commercial seed systems.	
Louette, D., Charrier, A., & Berthaud, J. (1997). In Situ Conservation of Maize in Mexico: Genetic Diversity and Maize Seed Management in a Traditional Community. *Economic Botany*, *51*(1), 20-38.	a classic study of maize seed flow in a traditional village of Jalisco State, Mexico, showed maize diversity to be the result not of geographical isolation, but of the introduction of both improved cultivars and of landraces from neighboring communities.	
Bañales-Seguel, C., Riquelme Maulén, W., Álvez, A., & Habit, E. (2020). Scientific Landscape Related to Mapuche Indigenous Peoples and Wallmapu Territory. *Sustainability*, *12*(19), Article 19. https://doi.org/10.3390/su12197895		

Peláez, A. S. (2000). Notas sobre la población Mapuche actual. Revista Austral de Ciencias Sociales, 4, Article 4. https://doi.org/10.4206/rev.austral.cienc.soc.2000.n4-01	17th-19th century: the Mapuche did not only make use of the horse that was introduced by the Spanish. The Mapuche made expeditions to the other side of the Andes. Nowadays often, we speak about 'the Mapuche' without clarifying in which historical period or what specific group. The economy was based on small agriculture combined with livestock on a small scale. La agricultura mapuche se dedica principalmente a la producción de trigo, avena, papas y de hortalizas en pequeños huertos. Pocos tienen una yunta de bueyes y sólo algunos tienen otros vacunos y caballares. En algunos sitios crían cabras (zonas cordilleranas) u ovejas. Estas actividades son complementadas con algunas aves y cerdos para el consumo, con la recolección y la pequeña producción artesanal.	
Bengoa, J. (2020). *Sociedad Mapuche rural: 40 años*. http://bibliotecadigital.academia.cl/xmlui/handle/123456789/6329	The fate of Mapuche farmers is closely related to that of non-Mapuche farmers on small scale farms and to the agricultural policies by the government and the deterioration of productive conditions on small scale farming. Over the past 30 years, agriculture has shifted towards export. Lentils for example, were before cultivated by the Mapuche, among others. Nowadays they are exported to all over the world. Agriculture: trigo, pastos para los animales, producción de hortalizas, huerto frutal, generalmente de manzanas, y muy pocas cosas más	
Oyarce, A. M., Romaggi, M. I., & Vidal, A. (1989). Como viven los Mapuche: Análisis del Censo de Población de Chile 1982. *Programa de apoyo y extension en salud materno infantil (PAESMI)*. https://repositorio.cepal.org/server/api/core/bitstreams/4a0db3e1-52ee-4544-9a35-3de98d4414ab/content	Water is mostly obtained from a well or from a river.	