agriculture

MDPI

Article

Small Farmers' Agricultural Practices and Adaptation Strategies to Perceived Soil Changes in the Lagoon of Venice, Italy

Tiziana Floridia [1], Julia Prakofjewa [1,*], Luigi Conte [1,2], Giulia Mattalia [1,3], Raivo Kalle [4] and Renata Sõukand [1]

1 Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice, Via Torino 155, 30172 Venezia, Italy; tizianafloridia@outlook.com (T.F.); luigi.conte@unive.it (L.C.); giulia.mattalia@uab.cat (G.M.); renata.soukand@unive.it (R.S.)
2 Faculty of Biological and Environmental Sciences, Greater Dourados Federal University, Dourados 79825-070, Mato Grosso do Sul, Brazil
3 Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona (ICTA-UAB), 08193 Barcelona, Spain
4 Estonian Literary Museum, Vanemuise 42, 51003 Tartu, Estonia; raivo.kalle@mail.ee
* Correspondence: yuliya.prakofyeva@unive.it

Abstract: Farmers have a pivotal responsibility in soil conservation: they can either preserve or deplete it through their choices. The responsibility of agriculture increases when practised in delicate ecosystems, such as lagoonal ones. The Venetian Lagoon islands, which are increasingly subjected to natural and anthropic subsidence, occasional flooding events (*acqua alta*), and eustatic sea level rise, are constantly exposed to erosive processes that challenge farmers to play with their adaptive capability. This research was carried out on the islands of Sant'Erasmo and Vignole, the most representative of island agriculture in the Venetian Lagoon: they almost exclusively rely on agriculture, which is non-existent in the other islands. This empirical research aimed to explore farmers' agricultural practices, perceptions of soil changes, and how they adapt to them. It was fundamental for this study that the field research involved direct human contact with farmers (through semi-structured interviews) for data collection and using qualitative methods for data analysis, integrating scientific and non-scientific forms of knowledge and actors. The final purpose was to demonstrate the sustainability (valued on the potential depletion or regeneration capability) of agricultural practices and adaptation strategies on a theoretical basis. Despite their polycultural landscape (maintained by low-input farming systems), escaped from the predominant landscape oversimplification, Sant'Erasmo and Vignole are also subjected to unsustainable agricultural practices, including heavy mechanisation and synthetic inputs. Coupled with natural soil salinity that is exacerbated by increasing drought periods, these practices can contribute to soil degradation and increased salinity. The reported adaptation strategies, such as zeroed, reduced, or more conscious use of machines, were guided by the need to reduce the negative impact of soil changes on productivity. Our research revealed some of them as sustainable and others as unsustainable (such as increasing irrigation to contrast soil salinity). Participatory action research is needed to support farmers in designing effective sustainable agricultural practices and adaptation strategies.

Keywords: lagoon of Venice; local and indigenous knowledge; empirical research; agricultural practices; soil erosion; soil salinity; adaptation strategies; sustainable island agriculture

check for updates

Citation: Floridia, T.; Prakofjewa, J.; Conte, L.; Mattalia, G.; Kalle, R.; Sõukand, R. Small Farmers' Agricultural Practices and Adaptation Strategies to Perceived Soil Changes in the Lagoon of Venice, Italy. *Agriculture* **2024**, *14*, 2068. https://doi.org/10.3390/agriculture14112068

Academic Editor: Anlu Zhang

Received: 14 October 2024
Revised: 3 November 2024
Accepted: 13 November 2024
Published: 16 November 2024

1. Introduction

Since soil is the foundation of life, it is crucial to guarantee its conservation [1]. Human activities can cause soil degradation or improvement and contribute to sustainability, biodiversity, and the protection of natural resources [2]. Agriculture plays a key role in these dynamics, as it stands at the intersection of human action and soil conservation, influencing cultural landscapes and natural resource management. However, unsustainable agricultural practices, driven primarily by farmland expansion and intensive use of agricultural inputs, contribute significantly to soil degradation, the pollution of air, water, and soil, the fragmentation of habitats, and biodiversity loss. Globally, more than half (52%) of the fertile, food-producing soils are considered as degraded, with many severely degraded, and 12 million hectares of land are lost to food production annually. As the FAO highlights [3], soil degradation, alongside climate change, represents one of the most pressing challenges [4].

Modern agriculture often relies on large machinery to facilitate intensive field management. The widespread use of machinery is associated with large amounts of chemical compounds, leading to the removal of features like hedgerows, shelterbelts, ponds, and woods, which are typical of traditional agroecosystems. Consequently, monocultures have become prevalent in many regions, homogenising landscapes and exacerbating environmental degradation [5]. The methods of cultivation, land management, and resource use can either mitigate or worsen soil degradation, erosion, and greenhouse gas emissions. Understanding how environmental changes affect small farmers' agricultural practices is essential for developing sustainable strategies that support agricultural productivity and ecosystem health [6].

Farmers have a profound impact on soil health and productivity, contributing to broader environmental change through their practices [7]. Agroecosystems and agricultural landscapes provide important soil-related ecosystem services, i.e., maintaining soil fertility and structural properties, filtering and providing reservoirs for water, nutrient cycling, and climate regulation [8]. The production and preservation of healthy soils in agricultural areas are fundamental to sustainable agricultural development.

However, the overexploitation, conservation, or sustainable use of natural resources are not solely ecological matters. They are influenced by social and political institutions, norms, and values. Sustainable resource management requires diverse knowledge sources, encompassing both academic and non-academic forms, such as indigenous and local knowledge [9]. Local knowledge is sensory and experiential, being grounded in repeated observations within cultural landscape and contributing to a sense of belonging. This knowledge is often overlooked in Western scientific research, which tends to prioritise technology and artificial sensory tools, resulting in a disconnect from the human and emotional experiences of place [10].

Indigenous and local knowledge systems, developed over centuries, provide insights into the environment through direct interaction with nature. Local knowledge includes detailed observations of species, weather, and ecological relationships that complement scientific approaches and contribute to effective conservation strategies [11].

Integrating local knowledge with scientific knowledge fosters comprehensive and culturally sensitive solutions for environmental management [12]. Collaborative approaches that respect and incorporate indigenous and local knowledge systems enhance sustainability efforts but also empower local communities to actively participate in environmental stewardship [13]. Recognising and valuing local knowledge is vital for addressing environmental challenges and fostering a sustainable future, particularly in vulnerable areas.

The vulnerability to climate change has been defined by scholars as the "extent to which climate change may damage or harm a system" [14]. The Northern Italian plain, including the Po delta and the Venetian Lagoon, is particularly susceptible to climate change impacts, such as sea level rise, increased flood risk and permanent submersion of low-lying areas [15]. In addition, occasional floods, which, in the case of the Venetian Lagoon, are known as high-water events (*acqua alta*), temporarily affect the coasts of the Northern Adriatic Sea [16]. It is also likely that this area will be affected by an intensification of saltwater intrusion in freshwater systems, particularly in groundwater. The elevation of this coastline rarely exceeds two meters, and because of natural and human-induced subsidence and eustasy, various zones presently lie below sea level. Natural subsidence is mainly caused by the natural compaction of sediments and partly by local tectonic adjustment. Anthropic subsidence has been induced by events such as the overexploitation of groundwater reservoirs for industrial and agricultural purposes and the overexploitation of gas reservoirs in the Northern Adriatic Sea. Consequently, the Venetian Lagoon constantly undergoes erosive processes [15].

Local perceptions of soil quality and governance influence decision making and conservation efforts, highlighting the interconnectedness of social, environmental, and historical factors in agroecosystems [2]. According to Özgen [16], in addition to social background and assets, the decision making and attitudes within an agroecosystem also depend on the state of the environment itself and past experiences, all of which influence perception. Farmers' soil quality knowledge, choices, and actions depend on their individual cognitive processes inter-related with perceptions and, at the same time, are an active part of the agroecosystem.

Farmers on the Sant'Erasmo and Vignole islands, nestled in the Venetian lagoon, have long cultivated their land, balancing traditional practices with evolving environmental challenges. This study investigates their perceptions of soil changes, agricultural practices, and adaptation strategies. This study seeks to reach the following objectives:

1. Documenting the types of agriculture, critical agricultural practices, and inputs adopted by farmers on the Sant' Erasmo and Vignole islands;
2. Exploring farmers' perceptions of soil changes;
3. Identifying the adaptation strategies used to mitigate negative impacts on productivity.

By employing the chosen methodology (see Section 2.2), the research will facilitate the knowledge exchange between farmers and researchers. Engaging farmers in participatory processes can enhance communication and lead to more effective interventions [13,17].

2. Materials and Methods

2.1. Study Area

The Venetian Lagoon (Figure 1) is one of the largest lagoonal systems in the Mediterranean and the widest one in Italy [18], covering an area of 550 km^2, with 8% of the surface occupied by minor islands (60 in total, with Venetian settlements excluded), 25% by saltmarshes (*barene*), and 67% by water (average depth of 1.2 m and salinity between 18 and 30‰, following seasonal variations) [19]. Flooding events, known as *acqua alta*, mainly result from tides, seiches, and easterly winds. Spring and fall are the rainiest seasons, and June, September, and October are the less rainy months [18], with precipitations ranging from 650 mm to 850 mm [20]. Winter is the driest season. Average monthly temperatures generally range from 3 °C to 24 °C but can reach 30 °C and fall to 0 °C [18].

The lagoon surrounds the city of Venice, with circa 70,000 inhabitants [18]. Two long, narrow barrier islands (*lidi*), the Lido and Pellestrina, separate the lagoon from the Adriatic Sea. To the north of the Lido and sheltered by the Cavallino–Treporti Peninsula, the lagoon is populated by numerous estuarine islands, with some of them (Murano, Mazzorbo, Burano, and Sant'Erasmo) hosting sizeable permanent populations [21]. The agricultural communities are concentrated to the west of Murano, in Sant'Erasmo (population: 669) and Vignole (population: 56) [21].

Sant'Erasmo has an agricultural landscape (Figure 2) characterised by a variety of crop cultivations (polyculture), growing mainly wine grapes (producing a typical wine with a salty taste) and vegetables, like the famous "*Violetto di Sant'Erasmo*", an artichoke landrace also cultivated on Vignole island [22], whose agricultural landscape is very similar to that of Sant'Erasmo although smaller in size. The strong presence of water on the islands cannot escape the eye. Indeed, both islands are characterised by extensive ditches and canals crisscrossing the landscape, creating a peculiar irrigation system. This interplay between land and water makes a distinctive agricultural environment that is both highly productive and aesthetically pleasing.

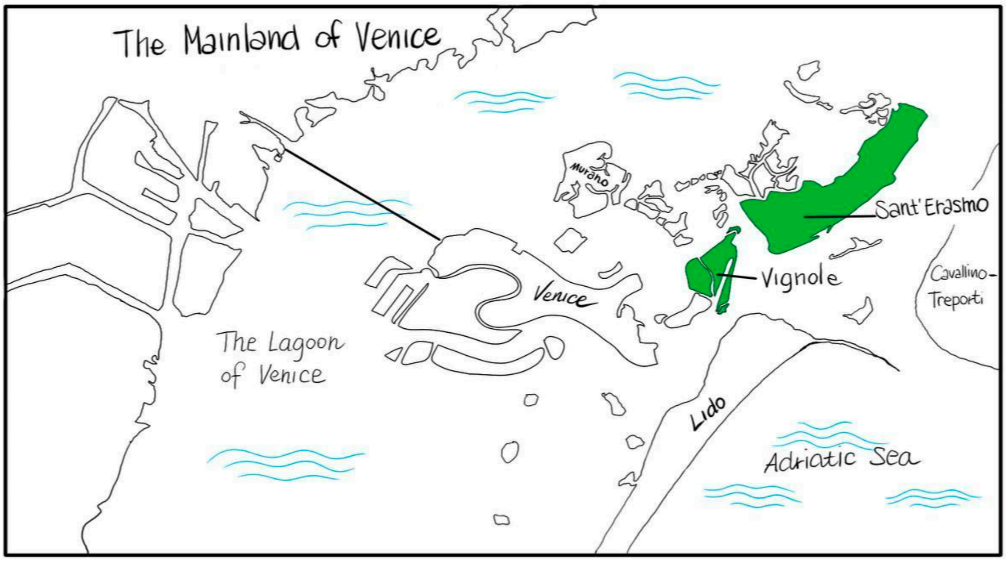


Figure 1. The study area and its landscape: view of the lagoon of Venice, with the featured Vignole and Sant'Erasmo islands. Traced (on a background Google Maps image mapping the lagoon of Venice) and edited with SketchBook PRO 3.0 (designed by T.F.).

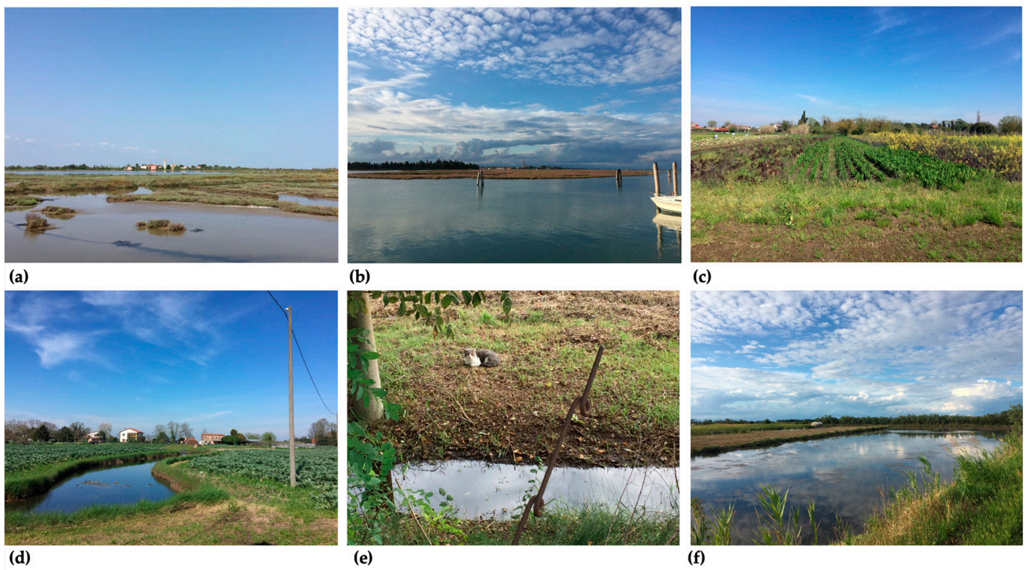


Figure 2. Venetian Lagoon and Sant'Erasmo landscape: (**a**) saltmarshes (*barene*); (**b**) the Venetian Lagoon from a Sant'Erasmo perspective, with San Francesco del Deserto island in the background; (**c**) fields in Sant'Erasmo; (**d**) a drainage ditch in the middle of a typical field of artichokes in Sant'Erasmo; (**e**) a small drainage ditch in Sant'Erasmo; (**f**) one of the most extensive drainage ditches in Sant'Erasmo. Credit: T.F.'s archive, 2023.

2.2. Data Collection and Analysis

Fieldwork was conducted on the islands of Sant'Erasmo and Vignole between April 2023 and June 2024. Specifically, semi-structured interviews were carried out with farmers from nineteen local farms. The sample was selected using a combination of snowball, purposive, selective, and convenient sampling. Given that agriculture in the Venetian Lagoon is primarily practised in Sant'Erasmo and Vignole (only very few small farms on other islands) and that there are 18 official farms in Sant'Erasmo and 5 in Vignole, our sample achieved high representativeness—approximately 78% for Sant'Erasmo and 80% for Vignole—and, thus, a strong representation of the entire Venetian Lagoon's farming community. Additionally, one non-official farmer on Sant'Erasmo was interviewed.

In some cases, follow-up interviews (either in person or over the phone) were conducted to complete the initial interviews (for the short time availability of the interviewee). There were two cases in which the second interview was conducted with a relative. More precisely, (i) in one case, one interviewee died during the research project; therefore, the second interview was conducted with the son. (ii) In another case, the second interview was conducted over the phone (for time reasons), and given the interviewee's old age, it was agreed that the interview would be conducted with the daughter. In both cases, the second interviewees were not official farmers, yet they helped the parents work the land.

As a result, the final study sample comprised 21 individuals, 6 women and 15 men (4 men residing in Vignole and the rest on Sant'Erasmo), with their ages ranging between 24 and 87 years (average age is approximately 61). Table 1 details the sample distribution selected for analysis. The majority of participants had a low level of education, according to the ISCED-11 [23] classification, with only two having completed higher education.

Table 1. Sample distribution by education and years of farming.

Education	**Total Number = 21**
0, no schooling	1
1, primary	5
2, lower secondary	7
3, upper secondary	6
4, post-secondary non-tertiary	1
5, equivalent tertiary education level	1
Years of farming	
<10	3
10–19	5
20–39	4
40–59	3
≥60	4
NQ [1]	2

[1] NQ stands for non-quantifiable, as the farmers did not provide an answer in years; instead, they stated they had had been cultivating the land since childhood.

The study was approved by the Ethics Committee of Ca' Foscari. The interviews were conducted and voice recorded (in the case of face-to-face interviews only) after explaining the purpose of the study, providing the interviewee with information on processing their personal data, and receiving oral consent.

Open-ended questions do not impose limiting borders on the conversation but create space for an informal free-flowing conversation. The subjects of the questions were (i) the type of agriculture practised; (ii) the agricultural practices adopted (advantages, disadvantages, and possible solutions to disadvantages); (iii) the inputs used (external and internal to the farm); (iv) the perceived soil changes; and (v) the adaptation strategies to perceived soil changes.

The interviews were accompanied by field visits to the interviewees' fields and gardens cultivated (to record the agricultural methods adopted), the island ecosystem, etc., always ensuring data anonymity (thus not taking any photos that could make the interviewees and their farm/garden identifiable). The duration of the interviews ranged from 0.5 to 2 h, depending on the interviewee's degree of involvement in answering the questions and emotional or time availability.

All the information collected through the interviews was (i) accurately transcribed to ensure every nuance was kept for more transparency and reproducibility of the data analysis and (ii) deprived of any direct personal data information to ensure anonymity and respect for privacy. Through qualitative content analysis of documented narratives, we identified the main topics and common denominators emerging from the semi-structured, open-ended interviews and created main categories.

3. Results

3.1. Types of Agriculture Practised on Islands

We recorded four main types of agriculture in the two islands (see Table 2), yet on Vignole island, only two of them are practised (integrated polyculture and polyculture). The most observed type of agriculture in the entire sample was "integrated polyculture" (approximately 63%); that is, the majority of farmers cultivate more crops within the same farm or the same field, using not only external natural (organic and inorganic) products, but also synthetic (inorganic) products.

Table 2. Sample distribution is by the type of agriculture on Sant'Erasmo and Vignole islands.

Type of Agriculture	Total Number = 19
integrated polyculture [1]	12
polyculture	5
do-nothing synergic vegetable gardening	1
agroecological farming	1

[1] Integrated polyculture is a mix of conventional and organic agriculture.

3.2. Agricultural Practices Adopted on Islands

We identified several agricultural practices, which are divisible into 23 processes, some of which are practiced together (such as crop rotation, set-aside, and green manure; however, they will not be discussed in this study) or can overlap (such as cover crops and insectary plants), as shown in Table 3.

Table 3. Agricultural practices mentioned by farmers in 19 farms on Sant'Erasmo and Vignole islands.

Agricultural Practice	Type of Equipment/Means Used	Process
soil mechanical pressure	heavy machines	milling
		chopping
		ploughing
		harrowing
	light machines	hoeing (motor hoe)
		chopping
	hand tools	hoeing (manual hoe)
		shovelling (shovel)
		chopping (with sickle)
soil regeneration/windbreak (shelterbelt)/supporting biodiversity/biological control		crop rotation
		set-aside
		green manure
		companion plants (either spontaneous or sown)
		cover plants (either spontaneous or sown)
		insectary plants
		planting crops that attract useful or harmful insects

Table 3. *Cont.*

Agricultural Practice	Type of Equipment/Means Used	Process
		free-to-roam chickens and/or ducks
		hedgerows as field margins
	heavy machines	mulching (entirely inorganic): polyethylene film mulch
		mulching (partly inorganic): biodegradable plastic film mulch
	hands	mulching (organic): hay mulch
fertilisation using inputs	see Table 4	see Table 4
plant protection * using inputs		
seeding/planting	heavy machines	-
	hand tools	
	hands	
weeding	heavy/light machines	-
	hand tools	
	hands	
harvesting	hand tools	-
	hands	
water management (tap water, groundwater, and rainwater)	drip line	irrigation
	sprinkler	
	hosepipe	
	pump	
	artesian well	collecting water
	tank	

* Plant protection products are "pesticides" that protect crops or desirable or useful plants [24]. Only the processes mentioned by farmers are reported.

Table 4. External and internal inputs (pesticides and fertilisers) mentioned by farmers in 19 farms on Sant'Erasmo and Vignole islands.

External (to the farm)			
Pesticides *		Fertilisers	
natural	organic	natural	organic
	inorganic		inorganic
synthetic	inorganic	synthetic	inorganic
Internal (to the farm)			
Pesticides *		Fertilisers	
	plant products		plant products
	animal products		animal products

* A "pesticide" prevents, destroys, or controls a harmful organism ("pest") or disease or protects plants or plant products during production, storage, and transport. They include, amongst others, herbicides, fungicides, insecticides, acaricides, nematicides, molluscicides, growth regulators, repellents, rodenticides, and biocides [24]. Only the categories mentioned by farmers are reported.

Crop rotation was practised by 15 farmers (approximately 79%) on both islands. P16 reported the practice of crop rotation to not deplete the soil and to maintain its productivity:

> *"When you do crop rotation you have to change the crop you plant; you can't replant the same crop you plant in Spring. By rotating crops, you should guarantee the new planted crop provides the soil with the substance taken by the previous crop and takes the substance released by the latter from the soil. For example, in Autumn I planted green beans; now I'm going to plant peas. The next crop I'm going to plant are zucchini. This way, one plant helps the other. If you plant always the same crop on the same plot of land, it will grow, yet, it will deplete the soil over the years."*

P4 described crop rotation as a way to increase soil health and, thus, reduce attacks from nematodes:

> *"We always practice crop rotation. For example, where we have nematode infestations. Nematodes are parasites which are usually found in Solanaceae roots. However, in the case of yearly crop rotation, the tubers of Solanaceae, like potatoes, are not so often attacked. Differently, they are more attacked in case of 15-year-monocultures of potatoes, thus without crop rotation, they are more attacked."*

P11 reported the practice of crop rotation to avoid the use of nitrogen fertilisers:

> *"I planted two rows of nitrogen-fixing peas; next year, I will plant tomato plants in the place of peas since they need a lot of nitrogen to grow and will move peas to parallel rows to keep doing the same thing in another piece of terrain; this way I avoid the use of nitrogen fertilisers."*

Similarly, the same farmer uses companion plants (also named in two other farms) in vineyards to avoid the use of nitrogen fertilisers:

> *"I put legume crops between the rows of vines, since they [naturally] provide soil and vineyards with nitrogen."* [P11]

Another farmer argued that he naturally provides the soil with nitrogen in the vineyard through companion, either sown or spontaneous cover crops:

> *"We plant four-leaf clover and vetch between the vineyard rows to add nitrogen to the soil. However, our soil is always covered; we never leave it uncovered. (. . .) We have not ploughed for 20 years. I pay a lot of attention to the soil. If our soil is fertile, it's because there's a soil microbiology that works for us, such as bacteria. If the soil is too much turned and exposed to sun and cold, all this life is killed, and the soil is no longer fertile, thus needing to be fertilised. (. . .) We also leave spontaneous cover crops, which we then chop, thus providing mulch and organic matter to our soil. Cover cropping, in general, prevents water from stagnating when it rains. Otherwise, the earth (mostly clayey here) becomes like concrete and waterproof. The latter tends to go down in depth thanks to the competition between weed and vineyard roots. Cover cropping eventually gives stability to the soil."* [P17]

Some cover crops are also used as insectary plants as a form of biological control: "*This is alfalfa and is useful for bees*" [P6]; "*I planted alfalfa for bees, it feeds them, but I don't use it. (. . .) This is an area of grassland. I let it grow for bees that land on flowers feeding themselves*" [P8].

In one case, one farmer [P10] observed that broad bean plants attract harmful insects: "*I planted broad bean plants in the garden since they attract little lice (pidocchietti) and insects in general; this way, they don't disturb the other plants*".

In some cases, farmers (only four) decided to adopt the practice of leaving free-range chickens and ducks as biological control agents, thus as natural substitutes of synthetic fertilisers and pesticides in general:

> *"We leave chickens and ducks free to roam since they fertilise and help us with snails as well. We free them in the afternoon; this way they eat, and they come back in the evening, this way they eat less wheat and help us with insects."* [P6]

Otherwise, another recorded practice is that of using hedgerows as field margins not only as a form of biological control but as a windbreak (shelterbelt):

> *"If you see, I left edible blackberry plants as hedgerows. Why? Because there, both good and "bad" insects flourish. And then the good ones eat the bad ones. (. . .) Moreover, they shelter the fields and thus help control soil erosion caused by tramontana, a wind from the north."* [P11]

Similarly, a farmer reported:

> *"The hedge you see there is all ours. We leave the field margins on purpose without disturbing them because they are a shelter in winter for useful insects."* [P8]

Milling is another practice adopted by more than half of the island farmers (approximately 79%). Although many farmers noticed soil compaction, which was a consequence of this practice and consequently decreased soil permeability caused by heavy machines, they still could not avoid using them. This has been evidenced, for example, by a farmer [P3], who also documented the need to use a harrow after the miller to break the impermeable layer caused by the latter:

> *"Sometimes you have to do soil milling; it makes the earth like dust and is convenient since it softens the soil. However, it causes soil compaction. (. . .) For this reason, you must then go with a harrow to break the impermeable layer."*

Two other farmers reported the disadvantage of soil impermeability, which is especially prominent in the case of heavy rains, where water is lost and not absorbed by the soil, which has lost its water absorption capacity. Respectively,

> *"The milling machine does great work since it helps to integrate organic matter in the soil; it softens and levels the soil, thus preparing it for planting. Yet, it has the disadvantage of creating an impermeable layer; therefore, you must go with a harrow to break the layer and make a water drain. The problem of soil milling is therefore particularly evident in the case of water bombs since water doesn't drain and there appear lakes."* [P6]

> *"I have noticed soil thinning. When it rains, water goes to the ditches (that work as a drainage system in the fields; see Figure 3). If soils are ploughed, they have a better drainage capacity since you open the soil; if they are milled, water drains very little because of soil compaction. This way, soils are leached with excess rainfall."* [P9]

In this regard, one farmer [P2] explained that *"the difference between ditches and canals is that canals are navigable, deeper, generally larger and saltier than ditches. Indeed, ditches contain brackish water (approximately 70% salty water and 30% fresh water, either rain or irrigation water). (. . .) I close the ditch lock in my field at >10 cm (when the canal water is >10 cm than that of the ditch) and open it at <10 cm (when the canal water is <10 cm than that of the ditch). In the first case, I avoid the canal's salty water entering the ditch. In the second case, I make the brackish water go out in the canal (brackish since, although the ditch lock is closed, there is saltwater intrusion anyway). (. . .) However, [although MOSE has been built and activated and a drainage system exists on the island], we are not free from water problems. After a heavy rain yesterday, our land is soaked today. And we can't even empty the ditches full of rainwater because we can't open the ditch lock due to the 'acqua alta' in the canals"* (see Figure 3).

Waterlogging is especially visible in soil impermeability, either anthropic (caused by mechanical pressure) or natural (caused by the natural structure of the soil, such as that of clayey soils, being less permeable compared to sandy soils).

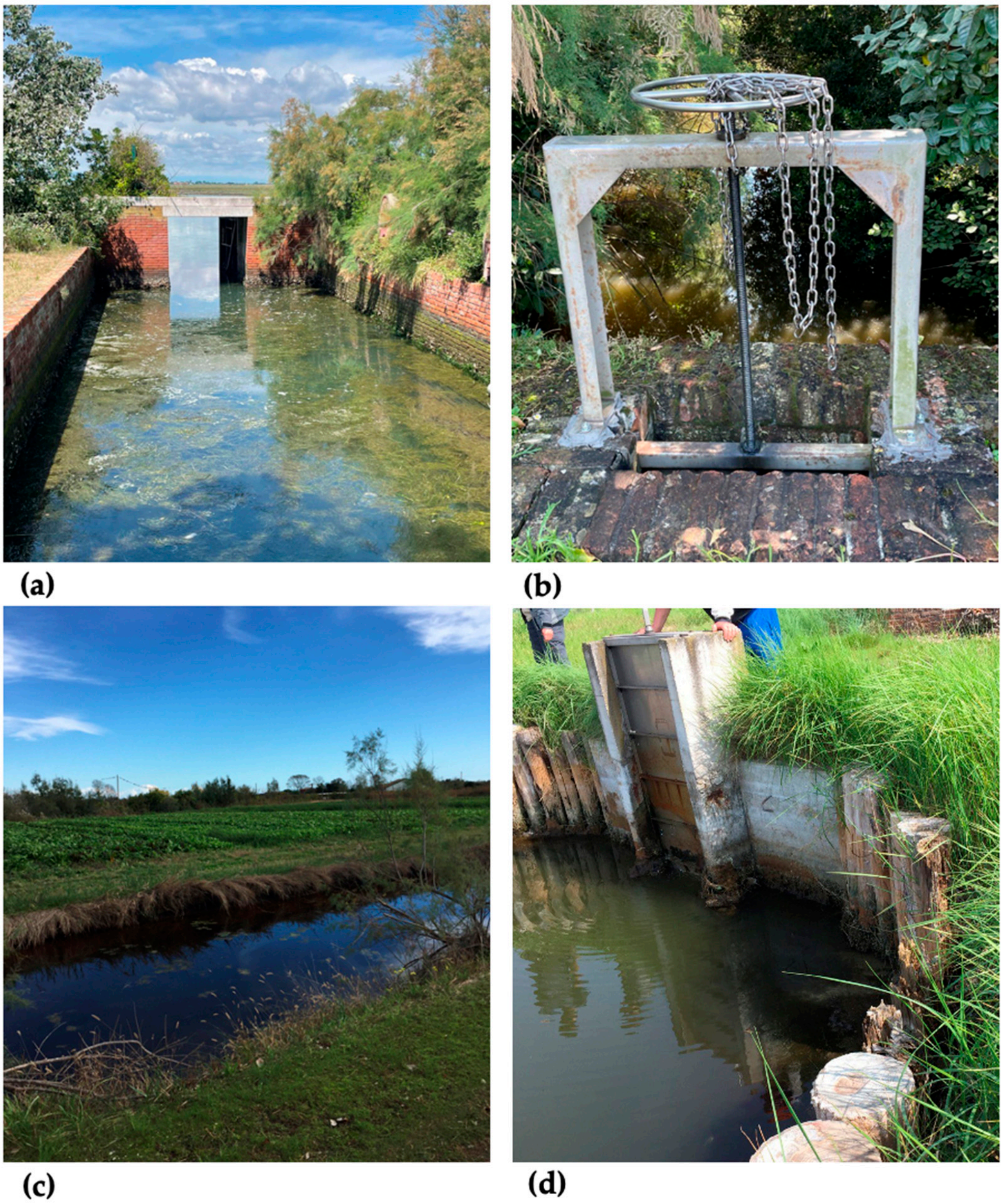


Figure 3. Canals and ditches in Sant'Erasmo: (**a**) the walled part of the island, the reclaimed area: an open canal outlet, which connects canal water to lagoon water; (**b**) the walled part of the island, the reclaimed area: a closed ditch lock, which separates ditch water to canal water; (**c**) a ditch along the perimeter of a plot of land, slightly sloping towards the ditch, thus used as a drainage system in the fields of the islands; (**d**) a ditch in a farmer's field; the lock is closed so as to not allow the salty water of the adjacent canal to enter the ditch dug around the field. Credit: T.F.'s personal archive, 2023–2024.

An interesting result from our research is that many farmers still use their hands and hand tools for farming activities. For example, in the case of weeding,

"We remove weeds either with our hands or with the hoe." [P2], [P5], and [P13]

There are also cases in which farmers let the weeds grow, since they are recognised as nourishment for the soil: *"We leave the weeds growing since they are good for the soil (. . .)."* [P2] (Figure 4).

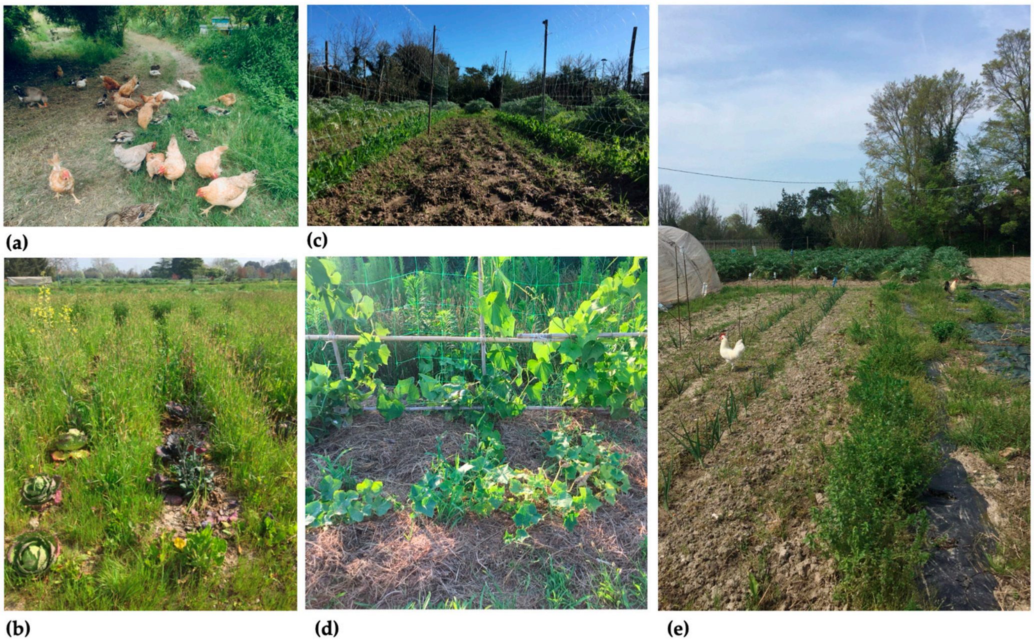


Figure 4. Agricultural practices in Sant'Erasmo and Vignole: (**a**) free-range chickens act as organic fertilisers and natural pesticides; (**b**) weeds left in the field as plants that nourish the soil; (**c**) experimental crop rotation: two rows of nitrogen-fixing peas; the following year, the farmer will plant tomato plants in the place of peas, since they need a lot of nitrogen to grow and will move peas to parallel rows to keep doing the same thing on another piece of terrain; this way, he avoids the use of nitrogen fertilisers; (**d**) companion planting: a synergistic garden; (**e**) free-range chickens act as organic fertilisers and natural pesticides. Credit: T.F.'s archive, 2023–2024.

Another practice widely adopted by farmers (approximately 74%) is set-aside, of which two farmers highlighted the capacity to avoid soil depletion, keep the soil fertile, and, thus, improve yields. Respectively,

> *"All my fields are left resting for the whole winter. This way, the land doesn't have to produce, so [the next year] it will give a better yield [since it has the time to regenerate]. Indeed, if you always work the land, you deplete it."* [P16]

> *"There are fields I haven't cultivated for 3 years since I practice set-aside there. Yet, when you then start growing vegetables on a set-aside land, the yield performance is increased."* [P14]

However, crop losses have also been documented in recent years: *"Last year we lost ¾ (three quarters) of cultivations of artichokes because of Acid rains. (. . .)"* [P9]. The same farmer reported an increase in diseases due to pollution: *"Now, there are more diseases than in the past. We didn't even know what late blight 'peronospora' was in the past. It means pollution has caused an increase in diseases."*

3.3. Inputs (Pesticides and Fertilisers) Used on Islands

The use of herbicides was reported only by two, one of which reported use in micro-doses (Table 4). The rest of the sample declared zero use of herbicides. Furthermore, among the twelve farmers applying integrated polyculture (see Table 2), eight reported the reduced use of synthetic products (including one who reported the reduced use of machines). While four reported very limited use of synthetic products, including two who also mentioned reduced use of machines (e.g., one stated no ploughing for 20 years). Within the polyculture practitioners, all five farmers declared not to use synthetic products, and among these, one also stated zero use of heavy machines. The farmer reporting agroecological farming methods declared zero use of synthetic products, and the only interviewee applying do-nothing synergic vegetable gardening declared zero use of either natural inorganic or synthetic (organic and inorganic) products and machines.

Regarding late blight ("*peronospora*"), we documented how small farmers on the islands have addressed it: *"By doing deep soil aeration [with a fixed-tooth harrow], you eliminate a lot of fungal diseases, or diseases like late blight ('peronospora'), rot, etc., on tomato plants and eggplants. Then, it is a couple of years since there's a nice breeze that dries plants. This way, the moisture [causing fungal diseases] decreases. Indeed, we've used copper (the one admitted in organic agriculture) on tomato plants only one time this year. I'm trying to use it ever less"* [P8].

Copper fungicides (synthetic inorganic pesticides) are used by more than half of our farmers—in the form of copper sulphate, copper oxychloride, and Bordeaux mixture—generally to contrast tomato plant fungal diseases such as the mentioned late blight. However, the perceptions on copper are various.

Some perceive it as poison:

> *"Also, plant protection products of natural extraction are poison. I'm talking of copper, for example."* [P1]

Others do not perceive it as a synthetic pesticide, since it is admitted in organic agriculture:

> *"We usually put verdigris (copper sulphate), which is allowed in organic farming. In fact, you don't need a license, you don't need anything to buy it because it is a product allowed in organic farming. If necessary. If it is not needed, we avoid using this product too."* [P5]

Others found alternatives, such as some beneficial fungi, to reduce its use as much as possible (although admitted in organic agriculture), yet did not use any negative or positive connotations:

> *"It must be said that parasites help fungi. If the pest bites the plant, the fungus enters better because the plant is injured. (...) We must know the world of fungi, and we must try not to let them develop, not using copper or using it very little, especially in exceptional cases. We currently integrate good fungi into the seedlings. (...). This means that other pathogens are unable to infest the root, and therefore, the plant is healthier (...). And therefore, we do not have problems with fungal diseases. The tomato plant, as well as the vine, is one of the products that gets very sick. What do we do? We cut the leaves. You will say to me: do you hurt the plant? Do pathogens go inside? It's not like that. In the sense that fungi develop when they have their home: if a leaf touches the ground, they develop because there is humidity and little air circulating."* [P6]

More than half the farmers on the islands reported using synthetic fertilisers (approximately 58%), and less than half used synthetic pesticides (approximately 42%).

Four farmers mentioned the Green Revolution (1960s) as the beginning of chemical use in agriculture on the islands. Among them, (i) one also reported the flood of 1966 as the beginning of chemicals in agriculture:

> *"Organic fertilisation was the only one used here once. Indeed, many people here had cowsheds and used to use fresh cow manure to fertilise soils. Now Sant'Erasmo is known as 'the vegetable garden of Venice', but since recent times. Indeed, before the 'acqua alta' [of '66], it was the 'orchard and the vineyard of Venice' (...). The vegetable garden was only marginal before. After the 'acqua alta' of '66, the great majority of orchards died and were substituted by vegetable gardens and chemical fertilisation, which was used since the Green Revolution at the end of the '60s. So, after '66 chemical fertilisation was introduced and substituted to the organic one. Nowadays people fertilise and pollute soils and rivers with nitrates and other chemicals; thus, soil is not fertile anymore."* [P14]

(ii) Another farmer reported the need for a support, the need to have a new system to make it possible for him to stop chemical treatments:

> *"If they give us a system to live without doing these things—since I recognise not doing treatments, not using herbicides, pesticides and all that is the right thing, I recognise it's not the wrong thing—they would give me 20 years of life, because we have to fight with everything."* [P9]

(iii) A farmer clearly expressed he clashed with this "Green Revolution" tendency to realise a truly green revolution, stopping the chemical treatments his father used to do, although this change, of course, required some time before unveiling its success:

> *"My father used to use chemical fertilisers since he cultivated in the '60s (the green revolution). Twenty years ago, I clashed with this category. So, I wanted [the real] green, while my father wanted to go on with chemicals (nitrates, herbicides, and insecticides) in agriculture: at the beginning the soil was not fertile—although we started doing green [agriculture]—because it was used to receive chemical inputs. Only after 5 years they backed me up. The land healed and now it's wonderful. (...) This separation from my father was important."* [P6]

Another farmer highlighted the slow pace of change when there is a switch to organic agriculture:

> *"The problem of aphids in the artichokes... Unfortunately, in Sant'Erasmo, farmers are 'old-school' and it's hard to put it into their minds: the change is not immediate. When you stop using chemicals, it takes three years to see results. The first year is a disaster. Everything is lost every time. The first year is a swim in the blood."* [P8]

The same farmer reported the taste of medicine he is now able to perceive when he eats chemically treated fruits and vegetables and mentioned lung problems caused by their own chemical treatments as the reason they switched to "green agriculture":

> *"When I now eat a product which is not mine, for example some fruit, I perceive it. I am not able to eat it anymore. I perceive the taste of medicine (...). It's 10 years, maybe 12, 13 that we don't use chemical products anymore. (...) I started feeling bad when I used to use those products. When I used insecticides, I didn't use to wear the face mask and not only when breathing them, but also when tasting the products treated with them, I started not to tolerate them anymore."* [P8]

Another farmer also paid attention to the negative impact of chemicals on his health: *"When I did chemical treatments, I noticed they hurt my lungs. This way I started little by little (...) to switch to a natural agriculture. We farmers are the first ones to suffer the consequences of the treatments we do, but this is just routine of industrialised agriculture"* [P6].

In this respect, three farmers documented the health risks associated with synthetic products yet ignored by farmers with lower education levels and also because sellers and experts did not explicitly communicate them:

> *"However, in my view this evil chemical should be eliminated; we need to remove it. I remember when I was a child, chemical was used of course: 'pump it, pump it'. They didn't tell you about its harmfulness. My grandparents, everybody... Once they didn't use anything since there was no products at the time of my grandparents. I also understand them, I put myself in their shoes. 10, 15 women on their knees hoeing, removing weeds. A shoulder atomiser arrived [in the farms] and killed all the weeds. They said 'America'. They sprayed it everywhere, how much lower work for these poor people. Yet, ignorantly, ignoring it was perilous."* [P8]

Two of them explicitly talked of the risks connected to nitrates, which are hidden by the people promoting/selling them. For example:

> *"Since the '60s, since the Green Revolution, the years in which trade unions said 'cultivate with nylon sheets, with nitrates, etc., in order to produce more'—I went to school; nonetheless I feel uneducated— if an expert tells me that nitrates are good, I don't search on the Internet to see if its carcinogenic, I just use it. They had an influence, instead."* [P3]

The small farmer contemplated the soil contamination caused by Montedison's release of red sludge into the Venetian Lagoon during the 1970s: *"Then, working in a shipping agency I realised everything that Montedison threw into the sea, also because we worked a lot with Montedison, we sent away different stuff from Montedison. I know for sure that once Montedison discharged the famous red sludge ('70s), the sludge from aluminium processing, into the sea. In those years, the former Yugoslavia realised this and began to strafe the unloading boat with patrol boats. As a solution Montedison found that it could put it as an inert product in fertilisers to get rid of it. So that ended up in all the lands here, everywhere. (. . .) On that occasion Gardini shot himself in the head. He called himself "the chemistry is me", it was Montedison."* [P3].

Also, air pollution was mentioned by one farmer [P5], being caused by the continuous passing of planes due to the proximity of the Venice airport.

> *"With the environmental pollution caused by all the planes flying over our fields, there is nothing organic, nothing natural."*

During the interview, the same farmer reported her way of avoiding the use of synthetic pesticides, such as macerates she prepares herself together with her husband, a tradition learnt by her husband's grandfather:

> *"We use a macerate prepared with nettle, mixed with Marseille soap, and tobacco—which we buy—to combat various types of pests. We put everything in a bin with water according to certain percentages, based on the size of the tank, mix it and let it decompose."*

Another farmer [P14] prepares a macerate with nettle and horsetail as natural fertiliser:

> *"I use the well as a container to macerate horsetail and nettle mainly. (. . .) There's plenty of horsetail in the beach. So, I cut it, put it in the well and leave it macerating together with nettle. Then I pull the rotten part away and use the water left. And then I use it as fertiliser."*

Then, a few farmers reported that they did not use synthetic pesticides to kill both "bad" and "good" insects, therefore respecting the predator–prey equilibrium of a healthy ecosystem:

> *"We don't use any synthetic pesticides. There's one thing to understand: if we kill the 'bad' insects, then there's no food for the good insect anymore. That is, if we kill aphids, then ladybirds starve. So, there must always be the good and the bad."* [P6]

Differently, some farmers tried to control harmful insects with natural organic products without success, thus resorting to synthetic products. For example, one farmer decided to use a systemic insecticide to kill the Colorado potato beetle, although they recognised the dangerousness of the insecticide for beneficial insects:

> *"We had big problems with the Colorado potato beetle on potatoes and aubergines this year. We were not able to control it organically; therefore we did some interventions with the [systemic] insecticide (. . .), which is the one used in vineyards too for golden Flavescence. But in the end, they are all products based on pyrethroids, which I don't like to use since they make a clean sweep of insects, so they also kill beneficial insects."* [P1]

Peculiar is the case of vineyards, in which farmers are not allowed, in specific instances, to avoid the use of synthetic products, which is mandatory by law (Legislative Decree 47/2023):

> *"For law, we must use chemical pesticides against a disease that kills vineyards, the golden Flavescence."* [P17]

> *"We use synthetic products, and they are used in organic agriculture, too. Since organic agriculture doesn't mean 'no treatments'; however they are [generally] not synthetic products, except for some products which are mandatory, such as those used for the golden Flavescence in vineyards. You must do two treatments per year, systemic treatments. Yet this is better than using 'natural' products, which you must intervene every 7/8 days.*

Also, phytosanitary products of natural extraction are poisonous; I'm talking of copper, for example." [P1]

In some cases, farmers use fresh manure from their chickens in cages (not battery ones):

"We sometimes spread fresh chicken manure on the ground, which is not the pelleted one. And you soon see the results, you see the vegetables are [more] beautiful [compared to when you use pelleted manure]." [P12]

3.4. Soil Changes Perceived by Farmers

Below, we explain, in detail, the specific changes mentioned by.

The change mostly mentioned by farmers was soil salinity, cited in 12 farms out of 19 (Figure 5). In this respect, one farmer reported increased salinity caused by the use of chemicals, which is also encouraged by agricultural associations:

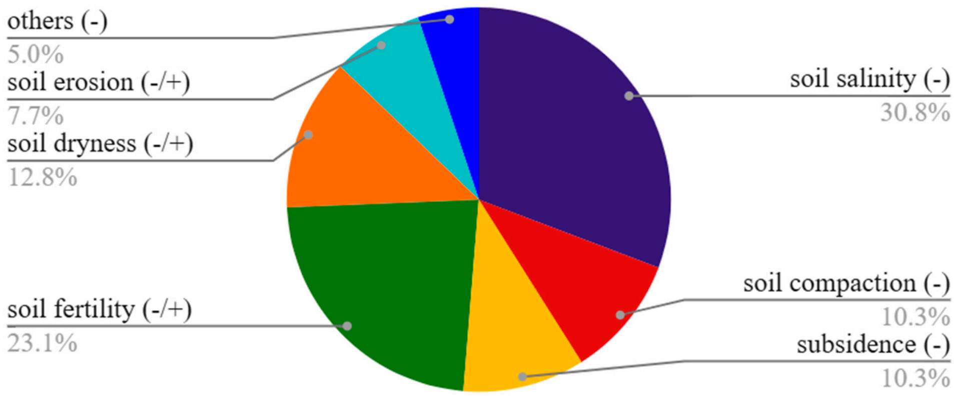


Figure 5. Pie chart with macro-categories of perceptions of soil changes (the exact changes mentioned by farmers are described below). Some farmers mentioned more than one type of soil change (both within the same macro-category and in different macro-categories); thus, the total number of modifications mentioned is higher than 19 (total number of farms). Therefore, the percentages refer to the mentions, not to the number of farms where they were mentioned. The symbols "−" and "+" represent negative and positive changes, respectively.

"Soil salinity is increasing ever more. Then, I think too much chemical has been used over the years, by my parents too. Sometimes my father went to meetings sponsored by Coldiretti. Then the representative of the chemical product of the time started telling them you have to put this and that. I remember there was a small mirror for the salad with all products to be used every 15–20 days." [P3]

One farmer documented the death of trees because of drought and salinity: *"Several trees died because of drought, therefore going deep underground they found salt. (. . .) When there's drought you see dirt roads become white [because of salt upwelling]"* [P6].

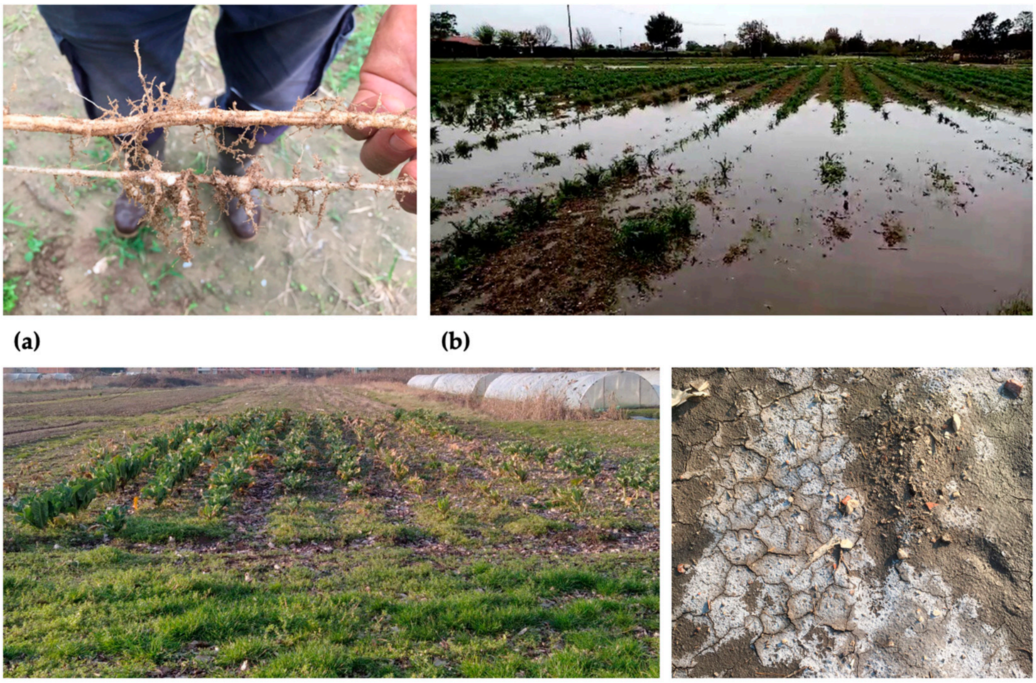
However, although farmers described salinity as a negative soil change, seven of them reported it as being a positive aspect in terms of income (not in terms of soil change), since it lends a unique salty taste to the products of the islands: *"The problem of our soils is salinity, which is a problem, but also an added value, since it gives our products a peculiar taste (. . .); therefore there's a great demand of our products for their uniqueness"* [P1].

The second most mentioned change regarded "soil fertility". Changes in soil fertility, either positive or negative, were reported by 10 farmers. However, the farmers reporting positive soil changes generally were only five (P6, P8, P10, P11, and P14). P6 and P8 practice polyculture with almost zero use of chemical products (except for copper, the one admitted in organic agriculture), and P11 practices polyculture with zero use of chemical products and zero use of heavy machines. P10 and P14 practice do-nothing synergic vegetable gardening and agroecological farming, respectively. The latter reported both positive (increased fertility) and negative changes (increased soil dryness):

> *"I noticed improvements where we mulched the soil with hay; there is more life, there is more humidity; it is more vital."* [P10]

> *"I noticed that soil became drier. Despite the increase in fertility due to the work I have done, there are also climatic events that have occurred; therefore, I have noticed that in summer it has become impossible to cultivate. It has become impossible. I can no longer plant for a whole series of reasons."* [P14]

"Soil compaction" caused by heavy machines and "subsidence" were observed, respectively, by four interviewees. "Soil erosion" was cited by two, and "decreased permeability" (within the "soil dryness" category) and "decreased fertility" (within the "soil fertility" category) were cited by only one interviewee (see Figure 6).



(a) **(b)** **(c)** **(d)**

Figure 6. Some environmental issues on Sant'Erasmo and Vignole islands: (**a**) root-knot nematodes; (**b**) a case of waterlogging caused by low permeability in clayey soil after rainfall; (**c**) difference in production in the same field; on the left: Brassica production following green pea cultivation the previous year; on the right: Brassica production where no crop was planted the previous year (indicating the need for a strong green manure); (**d**) crystallised *salso*, saltwater infiltration from groundwater in periods of severe drought; earth road on Vignole island. Credit: T.F.'s archive, 2023–2024.

Only one interviewee out of nineteen reported not noticing any changes in the soil during the years he spent cultivating his land.

3.5. How Have Farmers Adapted to Perceived Soil Changes?

The most mentioned adaptation strategy to soil change was "increase soil organic matter" (approximately 21%; Table 5).

Table 5. Adaptation strategies (to perceived soil changes) mentioned by farmers in 19 farms on Sant'Erasmo and Vignole islands.

Main Category	Subcategory
external inputs	increase (investment in) irrigation (to contrast salt upwelling)
	ploughing
	cover the soil with biodegradable mulch
	use machines at medium soil moisture (not on very wet soils)
	use phytosanitary products
natural soil regeneration and reduced soil stress (both mechanical and productive)	increase soil organic matter
	non-ploughing
	reduce intensive agriculture (set-aside with spontaneous cover crops)
seeds and plants	plant salt-tolerant plants
	plant resistant vegetables
	sow resilient seeds (hybrid varieties)

In this respect, one farmer [P14], who cited both "increase soil organic matter" and "cover the soil with biodegradable mulch" (the latter mentioned only by P14), reported that his agroecological methods (based on water use efficiency) are not sufficient to deal with soil aridity when long periods of drought occur:

"I don't irrigate, so I need moist soil, and if it doesn't rain for 3, 4 months, it becomes difficult for me to manage production. For me, it becomes difficult, if not impossible. The summer of 2022 was dramatic because it never rained from February to June. I can also increase the fertility of the soil. I can mulch the soil and make it less exposed to the sun so that it does not lose moisture, but it becomes difficult, you still need water. The soil must still be moist. It was arid everywhere. (. . .) Let's call it climatic aridity instead of soil aridity. However, I can't cultivate my fields with my techniques or my method if it doesn't rain. This is fundamental. I can't make it. It becomes complicated."

Differently, three farmers (approximately 16%) reported increased investment in irrigation [systems] (to contrast salt upwelling):

"For sure, in the coming years, we should invest more in irrigation in order to eliminate the salinity problem that you cannot stop by not doing certain processes, but only with the use of organic matter (and we already do this) and freshwater because if we keep our soil constantly wet with fresh water, salinity does not come up." [P1]

Another adaptation strategy proposed (by 2/19 farmers only) was planting salt-tolerant plants to adapt to increased soil salinity:

"In some parts of the field (I am talking about the part with artichokes, for example), there are corners, a nice piece of land that has become arid and not very suitable for cultivation because there is salt. So, what do I do there? I grow spinach, beets, and Chenopodiaceae, which are the least sensitive to salinity, so you can grow them anyway. And they are saved if it rains a little." [P14]

"In some very salty soils, we try to put olive trees as they are very resistant to salinity. An olive tree planting is [a] long-term [adaptation strategy] though." [P1]

On the other hand, only one farmer reported the use of machines at medium soil moisture to reduce observed soil compaction:

"If we use machines on the soil that are ready to be worked on, then it is not so compacted. (. . .) So, it's ok if you till the soil at medium soil moisture. On the other hand, if you go at a time when the ground is very wet, obviously, you cause soil compaction. That is, there are precise moments when the land should not be worked, and many people still work it for convenience and not for intelligence, not for a thought moved by the ethics of the land." [P7]

A total of 5 out of 19 farms stated that adaptive measures are absent or do not look for adaptive measures.

4. Discussion

4.1. Agricultural Practices on Islands

Sant'Erasmo and Vignole islands are the visible expressions of millennial human–landscape interaction, a mosaic of farmers' fields embedded into a network of roads, artificial canals, and ditches, communicating with semi-natural habitats. The people cultivating on the studied islands are almost all small-scale farmers, primarily cultivating artichokes, grapes, and other seasonal products.

Our findings indicated that polyculture systems prevail on both islands, where we recorded more farms adopting integrated polyculture systems (conventional and organic agriculture mixed, approximately is 63%) than farms adopting polyculture with no use of synthetic inorganic products (approximately 26%), such as nitrogen fertilisers and pyrethroids as pesticides. Instead of synthetic products, they use natural organic (and some few, inorganic) products to respect the environment and human health. For example, some use home-made macerates mainly prepared with nettle: (1) nettle, (2) nettle and garlic, and (3) nettle and horsetail. In this regard, Trebbi et al. [25] specifically investigated the potential of *Equisetum arvense* (horsetail macerate) compared to Cu-based treatments for the control of *Solanum lycopersicum*. The results affirmed the potential of horsetail macerate as an ACP Cu-alternative treatment for tomato late blight in agroecological/organic management systems. The horsetail was effective under both moderate and severe conditions of late blight, with positive effects on overall yield [25]. This is a significant finding, as more than half of the farmers use Cu-based treatments to contrast late blight.

Another way reported by farmers to control pests (but also to provide shelter for useful insects) is that of delimiting the fields with hedgerows. Indeed, field margins are of great importance in maintaining ecosystem services. They have a range of associated fauna, some of which may be pest species. At the same time, many are beneficial either as crop pollinators or as pest predators and, therefore, contribute to the sustainability of production by enhancing beneficial species within crops, helping control pests, thus reducing pesticide use [26]—a strategy specifically known as conservation biological control—and increasing landscape biological complexity [27].

As suggested by Brunelle et al. [28], another way to reduce the use of pesticides is crop diversification (crop rotation), which was reported by more than half of the farmers, who also reported this practice as a method for improving yields and soil fertility. Indeed, [29], after a review of the recent literature on crop rotation as a tool to manage soil fertility (specifically for vegetable production), reported that crop rotation guarantees the long-term productivity and sustainability of agricultural systems. More specifically, rotating crops contributes to improving the nutrient use efficiency and pursuing the self-sufficiency for nitrogen in vegetable production. Rotating crops directly benefits soil fertility. Species differ in root architecture and their ability to take nutrients from the soil. Some species may establish symbiosis with arbuscular mycorrhizal fungi, which have a high nutrient extraction ability, or nitrogen (N)-fixing bacteria, which provide the plant with N derived from the atmosphere. This latter aspect, typical of legumes, makes N a renewable resource for the system and can be exploited by growing legumes purposely for green manuring to supply new nitrogen to the soil for the subsequent crop [29]. Biologically fixed nitrogen provided by legume species can be realised by including them not only as a main crop (also rotating it with other crops) but also in companion crops, in cover crops (between two harvested crops), or in intercrops (with another crop grown at the same time but not harvested) can provide biologically fixed nitrogen [28].

In this regard, a few farmers rotate crops specifically with legumes to naturally provide the soil with nitrogen and thus avoid the use of synthetic inorganic nitrogen fertilisers. While other farmers substitute synthetic nitrogen fertilisers by using leguminous plants as cover crops in vineyards. Abad et al. [30] reported that cover crops are one of the most appealing options for soil management in vineyards because they increase biodiversity, improve water infiltration and aggregate stability, reduce soil erosion, and increase soil organic carbon (SOC). Finney et al. [31] argued that polyculture cover cropping (either spontaneous or sown) increases the functions critical to the production of agroecosystem services, such as weed suppression and N retention. Indeed, Abad et al. [30] reported that the increase in soil organic carbon from cover crops improves soil aggregate stability compared to tilled soils and is directly associated with a significant reduction in soil erosion. Additionally, these studies noted a remarkable increase in soil microbial diversity and passerine bird diversity, contrasting vineyards under conventional management with bare soil and soil tillage. In this regard, one farmer stated that he had not tilled (ploughed) the soil for 20 years (the only one reporting this long no-till duration) and never leaves the soil bare. Indeed, not only does he use companion cover crops to cover the soil, but he also chops them to mulch the soil. Mulching has several essential applications, including reducing soil water loss and erosion, enriching soil fauna, and improving soil properties and nutrient cycling. It also reduces the pH of the soil, which improves nutrient availability. Mulching reduces soil deterioration by limiting runoff and soil loss, increasing soil water availability by reducing evaporation, managing soil temperature, or reducing crop irrigation requirements [32]. Mulch protects the soil surface from heavy rain and stops a crust from forming. It also helps minimise compaction by animals and equipment [33]. Moreover, by not ploughing, the pores and channels made by roots, earthworms, and other soil life are preserved. They let water and air move into the soil suitable for crops [33].

However, although most farmers reported mulching (mainly to control weeds), only a few reported the use of organic mulching, and some reported the use of plastic mulch films. The majority of farmers reported the use of biodegradable mulch films (Mater-Bi®). Both organic and biodegradable plastic mulches eventually collapse or boost nutrients to the soil's surface, enhance moisture retention, and increase the humus layer [32]. Yet, although biodegradable mulch films potentially offer an encouraging alternative to conventional (petroleum-based) plastic films, they are more susceptible to rapid degradation. It means more microplastics (MPs, plastic particles with a diameter from 1 μm to 5 mm [34]) are likely to be generated from them than conventional films within the same time frame, probably leading to more severe MP pollution and associated effects. In addition, bio-MPs have a significant chance of forming nanoplastics (plastic particles with a diameter < 1 μm [35]), potentially causing a more substantial toxic effect on plants relative to conventional MPs.

Consequently, this would influence plant health, crop productivity, and food safety, leading to potential health risks. Bio-MPs share some standard features with MPs, from which some parallels may be drawn. Bio-MPs can cause weight loss, reduce growth rates and casting yields, increase mortality, decrease reproduction rates, and induce DNA damage and oxidative stress via a wide range of toxicity mechanisms. For instance, earthworms suffered physical damage and lost surface mucous upon moving into the bio-MP-polluted soil, resulting in burns and lesions on their bodies and, thus, inducing an adverse effect on earthworms. Second, bio-MPs (like PLA and PPC) can be ingested by some mesofauna (i.e., earthworms) because of their higher degradability and, subsequently, more extensive associated biofilm and microbial loads [36].

Additionally, there are practices still widely adopted on the islands that have adverse effects on soil and are also perceived as such by farmers, e.g., mechanical tillage (ploughing and milling in particular), as also confirmed by Nawaz et al. [37], who reported the degradation of soil properties by reducing the SOC pool.

Mechanical tillage also causes soil compaction [38] and soil organic matter and biodiversity decreases [39]. More specifically, soil macro- and microorganisms are particularly important for regulating carbon and nitrogen cycling and providing nutrition to plants.

In this respect, crop residue retention in no-till (NT) soils helps improve the soil structure and total porosity through the reduction of soil bulk density and penetration resistance and moderating soil temperature. Penetration resistance was reduced under NT with mulch, probably because of the decrease in soil bulk density, increase in total soil porosity, and reduction in overall compaction [37].

The combination of mulching and no-till farming can, therefore, be a solution to prevent rain/soil water loss and reduce irrigation water thanks to increased soil permeability and lower soil water evaporation. Contrarily, these cannot be avoided in naked soils subjected to mechanical tillage (MT), where, in the case of rainfall events, the compaction and impermeability of the soils caused by MT results in water loss due to runoff. Additionally, soil loss because of leaching during irrigation or rainfall events was increased by the typical low slope fields of the islands.

Practices like ploughing, milling, and chopping are performed by farmers with heavy machines, although it is recognised at the same time that they cause soil compaction, as also supported by Shah et al. [40]. In this regard, they reported that mechanically caused soil compaction is characterised by the reduction of crop growth and deterioration of soil quality. However, the vulnerability of soil to become compacted has been observed as an interaction of numerous factors, including soil physical properties, drop in humus content, and increased mineralisation, and issues effectively detected by farmers in the islands.

4.2. Adaptation Strategies to Perceived Soil Changes

The most perceived soil change by farmers on Sant'Erasmo and Vignole islands is salinity, to which farmers adapt in multiple ways, such as non-ploughing, mulching, increasing soil organic matter, increasing (investment in) irrigation (to contrast salt upwelling), and the planting of plants that tolerate saltiness. Indeed, as confirmed by Soni et al. [41], who conducted a study in a saline-deficit water irrigation agroecosystem, mulching and zero tillage (ZT) effectively reduce soil salinity, increase the availability of organic substrate, and improve soil health for higher biological activity without affecting the productivity of the crop system. Moreover, mulching treatment with a daily drip irrigation regime can be considered a suitable treatment in arid regions to reduce water losses, enrich soil water content within the flow domain, and avoid salt accumulation at the soil surface [42]. On one hand, the surface-applied mulch helped in producing favourable conditions for soil microbial activity during dry spells, being responsible for organic matter decomposition and the mineralisation of N, P, and K associated with soil organic matter. Further, the decomposition of organic mulch also promoted the natural leaching of soluble salts from the root zone, mineralisation, and the release of nutrients. On the other hand, zero tillage is also effective in improving soil fertility, restoring soil organic carbon and structure, and reducing soil evaporation and salinity. Because of relatively decreased soil salinity in ZT compared to CT and reduced tillage (RT), ZT showed a greater soil health index (SHI) than conventional tillage (CT) [41].

Planting salt-tolerant crops is another adaptation strategy farmers use. Indeed, as confirmed by Brunner [43], salt-tolerant crops in salty soils would help save water.

However, the most mentioned adaptation strategy adopted by farmers is increasing irrigation. In this regard, it should be highlighted that the water used is mainly groundwater, which is ever more subjected to sea water intrusions. The excessive pumping of groundwater, associated with the lack of natural recharge, has exacerbated the SWI problem in arid and semi-arid regions [44]. Increasing irrigation may not be the optimal solution to reduce soil salinity. Indeed, "saline" groundwater discharge activates, among others, soil processes of oxidation and salinisation, which cause the soils to lose structure and fertility, as reported by Salama et al. [45]. Moreover, water irrigation should always be complemented by increased SOC for sustainable water-efficient agriculture, as argued by Lal [46]. Namely, Lal [46] demonstrated that (i) in soils with high organic matter, the irrigation amount and frequency can be reduced; (ii) restoring soil organic matter content increases soil water retention and plant available water capacity in the root zone; and (iii) high soil organic matter in the root zone increases resilience to short dry spells. Moreover, soil organic matter content suppresses evaporation losses, thus maintaining the moisture within the soil.

Some farmers also observed the risks of soils in dry periods, and upward movements of saline groundwater, which, combined with the evaporation of applied irrigation water, may result in the formation of an ever more saline soil, as also supported by Allison [47]. In severe cases, salts may accumulate at the soil surface, with the total loss of production. To this, low permeability of the soil can be added, causing waterlogging, which may be due to a highly fine-textured condition of the soil to well below the root zone or to the presence of an impermeable barrier below the root zone, which was documented by several farmers using heavy machines.

5. Conclusions

Sant'Erasmo and Vignole islands are characterised by a diverse, polycultural landscape maintained through low-input farming systems, which have managed to avoid the oversimplification common in many modern agricultural landscapes. However, while some farmers demonstrated a significant awareness of sustainable agricultural practices, many still rely on unsustainable methods, including heavy mechanisation and the use of synthetic inputs. These practices combined with naturally high soil salinity, which is worsened by increasing droughts, contribute to soil degradation issues, such as erosion, compaction, impermeability, and elevated salinity levels.

The farmers generally perceived soil changes negatively, and some adaptation strategies—such as increased investment in irrigation to counteract salt upwelling—were not always sustainable. Our research indirectly highlighted the sustainability (or lack thereof) of these practices and strategies by assessing their theoretical potential to either protect or deplete natural resources.

It is important to note that our data and findings are based on farmers' narratives and perceptions, which may have been influenced by factors such as emotional status, time constraints, and accuracy in providing information. Therefore, further research should integrate quantitative soil assessments with these qualitative insights to provide a more comprehensive understanding. While qualitative methods can capture nuances that quantitative analysis may miss, the opposite is also true.

Combining quantitative soil analyses with narratives collected from local communities can strengthen our results and add objectivity to the research. Future studies could further explore the behavioural logic of small-scale farmers' agricultural practices and their adaptation strategies to soil change and how environmental changes, soil characteristics, and management methods influence farmers' choices, specific policy needs, and feasibility. Understanding farmers' attitudes and needs through a collaborative approach is crucial for participatory action research. Establishing a meaningful connection with small farmers will better support the development of effective and sustainable agricultural practices and adaptation strategies. In this regard, customised approaches that consider varying soil types will lead to more effective and lasting outcomes.

Author Contributions: Conceptualisation, T.F., J.P. and R.S.; methodology, R.S. and T.F.; formal analysis, T.F.; investigation, T.F.; data curation, T.F.; writing—original draft preparation, T.F. and J.P.; writing—review and editing, R.S., L.C., G.M. and R.K.; visualisation, T.F.; supervision, R.S. and J.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted following the Declaration of Helsinki and approved by the Ethics Committee of Ca' Foscari University of Venice (protocol code 3/2023 of 14 March 2023).

Data Availability Statement: The data are unavailable due to privacy restrictions.

Acknowledgments: We heartfully thank the farmers who dedicated their time and effort to share their precious local knowledge with us.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

FAO—Food and Agriculture Organization of the United Nations; ISCED—International Standard Classification of Education; SOC—soil organic carbon; NT—no-till; C—carbon; MT—mechanical tillage; CT—conventional tillage; ZT—zero tillage; Cu—copper; ACP—agroecological crop protection; N—nitrogen; P—phosphorus; K—potassium; SHI—soil health index; RT—reduced tillage; MPs—microplastics; PLA—poly(lactic acid); PPC—polypropylene carbonate; SWI—seawater intrusion.

References

1. Falcão, R.N.; Vrana, M.; Hudek, C.; Pittarello, M.; Zavattaro, L.; Moretti, B.; Strauss, P.; Liebhard, G.; Li, Y.; Zhang, X.; et al. Farmers' perception of soil health: The use of quality data and its implication for farm management. *Soil Use Manag.* **2024**, *40*, 13023. [CrossRef]
2. De Souza Mello Bicalho, A.M.; Trippia dos Guimarães Peixoto, R. Farmer and scientific knowledge of soil quality: A social ecological soil systems approach. *Belgeo* **2016**, *4*, 1–21. [CrossRef]
3. FAO (The Food and Agriculture Organization of the United Nations). *Soil Degradation: A Major Threat to Humanity*; FAO: Bristol, UK, 2015. Available online: https://assets.fsnforum.fao.org/public/discussions/contributions/Soil-degradation-Final-final_0.pdf (accessed on 3 November 2024).
4. Petrescu-Mag, R.M.; Petrescu, D.C.; Azadi, H. A Social Perspective on Soil Functions and Quality Improvement: Romanian Farmers' Perceptions. *Geoderma* **2020**, *380*, 114573. [CrossRef]
5. Paoletti, M.G.; Boscolo, P.; Sommaggio, D. Beneficial insects in fields surrounded by hedgerows in northeastern Italy. *Biol. Agric. Hortic.* **1997**, *15*, 310–323. [CrossRef]
6. Rehman, A.; Farooq, M.; Lee, D.J.; Siddique, K.H. Sustainable agricultural practices for food security and ecosystem services. *Environ. Sci. Pollut. Res. Int.* **2022**, *29*, 84076–84095. [CrossRef]
7. Önder, M.; Ceyhan, E.; Kahraman, A. Effects of agricultural practices on environment. *Biol. Environ. Chem.* **2011**, *24*, 28–32.
8. Dominati, E.; Patterson, M.; Mackay, A. A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecol. Econ.* **2010**, *69*, 1858–1868. [CrossRef]
9. Rist, S.; Wiesmann, U.; San Martin, J.; Delgado, F. From scientific monoculture to intra- and intercultural dialogue–endogenous development in a North-South perspective. In *Moving Worldviews. Reshaping Sciences, Policies and Practices for Endogenous Sustainable Development*; Haverkort, B., Reijntjes, C., Eds.; Compas Series on Worldviews and Sciences 4; ETC/COMPAS: Leusden, The Netherlands, 2006; pp. 320–339.
10. Cameron, L. Indigenous Ecological Knowledge Systems—Exploring Sensory Narratives. *Ecol. Manag. Restor.* **2022**, *23*, 27–32. [CrossRef]
11. Gadgil, M.; Olsson, P.; Berkes, F.; Folke, C. Exploring the role of local ecological knowledge in ecosystem management: Three case studies. In *Navigating Social-Ecological System: Building Resilience for Complexity and Changes*; Berkes, F., Colding, J., Folke, C., Eds.; Cambridge University Press: Cambridge, UK, 2003; pp. 189–209.
12. Rist, S.; Dahdouh-Guebas, F. Ethnosciences—-A step towards the integration of scientific and indigenous forms of knowledge in the management of natural resources for the future. *Environ. Dev. Sustain.* **2008**, *8*, 467–493. [CrossRef]
13. Conte, L.; Prakofjewa, J.; Floridia, T.; Stocco, A.; Comar, V.; Gonella, F.; Lo Cascio, M. Learning from farmers on potentials and limits for an agroecological transition: A participatory action research in Western Sicily. *Front. Environ. Sci.* **2024**, *12*, 1347915. [CrossRef]
14. Schneider, S.H.; Semenov, S.; Patwardhan, A.; Burton, I.; Magadza, C.H.D.; Oppenheimer, M.; Pittock, A.B.; Rahman, A.; Smith, J.B.; Suarez, A.; et al. Assessing key vulnerabilities and the risk from climate change. In *Climate Change 2007: Impacts, Adaptation and Vulnerability*; Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change; Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E., Eds.; Cambridge University Press: Cambridge, UK, 2007; pp. 779–810.
15. Carminati, E.; Martinelli, G. Subsidence rates in the Po Plain, northern Italy: The relative impact of natural and anthropogenic causation. *Eng. Geol.* **2002**, *66*, 241–255. [CrossRef]
16. Özgen, N. A qualitative research on perception of geography by training teachers of geography: Sample of Turkey. *High. Educ. Soc. Sci.* **2013**, *5*, 25–34.
17. Karltun, E.; Lemenih, M.; Tolera, M. Comparing farmers' perception of soil fertility change with soil properties and crop performance in Beseku, Ethiopia. *Land Degrad. Dev.* **2011**, *24*, 228–235. [CrossRef]

18. Solidoro, C.; Bandelj, V.; Bernardi, F.A.; Camatti, E.; Ciavatta, S.; Cossarini, G.; Facca, C.; Franzoi, P.; Libralato, S.; Canu, D.M.; et al. Response of Venice Lagoon Ecosystem to Natural and Anthropogenic Pressures over the Last 50 Years. In *Coastal Lagoons: Systems of Natural and Anthropogenic Change*; CRC Press: Boca Raton, FL, USA; Taylor and Francis: Abingdon, UK, 2010; pp. 483–511.
19. Donnici, S.; Serandrei-Barbero, R.; Canali, G. Evidence of climatic changes in the Venetian Coastal Plain (Northern Italy) during the last 40,000 years. *Sediment. Geol.* **2012**, *281*, 139–150. [CrossRef]
20. Washa, M.; Nadimi-Goki, M.; Gallo, A.; Cabianca, C.; Bini, C. Submerged pedology: The soils of minor islands in the Venice lagoon. *EQA Int. J. Environ. Qual.* **2015**, *18*, 1–9.
21. Grydehøj, A.; Casagrande, M. Islands of connectivity: Archipelago relationality and transport infrastructure in Venice Lagoon. *Area* **2020**, *52*, 56–64. [CrossRef]
22. Laghetti, G.; Miceli, F.; Cifarelli, S.; Hammer, K. Collection of crop genetic resources in Italy. *Plant Genet. Resour. Newsl.* **2007**, *152*, 82–87.
23. ISCED. International Standard Classification of Education ISCED 2011. 2012. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_Standard_Classification_of_Education_(ISCED)#Implementation_of_ISCED_2011_.28levels_of_education.29 (accessed on 12 March 2024).
24. European Commission. Pesticides—European Commission—Food Safety. Available online: https://food.ec.europa.eu/plants/pesticides (accessed on 13 September 2024).
25. Trebbi, G.; Negri, L.; Bosi, S.; Dinelli, G.; Cozzo, R.; Marotti, I. Evaluation of *Equisetum arvense* (Horsetail Macerate) as a Copper Substitute for Pathogen Management in Field-Grown Organic Tomato and Durum Wheat Cultivations. *Agriculture* **2020**, *11*, 5. [CrossRef]
26. Krebs, J.; Bach, S. Permaculture-Scientific Evidence of Principles for the Agroecological Design of Farming Systems. *Sustainability* **2018**, *10*, 3218. [CrossRef]
27. Clem, C.S.; Harmon-Threatt, A.N. Field borders provide winter refuge for beneficial predators and parasitoids: A case study on organic farms. *J. Insect Sci.* **2021**, *21*, 2. [CrossRef]
28. Brunelle, T.; Chakir, R.; Carpentier, A.; Dorin, B.; Goll, D.; Guilpart, N.; Maggi, F.; Makowski, D.; Nesme, T.; Roosen, J.; et al. Reducing chemical inputs in agriculture requires a system change. *Commun. Earth Environ.* **2024**, *5*, 369. [CrossRef]
29. Benincasa, P.; Tosti, G.; Guiducci, M.; Farneselli, M.; Tei, F. Crop rotation as a system approach for soil fertility management in vegetables. In *Advances in Research on Fertilization Management of Vegetable Crops*; Springer: Cham, Switzerland, 2017; pp. 115–148.
30. Abad, J.; Hermoso De Mendoza, I.; Marín, D.; Orcaray, L.; Santesteban, L.G. Cover crops in viticulture. A systematic review (1): Implications on soil characteristics and biodiversity in vineyard. *OENO One* **2021**, *55*, 295–312. [CrossRef]
31. Finney, D.M.; White, C.M.; Kaye, J.P. Biomass production and carbon/nitrogen ratio influence ecosystem services from cover crop mixtures. *Agron. J.* **2016**, *108*, 39. [CrossRef]
32. El-Beltagi, H.S.; Basit, A.; Mohamed, H.I.; Ali, I.; Ullah, S.; Kamel, E.A.; Shalaby, T.A.; Ramadan, K.M.; Alkhateeb, A.A.; Ghazzawy, H.S. Mulching as a Sustainable Water and Soil Saving Practice in Agriculture: A Review. *Agronomy* **2022**, *12*, 1881. [CrossRef]
33. Mkomwa, S.; Kaumbutho, P.; Makungu, P. Farm Machinery for Conservation Agriculture. In *Conservation Agriculture*; Farooq, M., Siddique, K.H.M., Eds.; Springer International Publishing: Berlin/Heidelberg, Germany, 2015; pp. 109–131.
34. Pradel, A.; Gautier, M.; Bavay, D.; Gigault, J. Micro- and nanoplastic transfer in freezing saltwater: Implications for their fate in polar waters. *Environ. Sci. Process. Impacts* **2021**, *23*, 1759–1770. [CrossRef]
35. Gigault, J.; El Hadri, H.; Nguyen, B.; Grassl, B.; Rowenczyk, L.; Tufenkji, N.; Feng, S.Y.; Wiesner, M. Nanoplastics are neither microplastics nor engineered nanoparticles. *Nat. Nanotechnol.* **2021**, *16*, 501–507. [CrossRef]
36. Zhou, J.; Jia, R.; Brown, R.W.; Yang, Y.; Zeng, Z.; Jones, D.L.; Zang, H. The long-term uncertainty of biodegradable mulch film residues and associated microplastics pollution on plant-soil health. *J. Hazard. Mater.* **2023**, *442*, 130055. [CrossRef]
37. Nawaz, A.; Lal, R.; Shrestha, R.K.; Farooq, M. Mulching Affects Soil Properties and Greenhouse Gas Emissions Under Long-Term No-Till and Plough-Till Systems in Alfisol of Central Ohio. *Land Degrad. Dev.* **2016**, *28*, 673–681. [CrossRef]
38. Pagliai, M.; Vignozzi, N.; Pellegrini, S. Soil structure and the effect of management practices. *Soil Tillage Res.* **2004**, *79*, 131–143. [CrossRef]
39. Sheibani, S.; Ahangar, A.G. Effect of tillage on soil biodiversity. *J. Nov. Appl. Sci.* **2013**, *2*, 273–281.
40. Shah, A.N.; Tanveer, M.; Shahzad, B.; Yang, G.; Fahad, S.; Ali, S.; Bukhari, M.A.; Tung, S.A.; Hafeez, A.; Souliyanonh, B. Soil compaction effects on soil health and crop productivity: An overview. *Environ. Sci. Pollut. Res.* **2017**, *24*, 10056–10067. [CrossRef]
41. Soni, P.G.; Basak, N.; Rai, A.K.; Sundha, P.; Narjary, B.; Kumar, P.; Yadav, G.; Kumar, S.; Yadav, R.K. Deficit Saline Water Irrigation under Reduced Tillage and Residue Mulch Improves Soil Health in Sorghum-Wheat Cropping System in Semi-Arid Region. *Sci. Rep.* **2021**, *11*, 1880. [CrossRef]
42. Han, D.M.; Zhou, T.T. Soil water movement in the unsaturated zone of an inland arid region: Mulched drip irrigation experiment. *J. Hydrol.* **2018**, *559*, 13–29. [CrossRef]
43. Brunner, P.A. Water and Salt Management in the Yanqi Basin, China. Ph.D. Thesis, ETH Zurich, Valendas, Switzerland, 2005.
44. Hussain, M.S.; Abd-Elhamid, H.F.; Javadi, A.A.; Sherif, M.M. Management of Seawater Intrusion in Coastal Aquifers: A Review. *Water* **2019**, *11*, 2467. [CrossRef]
45. Salama, R.B.; Otto, C.J.; Fitzpatrick, R.W. Contributions of groundwater conditions to soil and water salinisation. *Hydrogeol. J.* **1999**, *7*, 46–64. [CrossRef]

46. Lal, R. Regenerative agriculture for food and climate. *J. Soil Water Conserv.* **2020**, *75*, 123A–124A. [CrossRef]
47. Allison, L.E. Salinity in relation to irrigation. *Adv. Agron.* **1964**, *16*, 139–180.