Ecosystem Restoration and Agriculture—Putting Strong Sustainability into Practice

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1. Introduction

Although it is undisputed that agriculture is essential for supplying people with food and plant-based resources, today it is one of the most important causes of global environmental problems. The worldwide loss of biodiversity, deforestation, soil erosion, soil salinization, eutrophication of soils and water, and the contamination of soils and water with persistent pesticides are no longer a local problem in agricultural regions but have reached global dimensions (EEA 2016; Tilman et al. 2001; Springmann et al. 2018; IPBES 2019). Along the gradient of extensive towards intensive agriculture, large-scale monocultures in particular, with a high input of fertilizer and pesticides in order to gain maximum yields, are responsible for land degradation and the loss of ecosystem services (Benton et al. 2003; Tscharntke et al. 2005; Olsson et al. 2019).

Ecosystem degradation caused by intensive and unsustainable agriculture is not only a problem for species and habitat conservation and resource protection, respectively, but it can also have significant negative socio-economic impact and is increasingly proven by appropriate studies. For example, Pretty et al. (2003) provided a cost balance for England and Wales on the eutrophication of ecosystems and landscapes, in particular due to intensive agriculture. In their study, they took into account damage to humans and the environment and the associated costs of environmental policy. The costs include, for example, the depreciation of water-related dwellings; the purification of eutrophic water to drinking water quality by the removal of nitrogen, algae toxins, and toxic degradation products; and the depreciation of surface waters for recreation and tourism. Overall, the authors estimate the damage associated with eutrophication of terrestrial and surface waters at 105–160 million USD and the costs of environmental measures and policy, respectively, at 77 million USD per year. The findings of Pretty et al. (2003) indicate the severe effects of nutrient enrichment and eutrophication and that the damage costs are substantial, causing considerable loss of value to many stakeholders in the U.K. Accordingly, the polluters (farmers) do not pay for the damage costs, and these are externalized to society.

Against this background, new approaches in agriculture have to be developed to meet the need for ecological sustainability. The restoration of degraded ecosystems has become a challenge for our societies in the 21st century in order to restore ecosystem services. Walder (2018) rightly states that ecosystem restoration is "one of the most important steps we can take to ensure that people can continue to survive, and thrive, on Planet Earth". In 2019, the United Nations General Assembly declared 2021–2030 the UN Decade on Ecosystem Restoration, thus putting restoration on the global environmental agenda.

All approaches in agriculture that meet the Sustainable Development Goals (SDGs), introduced by the United Nations (UN 2019), should be considered as potential solutions to the global environmental crisis. Ecosystem restoration, in principle, can directly or indirectly contribute to all 17 SDGs with regard to ecological as well as socioeconomic aspects. However, SDG 15 explicitly addresses ecosystem restoration as it states to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (UN 2019). In this chapter, agroforestry systems and social agriculture are discussed as an approach for sustainable land use and ecosystem restoration. The geographic focus will be on Central Europe and, in particular, the mountain areas of the European Alps. These approaches will be discussed on the basis of the principles of ecosystem restoration and strong sustainability. They contribute to the restoration of natural as well as financial, human, and social capital, enhance the multifunctionality of landscapes, and might also prevent or reverse the abandonment of traditional cultural landscapes.

2. Ecosystem Restoration and Strong Sustainability

The international Society for Ecological Restoration (SER) defines ecological restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (Clewell et al. 2002). This rather broad and unspecific definition was specified by Zerbe et al. (2009) by focusing on the restoration of ecosystem services and structure against the background of the current ecological and socio-economic conditions. As measures are increasingly applied in the name of "ecosystem restoration" that have led to land degradation, such as, for example, controlled burning, topsoil removal, or the application of pesticides, Zerbe and Konrad (2021) calls for ethical standards in the practice of ecosystem restoration.

In order to assist this recovery of degraded, damaged, or destroyed ecosystems or land-use systems, a broad set of measures are applied, which range from doing nothing (i.e., passive restoration; e.g., Prach and Pyšek 2001; Moral et al. 2007; Prach

and Hobbs 2008) up to comprehensive technological measures, often adapted from ecological engineering, for example for the restoration of natural river or coast dynamics by opening or removing dykes (e.g., Roman and Burdick 2012) or changing the hydro-morphology of rivers (e.g., Darby and Sear 2008). Restoration measures also comprise well-known agricultural practices (e.g., mowing, grazing) as well as the practice of habitat management for nature conservation purposes (Zerbe 2019a).

Although the concept of sustainability is increasingly watered down and also overused and abused for non-sustainable action (Ott 2010, p. 164, states "linguistic inflation"), it sets a clear guiding principle for global human society with careful reference to definition and content. Leading the way in global and national environmental policy, the term "sustainability" was coined in 1987 by the so-called "Brundtland Commission" for all land uses and land development (Ott 2010). Development is considered sustainable if it "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). This anchors the principle that people have the right to permanently satisfy their basic needs. Since the environmental conference in Rio de Janeiro in 1992, the idea of sustainable development has been one of the guiding principles of environmental and development policy and has been incorporated into countless documents and statements. As guidance for a global environmental policy, the UN (2019) has formulated 17 Sustainable Development Goals (SDGs).

Following the paradigm that sustainability encompasses the three pillars of ecology, economics, and social affairs ("triple bottom line"), it can be operationalized through capital. Capital, borrowed as an economic term, comprises the physical or natural (e.g., agricultural land), social (e.g., institutions, administrations), human (e.g., education), and knowledge capital (Döring 2004; see also Cirella and Zerbe 2015). Conceptually, a distinction is made between weak and strong sustainability (Neumayer 2003; Daly 2006; Ott and Döring 2007). The main difference between the two concepts lies in the assessment of the substitution possibilities of natural capital. In the concept of strong sustainability, natural capital should be kept constant for future generations (Constant Natural Capital Rule, Costanza and Daly 1992; Daly 1997), whereas in the case of weak sustainability natural capital can, on principle, be indefinitely substituted by other capitals so that utility per capita is not decreasing. With the concept of strong sustainability, natural capital and, thus, also the restoration of ecosystems play particular roles, namely when natural capital can be renewed with the restoration of ecosystems (Aronson et al. 2007; Crossman and Bryan 2009; Gradinaru 2014). For example, Döring (2004) sees investments in natural capital in the restoration of soil fertility, erosion control, the development of near-natural forests,

the restoration of fish stocks, the restoration of flowing waters, and the improvement of groundwater quality (see also Döring 2009). Ecosystem restoration, thus, has a direct relation to the sustainable development of nature, environment, and land use and, accordingly, becomes crucial for SDG 15.

3. Combining Tradition with Innovation on Agricultural Land

From the viewpoint of private benefits, extensive traditional agricultural land-use systems may not be able to compete with intensive agricultural land-use systems (e.g., large-scale monocultures with a high input of fertilizer and pesticides). However, by taking all ecosystem services into account and also by balancing costs and benefits not only on the farm but also on the macroeconomic level (e.g., through externalities, negative impact on natural resources), extensive agriculture might turn out to have more benefits for society than intensive agriculture (cp. Oltmer and Nijkamp 2005; Daujanov et al. 2016). Additionally, the restoration of natural capital on agricultural land contributes to sustainability in the medium and long term.

It has been proven by many studies that, in particular, traditional and extensive agricultural land-use systems in Central Europe contribute largely to the biodiversity of our cultural landscapes (Finck et al. 2017; Zerbe 2019a). Additionally, these land-use systems might contribute positively to the socio-economy of a given region. This has been shown, for example, for the nature conservation area of the Lüneburg Heath, a remnant of the heathland formerly widespread in Northern Germany (Härdtle et al. 2009). Tourism is the strongest economic activity in this particular German lowland region with a gross turnover of 1.2 billion euros, more than 32,000 people employed in tourism, income from tourism of approx. 650 million euros, and more than 5 million overnight stays per year (IHK 2016).

In the following, two approaches in agriculture are suggested that

1) can support the restoration of ecosystem services on degraded agricultural land,
2) can contribute to the revitalization of abandoned land in remote areas,
3) can enhance the multifunctionality of cultural landscapes, and/or
4) can integrate ecosystem with social services.

Thus, agroforestry systems and social agriculture are discussed by focusing on their benefits to nature and society.

3.1. Agroforestry Systems

The Food and Agriculture Organization (FAO 2015) defines agroforestry systems as "a collective name for land-use systems and technologies where woody

perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence". Agroforestry can also be defined as "a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels" (FAO 2015).

Three main types of agroforestry systems can be differentiated:

- agrisilvicultural systems are a combination of crops and trees, such as alley cropping or home gardens;
- silvopastoral systems combine forestry and grazing of domesticated animals on pastures, rangelands, or on-farm; and
- the three elements, namely trees, animals and crops, can be integrated in what are called agrosylvopastoral systems and are illustrated by home gardens involving animals as well as scattered trees on croplands used for grazing after harvests.

Agroforestry systems are widespread in the tropics and subtropics, either as traditional types of land use or for intensive agricultural production (e.g., Atangana et al. 2014; Montagnini 2006; Nair and Garrity 2012). However, only relics of traditional land-use systems exist in Central Europe today. For example, extensive orchards are a traditional, multifunctional agroforestry system (Herzog 1998), which is common in the lowlands and the low mountain ranges. Fruit (and timber) is produced on the one hand, and on the other hand it is possible to use the grassland as a meadow or pasture due to the loosely scattered fruit trees (Lucke et al. 1992), often associated with beekeeping (Kornprobst 1994; Traynor 2006). Table 1 shows such traditional agroforestry systems as were once used in Europe. The diverse and multifunctional agroforestry systems in the Mediterranean region that are still used today should not go unmentioned (e.g., Rigueiro-Rodríguez et al. 2009).

Table 1. Traditional agroforestry systems in Europe (compilation from Zerbe 2019b).

Agroforestry System	Examples of Occurrence	Agricultural Component	Forestry Component	Production Service	References
Orchard (in German *Streuobstwiese*)	In the lowlands and lower mountain areas, e.g., in the Oberes Gäu (SW Germany), the Spessart, and Upper Austria	Meadows and pastures; traditionally also arable land	Mostly apple (*Malus domestica*), pears (*Pyrus communis*), plums (*Prunus domestica* s. l.) or cherries (*Prunus avium*, *P. cerasus*)	Fruit and their processed products (e.g., juice), fodder for animals, timber, grain, honey	Herzog (1998), Küster (2010)
Chestnut grove	In many areas of Europe, closely linked to viticulture, e.g., in South Tyrol, in the Austrian Burgenland, and in southwestern Germany	Meadows and pastures	Sweet chestnut (*Castanea sativa*)	Chestnuts and their processed products (e.g., flour, beer), fodder for animals, timber, honey	Conedera et al. (2004a, 2004b)
Larch meadows/pastures	Alps, in particular, in South Tyrol and Switzerland	Meadows and pastures	Larch (*Larix decidua*)	Fodder for animals, timber, larch resin and oil, respectively	Fontana et al. (2013, 2014), Zerbe (2019b)
Tree meadow (in German *Baumwiese*)	East and Northern Europe, Alps	Meadows and pastures	Maple (*Acer pseudoplatanus*), ash (*Fraxinus excelsior*), linden (*Tilia cordata*), and other tree species	Fodder for animals, leaved branches as litter for stalls, timber, honey	Hæggström (1983), Aavik et al. (2008); Kull et al. (2003)
Forest pasture	Widespread in Europe, in particular in Southern Europe	Pasture	Mainly oaks (*Quercus* spec.), also other light demanding tree species	Fodder for animals, timber, tanning agent, honey	Bergmeier et al. (2010), Küster (2010)
Grazed vineyards (*vitipasture*)	South East and Central Europa	Pasture with sheep	Wine (*Vitis vinifera*)	Grapes and wine, respectively; fodder for sheep	Wallis De Vries et al. (2010); Francaviglia et al. (2014)
Walnut fields	France, Netherlands	Arable fields with, e.g., grain and other crops	Walnut (*Juglans regia*)	Walnuts and their processed products (e.g., flour), crops (e.g., grain)	Graves et al. (2007), Rigueiro-Rodríguez et al. (2009)

In the Alps in the montane mountain forest belt between about 1000 and 2000 m above sea level, the European larch (*Larix decidua*) occurs in meadows and pastures, thus forming a traditional agroforestry system. This land-use system that has combined agricultural use with timber production on the same area since the Bronze Age (Gobet et al. 2004) is still found today in Switzerland (Burga 1987), in Austria (Blassnig 2012; Tiefenbach et al. 1998), as well as in North Italy in the Provinces of Trento (Giovannini 2017) and South Tyrol (Fontana et al. 2014). Today, they occur in particular in South Tyrol with the largest larch meadow in Europe on the high plateau of the Tschögglberg north of the city of Bolzano (Figure 1). While the grassland is used as a meadow or pasture, the larches with their summer green needle litter contribute to soil improvement, and the trees can be used as timber. The larch, together with the common yew (*Taxus baccata*), yields the heaviest and hardest timber (Grosser and

Ehmcke 2012). Due to the weather resistance of larch wood, it is an important timber for construction in the mountain areas of the Alps. Larch resin has traditionally been used to make turpentine as a component of folk and veterinary medicine. Larch oil is used today in paints and adhesives and for the production of cosmetic products. The overall ecosystem services of these larch meadows and pastures are given in Table 2.

Figure 1. Larch meadow or pasture on the Tschögglberg near the village of Jenesien in South Tyrol in the spring (Zerbe 2019b).

Table 2. Ecosystem services of larch meadows and pastures (Zerbe 2019b with categorization of ecosystem services according to MEA 2005).

Category	Ecosystem Services of Larch Meadows and Pastures
Provision	Fodder for animals, medical and spice plants, timber for buildings and furniture, firewood, resin, oil, needle litter as natural fertilizer, drinking water
Regulation	Erosion and rockfall protection at slopes, carbon sequestration in above- and belowground biomass and organic soil layer, habitats for plants and animals, water purification
Cultural services	Recreation and tourism, environmental education, environmental research, aesthetics and inspiration for art, identification with home range, bioindication (e.g., with lichens), mythology
Supporting services	Primary production (wood and litter), nutrient cycling, soil formation in the Alpine environment

Today, this traditional land-use system of larch meadow/pasture is under threat of two divergent developments (Fontana et al. 2013; Nagler et al. 2015). On the one hand, farmers intensify land use by cutting the larch trees and transform the agroforestry system into a high-input grassland; on the other hand, the extensive agroforestry system is abandoned. As soon as its abandoned, natural succession leads to the development of a forest with a subsequent loss of biodiversity (Pornaro et al. 2013).

3.2. Social Agriculture

Social agriculture, also known as Social Farming, Green Care, or Care Farming, means all agricultural practices aimed at promoting the rehabilitation, education, health, and integration of various target groups such as, for example, children, elderly people, disabled people, former prisoners, and migrants; this includes pedagogical and nursing services in rural areas, especially for infants and seniors (Di Iacovo and O'Connor 2009; Limbrunner and van Elsen 2013). Historically, farms have always used agricultural labor as an instrument of solidarity, self-support, and social inclusion by providing work for family members of all generations and also including family members with physical or mental disabilities into everyday farm life. Accordingly, social agriculture is a traditional agro-social concept (Di Iacovo and O'Connor 2009), which today is revitalized or institutionalized under different socio-economic conditions (European Communities 2010).

Today, social agriculture is performed by multifunctional agricultural and/or forestry or horticultural enterprises, social cooperatives, or facilities of the public sector that enable people with special needs to develop their own skills and abilities through working with plants, animals, and nature (Di Iacovo et al. 2014; García-Llorente et al. 2016; Nicli et al. 2020). With this kind of cooperation, crafts and social skills should be gained or a recovery process supported. Accordingly, the added value of social agriculture lies not only in the generation of jobs, agricultural production, and health services, but in particular in social inclusion, prevention, education, and improving the quality of life (Di Iacovo and O'Connor 2009; Wiesinger et al. 2013).

Within an interdisciplinary research project on social agriculture in the Southern Alps and adjacent regions, a survey of 22 farms was conducted (Nicli et al. 2020). Semi-structured interviews were carried out to explore whether and how the practice of social farming also met ecological sustainability. We found that all initiatives of social agriculture met the hereby applied criteria for ecological sustainability: (1) organic or ecological farming; (2) activities for nature, resource, and/or cultural landscape protection; and (3) education for sustainable development

and environmental education, respectively (Table 3). Those farms which met all three criteria can be considered as best practice for eco-social farming such as, for example, Terre Altre, La Capra Felice, La Pachamama, Santer Farm, and Peintner Farm.

Table 3. Engagement of 22 initiatives of social agriculture, studied in the Southern Alps and adjacent regions, for nature, environmental, and resource protection, respectively; criteria applied are (1) organic or ecological farming; (2) activities for nature, resource and/or cultural landscape protection; and (3) education for sustainable development and environmental education, respectively (based on data from Nicli et al. 2020).

No.	Initiative, Project	Criteria 1	Criteria 2	Criteria 3	Explanation and Specification
1.	Villa Rizzi	x	-	-	Organically certified cultivation of 45 different medicinal herbs and herbs for cooking as well as vegetables
2.	Terre Altre	x	x	x	Biodynamic cultivation of local cereals, fruits, and vegetables, fiber and medicinal plants; beekeeping; preservation of traditional agriculture; various events and courses on biological farming; environmental education and school garden for vegetable cultivation
3.	Cooperativa Samuele	x	-	-	Organically certified viticulture, fruit and vegetable cultivation; beekeeping
4.	La Capra Felice	x	x	x	Certified organic animal husbandry of a domestic goat breed for milk and cheese production; egg-laying hens; vegetables; management of the traditional cultural landscape through grazing; educational offers for school classes
5.	Consorzio delle Valli e Dolomiti Friulane	pt [1]	x	-	Includes 25 small farms; own flock of sheep for milk and meat production; preservation of the cultural landscape and agricultural infrastructure; preservation of local sheep breed
6.	Cadore SCS	x	x	-	Organic cultivation of the Alpine artichoke; landscape management in the alpine mountain range
7.	La Pachamama	x	x	x	Organically certified vegetable, fruit, olive, vine and cereal cultivation; beekeeping; cultivation of old cereal varieties; school at the farm, guided mountain excursions; courses on organic agriculture
8.	Conca d'oro	x	x	-	Organically certified cultivation of vegetables, cereals, fruits and olives; restoration of the traditional cultural landscape
9.	La Costa	x	-	-	Organically certified viticulture and cultivation of vegetables; use of renewable energies
10.	School at the farm	pt [1]	-	x	Consortium of 30 farms with various offers for environmental education and nature experience
11.	Initiative *Mit Bäuerinnen lernen-wachsen-leben*	pt [1]	-	x	Care for children with 120 nannies; employment of senior citizens on the farms; leisure activities in nature and on the farm
12.	Santer Farm	x	x	x	Organically certified apple and vine production; animal husbandry (pigs, goats, chicken, and sheep); school at the farm

Table 3. *Cont.*

No.	Initiative, Project	Criteria 1	Criteria 2	Criteria 3	Explanation and Specification
13.	Vintler Farm	x	-	-	Organically certified vegetable and cereal cultivation; beekeeping; animal husbandry with donkeys and poultry
14.	Vinterra	x	-	-	Biologically certified cultivation of more than 30 different cereals and vegetables
15.	Valentin Farm	x	-	-	Organically certified cultivation of about 60 different apple, berry, and vegetable varieties
16.	Sägemüller Farm	x	x	-	Biodynamically certified (Demeter) farm; cultivation of vegetables, cereals, and potatoes; preservation of endangered cattle breed; restoration of agricultural land after gravel mining
17.	Salewa Garden	x	-	-	Urban agriculture based on the concept of permaculture
18.	Orti Semirurali	pt[1]	-	x	Urban subsistence gardens; beekeeping; events on the concept of sustainability for schools and members
19.	Initiative *Alm-Erleben*	x	-	x	Organic cannabis, saffron, lupine, and poppy production; various pedagogical offers
20.	Peintner Farm	x	x	x	Organic agriculture; animal husbandry of local livestock breeds; seminars on a sustainable and healthy lifestyle
21.	Initiative *Heimstätte Birkenhof*	x	x	-	Biodynamically certified (Demeter) agriculture; cultivation of cereals and vegetables; egg-laying hens; animal husbandry with cows, donkeys, and local animal breeds
22.	Ecological Farm Attendorf	x	-	-	Organic certified cultivation of fruit, vegetable, and medicinal herbs with about 55 different varieties

[1] pt = partly biological, which means not all members are certified organic farms.

4. Discussion

Additional to the overall benefits for society and the manifold ecosystem services they provide, agroforestry systems and social agriculture can considerably contribute to ecosystem restoration. When taking the whole range of ecosystem services into account, these approaches might have a better cost–benefit balance than conventional agricultural systems. For the example of larch meadows in the Alps, two currently occurring developments, the intensification as well as abandonment of larch meadows, were compared. These divergent developments were compared, with respect to their ecosystem services, with existing larch meadows on the basis of interviews with actors and experts and with the help of a multicriteria decision analysis (Fontana et al. 2013). In terms of production services, forest development was ranked highest. Nevertheless, the larch meadows were ranked highest in terms of their cultural and historical importance, biodiversity, aesthetics, and their regulatory capacities (e.g., carbon storage, water balance). In general, traditional agroforestry systems seem to provide, from a qualitative point of view, more ecosystem services than pure

agricultural or forestry systems (Figure 2; see also Jose 2009; Schroth et al. 2004). The FAO (2015) highlights the advantages of multifunctional agroforestry systems, which diversify land use, bring social, economic, and nature conservation benefits, and promote sustainable regional development. Accordingly, the restoration of these systems becomes an option for land-use development as well as implementation of the SDGs and, in particular, SDG 15.

Up to now, there have been numerous successful examples from Central Europe and the Alps, which show that the preservation or restoration of traditional land-use systems such as orchards (e.g., Seehofer et al. 2014), heathlands (e.g., Keienburg and Prüter 2006), extensive grasslands (Jedicke et al. 2010), and traditional alpine farming (Blaschka 2015) can combine the objectives of environmental protection as well as the conservation of the cultural landscape with those of sustainable regional development to benefit local communities. Financial support for these initiatives is provided on various levels, from regional towards national and international (e.g., from the European Union) levels (see compilation by Zerbe 2019a).

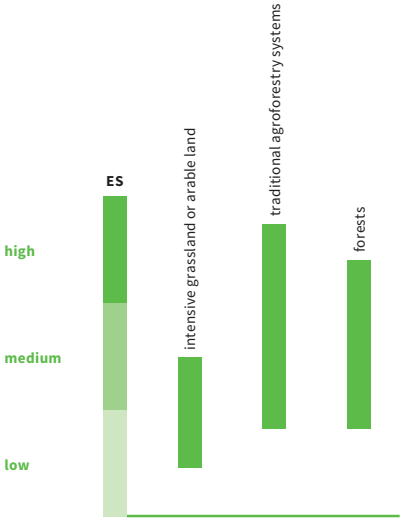

Figure 2. Comparison of the estimated relative number (low, medium, high) of ecosystem services (ES) of intensively managed grassland and arable land and forests with traditional agroforestry systems (Zerbe 2019b).

Our survey of social agriculture in the Alps and adjacent regions has shown that offering social services by farms is also related to responsibility and engagement in environmental services. Accordingly, the investigated farms performed organic

or biological agriculture, preserved manifold traditional varieties of agricultural crops, provided environmental education for various groups of people, contributed to management of the traditional cultural landscape, and promoted the diversity of species and habitats on their agricultural land. Some of these initiatives are also actively involved in ecosystem restoration projects (Table 3). Consequently, social agriculture becomes eco-social agriculture (Nicli et al. 2020).

In order to further develop the potential of eco-social agriculture from nature conservation as well as ecosystem restoration perspectives, cooperation between these initiatives (e.g., farms, farm associations, social enterprises) and regional and national agencies for nature conservation has to be promoted. For example, programs for the provision of social services could be linked with those for nature, environmental, and cultural landscape protection. Additionally, cooperation between local, regional, and national institutions must be strengthened by respective policy framework and funding opportunities. The European Union offers a wide range of subsidies (e.g., with the LIFE Program for Environmental Protection, Conservation and Climate Projects (van Elsen and Götz 2000), the European Regional Development Fund (ERDF), the Agricultural Fund for Rural Development 2014–2020 (EAFRD), and of the European Social Fund (ESF; RRN 2017)).

The Man and Biosphere Program, which was launched by UNESCO in 1971, is an intergovernmental scientific program that aims to establish a scientific basis for enhancing the relationship between people and their environments (UNESCO 2019). This program wants to improve human livelihood and safeguard natural and managed ecosystems. Accordingly, biosphere reserves all over the world can be considered as "real-world laboratories" (Zerbe et al. 2020) promoting innovative approaches to economic development that are socially and culturally appropriate and environmentally sustainable.

Case studies of agroforestry systems and social farming initiatives in the Alps and adjacent regions (Tables 2 and 3) should be considered as local contributions of agriculture to a global goal. Worldwide, agricultural lands constitute the largest "anthropogenic biome" (Ellis and Ramankutty 2008), occupying one-third of the global ice-free land area (Ramankutty et al. 2008). Agriculture is a major livelihood for 40% of the world's population. Twenty-five years ago, Daily (1995) stated that around 45% of the terrestrial land surface has a reduced capacity due to non-sustainable land use in the past. With ongoing forest clearing for agricultural land use, in particular in tropical countries, and continuous worldwide biodiversity loss (IPBES 2019) and increasing desertification (Mirzabaev et al. 2019), this situation has not become better in recent decades. Accordingly, agriculture plays a major role in contributing to the

SDG 15. Zerbe (2019a) has shown for the large variety of Central European land-use systems how restoration can be put into practice, comprising grassland, wetlands, forests, arable fields, heathland, rivers and lakes as well as urban environments.

5. Conclusion

The restoration of degraded agricultural land is a worldwide challenge and has to be strongly put forward in the next decade. Those approaches are promising from which the environment as well as the socio-economic systems will benefit. Agroforestry systems and eco-social agriculture are highlighted here because they can meet several objectives of sustainable land use and particularly the SDG 15:

- With both approaches, natural as well as social and economic capital can be restored, thus implementing strong sustainability. Ecosystem services can be coupled with social services on agricultural land.
- Both approaches positively contribute to biodiversity on the species, ecosystem and landscape level. Additionally, they promote agrobiodiversity, e.g., by (re-)introducing local animal breeds and local cultivars or crop varieties, respectively.
- Agroforestry as well as eco-social agriculture enhances the multifunctionality of cultural landscapes.
- The implementation of agroforestry on degraded land and the various environmental and social activities of eco-social agriculture can prevent or reverse land abandonment.

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